City of Cottage Grove

WATER SERVICE FEASIBILITY STUDY FOR TRANSMISSION LINE CUSTOMERS

FEASIBILITY REPORT

FINAL

November 2003

The undersigned has approved this document for and on behalf of Carollo Engineers, P.C.

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Partner

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WATER SERVICE FEASIBILITY STUDY
FOR TRANSMISSION LINE CUSTOMERS

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COTTAGE GROVE WATER SYSTEM FEASIBILITY STUDY REPORT

EXECUTIVE SUMMARY

The City of Cottage Grove hired Carollo Engineers (Carollo) to review alternative water sources, or combinations of sources and infrastructure, that would most cost effectively provide water service to the customers located in the study area along the Layng Creek WTP transmission pipeline east of Dorena Mobile Home Park. The study area contains approximately 110 connections that would lose municipal water service should the transmission pipeline be removed from service. It is recommended that two US Army Corps of Engineers (USACE) connections and one US Department of Agriculture-Forest Service (USDA-FS) connection located on the west end of the study area continue to be supplied water through an extension of the City's existing Row River supply. The results of this feasibility study indicate that groundwater is capable of supplying the remaining 107 connections in the study area with an adequate source of potable water.

Evaluation of the groundwater supply in the study area indicates that withdrawal of sufficient quantity of water to serve the study area will not impact existing wells or limit capacity for all water users, even during drought periods. Treatment for removal of potential contaminants, primarily arsenic, is recommended, although contaminants may not be present in the wells recommended for this project.

The recommended water system configuration was developed to provide a community water system to three "clusters" of users (see Table ES 1, below), with a single agency providing administrative and operational services for all clusters. These community systems include approximately 89 connections, with each cluster relying on 3 or 4 wells. It is proposed that the remaining 18 connections be served by individual wells. A total of approximately 29 wells will be required to service all of the existing connections in the study area.

Table ES 1 Community Water System Design Criteria
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove

Cluster Criteria	Cluster		
	Dorena School	Dorena	Culp Creek
No. of connections	22	36	31
Maximum Day Demand (gpm)	17	33	14
Number of wells (duty/standby)	3/1	3/1	2/1

Costs to construct the required infrastructure for each identified cluster, as well as the costs for each of the individual wells, were developed at a feasibility level basis and are presented below in Table ES 2.

Table ES 2 Total System Capital Costs
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove

Customer Group	Number of Connections	Development Cost
Dorena School Cluster	22	$633,000
Dorena Cluster	36	$622,000
Culp Creek Cluster	31	$607,000
Individual Wells	18	$330,000
TOTAL (rounded)	107	$2,192,000

There are several components of the action plan required to implement a groundwater supply. These include:

- Community Involvement - Meet with members of the community to discuss the plan and obtain community support.
- Pilot Well Test Program - Select test well and monitoring well locations, perform well testing and data collection, and evaluate the program results. This may significantly affect the project cost estimate if arsenic is not detected or if the well production exceeds the conservative estimate of 10-20 gpm capacity.
- Regulatory Issues - Meet with regulatory agencies to discuss water rights, water quality and permitting issues, and requirements for qualified system operator.
- Special District Formation - Meet with the City's legal advisors to determine the most appropriate means of forming and governing the special districts for water supply.
- USACE, USDA-FS Coordination - Meet with representatives from both agencies to determine the specifics of water supply provision.
- Design and construction of the new wells, treatment systems, and water supply system.
- Determine detailed operational requirements of system.
- Determine water rights management needs.

1.0 INTRODUCTION/BACKGROUND

The City of Cottage Grove currently provides water supply service to its customers through two sources of supply: the Layng Creek Water Treatment Plant (WTP) and the Row River WTP. A recent report (Layng Creek Water System Facilities Plan prepared by LDC Design Group, September 2002) recommended that the Layng Creek WTP and approximately 15 miles of transmission pipeline be removed from service, using the Row River WTP to make up for the lost water supply. This approach does not provide water service to approximately 110 current connections located east of Dorena Mobile Home Park, outside the City's urban growth boundary. During the course of this study, it was determined that two USACE connections and one USDA-FS connection could be served from an extension of the City's existing Row River supply.

In order to address water supply needs for the remaining 107 existing connections, the City hired Carollo Engineers, in association with Groundwater Solutions, Inc., in July 2003 to review alternative water sources, or combinations of sources and infrastructure, that would most cost effectively provide water service to the affected connections. Emphasis of the study was placed on determining the feasibility of providing the water supply needs through the use of a groundwater supply.

Under a subcontract to Carollo Engineers, Groundwater Solutions (GSI) conducted a groundwater study in the Dorena Lake/Culp Creek area to determine the feasibility of supplying approximately 107 City of Cottage Grove (City) water connections from a local groundwater source. Figure 1 is a vicinity map that shows the limits of the study area.

This report summarizes the work that has been completed, results of our hydrogeologic characterization, infrastructure requirements, water treatment requirements, regulatory requirements, and estimated cost.

Figure 1 Transmission Pipeline Connections Groundwater Supply Map

11 x 17

2.0 GROUNDWATER SUPPLY INVESTIGATIONS

The scope of work for the groundwater supply investigations included the following elements:

- Hydrogeology Characterization - Prepared well location maps, geologic map, and cross sections.
- Hydraulic Connection with Surface Water - Compiled well inventory data and prepared well location maps. Evaluated the potential for groundwater to be under the influence of surface water (GWI).
- Potential Contaminant Sources - Reviewed Oregon Department of Environmental Quality (DEQ) leaking underground tank and confirmed release list.
- Groundwater Quality - Identified wells suitable for sampling, interviewed 10 well owners, and assisted the City in sampling 7 wells. Wells were tested for total dissolved solids (TDS), Coliform bacteria, E.Coli bacteria, nitrate, iron, manganese, arsenic, mercury, and radon (2 wells).
- Target Aquifer Units - Assessed yield versus drawdown within each geologic unit, prepared yield map, estimated potential well yield, assessed feasibility of larger wells serving multiple locations, assessed groundwater feasibility at the United States Department of Agriculture-Forest Service (USDA-FS) Dorena Genetic Resource Center.
- Long Term Sustainable Yield - Prepared a semi-quantitative water budget for the area to be served by wells.
- Technical and Regulatory Constraints - Interviewed Oregon Water Resources Department (OWRD) Water Master and the Oregon Department of Human Services (ODHS) Drinking Water Program. Assessed septic tank setback issues. Assessed water rights alternatives and requirements.
- Well Locations and Placement Criteria.

