Efficiency Conservation Definite Plan

ON-FARM ANALYSES (VOLUME 2)
TECHNICAL APPENDICES 2.D.

Prepared as part of the

Imperial Irrigation District Efficiency Conservation Definite Plan

May 2007

Definite Plan Team:

Davids Engineering, Inc. and
Keller Bliesner Engineering, LLC,
in association with CONCUR, Inc.,
DAVEY-CAIRO ENGINEERING, INC.,
GEO/Graphics, ITRC,
Western Resource Economics,
Colorado State University and
Utah State University

Final

2.d. Conservation Measures and Costs

Prepared as part of the

Imperial Irrigation District Efficiency Conservation Definite Plan

May 2007

Davids Engineering, Inc.

1772 Picasso Avenue, Suite A
Davis, CA 95618-0550
(530) 757-6107

TABLE OF CONTENTS

List of Tables

List of Figures

Attachments

1. Introduction

A major element of the Efficiency Conservation Definite Plan (Definite Plan) Team's work involved estimating the costs of conservation measure (CM) that growers could adopt in response to financial incentives to conserve water. Estimation of costs was approached by developing an extensive list of potential CMs and then selecting a smaller number of CMs for development of conceptual designs and costs. Cost estimates included the major components of capital, maintenance and operations. Other factors considered were costs or benefits due to yield changes, fertilizer cost savings and water cost savings. All costs were indexed to 2006.

Cost estimates for individual CM components were obtained from consultations with Imperial Valley irrigation equipment and system suppliers, on-farm construction contractors, and growers. Budgets were developed across a range of field sizes and crop types. For each CM characterized, brief overviews of the conceptual designs and costs follow. Detailed cost breakouts are attached.

2. Identification of Potential Measures

Conservation measures likely to be considered when water conservation incentives are offered were identified through consultation with Imperial Valley growers. The range of potential conservation measures identified includes measures that are currently in use in the Valley as well as those that may be considered in the future. A list of measures identified is provided in Table 1.

Table 1. Potential Conservation Measures

Conservation Measure	Included Explicitly in Analysis?
Advance uniformity management	
Cascading between fields	
Center pivot irrigation	✓
Cutback irrigation	
Downstream farm delivery gate control	
Furrow dams and end blocking	
Gated pipe	
Head ditch lining	
Improved grade design	
Improved pressurized system design	
Improved pressurized system maintenance	
Improved water measurement	
Level basin irrigation	✓
Linear move irrigation	
Micro irrigation	✓
Minor management and physical improvements	✓
Mulch planting	
On-farm reservoirs	
Precision land leveling	

Table 1. Potential Conservation Measures (Con't)

Conservation Measure	Included Explicitly in Analysis?
Reduced border width	
Reduced run length	
Scientific irrigation scheduling	✓
Scientific irrigation scheduling and event management	✓
Soil amendments	
Sprinkle germination	
Sprinkle irrigation	✓
Tailwater recovery systems with reservoirs	✓
Tailwater recovery systems without reservoirs	✓
Tile and drain water reuse	

These measures are described in greater detail in Attachment 1.

As indicated in Table 1, a subset of conservation measures was selected for detailed characterization of costs and water savings. The selection of conservation measures was made based on grower interest, applicability, cost, potential water savings, and system impacts. CMs were selected to provide a representative set for analysis. In program implementation, the expectation is that growers will be allowed wide latitude in selecting the measures considered best for their operations.

3. Applicability of Conservation Measures to Conservation Families

The applicability of a given conservation measure to the field-seasons within a conservation family requires that the conservation measure be compatible with the irrigation method, crop, and soil present and that the conservation measure has the potential to achieve water conservation for the family. The applicability of each conservation measure to each conservation family was evaluated by considering irrigation method, soil, and crop constraints limiting the physical ability to implement the measure and the potential effectiveness in conserving water. Applicability of conservation measures to families is described in Attachment 2.

4. Incremental Cost Characterization Framework

The selected CMs listed in Table 1 were characterized quantitatively with respect to net on-farm implementation costs. Net costs are based on capital costs, maintenance costs, operations costs, and additional costs and benefits of CM adoption. In all cases, the cost of CM adoption was estimated as an incremental cost above existing irrigation costs. Incremental costs were calculated as the difference between the total implementation cost and the current cost of irrigation.

Detailed feasibility-level cost estimates were developed for the selected CMs. Cost estimates for individual CM components, including hardware, labor and management, were obtained in consultation with irrigation equipment and system suppliers, on-farm construction contractors, and Imperial Valley growers. Budgets were developed across a range of field sizes and crop types to develop cost functions for estimating unique costs for individual CM-field-season

combinations. Capital and maintenance costs were estimated on an annual basis, while operations costs and additional costs and benefits were estimated for a typical season.

4.1. Incremental Capital and Maintenance Costs

Capital and maintenance costs represent the costs of purchasing, installing, and maintaining CMs implemented on agricultural fields. A list of cost items was developed based on conceptual designs for the representative CMs, and current (2006) unit cost estimates for the items were developed. Cost estimates were developed primarily through consultation with Imperial Valley equipment suppliers and on-farm contractors. For all cost items, multiple sources were sought to provide increased certainty in the reliability of the cost estimates.

Annual maintenance costs were estimated as a percentage of total capital cost for each cost item. The primary source of maintenance cost estimates was published estimates (Selection of Irrigation Methods for Agriculture, ASCE On-Farm Irrigation Committee, 1999), adjusted based on review by the On-Farm Technical Advisors, comparison to actual maintenance costs provided by IID and Imperial Valley on-farm contractors, and professional judgment. The useful life of each capital cost item was estimated drawing on the same sources listed above. Unit cost values, maintenance costs as a percentage of total capital, and useful lives used to estimate CM capital and maintenance costs are listed in Attachment 3.

Incremental capital costs for each CM were estimated based on conceptual designs. These designs were developed based on existing systems in IID, standard design guidelines (e.g., NRCS Irrigation Manual), and existing systems used in other similar areas. Designs were developed for alternate configurations and across a range of field sizes to enable development of cost functions relating capital cost to field size. The ability to reduce per-acre costs by combining fields or integrating multiple fields into a single CM (e.g., tailwater recovery systems) was accounted for by estimating the total area served by a given CM installation relative to the field size for which the cost was estimated.

Based on the conceptual designs, a list of cost items was prepared, quantities were estimated, and total capital costs were computed as the product of unit cost and quantity. Annualized capital costs were calculated by amortizing each capital cost item across its useful life using a nominal interest rate of 4 percent. Annual maintenance costs for each item were estimated as the product of the total capital cost of the item and the estimated percentage of total capital required annually for maintenance.

It is anticipated that landowners will minimize per-acre costs for permanent capital improvements by combining fields, where possible. For example, a landowner with two adjacent 80-acre fields would likely construct a single pond to collect tailwater and a single pump to return it to the head of one or both fields when constructing a TRS system, rather than building separate systems for each field. The result is that the cost per acre of constructing the system is decreased. A capital cost adjustment factor was developed to estimate the potential reduction in capital costs due to field consolidation as described in Attachment 4. Adjustment factors of 0.60, 0.75, and 0.91 were developed for 36, 72, and 144-acre fields, respectively.

For permanent CMs installed on a field, the crop (and irrigation method) may change over time. For example, a field may have a surface irrigated alfalfa crop for four years, followed by drip

irrigation is present, but the capital improvements remain, and the cost must be recovered over time. To adequately account for capital recovery, cost estimates were developed for permanent CMs even for field-seasons when the CM would not be used. The cost estimates include the amortized permanent capital components (e.g., reservoirs, buried pipelines, etc.) but not the operations costs or portable capital (e.g., trailer mounted pumps).

