U.S. Bureau of Reclamation

Lower Umatilla River Basin

Shallow Groundwater Artificial Recharge Study

March 1990

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EXECUTIVE SUMMARY

This report discusses the potential for shallow groundwater recharge in the lower Umatilla River Basin and gives a phased plan of implementation for development of pilot-scale and full-scale recharge facilities. The primary purpose of shallow groundwater recharge will be to increase Umatilla River flows during low flow periods to aid migration of anadromous chinook salmon and steelhead trout.

Recharge would be accomplished by diverting winter river flows, in excess of minimum flow requirements, that would normally be lost to the Columbia River. In past years, these winter flows have averaged approximately 300,000 acre-feet annually. Flow augmentation would be achieved through either (1) natural return flow of recharged groundwater as baseflow to the Umatilla, (2) an exchange program in which surface water, which is normally diverted for irrigation, is held in McKay Reservoir for Umatilla flow augmentation while new groundwater supplies are pumped from wells to meet irrigation demands, or (3) direct pumping of groundwater to the river for flow augmentation.

The phased implementation plan involves the initial construction of a pilot project which should develop sufficient information and data to determine the feasibility of a full-scale recharge project. Following completion of the pilot project, an intermediate development phase will evaluate the data generated by the pilot project. The intermediate phase also will determine if additional data, beyond that obtained from the pilot study, is required prior to finalizing designs for full implementation. Using the phased plan allows for incremental decisions regarding economics, effectiveness, and possible alternatives for the full scale project without the associated risk of full capital outlay.

Potential for groundwater recharge is found in the Umatilla Basin in areas underlain by deposits of glaciofluviatile sands and gravels. These permeable sediments form a productive shallow aquifer which extends in an east-west trending band several miles wide from the Umatilla River, south of Hermiston, westward to and beyond the Umatilla-Morrow County line. Wells completed in this aquifer have high yields, often in excess of 1,000 gpm. A recharge project in the shallow aquifer is presently operating along the Umatilla-Morrow County line south of Ordnance. This project recharges an average of about 6,000 acre-feet per year to the shallow groundwater reservoir in that area.

As part of this study, several potential pilot recharge sites were selected and evaluated. Criteria used in selection of these sites included the following: the location of sites with respect to the shallow glaciofluviatile aquifer; the proximity of existing irrigation canals or other conveyance facilities; storage and return flow characteristics of the aquifer in the vicinity of the sites; and costs for development of the sites. Sites selected for evaluation included two gravel pits (the Highway I-82 site and the Highway 30 site) which would use water supplied by the Westland A-Line Canal, and expanding the volume of the existing county line recharge facility or construction of a new recharge canal using water from the B-Line Canal. The total potential recharge volume that could be achieved through development of these sites is approximately 16,000 acre-feet annually. The flow capacity of the A-Line and B-Line canals is the primary factor limiting the total potential recharge volume for these sites. The availability of flows in the Umatilla also limits the potential annual recharge volume of the sites. Costs to develop each site and recharge for one season are estimated in the report. Also estimated is the timing of flows returning naturally to the river as a result of recharge activities.

Based upon the evaluation of selected sites, an implementation plan is presented for recommended pilot facilities. This implementation plan discusses construction and monitoring of pilot project sites. Permitting required for artificial recharge and utilization of recharged groundwater is also discussed. Following implementation of the pilot phase project, an intermediate phase is proposed to evaluate the effectiveness of the pilot project and to determine the feasibility of constructing an upgraded version of the pilot project or a full scale recharge project.

Based upon the investigations completed during the preparation of this report, it is recommended that pilot projects, which would basically provide up to 16,000 acre-feet of additional recharge to the shallow aquifer, be constructed. This report demonstrates the pilot facilities could physically be constructed with a minimal cost, by utilizing existing conveyance facilities. Development of the pilot facilities would utilize river flows in excess of instream needs.

It is recommended that the I-82 site be given first consideration as the pilot project since it would provide new data and research information beyond that available at the existing county line site. The I-82 site is located further downstream than the Highway 30 site and would thus be able to capitalize on the additional leakage that would occur from the canal bottom without any significant cost increase. The I-82 site also offers all the necessary elements for the intermediate phase of the project, with a minimal cost. However, as stated in Section 3 of this report, the cost associated with gaining access to and using this site, versus the Highway 30 site, must be considered before making a final selection for the pilot project.

Additional water supplies beyond the present 20,000 acre-feet available in the State's Basin Plan would be necessary for full scale development. Costs for full scale project development are expected to be high because of land acquisition/construction costs for new canals or expansion of existing canal capacity to convey the required flows to recharge sites.

Section 1

SECTION 1

INTRODUCTION

PURPOSE

The purpose of this study is to investigate the potential for development of shallow groundwater artificial recharge facilities in the Umatilla River Basin for the primary purpose of augmenting Umatilla River flows during low-flow periods. Other benefits that may occur as a result of recharge projects include increased groundwater supplies for irrigation, industrial uses and domestic uses, all of which may lead towards economic development. Recharge would be accomplished by diverting excess winter river flows. In past years, these excess winter flows have totaled approximately 300,000 acre-feet. River flow augmentation is desired to aid in migration of anadromous fish in the Umatilla River, primarily steelhead and chinook salmon. A minimum of 20,000 acre-feet of excess river flow has been reserved as part of the Oregon Water Resources Commission's (OWRC) Umatilla Basin Plan for artificial groundwater recharge. The area studied is shown on Figure 1-1.

At the present time, anadromous fish migration is hampered by low flows in the late spring and fall. Low flows are caused, in part, by irrigation diversions. As a result, stream flow augmentation could be accomplished by either (1) replacing surface water irrigation with groundwater irrigation, (2) promoting a larger baseflow to the Umatilla through increased groundwater levels, or (3) pumping groundwater directly to the river for flow augmentation.

SCOPE

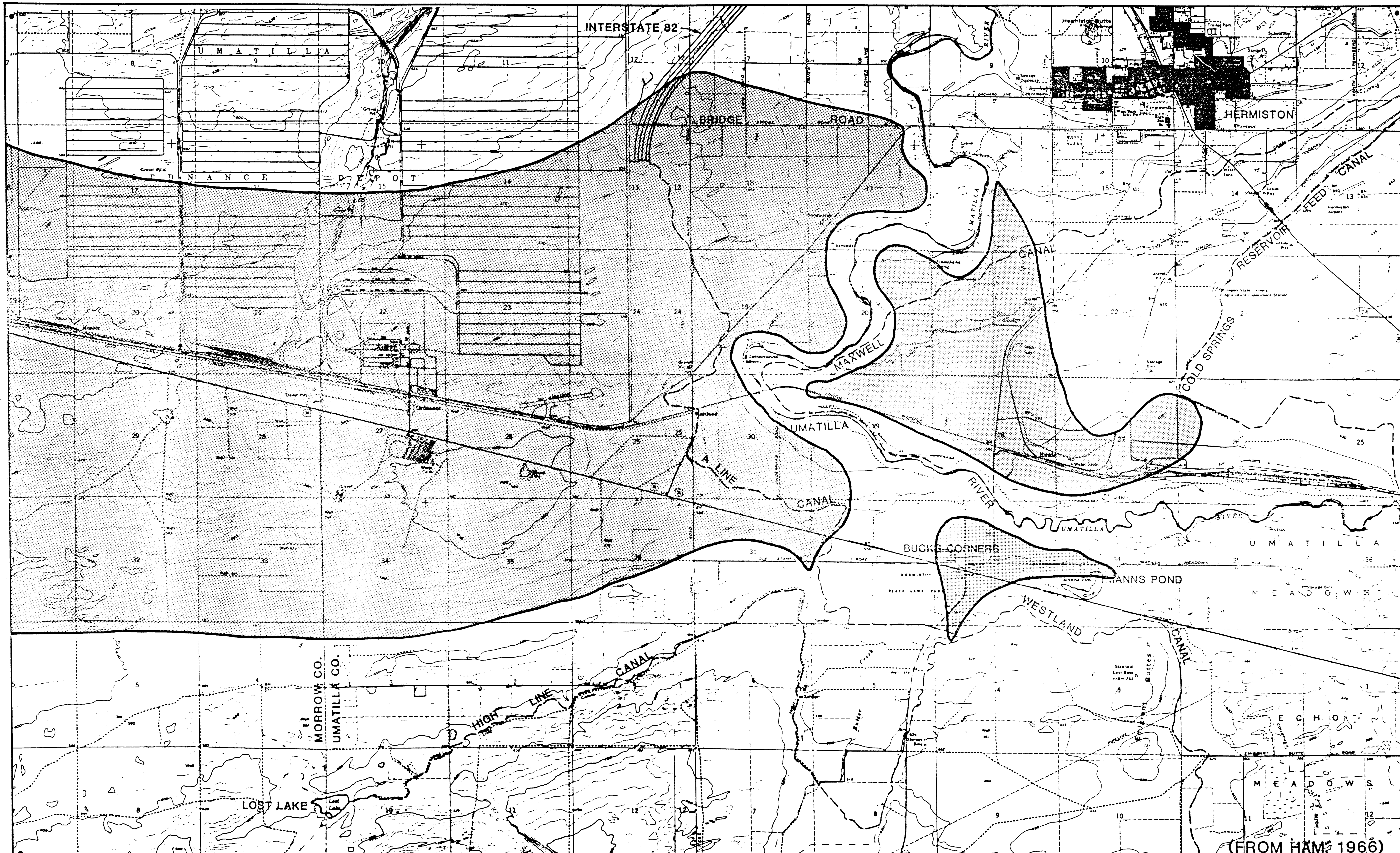
The scope of this study included the following tasks:

- Identification of Recharge Areas - This task included (1) a review of available geologic and hydrologic data to determine areas amenable to shallow groundwater recharge, (2) discussion of potential recharge areas with local irrigation district personnel and other knowledgeable people, (3) selection of a minimum of three areas for analysis as potential pilot recharge projects. Sites examined for pilot facilities were constrained to those that could be developed with existing infrastructure. Facility locations for long-term full scale recharge projects could be selected based upon data generated by pilot projects.

- Method of Recharge - This task consisted of an investigation of methods for accomplishing recharge in each of the areas selected for potential pilot recharge projects.

- Amount of Recharge - An examination was conducted of Umatilla River hydrographs, canal conveyance capacities, and potential infiltration rates to determine the amount of water available for recharge at each site. From a water rights standpoint, it was assumed that a minimum of 20,000 acre-feet would be available for recharge on an annual basis (as reserved in the OWRC's Umatilla Basin Plan).

- Utilization of Recharged Water - For each of the areas identified, an estimation was made of the potential methods to utilize recharged groundwater for river flow augmentation. These methods included (1) natural return flow to the river by



LOCATION OF
GLACIOFLUVIATILE SEDIMENTS
FIGURE 2-1

springs and baseflow contribution, (2) pumping groundwater directly to irrigation in exchange for McKay Reservoir surface water storage (which would then be available for stream flow augmentation as needed), or (3) pumping of shallow groundwater directly to the river for flow augmentation.

- Costs - An estimate was made of the costs to develop pilot recharge facilities. These costs included construction, operation, maintenance, monitoring, and utilization of recharged groundwater. Right-of-way, property purchase, or property leasing costs were not included.

- Implementation Program - A plan was outlined for implementation of a pilot recharge program. This plan includes construction of recommended pilot recharge facility alternatives. Included in this plan were suggestions for monitoring and a discussion of potential utilization alternatives. Permitting needs and other legal issues were also investigated.

AUTHORIZATION

James M. Montgomery Consulting Engineers, Inc. (JMM) was authorized by the Bureau of Reclamation to conduct this investigation by order number 9-PG-10-14110, dated August 18, 1989.

PREVIOUS INVESTIGATIONS

This investigation builds upon a previous JMM investigation of shallow groundwater artificial recharge potential in the Umatilla Basin. In addition, there have been several other previous investigations related to shallow groundwater and artificial recharge in the lower Umatilla Basin. Reports of previous investigation which were examined as part of this present study include the following:

(1) Water Resource Investigations within the Umatilla River Basin for the U.S. Department of Interior, Bureau of Reclamation, Pacific Northwest Region, by JMM (October 1987), which included a study of shallow aquifer recharge potential within the Umatilla Basin.

(2) An Evaluation of Artificial Recharge to the Alluvial Ground Water Reservoir Near Ordnance, Oregon for the Period of 1977-1984 (Preliminary), by Donn W. Miller, Oregon Water Resources Department (May 1985).

(3) Ground-Water Conditions and Declining Water Levels in the Ordnance Area, Morrow and Umatilla Counties, Oregon, by William B. McCall, Oregon Water Resources Department (October 1975).

(4) A Brief Description of the Ground-Water Conditions in the Ordnance Area, Morrow and Umatilla Counties, Oregon, by Jack E. Sceva, Oregon Water Resources Department (May 1966).

(5) Development Potential of Groundwater for Irrigation in the Umatilla Basin Umatilla County, Oregon, by Herbert H. Ham, Bureau of Reclamation (November 1966).

(6) Umatilla Return Flow Study (Draft No. 1), Bureau of Reclamation (December 7, 1987).

(7) Soils Survey of the Umatilla County Area, Oregon, U.S.Department of Agriculture, Soil Conservation Service (November 1988)

Section 2

SECTION 2

PHYSICAL ASPECTS OF SHALLOW GROUNDWATER RECHARGE

GENERAL

Potential shallow groundwater recharge sites require thick deposits of permeable sediments which extend to within a few feet of the ground surface. These deposits must be of sufficient areal extent to store appreciable amounts of groundwater, and must be suitable for later extraction of the stored groundwater by direct pumping from wells or by natural aquifer discharge from either springs or stream-bed discharge. The deposits should be relatively clean and must not contain extensive layers of fine-grained sediments (silts and clays) or other low permeability materials that might impede vertical flow or cause perched groundwater bodies to develop. Within the Umatilla Basin, very little potential for shallow groundwater recharge exists upstream of the town of Echo because geologic conditions do not meet the criteria described above. However, the geologic and hydrologic conditions in some areas of the lower Umatilla Basin (below Echo) meet the criteria necessary for consideration as potential groundwater recharge sites and are discussed further in this report.

GEOLOGY OF THE LOWER UMATILLA BASIN

The geology of the lower Umatilla Basin can be divided into four primary deposits: (1) Miocene-age Columbia River Group basalts and interbedded sediments, (2) Pleistocene-age glaciolacustrine sediments, (3) Pleistocene-age glaciofluviatile sediments, and (4) Recent-age alluvial sediments. Columbia River Group basalts and interbedded sediments underlie the entire area to depths of several thousand feet or more. The glacial and alluvial sediments overlie the basalts, generally to depths of 200 feet or less. The alluvial sediments are found as narrow strips along the Umatilla River and Butter Creek. Groundwater is found in all of these deposits but the usefulness of these deposits for shallow groundwater recharge varies widely.

Columbia River Group

The basalts and interbedded sediments of the Columbia River Group contain the largest and most extensive aquifer system in the Columbia Basin. The aquifers in the Columbia River Group consist of permeable interflow zones of fractured or scoriaceous basalt, or coarse-grained sedimentary interbeds. Within the lower Umatilla Basin these aquifers are extensively developed for irrigation and municipal/industrial uses. Aquifers within the basalts are considered deep aquifers. Direct recharge of the basalt aquifers is possible only through the use of injection wells. However, recharge of deep basalt aquifers is outside the scope of this study and these aquifers will not be considered further.

Glaciolacustrine Sediments

The glaciolacustrine sediments consist primarily of fine-grained lake-bed sediments which predate the glaciofluviatile deposits. The glaciolacustrine sediments were deposited in shallow lakes formed by downstream damming of the Columbia River and are generally less than 80 feet thick. These deposits are exposed at the ground surface to the south and north of the band of glaciofluviatile deposits. Although groundwater is found within the glacial lake sediments, these materials are generally fine-grained silts and clays which do not readily transmit water. As such, the glaciolacustrine deposits do not contain significant aquifers and do not have potential for groundwater recharge.

Glaciofluviatile Deposits

The glaciofluviatile deposits are the primary deposits suitable for shallow groundwater recharge in the Umatilla Basin. These deposits consist of highly permeable gravels and sands which range in thickness up to 200 feet. The sands and gravels are crudely stratified with only occasional lenses of silt or clay. Glaciofluviatile sands and gravels were deposited by torrential ice-age floods of the Columbia River.

The glaciofluviatile deposits are exposed at the ground surface primarily in the area west of the Umatilla River in an east-west trending band several miles wide (Figure 2-1). This band extends westward out of the Umatilla Basin for several miles past the Umatilla-Morrow County line. Where these highly permeable deposits are exposed at the ground surface, surface water and precipitation infiltrate rather than run off. As a result, surface drainage is poorly developed on the glaciofluviatile sands and gravels.

Recent-Age Alluvium

Recent-age alluvial deposits are found in thin narrow strips along the Umatilla River and Butter Creek. These deposits vary in grain-size and sorting. As a result, permeability of these deposits is rather variable. Because of the proximity of these deposits to the river, their relatively limited areal extent, and their variable permeability, aquifers within the Recent-age alluvium are not important from a recharge standpoint. However, these deposits are interconnected with the glaciofluviatile aquifers in many areas and may act as discharge points for groundwater from the glaciofluviatile deposits.