2.1 Hydrogeologic Characterization

The study area is located in the Row River watershed beginning from Dorena Dam on the west end to the town of Culp Creek on the east. The geology of the study area is presented in Figure 2. In general, the area is underlain by an assortment of volcanically derived materials. Geologic information in the area is limited to reconnaissance scale mapping (1:500,000, Figure 2), and in general, consists of two basic rock types, volcanic tuffs (Tfe, Tus, and Tut) and basalt flows (Tub). Overlying these rock units in some areas along the axis of the Row River drainage is a thin veneer of alluvial material deposited by the river.

Figure 2 Local Geologic Map

11 x 17

The volcanic tuffs are located on the south side of Dorena Lake and the Row River (Tfe, Tus, and Tut, Figure 2), and generally consist of Oligocene and upper Eocene-aged volcaniclastic (derived from volcanic eruptions) conglomerate, siltstone, and sandstone in varying degrees of consolidation and thickness. The total thickness of these units in the study area is unknown, but outside of the study area they are up to 1,500 feet (Peck, et. al., 1964). Most water wells in the area penetrate these units, and based on well yield at the time of drilling (Figure 3), produce in the range of 5 to 50 gallons per minute (gpm), with most wells producing approximately 10 gpm.

The basalt rocks are described as Oligocene-aged basaltic and basaltic andesite lava flows and breccia (Walker and MacLeod, 1991) and are located on the northeast side of Dorena Lake (Tub, Figure 2), and based on water well logs, also on the north side of Row River below Dorena Dam (not shown on Figure 2). Based on topography, the thickness of this unit appears to be on the order of 300 feet. Water wells that penetrate the basalt have yields ranging from 10 to 70 gpm (Figure 6), and on average, have slightly higher yields than wells penetrating the volcanic tuffs. Although this unit appears on the geologic map (Figure 2) on the north side of Row River east of Dorena Lake, no water wells were found that penetrate basalt in that area. It is likely, based on the geologic map, the basalt comprises the elevated topography on the north side of the Row River valley.

Also present in the area are Quaternary-aged alluvial deposits flanking most rivers and creeks and several landslide deposits at various locations in the basin. The alluvial deposits are typically thin (less than 30 feet) and consist of clay, sand, and boulder sized materials. These materials are present in some locations along the river and not in others, as evidenced by bedrock exposures in the riverbed and along the banks in many locations.

A total of 79 water well logs (Appendix A) were examined for geologic information, aquifer description, well construction information, and aquifer yield. Wells ranged in depth from 54 to 535 feet, with an average of approximately 180 feet. Geologic information from the selected well logs and the geologic map were used to construct six cross-sections as shown on Figures 3, 4, and 5. A summary table for wells used to construct the sections and well logs are contained in Appendix A.

Two sections (Figure 3) illustrate the sub-surface geology along the axis of the Row River drainage. These sections are characterized by the thick volcanic tuff (Tfe) package that underlies the majority of the study area. Four additional cross-sections (Figures 4 and 5) cut perpendicular to the lake and river. Again, these sections illustrate the prevalence of the tuffaceous units (Tfe and Tus) and basalt (Tub) on the eastern end of the study area (F-F', Figure 5). None of the geologic sections show contiguous layers of rock or sediment layers within each unit because it was not possible to correlate these materials horizontally with any degree of confidence. It appears that layers of sandstone and conglomerate within the tuffs and permeable layers between basalt lava layers that typically transmit most of the water within these units are not homogeneous and are laterally discontinuous. For the

Figure 3 Generalized Geologic Cross-Sections A-A' and B-B'

11 x 17

Figure 4 Generalized Geologic Cross-Sections C-C' and D-D'

11 x 17

Figure 5 Generalized Geologic Cross-Sections E-E’ and F-F’

11 x 17

Figure 6 Water Well Yield Distribution Map

11 x 17

same reason, it was also not possible to identify fracture zones that likely also convey groundwater within these bedrock units.

2.2 Groundwater Supply Analysis

This section describes methods used to assess expected groundwater yield, groundwater quality, and sustainability of pumping groundwater over the long term. In general, expected water well yields within the study area typically range from 5 to 30 gpm, groundwater quality is variable, and groundwater pumping appears to be sustainable in the study area. Details of this analysis are presented in the following sections.

2.2.1 Groundwater Quantity

As previously mentioned, water well logs were used to assess well yield in the study area. This information was used to illustrate the distribution of well yields shown in Figure 6 to get an idea of where more productive or unproductive zones might be. In general, well yields in the eastern end and the western end of the study area are relatively high, while the areas in between are relatively low. The higher yield wells in the eastern end of the study likely are intersecting more coarse grained materials than those wells in the middle portion of the study area along the south side of Dorena Lake, which have lower yields. Water wells drilled in the eastern and western portions of the study area are expected to yield approximately 10 to 30 gpm. The higher yield wells in the western end of the study area located below Dorena Dam are completed in fractured basalt bedrock, which is not found in other wells in the study area, but based on geologic mapping, are likely present in the hills to the north of Dorena Lake. Wells in the middle of the study area along the south side of Dorena Lake penetrate silt, sand, and conglomerate of the volcanic tuff unit. These materials appear to be finer grained than the volcanic tuff penetrated in the eastern end of the study area. Water wells drilled in this area (middle portion of the study area) are expected to yield 5 to 15 gpm.

2.2.2 Groundwater Quality

A preliminary assessment of groundwater quality was performed to identify potential groundwater quality concerns that could affect the feasibility and cost of a groundwater source in the study area. This assessment also included a review of the Department of Environmental Quality (DEQ) confirmed release list and leaking underground storage tank list. The United States Geological Survey (USGS) recently completed a groundwater study in the Willamette Valley that identified a number of wells in the southern portion of the valley near Cottage Grove as containing high levels of arsenic exceeding the drinking water standard. In addition, there is mining activity in the upper portion of the Row River watershed and there are anecdotal reports of metals (including arsenic and mercury) being present in surface water and groundwater in the Row River watershed. We also know that there are septic systems present at each home site and that because of the high density of homes present in some areas within the study area (e.g., Dorena, Dorena School, and Culp Creek), the potential for groundwater contamination from septic tank drain fields exists.

To get a preliminary indication of groundwater quality in the study area, we interviewed a number of residents who get their water from wells and selected a subset of well owners for sampling. In addition, we reviewed the DEQ confirmed release list and leaking underground tank list to identify areas where there may be documented groundwater contamination or potential for contamination. The results of these investigations are summarized in the following subsections.

