Benchmarking of Flexibility and Needs

2000

Survey of Irrigation Districts

USBR Mid-Pacific Region

on behalf of

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Prepared by

Irrigation Training and Research Center (ITRC)
California Polytechnic State University
San Luis Obispo, California 93407

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Authors: Charles Burt, Andrew Mutziger, and Darren Cordova of ITRC.

Copies are available from the Cal Poly ITRC.

Irrigation Training and Research Center
California Polytechnic State University
San Luis Obispo, California 93407
(805)756-2434 FAX (805)756-2433

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Executive Summary

ITRC interviewed irrigation district personnel from 60 agricultural districts representing approximately 91% of the irrigated acreage within the U.S. Department of the Interior Bureau of Reclamation's (USBR) Mid-Pacific Region.

Data were analyzed to determine the degree of water delivery flexibility provided to farmers and the extent of existing and planned district modernization.

The interview process defined needs for direct technical assistance and training. These needs varied by district and area in California. The Irrigation Training and Research Center (ITRC) concluded that training programs should incorporate some common classes using the Water Delivery Facility and other resources located on campus at California Polytechnic State University, San Luis Obispo, in addition to small specialized training efforts customized for single or small groups of districts. The data also indicated that more Rapid Appraisal Process (RAP) visits are needed to determine possible physical and managerial improvements (modernization and efficiency) for districts to accommodate the ever-changing needs of the consumers. Direct technical assistance to individual districts has been and will continue to be a key element of continuing success in modernization.

This report summarizes the results and provides brief comments on various aspects of those results.

Background

Purpose

In the winter of 1999 and spring of 2000, the Irrigation Training and Research Center (ITRC) of California Polytechnic State University, San Luis Obispo (Cal Poly) conducted, as part of the technical assistance program, interviews of selected irrigation districts within the Mid-Pacific Region of the USBR. The Benchmarking Survey was similar to the Status and Needs Survey conducted 5 years earlier by ITRC for the Mid-Pacific Region.

The purpose of this Survey was to:

- Identify the extent of flexibility of water delivery presently offered by irrigation and water districts to farmers;
- Identify educational programs in which districts currently participate or have accomplished; and
- Identify improvements can be made in regards to technology and water conservation and what types of assistance districts will require in the future to make those improvements.

Survey

The Survey contained over 200 questions included in the following general categories:

- Information to describe the present degree of water delivery flexibility offered by districts;
- District characteristics such as water reliability, water prices, various irrigation methods, water conservation programs, modernization, etc.;
- Current and future district sponsored programs; and
- District needs and areas requiring technical assistance from ITRC as part of the USBR grant.

The survey questions can be found in Appendix A.

District Selection

The Mid-Pacific Region list of water districts consisted of 117 agencies. The number of districts in each state and the acreage those districts represent are displayed in Table 1.

Table 1. *Water Districts Within the Mid-Pacific Region*

State	No. of Districts	Acres
California	110	2,253,612
Nevada	3	102,200
Oregon	4	166,000
TOTAL	117	2,521,812

Very small districts were not interviewed to minimize Survey costs yet still cover a large and representative acreage. Interviews with 51% of the districts encompassed approximately 91% of the irrigated acreage within the Mid-Pacific Region. A listing of the participating districts is included in Appendix B.

Table 2. *Water Districts Interviewed and Acreage Represented*

State	No. of Districts Interviewed	Acreage Represented
California	58	2,188,163
Nevada	1	59,162
Oregon	1	39,000
TOTAL	60	2,286,325

Interviews

Before conducting interviews, districts were contacted with a letter from ITRC. Those letters were then followed up with a phone call to arrange the interview, and a subsequent confirmation letter.

Interviews consisted of a combination of appointments and telephone conversations with district managers, or other district personnel with a good understanding of district operations and plans. Districts were very cooperative and managers and engineers took valuable time to participate in a lengthy personal interview.

Feedback (questions of needs and opinions) sections of the Survey were well received by the interviewees. Persons interviewed were willing to discuss their views, opinions, and interests.

Collection of Survey data was completed in March of 2000.

District Flexibility

Introduction

Answers from the Status and Needs Assessment Survey were compiled to characterize the present status of districts as well as future needs of technical assistance. Items of primary interest include: level of service provided to water users, and types and numbers of water delivery structures.

The information in this section is provided by topic and describes the characteristics of districts and their customers. Significant figures vary throughout the report as the nature of data varies; the totals generally reflect reported totals, and are not rounded off.

Flexibility Indices

Urban homeowners are accustomed to receiving water from the tap "on demand" (i.e., without providing advance notice), with unlimited flexibility in frequency (when), duration (how long), and flow rate. In the Mid-Pacific Region, agricultural water users (i.e., farmers) receive water with a high degree of equity (not measured in this study) and with much more flexibility than most of their counterparts in other areas of the world. Nevertheless, the flexibility of water deliveries in the Mid-Pacific Region does not compare with the "demand" flexibility provided to homeowners.

