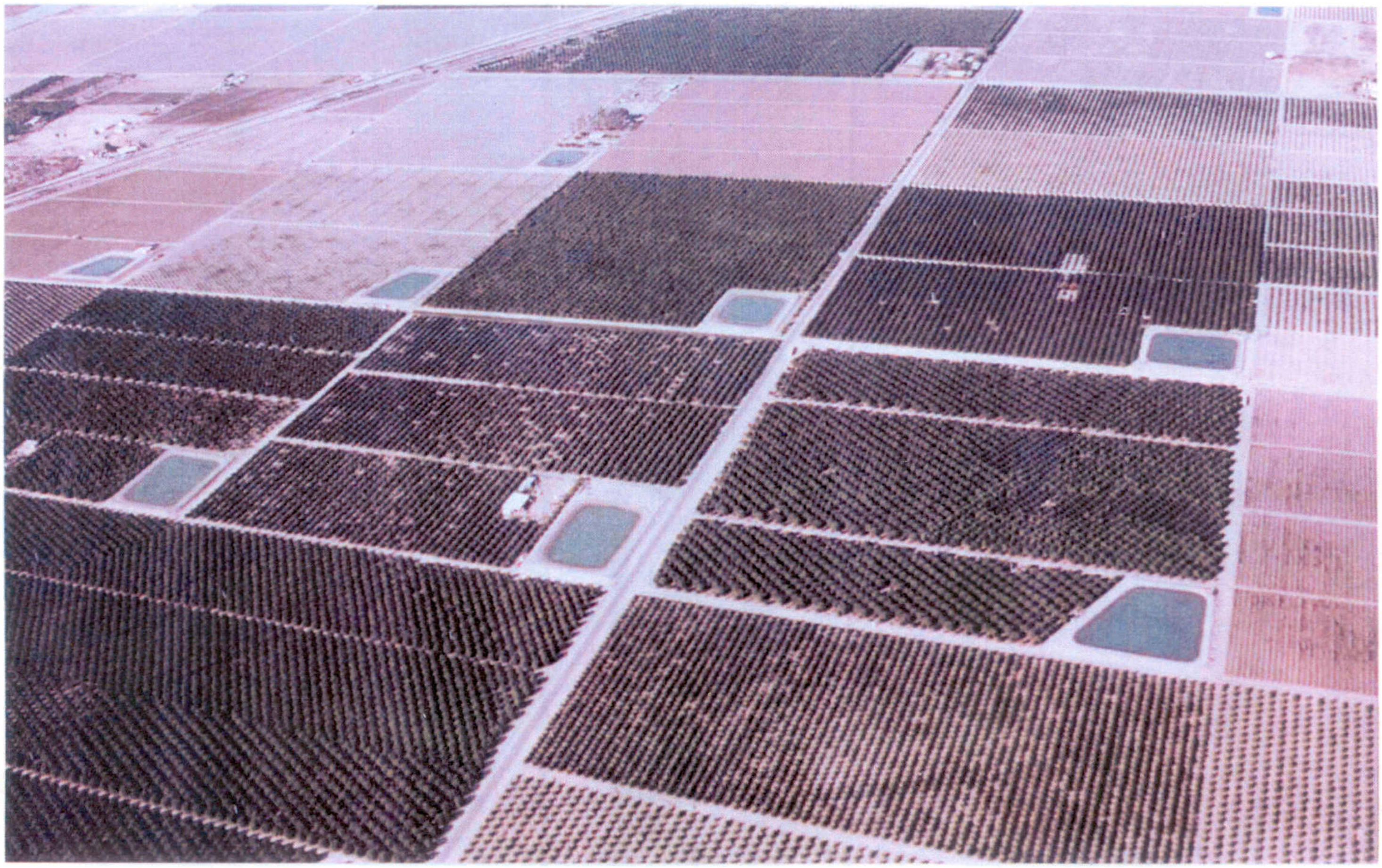
IRRIGATION MANUAL TO CONVERT FROM WELL WATER TO COLORADO RIVER WATER



EXECUTIVE SUMMARY

Good water management can prove the difference between a successful or unsuccessful farming operation. The correct amount of water applied at the most critical time can mean the difference between mediocre and lucrative crop yields. Crop water requirements can vary from crop cooling in some months to *peak consumptive use* in other months. The successful conversion from *groundwater* to *canal water* will depend upon knowing when to irrigate and how much water to apply.

This manual is intended to provide growers currently using *well water* with information to convert to canal water in order to minimize reliance on groundwater. If this can be accomplished within the next few years, groundwater extractions from the already *overdrafted* groundwater basin can be reduced thereby stabilizing the water table in the lower Coachella Valley. Growers with immediate access to an existing *Coachella Valley Water District (CVWD)* delivery meter should be the first to investigate converting from groundwater to canal water.

***Colorado River water* supplied by CVWD has been the most stable, reliable water supply for the Coachella Valley over the past 45 years. Except for minor, short term, scheduled maintenance, growers have consistently been supplied with 8.5 gallons per minute per acre on over 70,000 acres at a fair and reasonable cost. Assuming a typical 6 acre-feet per day water delivery, the cost of canal water is $16 per acre-foot.**

Growers who have experienced deep well pump, motor, electrical panel or well casing failures know how critical it is to immediately repair the equipment. Many times it is very difficult to locate qualified technicians, equipment or materials to quickly implement repairs. Growers understand failure of the well water supply is a very critical situation if canal water is not available for backup.

Some wells contain high nitrogen levels which cause unwanted growth patterns on some crops during critical times of the growing season. Other wells contain sodium salts in excess of calcium salts which inhibit water infiltration as the growing season progresses.

The true cost of well water must consider the annualized capital cost of the well, pump, motor, electrical panel in addition to repair, maintenance and operational (power) costs. The operational costs will continue to increase as the water table is drawn down if the same amount of groundwater (gallons per minute) is extracted. Depending upon the *pumping water level*, actual well water costs exceed $60 per acre-foot. A potential CVWD *replenishment charge* of $5 to $30 per acre-foot will also substantially increase the cost of well water. It will be shown in this manual groundwater can cost 2.3 times more than canal water.

The foresight of the Coachella Valley Water District is helping to alleviate the overdraft situation in the Coachella Valley. Currently the replenishment charge is

$89.00 per acre-foot in the upper Coachella Valley. Groundwater users will continue to pay more for water as the water table declines. CVWD is currently researching several plans for helping to provide monetary assistance for growers in the lower Coachella Valley interested in converting from groundwater to canal water. Producing this conversion manual is a step forward to help answer growers' concerns or questions. Coachella Valley Water District encourages good water management throughout the Coachella Valley. They are willing to assist growers whenever possible in conserving the groundwater basin in the entire Coachella Valley.

BACKGROUND

The purpose of this manual is to help growers convert from utilizing groundwater to Colorado River water. This manual is based upon the assumption canal water is currently available at the highest corner of the property to be converted.

In the long run, it will be cost effective to abandon older, unreliable pumps and/or wells in the Coachella Valley and convert to a canal water delivery system. Older, unreliable wells are generally more costly to rehabilitate versus the cost to drill a new well or convert to canal water.

Growers can expect continued increases in groundwater pumping costs due to several factors:

1. *Imperial Irrigation District (IID)* power, including surcharge fees, cost increases.

2. Declining water tables which require more horsepower (energy) to lift equivalent amounts of water to the surface.

3. A proposed CVWD replenishment charge from $5 to $30 per acre-foot.

4. The cost for well construction continues to escalate.

Greater demands are continually being placed on the Coachella Valley groundwater basin. It is estimated over 300,000 permanent residents will be living in the Coachella Valley by the Year 2000. Winter residents and visitors could increase that number by 40%. As housing, greenbelts, golf courses and parks continue to develop groundwater will be reserved for urban uses. At this time, it is easier and less expensive for water purveyors to supply domestic water via groundwater than attempt to treat or reclaim Colorado River water. Groundwater will be designated for urban users.

If agricultural operations are to continue to have sufficient water, sustainable water resource management is very critical. Increased use of canal water for agricultural irrigation is imperative in order to help ensure sufficient groundwater supplies for ever increasing urban demands. It is our responsibility to ensure our children and grandchildren have domestic water in the future.

Groundwater resource management is critical throughout the Coachella Valley. The upper portion of the Coachella Valley is generally defined as northwest of Washington Street, from Interstate 10 to La Quinta. Groundwater is predominantly for domestic use including greenbelts, golf courses, parks, schools, etc. Agriculture extracts relatively minimal water supplies from this upper portion. See Location Map, Appendix D. This upper basin is annually recharged with approximately 60,000 acre-feet of water purchased from the State Water Project.

The lower portion of the Coachella Valley is generally defined as southeast of Washington Street from the Coachella Canal to the Salton Sea and down to Avenue 86 (Riverside County line) or simply below Point Happy at the corner of Washington Street and Highway 111, La Quinta. The population in this area is significantly less than the population in the upper portion of the valley. Agricultural irrigation is the main groundwater extractor in the lower portion. Except for lack of CVWD delivery facilities, canal water is generally available in this area. Location of the I.D. 1 boundary where CVWD is able to serve canal water is also shown on the Location Map (Appendix D).

Precise details needed to successfully convert from groundwater to canal water will be outlined during a detailed engineering analysis of the jobsite. There are many parameters to be analyzed prior to construction of a reservoir or pump and filter station. The location, soil type, type of irrigation system, power supply, reservoir

overflow, operation and management of the system are very site specific, see Appendix C. The entire system should be professionally designed by an experienced, qualified, certified Registered Professional Engineer.

Coachella Valley Water District is currently working on implementation of a ground-water recharge program. Current groundwater users will be required to pay for this program through a replenishment charge based upon the amount of water (measured in acre-feet) extracted from the ground by each grower. This manual is intended to help growers convert from groundwater to canal water relieving the current trend of overdrafting the basin. If the water table can be stabilized and balanced simply with less overall usage, CVWD's recharge program costs will be minimal as will the replenishment charge.

General <u>capital</u> and <u>operational</u> costs will be reviewed in this manual. These costs are very site specific and dependent upon the type of irrigation system to be operated. For example, the costs for converting a well water irrigation system to canal water are much higher for a pressurized *drip/sprayer* irrigation system than for a flood irrigation system. The costs per acre also depend upon the number of acres to be serviced with a specific reservoir or pump and filter station. If the <u>capital</u> costs are spread over 40 acres, they will be significantly more per acre than the same cost divided over 160 acres.

Several basic assumptions must be made in order to project general costs and guidelines for converting from groundwater to canal water. The water supply system typically provides at least 10 gallons per minute per acre. CVWD generally provides a minimum of 8.5 gallons per minute per acre.

Only agricultural land within CVWD (ID-1) boundaries are eligible to receive canal water, see Appendix D. CVWD water delivery flexibility is very site specific and totally depends upon existing CVWD pipeline capabilities. For example, if CVWD does not have a lateral pipeline adjacent to the farmland, the cost to convert to canal water will be higher. For this manual it is assumed CVWD canal water is available at the highest point of the property.

ECONOMICS

Various costs as discussed below are presented as part of a very general discussion relating to the cost of converting from groundwater pumping to canal water, gravity fed into a reservoir or directly onto the ground surface. The cost of lifting the water via a booster pump is addressed later in this manual. As mentioned throughout this manual, these costs are very site specific and can vary greatly depending upon the final engineering design. It is assumed the current well at the site is operating

efficiently (wire to water efficiency over 60%) and supplying sufficient water to satisfy peak consumptive use requirements.

Static or *standing water level* in a well is measured from the ground surface down to the water surface when no water is being extracted. The well is at rest and sufficient time has passed since it was operated hence the water level has stabilized. Standing water level can change throughout the year and from year to year depending upon the quantity of water extracted from the aquifer. If a neighboring parcel extracts several thousand acre-feet of groundwater in a year, actual standing water level tests have shown an adjacent well could experience a decrease of 100 feet in only two or three years.

If the standing water level drops dramatically, power costs increase to lift the same amount (gallons per minute) of groundwater to the surface. Over $50,000 was spent in one case to maintain adequate flow to the surface after the standing water level dropped 100 feet in less than three years. The pump bowls were replaced and lowered 100 feet; the column, tube and shaft were increased in length and size; the electric motor and panel was changed from 20 horsepower to 100 horsepower and the power utility line size (2 miles of wire) and transformers were increased substantially.

When the water level is lowered dramatically, well casings can collapse due to increased stresses from the earth above the water table. Of course, if the steel casing collapses, the well, and usually the pump, column, tube and shaft must be abandoned.