GROUNDWATER

Shallow Groundwater Occurrence

In this investigation, shallow groundwater is defined as groundwater found within the uppermost or water-table aquifer system. Shallow groundwater is found in both the glaciofluviatile aquifers and Recent-age alluvium aquifers. These aquifers are typically in direct hydraulic connection with the Umatilla River. Shallow groundwater aquifers are recharged from infiltration of precipitation and irrigation and by leakage from surface streams, irrigation canals, and an existing recharge canal. Discharge from these aquifers occurs as spring discharge or baseflow to the Umatilla River or Butter Creek, or as pumpage from wells. As previously mentioned, the deposits of Recent-age alluvium in the area are relatively thin and not areally extensive. Therefore, the glaciofluviatile deposits are more important from a recharge standpoint, and the Recent-age alluvium will not be discussed in detail.

The boundaries of the glaciofluviatile groundwater reservoir have not been well defined, but essentially follow the boundaries of the glaciofluviatile deposits shown on Figure 2-1. To the south, the fine-grained glaciolacustrine sediments form a boundary. To the west of the Ordnance area, the saturated thickness of the sediments thins, which may form a boundary of sorts. However, the western boundary may actually be a groundwater divide, where groundwater on the east flows to the Umatilla and groundwater to the west flows to the Columbia. The eastern boundary of the aquifer is near Hermiston. Well log data suggest that the permeable gravels extend slightly eastward from the Umatilla river. The Umatilla River acts as a discharge area to the east but probably not a boundary. To the north, the boundary of the reservoir in the Ordnance area is unclear. McCall suggests that

LOCATION MAP

FIGURE 1-1

it extends to the Columbia River. Geologic mapping by Ham (1966) shows the northern boundary of the glaciofluviatile deposits crosses the center of the Ordnance Military Reservation. Glaciolacustrine sediments predominate north of this boundary. Well log data examined as part of the present investigation suggest that the northern border of the reservoir in the area east of the Ordnance Reservation is in the vicinity of Bridge Road.

Earlier work by McCall (1975) separated the shallow groundwater system into two bodies, the Lost Lake-Depot area and the Westland Road area. McCall reported that the glaciofluviatile deposits in the two areas are separated by fine-grained deposits because wells constructed in the area between the Lost Lake-Depot area and the Westland area penetrated only fine-grained sediments and correspondingly had low yields. However, Miller's (1985) interpretation of well log data suggests that the aquifer is continuous from the Lost Lake-Depot area to the Westland Road area. Examination of well log data as part of the present investigation also suggests that the aquifer is a single groundwater body, although thickness and permeability may vary significantly. Thickness of saturated glaciofluviatile deposits in the Lost Lake-Depot area ranges from about 25 to 75 feet. Saturated thickness is slightly greater in the Westland area, ranging from about 25 to 100 feet.

Shallow Groundwater Use

The shallow groundwater system in the glaciofluviatile deposits is highly developed. Annual withdrawal from the shallow sedimentary aquifers in the Hermiston-Ordnance vicinity is estimated to be 23,500 acre-feet (JMM 1985). Groundwater withdrawn from these aquifers is used primarily for irrigation, and well yields from these deposits are relatively high. Several wells in the Westland area have yields in excess of 1,000 gpm, and McCall reported two wells with yields of 3,000 gpm. Well yields in the Depot-Lost Lake area are reported by McCall to range from about 400 to 3,000 gpm, with an average of about 1,800 gpm. However, these irrigation wells are typically unscreened, and the lower yielding wells may reflect inefficient well completions. As such, the actual permeability of the aquifer in the area may be better reflected by the high yield wells.

Groundwater Flow Direction

Within the glaciofluviatile groundwater body, the direction of groundwater movement is not well documented. Groundwater flow moves from areas of recharge to areas of discharge. Recharge from precipitation and irrigation occurs throughout a large area of the glaciofluviatile deposits. Discharge occurs to wells, springs, and river baseflow. The wells are scattered throughout the aquifer area, while springs and river baseflow occur along both the Umatilla and Columbia Rivers. A water-table contour map by McCall (1975) suggested that groundwater flow was in a northwesterly direction with a gradient of approximately 12 feet per mile, with discharge occurring to the Columbia River, from Irrigon eastward for several miles. However, this flow direction is not substantiated by Miller's (1985) review of the data. In addition, mapping by Ham (1966) suggests that glaciolacustrine sediments north of Ordnance forms a northern boundary to the shallow groundwater reservoir, which would preclude flow in a northerly direction. Determination of individual well elevations, and thus groundwater elevations, would be necessary to determine actual groundwater flow patterns. However, it is probable that a groundwater divide occurs somewhere (the exact location is unknown) in the Ordnance area with groundwater in the area east of the divide flowing toward the Umatilla River, which acts a drain. This drain-like influence of the Umatilla River is suggested from (1) discharge of springs on the river bank, (2) river baseflow gains in the reach which flows across the glaciofluviatile deposits, and (3) elevation comparisons of the river level and the shallow aquifer water table. Groundwater flow in the area west of the postulated groundwater divide would be northwesterly, toward the Columbia River, as suggested by McCall.

Groundwater Flow Velocity

Groundwater flow velocity within the glaciofluviatile aquifer varies considerably from place to place, depending upon permeability, proximity to recharge and discharge sources, time of year, etc. By assuming "typical" values for aquifer parameters, a range of flow velocities within the glaciofluviatile aquifer can be calculated using Darcy's equation ($v=Ki/n$), where velocity (v) is equal to the product of hydraulic conductivity (K) and hydraulic gradient (i), divided by the effective porosity (n).

Hydraulic conductivity of the glaciofluviatile aquifer materials can be estimated using well yield and well log information. Wells in the Westland Road and Lost Lake-Depot areas have yields of 1500 gpm or more. Assuming that these wells average about 15 feet of drawdown when pumping, average well specific capacity would be in the range of 100 gpm/ft. For a water-table aquifer, a specific capacity of 100 gpm/ft would correspond to an approximate aquifer transmissivity in the range of 100,000 to 150,000 gpd/ft. Assuming an average saturated thickness of 50 feet, the hydraulic conductivity would be approximately 300 ft/day. Assuming an average hydraulic gradient of 10 feet per mile and porosity of 25 percent (typical for a sand and gravel deposit), the horizontal flow velocity would be only about two to three feet per day. Given that the parameters used in this calculation (particularly hydraulic conductivity and gradient) are approximations and can be expected to vary considerably throughout the aquifer, this calculated horizontal groundwater flow velocity may vary by an order of magnitude or more. However, the calculated velocity does reflect a typical rate of movement for groundwater in storage within the aquifer. Velocities will be greater in areas of higher gradients, such as in the vicinity of aquifer recharge or discharge areas.

Although the calculated groundwater velocity is only a few feet per day, pressure effects from artificial recharge or discharge sites can travel much more rapidly. For instance, Miller states that pressure effects of water moving away from the CLWID recharge canal may travel 1,000 feet per day or more. These pressure effects may result in relatively rapid changes in river baseflow or spring discharge, even though the actual recharged water has not migrated from the vicinity of the recharge facility. As such, effects of recharge activities could be detectable in well levels or spring discharge rates within a few days of the time that recharge begins. Recharge effects will be site specific. Thus, hydraulic responses from the pilot projects will differ from those documented by the CLWID project.

SURFACE WATER

Surface Water/ Groundwater Interactions

Groundwater and surface water are in direct hydraulic connection at those areas where the bed of the Umatilla River intercepts the water table. According to Miller (1985), water-table elevations in the glaciofluviatile aquifer in 1985 were about 500 feet. The 500-foot river elevation occurs about one-half mile south of Cottonwood Bend. As such, significant baseflow from the glaciofluviatile aquifer probably does not occur upstream of Cottonwood Bend (approximately river mile 12). In fact, it is possible that the river is losing water into the shallow groundwater aquifer above that point. Data from the Umatilla Return Flow Study (1987) suggest that the river is gaining below about mile 9 (river elevation 490), with gains of about 35 to 65 cfs of baseflow during the irrigation season.

In addition to the contribution of groundwater to the river baseflow through the streambed, considerable groundwater discharge occurs from springs located along the banks of the river. The area of spring flow, which is located along the Umatilla River north of Bridge Road, is approximately river elevation 445 or less. The time for response of springs to filling of the irrigation canals is about three weeks. This indicates that response time from the recharge sites could be relatively rapid. However, those responses in the past may have resulted from leaky canals within a mile or less of those springs. By moving a recharge site several miles from the springs it is probable that the time it takes for the recharge effects to reach the river would be increased.

Annual Hydrographs and Flow Availability for Recharge

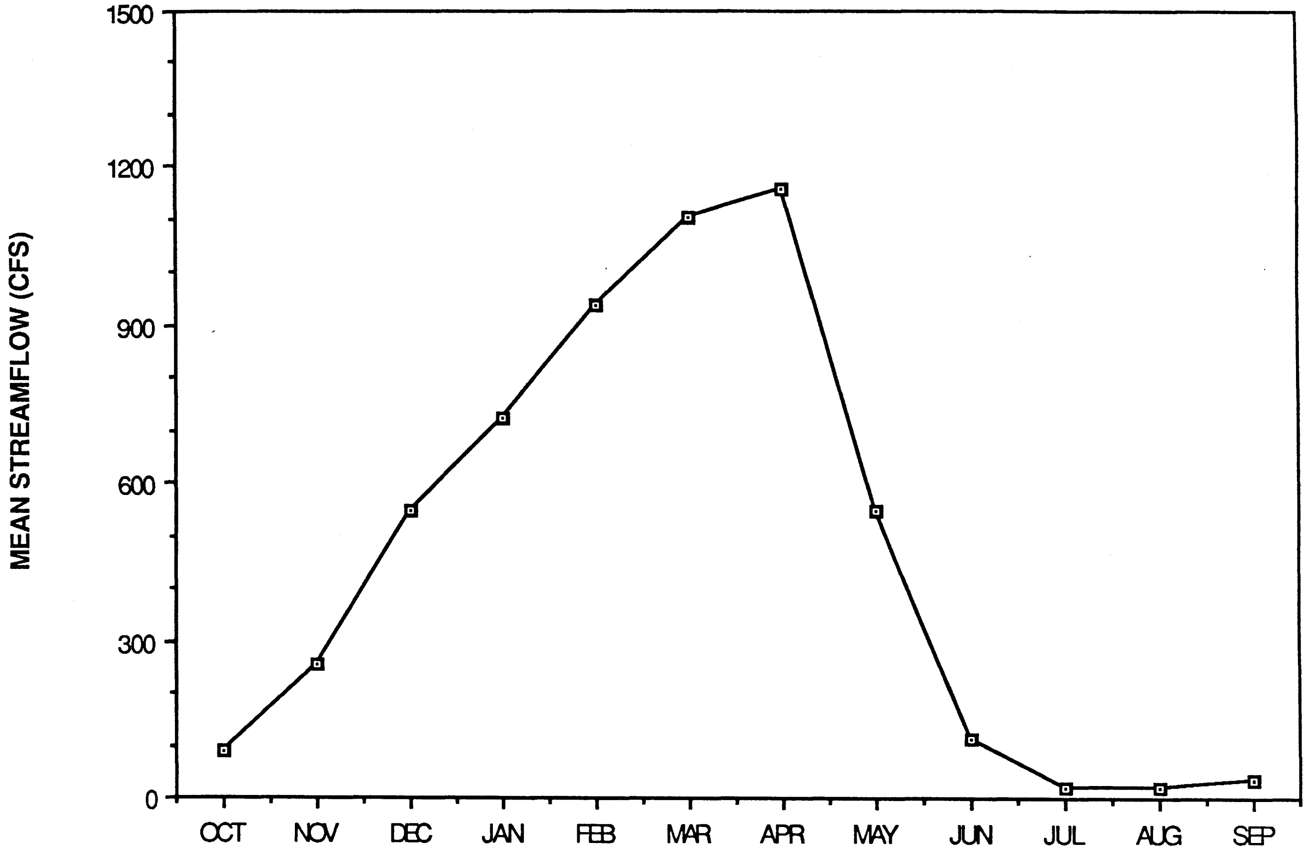
Flow in the Umatilla River in the vicinity of Hermiston fluctuates widely throughout the year. Figure 2-2 is an average hydrograph of Umatilla River flow at Umatilla. The variations in flow shown on the hydrograph are due to seasonal effects of precipitation and runoff and also man-made effects of irrigation diversion and upstream surface water storage. River flow in typical years is essentially absent in certain reaches from June through September due to irrigation diversions. In the late winter and early spring, river flow is often very high because of precipitation and snowmelt runoff. Based upon examination of hydrographs and assuming that instream flow must be maintained at about 300 cfs, it appears that flow is generally available for recharge during the months of December through May. Flows in excess of 300 cfs are available intermittently during other months, particularly October and November. Actual recharge volumes during late April and all of May are generally less than potential volumes because canal capacities are utilized for irrigation rather than recharge purposes. Flow availability for recharge is discussed in detail in Section 3 of this report.

ARTIFICIAL RECHARGE

Physical Aspects

Artificial recharge of groundwater can be achieved where geologic and hydrologic conditions are suitable. As previously discussed, artificial recharge in the lower Umatilla Basin is viable in the area of glaciofluviatile deposits, where soils are permeable and the aquifer is unconfined.

Artificial recharge in the lower Umatilla Basin area can be accomplished using gravel pits, infiltration basins, or infiltration canals. Recharge water would be obtained using surface water flows diverted from the Umatilla River and conveyed to the recharge sites in existing canals. Initial infiltration rates would be high, due to the permeable nature of the soils and near surface sand and gravel deposits in the area, but could decrease with time because of settling of suspended sediments on the bottom of the recharge facility. This is particularly true in the lower Umatilla Basin where recharge water supplies are available primarily during runoff periods when river sediment loads are highest. Biological activity (bacterial or algal growth) can also reduce infiltration through the formation of clogging layers. As a result, recharge facilities must be periodically cleaned to remove accumulated sediment and organic material. Cleaning is typically accomplished by scraping, raking, and/or drying. Because of the cost of cleaning, design of recharge facilities should consider control of sedimentation. In some instances, it may be desirable to use canals (as opposed to basins or gravel pits) for infiltration because water velocity may reduce the amount of sediment settling. Alternatively, pre-sedimentation facilities, such as settling basins, could be considered.



MEAN MONTHLY STREAMFLOW FOR UMATILLA RIVER NEAR UMATILLA, OR. (GAGE NO. 14033500)

(FOR WATER YEARS 1928-1988)

FIGURE 2-2

Artificial groundwater recharge can change the quality of groundwater in an aquifer. This occurs from mixing groundwater and surface waters which have differing chemistries. In addition, recharge water quality can change as it infiltrates through the vadose (unsaturated) zone into the aquifer. Typically, the quality of recharged water is improved as it infiltrates to the aquifer. This improvement occurs as suspended solids, bacteria, and other microorganisms are filtered by soil and sediments. The amount of filtering is site-specific depending on the coarseness of soil and aquifer materials. In addition to filtration, water chemistry changes can occur during infiltration from chemical and biological processes. These processes typically result in decreased concentrations of constituents such as nitrate and organics. However, because the media through which infiltration occurs is typically coarse-grained (i.e. sand and gravel without clay or silt), ion exchange will be insignificant and the concentrations of most dissolved ions will remain unchanged. Thus, the chemistry of recharged groundwater will reflect the surface water (Umatilla River) chemistry prior to recharge but with a substantial reduction in suspended solids and microorganisms. The resulting groundwater chemistry will be a mix of existing groundwater and artificial recharge water.

CLWID Project

The County Line Water Improvement District (CLWID) artificial recharge project began in 1977, following the establishment of the Ordnance Critical Groundwater Area. The "critical area order" imposed a limit of 9,000 acre-feet per year on shallow groundwater pumpage in the Lost Lake-Depot area. This limit was a reduction of about 6,000 acre-feet from previous annual pumpage. The recharge project was constructed to replace this 6,000 acre-feet reduction with Umatilla River flows during winter months. The CLWID project is located about two miles south of Ordnance. Recharge is accomplished through a leaky ditch about 3 miles long. Water is supplied to the project by the High Line Canal (B-Line Canal) and about 1.5 miles of 36-inch pipeline.

Artificial recharge from the project averages about 6,000 acre-feet per year. The CLWID project has produced a documented improvement in groundwater levels in the glaciofluviatile aquifer in the Ordnance area. Wells in the project vicinity achieved an average 12-foot increase in static water levels between 1977 and 1985, of which more than half of the increase has been attributed to the recharge project. According to Miller, wells in the Westland area have also benefited from the CLWID recharge.

Using a continuity-equation approach (conservation of mass), Miller calculated that the addition of 7,500 acre-feet of storage in the aquifer will produce a one-foot rise in water level within the local aquifer. This figure may overestimate the water needed to produce a one-foot water level rise because it underestimates the documented increase in water level achieved by CLWID recharge project. Another way of estimating water level increase from storage is by aquifer volume and porosity. Assuming that the shallow groundwater reservoir has an effective area of 30 square miles (based on geologic mapping), and that porosity of the reservoir is about 25 percent, an addition of 5,000 acre-feet would produce a water level increase of about one foot. Based on these calculations, it is probable that the additional groundwater storage needed to produce a one-foot water level increase is probably in the range of about 4,000 to 8,000 acre-feet.