4.2. Incremental Operations Costs

Operations costs include the costs of labor and energy required to operate a CM for a given crop during a typical season. The labor component of operations costs includes estimates for management, field supervision (irrigation foreman), and field labor (irrigator). Energy costs may include diesel fuel, electrical energy, or natural gas. Incremental operations costs were estimated for each CM on a seasonal basis according to crop and irrigation method. For each CM, functions of per-field and per-acre seasonal operations costs were developed based on a typical season length. For tailwater recovery systems, where the amount of energy required for pumping is related to the amount of water conserved, operations costs for energy were estimated as a variable cost per acre-foot of pumped (conserved) water.

Unit operations costs were developed in the same manner as the unit costs for capital cost items—through consultation with Imperial Valley growers and suppliers, and from additional sources outside the Valley, as needed. Unit operations costs are summarized in Attachment 3.

Incremental operations costs for each CM were estimated as the difference of seasonal labor costs following CM implementation and CM costs under pre-adoption conditions. Pre-adoption operations costs were estimated as the total seasonal labor hours for each on-farm irrigation position (irrigator, foreman, manager) multiplied by the corresponding unit cost of labor. Labor estimates were calculated based on input from Valley growers and from queries of IID cropping and delivery data which were used to estimate the typical seasonal irrigation hours by crop. Baseline irrigation labor estimates for irrigators, foremen, and managers are provided in Tables 2, 3, and 4, respectively.

Table 2. Estimated Seasonal Irrigator Labor Prior to CM Adoption and Resulting Operations Costs

Crop Type	Field Size (ac)	Number of Irrigations[1]	Irrigation Duration (hrs)[1]	Irrigator Cost ($/hr)[2]	Total (for field)[3]	Total (per acre)
Alfalfa, Flat	36	15	24	$12.10	$ 3,630	$ 100.83
	72		32		$ 4,840	$ 67.22
	144		48		$ 7,260	$ 50.42
Alfalfa, Row	36	16	24	$12.10	$ 3,872	$ 107.56
	72		36		$ 5,808	$ 80.67
	144		52		$ 8,389	$ 58.26
Bermuda	36	16	24	$12.10	$ 3,872	$ 107.56
	72		32		$ 5,163	$ 71.70
	144		56		$ 9,035	$ 62.74
Field Crops, Flat	36	9	24	$12.10	$ 2,178	$ 60.50
	72		32		$ 2,904	$ 40.33
	144		52		$ 4,719	$ 32.77
Field Crops, Row	36	9	36	$12.10	$ 3,267	$ 90.75
	72		42		$ 3,812	$ 52.94
	144		60		$ 5,445	$ 37.81
Sugar Beets	36	12	36	$12.10	$ 4,356	$ 121.00
	72		48		$ 5,808	$ 80.67
	144		68		$ 8,228	$ 57.14
Truck Crops	36	9	36	$12.10	$ 3,267	$ 90.75
	72		48		$ 4,356	$ 60.50
	144		72		$ 6,534	$ 45.38
Wheat	36	7	24	$12.10	$ 1,694	$ 47.06
	72		32		$ 2,259	$ 31.37
	144		48		$ 3,388	$ 23.53

1. Estimated from Water Year 98 Single Field Gate Crop Seasons.
2. Fully-burdened hourly rate from Operations Unit Cost Table.
3. Total seasonal cost per field assuming 4 hours break per 24-hour irrigation turn.

Table 3. Estimated Seasonal Foreman Irrigation Labor Prior to CM Adoption and Resulting Operations Costs

Crop Type	Field Size (ac)	Number of Irrigations[1]	Irrigation Duration (hrs)[1]	Fields Covered[2]	Hours per Day[3]	Foreman Cost ($/hr)[4]	Total (for field)[5]	Total (per acre)
Alfalfa, Flat	36	15	24	12	12	$20.70	$ 311	$ 8.63
	72		32				$ 414	$ 5.75
	144		48				$ 621	$ 4.31
Alfalfa, Row	36	16	24	12	12	$20.70	$ 331	$ 9.20
	72		36				$ 497	$ 6.90
	144		52				$ 718	$ 4.98
Bermuda	36	16	24	12	12	$20.70	$ 331	$ 9.20
	72		32				$ 442	$ 6.13
	144		56				$ 773	$ 5.37
Field Crops, Flat	36	9	24	12	12	$20.70	$ 186	$ 5.18
	72		32				$ 248	$ 3.45
	144		52				$ 404	$ 2.80
Field Crops, Row	36	9	36	12	12	$20.70	$ 279	$ 7.76
	72		42				$ 326	$ 4.53
	144		60				$ 466	$ 3.23
Sugar Beets	36	12	36	12	12	$20.70	$ 373	$ 10.35
	72		48				$ 497	$ 6.90
	144		68				$ 704	$ 4.89
Truck Crops	36	9	36	12	12	$20.70	$ 279	$ 7.76
	72		48				$ 373	$ 5.18
	144		72				$ 559	$ 3.88
Wheat	36	7	24	12	12	$20.70	$ 145	$ 4.03
	72		32				$ 193	$ 2.68
	144		48				$ 290	$ 2.01

1. Estimated from Water Year 98 Single Field Gate Crop Seasons.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
3. Estimated paid hours per day of work during irrigation season.
4. Fully-burdened hourly rate from operations unit cost table.
5. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.

Table 4. Estimated Seasonal Manager Irrigation Labor Prior to CM Adoption and Resulting Operations Costs

Crop Type	Field Size (ac)	Number of Irrigations[1]	Hours per Irrigation[2]	Manager Cost ($/hr)[3]	Total (for field)[4]	Total (per acre)
Alfalfa, Flat	36	15	0.5	$41.90	$314	$ 8.73
	72					$ 4.36
	144					$ 2.18
Alfalfa, Row	36	16	0.5	$41.90	$335	$ 9.31
	72					$ 4.66
	144					$ 2.33
Bermuda	36	16	0.5	$41.90	$335	$ 9.31
	72					$ 4.66
	144					$ 2.33
Field Crops, Flat	36	9	0.5	$41.90	$189	$ 5.24
	72					$ 2.62
	144					$ 1.31
Field Crops, Row	36	9	0.5	$41.90	$189	$ 5.24
	72					$ 2.62
	144					$ 1.31
Sugar Beets	36	12	0.5	$41.90	$251	$ 6.98
	72					$ 3.49
	144					$ 1.75
Truck Crops	36	9	0.5	$41.90	$189	$ 5.24
	72					$ 2.62
	144					$ 1.31
Wheat	36	7	0.5	$41.90	$147	$ 4.07
	72					$ 2.04
	144					$ 1.02

1. Estimated from Water Year 98 Single Field Gate Crop Seasons.
2. Estimated number of hours of planning and supervision per irrigation event.
3. Fully-burdened hourly rate from operations unit cost table.
4. Total seasonal cost per field = irr/season x hrs/irr x unit $.

Labor requirements following CM adoption were estimated based on characterization of an operational strategy for each CM for a typical season, across the range of crop-method groups listed in Tables 2, 3, and 4. These operational strategies are described as part of the descriptions of each CM provided later in this report.

Incremental energy costs were estimated as energy usage following CM adoption multiplied by the unit cost of energy. Due to difficulties in identifying the proximity of individual fields to single-phase or three-phase electrical power as well as uncertainties regarding the cost of supplying additional electricity to agricultural producers, energy costs were estimated assuming diesel power to pump water. The cost of energy per unit of water pumped varies by CM according to the head (pressure) and flow requirements and type of engine used to drive

the pump. Additionally, for tailwater recovery systems, pumping costs were quantified as a cost per unit of water conserved. For other CMs with pumps (pressurized irrigation), pumping costs were estimated based on seasonal water use.