2.2.2.1. Well Owner Interviews and Sampling

A total of 10 well owners located in the study area were interviewed to find out how their wells perform and if they have had water quality problems (including taste and odor). The well owners were selected on the basis of having documented well construction and having an address that allowed us to locate the well (many well logs do not have accurate location information). We also selected locations that gave us good coverage across the study area and in the areas where community water wells might be located. The interviews were documented on forms contained in Appendix B.

All but one person interviewed said that their water tasted good and had no odor. One resident located in Dorena remarked that his water tasted bad and had an odor.

Several of the well owners were asked if we could sample their well. Table 2.1 provides a listing of the well owners that participated in the sampling and details relating to each well. GSI made the arrangements for the sampling and wrote procedures for City staff to use in collecting the samples (refer to Appendix C for an explanation of sampling procedures). The City collected the samples on July 30, 2003 and submitted the samples to Umpqua Research Company for chemical analysis of the following constituents:

- Total Dissolved Solids (TDS)
- Iron
- Manganese
- Arsenic
- Mercury
- Nitrate
- Total Coliform bacteria (most probable number)
- E.Coli bacteria
- Radon (two locations only) - Analysis performed by Truesdail Laboratories, Inc.

Table 2.1 Water Quality Sampling Results

Results of the sampling are presented in Table 2.1 and laboratory data sheets are presented in Appendix D. The quality of the groundwater is generally good; however, three of the seven wells sampled have arsenic concentrations that exceed the EPA primary drinking standard of 0.01 mg/L. One well location (Well ID#61515, Figure 7) had a mercury detection that was equal to the EPA drinking water standard (0.002 mg/L) and one location (Well ID#50502, Figure 7) had a radon concentration that exceeds the proposed EPA drinking water standard of 300 pCi/L). Arsenic, mercury, and radon are naturally occurring in the bedrock formations in the area. One well location (Well ID#61515) had iron and manganese concentrations that exceeded the EPA secondary drinking water standards.

With the exception of one well located in Dorena (Well ID#60071, Figure 7), all homeowners interviewed stated that their water tasted good and did not have a noticeable odor. One well (Well ID#60071), located in the town of Dorena, also has elevated total dissolved solids and coliform bacteria, suggesting that this well may be affected by septic tank drain fields (interestingly, however, this well did not contain measurable nitrate). These results indicate that groundwater quality has the potential to be affected by septic tanks in areas where there is a high density of homes with septic tanks, such as in the Dorena, Dorena School, and Culp Creek areas. However, selected wells sampled in the Dorena School and Culp Creek areas did not indicate this problem exists in these areas.

2.2.2.2. DEQ Database Search

A search of DEQ’s databases was conducted inside the study area to locate potential groundwater contaminant sources. This database contains information on environmental cleanup sites (ECSI), confirmed contaminant releases, permitted septic drain fields (SIS), leaky underground storage tanks (LUST), and hazardous material storage sites (HWMS). The Source Water Assessment Report prepared by DEQ and ODHS for the City of Cottage Grove in December of 2000 was also reviewed. The search returned the following 10 locations and information:

1. Bohemia Inc (now owned by Weyerhaeuser), Culp Creek (ECSI) - Wood preservative leaked into the Row River from the sawmill.
2. Willamette Industries (now owned by Weyerhaeuser), Culp Creek Loading Area (ECSI) – Soil and near surface groundwater impacts from petroleum products, polyaromatic hydrocarbons (PAHs), and metals.
3. USDA-FS Dorena Genetic Resource Center (HWMS) – Storage of hazardous materials.
4. Boyd’s Grocery, Dorena (LUST) – Leaky underground petroleum storage tank.
5. Row River Store, Dorena (LUST) – Leaky underground petroleum storage tank.
6. Baker Bay County Park (LUST) – Leaky underground petroleum storage tank.

Figure 7 Water Wells Sampled for Water Quality Parameters

11 x 17

7. Willamette Industries (now owned by Weyerhaeuser), Dorena (HWMS) – Storage of hazardous materials.
8. USACE Schwarz Park (SIS) – Permitted for septic drain field.
9. USACE Dorena Dam (HWMS) – Storage of hazardous materials.
10. Ruiz, Susanne M. (SIS) – Permitted for septic drain field.

Available information does not indicate that any of these sites pose a substantial risk to groundwater quality beyond possibly a localized area near the facility. The location of these facilities should be considered when siting water supply wells. To further minimize the risk of contamination, water supply wells should be sealed to at least 50 feet below ground surface and into competent, low permeability material, if present.

2.2.3 Long Term Sustainable Yield

An important consideration for developing a groundwater supply is the ability of the aquifer to sustain existing and future increased pumping rates during normal and low rainfall periods. A simplified water budget was developed for the area that considered recharge to the aquifer from precipitation and discharge from the aquifer from pumping, groundwater flow out of the basin, evapotranspiration, and river flow. This simplified approach allows us to assess the likelihood for decreased precipitation and/or increased pumping associated with this project to reduce groundwater levels and reduce the ability of the aquifer to sustain existing and future pumping in the area.

The following simplifying assumptions were made in the analysis:

- Average annual precipitation at Dorena Dam from 1939-2000 (Oregon Climate Service, 2003) was 48.1 inches per year.
- Average precipitation (48.1 in.) multiplied by the area of the watershed (approximately 8 x 109 ft2) yields a volume of available annual recharge of roughly 735,000 acre-feet. To get an idea of how much water this is, the volume of water in Dorena Lake at full pool is approximately 77,600 acre-feet.
- The lowest three-year moving average of precipitation from 1939-2000, which is assumed to represent drought conditions, was 36.1 inches per year or roughly 551,000 acre-feet per year.
- Changes in soil moisture storage and groundwater levels are ignored.
- The river is assumed to be a gaining river (e.g., groundwater flow is to the river).
- Average annual surface water flow during baseflow conditions, which represents water leaving the basin, (assumed to be July) measured on the Row River below Dorena Dam from 1980-2000 was approximately 115,000 acre-feet per year.