Pumping water level is measured (again from the ground down to the water surface) when water is being extracted from the well. It is totally dependent upon the amount of water extracted per unit of time, usually measured in gallons per minute (gpm). The pumping water level is always below the standing water level with the mathematical difference between the two termed *drawdown*. For example, if 400 gpm is being extracted from a well with 20 feet of drawdown, the *specific yield* is 20 gpm per foot of drawdown (abbreviated as 20 gpm/ft.). If the flowrate increases to 800 gpm, generally, the pumping water level will drop an additional 20 feet, thereby substantially increasing the energy (horsepower) required to lift water from the pumping water level to the ground surface. As the water level (both standing and pumping) drops, the cost per acre-foot of water lifted to the surface will increase.

Capital cost of a "well system" can be divided into the well (drilling, testing, perforated steel casing and gravel pack) and mechanical (pump, motor, column, tube, shaft, electrical panel and meter service).

A gravel packed well with 16" casing, 800 to 1000 feet deep, capable of 1500 gpm can cost from $80,000 to $200,000. In this analysis $135,000 is used for the cost of the well. The annual fixed cost over 30 years is $4500 per year ignoring interest rate and inflation. The cost of the mechanical portion of the well is very dependent upon the

depth of the pumping water level and amount of water desired at the ground surface. Assuming 1500 gpm lifted from 200 feet deep, a 100 horsepower pumping station <u>(mechanical)</u> would cost approximately $50,000. The annual fixed cost of the pump, motor, etc. over 20 years is $2500 per year. The total annual fixed cost is $4500 + $2500= $7000 per year regardless of the number of acre-feet pumped or the number of hours operated. In order to simplify this cost analysis, well insurance and property taxes (both real and personal) were assumed to be inconsequential. Interest rate and inflation rate were assumed to be equal.

Assuming the well pump in the above example operates 2000 hours per year, 550 acre-feet per year will be pumped. If this well provides water for 120 acres, approximately 4.6 acre-feet of water is applied per acre per year. The annual <u>capital</u> cost divided by the number of acre-feet pumped per year equals $13 per acre-foot ($7000÷550 acre-feet=$13/acre-foot). In order to simplify this presentation, all per acre-foot costs will be rounded to the nearest whole dollar.

<u>Variable</u> costs such as pump, motor, electrical and well maintenance also depend upon how hard the well system is worked or the number of hours operated per year. Typical repair and maintenance costs range from $1500 to $3000 per well system per year. Assuming a relatively new, high efficiency, high capacity well system, $2000 per year will be used in this example. Therefore, repair and maintenance costs on an acre-foot basis equals $4 per acre-foot ($2000÷550 acre-feet= $4/acre-foot).

Imperial Irrigation District is the power purveyor in the lower portion (below Point Happy) of the Coachella Valley. Their current agricultural use rate, including surcharge fee, is approximately 12¢ per kilowatt-hour. Again assuming a relatively high efficiency, high capacity well system with pumping water level of 200 feet, the cost of power is $32 per acre-foot. Generally, power costs can be estimated between 14¢ and 18¢ per acre-foot per foot of lift out of the well depending upon the efficiency of the well system. An assumed power cost of 16¢ per acre-foot per foot of lift out of the well was used in the above calculation.

Coachella Valley Water District is the water purveyor for the area legally known as ID-1, see Appendix D. Replenishment charges are being proposed by CVWD to help defray expenses incurred to recharge water back into the lower valley groundwater basin. This replenishment charge is based upon actual costs to replenish the groundwater basin. The more expense required by CVWD to recharge the groundwater basin, the higher the replenishment charge imposed for each groundwater pumper. The more groundwater extracted, the higher a growers overall water cost.

The replenishment charge may start as low as $5 per acre-foot. However, if the current overdraft trend continues, the replenishment charge could escalate to $30 per acre-foot within five to seven years. By comparison, CVWD currently charges groundwater users in the upper portion of the Coachella Valley $89 per acre-foot. For

this well water economic analysis, the CVWD replenishment charge is assumed to be $25 per acre-foot.

Well water costs are based on 120 acres of farmland, 200 feet pumping water level, 4.6 acre-feet applied per acre per year. The following summary presents these costs on an acre-foot basis:

<u>Capital Costs</u>- Depreciated well, pump, motor and electrical	**$13/ac-ft**
<u>Variable Costs</u> -Well system repair and maintenance	**$ 4/ac-ft**
IID power costs *	**$32/ac-ft**
CVWD replenishment charge	**<u>$25/ac-ft</u>**
TOTAL ESTIMATED GROUNDWATER COST	**$74/AC-FT**

***If pumping water level was only 100 feet, IID power costs would be $16/ac-ft thereby reducing the overall groundwater cost to $58/ac-ft.**

Coachella Valley Water District *stand-by fee* is used to help pay the cost of the original canal and water distribution system. It is spread equally throughout the ID-1 boundary area where delivery points are available. This annual fee is based on acreage. The current CVWD stand-by fee is $85 per acre per year. *User fees* are currently $26 per acre foot plus $10 per day delivery gate fee. On an annual basis, a combination of these costs result in an actual net user fee of approximately $28 per acre foot. The user fee ($28/ac-ft) is credited against the stand-by fee ($85/ac-ft), which is approximately equal after using 3.8 acre-feet per acre.

Due to the complexity of the canal water distribution system (designed in 1930's), canal water delivery requires certain rules and regulations. Generally, if the following requirements are met, canal water will be reliably and dependably delivered as requested:

1. **Twenty four hour notice by phone to CVWD prior to delivery.**
2. **Minimum of twenty four hour duration (or multiple thereof) per order.**
3. **Depending upon other water deliveries on a main lateral line, flowrates can vary throughout the delivery period.**
4. **Maximum of 1350 gpm (3 cubic feet per second, 150 miners inches) per meter.**
5. **Monetary penalty for emergency turnoff of delivery, however one "free" emergency turnoff is allowed every two weeks.**
6. **Excess surface water or "tailwater" is not allowed to leave a field and "wasted" into either a surface or subsurface drain.**

An accurate comparison of water costs is dependent upon many factors. If flood irrigation is required and the grower is willing to irrigate with a relatively constant flowrate of 1350 gpm, groundwater costs $62 per acre-foot and canal water costs $16 per acre-foot. If the grower wants to irrigate only during the daylight hours and wants to use 2700 gpm at one time to irrigate more area at one time, a 3 acre-feet storage reservoir is required for either well water or canal water.

If a grower is currently utilizing a pressurized type of irrigation such as drip/sprayer with well water, directly out of the well discharge and only a screen filter, <u>capital</u> investment is required to convert to canal water. A lined storage reservoir is required to help settle heavy silt loads, regulate canal water deliveries and receive filter flush water. Reservoir costs range from $30,000 for a plastic lined, 3 acre-feet reservoir with inlets and outlets up to $40,000 to $60,000 for a cement lined, 3 acre-feet reservoir with inlet and outlet pipes and structures. The addition of a new booster pump and sand media filter station may also be required at a cost of $30,000 to $50,000. Generally, additional horsepower is required along with additional or upsizing of IID transformers, electrical panel and installation. Additional electrical requirements would add approximately $10,000 to the conversion cost. If a new CVWD delivery meter is required, it will cost approximately $15,000.

Conversion (<u>capital</u>) costs for pressurized drip/sprayer irrigation systems with canal water are summarized as follows:

Reservoir	**$20,000 to $60,000**
Booster pump and sand media filter station	**$20,000 to $60,000**

Refurbished electrical facilities $10,000

CVWD Delivery Meter <u>$15,000</u>

TOTAL ESTIMATED CONVERSION COSTS = $65,000 to $145,000

If the entire reservoir, pump, filter station and electrical system <u>capital</u> costs are divided over 20 years, the annual fixed cost ranges from $3250 to $7250 per year assuming no interest rate or inflation. This cost comparison will assume $5000 per year for fixed costs. Booster pump, filter, steel pipe fabrication, repair and maintenance costs are estimated at $1000 per year. Therefore, $5000 + $1000= $6000 per year for fixed costs divided by 550 acre-feet per year (from previous well pump analysis) equals $11 per acre-foot per year. Booster pump power costs and chemigation (chemical injection equipment) costs for both the original well system and a new canal water delivery system would be the same and therefore not a part of this comparison.

Canal water costs per acre-foot for a typical drip/sprayer system are as follows:

<u>Capital Costs</u>- Depreciated pump, filter and reservoir cost $11/ac-ft

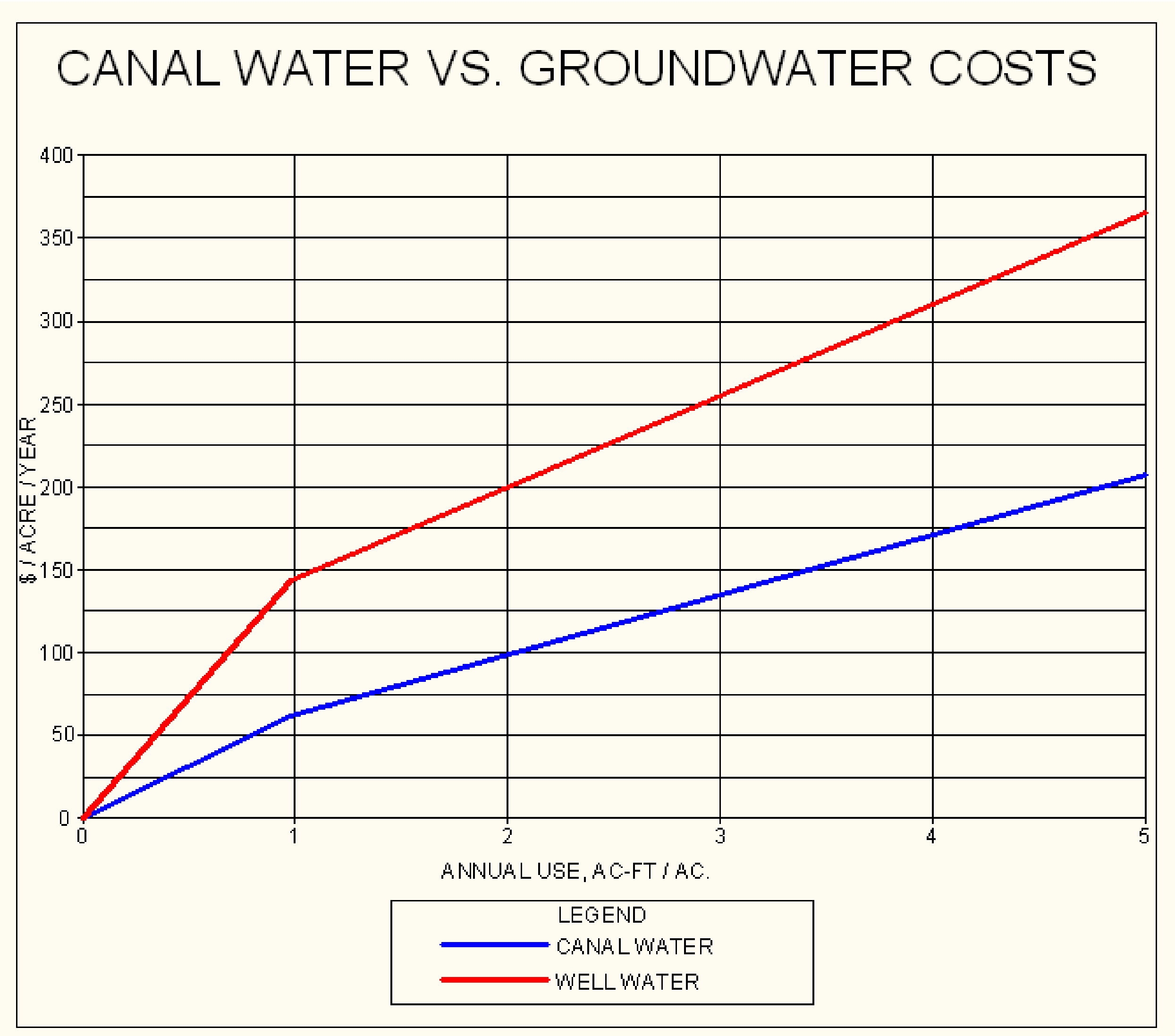
CVWD canal water cost including stand-by fees, daily gate

fees and water toll	<u>$29/ ac/ft</u>
TOTAL CANAL WATER COST	**$40/ac-ft**

Comparison of canal water versus well water cost assumes 120 acre plot, 4.6 acre-feet per acre per year, 200 feet to pumping water level and drip/sprayer irrigation system.