4.3. Incremental "Additional" Costs and Benefits

As stated previously, additional costs of CM adoption include lost returns due to decreased yields. Additional benefits include reduced water costs, increased returns due to increased yields, production and harvesting cost savings due to decreased yields, and fertilizer savings due to decreased losses to tailwater and tilewater.

4.3.1. Costs/Benefits Due to Yield Changes

The cost (benefit) to the grower of decreased (increased) yields resulting from a loss (gain) of yield was estimated for each CM and crop water use category based on the estimated change in crop ET resulting from CM implementation. The change in crop ET was translated into a change in returns, net of variable costs. Crop prices were estimated from Imperial Valley Agricultural Commissioner crop reports. Variable production costs were estimated from Imperial Valley Cooperative Extension cost and return studies.

For CMs with an estimated change in marketable yields without a change in crop ET, a percent change in yield was estimated and used to calculate a seasonal change in returns, net of harvest costs, based on agricultural commissioner crop reports. Yield increases are expected for drip and sprinkle irrigation due to improved crop uniformity and quality. Potential yield increases were estimated empirically based on historical drip and sprinkle adoption rates in the Imperial Valley as described in Attachment 5.

4.3.2. Fertilizer Cost Savings

Fertilizer savings for each CM-crop combination were estimated on a seasonal basis from aggregate water savings estimates and in-season fertilizer cost estimates from Imperial Valley Cooperative Extension cost-return studies. It was assumed that reductions in tailwater (and sometimes minor reductions in tilewater) following CM adoption would result in proportional reductions in fertilizer losses. Thus, the amount of fertilizer applied in-season (does not include pre-plant) may be reduced in proportion to the reduction in delivered water.

The estimated cost of fertilizers applied in-season for each crop family is listed in Table 5. These values were estimated based on 2004 cost-return studies published by the Imperial Valley Cooperative Extension and adjusted to 2006 values based on the National Agricultural Statistics Service Prices Paid Index for Fertilizers using an adjustment factor of 1.3.

Table 5. Estimated Cost of In-Season Fertilizer by Crop Family

Crop Family	In-Season Fertilizer Cost ($/ac)
Alfalfa, Mature	$ 46.31
Alfalfa, New	$ 46.31
Bermuda, Mature	$ 169.00
Bermuda, New	$ 169.00
Field Crops	$ 77.74
Sugar Beets	$ 89.44
Truck Crops	$ 97.57
Wheat	$ 57.20

4.3.3. Reduced Water Costs

Changes in water costs for each field-season were calculated as the product of an estimated water rate ($17/af) and the estimated decrease in delivered water, net of the water charges associated with dependent savings. These costs were calculated in the Demand Generator and are documented in Appendix 3.f. Demand Generator.

5. Characterization Results: Management Practices

Management practices include those CMs with little or no permanent capital investment. Conservation through improved management is the result of planning, supervision, and execution of irrigation events using the existing physical system with the objective of reducing water losses (primarily tailwater). For surface irrigation systems, improved management often includes both increased planning prior to the event and increased irrigation labor during the event due to increased labor intensity (irrigator-hours per acre-foot applied) required to reduce water losses while maintaining irrigation adequacy.

5.1. Scientific Irrigation Scheduling (SIS)

Scientific irrigation scheduling (SIS) refers to the decisions made prior to ordering water that result in reduced water losses. SIS includes not only traditional irrigation scheduling (deciding when and how much water to order), but also deciding how to irrigate. In the case of surface irrigation, SIS includes consideration of the set size and duration required to provide adequate irrigation while minimizing losses to tailwater and, to a lesser extent, tilewater.

5.1.1. Applicability

SIS may be applied to any field-season where a crop is present. Regardless of crop, soil, or irrigation method, SIS has the potential to reduce losses to tailwater and, in some cases, tilewater.

5.1.2. Net On-Farm Implementation Costs

5.1.2.1. Capital and Maintenance Costs

SIS is primarily a management practice and thus requires little capital investment. For budgeting purposes, a small amount of training for the irrigator, foreman, and irrigation manager was estimated as a capital cost. The estimated training time required and resulting

costs are provided for each SIS configuration in Attachment 6. The resulting annual capital and maintenance cost per field for SIS was estimated to be $361.40 across all crops and field sizes.

5.1.2.2. Operations Costs

Operations costs for SIS represent the effort of monitoring field conditions and irrigation events to estimate optimal timing, amount, and design of irrigation events as well as the effort to both integrate SIS recommendations into the operation of the farm and execute the irrigation event according to the recommendation.

Conceptually, SIS labor requirements are based on an irrigation-scheduling consultant monitoring fields and observing irrigation events to develop recommendations for the client (grower), who then integrates the recommendations into his farming operation as part of the water ordering and irrigation event execution. Adoption of SIS requires an investment of labor by the consultant, manager, foreman, and irrigator.

The cost of irrigation scheduling services was estimated based on discussions with three consultants in the San Joaquin Valley, where irrigation scheduling services are frequently used by farmers to manage scarce and/or costly water supplies. Based on these three sources, the cost of seasonal irrigation scheduling services was estimated to be $1,170 per field per season, independent of field size.

Irrigation labor costs for irrigators, foremen, managers, and irrigation scheduling consultants to implement SIS are detailed in Attachment 6 for various field sizes (36, 72, and 144 acres) and crop types.

Resulting typical operations cost functions for each crop type across all field sizes were developed based on the detailed cost estimates presented in Attachment 6 by performing linear regressions of the estimated costs across multiple field sizes. The data points are plotted in Figure 1 and the regression coefficients presented in Table 6. Total seasonal cost for a particular field is estimated as the per field cost plus the product of the field size and per acre cost.

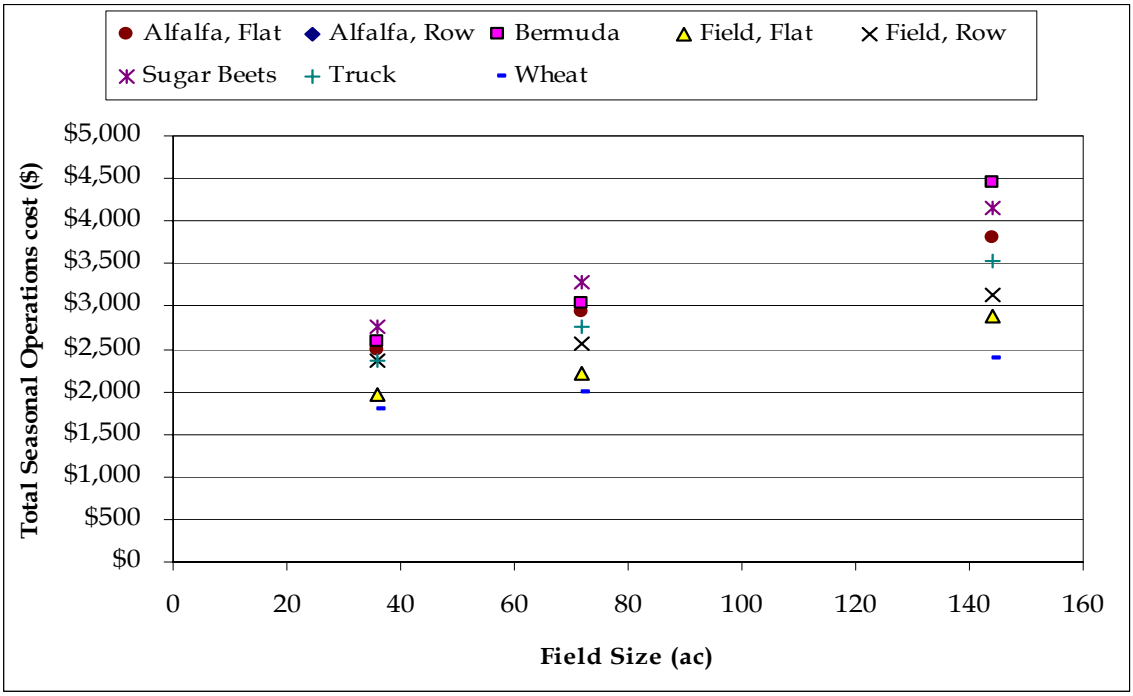

Figure 1. Operations Costs by Crop Type and Field Size for SIS

Table 6. Operations Cost Functions by Crop Type for SIS

	Seasonal Operations Cost	
Crop	per Field	per Acre
Alfalfa, Flat	$2,055.49	$12.11
Alfalfa, Row	$2,114.52	$14.77
Bermuda	$1,881.01	$17.55
Field Crops, Flat	$1,635.62	$8.57
Field Crops, Row	$2,062.50	$7.39
Sugar Beets	$2,316.22	$12.81
Truck Crops	$1,963.99	$10.91
Wheat	$1,583.23	$5.65