- Average evapotranspiration, based on pastureland in the Willamette Valley, is 26.8 inches per year or roughly 400,000 acre-feet when applied to the area of the watershed.
- There are approximately 250 wells in the Row River watershed above the Dorena Dam; if each were assumed to pump at 5 gpm continuously (a conservative assumption for domestic use), they would remove approximately 2,100 acre-feet of groundwater per year.
- Irrigation and septic tank return flow is ignored.
- The total increased water demand from 107 connections relying on a groundwater source would be 161 acre-feet per year.
- The estimated annual groundwater outflow from the basin is approximately 5 acre-feet, assuming this occurs through a 3 x 105 ft2 cross sectional area on the west end of the basin and the groundwater gradient is equal to the river gradient.

On an annual basis, the total available recharge in the watershed during a drought is approximately 550,000 acre-feet and the sum of all the outputs from the basin, including the additional 107 water connections, totals approximately 528,000 acre-feet of water. This leaves approximately 22,000 acre-feet of excess water over and above what is leaving the basin. The increased groundwater production necessary to supply the 107 water connections is approximately 0.03 percent of the total recharge to the watershed and 0.8 percent of the quantity in excess of discharge from the watershed.

On the basis of this simplified water budget, there is an adequate volume of water available in the basin annually to supply the additional wells that would be needed to serve the 107 connections. Because the increased demand on the groundwater system occurs during the summer when there is less rainfall recharge, it is also important to consider seasonal water level declines that could be caused by increased pumping. This is a function of both the total number of wells but also the location of the wells relative to one another because the cone of depression of a pumping well can impact the water level in a nearby well. To get an idea if this has been a problem in the past or if drought conditions caused wells to go dry or lose production, we asked a number of existing well owners interviewed as part of the groundwater sampling program if they had experienced well problems in the past. None of the well owners indicated that they had well problems during low rainfall periods or as a result of pumping elsewhere. The Oregon Water Resources Department (OWRD) Water Master was also not aware of any well production problems in the area or disputes resulting from interference between wells.

On the basis of this information and the results of the simplified water budget calculations, we believe that the study area can support additional pumping necessary to supply the needs of 107 City water connections. Wells should be located a sufficient distance from existing wells (on the order of 500 feet) to minimize potential for well interference and the wells should be 250 to 300 feet deep so that the wells are less affected by drought and seasonal water level changes.

2.3 Community Well Siting Criteria

Section 4 identifies three groupings, or clusters, of water connections that can be supplied through common community water systems, while the remaining connections outside of these clusters can be served by individual wells. This is displayed graphically in Figure 1. Note that individual well locations are shown in the middle of the tax lot; residents will be consulted to determine the best location for the well. Figures 8, 9, and 10 (presented later in this report) display blow-ups of each cluster and the tentative locations for community water supply wells. These well locations are intended for planning purposes only and are subject to change depending upon land ownership considerations, land owner approval, proximity to infrastructure, etc. Criteria used in selecting tentative well locations are as follows:

- Favorable hydrogeology (only to a limited extent because it probably does not make that much difference given the variability observed).
- Larger tax lots to minimize interference with existing and future uses of the property.
- Adequate setback from wells, septic tanks, and drain fields (inferred from the size of the tax lot and density of homes). Minimum setbacks must be 50 feet from septic tanks and 100 feet from drain fields.
- To the extent possible, select community well locations that are at least 500 feet from the river to minimize potential influence from surface water pathogens.
- DEQ file review revealed two potentially contaminated industrial sites to be avoided in the Culp Creek area: Bohemia Inc. and Willamette Industries sites (both companies may now be owned by Weyerhaeuser). Locations near possible leaking underground storage tanks at Boyd's Store and Row River Store in Dorena should be avoided.
- Community wells should be located relatively close together so that water can be conveyed to a single treatment facility.
- Community well spacing at least 500 feet to minimize interference.
- Community wells must be in a position to serve connections on both sides of the river. A pipeline crossing on an existing bridge is suggested in some cases.
- The number of wells was based on assuming a well would produce a minimum of 10 gpm for 24 hours and assuming the peak day demand is 1 gpm per connection. (Some locations may produce more than 20 gpm, but further testing is required for verification).
- One additional community well was added in each cluster for redundancy.

2.4 Groundwater Under the Influence of Surface Water Considerations

The ODHS Drinking Water Program is required to review community water supply systems in terms of sensitivity and vulnerability to known contaminant sources, surface water pathogens, and viral contamination. In December of 2000, the ODHS completed a Source Water Assessment Report for all surface water intakes within the Row River watershed, which included the City's intakes at both Layng Creek and the Row River. This report identified a number of potential contaminant sources within the watershed that could impact water quality at the City's surface water intakes.

For communities served by groundwater, EPA has proposed a "Groundwater Rule" that requires certain actions, including disinfection, filtration, and additional monitoring, if the source water (groundwater in this case) is found to be highly sensitive. ODHS has begun linking its source water assessment program with the criteria in the proposed Groundwater Rule to provide water purveyors with a heads up regarding coming regulatory requirements. These ODHS assessments focus on well construction and aquifer vulnerability to surface water influence and viral contamination. In general, wells completed in an unconfined aquifer and located within 500 feet of a surface water body are considered under the influence of surface water and vulnerable to surface water pathogens. Wells located further away from surface water but within a two-year time of travel distance from a viral source (e.g., septic drain field) may also be considered vulnerable. The degree of sensitivity and vulnerability is also a function of well construction. Deeper wells having deep well seals are generally less vulnerable, particularly if they are tapping a confined aquifer or an aquifer containing low permeability layers that would inhibit surface water influence.

To minimize the potential for new wells to be considered by ODHS as vulnerable, new well locations should be at least 500 feet from the river and well seals should be at least 50 feet deep or tap into a low permeability-confining layer, if present. Because the vulnerability assessment can be considered somewhat subjective, we recommend meeting with the ODHS prior to finalizing well locations and well design in order to discuss the issue further.

2.5 Treatment Requirements

Water quality testing results indicate that arsenic, and possibly mercury, may be present in some wells at levels exceeding drinking water standards. Radon was detected above the proposed drinking water standard at one of two locations sampled. It is possible that new wells will not have these problems or that blending of water from several community water supply wells will produce water that does not exceed the standard. We recommend that treatment be included in the water supply plan at this time and that the need for treatment be further evaluated during the pilot well program (discussed later). We expect that disinfection will be required at the community well locations due to their proximity to a large number of septic systems. The need for disinfection at individual wells will be evaluated on a case-by-case basis at the time the wells are drilled and tested.