Graph 1. Canal Water versus Groundwater Costs

Canal Water **4.6 ac-ft/acre @ $40/ac-ft/year = $184/acre/year**



Groundwater **4.6 ac-ft/acre @ $74/ac-ft/year= $340/acre/year**

If only 3 acre-feet are required per acre per year, the above per acre costs would be reduced 35% or $81/acre/year for canal water and $186/acre/year for groundwater. *Summarily, well water costs are approximately 2.3 times greater than canal water.*

COLORADO RIVER WATER QUALITY

Colorado River water is well known for its good infiltration characteristics. Approximately 1000 pounds of gypsum is naturally available per acre-foot of canal water which helps enhance water infiltration. Relatively high amounts of calcium and magnesium ions versus sodium creates a Sodium Adsorption Ratio of approximately 3.2 which is also very beneficial for soil infiltration.

Canal water is more basic than acidic with a pH=8.2. Periodic acidification (lowering the pH) will help release natural elements in the soil. Nitrates are very low hence no unwanted excessive growth patterns. Relatively high bicarbonate levels (from 160 to 200 mg/l) may cause foliar deposits and/or defoliation on some crops if sprayed on leaves.

Boron levels are well below threshold levels of 1.0 part per million. Heavy metals such as Aluminum (0.780 ppm) and Iron (0.529 ppm) are present in canal water but do not present a serious hazard for most crops.

Relatively high total dissolved solids (TDS) of 830 parts per million generally require growers to periodically leach excessive total salts out of the root zone. Leaching salts from the root zone is more critical on heavier soils.

Total Undissolved Solids will vary throughout the year in canal water. Canal water has much better clarity in Winter and early Spring. The largest amount of moss, silt and algae occurs during late Spring and Summer. Hence, a reservoir is very beneficial to help settle the silt load and segregate moss prior to water entering the booster pump or filtration station.

It is beyond the scope of this report to provide a complete chemical analysis of Colorado River water. The 1994 Canal Water Quality Summary is included in Appendix A. Consistent soil monitoring is highly recommended in order to prevent salt buildup in the root zone.

It is imperative growers learn which fertilizers can be used with drip/sprayer irrigation systems and which cannot. Local fertilizer suppliers or U.C. Extension Service personnel are very cognizant of calcification effects of certain chemical additives when utilizing canal water for drip irrigation.

Water is delivered from the Colorado River to the Coachella Valley in 100 miles of open canal. Silt and multiple forms of aquatic growth seasonally appear in various concentrations in the canal water. To prevent plugging, undissolved, suspended solids must be removed when irrigating with a drip/sprayer irrigation system. The regulating/storage reservoir required for canal water use has additional benefits when used with drip/sprayer systems. Depending upon reservoir size and distance between inlet and outlet, it allows for settlement of the seasonal silt load. It can also help regulate filter flush water.

The reservoir must be lined in order to prevent excessive seepage and loss of water. Soil cement lining is more expensive initially but much less to maintain. A small scraper can be used to annually remove silt or sand buildup in the reservoir. Plastic lined reservoirs cost less initially but have higher maintenance costs. Thin plastic film should be covered with approximately 12 inches of native soil. Equipment cannot drive on the plastic lining hence spraying is required for weed control and silt buildup is carefully removed by manual labor.

The reservoir is used to buffer CVWD delivery fluctuations as well as store additional water for periodic flushing of the filters. Generally, CVWD delivers approximately

1350 gpm (150 inches or 3 cubic feet per second). Twelve hours of storage with no outflow requires approximately 3 acre-feet. The majority of reservoirs built in the Coachella Valley will hold a minimum of 3 acre-feet (1 million gallons). However, reservoir sizing, construction, overflow elevation, inlet/outlet separation, freeboard, outlet location, etc. are very site specific, see Appendix C. New reservoirs should be designed by a Registered Professional Engineer.

Water filtration is required as the water exits both the reservoir and the booster pump station. Pre-screening at the reservoir outlet will minimize large debris from entering the booster pump stand. The degree of filtration required will vary directly with the type of irrigation system to be utilized. The smaller the orifice in the field, the finer filtration required. Row crop drip tape, low volume sprayers and low gallonage *emitters* generally require sand media filtration down to 200 mesh (75 micron). High volume sprayers, sprinklers and large orifice emitters may only require 100 mesh (150 micron) screen filtration.

Larger orifice sizes require less filtration because they tend to pass more silt and exhibit less overall plugging. The engineer must use caution with large orifice devices to not exceed the long term soil infiltration rate and create runoff. Higher flowrate emitters and sprayers should be used only on coarser, more porous soils.

Smaller orifices require much finer filtration in conjunction with better monitoring

and water management. Siltation, bacterial growth, freshwater clams or chemical deposits are very detrimental to the successful operation of row crop drip tape, smaller gallonage emitters and small orifice sprayers.

Despite the best design and engineering, not all problems can be anticipated. An experienced professional engineer should be consulted prior to designing a new reservoir and irrigation system. Each site generally has its own set of design parameters to consider and resolve. Equipment manufacturers can also provide valuable insight into the layout and operation of a new irrigation system using canal water.

Canal water contaminants should be removed in the filter system. Hence, periodic flushing of the filter is required. One cannot deposit filter flush water into either the CVWD irrigation distribution system nor CVWD underground drainage system. This silt and aquatic growth laden flush water can be recirculated back into the reservoir, deposited into an existing flood irrigation system or sprinkled (large orifice only) on field roadways. The in-field mainlines, laterals and tubing should also be periodically flushed (until the water runs clean) depending upon the system filtration parameters.

Periodic acidification of the irrigation system will help sanitize and prevent plugging in the emitters or sprayers. Lowering the pH will help kill bacteria, clams, fish eggs, and dissolve chemical deposits. N-furic fertilizers, UN-32, sulfuric acid are

commonly used to help lower the pH. Magnacide or bluestone treatments have been successfully used to inhibit algae growth in reservoirs. The cleaner the reservoir, the more successful the pressurized filtration system.

COMMON MYTHS AND MISTAKES

Unfortunately, there have been many myths and mistakes encountered when using canal water for pressurized drip/sprayer irrigation systems in the Coachella Valley. The following items are common mistakes by growers:

- **Swimming pool filters are not designed for agricultural use.**
- **Inappropriate control valve size and location can create significant pressure changes in a system.**
- **Pipelines or tubing should not run uphill.**
- **The irrigation system cannot operate itself, it must be checked often.**
- **PVC pipe cannot be laid above ground without significant sunburn degradation.**
- **Clear or white tubing, installed above ground, will allow algae growth.**
- **Only approved underground feeder (UF) wire should be used with 24volt field control valves.**
- **Emitters and sprayers will not operate without some form of filtration.**

There are also many myths which have been discussed:

Myth- **Cannot use drip irrigation on dates.**

Truth- **There are many successful drip and sprayer irrigated date groves, some in combination with flood irrigation, in the Coachella Valley.**

Myth- **Cannot use canal water for drip irrigation.**

Truth- **Approximately 55,000 acres are currently using drip irrigation on all type of crops, from Artichokes to Zucchini, in the Coachella Valley.**

Myth- **Cannot use drip due to fresh water clams plugging the system.**

Truth- **Proper filtration and sanitization of the water supply is required.**

EXISTING SUCCESSFUL CONVERSIONS

There are several examples in the Coachella Valley of successful conversions from groundwater to canal water. Even if the well system is operable, canal water has become the primary source and groundwater generally the secondary source. The following photographs of successful installations (including commodities) utilize either a combination or have completely converted from groundwater to canal water. The photographs and labels will help explain how each system was converted from groundwater to canal water.

Photographs of Successful Conversions from Groundwater to Canal Water:

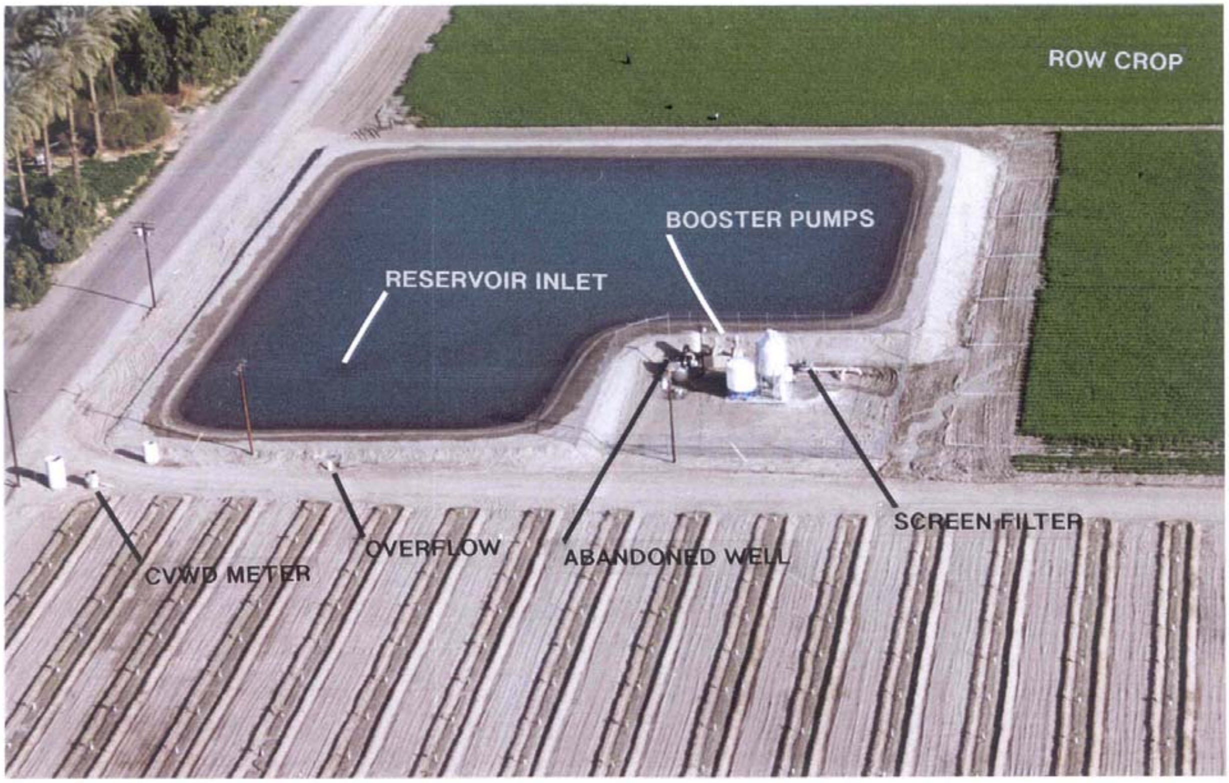
PHOTO NUMBER - 1 **OASIS AREA**

Type of Irrigation System - **Drip, sprayer and flood**
Reservoir - **Plastic lined, 7 acre-feet**
Crop - **Citrus and Nursery, 200 acres**
Pump and Filter - **50 hp, 1200± gpm, 140 mesh filters**
Water Supply - **Abandoned adjacent well but other wells available.**
Existing CVWD meter as shown

Estimated Capital Costs -

Reservoir		**$35,000**
Pump and filter station		**18,000**
Pipeline from meter to reservoir		**5,000**
Estimated Capital Costs	**=**	**$58,000**
	=	**$ 300/acre**