5.1.2.3. Additional Costs and Benefits

An incidental (1 percent) reduction in crop ET and yield has been estimated for SIS on row and combination method families. Reduced crop returns, net of harvest costs, are estimated in the Demand Generator as described in Appendix 3.i. Reduced variable production costs, other than harvest costs, were estimated to range between $0.61 and $4.07 per acre for a typical season.

Fertilizer savings were estimated based on typical water savings, as described in Appendix 2.e. For SIS, fertilizer savings were estimated to range between $0.29 and $4.85 per acre for a typical season.

5.2. Scientific Irrigation Scheduling and Event Management (SEM)

Scientific irrigation scheduling and event management (SEM) includes all of the activities of scientific irrigation scheduling plus actions to taken during the irrigation event to reduce losses based on observation of soil infiltration characteristics. Event management is the practice of observing the first and possibly second irrigation set and making decisions to adjust set size, set duration, or delivery flow to reduce losses the first and in subsequent sets.

5.2.1. Applicability

SEM is limited to surface irrigation events, where the outcome of the event is strongly dependent on soil infiltration characteristics, which may be difficult to predict before observing the first irrigation set. As a result, SEM is applicable to flat, row, and combination irrigation method families.

5.2.2. Net On-Farm Implementation Costs

5.2.2.1. Capital and Maintenance Costs

SEM is primarily a management practice and thus requires little capital investment. For budgeting purposes, a small amount of training for the irrigator, foreman, and irrigation manager was estimated as a capital cost. The estimated time required and resulting costs are the same as for SIS and are provided in Attachment 7.

5.2.2.2. Operations Costs

Operations costs for SEM are similar to those for SIS in that they represent the effort of monitoring field conditions and irrigation events to estimate optimal timing, amount, and design of irrigation events as well as the effort to both integrate SIS recommendations into the operation of the farm and execute the irrigation event according to the recommendation. Additionally, SEM includes additional labor to monitor irrigation events as they unfold and to adjust set size, inflow, and/or duration in order to maximize application efficiency. These adjustments result in changes to the IID water order.

To implement SEM effectively, it is expected that growers will need to extend the duration of irrigation events. Extended deliveries may be due to decreased set size and/or delivery rate to provide greater opportunity for adjustments to be made as the event unfolds based on observed advance and infiltration. These increases in duration and order adjustments require that the irrigator be present at the field during the event and that the foreman and manager provide supervision and coordinate changes with IID to achieve water savings.

Irrigation labor costs for irrigators, foremen, and managers to implement SEM are detailed in Attachment 7 for various field sizes (36, 72, and 144 acres) and crop types.

Resulting typical operations cost functions for each crop type across all field sizes were developed based on the detailed cost estimates of Attachment 7 by performing linear regressions of the estimated costs across multiple field sizes. The data points are plotted in Figure 2 and the regression coefficients are presented in Table 7. Total seasonal cost for a particular field is estimated as the per-field cost plus the product of the field size and per acre cost.

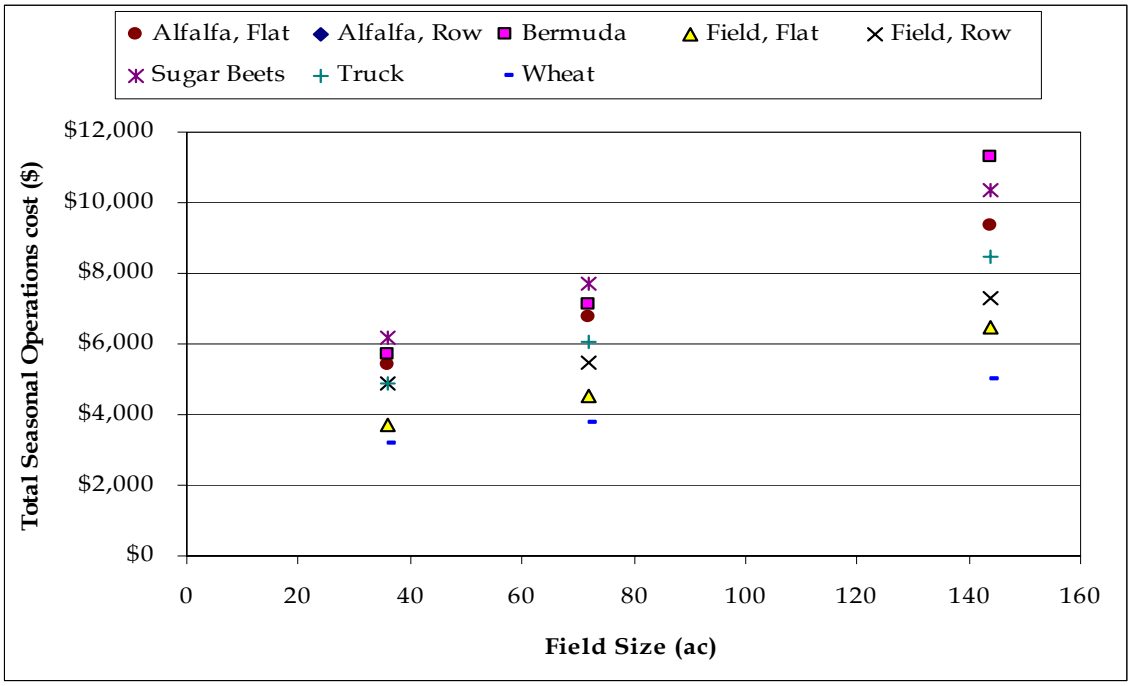

Figure 2. Operations Costs by Crop Type and Field Size for SEM

Table 7. Operations Cost Functions by Crop Type for SEM

	Seasonal Operations Cost	
Crop	per Field	per Acre
Alfalfa, Flat	$4,111.25	$36.49
Alfalfa, Row	$4,307.33	$44.48
Bermuda	$3,606.80	$52.82
Field Crops, Flat	$2,737.73	$25.80
Field Crops, Row	$4,018.39	$22.28
Sugar Beets	$4,836.50	$38.57
Truck Crops	$3,722.85	$32.84
Wheat	$2,542.58	$17.03

5.2.2.3. Additional Costs and Benefits

An incidental (1 percent) reduction in crop ET and yield has been estimated for SEM on row and combination method families. Reduced crop returns, net of harvest costs, are estimated in the Demand Generator as described in Appendix 3.i. Reduced variable production costs, other than harvest costs, were estimated to range between $0.61 and $4.07 per acre for a typical season.

Fertilizer savings were estimated based on typical water savings, estimated as described in Appendix 2.e. For SEM, fertilizer savings were estimated to range between $1.42 and $8.10 per acre for a typical season.