Optimum Locations for Recharge Facilities

The glaciofluviatile deposits in the lower Umatilla Basin have significant recharge potential. However, the location and areal extent of these deposits with respect to existing canals limit the potential for recharge. Areas outside the glaciofluviatile deposits do not have significant recharge potential.

Maintaining recharged groundwater in storage is important for this project because several months may elapse between the end of recharge operations and the time that groundwater is to be exchanged for surface water or that natural return flow to the river is needed. From a storage standpoint, it would be best to recharge as far as possible away from the river so that recharged water is not immediately lost to the river. However, there are no conveyance capabilities west of the Umatilla-Morrow County line. In addition, groundwater flow west of the county line may be to the northwest, out of the Umatilla Basin. Therefore, from the standpoint of storage, recharge would probably best be accomplished in the general area of the existing CLWID project. Recharge in the CLWID area would produce some additional base flow to the Umatilla River. Groundwater level monitoring would be needed to determine if all of the flow is occurring toward the Umatilla River or if some is out of the basin to the Columbia River. The timing of the baseflow augmentation is impossible to predict because of the many variables involved. These variables include interception of recharge effects by irrigation wells, and variations in aquifer permeability and storage characteristics between the recharge site and the river. However, it is likely that baseflow augmentation effects could persist for several months after the end of recharge operations in the CLWID area.

The glaciofluviatile area between CLWID recharge site and the Umatilla River also is suitable for groundwater recharge. At those sites close to the river, baseflow augmentation would begin rapidly (within a few days to a few weeks) after the start of recharge. This rapid response is suggested by the timing of increased spring discharge in the Bridge Road area. The spring flow response normally begins about three weeks after the irrigation canals fill. Unfortunately, baseflow augmentation also would begin to decrease rapidly after recharge ends. The length and amount of return flow to the river from recharge would depend on the amount and timing of recharge and the distance of the recharge facilities from the river. Thus, almost any area within the glaciofluviatile deposits will be suitable for recharge, but the length of time that the recharged water remains in groundwater storage will be dependent upon location of the recharge facilities with respect to the river. Actual responses of groundwater levels and river baseflow to artificial recharge operations will be best determined through monitoring of test recharge projects.

Given the location of the glaciofluviatile deposits and the elevation of the water table in the glaciofluviatile aquifer, river baseflow increases resulting from artificial recharge will probably not occur upstream of Cottonwood Bend. Therefore, river flow supplementation in the reach of the Umatilla River upstream of Cottonwood Bend will need to be accomplished by some method other than natural return flow of recharged groundwater. One method for flow supplementation upstream of Cottonwood Bend might include pumping from storage in the aquifer into canals in exchange for surface irrigation flows that would be left in the river.

Section 3

SECTION 3

EVALUATION OF POTENTIAL RECHARGE FACILITIES

BACKGROUND

Information on existing conveyance facilities and potential recharge sites in the Umatilla recharge project area was collected through literature review, field inspections, and conversations with local knowledgeable persons. Considerable information was gathered with respect to potential recharge sites, conveyance capacities of irrigation canals, infiltration capacities, groundwater return flow patterns to the Umatilla, irrigation district operational policies, and other topics. Sources of this information included Mr. Bill Profily (Stanfield-Westland Irrigation District Manager), Mr. Tyler Hansel (Director of the County Line Water Improvement District), the U.S. Bureau of Reclamation (USBR), the United States Geological Survey (USGS), and the Oregon Water Resources Department (OWRD). Information obtained through this investigation was used to select sites for small-scale, pilot recharge facilities to determine the effectiveness of shallow groundwater recharge for the purposes outlined in Section 1. Based on the performance of such pilot facilities, the feasibility of full-scale facility construction could be subsequently evaluated.

CRITERIA FOR PRELIMINARY EVALUATION OF PILOT CONVEYANCE AND RECHARGE FACILITIES

Existing conveyance facilities (mainly irrigation canals) in the Hermiston, Stanfield, and Westland irrigation districts were inspected to help determine the potential of utilizing the canals in a pilot recharge project. The following criteria, listed in order of importance, were used for preliminary evaluation of the canals.

1) The proximity of the canals relative to the thick glaciofluviatile (sand and gravel) subsurface geologic layer.

2) The seepage loss histories of the canals and their potential to serve as insitu recharge sites through canal bottom leakage.

3) Total maximum flow capacity in the canals at various points.

4) Available flow capacity in the canals during the most probable recharge months of November through April.

If a canal under question was considered unfavorable with respect to both of the first two criteria, then it was not considered further with regard to its ability to serve as a part of the pilot recharge project. If a canal was considered favorable with respect to either of the first two criteria, then the canal's maximum flow capacity and available flow capacity during the months of November through April were investigated.

In addition to this field evaluation of existing conveyance facilities, a preliminary evaluation was also performed of areas which have the potential to be utilized as pilot recharge sites. The first and most important factor for evaluating a site's recharge potential is the physical location with respect to the permeable glaciofluviatile deposits. If a site was not located on this highly permeable, sand and gravel material, it was not considered as a possible recharge site. If the site had a favorable location, then the following additional questions were pursued to further evaluate the site's potential as a pilot recharge facility.

- Does subsurface geology and historical groundwater flow patterns indicate that the recharged water will (1) return to the Umatilla River, (2) not migrate significant distances, or (3) possibly move away from the Umatilla River and not contribute to Umatilla return flow?
- What is the total volumetric capacity and bottom seepage area of the site?
- How close is the site to an existing conveyance facility which has the potential to be utilized in the project?
- What type of turnout structure(s), conveyance structure, and other facilities would be necessary to utilize the site?

All of the above criteria played an important role in the preliminary evaluation of potential pilot recharge facility.

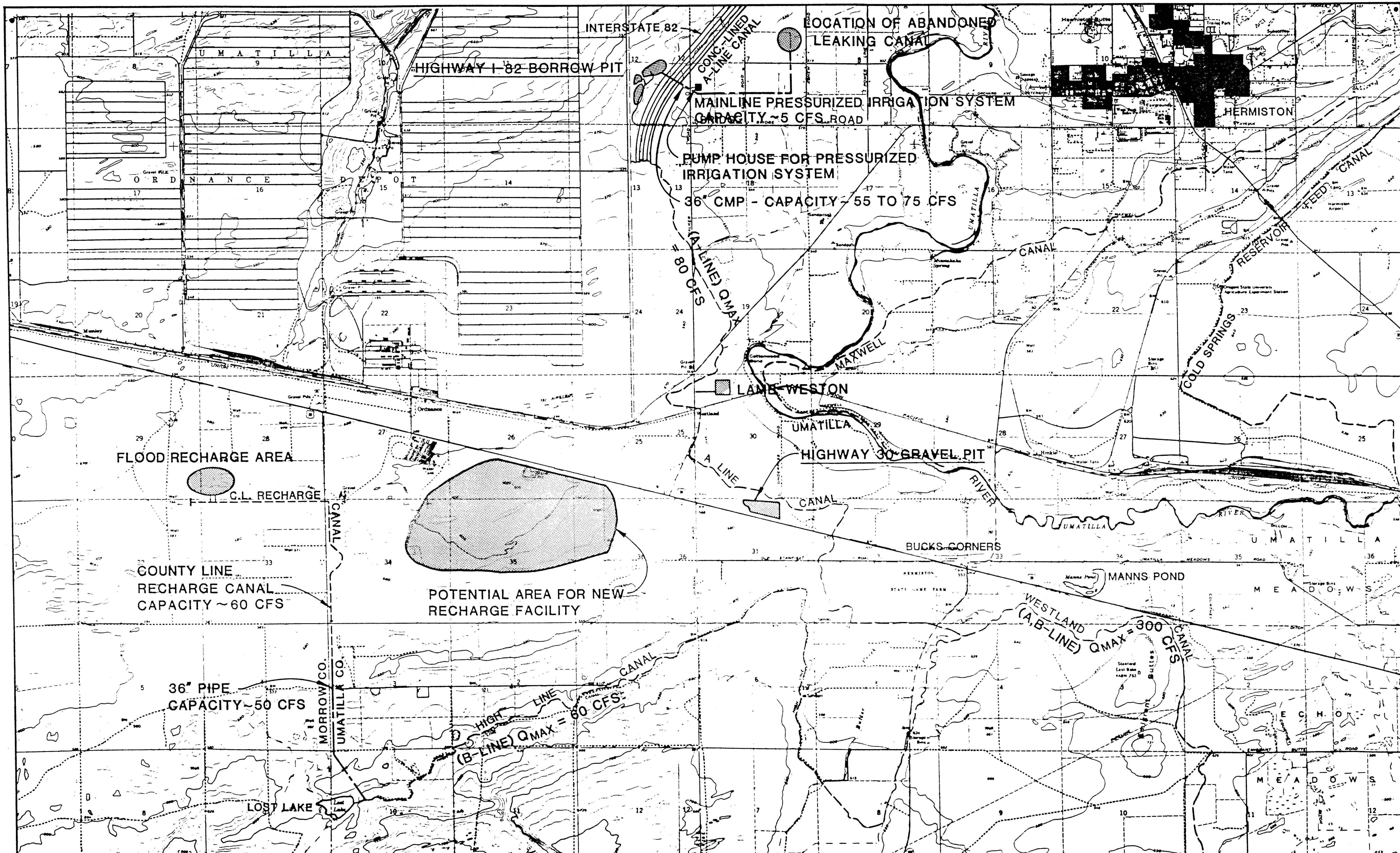
EVALUATION OF PILOT RECHARGE FACILITIES

Potential recharge sites for the pilot phase of the Umatilla recharge project are evaluated below. Each site is listed under the existing canal which would be responsible for conveying water to the site. Principal irrigation canals in the project vicinity are identified on Figure 3-1. All recharge facilities evaluated, with the exception of a new facility served by the High Line (B-Line) Canal, are existing facilities so that pilot-phase recharge project costs will be minimized. However, it is important to note that pilot conveyance and recharge facilities identified in this study are limited in the amount of recharge they can convey or accept. (This point is explained in detail later in this section.) Thus, for a future full-scale recharge project, it will probably be necessary to construct new conveyance and recharge facilities. The sizing of new facilities will be determined by the annual volume of recharge which is desired.

Maxwell Canal and Cold Springs Reservoir Feed Canal

The Maxwell Canal runs either through or close to the area of glaciofluviatile sediments which lies to the north and to the east of the Umatilla River as shown in Figure 2-1. The Maxwell Canal closely parallels the Umatilla River near Cottonwood Bend. From Cottonwood Bend, the canal runs in a northeasterly direction towards the Hermiston Airport. Because of Maxwell Canal's proximity to both the Umatilla River and to residences in this area, the canal was not considered to be a potential conveyance facility for the pilot recharge project.

The Cold Springs Reservoir Feed Canal is used to nearly full capacity throughout the recharge season (November through May) to fill Cold Springs Reservoir. This canal also is generally located to the east of glaciofluviatile sediments suitable for recharge. Thus, because of (1) the feed canal's low additional available capacity during the months of November through May, and (2) the lack of suitable recharge sediments beneath the canal, the canal was not considered to be a potential conveyance facility for the pilot recharge project.



PILOT PHASE RECHARGE
FACILITIES LOCATION MAP
FIGURE 3-1

Stanfield Irrigation Canal

The Stanfield Irrigation Canal could potentially supply a recharge area located south of the Hermiston airport. This area, which is presently level hay fields, has been flood irrigated in the past from the Stanfield Irrigation Canal. The water reportedly infiltrated rapidly and, within a half day, groundwater supposedly surfaced nearly one mile to the north near Highland Avenue and 10th Street near Hermiston. This response suggests that storage of recharged water would be poor, with recharged groundwater quickly lost to surface discharge. The site appears to be located outside the glaciofluviatile aquifer (Figure 2-1). Surface slopes and groundwater gradients also suggest that water recharged to this area probably travels toward the City of Hermiston area where increased groundwater levels could result in damage to residences and businesses. For these reasons, a possible recharge site to the south of Hermiston airport was not evaluated further. No other possible recharge sites appeared to be easily accessible to the Stanfield Irrigation Canal. Thus, the canal was not evaluated further as a possible pilot recharge conveyance facility.

Westland Irrigation Canal

The Westland Irrigation Canal (referred to as the A,B-Line) generally passes to the south of any thick deposits of coarse-grained glaciofluviatile sediments with recharge potential. The closest coarse-grained deposits are found in the vicinity of Bucks Corners. These deposits could potentially be recharged from the A,B-Line Canal by constructing approximately one mile of gravity pipeline or a slightly longer canal. However, since these conveyance facilities are not in existence and because the conveyance facilities would have to cross Interstate I-84, recharge in the Bucks Corners area was not studied in detail.

Echo Meadows was another area along the A,B-Line mentioned by the USBR as a possible recharge site. Located down-gradient from the A,B-Line, such a site could receive water by gravity flow from the A,B-Line. However, geologic maps and well logs indicate that considerable fine-grained sediments exist in the area, possibly explaining part of the reason for the marshy character of the area. For this reason the site was not investigated any further.

A-Line (Low-Line) Irrigation Canal

About one-half mile south of Bucks Corners, the A,B-Line Canal splits into the A-Line (or Low-Line) Canal and the B-Line (or High-Line) Canal. The A-Line Canal flows generally northwest towards Westland and then generally north until the canal reaches the Bridge Road overpass over Highway I-82. From this area, the A-Line meanders in a northeasterly direction until it drains into the Umatilla River in Section 33, T.5N., R.28E. Virtually the entire length of the A-Line Canal south of Bridge Road overlies relatively thick deposits of coarse-grained glaciofluviatile sediments. The A-Line's flow capacity to the potential recharge sites is approximately 80 cfs. Along the A-Line, two large potential recharge sites were examined as part of this study. These two recharge sites are (1) a gravel pit (owned by Mr. Howard Gass) located roughly 100 yards north of Highway 30 (I-84) and slightly west of Underpass Road and (2) the Highway I-82 gravel pit located north of Bridge Road along the west side of Highway I-82. The Highway 30 gravel pit is near the southern boundary of the glaciofluviatile aquifer. The Highway I-82 gravel pit is near the northern boundary of the aquifer. Exploratory borings may be necessary to confirm subsurface conditions at these sites. A small abandoned lateral canal was also examined as a potential recharge site. The locations of these sites are shown on Figure 3-1.

Highway 30/Underpass Road Gravel Pit. The Highway 30/Underpass Road Gravel Pit is bordered by the A-Line Canal along its north edge. The close proximity of the gravel pit to the A-Line Canal makes it an obvious candidate for a recharge site. Approximately 50 feet of pipe would be required to divert the A-Line flow to the top edge of the gravel pit and an estimated additional 150 feet of pipe would be needed to transport the recharge water to the gravel pit bottom away from the banks of the pit. In October 1989, when personnel from JMM visited this gravel pit site, there was some standing water on the north side of the pit which may have been an indication of the local water-table level or a perched groundwater body.

The top area of the pit is estimated to be approximately 17 acres. The average depth of the pit is approximately 30 feet beneath the surrounding ground surface and roughly 25 feet beneath the A-Line Canal bottom. Using an average bank slope of roughly 2.5:1, the full usable capacity of the pit (filled to a 25-foot depth), is calculated to be approximately 325 acre-feet. The bottom area of the pit is calculated to be approximately 11 acres.

Highway I-82 / Bridge Road Gravel Pit. The other large potential recharge site along the A-Line Canal, the I-82 gravel pit, is located on the west side of Highway I-82 just north of the Bridge Road overpass. The canal is located on the east side of Highway I-82. During construction of Highway I-82, the manager of the Stanfield Irrigation District installed a 36-inch corrugated metal culvert arch pipe (CMP) underneath both the newly concrete-lined A-Line Canal and Highway I-82. This 36-inch arched pipe was installed with the intent of using the gravel pit as a future recharge site. Depending on the actual slope of the 36-inch pipe, the maximum flow capacity of this pipe is estimated to be in the range of 55 cfs to 75 cfs. Field verification of the pipe's slope would better define the pipe's maximum flow capacity.

The I-82 gravel pit is currently made up of one large cell and two smaller cells. The culvert pipe enters into the large cell on its southeast side. The two smaller cells are located roughly 500 feet away on the southwest side of the large cell. The large cell would overflow into the smaller cells when the depth of water in the large cell reaches roughly one-half to two-thirds of its maximum depth. A small amount of earth moving could allow all three cells to act as one, if necessary.

The total volume of all three cells of the gravel pit is calculated to be approximately 400 acre-feet based upon an average depth of all three cells of approximately 24 feet beneath the ground surface. The usable volume of the gravel pit site is estimated to be roughly 325 acre-feet based upon an average depth of 20 feet beneath the A-Line Canal bottom. The total bottom surface area of all three cells is estimated to be approximately 16 acres.