Farmers are requesting more flexible deliveries, and the data show that the degree of water delivery flexibility is high in many cases. As later sections of this report show, irrigation districts are implementing a wide range of measures to improve the level of service they provide to farmers. Improvements are hampered by high initial costs, plus the lack of technical knowledge of engineering options related to water delivery control.

Frequency Flexibility

Advance ordering of water on an unlimited frequency schedule is utilized on 2,207,663 acres in surveyed area the Mid-Pacific Region (Table 3). For those farmers, the mean advance notice time was 23 hours and the mean number of times a farmer cannot get water on the requested day is less than once per season.

Of all the districts surveyed, none use a strict fixed rotation (no trading turns) or a fixed rotation during peak water use periods (Table 3). A modified rotation schedule is utilized over 19,500 acres in one district representing less than one percent of the total acreage surveyed.

Table 3. Common Characteristics of the Delivery Schedules

Description	*(n=59)*
Districts Reporting Fixed Rotation	0
Districts Reporting Modified Rotation	1
Acreage	19,500
Days of deviation from fixed rotation	2
Number of days between standard rotation	13
Hours of advance notice required	24
Districts Reporting Unlimited Frequency	58
Acreage	2,207,663
Average hours of advance notice required	23
Average number of times in a year a turnout cannot get water on the day requested	0.59

Flow Rate Flexibility

Only two districts responded that farmers could not receive different flow rates for each irrigation (Table 4). The remaining districts have policies allowing farmers to receive different flow rates at each irrigation.

During an irrigation event, 52 districts have no restrictions on changing a flow rate whereas 4 districts do not allow a flow rate change (Table 5). Also, fifteen districts have a policy of zero advance notice required before a flow rate change (Table 6). Comparatively, there are 41 districts that require advance notice for a flow rate change during irrigation with an average notice time of 14 hours. Overall, farmers receive a high degree of flow rate flexibility.

Table 4. *Flexibility of Delivery Flow Rate Selection at Each Event*

Response	Number of Responses (n=59)
Essentially the same flow rate must be delivered for each irrigation	2
The farmer can request several different flow rates through the season	0
Can have different flow rates each irrigation	57

Table 5. *Flexibility of Changing Flow Rate Selection During an Event*

Response	Number of Responses *(n=58)*
No change is allowed	4
One time	2
Two times	0
There are no restrictions	52

Table 6. *Advance Notice Required Before a Flow Rate Change is Made During an Event*

Response	*(n=56)*
Average required hours	14
Number of districts that require no advance notice before flow rate change	15

Duration Flexibility

Duration flexibility is important for all forms of on-farm irrigation, but it can be very difficult for irrigation districts to allow farmers to shut water off unannounced or at odd times - canals and pipelines with conventional control hardware can overflow if this happens. Farmers would like more duration flexibility to reduce over-irrigation, and avoid unnecessarily high bills and deep percolation of water and nutrients. Drip and microirrigation systems are easily automated to provide the correct amount of water to replace evapotranspiration (ET) plus losses due to evaporation and non-uniformity, so they are ideally suited for management with unlimited duration flexibility. As soil infiltration rates change throughout the season with surface irrigation, farmers rarely know exactly when they will complete an irrigation. Since an irrigation could be finished at any hour of the day or night, farmers can prevent over-irrigation if they can shut off their water with no advance notice.

Farmers are allowed to receive water for any duration in thirty-nine districts. The remaining districts allow durations of 12 or 24 hours for delivery (Table 7). The average advance notice required before farmers can shut off the water was 16 hours; eleven districts do not require advance notice to shut off (Table 8).

Table 7. *Flexibility in Duration of an Irrigation Event*

Response	*(n=57)*
Unlimited - any duration is allowed	39
12 hour increments	5
24 hour increments	13
Other fixed, district-determined increment	0

Table 8. *Advance Notice Required by the District Before Farmers Can Shut Off Water*

Response	*(n=58)*
Average required hours	16
Number of districts that require no advance notice prior to shutoff	11

In order to achieve a high degree of flexibility in irrigation delivery duration, farmers ideally ought to be able to operate their own turnouts. If the district requires that a district employee operates the turnouts, the farmer's ability to automate an on-farm irrigation system disappears. Farm employees must wait until the ditchrider arrives to begin irrigation.

Many delivery canals and pipelines are not designed with adequate control systems to permit farmers to operate turnouts. Often when one farmer makes a flow rate change, the ditchrider must move along the complete length of the supply canal or pipe to readjust the flows of other open turnouts.