5.3. Minor Management and Physical Improvements (MMP)

Minor management and physical improvements (MMP) refers to a wide range of activities that managers, foreman, tractor operators, and irrigators can implement to reduce water losses in cases where large losses would otherwise occur. Examples of minor management and physical (MMP) improvements include increased field labor to control advance uniformity, laser leveling (or more frequent laser leveling), improved headlands preparation, use of gravity-fed polyethylene gated pipe in lieu of traditional headlands, use of cross-borders, use of "water buster" advance indicators, reduced grade at the bottom end of a field, improved maintenance of pressurized irrigation systems, etc. Irrigation scheduling is not included in the definition of the minor management and physical improvements CM.

5.3.1. Applicability

Due to the general, inclusive nature of the CM, MMP is applicable to all conservation families.

5.3.2. Net On-Farm Implementation Costs

5.3.2.1. Capital and Maintenance Costs

MMP covers a wide range of minor management and physical improvements listed previously. Costs were estimated based on an increase in labor equivalent to that included in the budget for SIS, minus the cost of an irrigation scheduling consultant. Although during implementation, some capital could be invested as part of MMP (e.g., laser leveling), all costs have been accounted for as operations costs.

5.3.2.2. Operations Costs

Costs for MMP were estimated as the cost of increased on-farm irrigation labor from the SIS budgets (see Attachment 8). The cost of an irrigation scheduling consultant was not included in the MMP budget.

Resulting typical operations costs functions for each crop type across all field sizes were developed based on the detailed cost estimates of Attachment 8 by performing linear regressions of the estimated costs across multiple field sizes for each crop type. The regression coefficients are presented in Table 8. Total seasonal cost for a particular field is estimated as the per-field cost plus the product of the field size and the per acre cost.

Table 8. Operations Cost Functions by Crop Type for MMP

	Seasonal Operations Cost	
Crop	per Field	per Acre
Alfalfa, Flat	$1,189.92	$12.16
Alfalfa, Row	$1,269.24	$14.83
Bermuda	$1,035.73	$17.61
Field Crops, Flat	$648.28	$8.60
Field Crops, Row	$1,075.16	$7.43
Sugar Beets	$1,389.77	$12.86
Truck Crops	$976.65	$10.95
Wheat	$555.29	$5.68

5.3.2.3. Additional Costs and Benefits

Fertilizer savings were estimated based on typical water savings, estimated as described in Appendix 2.e. For MMP, fertilizer savings were estimated to range between $0.07 and $3.46 per acre for a typical season.

6. Characterization Results: Physical Improvements

Physical improvements include CMs that require substantial investment of capital, such as for construction of structures, installation of pipelines, and purchase of equipment. Conservation through physical improvements results from a combination of changes to the physical irrigation system, and, for some systems, from improved irrigation management. As in the case of management practices, conserving water with physical improvement CMs often includes both increased planning prior to the event and increased irrigation labor during the event due to increased labor intensity (irrigator-hours per acre-foot applied) required to reduce losses while maintaining irrigation adequacy.

6.1. Tailwater Recovery Systems (TRS)

Tailwater recovery systems have components for collecting, storing, conveying, and applying surface runoff. They can be used to conserve water by reducing deliveries in proportion to the amount of tailwater collected and reapplied. TRS systems vary widely in configuration, depending on the size and configuration of storage ponds and distribution structures and on the type of pump driver used to lift and redistribute water.

A total of forty TRS designs and cost estimates were developed, representing three general TRS physical configurations and two operational strategies. The physical configurations differ on the basis of pond capacity and pump capacity. The variations within each configuration differ on the basis of pump type, pond length, and pipeline length. Specific physical configurations are detailed in Table 9.

For each of the 20 physical configurations listed in Table 9, two operational strategies were characterized—normal delivery and extended delivery. Normal delivery involves a grower ordering water for essentially the same duration as in the past and operating the TRS to capture and reapply tailwater. Extended delivery involves a grower increasing the duration of an irrigation event relative to historical practice by decreasing the ordered flow and reducing the set size. The advantage of extended delivery is that much of the tailwater generated runs off of the field while the event is still in progress, allowing more tailwater to be reapplied and the delivery flow to be reduced for more of the delivery. Under normal delivery, much of the tailwater generated commonly runs off of the field and into the pond after the last set, remaining in the pond until the next irrigation event or being lost to evaporation, seepage, and draining of the pond.

Detailed budgets for the 40 unique physical and operational TRS configurations are provided in Attachments 9, 10, and 11.

Table 9. TRS Physical Configurations

Config ID	General TRS Configuration	Field Size (ac)	Pond Capacity (ac-ft)	Pond Length (mi)	Pump Capacity (cfs)	Pump Type	Pipeline Length (mi)
1	Portable TRS with limited storage.	36	0.1	0.25	1 – 3	Trailer mounted trash pump	0.25
2		36	0.1	0.25	1 – 3	PTO-driven trash pump	0.25
3		72	0.1	0.5	1 – 3	Trailer mounted trash pump	0.25
4		72	0.1	0.5	1 – 3	PTO-driven trash pump	0.25
5		72	0.1	0.25	1 – 3	Trailer mounted trash pump	0.5
6		72	0.1	0.25	1 – 3	PTO-driven trash pump	0.5
7		144	0.1	0.5	1 – 3	Trailer mounted trash pump	0.25
8		144	0.1	0.5	1 – 3	PTO-driven trash pump	0.25
9		144	0.1	0.5	1 – 3	Trailer mounted trash pump	0.5
10		144	0.1	0.5	1 – 3	PTO-driven trash pump	0.5
11	Permanent TRS with small pond	36	4	0.25	3	Permanent vertical turbine	0.25
12		72	4	0.25-0.5	3	Permanent vertical turbine	0.25
13		72	4	0.25	3	Permanent vertical turbine	0.5
14		144	4	0.25-0.5	3	Permanent vertical turbine	0.25
15		144	4	0.25-0.5	3	Permanent vertical turbine	0.5
16	Permanent TRS with big pond	36	8	0.25	3	Permanent vertical turbine	0.25
17		72	8	0.25-0.5	3	Permanent vertical turbine	0.25
18		72	8	0.25	3	Permanent vertical turbine	0.5
19		144	8	0.25-0.5	3	Permanent vertical turbine	0.25
20		144	8	0.25-0.5	3	Permanent vertical turbine	0.5

6.1.1. Applicability

Tailwater recovery systems are applicable to all surface irrigated fields where tailwater is produced. Thus, a tailwater recovery system is applicable to flat, row, and combination irrigation method families. It was not considered for level basin, which is typically designed for zero tailwater, although tailwater can occur.

6.1.2. Net On-Farm Implementation Costs

6.1.2.1. Capital and Maintenance Costs

Key components of a TRS system include a pond to temporarily store tailwater, a pump to lift water back to the head of the field or set of fields served, a pipeline to convey tailwater back to the head of the field, and a modified tailwater ditch at the bottom of the field with one or more drop boxes to convey surface runoff into the pond without appreciable soil erosion. For each physical configuration of TRS, a detailed feasibility-level budget was developed to estimate the total and annual capital cost and the annual maintenance cost (Attachments 9, 10, 11).

6.1.2.1.1. Tailwater Pond

Construction costs for tailwater ponds were estimated based on excavation of the pond, construction of a headwall and trash rack at the end of the pond with the pump station, and construction of a drain box at the other end of the pond. Pond designs were developed based

on below-ground, reverse-grade ponds consistent with those constructed under the IID-MWD water transfer program.

Excavation quantities were calculated for unique combinations of ground slope, pond volume, and pond length. In all cases, the design pond had a reverse grade of 0.05 percent, side slopes of 1:1, and freeboard (at the lower end) of 0.5 feet. Three ground slopes were used for each combination of pond capacity and length based on the approximate range of slopes found in IID. Pond lengths were ¼ mile and approximately ½ mile. Pond capacities included a simple reverse-grade ditch with minimal storage capacity (0.1 AF), a small pond (4 AF), and a big pond (8 AF).