2.6 Water Rights Strategy

Individual wells producing less than 15,000 gpd and irrigating less than ½ acre would be exempt from having to have a groundwater permit. Because exempt use does not allow irrigation of more than ½ acre on all parcels combined, community wells must have either group domestic – expanded, municipal, or a quasi-municipal groundwater permit. The group domestic-expanded category allows irrigation of ½ acre areas only on parcels specifically identified in the permit. The quasi-municipal category allows more flexibility to define a service area within which the water will be used and would not restrict irrigation to ½ acre per parcel. Both of these categories would require that the applicant be a special district. The municipal category has the same flexibility as the quasi- municipal category but would not require the City to form a special utility district. In each case, the OWRD must determine that there is adequate water available and that the application will not injure existing water rights (including exempt well owners).

According to the OWRD Water Master, the Row River may not be open to further appropriation, and therefore, hydraulically connected groundwater would also not be available for appropriation. In order to obtain a groundwater permit in this circumstance, we must show that the wells (individually and in total) do not substantially interfere with surface water. This can be shown if we are able to find a deeper portion of the aquifer that has a confining layer that isolates the surface water from the underlying aquifer. Given the potential difficulty in making this demonstration in this aquifer system, the City should consider relinquishing a portion of its older surface water right as mitigation for the groundwater withdrawal. The City has approximately 14 cubic feet per second (cfs) of water rights located upstream at the Layng Creek plant, which it would like to transfer downstream to the Row River plant at some time in the future. The total amount of water required to meet the peak water demands for the 107 connections is approximately 100 gpm or 0.22 cfs. This represents approximately 1.6 percent of the City's water rights in the Layng Creek drainage basin if it were used for mitigation purposes.

Groundwater permits take from 7 months to 1 year to obtain and longer if there is a protest and a contested case process.

2.7 Oregon Department of Human Services (ODHS) Drinking Water Program Review

Discussions were held with ODHS staffers to obtain their input during the development of the project. ODHS input was two-fold: first, new water supply facilities should be designed to meet existing water quality regulations, with awareness of the impacts of pending regulations. Secondly, ODHS is very interested in the establishment of a single agency that would be responsible for all of the community water systems, as opposed to the formation of separate entities for each community water system. There are not only advantages in terms of cost savings through economy of scale, but a single controlling entity or district would greatly simplify both operational and administrative impacts.

It is recommended that the City seek input from their legal counsel regarding the formation of a special water supply district.

ODHS regulations require the following:

> "Every water supplier shall employ, contract with or otherwise utilize an operator designated to supervise the water system, to be in direct responsible charge of the water system, and to be available during those periods of time when treatment process and operational decisions that affect public health are made."

Grade levels 1 through 4 have been established by ODHS, with more complex water systems requiring a higher degree of certification. Current City of Cottage Grove staff range from Grade 2 and Grade 3. These classifications are qualified to operate the proposed groundwater system.

Alternatively, ODHS has also established a separate certification - "operator of a small groundwater system" - as an alternate requirement for an operator of a small system treating groundwater only. Requirements for this certification are less stringent that the Grade levels 1 through 4. Each of the water systems proposed for this project will be considered to be a small groundwater system, defined as "a community….. water system serving less than 150 connections and using groundwater as its only source." In accordance with OAR 333-061-0228, Certification Requirements for Small Groundwater System Operators, an individual can be certified as a small groundwater system operator if he/she possesses a high school diploma, has taken ODHS approved training (4 to 6 hour training course offered through ODHS), and has obtained a passing score on a post training exam covering basic small groundwater system operation and water treatment. An individual can also be certified as a small groundwater system operator by obtaining a passing score on the above-mentioned exam. Once certified, an operator must maintain a current license by participating in six hours of continuing education every 3 years.

3.0 WATER DEMAND

In order to best determine the required amount of water supply, the City supplied approximately three years of consumption history for the connections along the transmission pipeline in the study area. The data were extracted by City staff from the City's utility records. In addition, the City provided production records from the distribution system that allowed Carollo to approximate water usage along the transmission pipeline. Each of these data sets is discussed below.

3.1 Utility Records

The data provided in the utility records were compiled and analyzed to determine the flow rate required for a new water supply. The data were initially analyzed for overall consumption patterns. Usage by the US Forest Service at the USDA-FS Dorena Genetic Resource Center and the US Army Corps of Engineers (two separate connections) were noted to be significantly higher than other individual users along the pipeline route. Furthermore, previous studies conducted by the USDA-FS and reviewed by the Carollo team indicated that an adequate groundwater supply for these facilities would likely prove difficult. One potential solution is to extend the City's pipeline across the Row River bridge and provide Row River WTP water to these three connections. This option was discussed with City staff during the development of this study, and it was determined with a relatively high level of confidence that the City could assume responsibility for providing water to the USDA-FS and USACE.

Initial analyses indicated that the average water consumption for the remaining 107 existing connections in the study area was 342 gpd per connection. Further review of the data revealed that the maximum consumption of water occurred in August 2000, when monthly consumption reached 94,000 gpd, or 875 gpm per connection. This consumption is approximately 40% higher than the second highest monthly consumption, 66,000 gpd in September 2002. Inspection of the data reveals that the increased consumption occurred at the majority of the connections, indicating that the higher values represent a system-wide increase in usage, and not an anomaly based on abnormal uses of a few individual users.

The usage was initially separated into segments according to tax lot maps, then analyzed for consumption patterns per map. The data are presented below.

Table 3.1	**System-Wide Water Consumption Patterns Cottage Grove Water System Feasibility Study Report City of Cottage Grove**				
Section	**No. of Conns.**	**Average Month(1)**	**Maximum Month(2)**	**Maximum Day(3)**	
		(gpd/acct)	(gpd/acct)	(gpd/acct)	(gpm/acct)
21 02 04	4	458	1628	5.2	1.70
21 02 10	3	912	1410	4.4	1.47
21 02 14	4	325	820	3.4	0.85
21 02 13	9	502	1889	15.7	1.97
21 02 24	13	369	687	5.0	0.72
21 01 19	7	380	911	11.4	0.95
21 01 30	38	309	878	32.9	0.91
21 01 31	17	224	421	7.0	0.44
21 01 32	12	249	561	7.0	0.58
Average Day Flow for study area				36,500	gpd
Maximum Day Flow for study area				140,000	gpd
Maximum Day Flow for study area				0.9	gpm/acct
Ratio of Max Day to Avg. Day Consumption				3.8	
Assumptions:	(1) Average month = Water consumption from City billing records (2) Maximum month = August 2000, highest water consumption, City billing records (3) Maximum day demand = 1.5 times maximum month demand				

The following conclusions were made following analysis of the data:

- The maximum day flow is 0.9 gpm/connection, on average, for all connections.
- The maximum day to average day demand ratio of 3.8 is higher than typically experienced for water systems. This is most likely attributable to the small data set -- in larger systems, peak flows tend to be mitigated by the larger number of consumers.
- Specific water supply requirements for each of the identified clusters is evaluated in Section 4 of this report.