PHOTO NUMBER - 2 **OASIS AREA**



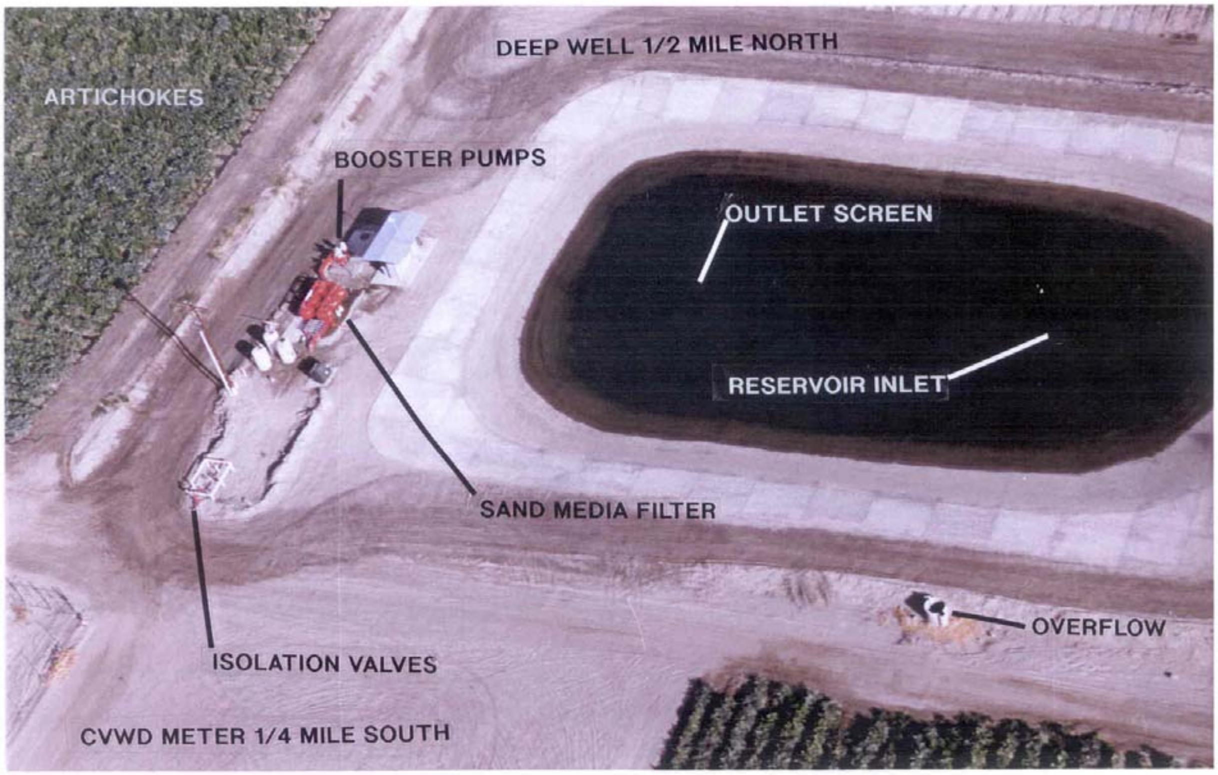
Type of Irrigation System - **Sprinkler and flood**

- **Reservoir -** **Plastic lined, 5 acre-feet, 18" PVC inlet/outlet**
- **Crop -** **Row crops, 300 acres**
- **Pump and Filter -** **Multiple boosters, 30 hp and 60 hp, 100 mesh screen filter**
- **Water Supply -** **Abandoned well, existing CVWD meter as shown**

Estimated Capital Costs -

Reservoir		**$20,000**
Pump and filter station		**30,000**
Pipeline from meter to reservoir		**5,000**
Estimated Capital Costs	**=**	**$55,000**
	=	**$185/acre**

PHOTO NUMBER - 3 **OASIS AREA**



Type of Irrigation System - **Drip, sprayer, flood and sprinkler**

Reservoir - **Cement lined, 4 acre-feet, 18" PVC inlet/outlet**

Crop - **Row crops, dates, citrus, grapes; 185 acres**

Pump and Filter - **75 hp, 1575 gpm, sand media with backup screen filter**

Water Supply - **100 hp well, 1500 gpm, ½ mile to north**
Existing CVWD meter as shown

Estimated Capital Costs -

Reservoir		**$60,000**
Pump and filter station		**50,000**
Pipeline from meter to reservoir		**5,000**
Estimated Capital Costs	**=**	**$115,000**
	=	**$620/acre**

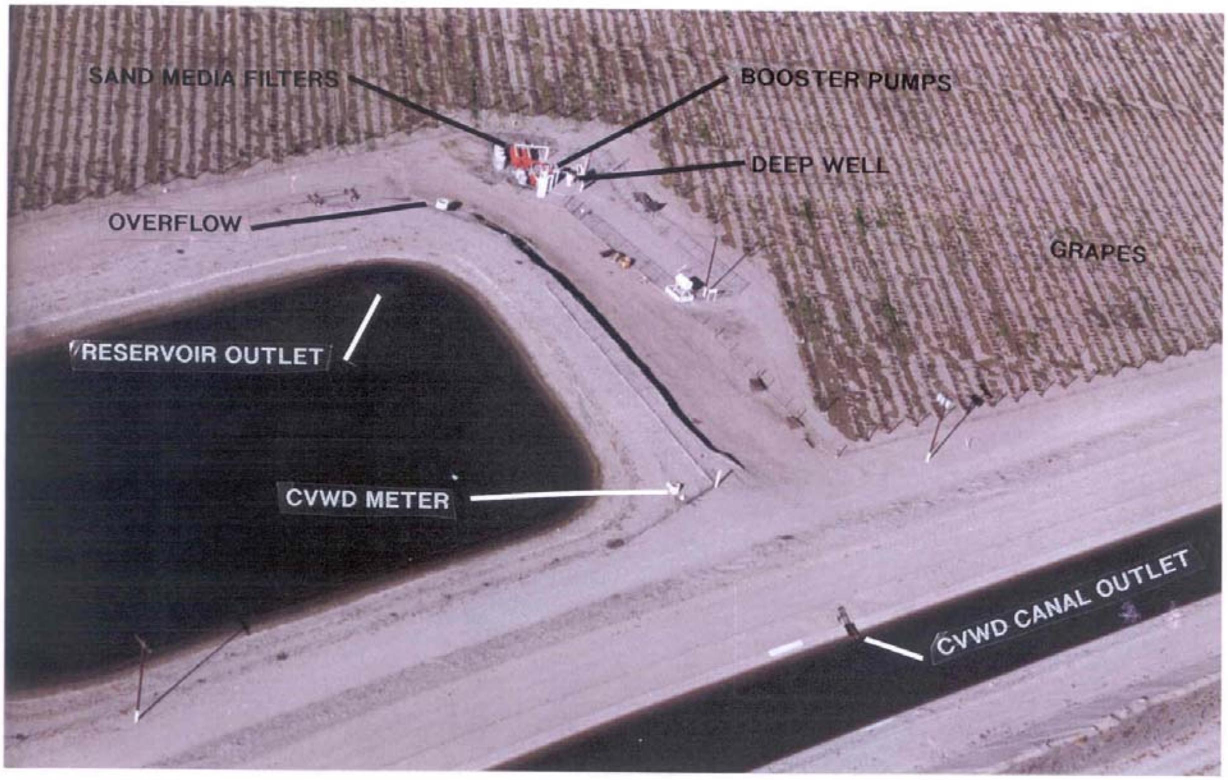
PHOTO NUMBER - 4 **COACHELLA AREA**

Type of Irrigation System - Drip and sprayer
Reservoir - Plastic lined, 3 acre-feet
Crop - Citrus, 80 acres
Pump and Filter - 800 gpm deep well, 100 mesh screen filters
Water Supply - Deep well, CVWD meter application pending

Estimated Capital Costs -

Reservoir		$25,000
Pump and filter station		15,000
Pending CVWD meter delivery		20,000
Pipeline from meter to reservoir		10,000
Estimated Capital Costs	=	$70,000
	=	$ 875/acre

PHOTO NUMBER -5 **MECCA AREA**



Type of Irrigation System - **Drip and sprinkler**

- **Reservoir -** **Cement lined, 4 acre-feet**
- **Crop -** **Grapes and citrus, 60 acres**
- **Pump and Filter -** **15 hp (400 gpm) and 75 hp (1800 gpm), sand media filter**
- **Water Supply -** **60 hp deep well (500 gpm) and existing CVWD meter**

Estimated Capital Costs -

Reservoir		**$50,000**
Pump and filter station		**40,000**
Pipeline from meter to reservoir		**5,000**
Estimated Capital Costs	**=**	**$95,000**
	=	**$1600/acre**

A Registered Professional Engineer should provide the grower with an independent design representing only the growers best interest. There should be no connection to the subsequent sale of materials or a particular manufacturer's product. This independent design should provide the grower with a complete set of Construction Drawings, Bill of Materials and Materials Specifications.

SIMPLIFIED PROCESS

Conversion from groundwater to canal water starts with filling out a simple application for service from CVWD, see Appendix B. Basic information such as the owners name, address, location, etc. are required prior to processing an application. This application is then circulated within several CVWD departments such as Engineering, Right-of-Way, Accounting, Operations, etc.

If water delivery is feasible, CVWD will provide the meter overflow elevation to the grower or his representative. Typically, three (3) feet of pressure head is required upstream from the CVWD flowmeter. Detailed, engineered drawings such as specific location, elevations, flowrates, pressures, pump and filter size, valve specifications, etc. are supplied to CVWD Engineering Department for approval. These parameters are very site specific and require careful engineering analysis prior to processing the application. If CVWD facilities are not currently adjacent to a project site, several months of lead time may be required to allow for construction of additional facilities, delivery meters or pipelines. Imperial Irrigation District also requires approximately 6

to 8 weeks for delivery of new power to a specific site.

Both IID and CVWD applications should be made early in the project planning stages.

- **After IID and CVWD approvals, a detailed, specific materials list should be submitted to responsible irrigation suppliers.**
- **The materials bid should be awarded and materials delivered (generally 2 to 4 weeks lead time).**
- **Construction staking should begin prior to start of installation of a new irrigation system.**
- **Property corners should be located prior to installation of any trees or vines, pipelines, pump or filter stations.**
- **Construction can then begin with either the owners crews or a qualified outside contractor.**
- **After construction has been completed, correct rotation of the booster pump should be verified.**
- **Canal water should be ordered from CVWD.**
- **The entire system pressure tested for several hours at high operating pressures.**

SUCCESSFUL IRRIGATION SYSTEM OPERATION

There are four basic interrelated requirements for the success of a new pressurized *irrigation system*. If one of the following items does not correlate with the others, the system will not be as efficient as possible and could fail. The following parameters help define the term irrigation system:

- **Water quality and quantity**
- **Orifice size**
- **Degree of filtration**
- **Management and operation**

If any one of the above items is not completely and accurately linked with the other three, the irrigation system will not reach peak efficiency and may not even operate. For instance, if the entire design requires 2000 gallons per minute (24 hours per day during peak consumptive use) and only 1350 gpm is available, the orifice size, degree of filtration and management of the system will be irrelevant. The system simply will not operate due to lack of sufficient water.

When converting to canal water, <u>water quality</u> and <u>quantity of flow</u> parameters are readily available from CVWD, see Appendix A. The less silt load at the filter station, the easier the system is to manage and the better the filters will work. It is most economical and efficient to chemically treat algae in the reservoir rather than in the filter station.

The smaller orifice in either drip/sprayer or sprinkler irrigation systems, the finer filtration required. A small orifice produces less runoff but requires more hours of operation per day to satisfy peak consumptive use requirements. Underground pipelines and valves are usually smaller due to less quantity of water required per acre.

Conversely, with a larger orifice, more runoff can be expected, especially in heavy, clay soils. Coarser filtration can be utilized and less hours are operated per day. Underground pipe and valve sizes are generally larger due to more water supplied per acre.

Pre-filtration is always recommended at the reservoir outlet. A galvanized or stainless steel woven wire can be wrapped around a steel frame to limit debris from entering the booster pump stand. The more contaminants contained in the water (such as silt, algae, moss) and smaller the orifice, the finer filtration and more backflushing required. Conversely, the cleaner the reservoir water supply and larger the orifice in the field, the less filtration and less backflushing is required.

Management is the key to properly operating the irrigation system. It is imperative all levels of management fully understand the above interrelationships. If the grower/manager is to provide sufficient water and nutrients to the plants in a timely manner in order to maximize productivity and minimize water use, the entire

irrigation system must operate correctly.

SUMMARY

Demands on limited groundwater resources are dramatically increasing. As population in the Coachella Valley surpasses 300,000 permanent residents, groundwater must be reserved for domestic use. Use of canal water by agricultural users decreases reliance on groundwater thereby relieving overdrafting of the lower Coachella Valley basin.

Pumping water levels are on a downward spiral. The sooner agricultural users convert from groundwater to canal water, the less water will need to be recharged into the basin. CVWD has embarked on an ambitious plan to first educate all water users, not just agriculturists, then begin recharging the underground basin in 1996. We really are using our childrens water supply. Time is of the essence.

Costs to convert from dependency on groundwater to canal water are very site specific. Depending upon basic assumptions as outlined in the manual and exact location in the lower valley, groundwater can cost over 2.3 times the cost of canal water. Not only are groundwater levels dropping, it is also much more expensive to lift water out of the ground.

A good, sound engineering design is the best way to start the process of converting from groundwater to canal water. Usually, applications must be processed by both Imperial Irrigation District and Coachella Valley Water District.