Abandoned A-Line Lateral. A small recharge facility that also could be supplied by the A-Line Canal is an abandoned leaky canal located in the SE1/4 NE1/4 Section 7, T.4N., R.28E. The canal had a history of severe seepage problems and according to the irrigation district manager was used before the new pressurized irrigation system was put into service in 1986. (The pressurized irrigation system currently serves approximately 1,800 acres in Sections 7, 8, 17, and 18, T.4N., R.28E.) According to the Stanfield-Westland Irrigation District Manager, approximately 5 cfs (10 acre-feet per day) could be pumped from the A-Line Canal through a 14-inch main line in the existing pressurized irrigation system and discharged into the abandoned canal for recharge purposes.

Proposed Cottonwood Bend Pump. A 30 cfs pump station has been authorized as part of the Bureau of Reclamation's Umatilla Basin Project for construction at Cottonwood Bend. If this pump station is constructed, it could potentially supply 30 cfs to the A-Line Canal (or pumped to some other recharge location) downstream of the Highway 30 site. Thus, the capacity of A-Line supplied sites (Highway 30 and Highway I-84 sites in combination) could be increased by 30 cfs. The pumping station may be available for recharge supply during the non-irrigation season. However, use of the proposed Cottonwood Bend pumping facilities have not been considered further in the evaluation of pilot recharge facilities because it is not part of the existing infrastructure.

High Line (B-Line) Irrigation Canal

The High Line (B-Line) Canal originates from the A,B-Line Canal about one-half mile south of Bucks Corners. Geologic maps indicate that the B-Line Canal does not begin to flow over or near the coarse-grained glaciofluviatile sediments until it reaches Section 31, T.4N., R.28E. From this point the B-Line travels in a southwesterly direction for roughly five canal miles until it reaches Lost Lake. This five-mile stretch generally runs parallel to the edge of the thick deposits of glaciofluviatile material with the canal usually one-half to one mile away from the potential recharge areas. The capacity of the B-Line Canal from its origin to Lost Lake is approximately 60 cfs.

The B-Line Canal could be utilized in either of two ways in the recharge project. The two possibilities are (1) increased use of the existing County Line Recharge Canal to its full capacity or (2) the construction of a new recharge canal or recharge facility in the vicinity of Sections 34, 35, or 36, T.4N., R.27E. or Section 31, T.4N., R.28E.

County Line Recharge Canal. The County Line Recharge Canal (CLRC) is managed by the County Line Water Improvement District (CLWID) which is principally made up of local farmers. CLRC begins on the county line between Umatilla County and Morrow County in Section 3, T.3N., R.27E. (see Figure 3-1). The canal has a total length of approximately 3 miles and terminates along the section line between Sections 29 and 32, T.4N., R.27E. The beginning of CLRC is connected to the B-Line Canal by a 1.5 mile, 36-inch diameter steel pipe. A flow gaging station at the outlet of this 36-inch pipe (at the beginning of CLRC) has been used to measure flows entering CLRC since the late 1970's when the canal began to be used for recharge purposes. Records from this gage have shown the pipe flow capacity to be approximately 50 cfs (99 acre-feet per day) when no significant back pressure exists on the pipe outfall. For purposes of computing recharge potential to CLRC, an operational pipe flow capacity of 43 cfs (85 acre-feet per day) was selected based on information from the period of record. The capacity of the open channel canal itself, when free of tumbleweeds, is estimated to be between 60 and 70 cfs. Currently, CLWID is recharging an average of 6,200 acre-feet per year through CLRC. Taking into account the time periods in which flows can be diverted from the Umatilla River, the flow capacity of the B-Line Canal, and the 43 cfs operational capacity of CLRC's 36-inch diameter pipe, the total potential recharge capacity of CLRC is approximately 10,600 acre-feet per year. (The derivation of this total recharge capacity is given in Table A-1 and is discussed in more detail in Appendix A)

New Recharge Canal. As mentioned previously, a new recharge canal or facility, possibly similar to the CLRC, could be constructed so that flow would be diverted from the B-Line Canal into the new canal. The new recharge canal would probably have to be constructed in the high potential recharge areas in either of Sections 34, 35, or 36, T.4N., R.27E. or Section 31 of T.4N., R.28E. (see Figure 3-1). Depending on the location of such a new recharge facility, the length of the canal or pipe diverting water from the B-Line Canal to the new recharge facility may vary in length from as little as one mile to as much as two miles. Calculations of water availability in the B-Line Canal (as presented in column L of Table A-1) during the recharge months of November through April indicate that the capacity of a new recharge facility should be in the range of 35 to 50 cfs.

RECHARGE INFILTRATION RATES

Little information is available on vertical infiltration rates through the permeable glaciofluviatile and alluvial material. The Stanfield-Westland Irrigation District has some experience in monitoring infiltration losses through certain portions of the A-Line Canal and the CLRC. From information supplied by the district manager, clean (silt free) canal vertical infiltration rates were estimated to be roughly 20 feet per day (i.e., 20 acre-feet of water can pass vertically through a one acre surface area in one day) for the A-Line Canal near Lamb Weston Factory and 30 feet per day for CLRC.

Some general information on infiltration rates in the project area is also supplied by the USDA-SCS. In the SCS's *Soil Survey of Umatilla County, Oregon*, the soils which overlay the glaciofluviatile and alluvial gravels are mainly classified as either Burbank or Quincy soil series. In all cases, these soil types are reported to have vertical infiltration capacities in the range of 12 to 40 feet per day. These numbers are reasonable when compared to the estimates of 20 and 30 feet per day from the Irrigation District experience in the project area.

All of the above infiltration rate figures are only rough estimates of the actual rates. These rates assume that the subsurface geology is suitable for recharge. Exploratory boreholes should be drilled prior to site development to confirm that hydraulically restrictive layers are not present at shallow depths. The actual infiltration rates at the recharge sites selected will need to be verified through recharge monitoring. For the purposes of this initial evaluation of recharge sites, a vertical infiltration rate of 25 feet per day was assumed for all sites.

AVERAGE ANNUAL RECHARGE POTENTIAL TO A-LINE CANAL AND B-LINE CANAL RECHARGE SITES

Average recharge potential to the A-Line and B-Line canal recharge sites was determined from Umatilla River stream flow records, CLWID recharge records, and irrigation district operational experience. Recharge potential to the identified recharge sites by month is shown in Table 3-1. A detailed explanation of recharge availability calculations is given in Appendix A. An examination of Table A-1 shows the amount of water available for recharge is currently limited by the conveyance capacities of the two existing canals that would bring water to the sites. (Note that the A-Line recharge potential does not include the additional 30 cfs that may be available from the proposed Cottonwood Bend pumping facilities.)

CONCEPTUAL DESIGN AND PRELIMINARY COST ESTIMATES OF RECHARGE ALTERNATIVES

Tables 3-2 and 3-3 summarize two alternatives for recharge via the A-Line Canal. Similarly, Tables 3-4 and 3-5 summarize two alternatives for recharge via the B-Line Canal. Each table includes a summary of operational and recharge site parameters, a conceptual design of the alternative, and preliminary estimates of capital and annual operational costs for the given alternative. Cost estimates are based upon 1989 price levels. Cost estimates for property purchase or annual lease of property are not included.

Tables 3-2 and 3-3 suggest that the two recharge alternatives (Highway 30 gravel pit and the Highway I-82 gravel pit) are essentially equal with respect to both productivity and costs with the exception of the cost of acquiring the property at each site. One advantage the Highway 30 gravel pit may have over the I-82 gravel pit is that it will be able to accept all the flow from the A-Line Canal during peak recharge periods (80 cfs) while the I-82 gravel

TABLE 3-1
AVERAGE ANNUAL ADDITIONAL RECHARGE POTENTIAL OF A-LINE CANAL AND B-LINE CANAL RECHARGE SITES**

MONTH	Avg. # of Days with Flows Exceeding ~400 cfs* (DAYS)	Recharge Potential to Sites Fed by A-Line Canal (AF)	Additional Recharge Potential to C.L.R.C. (AF)	Additonal Recharge Potential to New Site Fed by B-Line Canal (AF)	Total Additional Recharge Potential for A-Line Canal Recharge Sites & C.L.R.C. (AF)	Total Additional Recharge Potential for A-Line Canal & New B-Line Recharge Site. (AF)
OCTOBER	0.0	0	0	0	0	0
NOVEMBER	4.5	711	288	446	999	1157
DECEMBER	16.5	2607	990	1568	3597	4175
JANUARY	17.5	1383	840	840	2223	2223
FEBRUARY	23.0	1817	414	414	2231	2231
MARCH	28.0	4424	980	1960	5404	6384
APRIL	25.0	1975	925	925	2900	2900
MAY	14.0	0	0	0	0	0
JUNE	4.0	0	0	0	0	0
JULY	0.0	0	0	0	0	0
AUGUST	0.0	0	0	0	0	0
SEPTEMBER	0.0	0	0	0	0	0
Totals	**133**	**12900**	**4400**	**6200**	**17300**	**19100**
x Operational Efficiency of 80%:						
Adjusted Totals		**10400**	**3600**	**5000**	**14000**	**15400**

* Based upon nine years (1980-1988) of streamflow data for the Umatilla River near Umatilla, OR., (USGS station # 14033500).

** This table does not reflect the 30 cfs that might be available from the proposed Cottonwood Bend pumping facilities.

TABLE 3-2

A-LINE PILOT RECHARGE ALTERNATIVE NO. 1

RECHARGE SITE: HIGHWAY 30 GRAVEL PIT

SUMMARY OF OPERATIONAL AND RECHARGE SITE PARAMETERS

• Average Annual Recharge Potential to Site From A-Line Canal	10,400 acre-ft
• Recharge Season Duration	~85 days
• Average Recharge Loading Rate to Site	122 acre-ft/day
• Maximum Flow Through Turnout Structure	80 cfs
• Turnout Conveyance Potential Over Recharge Season	~13,500 acre-ft
• Site Bottom Seepage Area	~11 acres
• Site Usable Volume	~325 acre-ft
• Average Depth of Site Beneath A-Line Canal Bottom	~25 ft
• Estimated Initial Seepage Rate of Recharge Site	~25 ft/day

CONCEPTUAL DESIGN: The entire available recharge conveyance potential of the A-Line Canal (~10,400 acre feet per year as given in Table 3-1) is diverted via a new 80 cfs turnout and stop-log diversion structure into the Highway 30 gravel pit. An estimated 200 feet of 48-inch CMP would be necessary to convey 80 cfs into the recharge site. A 48-inch canal gate would be installed at the headwall to control recharge flow and large riprap would be used at the pipe outlet to dissipate excess energy.

TABLE 3-2

A-LINE PILOT RECHARGE ALTERNATIVE NO. 1
(Continued)

PRELIMINARY COST ESTIMATES

CAPITAL COSTS (C.C.):

Item	Quantity	Unit Cost	Total Cost
Turnout Facility			
• 48" CMP	~200 ft	$35/ft	$7,000
• 48" Seating Head Canal Gate	1	$3,500	$3,500
• 16' Headwall & Turnout Facility (with flow measurement ability)	1	$6,000	$6,000
• Stop-Log Diversion Structure	1	$5,000	$5,000
• Overpass Walkway	1	$6,000	$6,000
• Miscellaneous	1	$3,000	$3,000
	Subtotal		$30,500
Outfall Structure for Energy Dissipation			
• 18" Riprap (installed)	30 c.y.	$85/c.y.	$2,500
	Subtotal		$2,500
	C.C. Subtotal		$33,000
	+ ~20% Contingency		$7,000
	C.C. Total		**$40,000**

ANNUAL OPERATIONAL COSTS (A.O.C.):

Item	Quantity	Unit Cost	Total Cost
Water Transportation Costs (paid to W.I.D.)	10,000 acre-ft	$5/acre-ft	$50,000
Operational Costs (5 man-hours/week)	100 man-hours	$20/man-hour	$2,000
Silt Removal/Maintenance (1 day per cleaning)	1 cleaning	$1,000/cleaning	$1,000
Monitoring (water levels & water quality)		$10,000	$10,000
	A.O.C. Subtotal		$63,000
	+ ~10% Contingency		$6.300
	A.O.C. Total		**$69,300**

TABLE 3-3

A-LINE PILOT RECHARGE ALTERNATIVE NO. 2

<u>RECHARGE SITE</u>: HIGHWAY I-82 GRAVEL PIT

<u>SUMMARY OF OPERATIONAL AND RECHARGE SITE PARAMETERS</u>

• Average Annual Recharge Potential to Site From A-Line Canal	10,400 acre-ft
• Recharge Season Duration	~85 days
• Average Recharge Loading Rate to Site	122 acre-ft/day
• Maximum Flow Through Turnout Structure	~60 cfs
• Turnout Conveyance Potential Over Recharge Season	~10,100 acre-ft
• Site Bottom Seepage Area	~16 acres
• Site Usable Volume	~325 acre-ft
• Average Depth of Site Beneath A-Line Canal Bottom	~20 ft
• Estimated Initial Seepage Rate of Recharge Site	~25 ft/day

<u>POSSIBLE COMPLEMENTARY RECHARGE SITE</u>: SMALL ABANDONED LEAKY CANAL SERVICED BY A MAIN LINE OF PRESSURIZED SYSTEM

• Recharge Season Duration	~85 days
• Maximum Flow Through 14-inch F-Line	~5 cfs
• Conveyance Potential To Abandoned Canal Over Recharge Season	~840 acre-ft
• Length of Site B Recharge Canal	~0.5 miles
• Site Bottom Seepage Area	~1 acre
• Average Recharge Loading Rate to Site	10 ft/day
• Estimated Initial Seepage Rate of Recharge Site	~25 ft/day

<u>CONCEPTUAL DESIGN</u>: As much as possible of the entire available recharge conveyance potential of the A-Line Canal (~10,400 acre feet per year as given in Table 3-1) is diverted via a new 42-inch turnout and stop-log diversion structure into an existing 36-inch CMP which runs from the east side of the lined A-Line Canal underneath the A-Line Canal and Highway I-82 into the vacant borrow pit. The capacity of the existing 36-inch CMP is estimated to be only 60-70 cfs and the maximum flow capacity of the A-Line Canal is 80 cfs. Thus, there may be periods when recharge flow in the A-Line Canal exceeds the flow capacity of the 36-inch CMP. For this reason, pumping of another 5 cfs from the A-Line Canal through the new pressurized irrigation system and into an old abandoned leaky canal in the SE1/4, NE1/4, Section 7, T.4N., R.28E. for additional recharge could be considered.

TABLE 3-3

A-LINE PILOT RECHARGE ALTERNATIVE NO. 2
(Continued)

PRELIMINARY COST ESTIMATES

CAPITAL COSTS (C.C.):

Item	Quantity	Unit Cost	Total Cost
Turnout Facility			
• 42" Seating Head Canal Gate	1	$3,000	$3,000
• 16' Headwall & Turnout Facility (with flow measurement ability)	1	$6,000	$6,000
• Stop-Log Diversion Structure	1	$5,000	$5,000
• Overpass Walkway	1	$6,000	$6,000
• Miscellaneous	1	$3,000	$3,000
	Subtotal		$23,000
Outfall Structure for Energy Dissipation			
• 18" Riprap (installed)	30 c.y.	$85/c.y.	$2,500
	Subtotal		$2,500
	C.C. Subtotal		$25,500
	+ ~20% Contingency		$4,500
	C.C. Total		**$30,000**

ANNUAL OPERATIONAL COSTS (A.O.C.):

Item	Quantity	Unit Cost	Total Cost
Water Transportation Costs (paid to W.I.D.)	10,000 acre-ft	$5/acre-ft	$50,000
Power Costs (for pumping 840 acre-ft to small leaky canal)	60,000 kw-hr	$0.05/kw-hr	$3,000
Operational Costs (5 man-hours/week)	100 man-hours	$20/man-hour	$2,000
Silt Removal/Maintenance (1 day per cleaning)	1 cleaning	$1,000/cleaning	$1,000
Monitoring (water levels & water quality)		$10,000	$10,000
	A.O.C. Subtotal		$66,000
	+ ~10% Contingency		$6,600
	A.O.C. Total		**$72,600**

TABLE 3-4

B-LINE PILOT RECHARGE ALTERNATIVE NO. 1

RECHARGE SITE: **ADDITIONAL RECHARGE TO CLRC**

SUMMARY OF OPERATIONAL AND RECHARGE SITE PARAMETERS

• Average Annual Additional Recharge Potential to Site From B-Line Canal	~3600 acre-ft
• Current Average Annual Recharge to Site from B-Line Canal	~6200 acre-ft
• New Total Annual Recharge to Site from B-Line Canal	~9800 acre-ft
• Recharge Season Duration	~85 days
• Average Total Recharge Loading Rate to Site	~115 acre-ft/day
• CLRC Bottom Seepage Area*	~4.5 acres
• Site Usable Volume	~30 acre-ft
• Estimated Initial Seepage Rate of Recharge Site	~25 ft/day

* Note that this bottom seepage area does not include the open field at the end of CLRC which is commonly flooded during high recharge periods.

CONCEPTUAL DESIGN: An additional 3600 acre feet per year (over the current average annual recharge of approximately 6200 acre-feet) is diverted to CLRC via the B-Line Canal. Because CLRC is currently in use, no new construction would be necessary for diverting the additional 3600 acre feet per year. Only operation and maintenance costs would be incurred.