3.2 Water Production Records

City staff provided daily data sheets for the water system, including data that measured production at the Layng Creek and Row River WTPs, as well as inflow to the City's reservoir. The spreadsheet format included an estimate of the water consumption that occurred along the transmission line from Layng Creek to the reservoir, a total of approximately 194 connections. (Note: The first 107 connections are those included in this study.)

The following observations of the data can be made:

- The production data had a much greater variability in comparison to the account records, which is to be expected as it is recorded on a daily basis rather than a monthly basis.
- It has been Carollo's experience that comparison of flow meters at separate locations (both WTPs, as well as the reservoir) are typically difficult to correlate.
- Five years of data were provided.
- Water consumption will include unaccounted-for water, as well as water consumed by the users along the pipeline route.
- Values in the data set labeled "14-inch Consumption" represented the difference between WTP outputs and storage reservoir input. This calculated value, therefore, is the amount of water consumed along the entire pipeline route. Approximately 7 percent of the data showed negative values, indicating that the flow into the reservoir exceeded WTP output. This would indicate that not only did no consumption occur, but water was somehow introduced to the system.
- The average day water consumption for the entire pipeline (as determined from the daily production records) was approximately 87,000 gpd, in comparison to 36,500 gpd for 107 connections in the study area. Thus, 55% of the total connections (107 versus 194) accounted for approximately 44% of the "14-inch Consumption" demand. When allowances are made for the high usage at the USACE and USDS-FS connections, both data sets predict a similar level of water requirement for the study area.

3.3 Water Demand Conclusions

The following assumptions and conclusions can be made:

- Water consumption data as measured by account records will serve as the basis for determination of water supply needs.
- The USDA-FS and USACE connections will be serviced directly by the City through an extension of a pipeline from the Row River WTP.
- The average maximum day demand for each connection will be 0.9 gpm.

4.0 WATER SUPPLY PLAN

Section 2 identifies the availability of groundwater as a potential source of supply for users in the study area. Considerations for community versus individual systems were identified, and guidelines for well locations and system configurations were also presented. Section 3 presents an overview of water demands for the affected area.

This section identifies the specific elements of a water supply plan to provide water service to all users within the study area.

4.1 Plan Overview

Following is an outline of the proposed water supply plan:

- USDA-FS Dorena Genetic Resource Center, USACE shops and campground can be served by City water extended across the bridge from the Row River plant.
- Communities (clusters of residents) at Dorena School (Figure 8 and Appendix E), Dorena (Figure 9 and Appendix E), and Culp Creek (Figure 10 and Appendix E) can be served by community wells (with one additional well included per cluster for redundancy). The target production rate for the community wells is at least 20 gpm each, although cost estimates are based on a conservative approach of 10 gpm per well.
- A storage tank in each cluster will improve peak supply reliability and take pressure off of wells to meet peak hour demands.
- Residents outside of main clusters can be served by individual wells. The target production rate for individual wells is 5 – 10 gpm.
- The total number of wells will be determined based on actual production at each location and the location of infrastructure relative to demand centers. We estimate that 18 connections can be served by individual wells. There are three clusters of connections that can be served by 3 to 4 community water supply wells each (Dorena School, Dorena, and Culp Creek). The total number of individual and community water supply wells, including additional community wells for redundancy, is 29 wells.
- The water quality sampling program indicates the potential presence of arsenic in wells in the study area. Although not likely, it is possible that arsenic may be present in each of the wells. Due to the random nature of this contaminant, it will be conservatively assumed that all community well systems will be provided with a treatment system for arsenic removal. In addition, due to the potential for bacteriological contamination attributed to the septic systems in each area, it will be assumed that a disinfection system will be required for each community well system.

Each community system will have a centralized treatment facility (if needed), storage tank and pumps for water distribution. For purposes of this report, costs have been included for self-contained, proprietary systems available from Adedge Technologies, Inc. These units achieve their effectiveness in arsenic removal through contaminant adsorption onto the proprietary media, which can be landfilled when expended. Similar products are available from other manufacturers and alternatives can be explored during the next phase of the project.

- The existing 14” diameter transmission pipeline has reached the end of its useful life and cannot be used without extensive rehabilitation or replacement. The project team evaluated the potential of sliplining portions of the transmission pipeline in the vicinity of each cluster with a smaller diameter HDPE pipe. For both cost and constructability purposes, it was determined that it was preferable to run a 4” diameter PVC pipeline parallel to the existing transmission pipeline for water conveyance to each connection in the cluster.
- In the areas of identified clusters, significant distribution piping exists and will remain in service to convey water from the existing 14” diameter transmission line to the individual users. This consists primarily of 4” and 2” PVC piping. It is assumed that this piping will be re-used for the new supply.

4.2 Cluster Identification

Three separate community water systems would be provided to serve the identified clusters of Dorena School, Dorena, and Culp Creek. Each cluster is shown in Figure 1, with greater detail provided later in this section. Each community water system would include the following components:

- Usage patterns within each cluster were evaluated to determine the following flow requirements:
    - Dorena School Cluster: Average/Maximum day demand: 7/30 gpm.
    - Dorena Cluster: Average/maximum day demand: 8/34 gpm.
    - Culp Creek Cluster: Average/maximum day demand: 5/15 gpm.
- Water supply wells, with an assumed capacity of 10 to 20 gpm. Four wells (three duty and one standby) are proposed for the Dorena School and Dorena clusters, while three wells (two duty and one standby) are proposed for the lower demands at the Culp Creek cluster.
- Water supply piping conveying well water to a common treatment and storage site. Length of piping varies with the assumed location of each treatment facility.
- Facility building.
- Arsenic removal system.

- Chlorine disinfection system.
- On-site reservoir storage.
- Water supply pumps to pressurize the water for conveyance.
- Water supply piping conveying treated water to existing transmission main. Length of piping varies with the distance from the assumed treatment facility location to the existing transmission main.
- Water distribution piping paralleling the existing transmission main for conveying treated water to each connection. Length of piping varies with the distance required to provide service to all connections.
- It was assumed that standby, or emergency, power would not be provided at the treatment facilities. Therefore, water supply will not be available in the event of a power outage.