On average, district personnel must be present to open and close farm turnouts 47% of the time (Table 9). In addition, district personnel operate gates within an average of less than one hour (Table 10). When there is not enough flow to match a water order, 20 districts pro-rate the order and 33 districts postpone the water (Table 11).

Table 9. *Percentage of Time District Personnel Must Be Present to Open and Close Farm Turnout Gates (n=57)*

Number of districts responding 100%	12
Number of districts responding 0%	21
Average percentage	47

Table 10. *How Closely to the Prescribed Time Turnout Gates are Operated by District Personnel (n = 37)*

Average time (hours)	0.9

Table 11. *Procedure if There is Not Enough Capacity or Flow Availability to Match Turnout Order (n = 53)*

Pro-rate: farmers receive a portion of their order	20
Postpone: farmers must wait to receive any water	33

Most irrigation districts have areas of their distribution system with limited capacity. When farmers request water orders, district personnel must check the pipeline/canal capacity to ensure there is enough capacity to supply that order without adversely affecting other users.

Flexibility Index (District Level)

The previously mentioned aspects of district delivery policies regarding frequency, flow rate and duration were indexed to quantify the degree of water delivery flexibility provided by each district. Each parameter (frequency, flow rate, and duration) has a rating from 1 - 5, with 5 as the most flexible score. The sum of these individual indices gives the "Flexibility Index," the highest possible score amounting to 15, and the lowest possible equaling 3. A district that allows farmers to obtain water on "demand" without providing advance notice to the district is the most flexible condition within the "Frequency Index" and is assigned a score of 5. A district that allows a farmer to change flow rates during an irrigation event without notifying the district has the most flexible condition within the "Flow Rate Index" and is assigned a score of 5. If no advance notice is required to alter the duration of an irrigation, therefore allowing farmers to receive water for any length of time, a score of 5 is assigned in the "Duration Index".

Guidelines for indexing flexibility, outlined in Table 12, were developed to provide benchmarking that can be used in future studies to determine how district operations have changed and to compare districts against each other.

The average sub-index values for frequency, flow rate, and duration were 4.0, 4.7, and 4.2 respectively. The average total flexibility index (i.e., the sum of the frequency, flow rate, and duration indices) was 12.9 out of a possible 15 (Table 13). For each category, there were districts achieving the highest rating (i.e., 5), indicating that some districts provide very flexible water supplies in terms of frequency, flow rate, or duration. Overall, the flexibility indices were high as the majority of districts (37) had flexibility ratings greater than 13 (Table 14).

Table 12. *Definition of the Flexibility Index*

Points	Condition
	FREQUENCY
1	Always a fixed rotation
2	Fixed rotation with trading, or limited frequency, or fixed rotation during peak season only
3	24 hours or more advance notice required before delivery is made
4	Less than 24 hours advance notice required before delivery
5	Farmer does not need to notify district before delivery
	FLOW RATE
1	Same flow rate must always be delivered
2	Several flow rates are allowed during the season
3	A different flow rate is available each irrigation, with up to 2 changes per irrigation allowed
4	Flow rate can be changed any time, provided advance notice is given to the district
5	Flow rates can be different and changed by the farmer without giving advance notice to the district.
	DURATION
1	District assigns a fixed duration of irrigation
2	District assigns a fixed duration, but allows some flexibility
3	Farmers must select a duration with a 24 hour increment; must give at least 24 hour notice before altering; and the district operates the gates ≥ 80% of the time
4	Farmers can choose any duration; must give at least 8 hours of notice before altering; and the district operates the gates < 80% of the time
5	Farmers can have any duration, with no advance notice required before changing

Table 13. *Average Flexibility Index Summary (n = 58)*

Parameter	Index
Frequency	4.0
Flow Rate	4.7
Duration	4.2
Flexibility Index	**12.9**

Table 14. *Flexibility Index Frequencies* (n = 57)

Flexibility Index	Number of Districts
<11	5
11-11.9	3
12-12.9	12
13-13.9	29
14-15	8

Flexibility Provided by District Supplier (USBR)

Flexibility in water delivery provided to farmers is affected by the flexibility of water supplies provided to districts. District personnel were asked to characterize this flexibility.

Required advance notice time prior to USBR flow rate changes are 18 and 16 h for weighted and unweighted averages respectively (Table 15). Regardless of district needs, the weighted and unweighted averages of the amount of water delivered, which was not ordered, was 830 and 624 acre-feet (AF) respectively (Table 16).