TABLE 3-4

B-LINE PILOT RECHARGE ALTERNATIVE NO. 1
(Continued)

PRELIMINARY COST ESTIMATES

CAPITAL COSTS (C.C.):

Item	Quantity	Unit Cost	Total Cost
None			$0
	C.C. Total		**$ 0**

ANNUAL OPERATIONAL COSTS (A.O.C.):

Item	Quantity	Unit Cost	Total Cost
Water Transportation Costs (paid to W.I.D.)	3600 acre-ft	$5/acre-ft	$18,000
Silt Removal/Maintenance (2 days per cleaning)	2 cleanings	$2,000/cleaning	$4,000
Monitoring (water levels & water quality)		$10,000	$10,000
	A.O.C. Subtotal		$32,000
	+ ~10% Contingency		$3,200
	A.O.C. Total		**$35,200**

TABLE 3-5

B-LINE PILOT RECHARGE ALTERNATIVE NO. 2

RECHARGE SITE: **NEWLY CONSTRUCTED RECHARGE CANAL OR RECHARGE FACILITY**

SUMMARY OF OPERATIONAL AND RECHARGE SITE PARAMETERS

• Average Annual Additional Recharge Potential to Site From B-Line Canal	~5000 acre-ft
• Recharge Season Duration	~85 days
• Average Recharge Loading Rate to Site A	~59 acre-ft/day
• Site Bottom Seepage Area	~3 to 4 acres
• Estimated Initial Seepage Rate of Recharge Site	~25 ft/day

CONCEPTUAL DESIGN: Approximately 5000 acre-feet of recharge would be conveyed via the B-Line Canal to a newly constructed recharge canal or recharge facility each year. The recharge from the B-Line Canal would be conveyed to the new facility through approximately 6000 feet of canal. It is estimated that roughly 3 to 4 acres of seepage area (either canal bottom or a small recharge facility) would have to be utilized in order to keep the average vertical recharge loading rate to the new recharge site under 20 feet per day.

TABLE 3-5

B-LINE PILOT RECHARGE ALTERNATIVE NO. 2
(Continued)

PRELIMINARY COST ESTIMATES

CAPITAL COSTS (C.C.):

Item	Quantity	Unit Cost	Total Cost
Turnout Facility			
• Conveyance Canal (~12' bottom width, 6' depth)	~6,000 ft	$15/ft	$90,000
• 36" Seating Head Canal Gate	1	$1,500	$1,500
• 12' Headwall & Turnout Facility (with flow measurement ability)	1	$4,500	$4,000
• Stop-Log Diversion Structure	1	$5,000	$5,000
• Overpass Walkway	1	$3,000	$3,000
• Miscellaneous	1	$2,500	$2,500
	Subtotal		$106,000
Recharge Canal Construction (~12' bottom width, 6' depth)	~10,000 ft	~$15/ft	~$150,000
	Subtotal		$150,000
	C.C. Subtotal		$256,000
	+ ~20% Contingency		$51,000
	C.C. Total		**$307,000**

ANNUAL OPERATIONAL COSTS (A.O.C.):

Item	Quantity	Unit Cost	Total Cost
Water Transportation Costs (paid to W.I.D.)	4,700 acre-ft	$5/acre-ft	$23,500
Operational Costs (5 man-hours/week)	100 man-hour	$20/man-hour	$2,000
Silt Removal/Maintenance (2 days per cleaning)	1 cleaning	$2,000/cleaning	$2,000
Monitoring (water levels & water quality)		$10,000	$10,000
	A.O.C. Subtotal		$37,500
	+ ~10% Contingency		$3,800
	A.O.C. Total		**$41,300**

pit may only be able to accept 60 or 70 cfs of the maximum 80 cfs during peak recharge periods because the 36-inch CMP may restrict flow. However, considering that some leakage will probably take place through the A-Line Canal bottom itself and that the old abandoned leaky canal in Section 7, T.4N., R.28E. can be used as a complementary recharge facility, it is assumed that the full 80 cfs can be used at this site. Thus, the cost to lease or obtain permission to use either of these two recharge sites will likely dictate which is most favorable.

Finally, inspection of the preliminary cost estimates in Tables 3-4 and 3-5 show that, if possible, use of the available additional recharge capacity in CLRC (~3,600 acre-feet per year) is much less expensive than the alternative of constructing a new recharge facility to achieve almost the same recharge (~5,000 acre-feet per year).

AMOUNT AND TIMING OF FLOWS RETURNING NATURALLY TO THE UMATILLA RIVER AND AMOUNT OF GROUNDWATER AVAILABLE FOR PUMPING

Based on the complexity of the Umatilla groundwater/surface water system, it is impossible to accurately predict the amount and timing of Umatilla River baseflow increases that would result from artificial groundwater recharge. However, rough estimates can be made based on past responses of groundwater levels and spring discharge rates to leakage from irrigation canal and recharge from the CLWID project. As would be expected, recharge at those sites near the river are expected to rapidly increase river baseflow and have only short-term storage properties. Sites farther from the river will have better longer-term storage characteristics, with less river baseflow contribution. As a result, the amount of groundwater available for pumping will be a large percentage of the amount of water recharged if the recharge site is several miles away from the river.

The amount of groundwater available for either (1) pumping to the river for direct river flow supplementation or (2) pumping to irrigation in exchange for surface water irrigation flows will be somewhat site specific. The primary criteria to be considered will be adverse impacts to nearby irrigation and domestic wells. For instance, pumping for flow supplementation or exchange could cause unacceptable water level interference with existing wells. Unacceptable interference would result if pumping levels in existing wells were lowered to pump intakes because of the drawdown effects of flow supplementation pumping or exchange pumping. The potential for well interference will be greatest during the irrigation season when irrigation wells are operating. During portions of the non-irrigation season (i.e. late October, November, and December), pumping of groundwater for direct river flow supplementation would probably be viable, provided that water pumped from groundwater storage is replaced with recharged water during the following winter and early spring.

Highway 30 Gravel Pit

Groundwater recharge at the Highway 30 Gravel Pit site would probably result in a rapid baseflow increase to the Umatilla River. The majority of the recharged water would probably be lost to baseflow increases. This baseflow might occur downstream of Cottonwood Bend, assuming that the water-table elevation is below the elevation of the river surface upstream of Cottonwood Bend. If the water table rises (as a result of recharge mounding) to stream level in the reach above Cottonwood Bend, then baseflow increase will probably occur above Cottonwood Bend, within about a mile of the recharge site. Given the proximity of the Highway 30 site to the river (about one-mile), it is unlikely that substantial long-term (i.e. several months or more) storage could be achieved at this site. However, given a relatively short storage period the timing of return flows (i.e. river baseflow increases resulting from winter recharge) may be good for spring-time river flow supplementation. Timing of return flows for fall flow supplementation is expected to be poor. Storage of water for summer irrigation exchange or pumping to the river in the fall is also expected to be poor in comparison to sites farther from the river. Exchange or pumping to the river may be practical if nearby wells are not adversely affected. However, the amount of water pumped will probably be less than the amount of water recharged because of "losses" of recharged water to river baseflow. The amount of water available could be determined on a trial pumping basis.

I-82 Gravel Pit

Groundwater recharge at the I-82 gravel pit will result in less rapid return flow than the Highway 30 gravel pit. This is due to the greater distance to the anticipated discharge points. Return flow of recharged water would probably occur in the vicinity of the Bridge Road springs. These springs are approximately 2.5 miles east of the I-82 gravel pit. In the past, flow from these springs usually increased approximately three weeks after the start of the irrigation season. This early response was probably caused by leakage from laterals within about a mile of the river. Given this distance, it is possible that a delay of a month or more would occur between the start of recharge and the increase in discharge from the springs.

As with the Highway 30 gravel pit, the timing of return flows from winter recharge operations will probably be good for spring-time river flow supplementation. Timing of return flows for fall flow supplementation are expected to be poor. Storage of water for summer irrigation exchanges or pumping to the river in the fall may be practical if nearby wells are not adversely affected. Adverse effects to nearby wells would result if pumping from wells for river flow supplementation caused unacceptable groundwater level declines.

Abandoned A-Line Lateral

Recharge from the abandoned A-Line lateral is expected to cause increased spring flow at the Bridge Road springs within about a month of the start of recharge. This lateral may have been the source of recharge for these springs in the past (prior to the pressurized irrigation system) when leakage of irrigation flows from the canal was substantial. Storage at this site may be relatively short-term (as evidenced by the three week response time of the springs). Exchange or pumping to the river may be practical if nearby wells are not adversely affected. However, the amount of water pumped will probably be less than the amount of water recharged.

County Line Water Improvement District Canal

Recharge using the CLWID canal has demonstrated the use of shallow groundwater storage of surface water for later pumping by wells. This storage has been utilized effectively by irrigators in the area who pump the entire amount of groundwater which is artificially recharged. Recharged water from the CLWID may have also increased baseflow to the Umatilla River by raising groundwater levels in the Westland Road area. The baseflow augmentation from the CLWID canal is probably a slow, year-round type response rather than a rapid response that would be expected at a site close to the river.

New Recharge Canal

The movement of recharged water and effects on water levels and river baseflow from a new recharge canal site east of the CLWID project will depend upon the location of the facilities. If the canal is close to the CLWID project, then good storage capabilities with only small river baseflow augmentation can be expected. If the facility is constructed closer to the river, then the baseflow augmentation will increase while the storage capabilities will probably decrease.

UTILIZATION OF RECHARGED GROUNDWATER BY PUMPING

As previously discussed, utilization of recharged groundwater can occur through either natural return flow to the river or through pumping from wells. If pumped from wells, the water can be either exchanged with irrigators for surface water flows or pumped directly to the river for flow augmentation. Costs for either pumping scenario are similar, consisting primarily of capital costs for wells and pumps plus annual costs for operation (mainly power) and maintenance.

On an exchange basis, the groundwater could be pumped from wells directly into existing canals. Wells would probably be located adjacent to the canals, in areas where the canals or laterals cross the shallow glaciofluviatile aquifer. Diversions of river flow into the canals would be reduced by an amount equal to the groundwater pumped from the wells. If the exchange is made with irrigators who own water stored in McKay Reservoir, the stored water could be released when flow augmentation is most needed. An advantage of exchange is that flow augmentation would occur along the entire river below McKay Creek whereas natural return flow augmentation will probably occur only below Cottonwood Bend.

If the groundwater is pumped directly to the river, pumping would occur in areas where the glaciofluviatile aquifer is near the river. Therefore, flow augmentation would not occur in the reaches of the river upstream of the glaciofluviatile aquifer. Areas where pumping would occur would depend somewhat upon the location of recharge facilities, but would probably be within a few miles of Cottonwood Bend.

Wells for extracting water from the glaciofluviatile deposits would probably have yields in the range of 1,000 to 3,000 gpm. Costs for construction of these wells are expected to average about $25,000 each (assuming 16-inch diameter wells with average depths of 175 feet). Pump, motor, and controls are estimated to average $20,000 per well. Miscellaneous facilities and piping may total an additional $5,000 per well. Thus, capital costs for each well are expected to be about $50,000.

Power costs to pump from these wells are estimated to be about $8.50 per acre-foot or $17 per cfs per day. This estimate assumes an average pump lift of 125 feet, power costs of $0.05/kw-hr, and 75 percent pump efficiency. Maintenance and replacement costs for each well and pump are estimated to be $4,000 annually.

Assuming an average well yield of 1,800 gpm (4 cfs), 10 wells would produce approximately 14,250 acre-feet if pumped continuously during a 180-day irrigation season. If this amount of groundwater was exchanged with irrigators for surface water stored in McKay Reservoir, flow augmentation of 100 cfs could be released as needed for a period of about 70 days each year. Capital costs for 10 wells would total approximately $500,000. Annual operation and maintenance costs would total $160,000 ($120,000 for power and $40,000 for maintenance). A summary of these well construction and operational cost estimates is given in Table 3-6.

TABLE 3-6

SUMMARY OF WELL CONSTRUCTION AND OPERATION COST ESTIMATES

CAPITAL COSTS (C.C.):

Item	Quantity	Unit Cost	Total Cost
•Well Construction (16" diameter well with casing depth of 175')	10 wells	$25,000/well	$250,000
•Pump, Motor, & Controls	10 wells	$20,000/well	$200,000
•Piping & Miscellaneous	10 wells	$5,000/well	$50,000
	C.C. Total		**$500,000**

ANNUAL OPERATIONAL COSTS (A.O.C.):

Item	Quantity	Unit Cost	Total Cost
•Power Costs (assuming well yield of 1800 gpm, avg. lift of 125', and continuous operation for 180 days)	240,000 kw-hr (per well)	$0.05/kw-hr	$120,000
•Pump & Well Maintenance	10 wells	$4,000/well	$40,000
	A.O.C. Total		**$160,000**

Section 4

SECTION 4

IMPLEMENTATION PLAN FOR PILOT FACILITIES

As noted in the previous section, the available conveyance capacity of the A-Line and B-Line Canals is the limiting factor on the total recharge potential for the project study area if only existing facilities are utilized. This limitation is applicable for considerations of the pilot program only. It is assumed that under full implementation the conveyance facilities would be modified to allow for full utilization of all water resources available to recharge the shallow groundwater aquifer. New conveyance facilities could potentially serve recharge sites (not identified for pilot projects) which are located away from existing canals. These potential full scale sites would be within the area identified on Figure 2-1. The capacity of existing conveyance facilities allows only 14,000 acre-feet per year to be recharged if both the A-Line and the B-Line Canals are utilized (without additional development of new facilities on the B-Line Canal or the potential 30 cfs which could be supplied by the proposed Cottonwood Bend pumping facilities). It is desirable for a pilot demonstration project to recharge the maximum quantity of available water. This maximum recharge will provide the best understanding of aquifer characteristics.

RECOMMENDED RECHARGE SITES FOR THE PILOT PROJECT

Evaluations made by JMM indicate that utilizing both the A-Line and B-Line Canals will be necessary to provide the maximum amount of water to the recharge sites. The amount of recharge available to supply sites located along the A-Line Canal would average about 10,400 acre-feet per year (assuming an 80 percent operational efficiency). Approximately 5,000 acre-feet of recharge water could be conveyed annually through the B-Line Canal (in addition to the amount of water currently diverted through the B-Line Canal for the CLWID recharge project). By utilizing the CLWID project to full capacity, 3,600 acre-feet of the available 5,000 acre-feet could be recharged. Thus, the total recharge available using one site on the A-Line and the additional capacity in the County Line Recharge Canal totals (10,400 + 3,600) 14,000 acre-feet per year.

In order to fully utilize the existing capacity of the B-Line and provide the maximum recharge amount of 15,400 (10,400 + 5,000) acre-feet per year, a new recharge canal, as suggested in Section 3, would need to be constructed. It was determined that up to 5,000 acre-feet per year could be recharged at this new location if CLRC does not increase its recharge volume over the current average recharge of 6,200 acre-feet per year. Due to the expense of constructing the new recharge canal compared to other existing facilities, this alternative was eliminated from the pilot project proposal.

A-Line Canal

Since one of the primary objectives in conducting the pilot project is to obtain new data regarding the response of the shallow aquifer to recharge loadings, beyond that presently being obtained in the County Line area, it is proposed that the site on the A-Line Canal furthest away from the existing recharge site be selected. It is therefore recommended that the I-82 Borrow Pit site be developed for the pilot project. By selecting the I-82 site, the potential of overlapping recharge effects from the County Line area would be greatly reduced. Thus, the I-82 site should be the optimal site for monitoring recharge travel time in the aquifer to the Umatilla River. This information, when utilized with the data from the CLRC, will therefore increase the level of technical understanding which will be beneficial prior to designing the full-scale development project.

One remaining factor that must be considered prior to finalizing the I-82 site selection for the pilot project involves the cost of gaining access to and utilizing the recharge sites on a lease or purchase basis. As noted in earlier sections, the estimated development costs for both sites along the A-Line are nearly the same. During the writing of this report, access costs to the sites were not available. If these costs, once developed, are significantly different and if budget constraints become a governing criterion, a re-evaluation of the final site selection should be made before implementation.

B-Line Canal

As noted on Table 3-1, the additional amount of water that could be recharged using the CLRC totals about 3,600 acre-feet. It is proposed that this additional quantity of water be conveyed through the B-Line Canal to increase the average historic recharge using the existing CLWID facilities. Providing the additional quantity for recharge at this location would increase the historical recharge amounts by 58 percent without requiring significant modification to the existing monitoring facilities. Providing the additional recharge amount would enhance the existing database and may provide better defined aquifer responses at a location further away from the Umatilla River than the A-Line site.

Using existing and new data from the CLRC in conjunction with the new data to be developed at the A-Line site, the pilot project should provide sufficient information for determining the technical feasibility of full implementation.

CONSTRUCTION

The following facilities must be constructed on both the A-Line Canal and B-Line Canal in order to fully utilize the proposed recharge sites. The construction elements include the facilities for recharge and also the necessary monitoring equipment required for monitoring flow rates, recharge quantities, groundwater levels, and groundwater quality.

Additional hydrogeologic investigations should be performed before choosing final locations for pilot recharge facilities. These investigations should include borings at recommended sites to confirm that subsurface conditions are conducive to artificial recharge. Investigation of groundwater flow direction is also recommended.