A schematic of a typical community water system is included as Figure 8.

Figure 8 Typical Community Water System

4.2.1 Dorena School Community Water System

A total of 22 connections will be included in this system. Based on consumption patterns observed in August 2000, the maximum day demand for the Dorena School cluster is approximately 17 gpm. In order to provide adequate storage to meet peak hour use, a diurnal curve was used to plot water usage over the course of the projected maximum day. The diurnal curve is shown in Table 4.2 and Figure 9. Design criteria for the Dorena cluster are presented in Table 4.1. A graphic of the Dorena School cluster is displayed in Figure 10. Connections are identified in Appendix E.

Table 4.1 Dorena School Cluster Design Criteria
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove

	Unit	**Number**
No. of Connections	ea	22
Design Flow - Maximum Day	gpm	30
Design Flow - Peak hour	gpm	48
No of wells (duty/standby)	no.	3/1
Arsenic Treatment Unit Size	cu ft	26
Disinfection	Free Chlorine	
Storage reservoir	gal	5,000
High service pumps		
Number	ea	2
Capacity	gpm	50

Table 4.2 Dorena School Cluster Daily Diurnal Demand Patterns

Figure 9 Dorena School Cluster Daily Diurnal Demand Patterns

Figure 10 Dorena School Cluster Well Location Map

11 x 17

Feasibility level costs for this option are included in Table 4.3. The markup for “Associated Project Costs” includes allowances for engineering design, City administration, legal consultation, financing assistance, and construction period services.

Table 4.3 Dorena School Cluster Capital Costs
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove

	Quantity	Unit	Unit Cost	Subtotal
Well Drilling, casing, liner & seal	4	EA	$18,350	$73,400
Power supply, conduit and wire	1	EA	$30,000	$30,000
Supply Piping - 4” PVC	1,500	LF	$22	$33,000
Treatment Building, Power & Site Work	1	EA	$27,750	$27,750
Arsenic Treatment	1	EA	$39,000	$39,000
Disinfection	1	EA	$4,000	$4,000
Instrumentation and Control	1	EA	$7,075	$7,075
Reservoir and Pumping	1	EA	$23,500	$23,500
Discharge Piping - 4” PVC	100	LF	$22	$2,200
Discharge Piping - 4” PVC (parallel 14” transmission main)	3,500		$22	$77,000
Easements and Permitting	1	EA	$37,500	$37,500
Subtotal (rounded)				$354,000
General Conditions	12%		$43,000	
Subtotal (rounded)				$397,000
Contractor Overhead & Profit	10%		$40,000	
Subtotal (rounded)				$437,000
Contingency	20%		$87,000	
Associated Project Costs	25%		$109,000	
TOTAL (rounded)				$633,000

4.2.2 Dorena Community Water System

A total of 36 connections will be included in this system. Based on consumption patterns observed in August 2000, the maximum day demand for the Dorena cluster is approximately 33 gpm. In order to provide adequate storage to meet peak hour use, a diurnal curve was used to plot water usage over the course of the projected maximum day. The diurnal curve is shown in Table 4.5 and Figure 11. Design criteria for the Dorena cluster are presented in Table 4.4. A graphic of the Dorena Cluster is displayed in Figure 12. Connections are identified in Appendix E.

Table 4.4 Dorena Cluster Design Criteria
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove

	Unit	**Number**
No. of Connections	ea	36
Design Flow - Maximum Day	gpm	34
Design Flow - Peak hour	gpm	54
No. of wells (duty/standby)	no.	3/1
Arsenic Treatment Unit Size	cu ft	26
Disinfection	Free Chlorine	
Storage reservoir	gal	6,000
High service pumps		
Number	ea	2
Capacity	gpm	60

Table 4.5 Dorena Cluster Daily Diurnal Demand Patterns

Figure 11 Dorena Cluster Daily Diurnal Demand Patterns

Figure 12 Dorena Well Cluster Well Location Map

Feasibility level costs for this option are included in Table 4.6. The markup for "Associated Project Costs" includes allowances for engineering design, City administration, legal consultation, financing assistance, and construction period services.

Table 4.6 Dorena Cluster Capital Costs
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove

	Quantity	Unit	Unit Cost	Subtotal
Well Drilling, casing, liner & seal	4	EA	$18,350	$73,400
Power supply, conduit and wire	1	EA	$30,000	$30,000
Supply Piping	1,500	LF	$22	$33,000
Treatment Building, Power & Site Work	1	EA	$27,750	$27,750
Arsenic Treatment	1	EA	$39,000	$39,000
Disinfection	1	EA	$4,000	$4,000
Instrumentation and Control	1	EA	$7,075	$7,075
Reservoir and Pumping	1	EA	$24,000	$24,000
Discharge Piping - 4" PVC	200	LF	$22	$4,400
Discharge Piping - 4" PVC (parallel 14" transmission main)	3,100	LF	$22	$68,200
Easements and Permitting	1	EA	$37,100	$37,100
Subtotal (rounded)				$348,000
General Conditions Contingency	12%		$42,000	
Subtotal (rounded)				$390,000
Contractor Overhead & Profit	10%		$39,000	
Subtotal (rounded)				$429,000
Contingency	20%		$86,000	
Associated Project Costs	25%		$107,000	
TOTAL (rounded)				$622,000

4.2.3 Culp Creek Community Water System

A total of 31 connections will be included in this system. Based on consumption patterns observed in August 2000, the maximum day demand for the Culp Creek cluster is approximately 14 gpm. In order to provide adequate storage to meet peak hour use, a diurnal curve was used to plot water usage over the course of the projected maximum day. The diurnal curve is shown in Table 4.8 and Figure 13. Design criteria for the Culp Creek cluster are presented in Table 4.7. A graphic of the Culp Creek cluster is displayed in Figure 14. Connections are identified in Appendix E.

Table 4.7 Culp Creek Cluster Design Criteria
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove

	Unit	Number
No. of Connections	ea	31
Design Flow - Maximum Day	gpm	15
Design Flow - Peak hour	gpm	24
No. of wells (duty/standby)	no.	2/1
Arsenic Treatment Unit Size	cu ft	11
Disinfection	Free Chlorine	
Storage reservoir	gal	2,500
High service pumps		
Number	ea	2
Capacity	gpm	30

Table 4.8 Culp Creek Daily Diurnal Demand Patterns

Figure 13 Culp Creek Daily Diurnal Demand Patterns

Figure 14 Culp Creek Well Location Map

11 x 17

Feasibility level costs for this option are included in Table 4.9. The markup for “Associated Project Costs” includes allowances for engineering design, City administration, legal consultation, financing assistance, and construction period services.