Table 15. *Hours of Advance Notice Required of USBR Before a Scheduled Flow Change Occurs (n = 53)*

Unweighted avg.	16
Weighted avg. (by irrigated acres)	18

Table 16. *Amount of Water Delivered to Districts Regardless of Need* (AF) (n = 52)*

Unweighted avg.	624
Weighted avg. (by irrigated acres)	830

***** Water that districts were required to accept even though they did not need the water. One possible reason is for flood control.

On-Farm Irrigation, Costs, and Pricing

On-Farm Methods

Degrees of supply flexibility required by farmers can be understood by recognizing the types of different irrigation methods utilized and the acreage associated with those methods. Over half the total acreage represented by the Survey used surface irrigation methods (i.e., furrow, border strip, or basin). Sprinkler and drip irrigation represented 15% and 13%, respectively, of the total irrigated acreage and is only expected to increase. The remaining acreage consisted of irrigated rice or used a combination of irrigation methods (i.e., hand-move sprinkler and drip on row-crops) (Table 17).

Table 17. *On-farm Irrigation Methods Used Within District Service Areas*

Irrigation Method	Total Acreage	Percent of Total
Furrow	692,939	30.3
Border strip or basin	391,344	17.1
Hand move or side sprinklers	234,327	10.2
Center pivot or linear move	23,911	1.0
Permanent sprinklers (trees or vines)	38,620	1.7
Rice	250,240	10.9
Drip on row crops	20,150	0.9
Microspray or drip on trees or vines	276,589	12.1
Solid set sprinklers on row crop	49,779	2.2
Combination	260,867	11.4
Flood for exclusively wetland habitat	47,559	2.1
TOTAL	2,286,325	100

Power Costs

Throughout the Mid-Pacific Region, a total of 442 district pumps were listed, resulting in an average of over $260,000/year in district pumping costs. The average cost for electricity to operate these pumps was found to be 0.076 dollars per kilowatt-hour ($/kW-hr) as shown in Table 18.

Clearly there is a need to examine energy efficiency improvements as a possible alternative to reduce costs for some districts. One possible avenue by which this can be accomplished is to replace existing pumps with higher efficiency units equipped with a Variable Frequency Drive (VFD).

Table 18. *District Power Costs* (n=44)*

Total number of district pumps	442
Average pumping power bill ($/yr)	267,607
Average pumping power bill ($/kW-hr)	0.076

* Includes power for both lift and groundwater pumps owned by district

Water Pricing

The majority of interviewed districts (46 districts representing 1,811,591 acres) charge for water on a volumetric basis. Of these, eleven districts (320,481 acres) reported using a tiered pricing structure (Table 19). The mean price for tiered and non-tiered water was 16.35 and 47.06 dollars per acre-foot ($/AF) respectively (Table 20).

A fixed pricing structure is employed in thirteen districts representing 415,572 acres wherein eight districts vary prices by acre depending on the crop type (Table 19). Average water cost for fixed price structures was 12.54 $/AF and ranged from 2.05 – 57.27 $/AF (Table 20). Normalized water prices are summarized in Table 21 using five-year historical deliveries.

Table 19. *Water Pricing Policies*

Method of Water Pricing	Number of Districts	Acreage
Volumetric ($/AF)		
Tiered	11	320,481
No Tier	35	1,491,110
Fixed price per acre ($/acre)		
Price varies by crop	8	263,540
Price does not vary by crop	5	152,032

Table 20. *Water Prices per Acre-Foot* ($/AF)*

Method of Water Pricing	Mean Price	Min. Price	Max. Price
Volumetric			
Tiered	16.35	7.31	48.46
No Tier	47.06	2.57	115.00
Fixed price per acre	12.54	2.05	57.27

* Based on current price structure and approximate historical five-year deliveries (*n = 26*). Includes standby and service charges. Mean prices are weighted by irrigated acreage.

Table 21. *Water Prices per Acre* ($/acre)*

Method of Water Pricing	Mean Price	Min Price	Max Price
Volumetric			
Tiered	44.33	21.75	122.27
No Tier	101.02	9.00	232.40
Fixed price per acre	54.26	9.24	122.56

* Based on current price structure and approximate historical five-year deliveries (*n = 26*). Includes standby and service charges. Mean prices are weighted by irrigated acreage.

Delivered Water

The water supply available to the districts is highly variable, by both district and year. Districts that experience wide fluctuations in water supply almost always see groundwater recharge as a major concern, and their policies may emphasize recharge during wet years rather than flexible deliveries during average or dry years.

On (weighted) average, districts had 3.2 acre-feet per year (AFY) per acre gross water available for deliveries during the last five years (Table 22). These values include both surface and groundwater supplies.