Calculations were performed using the prismoidal equation with a maximum cut depth limited to 8 feet. If the cut depth reached 8 feet, the pond bottom width was increased until the storage requirement was met. Earthwork calculation details are provided in Attachment 12.

The area occupied by the pond was estimated based on the average top-width of the pond, plus 16 feet to allow for a road along the length of the pond, multiplied by the length of the pond.

For some designs and pond configurations, large overburden resulted in excessive excavation volumes and costs. In these cases, it was assumed that these would not be considered by the grower due to the greatly increased cost. For example, an 8 acre-foot pond ½ mile in length on a 0.25 percent slope would require more than 3 times as much excavation as a pond of the same capacity on the same slope only ¼ mile long. The example configuration and the analogous configuration for a 4 acre-foot pond were considered infeasible. Representative earthwork quantities and resulting pond excavation costs are summarized for each TRS physical configuration in Attachments 9, 10, and 11.

Additional components of the tailwater pond include the headwall, trash rack, and drain box. For TRS systems with minimal storage (configurations 1 – 10), these components are not needed. For configurations 11 – 20, the cost of the headwall, trash rack, and drain box were estimated to be $6,400, $2,400, and $3,400, respectively, as listed in Attachment 3. The cost of each of these components was adjusted based on the field size adjustment factor to account for landowners taking advantage of opportunities to group fields.

6.1.2.1.2. Pump Station

Portable pump station cost estimates were based on costs for trailer mounted, self-priming trash pumps and for a combination tractor and PTO-driven pump. In each case, the cost of a flowmeter was also included. The unit costs, useful lives, and maintenance costs of these items are listed in Attachment 3. The total cost of the pump (and tractor) was divided by three based on the assumption that the pump (and tractor) would be used on up to three fields during an irrigation season to spread cost. The amortized capital and maintenance costs for these pumps can be found in the detailed budgets of Attachment 9.

Permanent pump station cost estimates were based on costs for a pump stand (sump), flowmeter, automatic oiler, diesel engine, vertical turbine pump, and heavy-duty security enclosure. These components were identified through consultation with Imperial Valley growers and on-farm contractors. The unit costs, useful lives, and maintenance costs of these

items are listed in Attachment 3. The capital costs were adjusted based on the field-size adjustment factors to account for landowners taking advantage of opportunities to group fields. The amortized capital and maintenance costs for these pumps can be found in the detailed budgets of Attachments 10 and 11.

6.1.2.1.3. Pipeline

Portable pipelines consist of 10-inch diameter aluminum sprinkle mainline. Mainline costs, useful life, and maintenance percentage are listed in Attachment 3. The amortized capital and maintenance costs for these pipelines can be found in the detailed budgets of Attachment 9.

Permanent pipelines consist of buried 12-inch class 80 plastic irrigation pipe plus all fittings including a steel pump discharge pipe, valves, transition, thrust blocks, vents, elbows, and outlet. Unit costs of PVC pipe are provided in Attachment 3. The cost of fittings was estimated to be 20 percent of pipe cost based on review of cost data from the TRS's constructed under the IID/MWD water transfer program. Permanent pipeline costs were not adjusted using the field size adjustment factors because it is anticipated that conveyance of tailwater to multiple fields from a single pond and pump station would require additional pipe. The amortized capital and maintenance costs for these pipelines can be found in the detailed budgets of Attachments 10 and 11.

6.1.2.1.4. Modified Tailwater Ditch

For TRS configurations with storage, a new tailwater ditch must be constructed between the field and the reservoir. Additionally, tailwater drop boxes must be installed along the reservoir to receive and convey runoff from the field. Costs estimated for the new tailwater ditch and drop boxes are provided in the detailed budgets of Attachments 9, 10, and 11.

6.1.2.1.5. Miscellaneous

Additional costs of CM implementation include the cost to the grower of administering the CM design and construction and contingencies. On-farm administrative costs were estimated to be 5 percent of capital costs, and a contingency of 10 percent was applied to the capital costs.

6.1.2.1.6. Resulting Cost Functions

Continuous functions of capital and maintenance cost per field and per acre were developed from the detailed TRS cost estimates using a log regression. For each physical configuration (across all three field sizes), the log cost curve was split into three components based on field size. Then, within each field size region, a linear regression was performed to generate a field-size specific estimate of annual capital and maintenance costs. The data points are plotted in Figure 3 and the regression coefficients presented in Table 10. Total seasonal cost for a particular field is estimated as the per-field cost plus the product of the field size and per acre cost.