A-Line Canal Facilities

At the I-82 site, an adequate diversion facility to redirect the water into the turnout would include an access walkway, a check board diversion structure, a concrete headwall, and an appropriate flow measurement device. The associated construction costs have been indicated on Table 3-3. The 42-inch turnout would be connected to the existing 36-inch arched corrugated metal pipe (CMP) that was installed during the construction of the freeway. The water diverted from the 42-inch headgate would flow into the existing CMP under the freeway and discharge into the existing gravel pit site on the west side of I-82. No additional CMP would be required, to convey the water to the bottom of the pit, but an estimated 30 cubic yards of 18 inch riprap material would be required to dissipate the energy. As noted in early sections, the exact discharge capacity of the 36-inch pipe was unknown, lacking information on the actual slope. Based upon an estimation of the slope, the carrying capacity of the 36-inch pipe was estimated to be 50 to 70 cfs. In order to fully utilize the capacity of the A-Line Canal, an additional 5-10 cfs may be removed by pumping from the existing pump station, that serves the pressurized irrigation system, into an abandoned canal (see Figure 3-1). The abandoned canal system could be utilized for recharge purposes. Therefore, by utilizing the I-82 gravel pit and the abandoned canal system, the full 80 cfs capacity of the A-Line could be utilized in recharge. The additional power cost for pumping 840 acre-feet into the abandoned canal would total about $3,000 per year plus other maintenance and replacement costs.

At the I-82 site, monitoring wells would be required to determine the effects of recharge. It is recommended that a minimum of three existing wells be selected near each site for monitoring the effects of recharge on the localized area. Prior to implementing the pilot phase, a "base condition" of both water levels and water quality should be developed which will be used to measure change caused by the recharge program. By obtaining permission to utilize existing wells, it will be possible to minimize the cost for the pilot project. Two additional wells located down-gradient might also be helpful to further track the influence of the recharge plume, as it moves toward the river system.

B-Line Canal Facilities

It is proposed that the CLRC also be utilized to its fullest extent to provide the largest quantity of recharge for the pilot program possible without constructing any new recharge facilities. Prior to fully utilizing the CLRC, a thorough cleaning of the canal would be required to ensure maximum infiltration rates. It is assumed that the existing monitoring system in use would generally be adequate for the pilot project with only minor modifications or additions. Similar parameters to those being monitored at the A-Line site would likewise be observed at this location. In order to use these existing facilities, a leasing agreement will probably be required with CLWID. If a lease is not possible, for whatever reason, the alternative B-Line new recharge site discussed in Section 3 should be considered. This site (see Figure 3-1) and its associated development costs are listed in Table 3-5. Capital costs for the construction of such a new facility would be approximately $300,000 while annual operational costs would total about $41,000 for the recharge of 5,000 acre-feet. It was assumed that appropriate conveyance, diversion and monitoring works would be constructed if this site were selected.

OPERATIONS

The pilot program should be operated in a manner similar to past recharge operations of the Westland Irrigation District. During past operations, the Westland Canal is shut off for maintenance immediately following the delivery of the last irrigation water. Upon completion of maintenance work, the canal is then refilled for delivery of recharge water. Recharge deliveries typically begin in November. The historic CLWID diversions have been reduced during the months of January and February for freezing conditions that develop. Similar operations were assumed to determine the volumes available for recharge in this study.

The amount of recharge available through the A-Line and B-Line Canals is shown in Table 3-1. An estimated total recharge volume of 14,000 acre-feet may result by using this proposed operation for the pilot project. It is worthy to note that during the operation of the recharge project there will continue to be leakage within the conveyance facilities themselves. The volume of conveyance seepage has not been included in our estimates, but will be an integral part of the recharge system. JMM's analysis involved many assumptions in the availability of water. If more water is available from the river system than calculated, the pilot project should attempt to divert it, up to the canal capacity of both the A-Line Canal and the B-Line Canal.

MONITORING

To determine the effects on local groundwater quantity and quality, monitoring is required in areas adjacent to the proposed recharge sites. To minimize and reduce associated costs with the pilot program, it is proposed that existing domestic and irrigation wells be utilized insofar as possible to monitor groundwater movement from the recharge sites. As discussed in earlier sections, it is proposed that a minimum of three existing wells located near or adjacent to each of the recharge facilities be utilized to monitor groundwater levels, movement, and quality. In order to further track the recharged groundwater, it is proposed that one or two additional groundwater wells be monitored down-gradient, toward the river, to further characterize groundwater movement. Assuming that monitoring will not include drilling of new wells, costs for monitoring at each site will be similar. The monitoring costs (assuming no construction of new wells) for the wells will probably be in the range of $10,000 per year per site.

It is recommended that monitoring should begin a full year before recharge operations are implemented. Monitoring will include groundwater levels, discharge rates from springs, river baseflow, and groundwater quality.

Groundwater Levels

A recorder should be installed on at least one monitoring well at each site to provide a continuous water-level record. Water-level monitoring should begin prior to recharge activities. In order to obtain the best data and for ease of installation of the recording device, it is recommended that a well not equipped with a pump be used as the recorder well. The wells not equipped with recorders can be monitored using manual water-level measurements. Data from the continuous water-level recorder can be extrapolated to the non-recorder wells to allow for a closer evaluation.

Groundwater elevations should ideally be monitored for a full year prior to initiation of recharge operations, and year-round thereafter. This schedule will provide the baseline and operational data needed to assess the project effects on groundwater conditions. The wells which are not equipped with recorders should be monitored monthly to allow for correlation of the data from the recording wells.

Spring Discharge and River Baseflow

It is proposed that the springs down-gradient of the selected recharge sites be monitored to determine any variation in flow and the response time of the recharge effects. Random flow measurements may be made or measuring devices installed, such as weirs, to allow for quantification if so desired by the USBR. In addition to spring discharge, river flow should be monitored closely to determine the effect of recharge operations on baseflow. This monitoring may require installation of a stream gage in the the vicinity of Cottonwood Bend.

As with the groundwater-level monitoring, spring discharge and baseflow monitoring should begin a full year before the start of recharge operations to fully document baseline conditions.

Water Quality

Water quality monitoring should be performed to determine any changes in groundwater quality resulting from recharge activities. This monitoring should include at least two groundwater sampling events utilizing all applicable monitor wells prior to initiation of recharge activities. This sampling before recharge begins is necessary to properly characterize background water quality. During recharge operations, groundwater and recharge water should be sampled on a semi-annual basis. Water samples should be analyzed for standard cations and anions, pH, conductivity, TDS, TSS, hardness, (and any other constituents of concern).

Section 5

SECTION 5

INTERMEDIATE DEVELOPMENT PHASE

Following the completion of the pilot recharge program, an intermediate development phase is proposed which would allow for a complete evaluation of the pilot program and its effectiveness in meeting overall recharge objectives. The purpose of this intermediate step is to review all of the collected data and determine if sufficient technical knowledge of the aquifer was developed during the pilot phase to allow for the rational design of a full-scale recharge project. Using the acquired understanding of the aquifer response to recharge, various alternatives should be considered to assure the most effective combination of recharge and removal schemes. The evaluation should include, but not be limited to, data review of recharge quantities and resultant groundwater elevations, groundwater travel times to produce desired streamflow levels, variations in groundwater quality as a result of local recharge activities, and any potential groundwater conditions either positive or negative that would result if a recharge project is implemented on a full scale. This evaluation should further identify any additional research that is needed to determine if full development is justified or if the desired objectives can be achieved by merely upgrading the pilot sites to full capacity. It is apparent that each additional amount of information will increase the level of confidence in making this determination. The effects of the limiting constraints experienced during the pilot phase should be examined to determine alternative solutions.

If the results of the intermediate phase indicate that all identified objectives of the pilot project were satisfied, design and permitting should be undertaken for full-scale implementation. If, however, this intermediate evaluation indicates some areas of concern, then additional data should be acquired to resolve these concerns. If the concerns are still unresolvable, then the project may be considered unfeasible either technically, economically, or politically.

Various alternative methods of removing groundwater from the shallow aquifer, including pumping directly into the river should likewise be analyzed. Creative exchange schemes which would allow surface water users to replace their water supply from surface to groundwater, thus leaving their surface water in the streams for instream purposes, should also be developed during this phase of the project.

The engineering and economic feasibility of implementing the full scale project should be determined during this phase of the project. The engineering and geologic evaluations would determine if the recharge project, as perceived, is accomplishable, while the economic feasibility of the project would determine if the costs equaled the benefits. Alternative recharge site locations and groundwater removal methods should be evaluated and a recommended plan selected. During this phase, the necessary public information and environmental evaluations should also be completed.

Section 6

SECTION 6

FULL SCALE DEVELOPMENT PHASE

Following the intermediate development phase, a full scale recharge project may be designed based upon the results of the intermediate phase feasibility studies. The full scale project would need to consider: 1) the total amount of water available for recharge from exchanges, storage, and direct flows, 2) the limiting physical and economic constraints of the various alternative recharge sites and required conveyance facilities, and 3) the alternative methods needed to return the recharge to the river during the required time periods.

The total amount of water available for recharge must be determined to allow for each component of the system to be properly sized. Once the total quantity of water available for recharge and the amount desired for recharge are determined, the conveyance and recharge facilities can be sized and designed. Examination of the historical flows on the Umatilla River indicate that a minimum flow of 300 cfs could be left in the river below the Westland Canal diversion and the following amounts could be diverted annually to the recharge projects for the various canal sizes:

Canal Capacity (cfs)	Recharge Volume (acre-feet)
250	50,000
200	40,000
150	30,000
100	20,000

Further examination of the mean monthly flow hydrograph for the Umatilla River shown as Figure 2-2 indicates the time in which the larger flows required for full scale implementation would be available for diversion. The mean flows in excess of 300 cfs occur from mid-November to mid-May, which would be the only time in which direct flow diversions could occur. However, full capacity diversions (i.e. 250 cfs) could occur over a portion of this time because the larger the canal capacity, the shorter the period of time in which the full capacity would be utilized. A complete analysis must be done for the full scale development phase to determine the effects of canal operation and maintenance requirements on the ability to divert usable stream flows.

Opportunities to develop an exchange with owners of water stored in McKay Reservoir would further enhance the amount of water available for instream flows. Developing this concept would require the construction of wells at locations adjacent to existing delivery systems. The wells would pump the water supply needed to satisfy the irrigation requirements of the storage owners in exchange for storage water which would be released for Umatilla flow augmentation when needed. The storage water would be released to meet the desired flow pattern in the Umatilla River while the storage owner would receive his supply from the new groundwater source. The economics (benefits and costs) of these exchanges would need to be closely evaluated during the pre-design phase of the project.

During the intermediate phase of the project, evaluations should be made concerning the feasibility of various size conveyance and recharge sites. Features such as land cost and availability, right-of-way or easement costs, and operation and maintenance costs must be factored in before selecting the final design for the full development phase. Limits will be developed, based upon economics and physical constraints, which will define the ultimate size of the recharge project.

Equally important to the method and amount of recharge that can be introduced into the shallow aquifer is the amount and the timing with which the recharged water will return to the stream. Considerations of the final recharge location should include travel time for the natural return flows or various options which would provide the flows to the river system at the time they are needed. Options might include groundwater wells located adjacent to the stream which would pump the water from the shallow aquifer into the stream exactly when needed. A fisheries biologist should be consulted to determine if this method would detract from the migration of the anadromous fish.

All state and federal requirements must be included as part of the final design. This will include, at a minimum, the preparation of an environmental assessment, acquiring the necessary state water right permits, and a continuous monitoring system of both quantity and quality. Due to the concerns expressed by state agencies during the implementation of the CLWID recharge program, a high level of coordination is needed. This will reduce many of the problems of intergovernmental interaction.

Consideration must be given to the long-term planning criteria of the county to determine if there exists an opportunity to enhance groundwater conditions through this proposed shallow aquifer recharge program and thus increase the benefits. One of the largest constraints centers around the limited geographical location containing the needed alluvial material for surface recharge and the resultant groundwater flows. Prior to finalizing the design for the full scale development, consideration should be given to other local concerns.

Section 7

SECTION 7

INSTITUTIONAL AND LEGAL CONSTRAINTS

The primary institutional and legal constraints that could affect the proposed recharge project involve the availability of the water supply (and the corresponding water rights) and water quality. The institutions that would be involved with these aspects of the project are various federal and state agencies within the State of Oregon.

FEDERAL INTERESTS

Depending upon the ownership of the lands that are finally selected for the recharge site it is possible that the Bureau of Land Management might become involved. Since one aspect of the project involves the fisheries of the Umatilla River either or both the U.S. Fish and Wildlife Service or the National Marine Fisheries Service would be involved in the planning process for this project.

STATE INTERESTS

The state agencies that will be involved in the project include the Water Resource Department and the Department of Environmental Quality. The Water Resource Department has developed rules relative to recharge which must be considered while implementing this project. In Chapter 690 of the Administrative Rules the term "artificial ground water recharge" is defined and associated rules for recharge and appropriation outlined in following subparagraphs. Chapter 690, including subparagraphs 690-11-085 (Recharge Permits) and 690-11-086 (Secondary Ground Water Permits), is included as Appendix B of this report. As stated in subparagraph 690-11-085, a permit is required for the appropriation of waters from any source for the purpose of recharging a groundwater reservoir and likewise any beneficial use of artificially recharged groundwater in any such groundwater reservoir requires a secondary groundwater permit. It is further encouraged, by the Department, that a pre-application conference be held and that the Department be involved with all aspects of the recharge project. The requirements further state that if a stream is the proposed recharge source, the applicant shall provide a copy of the document which establishes that the supplying stream has a minimum perennial stream flow for the protection of the aquatic and fish life. The following conditions must also be satisfied for the State license:

1) A maximum annual diversion rate and volume must be specified.

2) Meters must be in place to measure the recharge amount at both the recharge sources and the place of recharge.

3) Records must be kept to allow evaluation by the Director of both diversion to the site as well as water levels that result from the recharge effort.

4) Water levels in the monitoring wells must be provided as the basis for judging the effectiveness of the recharge program.

5) An annual report must be prepared to document the range of recharge rates and the total quantities during the year. The report shall also include a general operations review, an estimate of the storage account and the results of the water quantity and quality programs.

It is further stated, as an additional condition, if the recharge diversion is for 5 cfs or more the permit will require the permittee to have the construction and operation of the proposed project overseen by professional registered engineers licensed in Oregon to practice civil engineering.

In addition to the permit required for artificial recharge, a secondary ground water permit is required for the appropriation of artificially recharged groundwater for any beneficial use. The secondary ground water permit application requires a copy of the recharge permit and proof that the proposed use will be from the recharged reservoir. In addition, the secondary permit limits appropriation to 85 percent of the recharge volume during the first five years of recharge.

LOCAL SUPPORT

In order to obtain the necessary permits from the Oregon Water Resource Department local support will be required for such recharge project . Elements that should be considered in seeking local support are:

1) Improvement of the local groundwater conditions in the area. This would reduce declining groundwater levels and improve spring flows. It would also improve the local fishery due to the enhancement of the return flows and thus have the potential of increasing recreation and tourism in the regional area. Increased tourism also enhances the potential for greater economic development.

2) There may be outside entities which will oppose the proposal from an environmental viewpoint. These entities should be invited to become involved as early as practicable in the planning process to reduce the amount of miscommunication and develop a working relationship.

WATER QUALITY CONCERNS

A permit must be obtained from the Oregon Department of Environmental Quality for water quality monitoring. This permit is then submitted to the Oregon Water Resource Department to show that the required permits are either filed or that they are not necessary. Monitoring of the quality of water used for recharge is important to determine the effects on groundwater and to provide a data basis to reduce future potential injury claims.

Section 8

SECTION 8

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. Artificial recharge of the shallow groundwater aquifer of the lower Umatilla River Basin is physically feasible in the area southwest of Hermiston. This area is delineated by the extent of permeable glaciofluviatile sand and gravel deposits (Figure 2-1). Outside of the area of glaciofluviatile deposits the recharge potential is poor.

2. Relatively low-cost pilot artificial recharge projects can be developed in the area served by the Westland A-Line and B-Line Canals. The A-Line Canal projects would consist of routing Umatilla River water into gravel pits for infiltration. The B-Line projects would consist of either increasing the annual recharge volume at the County Line Water Improvement District (CLWID) recharge facility or constructing a new recharge facility (probably an infiltration ditch).

3. The total amount of water that could be recharged using both the A-Line and B-Line canals is about 22,000 acre-feet per year. This includes approximately 6,000 acre-feet of present annual recharge by CLWID and the potential for an additional 16,000 acre-feet per year. (This volume of 16,000 acre-feet does not reflect the 30 cfs that might be available from the proposed Cottonwood Bend pumping facilities.) The capacity of the A-Line and B-line canals is the primary limiting factor on the total amount of recharge that could be applied. Thus, either the capacities of the A-Line and B-Line canals would need to be increased or new canals would need to be built to recharge more than about 16,000 acre-feet per year.