Table 22. *Average Gross Water Available for Delivery During the Last Five Years (AFY) (n=26)*

Unweighted average	3.5
Weighted average (by irrigated acres)	3.2
Maximum	8
Minimum	1.5
Standard Deviation	1.9

Facilities - Present and Future

Regulating Reservoirs

Turnouts with privately owned reservoirs occur in 16 of the districts included in the Survey. The overwhelming majority of those (13 districts) have such reservoirs on less than 25% of their total turnouts (Table 23). This information suggests that few farmers have the ability to store surface deliveries (i.e., they must irrigate when they receive water from the district, regardless of whether it is the best time to irrigate). Limited flexibility in deliveries, combined with little to no on-farm storage, will impact a farmer's options for maximizing on-farm water management with sophisticated irrigation systems. In areas with excellent delivery flexibility, reservoirs may still be needed to remove silt from water (for drip systems) or for farmers to take advantage of time-of-use (TOU) electric power rates.

Table 23. *Turnouts Equipped with Farmer Owned Reservoirs*

Percentage of Total Turnouts with Farmer Owned Reservoirs	**Number of Districts** *(n = 16)*
<5%	9
5% - 25%	4
25% - 50%	1
50% - 75%	1
>75%	1

Water Conveyance and Delivery Systems

District personnel were asked about the characteristics of their delivery systems particularly in regards to the amount of time the systems are at capacity (maximum flow rate). Table 24 shows that capacity problems occur relatively frequently.

Table 24. *Percentage of Time Flow Rate is at Maximum Capacity in Distribution Systems*

Percentage of Time the Flow Rate is at Maximum Capacity	**Number of Districts** *(n=60)*	
	Mains	Laterals
No Response	7	7
0	8	3
1 - 25	33	35
26 - 50	9	11
51 - 75	2	3
76 - 100	1	1
Average Percentage	**16**	**18**

Flow Measurement

Conversations with district personnel showed that accurate flow measurement at farm turnouts and volumetric billing of water are stated policy objectives in the Mid-Pacific Region. Some districts have old facilities that did not originally have accurate measurement devices, however many have already installed or are studying the use of improved measurement devices. Traditional propeller meters, while very practical in some areas, are frequently plugged by weeds in other districts. These districts are looking for alternative flow rate measurement devices. The costs incurred by installing new flow meters will vary depending upon the nature of the turnout design, the available pressure, and the water quality. The devices currently in use are depicted in Table 25. Propeller meters were the most commonly used turnout flow measurement devices (47% of the total customers). Slide gates and weirs/flumes were the least used turnout measurement devices representing about 3 % and 5% of the total customers. Approximately thirteen percent of the total turnouts do not have flow measurement devices. Many districts use more than one type of measurement device.

Many flow rate measurement devices do not totalize the volume that has passed through a turnout. Instead, the standard procedure is to assume that once a turnout has been adjusted for the desired flow rate, that flow rate will remain constant, and then the volume can be computed (Volume = Flow Rate × Time). In fact, flow rates can change if water levels (or pressures) either upstream or downstream of the turnout change, as often happens. Turnouts with a low head (a small difference in water level on both sides of a turnout) are sensitive to slight water level fluctuations on either side of the turnout.

Turnout flow rate changes over time present three problems: (1) the farmer has difficulty managing a constantly changing water supply, (2) irrigation district personnel are reluctant to allow farmers to make flow rate alterations since those changes can upset the previously adjusted flows of other users, and (3) a farmer may receive more or less water than estimated (although these differences tend to even out with time).

Potential solutions include new turnout designs and better control of water surfaces or pressures in irrigation district distribution canals or pipelines. ITRC continues to work with districts, the USBR, and others to seek proper solutions for individual cases.

Anticipated Physical Infrastructure Changes

Modernization of water control and water delivery flexibility is closely related to improvements in physical infrastructure. A portion of the Survey was dedicated to determining what types of structures and control systems are currently in place. Furthermore, questions were asked regarding spending in the immediate future on various physical infrastructure needs as well as those districts interested in obtaining more information on such improvements. The results are recorded in Table 26

Table 25. *Type of Turnout Flow Measurement Devices*

Turnout Flow Measurement Device	**Total # of Turnouts with Device**	**Percent of Total Customers**	**Number of Districts**
No flow measurement devices	4,624	13.3	
Armco-type metering gates	5,475	15.8	12
Undershot orifice (slide gate)	900	2.6	3
Weir or flume device without a continuous record	1,573	4.5	7
Propeller meters	16,314	47.1	46
Other	5,774	16.7	9
Total	34,660	100	

Table 26. *Present Physical Infrastructures and Anticipated Changes in the Near Future*