Final conversion costs can be verified after an irrigation system design is presented for a specific site. As groundwater is totally dependent upon the current and future water table decline, both the lower cost and greater reliability of canal water emphasize the benefit of converting to Colorado River water. CVWD staff is ready, willing and able to help answer any questions.

APPENDIX A

CANAL WATER QUALITY SUMMARY

APPENDIX A

CANAL WATER QUALITY SUMMARY

Parameters	Symbols and Units		DLR	RESULTS Minimum	Maximum	Average
Calcium	Ca	mg/L		83	97	89
Magnesium	Mg	mg/L		33	37	34
Sodium	Na	mg/L		118	151	130
Potassium	K	mg/L		4.5	5.2	4.8
Carbonate	CO_3	mg/L	1.0	ND	5.8	1.2
Bicarbonate	HCO_3	mg/L		161	190	170
Sulfate	SO_4	mg/L		302	353	325
Chloride	Cl	mg/L		106	141	110
Nitrate	NO_3	mg/L	0.40	ND	1.3	0.5
Nitrite	NO_2	mg/L	0.40	ND	ND	ND
Fluoride	F	mg/L		0.37	0.43	0.41
Boron	B	mg/L		0.03	0.25	0.15
Ortho Phosphate	$O\text{-}PO_4$	mg/L	0.50	ND	ND	ND
Total Dissolved Solids	TDS	mg/L		773	931	820
Total Hardness (as $CaCO_3$)	TH	mg/L		342	392	362
Total Alkalinity (as $CaCO_3$)	ALK	mg/L		132	155	140
Hydrogen Ion Concentration	pH			8.1	8.3	8.2
Specific Conductance	EC	µmhos/cm		1180	1490	1290
Sodium Absorption Ration	SAR			2.7	3.3	3.0
Percent Sodium		%		42	45	44
Langlier Corrosivity Index				-0.36	1.1	0.29
Temperature		°F		54	86	70
Aluminum	Al	µg/L	50	*	*	780
Antimony	Sb	µg/L	6.0	*	*	ND
Arsenic	As	µg/L	2.0	*	*	4.2
Barium	Ba	µg/L	100	*	*	153
Beryllium	Be	µg/L	1.0	*	*	ND
Cadmium	Cd	µg/L	1.0	*	*	ND
Chromium	Cr	µg/L	10	*	*	ND
Copper	Cu	µg/L	50	*	*	ND
Iron	Fe	µg/L	100	*	*	529
Lead	Pb	µg/L	5.0	*	*	ND
Manganese	Mn	µg/L	30	*	*	ND
Mercury	Hg	µg/L	1.0	*	*	ND
Molybdenum	Mo	µg/L	10	*	*	14
Nickel	Ni	µg/L	10	*	*	ND
Selenium	Se	µg/L	5.0	*	*	ND
Silver	Ag	µg/L	10	*	*	ND
Thallium	Tl	µg/L	1.0	*	*	ND
Zinc	Zn	µg/L	50	*	*	ND

canal94

(1) Includes results for monthly and annual samples collected during 1994 from the Coachella Canal at Avenue 52.

ABBREVIATIONS

mg/L - milligram per liter (ppm)
µmho/cm - micromhos per centimeter
DLR - detection level for reporting
µg/L - microgram per liter (ppb)
ND - not detected
* - see average for annual test

APPENDIX B

CVWD CANAL WATER DELIVERY APPLICATION

APPENDIX B

CVWD CANAL WATER DELIVERY APPLICATION

______________________________ ______________

LANDOWNER (Please Print do not Sign) METER NO.

COACHELLA VALLEY WATER DISTRICT
Coachella, California

CERTIFICATE OF OWNERSHIP — AUTHORIZATION OF AGENT

Parcel No.____________________________ No. Acres__________

Sec.__________, T.________S., R.________E., S.B.B.M.

I hereby Authorize ____________________________________

Address____

to sign or give orders in my name to the Coachella Valley Water District for the delivery of water to the above described land, and hereby ratify and confirm each and every order which he may give, and guarantee the payment of all tolls and charges, under the rules and regulations of the district, for all water so ordered.

This authorization shall be revocable at any time upon notice in writing to the district.

Date____________________ Signature ________________________

LANDOWNER/TITLE

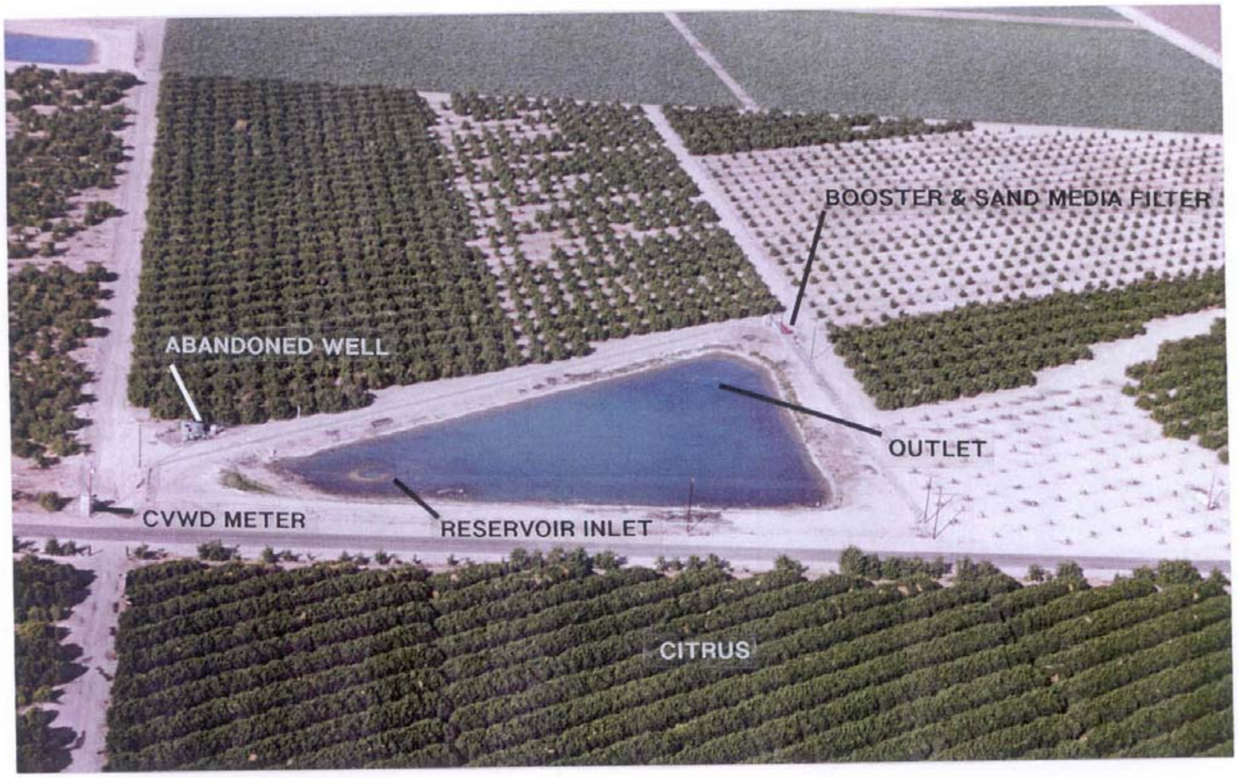
Send Bills To:
Owner ☐ Tenant ☐ Address __________________________

CVWD-106

APPENDIX C

ADDITIONAL PHOTO DESCRIPTIONS AND COSTS

PHOTO NUMBER - 6 MECCA AREA



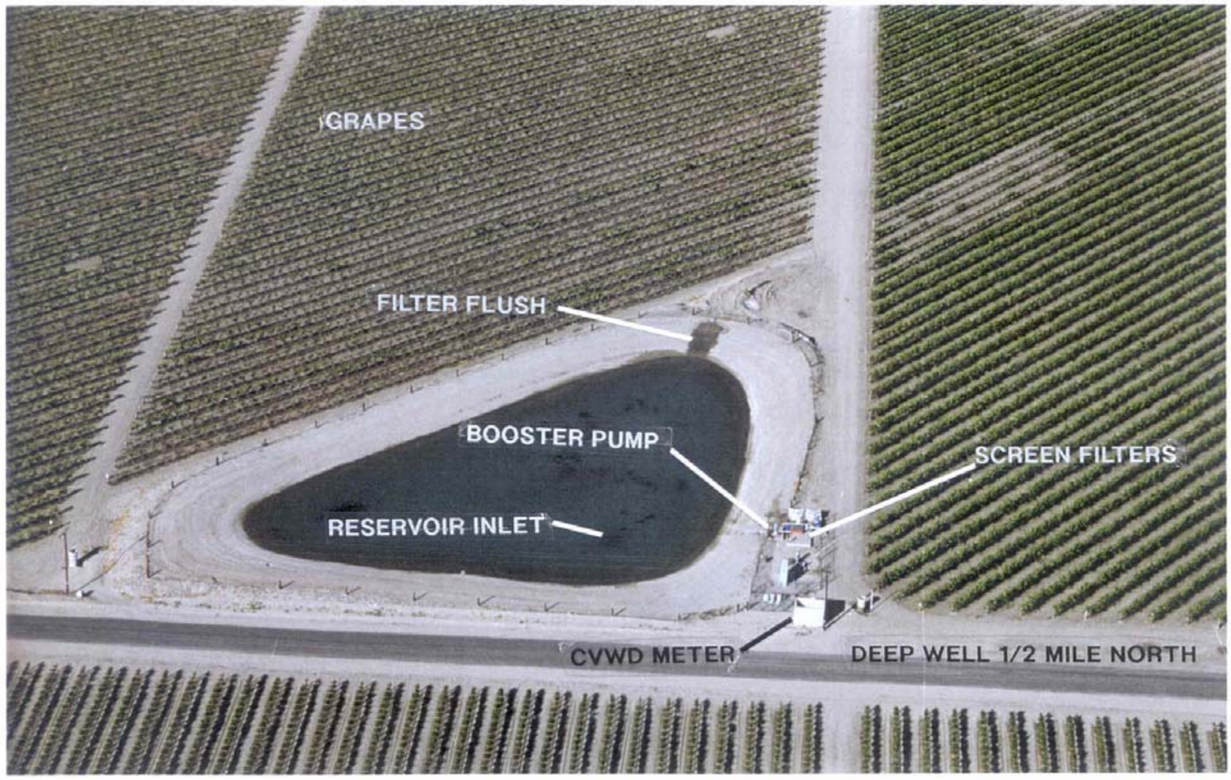
Type of Irrigation System - Drip and sprayer

- **Reservoir -** Plastic lined, 7 acre-feet
- **Crop -** Citrus, 80 acres
- **Pump and Filter -** 50 hp booster pump(1000 gpm) and sand media filter
- **Water Supply -** 50 hp deep well (600 gpm) and existing CVWD meter as shown

Estimated Capital Costs -

Reservoir		$40,000
Pump and filter station		30,000
Pipeline from meter to reservoir		5,000
Estimated Capital Costs	=	$75,000
	=	$950/acre