4. Umatilla River flow augmentation from the artificial recharge project could be accomplished through a combination of natural return flow (springs and baseflow) or pumping of shallow groundwater from wells either directly to the river or in exchange for natural flow or McKay Reservoir storage. Flow augmentation by natural return flow is likely to be significant during the late winter to late spring, following winter recharge operations. Natural return flows will probably not occur in reaches of the river upstream of Cottonwood Bend. Pumping of shallow groundwater can probably occur as needed, but must not adversely impact pumping levels in the wells of existing groundwater users. Pumped groundwater can be used for summer irrigation in exchange for fall or spring releases from McKay Reservoir for flow augmentation. An advantage of exchange is that flow augmentation could occur in reaches above Cottonwood Bend and the Westland Diversion Dam which would be upstream of flow augmentation by natural return flow processes. Alternatively, groundwater can be pumped directly to the river for flow augmentation, from aquifers located downstream of the Westland Diversion Dam.

5. Development of full scale recharge facilities (to add more than 16,000 acre-feet annually) will be costly because of land acquisition/construction costs for new canals or expansion of existing canal capacity to convey the required flows to recharge sites. Presently the OWRC Basin Plan reserves 20,000 acre-feet for additional recharge. Approximately 16,000 acre-feet of this reserve could be recharged with existing infrastructure. It is apparent that additional reserves would need to be secured for full scale development.

6. Implementation of both pilot and full scale recharge facilities will require a high degree of coordination with regulatory agencies (primarily Oregon Department of Water Resources) to obtain necessary permits to recharge and extract groundwater.

RECOMMENDATIONS

Based upon the investigations completed during the preparation of this report, it is recommended that pilot projects, which would basically provide up to 16,000 acre-feet of additional recharge to the shallow aquifer, be constructed. This report demonstrates the pilot facilities could physically be constructed with a minimal cost, by utilizing existing conveyance facilities. Development of the pilot facilities would utilize river flows in excess of instream needs.

Implementation of at least one pilot project is needed to determine if a full scale recharge project is feasible. It is recommended that the I-82 site be given first consideration as the pilot project since it would provide new data and research information beyond that available at the exiting county line site. However as stated earlier, the cost associated with gaining access to and using this site, versus the Highway 30 site, must be considered.

Appendix A

APPENDIX A

AVERAGE ANNUAL RECHARGE POTENTIAL TO A-LINE CANAL AND B-LINE CANAL RECHARGE SITES

Table A-1 steps through the process of determining the total actual recharge volume available to the CLRC and possible new recharge sites. The objective of compiling Table A-1 was to determine whether the capacity of available recharge sites or the capacity of existing conveyance facilities would limit recharge potential. Totals from Table A-1 indicate that the actual recharge potential in the lower Umatilla Basin (below Echo) is currently limited by the available conveyance capacities of the A-Line and B-Line Canals during the recharge months of November through April.

Beginning in column B of Table 3 A-1, the continuous operational flow capacity of CLRC is estimated to be approximately 85 acre-feet per day (43 cfs) due to restricted flow capacity in the 1.5 mile 36-inch diameter pipe. This value was obtained by inspection of six years of diversion flow data in the canal and through conversations with Mr. Tyler Hansel, Director of CLWID. The historic diversion flow data was also used to determine the average daily diversion to CLRC (column C) for each month of the year. (If all the values in column C are summed and then multiplied by the average number of days in a month (30.4), one can see that the average total volume of water diverted to CLRC each year is approximately 6,200 acre-feet.) Thus, subtracting column C from column B gives the available additional recharge capacity in CLRC for each month of the year (column D). However, the actual additional recharge capacity which could be diverted to CLRC (column F) is also dependent on the available recharge conveyance capacity in the B-Line Canal (column E).

Columns E and G show the maximum conveyance capacity in the B-Line and A-Line Canals is approximately 120 acre-feet per day and 158 acre-feet per day, respectively. Based upon information supplied by the Stanfield-Westland Irrigation District Manager, both the B-Line and the A-Line Canals should be 100 percent available for carrying recharge water during the months of October, November, December, and March. During January and February, it is assumed that the A-Line and B-Line Canals will only be available 50 percent of the time due to canal freezing problems and the possible necessity for recharge site maintenance. Finally, beginning around April 15th and extending

TABLE A-1
AVERAGE ANNUAL ADDITIONAL RECHARGE POTENTIALS OF A-LINE CANAL AND B-LINE CANAL RECHARGE SITES

A	B	C	D	E	F ****	G	H	I	J	K	L	M	N
MONTH	Total Capacity of C.L.R.C. (AF/DAY)	Current Average Use of C.L.R.C.*** (AF/DAY)	Available Recharge Capacity in C.L.R.C. (B - C) (AF/DAY)	Available Recharge Conveyance Capacity in B-Line Canal (AF/DAY)	Adjusted Available Recharge Capacity to C.L.R.C. (AF/DAY)	Available Recharge Conveyance Capacity in A-Line Canal (AF/DAY)	Total Available Recharge Cap.- C.L.R.C. & A-Line Sites (F + G) (AF/DAY)	Avg. # of Days with Flows Exceeding ~400 cfs ***** (DAYS)	Recharge Potential to Sites Fed by A-Line Canal (G x I) (AF)	Additional Recharge Potential to C.L.R.C. (F x I) (AF)	Additonal Recharge Potential to New Site Fed by B-Line Canal (E - C) x I (AF)	Total Additional Recharge Potential for A-Line Canal Recharge Sites & C.L.R.C. (J + K) (AF)	Total Additional Recharge Potential for A-Line Canal & New B-Line Recharge Site. (J + L) (AF)
OCTOBER	85	10	75	120	75	158	233	0.0	0	0	0	0	0
NOVEMBER	85	21	64	120	64	158	222	4.5	711	288	446	999	1157
DECEMBER	85	25	60	120	60	158	218	16.5	2607	990	1568	3597	4175
JANUARY	85	12	73	60 *	48	79 *	127	17.5	1383	840	840	2223	2223
FEBRUARY	85	42	43	60 *	18	79 *	97	23.0	1817	414	414	2231	2231
MARCH	85	50	35	120	35	158	193	28.0	4424	980	1960	5404	6384
APRIL	85	23	62	60 **	37	79 **	116	25.0	1975	925	925	2900	2900
MAY	85	10	75	0 **	0	0 **	0	14.0	0	0	0	0	0
JUNE	85	4	81	0 **	0	0 **	0	4.0	0	0	0	0	0
JULY	85	1	84	0**	0	0**	0	0.0	0	0	0	0	0
AUGUST	85	1	84	0**	0	0**	0	0.0	0	0	0	0	0
SEPTEMBER	85	4	81	0**	0	0**	0	0.0	0	0	0	0	0
							~TOTALS	133	12900	4400	6200	17300	19100
							x OPERATIONAL EFFECIENCY OF 80 %:						
							ADJUSTED TOTALS		10400	3600	5000	14000	15400

* Due to canal freezing and recharge site maintenance, assume canals and recharge sites are shut down for half of January and half of February.

** Since irrigation diversion usually begins around April 15, assume that from April 15 - September 31, no capacity will be available in neither the B-Line nor A-Line canals for recharge conveyance.

*** Based upon six years of diversion flow data in the 1980's.

**** F = D for E > 85, F = (E-C) for E < 85.

***** Based upon nine years (1980-1988) of streamflow data for the Umatilla River near Umatilla, OR. , (USGS station # 14033500).

through September, it is assumed that irrigation diversion flows will occupy 100 percent of the conveyance capacity in each canal.

With the available recharge conveyance capacity in the B-Line Canal established (as given in column E), the adjusted available recharge capacity to CLRC (column F) can be computed following the equations on the bottom of Table A-1. Also, given the available recharge conveyance capacity in the A-Line Canal (column G), the total available recharge capacity to both the CLRC and recharge sites fed by the A-Line Canal (column H) is found by adding columns F and G.

According to the USBR, certain minimum stream flows have been specified for the reach of the Umatilla River extending from the confluence of the Umatilla with the Columbia River upstream to the 3-Mile Diversion Dam. The minimum stream flows were specified mainly to aid fish passage through that stretch of the Umatilla River during fish migration periods. The minimum stream flow goals and corresponding time periods are as follows:

- September 16 through September 30 - 250 cfs
- October 1 through November 15 - 300 cfs
- November 16 through June 30 - 250 cfs

Using this information, nine years of stream flow data (1980-1988) for the Umatilla River near Umatilla, Oregon (USGS Station #14033500) were used to determine the average number of days during each individual month in which stream flows in the Umatilla exceeded approximately 400 cfs (300 cfs instream flow requirement + column H/1.98). The resulting numbers from this data review are given in column I of Table A-1. Column I shows that during the months of December through May, there are 15 days per month or more during which water could be diverted from the Umatilla for recharge purposes. The months of June through November show little or no possibility of stream flow diversions for recharge purposes because flows in the Umatilla over the project area are completely appropriated to either irrigation diversions, minimum instream flow requirements, or both. The total number of days per year on average in which sufficient stream flow is available to be diverted for recharge purposes is shown to be approximately 133 days. (In Tables 3-2, 3-3, 3-4, 3-5 the average number of days canals can carry recharge is only 85 days because canals are assumed inoperable for recharge one-half of January, February, and April and all of May through October.)

Using the results from column F and column I in Table A-1, column J gives the additional recharge potential to CLRC. The additional recharge potential to CLRC can occur mainly during the months of December through April with a total annual additional recharge potential of roughly 4400 acre-feet.

The recharge potential to all recharge sites fed by the A-Line and the additional recharge potential to sites fed by the B-Line Canal is given in columns K and L, respectively. Like CLRC, the recharge potential to recharge sites fed by the A-Line and B-Line Canals occurs mainly during the months of December through April. Annual totals for the A-Line and B-Line Canals are approximately 12,900 acre-feet and 6200 acre-feet , respectively. The B-Line total does not include present CLWID recharge of about 6000 acre-feet per year. Note that the difference between column J and column L is that column J is based upon using the B-Line Canal to feed the CLRC only and column J is based upon using the B-Line Canal to feed the present CLRC use plus a new recharge facility. A new recharge canal could take roughly 6200 acre-feet per year while the CLRC could take an additional 4400 acre-feet per year.

Finally, column M and column N give the total additional recharge potential to A-Line Canal recharge sites and CLRC, and to A-Line Canal recharge sites and a new B-Line Canal recharge site, respectively. The approximate annual totals for column M and column N are 17,300 acre-feet per year and 19,100 acre-feet per year, respectively. At the bottom of Table A-1, an 80 percent operational efficiency is assumed and the adjusted totals for each column are given. The operational efficiency takes into account (1) operational delays which may occur in diverting flows when the river flucatuates from minimum flow levels to higher levels, (2) unplanned maintenance shutdowns, and (3) any other operational related problems which reduce recharge below the maximum potential.

In summary, Table A-1 shows that the available recharge conveyance capacity of the A-Line and B-Line Canals is the limiting factor on the total actual recharge potentials in the project study area. Recharge sites along either the A-Line Canal or the B-Line Canal should, based upon current infiltration information, have no difficulty accepting all the water the A-Line and B-Line Canals can provide. Thus, relying totally on the A-Line and B-Line Canals as the principal conveyance facilities in the pilot phase of the project, and taking operational efficiency into account, Table A-1 suggests that it will be difficult to recharge more than 15,000 acre-feet per year in the project area. If it is desired later on during full scale phases to recharge more than 15,000 acre-feet per year, then it appears that new conveyance facilities for diverting water from the Umatilla to the potential recharge sites would have to be constructed.

Appendix B

WATER RESOURCES DEPARTMENT

ADMINISTRATIVE RULES

CHAPTER 690

DIVISION 11

APPLICATIONS AND PERMITS

Definitions

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

(1) Artificial ground water recharge: The intentional addition of water to a ground water reservoir by diversion from another source.

(2) Beneficial use: The reasonably efficient use of water without waste for a purpose consistent with the laws and the best interests of the people of the state.

(3) Commercial use: Use of water at a place where commodities or services are bought or sold, such as a gas station, restaurant, motel, etc.

(4) Deficiency of rate right: An additional right allowed from the same source for the same use at the same place of use when an earlier right does not allow a full duty or rate of flow of water.

(5) Domestic use: Use of water for human consumption, household purposes, watering livestock necessary for the sustenance of a family and related accessory uses.

(6) Domestic use expanded: Use of water, in addition to that allowed for domestic use, for watering up to 1/2-acre of lawn or noncommercial garden.

(7) Duty and rate of water for irrigation: Maximum quantity of water in cubic feet per second or gallons per minute and the total quantity of water in acre-feet per acre per year that may be diverted for irrigation.

(8) Ground water reservoir: A designated body of standing or moving ground water having exterior boundaries which may be ascertained or reasonably inferred. (ORS 537.515(4))

(9) Group domestic use: Delivery and use of water through a delivery system supplying water for domestic purposes to more than one residence or dwelling unit when the delivery system is not owned and operated by an incorporated municipality or a non-profit corporation created for the purpose of operating a water delivery system. For fee-collection purposes, each dwelling unit requires the statutory permit recording fee.

(10) Human consumption: Use of water within a household only for drinking, cooking, and sanitation.

(11) Industrial use: Use of water in the manufacture of a product.

(12) Irrigation use: Application of water to crops or plants by artificial means to promote growth or nourish plants.

(13) Municipal use: Delivery and use of water through the water service system of an incorporated municipality for all uses usual and ordinary to such systems. Such use includes but is not limited to uses of water for domestic, irrigation of lawns and gardens, commercial, industrial, fire protection,

irrigation and other uses in park and recreation facilities, and street washing, but does not include generation of hydroelectric power.

(14) Nursery operations use: Use of water for a commercial nursery which may include temperature control, watering of containerized stock, soil preparation, application of chemicals or fertilizers, and watering within greenhouses. The use of water within plant nursery operations constitutes a different use from field irrigation, although that may be a part of nursery use. If used for field irrigation for nursery stock, such use is not restricted to the defined agricultural irrigation season.

(15) Placer mining: As used in ORS 390.835, the process of extracting minerals from a placer utilizing mechanized or hydraulic equipment, except a motorized surface dredge with a suction hose intake four inches or less in diameter.

(16) Power development use: Use of water to develop electrical or mechanical power and the use of water for the operation of a hydraulic ram.

(17) Primary right: First or initial appropriation of water for an approved use.

(18) Quasi-municipal use: Delivery and use of water through the water service system of a nonprofit corporation created for the purpose of operating a water supply system, for those uses usual and ordinary to a muncipal water supply system. A quasi-municipal water right does not enjoy the statutory preferences given to a municipality under ORS 537.190(2), 537.230(1), or 537.410(2).

(19) Recharge permit: A permit for the appropriation of water for the purpose of artificial ground water recharge.

(20) Secondary ground water permit: A permit for the appropriation of ground water which was stored through the exercise of a recharge permit or certificate.

(21) Significant adverse effect: The result of a use that would impair or be detrimental to the public interest.

(22) Stockwater: Use of water for domesticated animals and wild animals held in captivity as pets or for profit.

(23) Stored recharge water: Ground water which results from artificial ground water recharge.

(24) Storage account: 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.

(25) Substantial public interest issue: An issue that raises a reasonable likelihood of a significant adverse effect on the public interest. A significant adverse effect is one that is more than moderate considering:

(a) The context of the proposed action,

(b) The intensity of the proposed action including the magnitude and duration of an impact and the likelihood of its occurrence,

(c) The relationship between a proposed action and other similar actions which are individually insignificant but which may have cumulatively significant impacts, and

(d) Proven mitigation measures which the proponent of an action will implement as part of the proposal to reduce otherwise significant effects to insignificant levels.

(26) Supplemental right: Additional appropriation of water to make up any deficiency in supply from the primary right.

(27) Surplus waters: All waters in excess of those needed to satisfy current existing rights and minimum streamflows established by the Water Resources Commission.

(28) Temperature control: Use of water to protect a growing crop from damage from extreme temperatures.

(29) Transfer: Change of use or place of use or point of diversion of a water right.

(30) Wasteful, Uneconomic, Impracticable or Unreasonable as used in ORS 537.170 have the following meanings:

(a) A use of water in a greater quantity or at a greater rate or duty than necessary to achieve the proposed use;

(b) A use of water for which quantifiable public and private economic costs exceed quantifiable public or private economic benefits over the life of the use as demonstrated in the record;

(c) A use of water which could not reasonably be developed with the available quantity of water;

(d) A use of water which would preclude present beneficial uses or other uses with a reasonable expectation of being developed during the proposed life of the use, which have a greater value to the public.

(31) Wastewater: Water that has been diverted under an authorized water right after it is beyond the control of the owner of that right but has not yet returned to the channel of a natural stream. In an irrigation district, the wastewater of an individual user is not subject to appropriation until it leaves the boundaries of the district. Wastewater abandoned to the channel of a natural stream becomes a part of that stream and is subject to appropriation.

(32) Water right subject to a transfer: 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.

Applications for Permits to Appropriate the Waters of the State of Oregon

690-11-015 If a water right permit application is submitted to the Department for a use of water that is not clearly defined as an allowable use under an applicable basin program classification, the Director shall review the basin program policies and objectives and determine whether the proposed use is an allowable use within one of the allowed categories of use.

If the Director is unable to make the necessary determination, or if the applicant is not satisfied with the Director's determination, the question shall be referred to the Commission for determination.