Item	Total Quantities Present	Additional Quantities Planned Between 2000-2004	Number of Districts that WILL Add an Undefined Quantity by 2004	Number of Districts that MAY Add an Undefined Quantity by 2004	Number of Districts Interested in Additional Information
Special control devices on canals					
Regulating reservoirs	191	15	0	0	6
Lateral interceptors	6	15	0	1	5
Flow measurement devices in the canals					
Weir/flume, flow rate only	398	173	2	3	6
Weir/flume, totalized	27	67	0	2	5
Other, totalized	37	17	0	3	4
No device, but gate rating tables	1,686	101	0	2	2
Local water level automation upstream control					
Amil gates	7	14	0	4	2
Electromechanical (Littleman)	10	0	0	2	3
Computerized	10	10	0	2	6
Long crested weirs	13	34	0	2	5
ITRC flap gate	1	14	0	1	6
Other	52	114	0	1	0
Local water level automation downstream control					
Hydraulic gates	2	11	0	3	3
Electromechanical	40	1	0	3	5
Computerized	21	11	0	4	4
ITRC flap gate	0	0	0	2	4
Other	17	8	0	0	0
SCADA Systems					
Remote monitoring package for the main office:	21	17	0	4	10
Remote monitoring on spill sites	17	121	0	2	5
Remote monitoring on other locations	126	256	1	5	7
Network for SCADA communications	34	28	0	4	5
Alarms (phone, beeper) on sites	236	219	1	4	2
Automated/remote flow rate control					
On check structures along the canal	39	23	0	5	6
On pumps	26	148	0	5	7
Radios/cellular phones for ditchriders.	467	4	0	4	2

Table 26 continued . . .

Table 26. *Present Physical Infrastructures and Anticipated Changes in the Near Future (continued)*

Item	Total Quantities Present	Additional Quantities Planned Between 2000-2004	Number of Districts that WILL Add an Undefined Quantity by 2004	Number of Districts that MAY Add an Undefined Quantity by 2004	Number of Districts Interested in Additional Information
Miscellaneous					
Hand held data recorders with download software	6	44	1	3	7
Field data management software	12	13	0	2	3
Water ordering software	11	10	0	2	2
Billing software	21	15	0	1	4
Lined canals (miles)	492	31	0	3	2
Recirculation of district spill/drainage (# of sites)	119	7	0	2	1
Recirculation of on-farm spill/drainage by district (# of sites)	117	12	1	1	1
Number of lift stations (from one canal to another canal)	403	13	0	4	1
Other automation on lift stations (into canals)	15	13	0	0	2
Other physical improvements	31	68	0	1	0

Management Perceptions

It may be helpful to note some perceptions of the upper level district personnel who assisted in providing the Survey information. The answers that are noted in this table were often given "off-the-cuff" and may not reflect official district policy.

Flexibility

The majority (34) of management interviewed believe that there is little to no need to improve the current flexibility in the delivery system whereas sixteen percent of the districts believe that improving the district's flexibility is very important (Table 27). Nearly a quarter of the responding persons prefer to improve district flexibility with structures only. Moreover, although there is the same number of districts that would prefer to improve flexibility with new concepts and limited hardware, most are in favor of a combination of the two (Table 28). It was reported that in fifty-nine percent of the districts, district flexibility has been addressed at board meetings on fewer than six occasions (Table 29) during the last 5 years. Overall, managers believe that farmers have a relatively low desire for improved district flexibility (Table 30).

Table 27. *Rating by Senior Personnel of Need to Improve Flexibility of Present Delivery System*

Response Rating of 0 to 9 (9 = very important)	**Number of Responses** *(n=56)*
0-3	34
4-6	13
7-9	9
Average	**3.2**

Table 28. *Senior Personnel Preference of Means to Improve Flexibility*

Response	**Number of Responses** *(n=50)*
Improve district flexibility with new structures	12
Improve flexibility with new management concepts and limited new hardware	12
Combination	26

Table 29. *Number of Times During the Last Five Years the Subject of Improving District Delivery Flexibility Has Been Addressed at Board Meetings*

Response	**Number of Responses** *(n=56)*
0 – 5	33
6 – 10	12
11 – 15	5
> 15	6
Average	**8.9**

Table 30. *Senior Personnel Rating of the Average Farmer's Desire for Improving District Flexibility*

Response Rating of 0 to 9 (9 = very important)	**Number of Responses** *(n=58)*
0-3	29
4-6	15
7-9	14
Average	**4.0**

Functions

Groundwater recharge is not considered to be a *major* district function by nearly seventy-five percent of the managers. However, managers more frequently than not responded that canal seepage and on-farm deep percolation are beneficial uses of water (Tables 31 – 33).