PHOTO NUMBER - 7 **MECCA AREA**



Type of Irrigation System - **Drip and sprinkler**

Reservoir - **Cement lined, 5 acre-feet**

Crop - **Grapes, 160 acres**

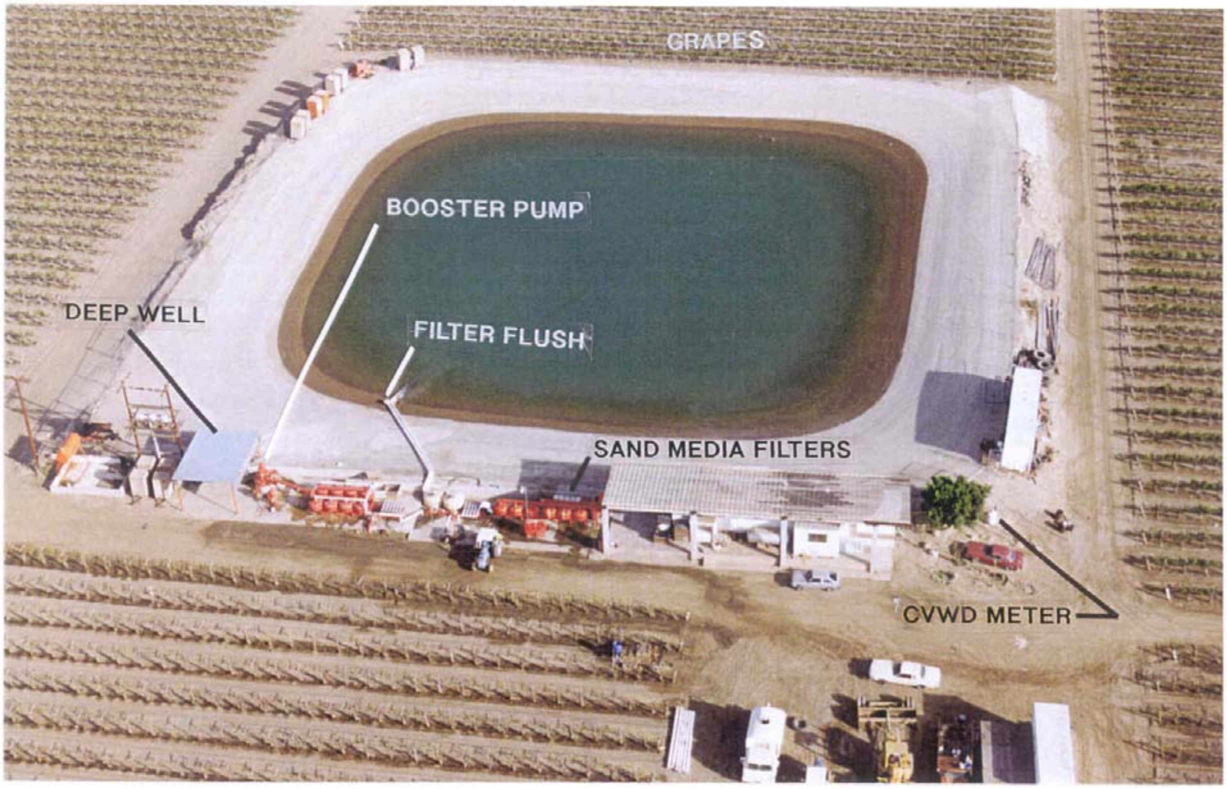
Pump and Filter - **75 hp booster pump and 100 mesh screen filter**

Water Supply - **125 hp deep well (1200 gpm) and existing CVWD meter**

Estimated Capital Costs -

Reservoir		**$60,000**
Pump and filter station		**20,000**
Pipeline from meter to reservoir		**10,000**
Estimated Capital Costs	**=**	**$90,000**
	=	**$565/acre**

<u>PHOTO NUMBER - 8</u> **VALERIE JEAN AREA**

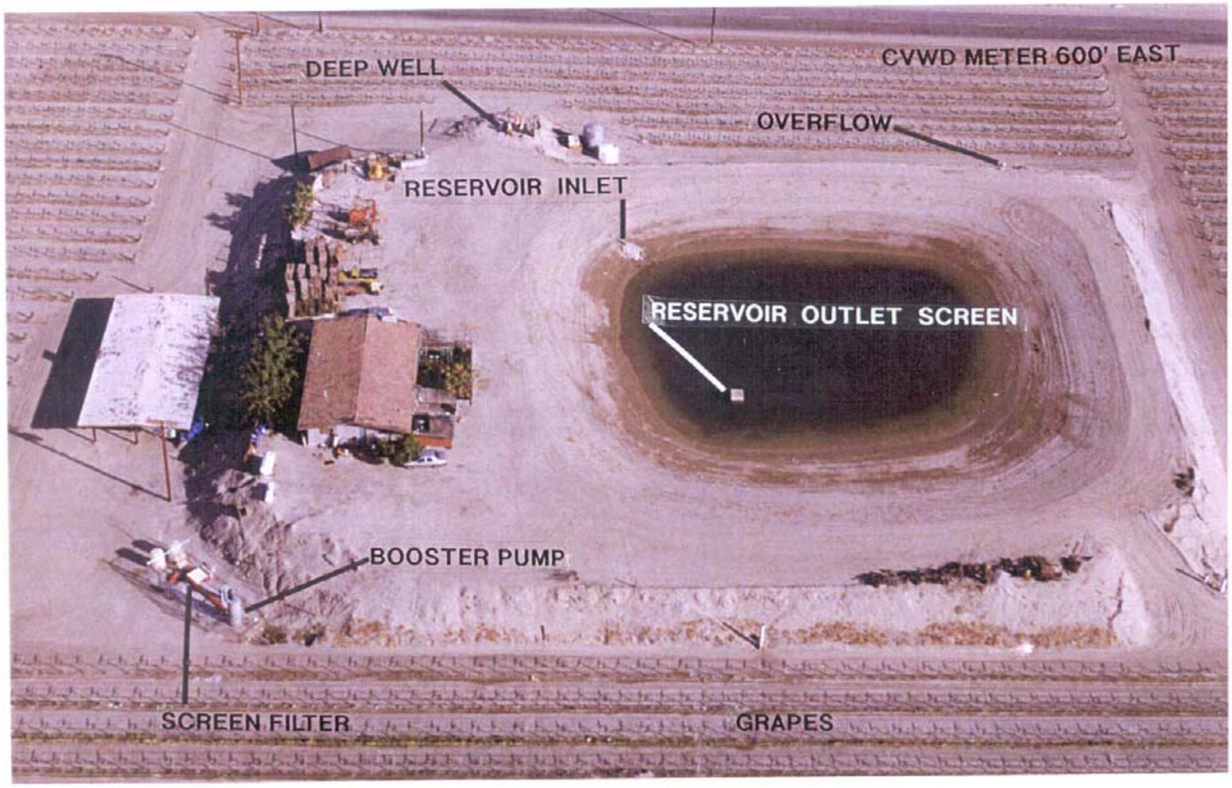


<u>Type of Irrigation System -</u> Drip and sprinkler
<u>Reservoir -</u> Cement lined, 8 acre-feet
<u>Crop -</u> Grapes, 260 acres
<u>Pump and Filter -</u> 75 hp (1800 gpm) and 100 hp (2200 gpm) multiple booster pumps, sand media filter systems
<u>Water Supply -</u> 150 hp (2000 gpm) and existing CVWD meters

<u>Estimated Capital Costs -</u>

Reservoir		**$60,000**
Pump and filter station		**70,000**
Pipeline from meter to reservoir		**<u>10,000</u>**
<u>Estimated Capital Costs</u>	**=**	**$140,000**
	=	**$ 550/acre**

PHOTO NUMBER - 9 **MECCA AREA**



Type of Irrigation System - **Drip and sprinkler**

Reservoir - **Cement lined, 2 acre-feet, 16" cement inlet/outlet**

Crop - **Grapes, 40 acres**

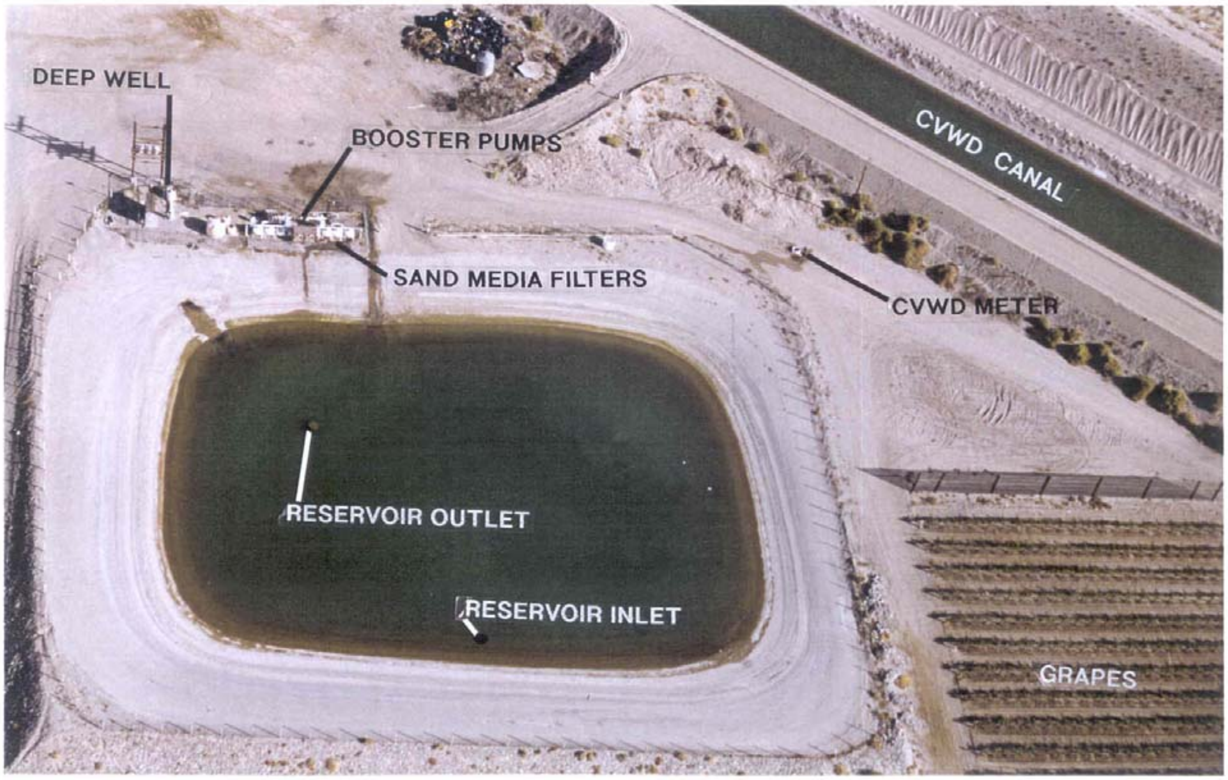
Pump and Filter - **60 hp (1400 gpm), 140 mesh screen filter**

Water Supply - **500 gpm well and existing CVWD meter as shown**

Estimated Capital Costs -

Reservoir		**$35,000**
Pump and filter station		**20,000**
Pipeline from meter to reservoir		**15,000**
Estimated Capital Costs	**=**	**$70,000**
	=	**$1750/acre**

PHOTO NUMBER - 10 **MECCA AREA**



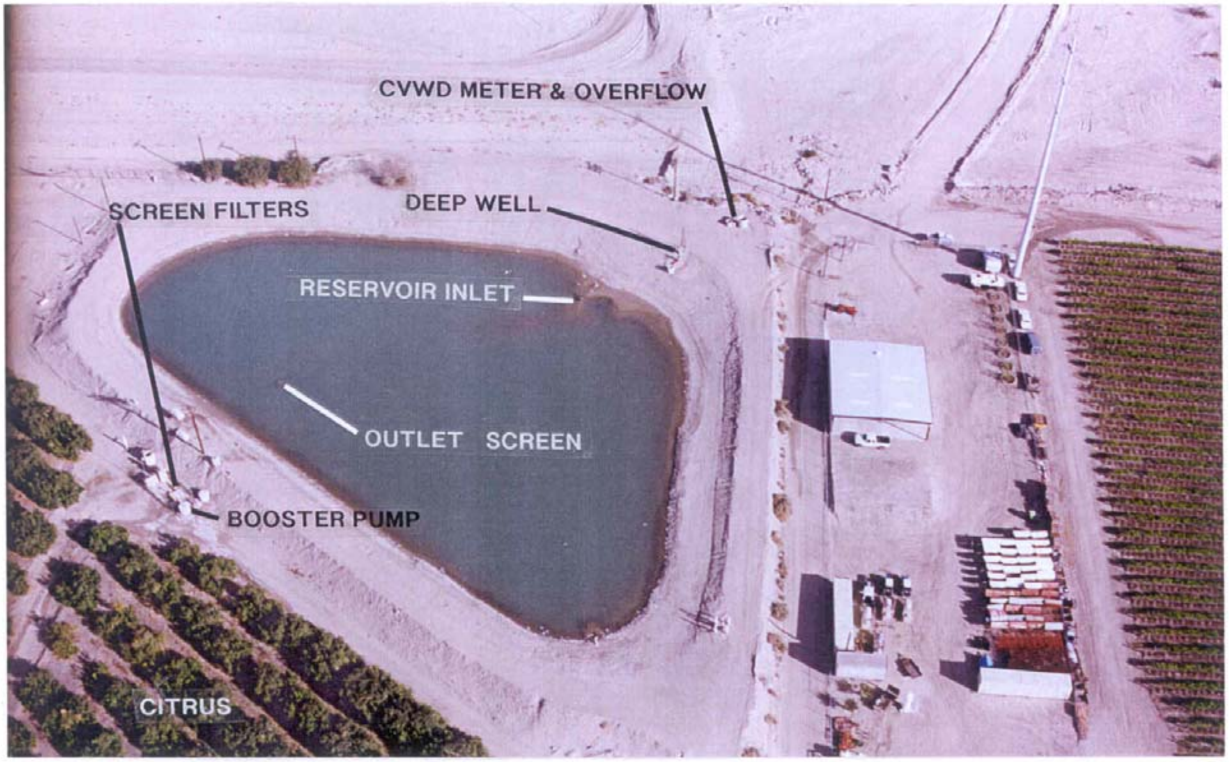
Type of Irrigation System - **Drip and sprinkler**