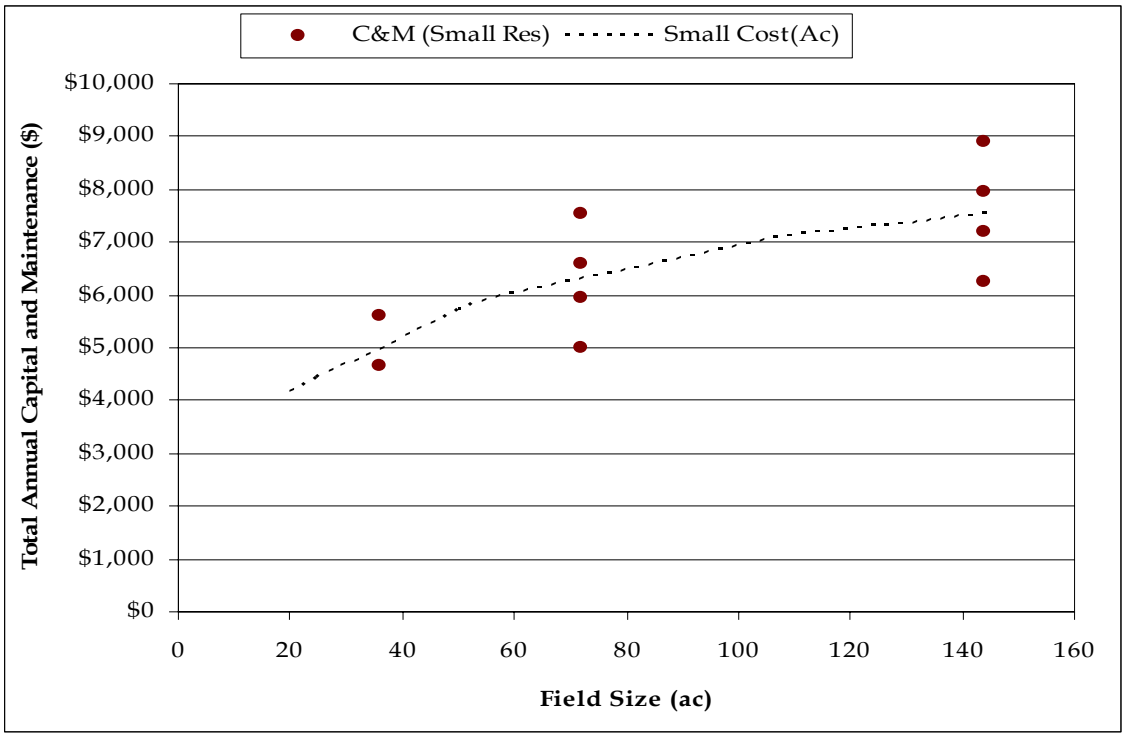

Figure 3.a. Capital and Maintenance Cost Functions for TRS with Minimal Storage

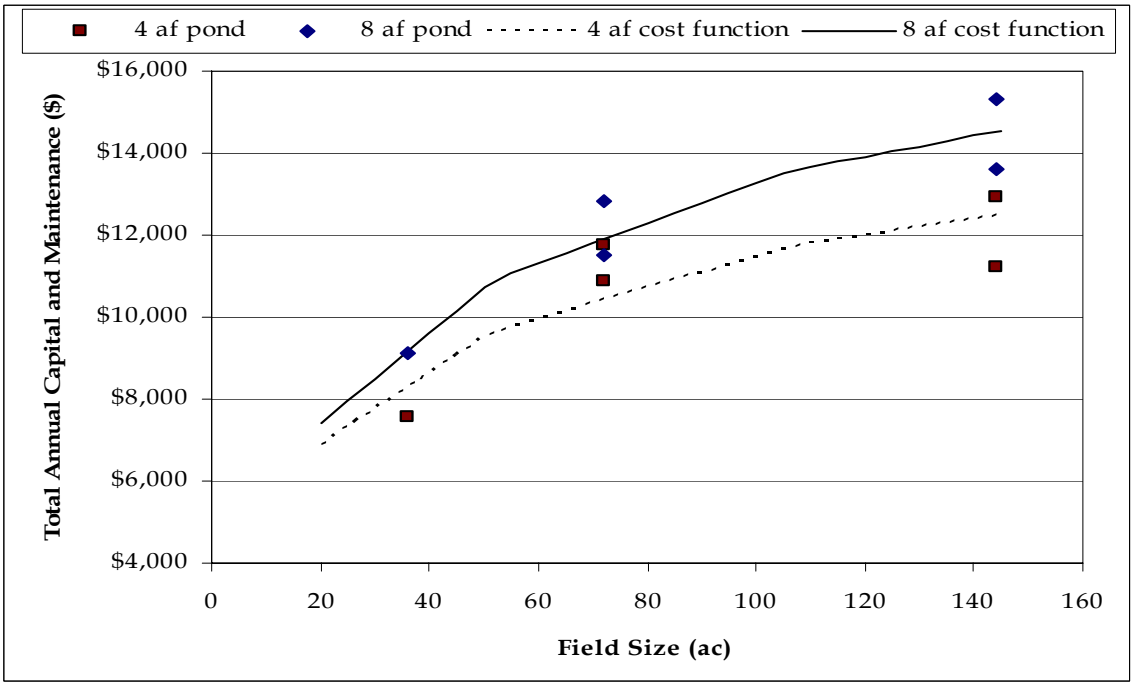

Figure 3.b. Capital and Maintenance Cost Functions for TRS with Reservoir

Table 10. Capital and Maintenance Cost Functions for TRS

Reservoir Size (af)	Field Size (ac)	Annual Capital and Maintenance Cost	
		per Field	per Acre
0.1	20 - 53	$3,103.88	$52.49
	54 - 107	$4,640.78	$22.89
	108 - 1000	$5,820.11	$11.87
4	20 - 53	$5,157.74	$86.65
	54 - 107	$7,694.70	$37.79
	108 - 1000	$9,641.41	$19.60
8	20 - 53	$5,187.82	$110.66
	54 - 107	$8,427.84	$48.26
	108 - 1000	$10,914.04	$25.03

6.1.2.2. Operations Costs

For normal delivery operational scenarios, a moderate increase in irrigation labor is anticipated. It is assumed that an irrigator will need to be present at the field throughout the irrigation event to operate the TRS effectively, and that additional foreman and manager time will be required to provide additional supervision and coordination of TRS operations. The increase in irrigation labor was estimated to be similar to that of SIS, minus the consultant cost.

For the extended delivery operational scenarios, the duration of irrigation events is expected to increase, substantially increasing irrigation labor costs. The increase is due to the need to have an irrigator operating the TRS during the event as well as additional supervision and coordination by the foreman and manager. Irrigation labor requirements are expected to double from the baseline case for extended delivery.

Operations costs for each TRS configuration and operational strategy are detailed in Attachments 9, 10, and 11. The data points are plotted in Figure 4 and the regression coefficients presented in Table 11.

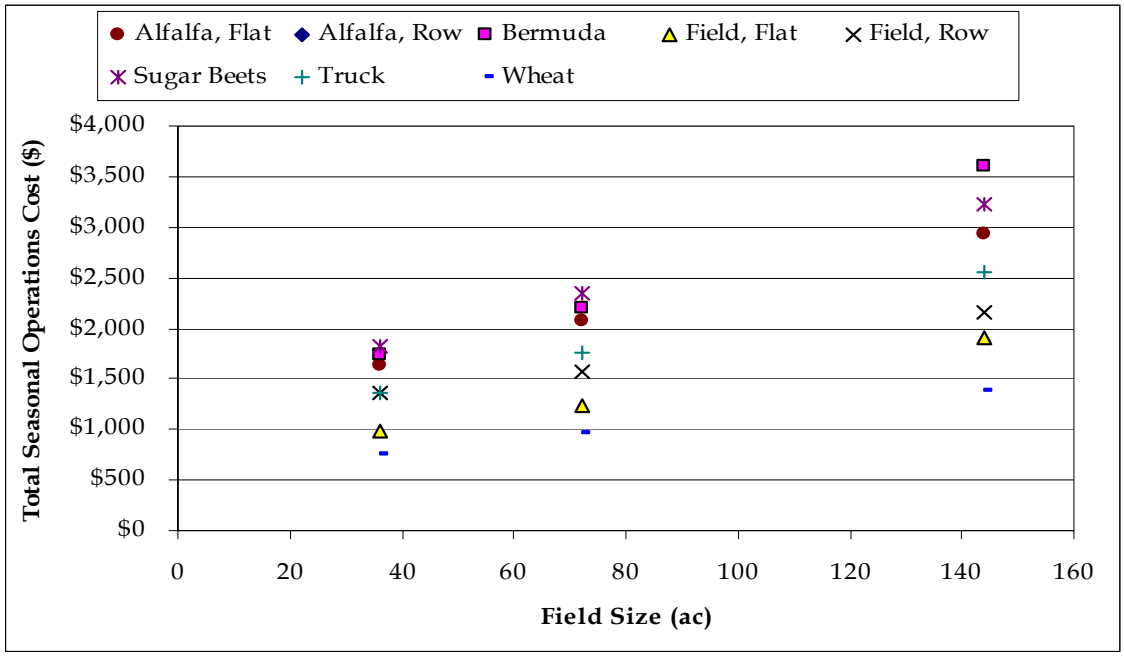

Figure 4.a. Operations Costs by Crop Type and Field Size for TRS with Normal Delivery