Table 31. *Is Groundwater Recharge a Major Function of the District?*

Response	**Number of Responses** *(n=59)*
Yes	15
No	44

Table 32. *Is Canal Seepage Considered a Beneficial Use of Water?*

Response	**Number of Responses** *(n=58)*
Yes	23
No	15
N/A	20

Table 33. *Is On-farm Deep Percolation Considered a Beneficial Use of Water?*

Response	**Number of Responses** *(n=59)*
Definitely yes	23
Possibly	16
Probably not	10
Definitely not	9
Do not know	1

Water Conservation Potential

Managers believe, on (weighted) average, that district deliveries could be reduced as much as 2,007 AF during a normal year. However, thirty-four districts observed no potential for reduced water deliveries during a normal year, whereas twenty-four of the districts believe they might transfer or sell the conserved water (Table 34, Table 35). In addition, nine of the districts would expand their service area or irrigated area. An overwhelming majority of districts (forty-two) believe that there is no potential to reduce district groundwater pumping during a normal year (Table 36).

In view of the fact that the districts may experience a wide range of water supplies, depending upon the weather, the Survey questions were asked for both average years and dry years.

Table 34. *Manager Estimate of Potential Reduction of District Deliveries (AF/year)*

Statistic	*(n=53)*	
	Avg. Year	Dry Year
Number of districts responding "0"	34	46
Unweighted Average	1,359	691
Weighted Average	2,007	1,562

Table 35. *Potential Use of Reduced Diversions*

Response	**Number of Responses** *(n=51)*
Expand service area/irrigated area	9
Groundwater recharge	7
Transfer/sell	24
Nothing	6
Other	5

Table 36. *Potential for Reducing Groundwater Pumping in the District*

Statistic	*(n=53)*	
	Avg. Year	Dry Year
Number of districts responding "0"	42	48
Unweighted Average	10	5
Weighted Average	6	2

District Identification of Desired Technical Assistance

One of the purposes of the Survey was to assess districts' current technical assistance programs and future needs in the Mid-Pacific Region. The Survey contained not only specific questions about types of short courses and hardware items, but also questions regarding special assistance from ITRC. The questions were often answered informally by district managers and are listed in Tables 37 and 38. Districts indicated a very strong need for irrigation short courses for both farmers and staff. Technical assistance from ITRC in the areas of Supervisory Control and Data Acquisition (SCADA) systems and remote monitoring proved to be popular interests as well.

Table 37. Current and Future District Programs

Item	Number of Districts Active in these Programs	Number of Districts Planning to be Active in these Programs Between 2000-2004	Number of Districts Interested in Further Information
On Farm Improvements			
Low interest loans	9	15	10
Mobile labs	25	34	14
Irrigation Evaluations	24	25	8
Other	4	5	-
Water Delivery Service			
Allow earlier water shutoff	26	24	3
Reduce carry-overs	9	10	1
Other	0	1	0
Education			
District newsletter	45	47	5
Seminars/training for staff			
Water measurement	37	35	6
SCADA	24	33	7
Automation	23	27	6
On-farm irrigation	17	18	5
Other	6	6	-

Table 37 continued . . .

Table 37. *Current and Future District Programs (continued)*

Item	Number of Districts Active in these Programs	Number of Districts Planning to be Active in these Programs Between 2000-2004	Number of Districts Interested in Further Information
Education			
Short courses for water users			
Irrigator classes	10	18	12
Irrigation scheduling	9	20	11
Salinity	3	13	6
Drainage	3	13	7
Specific irrigation methods	12	19	6
Other	0	0	1
ET scheduling information for water users	24	33	7

Table 38. Specific Requests for Technical Assistance

District Defined Need	Number of Interested Districts
Education assistance	
Staff short courses	24
New short courses advancing past current course material	2
Correspondence courses	1
On site Irrigator/Farmer short courses	14
Irrigator courses in Spanish	2
Educating districts on water saving technology via newsletter, e-mail, etc.	6
HHDR/Data Management implementation	13
Grant writing	2
Information on providing low interest loans to growers	10
On-farm assistance	
On-farm irrigation evaluations	14
Mobile labs	9
Implementing drip from open canals	1
District Infrastructure	
Tour/review district and offer improvement options or review projects or designs and offer opinions about the concept and functionality	5
Automatic downstream control gates	11
Automatic upstream control gates	9
Canal modeling & gate algorithm development	4
SCADA systems/enhancements	21
Remote monitoring	20
Canal or pipeline system modifications/consolidation	6
Addition of regulating ponds or capacity buffering pumps	3
Weir/flume design and or best installation location	10
Identifying best flow measurement device for a given situation	7
Developing solutions to flow meter problems	1
Canal weed control options or methods of changing flow rate coefficient over delivery season	1
Fish screen implementation	2
Filtration	1
Water quality issues	1
Managing saline water and or saline soils	6
Ground water banking/recharge or management	3
Assistance with water balances using ET	1
Landscape audits	2
Efficiency evaluations: Pumps, VFDs, or canal losses	8
Coating for pipes and or equipment	1
Equipment calibration	2
ITRC Software	1
Other	
Assistance in data management programming	1
Assist USBR to define water conservation with goal being less restriction on district water transfers	1
Need a more consistent supply of water to ensure conservation project money does not have to be used to purchase water	2
Assist USBR to understand water management	1
Want a consensus on measuring irrigation efficiency in terms of water management	1