- **Reservoir -** **Cement lined, 6 acre-feet**
- **Crop -** **Grapes, 250 acres**
- **Pump and Filter -** **Multiple booster pumps, sand media filters**
- **Water Supply -** **Deep well and existing CVWD meter as shown**

Estimated Capital Costs -

Reservoir		**$50,000**
Pump and filter station		**40,000**
Pipeline from meter to reservoir		**5,000**
Estimated Capital Costs	**=**	**$95,000**
	=	**$380/acre**

PHOTO NUMBER - 11 **MECCA AREA**



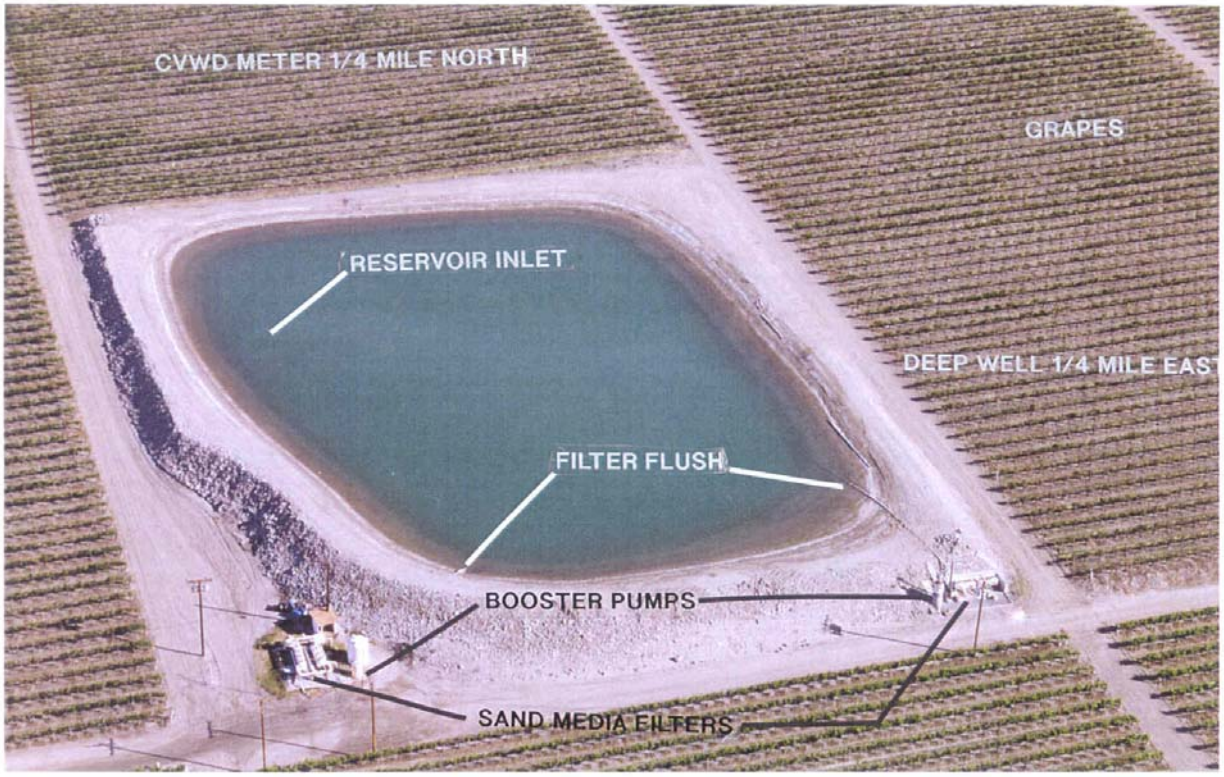
Type of Irrigation System - **Drip and sprayer**

- **Reservoir -** **Plastic lined, 5 acre-feet**
- **Crop -** **Grapes and citrus, 120 acres**
- **Pump and Filter -** **75 hp booster pump (1800 gpm), 140 mesh screen filter**
- **Water Supply -** **Deep well and existing CVWD meter**

Estimated Capital Costs -

Reservoir		**$25,000**
Pump and filter station		**20,000**
Pipeline from meter to reservoir		**5,000**
Estimated Capital Costs	**=**	**$50,000**
	=	**$425/acre**

PHOTO NUMBER - 12 **COACHELLA AREA**



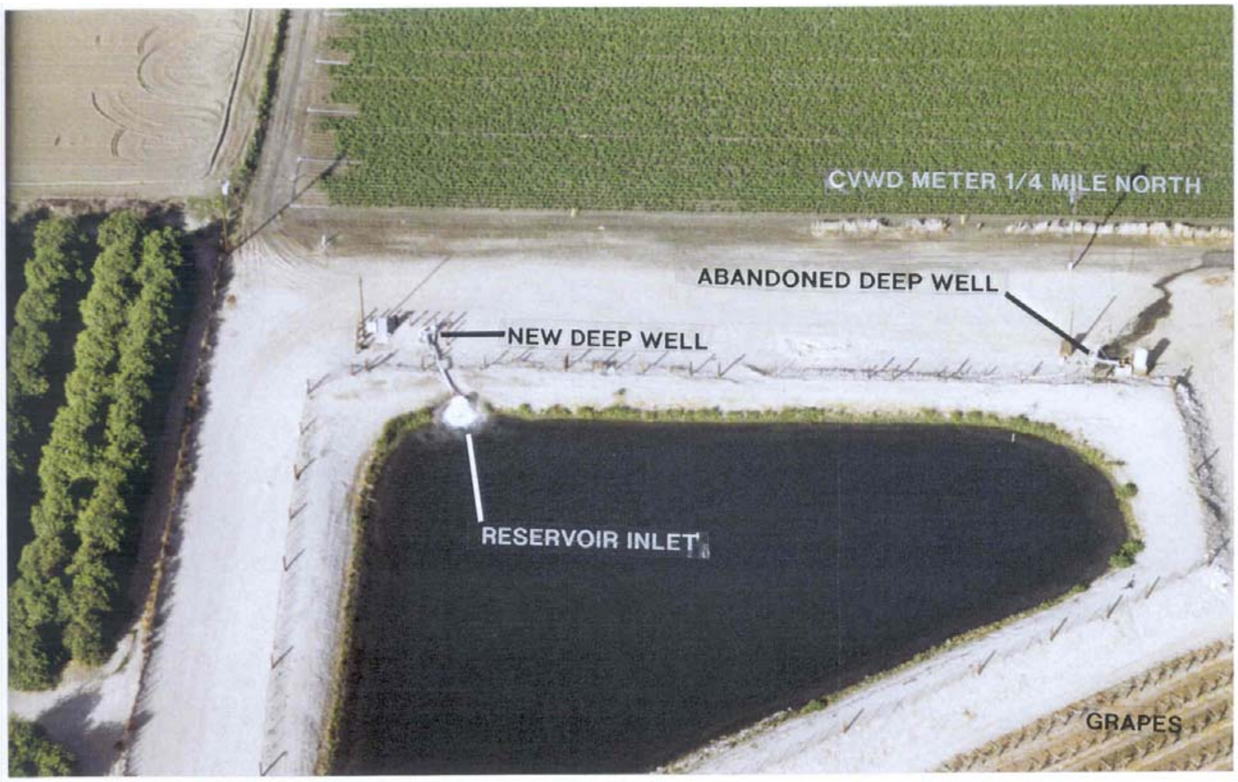
Type of Irrigation System - **Drip**

- **Reservoir -** **Plastic lined, 6 acre-feet**
- **Crop -** **Grapes, 220 acres**
- **Pump and Filter -** **75 hp booster pump (2000 gpm), sand media filters**
- **Water Supply -** **Deep well and existing CVWD meter as shown**

Estimated Capital Costs -

Reservoir		**$35,000**
Pump and filter station		**30,000**
Pipeline from meter to reservoir		**5,000**
Estimated Capital Costs	**=**	**$70,000**
	=	**$325/acre**

PHOTO NUMBER - 13 **OASIS AREA**



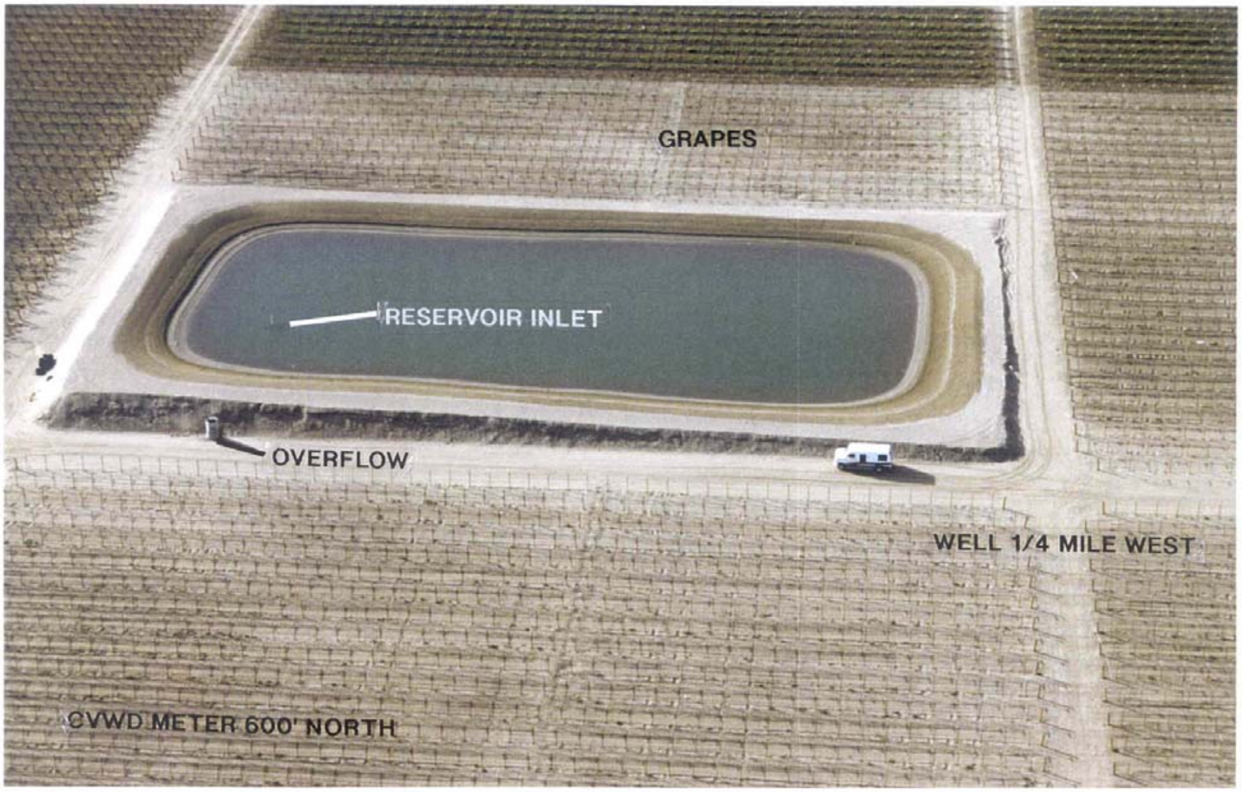
Type of Irrigation System - **Flood**

- **Reservoir -** **Plastic lined, 3 acre-feet**
- **Crop -** **Grapes, 160 acres**
- **Pump and Filter -** **No booster or filter required**
- **Water Supply -** **Two deep wells, existing CVWD meter within ¼ mile**

Estimated Capital Costs -

Reservoir		**$25,000**
New 150 hp Deep Well (1500 gpm)		**150,000**
Pipeline from well to reservoir		**5,000**
Estimated Capital Costs	**=**	**$180,000**
	=	**$1125/acre**

PHOTO NUMBER - 14 **OASIS AREA**



Type of Irrigation System - **Flood**

- **Reservoir -** **Plastic lined, 5 acre-feet**
- **Crop -** **Grapes, 80 acres**
- **Pump and Filter -** **None required**
- **Water Supply -** **100 hp (1500 gpm) deep well and existing CVWD meter within ¼ mile**