Table 4.9 Culp Creek Cluster Capital Costs
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove

	Quantity	Unit	Unit Cost	Subtotal
Well Drilling, casing, liner & seal	3	EA	$18,350	$55,000
Power supply, conduit and wire	1	EA	$21,000	$21,000
Supply Piping - 4” PVC	1,000	LF	$22	$22,000
Treatment Building, Power & Site Work	1	EA	$27,750	$27,750
Arsenic Treatment	1	EA	$23,000	$23,000
Disinfection	1	EA	$4,000	$4,000
Instrumentation and Control	1	EA	$5,500	$5,500
Reservoir and Pumping	1	EA	$17,500	$17,500
Discharge Piping - 4” PVC	200	LF	$22	$4,400
Discharge Piping - 4” PVC (parallel 14” transmission main)	5,400	LF	$22	$119,000
Easement and Permitting	1	EA	$40,700	$40,700
Subtotal (rounded)				$340,000
General Conditions	12%		$41,000	
Subtotal (rounded)				$381,000
Contractor Overhead & Profit	10%		$38,000	
Subtotal (rounded)				$419,000
Contingency	20%		$84,000	
Associated Project Costs	25%		$104,000	
TOTAL (rounded)				$607,000

4.3 Individual Wells

Approximately 18 water connections will be supplied with water supply through an individual water supply well. As stated previously, it is assumed that the capacity of each of these wells is between 5 to 10 gpm. A cost estimate was prepared for a home water well, including an installed well pump, hydropneumatic tank, piping and electrical supply. In addition, it was conservatively assumed that a home treatment unit for arsenic removal will also be required. It was assumed that disinfection of individual wells will not be required.

Table 4.10 Individual Well Capital Costs
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove

	Quantity	**Unit**	**Unit Cost**	**Subtotal**
Well Drilling and Pump Installation	1	EA	$7,300	$7,300
Power supply	1	EA	$4,000	$4,000
Pressure Tank	1	EA	$500	$500
Supply Piping	50	LF	$10	$500
Arsenic Treatment	1	EA	$2,500	$2,500
Subtotal (rounded)				$14,800
Contingency	25%		$3,700	
Total (rounded)				$18,500
TOTAL ALL INDIVIDUAL WELLS	18	EA	$18,500	$330,000

5.0 RECOMMENDED NEXT STEPS

5.1 Water Supply Plan Development

If the City decides to move forward with developing a groundwater source for the 107 connections located along the transmission pipeline, we recommend the installation of five or six pilot wells to confirm water quantity and quality throughout the area to be served. A number of steps are necessary as part of the pilot well project including:

- Meet with members of the community to discuss the plan and obtain support for the project.
- Meet with representatives of the USDA-FS Dorena Genetic Resource Center and USACE to discuss supplying treated water from the Row River plant to these locations.
- Meet with OWRD and ODHS to discuss the permitting strategy and well design.
- Meet with Lane County to discuss land use approval and other planning related issues.
- Select test well sites and obtain easements and/or permission from property owners to drill the test wells. Obtain approval from other property owners for additional well sites should the initial test well results not be favorable.
- Prepare specifications and a bid document for the test well drilling program and select a qualified drilling contractor.
- Identify wells that could be monitored during aquifer tests and obtain baseline water level data.
- Drill the test wells, conduct aquifer tests, and collect water samples.
- Evaluate the data, estimate well yields, assess interference with other wells, and assess treatment requirements.
- Update the project development plan and provide recommendations for how the utility should be managed and operated.
- Update the project cost estimate.

If the results of the pilot well drilling and testing are favorable and the City decides to proceed with implementing the plan, the City will need to move forward with establishing a special district and negotiating terms with individual property owners. At the same time, the City would proceed with the groundwater permitting process and design of the system. Alternatively, the City could submit a groundwater permit application during the test well drilling program to potentially shorten the amount of time required to obtain the permit.

Design and construction of the system would begin after the City obtains the approved groundwater permit.

5.2 Capital and Operating Cost Estimate Summary

Capital cost estimates for the individual systems were presented in Section 4 of this report and are summarized below. These cost estimates are feasibility level estimates and should be refined during the next phase of the report. At that time, additional data on well production and anticipated water quality can be incorporated to provide greater precision in determining the number of required wells and water treatment requirements.

**Table 5.1 Total System Capital Costs
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove**

Customer Group	Number of Connections	Cost
Dorena School Cluster	22	$633,000
Dorena Cluster	36	$622,000
Culp Creek Cluster	31	$607,000
Individual Wells	18	$330,000
TOTAL (rounded)	107	$2,192,000

Operating costs for the cluster systems only were also developed. It was assumed that the operation of the groundwater systems would be under the control of a special district that would contract operations to a private operations company. All other assumptions are included below.

**Table 5.2 Total System Operation and Maintenance Costs
Cottage Grove Water System Feasibility Study Report
City Of Cottage Grove**

O&M Cost Component	Cost/yr	Assumptions
Labor	$22,000	• $35/hr for average 12 hrs/week.
Power	$3,000	• TDH = 300 ft (groundwater lift plus system pressure). Avg power = $0.07/kwh. Building heat and venting included.
Maintenance	$7,000	• 2.5% of actual equipment and building structure costs.
Media Replacement	$15,000	• 75% of total arsenic treatment unit costs, replaced on 5-year basis.
TOTAL	**$47,000**	

5.3 Project Schedule

A multitude of issues exist surrounding development of a groundwater supply system for the transmission line connections. The more significant issues include system funding, customer acceptance, water rights availability and potential transfer, and establishment of an overall agency responsible for compliance with administrative and operating requirements. Recognizing that any of these issues are capable of causing significant delays or even possible cancellation of the entire project, Carollo has developed a schedule that indicates a “best-case” condition of being on-line in approximately 2-1/2 to 3 years. The schedule is shown in Figure 15.

Figure 15 Tentative Project Schedule

Appendix A

WATER WELL LOGS

Appendix B

WELL OWNER INTERVIEW FORMS

Appendix C

WATER WELL SAMPLING PROCEDURES

Appendix D

WATER WELL SAMPLING LABORATORY RESULTS

CUSTOMER IDENTIFICATION