690-11-020 Except as noted in OAR 690-11-085 for artificial ground water recharge, the Department shall accept applications for filing and thereby establish a tentative date of priority to appropriate the waters of the State of Oregon when the application is on forms provided or approved by the Department, is accompanied by the examination fee required by ORS 536.050, and contains the following information:

(1) Name and mailing address of the applicant(s).

(2) Source(s) of the water.
(3) Quantity of water to be appropriated.
(4) Location of the point of diversion by quarter-quarter section.
(5) Nature and place of the use(s).

(6) Name and mailing address of the legal owner of the property upon which any significant portion of the proposed development will occur, if other than the applicant. This requirement may be waived by the Director if the applicant is an agent acting on behalf of multiple users, such as a municipality, irrigation district, group domestic water system or ditch company.

(7) Signature of the applicant(s). (If the applicant is a public agency, corporation or business, the title or authority of the signator shall be indicated.)

690-11-025 The applicant shall also provide the information listed in OAR 690-11-030 for surface and groundwater applications or in OAR 690-11-040 for reservoir applications before the Department or Commission shall process the application for a permit. As applicable, the applicant shall provide the information listed in OAR 690-11-085 for artificial ground water recharge applications or in OAR 690-11-086 for secondary ground water permit applications before the Department or Commission shall process the application for permit. If any of the information required by these rules does not apply to the proposed use, the applicant shall indicate why it does not apply.

690-11-030 Applications to appropriate the surface or groundwaters of the state of Oregon shall include:

(1) Proposed dates for the beginning of construction, completion of construction, and complete application of the water.

(2) A map of the proposed place of water use prepared by a certified water right examiner in accordance with OAR 690-14-150.

(3) A copy of the legal description of the property on which the water is to be used.

(4) A description, including drawings if required by the Department, of the proposed means of diversion, construction, and operation of the diversion works and transmission of the appropriated waters, including provisions, if any, to measure the amount diverted, to prevent damage to aquatic life, to prevent the discharge of contaminated water to a surface stream or to prevent damage to public uses of affected surface waters.

(5) Such other information as the Department or Commission deems necessary.

690-11-040 Applications to store waters of the state of Oregon and to construct a reservoir, or multiple reservoirs on a single contiguous property on the same stream system, shall include or be accompanied by:

(1) Plans specifications and supporting information for the dam and impoundment area, as required in OAR 690, Division 20.

(2) A description, including drawings if required by the Department, of the proposed means of diversion and operation of the appropriation works and transmission of the appropriated waters, including provisions, if any, to measure the amount diverted, to prevent damage to aquatic life, or to prevent damage to public uses of affected surface waters.

(3) Proposed dates for the beginning and completion of construction of the reservoir.

(4) A legal description of the property upon which the water is to be

stored.

(5) Such other information as the Department or Commission deems necessary.

690-11-050 Applications which do not fulfill the requirements of OAR 690-11-030, and/or 690-11-040, shall be returned to the applicant for the occuring of defects. Applications so returned shall state a time within which the application must be returned to the Department cured of defects. The time allowed shall not be less than 30 days nor more than one calendar year from the date of first return for that defect. Failure to return the application within the time specified shall result in the loss of the tentative priority date and may result in the rejection of the application.

690-11-060 Applications may be replaced or amended without loss of the tentative priority date so long as the information provided in the application under OAR 690-11-020(2), and (3) is not increased and (5) does not change. If the replacement or amendment proposes additions to or increases in items listed in OAR 690-11-020(2), (3), or (5), the original proposal shall retain the original tentative priority date and the additions or increases shall be assigned a new tentative priority date, as of the date the amendment is received by the Department.

Map to accompany application for permit

690-11-070 Maps submitted with water right applications shall be prepared by a certified water right examiner and meet the following criteria:

(1) The application map, which is made part of the record, shall be permanent quality and drawn with sufficient clarity so as to be easily reproduced.

(2) Maps shall be drawn on tracing linen, tracing vellum or mylar except that maps measuring 11" x 17" or smaller may be prepared on good-quality paper. All maps shall be drawn to a standard, even scale of not less than 4 inches = 1 mile. Small area maps may be more easily and clearly drawn to a larger scale, such as 1 inch = 400 feet.

(3) Four prints of a platted and recorded subdivision may be submitted as the application map if all of the required information is clearly shown on each print. Notwithstanding the provisions of subsection (5)(a) of this section, the location of the diversion point may be given with reference to a lot or block corner of the subdivision.

(4) Four permanent-quality prints of other maps, such as deed description survey maps or county assessor maps, also may be used if all the required information is clearly shown on each print. A single print of these may be used only if it is reproduced as a transparency, such as a sepia print or on mylar film.

(5) Each copy of the map shall show clearly each of the following requirements that apply to the proposed appropriation:

(a) The location of each diversion point, well, or dam by reference to a recognized public land survey corner. The locations may be shown by distance and bearing or by coordinates (distance north or south and distance east or west from the corner).

(b) The location of main canals, ditches, pipelines, or flumes.

(c) The location of the place where water is to be used. If for irrigation, the area to be irrigated in each quarter-quarter of a section shall be indicated by shading or hachuring and the number of acres in each quarter-quarter section indicated.

(d) The scale to which the map is drawn, the section number, township, and range, and a North directional symbol.

Processing An Application

690-11-080 (1) The Director shall provide notice of all applications for permits received and of determinations made by the Director under section (2) of this rule, to those public agencies on the Department's weekly mailing list, to property owners listed on an applicaton pursuant to OAR 690-11-020(6), to affected Indian tribes and to any person who pays the subscription fee as established by the Department. The Director may presume the proposed use is not precluded by the laws and regulations of any public body that does not respond to the notice within 30 days.

(2) The Director shall screen applications to determine whether there is a substantial public interest issue involved.

(a) The Director shall make a preliminary determination under subsection (4) for applications in the following categories and submit a recommendation to the Commission regarding the need to make a public interest determination under ORS 537.170.

(A) Appropriations for greater than five cubic feet per second, except from the Columbia River.

(B) Out-of-basin diversions.

(C) Dams greater than ten feet in height or impounding more than 9.2 acre-feet of water.

(D) Conditional uses under basin programs.

(E) Artificial ground water recharge.

(b) The Director shall review all other applications to determine if the proposed use:

(A) Complies with Water Resources Commission policies and basin programs.

(B) Does not harm vested and inchoate rights.

(C) Appropriates waters likely to be available in the amount and at the times needed.

(D) Is not the subject of a request for review by a public agency or person.

(E) Conforms with the applicable recognized rate and duty.

(F) Does not raise any other substantial public interest issue.

(c) If (b)(A) through (F) are satisfied, the Director shall conclude the application is in the public interest and issue the permit if no petition for review under (2)(e) is filed.

(d) If one or more of (b)(A) through (F) is not satisfied, the Director may work with the applicant and any person or agency raising the concern to determine whether the issues can be resolved through mutually agreeable conditions, provisions of the permit, or modifications of the application.

If it appears that the application raises a substantial public interest issue that will not be resolved through negotiation, the Director shall refer the application to the Water Resources Commission with a recommendation to conduct a contested case hearing under ORS 537.170 and 537.180. If the Director determines that no substantial public interest issue is raised or that any such issue has been resolved through negotiation, the Director may issue the permit with appropriate conditions or modifications if no petition for review under (2)(e) is filed, or may submit a proposed permit to the Water Resources Commission for review prior to issuance of the permit.

(e) A formal petition to the Commission appealing the Director's decision under (2)(c) or (d) may be filed in accordance with OAR 690-01-010 through 020 within 20 days of the mailing of notice of the Director's decision pursuant to Section (1) of this rule.

(3) When the Commission receives an application or proposed permit for review, it may:

(a) Find that the use would not be detrimental to the public interest and instruct the Director to issue a permit; or

(b) Find that the use, as appropriately conditioned, would not be detrimental to the public interest and instruct the Director to issue the permit with the conditions; or

(c) Find that the use may be detrimental to the public interest because it raises a substantial public interest issue and require a contested case hearing under ORS 537.170 and 537.180.

(4) The following standards shall be applied by the Commission or Director in making determinations of public interest. The proposed use would have a significant adverse effect on the public interest if the use:

(a) Is inconsistent with adopted rules, policy statements and basin programs; or

(b) Adversely affects vested or inchoate rights; or

(c) Is a wasteful, uneconomic, impractical or unreasonable use; or

(d) Is not a beneficial use; or

(e) Impedes orderly economic development of the waters involved for multiple purposes or other preferred uses; or

(f) On balance, would jeopardize or have a significant adverse effect on the use of water for the broadest range of public good, considering basin policy, state statutes and the respective land-use plans of the jurisdictions affected.

(5) Following a hearing under ORS 537.170 or 537.180, the Commission may approve issuance of a permit, approve a permit with modifications or conditions, or reject the application with findings.

Emergency Water Use Authorization

690-11-081 It is in the public interest to provide a method for meeting certain emergency requirements for water use during drought conditions.

(1) The Director may approve use water immediately on a short-term basis, notwithstanding the requirements of OAR 690-11-080, whenever:

a) An applicant for a permit to appropriate water requests permission to make immediate short term use of the water while the application is being processed under OAR 690-11-080; and

b) All fees required by ORS 536.050 are submitted with the application; and

c) Except for applications for a secondary permit for use of stored water, the applicant establishes to the satisfaction of the Director that because of drought condition the applicant's inability to apply water immediately threatens the availability of essential services or resources, including long-term economic resources, or jeopardizes the health and welfare of the people of Oregon; and

d) If the application is for a secondary permit for use of stored water under 537.400, the applicant establishes that the water has been legally stored for the requested use and submits a contract for the use of the stored water, signed by the person in control of the stored water.

(2) A conditional approval processed by the director shall be subject to the following limitations:

a) Use is subject to all prior permits and rights and minimum streamflows;

b) Duration of use shall be limited as the director specifies, and shall in no case extend beyond the date the director or commission acts pursuant to OAR 690-11-080 to issue, approve, approve with conditions, or reject the application; and

c) Any other condition the director deems appropriate. (3)a) The director's conditional approval for immediate use of water shall be filed in the permit records of the department as required by ORS 536.211 (1).

b) Following conditional approval, the application shall be processed promptly in accordance with OAR 690, Division 11 to allow opportunity for public comment or protest, and full consideration of the proposed use.

c) Notwithstanding the director's conditional approval for an immediate, short-term use, the director or commission may reject the application, approve the application with conditions, or approve the application.

d) If a permit to appropriate water is issued after review of the application under OAR 690-11-080, no additional filing fee is required.

Recharge Permits

690-11-085 (1) Permit required: The appropriation of water from any source for the purpose of recharging a ground water reservoir requires a permit. Likewise, any beneficial use of artificially recharged ground water in any such ground water reservoir requires a secondary ground water permit.

(2) Pre-application conference: Due to the complexities and costs associated with recharge projects and recharge permitting, the Department encourages a pre-application conference.

(3) Contents of recharge permit application: In addition to data required on permit applications under OAR 690-11-020 to -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: If a stream is the proposed recharge source, the applicant shall provide a copy of the document which establishes that the supplying stream has a minimum perennial stream flow for the protection of aquatic and 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 an 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 ground water recharge.

(d) Annual storage: The applicant shall describe the volume of water, or the 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 5 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.

(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 ground water 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 ground water 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.

(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.

(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 an 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 ground water 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 ground water investigation: The applicant may present a definitive ground water 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 ground water 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.

(i) Allowable use of stored recharge water: See rules governing secondary ground water permits in OAR 690-11-086.

(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 ground water 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 5 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.

Secondary Ground Water Permits

690-11-086 (1) Permit required: The appropriation of artificially recharged ground water for any beneficial use requires a secondary permit.

(2) Contents of secondary ground water 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 ground water 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) Source proof: The applicant shall submit proof that the proposed use will actually be from the recharged reservoir. Documentation may include water level similarites to the recharged reservoir, geologic and geographic similarities, hydraulic information, and other pertinent data.

(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 ground water permit approval: During the first 5 years of recharge, the Department shall limit cumulative secondary permits to no more than 85 percent of the project's permitted annual recharge volume. Subsequent recharge permits may exceed 85 percent based on recharge performance as determined by the Department.

(4) Secondary ground water permit conditions: A secondary ground water 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 the 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 ground water right priority and the allowable use of stored recharge water. The allowable use of stored recharge water falls into 3 categories. For ease of reference, these categories are named as color zones.

(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.

been issued for use of water for temperature control (either heat or cold), a report detailing the amount of water used, the times of application and conditions requiring the use of water for temperature control shall be required annually. These shall be required as an element of proof of appropriation to the satisfaction of the Department prior to issuance of a confirming water right certificate.

(8) Assignment of permit: When a change of interest occurs in lands covered by a permit, the permittee may request the Water Resources Director to record the assignment of permit to the new name. In addition to an assignment executed by a permittee, the Water Resources Department shall also record and recognize an assignment based on proof of death or the permittee and survivor as heir or trustee. Should the record holder of the permit be unavailable, then the current owner of the property may furnish proof of such ownership to the Commission to obtain an assignment of the permit.

(9) Extension of time limits: The time limit to begin construction shall not be extended except for municipal use of water by a municipality or permits involving Federal Energy Regulatory Commission projects. The time limits to complete construction or apply the water to a beneficial use may be extended upon showing that the project has been prosecuted with reasonable diligence. The extent of progress made within the last time extension shall be the primary basis for any additional extension. This determination shall consider the requirements of ORS 537.230 and ORS 539.010(5).

(10) All groundwater permits issued after the date of adoption of these rules shall be administered subject to prior rights in any hydraulically connected surface water source, as well as prior groundwater rights.

Cancellation of Permit

690-11-100 When it appears from an onsite examination by the Water Resources Department that no appropriation has been made under the terms of the permit, a certified letter of intent to cancel the permit shall be sent to the permittee, allowing sixty days for response. Failure to respond during the sixty-day period shall result in cancellation of the permit.

Claims of Beneficial Use for Applications filed after June 30, 1987

690-11-103 All final proof surveys and claims of beneficial use for applications filed after July 9, 1987 shall be performed by Certified Water Right Examiners. Applicants prior to July 10, 1987 may either wait for the Department to perform the final proof survey on its own schedule or may hire a certified Water Right Examiner.

Applications Filed after November 29, 1987

690-11-105 All applications filed after November 29, 1987 shall have application maps prepared by a Certified Water Right Examiner.

(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 preceeding 12 months.

(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 ground water or there are other substantial ground water 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.

(i) Other conditions: The permit may contain other conditions which the Director specifies.

(5) Secondary Ground Water 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.

Miscellaneous provisions

690-11-090 (1) All permits for use of water from wells shall provide that the well shall be constructed in accordance with the Water Resources Department's General Standards for the Construction and Maintenance of Water Wells in Oregon.

(2) The statutory exemptions for use of groundwater include "watering any lawn or noncommercial garden not exceeding one-half acre in area." Not more than one-half acre of lawn and noncommercial garden in total area may be irrigated through a group delivery system under such exemption, nor shall more than one-half acre in total be irrigated from any groundwater source under the exemptions listed in ORS 537.545(1).

(3) Applications by municipal corporations for hydroelectric generation shall be processed under OAR 690, Division 51.

(4) Cancellation of rights:

(a) A notice give pursuant to ORS 540.631 for the proposed cancellation of a primary water right for irrigation of certain lands shall include notice of the proposed cancellation of any supplemental water right for irrigation of the same lands.

(b) If the primary right is determined to have been forfeited by nonuse and the supplemental right is not determined also to have been forfeited by nonuse, the owner of the land to which the right is appurtenant may apply to transfer the supplemental right, without loss of priority, to become a primary right.

(5) Diminution of a water right: A primary right may, at the request of the owner of the right, be diminished to supplemental status to allow for a new primary application from a more dependable source of water.

(6) Supplemental rights: Where more than one right exists, water shall be used from the primary source so long as there is sufficient quantity to satisfy the terms of the permit or certificate. Nevertheless, if requested by the applicant, a permit may be issued which describes a surface water source as supplemental to a groundwater right and shall provide that, in the interest of conserving the groundwater supplies, the supplemental right may be exercised at times when water is available from the surface water supply.

(7) Annual reports required for temperature control: Where a permit has

Proof of Appropriation

690-11-110 ORS 537.250(1) and 537.630(3) prescribe that the Director shall issue a certificate of water right upon satisfactory proof of appropriation.

(1) A determination by the Department that appropriation of water to beneficial use under the terms of the permit has been accomplished to the full extent authorized by the permit shall constitute proof of appropriation to the satisfaction of the Director pursuant to ORS 537.250(1) or 537.630(3).

(2) A determination by the Department that appropriation of water to a beneficial use under the terms of the permit has been accomplished to an extent less than the full extent authorized by the permit shall constitute proof of appropriation to the satisfaction of the Director for that portion of the appropriation.

(3) A proposed certificate of water right describing the right determined by the Department to have been established under the provisions of the permit shall be served upon the permittee, together with notice that the permittee or the landowner has a period of 60 days from date of service to petition the Department to reconsider the contents of the proposed certificate of water right. If no petition for reconsideration is filed within the 60-day period, the Director may proceed with issuance of a water right certificate to the permittee pursuant to ORS 537.250(1) or 537.630(3).

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