Observations and Conclusions

Sixty water/drainage districts were interviewed in the Mid-Pacific Region of the USBR. Together these districts comprised approximately 2,286,000 acres, or 91% of the irrigated acreage that receives USBR water in the Region. These districts had characteristics that were consistent with agricultural irrigation supply districts and the obtained data was used to characterize the Status and Needs of said districts.

Observations

The data gained from the Survey were discussed in the previous sections. Some observations and comments are included with the tables and figures, and most of those will not be repeated here. Some observations of the data include the following:

1. Reservoirs (either on-farm or within the district distribution system) can improve flexibility of water delivery. Only a small percentage of farm turnouts are reported to have reservoirs. However, districts report the existence of 191 regulating reservoirs in their distribution systems (Table 26). ITRC believes that this is a major increase over historical numbers.

2. There is an average annual pumping bill of $267,607 for the 44 districts with significant pumping (Table 18). If power rates increase over time, there will be a major impact on practices and costs of water in some districts with low power rates.

3. Districts report having significant capacity problems during periods of peak flow rates (Table 24). Advanced water level and pressure control systems would allow them to safely increase their capacities.

4. Propeller meters record flow rates and volume delivered in forty-seven percent of customer turnouts (Table 25). ITRC believes that this indicates a major increase over the last 10-15 years.

5. Irrigation district personnel manually open and close turnouts in nearly half of the districts (Table 9). In addition, they arrive at the turnouts within about an hour of their designated time (Table 10). This is a constraint on improved, automatic on-farm irrigation.

6. Districts do not always receive the flow rates they need from their suppliers. A small amount of water (weighted average of 830 acre-feet per year (AFY) per district) must be accepted for reasons such as flood control, even though there is no district request for water (Table 16).

7. ITRC believes that districts have a better understanding of the need for flexibility than in the past, but that a significant number of district senior personnel still do not recognize the importance of rapidly changing water delivery service needs of modern on-farm irrigation.

8. Sixty-four percent of the districts believe that water management will not decrease demand during a normal water year. Eighty-seven percent of the districts believe that district deliveries cannot be reduced during a dry year (Table 34).

9. The weighted average gross surface water supply available to users is 3.2 AFY per acre over the last five years (Table 22).

10. District managers have a relatively high level of interest in technical assistance and information from ITRC in the areas of remote monitoring, Supervisory Control and Data Acquisition (SCADA), including short courses for farmers and district staff (Table 38). However, due to the unique combination of hydrology, type of infrastructure, education background of employees, etc., of each district, developing many short courses that appeal to all districts proves to be difficult.

Conclusions

1. ITRC believes that districts have made notable improvements in providing flexible water deliveries. However, significant challenges remain to improve flexibility even more, as farmers rapidly shift toward more advanced and improved on-farm irrigation management.

2. The present state of water delivery flexibility must be improved in order to reduce groundwater pumping that supplies on-farm irrigation methods such as micro-irrigation. Sixty-one percent of district managers however, have a low interest level in further improving flexibility (Table 27). Presently only 13% of the acreage are irrigated with drip (Table 17). ITRC expects that acreage using micro-irrigation will more than double in the next decade, increasing the strain on district capabilities to provide water with the needed flexibility.

3. Training efforts are needed for both farmers and staff, including annual short courses on topics such as Supervisory Control and Data Acquisition (SCADA), irrigation scheduling, and remote monitoring (Table 37). Manager responses indicate that per class attendance may be low. Nevertheless, numerous small attendances can impact significant acreage.

4. This Survey revealed a need for specialized, regional training and assistance courses. Many short classes (one-half day to two full days) at the districts may be needed to properly address technical issues.

5. Automation has historically consisted of placing controllers on a few key structures. As the districts are required by their customers to improve service, they will need solutions involving integrated automatic control systems.

6. Many specific individual technical assistance needs have been defined by various districts (Table 38).

Appendix A

Benchmarking Survey

Section 1. Please answer in the space provided or on additional paper as needed.

What can the ITRC do through the USBR technical assistance program to help improve your water management efforts?
a.
b.
c.

What examples of recent water (or energy) conservation or modernization have you implemented and would like to publicize? ITRC, USBR, and the California Energy Commission may be able to help you promote your successful efforts.
a.
b.
c.

Is ITRC allowed to publicize these recent efforts? ________________________________

Appendix B

Interviewed Districts