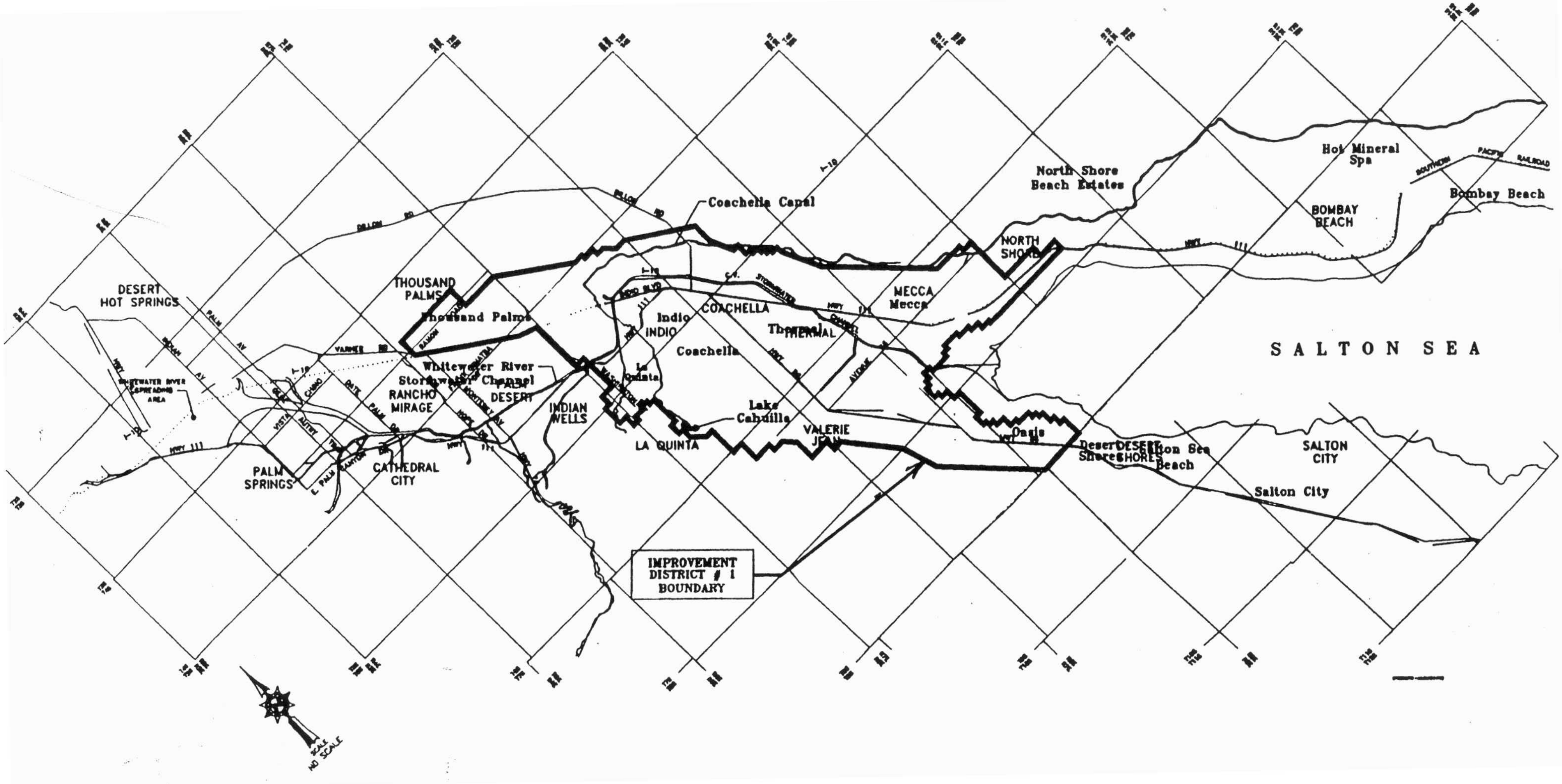
Estimated Capital Costs -

Reservoir		**$28,000**
Pump and filter station		**0**
Pipeline from meter to reservoir		**10,000**
Estimated Capital Costs	**=**	**$38,000**
	=	**$ 475/acre**

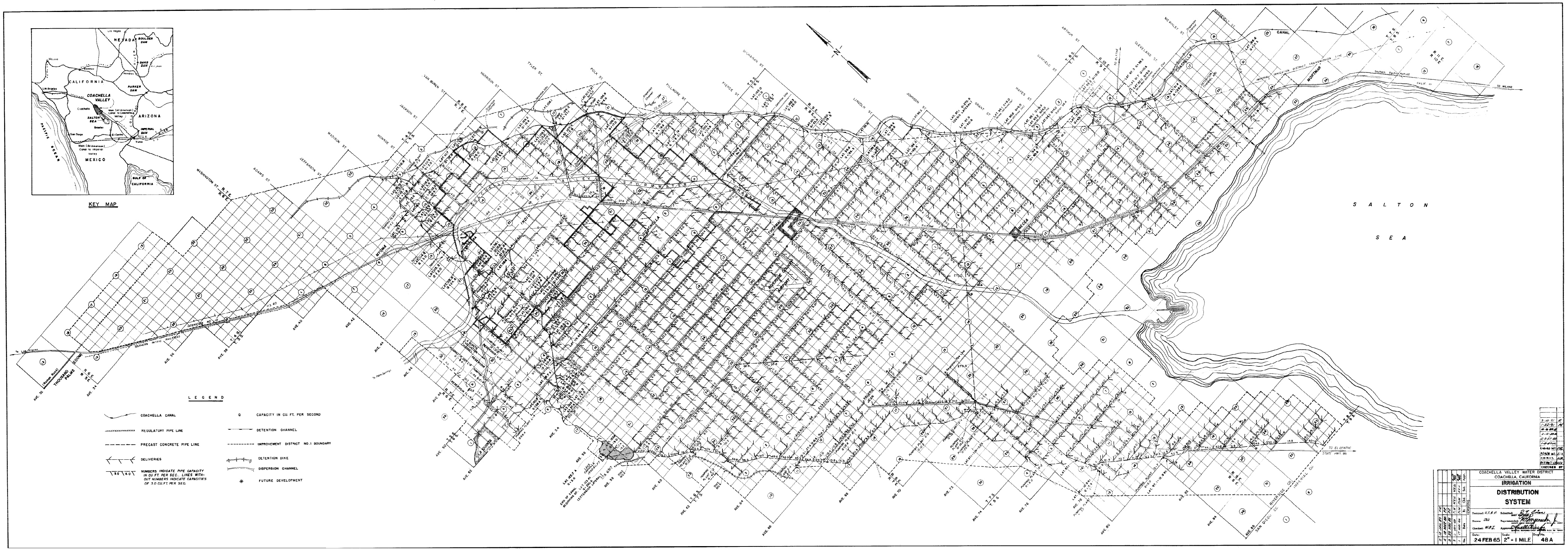
APPENDIX D

CVWD , IMPROVEMENT DISTRICT NO. 1

LOCATION MAP



DESERT HOT SPRINGS
WHITEWATER RIVER SPREADING AREA
I-10
HWY 111
PALM SPRINGS
CATHEDRAL CITY
RANCHO MIRAGE
THOUSAND PALMS
Thousand Palms
Whitewater River Stormwater Channel
PALM DESERT
INDIAN WELLS
LA QUINTA
La Quinta
Indio
INDIO
COACHELLA
Coachella
Thermal
THERMAL
Lake Cahuilla
VALERIE JEAN
MECCA
Mecca
Oasis
NORTH SHORE
North Shore Beach Estates
Coachella Canal
DILLON RD
SALTON SEA
Desert Shores
DESERT SHORES
Salton Sea Beach
SALTON CITY
Salton City
BOMBAY BEACH
Bombay Beach
Hot Mineral Spa
SOUTHERN PACIFIC RAILROAD
IMPROVEMENT DISTRICT # 1 BOUNDARY
NO SCALE


KEY MAP
SALTON SEA
LEGEND
COACHELLA CANAL
REGULATORY PIPE LINE
PRECAST CONCRETE PIPE LINE
DELIVERIES
NUMBERS INDICATE PIPE CAPACITY IN CU. FT. PER SEC., LINES WITHOUT NUMBERS INDICATE CAPACITIES OF 3.0 CU. FT. PER SEC.
Q CAPACITY IN CU. FT. PER SECOND
DETENTION CHANNEL
IMPROVEMENT DISTRICT NO. 1 BOUNDARY
DETENTION DIKE
DISPERSION CHANNEL
* FUTURE DEVELOPMENT
COACHELLA VALLEY WATER DISTRICT
COACHELLA, CALIFORNIA
IRRIGATION
DISTRIBUTION SYSTEM
Designed: U.S.B.R.
Drawn: JBH
Checked: W.C.I.
Submitted:
Recommended:
Approved:
Date: 24 FEB 65
Scale: 2" = 1 MILE
Dwg. No. 48 A
REVISIONS
CHECKED BY

GLOSSARY OF TERMS

Canal Water- **Water supplied through from CVWD metered delivery from the Colorado River canal system. Usually measured in "miners inches" (inches) or "cubic feet per second" (cfs). One miners inch= 9 gallons per minute or 100 miners inches = 900 gallons per minute. Synonymous with *Colorado River water.***

CVWD - **Abbreviation for Coachella Valley Water District, a public agency which supplies water to agricultural users, golf courses, domestic users as well as sewage treatment, and storm water facilities within I.D. 1 boundaries, see Appendix D.**

Drawdown- **Distance in feet between pumping water level and standing water level.**

Emitter- **Small plastic device designed to slowly apply water to the soil without creating runoff or erosion. Rates range from ½ gallons per hour (gph) to 4 gph. Synonymous with *dripper* or *drip emitter.***

IID - **Abbreviation for Imperial Irrigation District which supplies electrical power generally south of Point Happy.**

Irrigation System- **Delivery of water to a crop in the required amount at the proper time and place.**

Overdraft- **Depletion of water from the ground water exceeds recharge hence lowering the water table.**

Peak Consumptive Use- **Amount of water required to maximize plant growth and productivity. Measured in acre-inches per acre per day or acre-feet per acre per year. Synonomous with *optimal evapo-transpiration.***

Pumping Water Level - **Measured from the ground surface down to the water surface when water <u>is</u> being extracted from the well.**

Replenishment Charge- **Proposed CVWD fee to defray actual expenses incurred to recharge water back into the under ground aquifer.**

Sprayer- **Small, stationary plastic device used to spray irrigation water in various patterns over a certain specified area, generally under a tree. Rates range from 6 gallons per hour (gph) to 48 gph.**

Specific Yield- **Amount of water extracted from a well, in gallons per minute, divided by the drawdown, in feet. Generally abbreviated as "gpm/ft. of drawdown".**

Stand-by Fee- **Fee charged by CVWD to defray original canal and water distribution system costs. Currently $50 per acre per year.**

Standing Water Level- **Measured from the ground down to the water surface when <u>no</u> water is being extracted from the well.**

User Fee- **Fee charged by CVWD depending upon the amount of water, in acre-feet, actually delivered to a parcel as determined by CVWD flowmeter readings. Currently $13.75 per acre-foot.**

Well Water- **Water extracted from below the natural ground surface by either a submerged pump or natural pressure from a confined aquifer. Synonomous *with groundwater.***

<u>MISSION STATEMENT:</u>

MANUAL FOR ASSISTING GROWERS TO PRACTICALLY UTILIZE COLORADO RIVER WATER IN LIEU OF WELL WATER.

COACHELLA VALLEY WATER DISTRICT ***ENCOURAGES SUSTAINABLE RESOURCE MANAGEMENT FOR AGRICULTURE WHICH MAY MEAN INCREASED USE OF CANAL WATER FOR AGRICULTURAL IRRIGATION.***

USE OF CANAL WATER DECREASES RELIANCE ON GROUNDWATER BY AGRICULTURAL USERS, THEREBY REDUCING EXTRACTIONS ON THE ALREADY OVERDRAFTED GROUNDWATER BASIN IN THE LOWER COACHELLA VALLEY.

GENERAL MODIFICATIONS, BENEFITS AND APPROXIMATE COSTS WILL BE PRESENTED.

Coachella Valley Water District
P.O. Box 1058
Coachella, CA 92236

Manual Prepared by:

Ben R. Olson, Jr.
Olson Engineering Systems
P.O. Box 587
Indio, CA 92202

November, 1996
Partially Updated December, 2008

TABLE OF CONTENTS

Cover Photo- **Panorama view of several 3 acre-feet reservoirs serving 40 acres each in the Mecca area.**