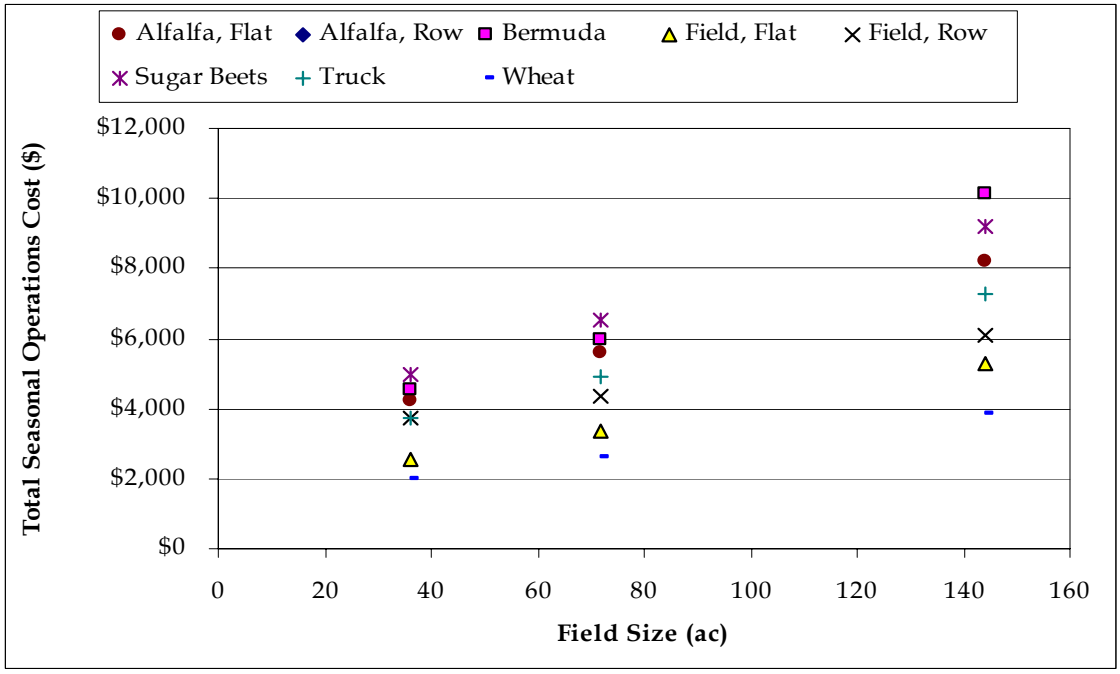

Figure 4.b. Operations Costs by Crop Type and Field Size for TRS with Extended Delivery

Table 11. Operations Cost Functions by Crop Type for TRS

	Seasonal Operations Cost			
	Normal Delivery		Extended Delivery	
Crop	per Field	per Acre	per Field	per Acre
Alfalfa, Flat	$1,189.92	$12.16	$2,941.25	$36.49
Alfalfa, Row	$1,269.24	$14.83	$3,137.33	$44.48
Bermuda	$1,035.73	$17.61	$2,436.80	$52.82
Field Crops, Flat	$648.28	$8.60	$1,567.73	$25.80
Field Crops, Row	$1,075.16	$7.43	$2,848.39	$22.28
Sugar Beets	$1,389.77	$12.86	$3,666.50	$38.57
Truck Crops	$976.65	$10.95	$2,552.85	$32.84
Wheat	$555.29	$5.68	$1,372.58	$17.03

6.1.2.3. Additional Costs and Benefits

Incidental reductions in crop ET and yield have been estimated to be 2 percent and 1 percent for TRS with large ponds and small ponds, respectively, due to decreased crop area. No adjustment of crop ET and yield was made for TRS systems with minimal storage. Reduced crop returns, net of harvest costs, are estimated in the Demand Generator as described in Appendix 3.f. Reduced variable production costs, other than harvest costs, are summarized in Table 12.

Fertilizer savings were estimated based on typical water savings, estimated as described in Appendix 2.e. Fertilizer cost savings are summarized in Table 12.

Table 12. Reductions in Variable Production Costs for TRS.

Pond Size (ac-ft)	Reduction in Cropped Area (percent)	Range of Seasonal Production Cost Savings ($/ac)			Range of Seasonal Fertilizer Savings ($/ac)		
0.1	0%	$0.00	to	$0.00	$1.47	to	$18.25
4	1%	$0.61	to	$4.07	$0.46	to	$24.18
8	2%	$1.22	to	$8.15	$0.93	to	$36.65

6.2. Pressurized Irrigation

Pressurized irrigation includes drip and sprinkle irrigation methods. With these methods of irrigation application, water distribution within the field is accomplished through the system, and does not depend on flow over the soil surface. This is fundamentally different from surface irrigation systems with which distribution and infiltration are interrelated. One potential advantage of pressurized irrigation relative to surface irrigation is that acceptably high distribution uniformities can be achieved without producing surface runoff.

6.2.1. Applicability

Pressurized irrigation is generally applicable to surface-irrigated fields across a wide range of crops and soils. An exception is center pivot irrigation, which is not suited to IID's heavy cracking soils, but is adapted to light and heavy soils.

6.2.2. Net On-Farm Implementation Costs

Key components of a pressurized irrigation system include a pump to pressurize water and convey it to the emitter, filtration to prevent clogging of the system, mainlines to carry water to the field, laterals to convey water to the plants, and emitters to distribute the water to the soil. Additionally a pond may be constructed to provide temporary storage, prevent surges in delivery flow from affecting the pump, or to settle silt and debris from the irrigation water before it is pumped into the system.

For drip irrigation, detailed feasibility-level budgets were developed for three unique physical configurations to estimate the total and annual capital cost and the annual maintenance cost (Attachment 13). The configurations include drip without a reservoir, drip with a reservoir hydraulically connected to the delivery system (overflow not possible), and drip with a reservoir hydraulically disconnected from the system (overflow structure needed). The distinction of whether or not the reservoir is hydraulically connected to the delivery system relates to whether water is rejected to the delivery system as the reservoir fills, or must be designed to spill water if it is overfilled.

For sprinkle irrigation, detailed feasibility-level budgets were developed for six unique physical configurations (various pump sizes and reservoir configurations) to estimate the total and annual capital cost and the annual maintenance cost (Attachment 14). The configurations include sprinkle without a reservoir, sprinkle with a reservoir hydraulically connected to the delivery system (overflow not possible), and sprinkle with a reservoir hydraulically disconnected from the system (overflow structure needed). For each configuration, budgets were developed based on both purchase cost of sprinkle and based on rental cost. Because amortized purchase costs were found to be more economical that rental costs, they were used to develop the cost functions for conversion to sprinkle irrigation.

For center pivot irrigation, detailed feasibility-level budgets were developed for two unique physical configurations to estimate the total and annual capital cost and the annual maintenance cost (Attachment 15). The configurations include center pivot irrigation without cropped corners and center pivot with cropped corners where the corners are irrigated using sprinkle.

6.2.2.1. Capital and Maintenance Costs

Earthwork quantities for on-farm reservoirs were calculated using the prismoidal equation based on a rectangular aboveground reservoir with a capacity of 4 ac-ft (Attachment 12). Cost estimates for pumps and system components were developed through discussions with Imperial Valley irrigation suppliers and growers.

Detailed cost estimates for drip, sprinkle, and center pivot irrigation are provided in Attachments 13, 14, and 15, respectively.

The capital cost functions for center pivot with cropped corners include a combination of costs for center pivot and sprinkle based on the proportion of the field irrigated under each method (13/16ths center pivot; 3/16ths sprinkle).

Continuous functions of capital and maintenance cost per field and per acre were developed from the detailed cost estimates using linear regression. The resulting functions for each pressurized system type are summarized in Table 13 and Figure 5.

Table 13.a. Capital and Maintenance Cost Functions for Drip Irrigation

	Annual Capital and Maintenance	
Configuration	per Field	per Acre
No Reservoir	$8,625.00	$201.31
Reservoir On System	$10,074.00	$209.07
Reservoir Off System	$10,310.00	$210.33

Table 13.b. Capital and Maintenance Cost Functions for Sprinkle Irrigation

Reservoir Type	Ownership Category	Annual Capital and Maintenance	
		per Field	per Acre
None	Rental	$7,647.00	$437.69
	Purchase	$2,206.50	$288.56
	Average	$4,926.75	$363.13
On System	Rental	$9,003.25	$444.88
	Purchase	$3,570.50	$295.69
	Average	$6,286.88	$370.29
Off System	Rental	$12,577.50	$464.00
	Purchase	$3,201.50	$296.78
	Average	$7,889.50	$380.39

Table 13.c. Capital and Maintenance Cost Functions for Center-Pivot Irrigation

Field Size (ac)	Annual Capital and Maintenance	
	Per Field	per Acre
20 - 54	$7,361.34	$134.29
54 - 108	$11,386.34	$57.28
108 - 1000	$14,388.00	$29.92

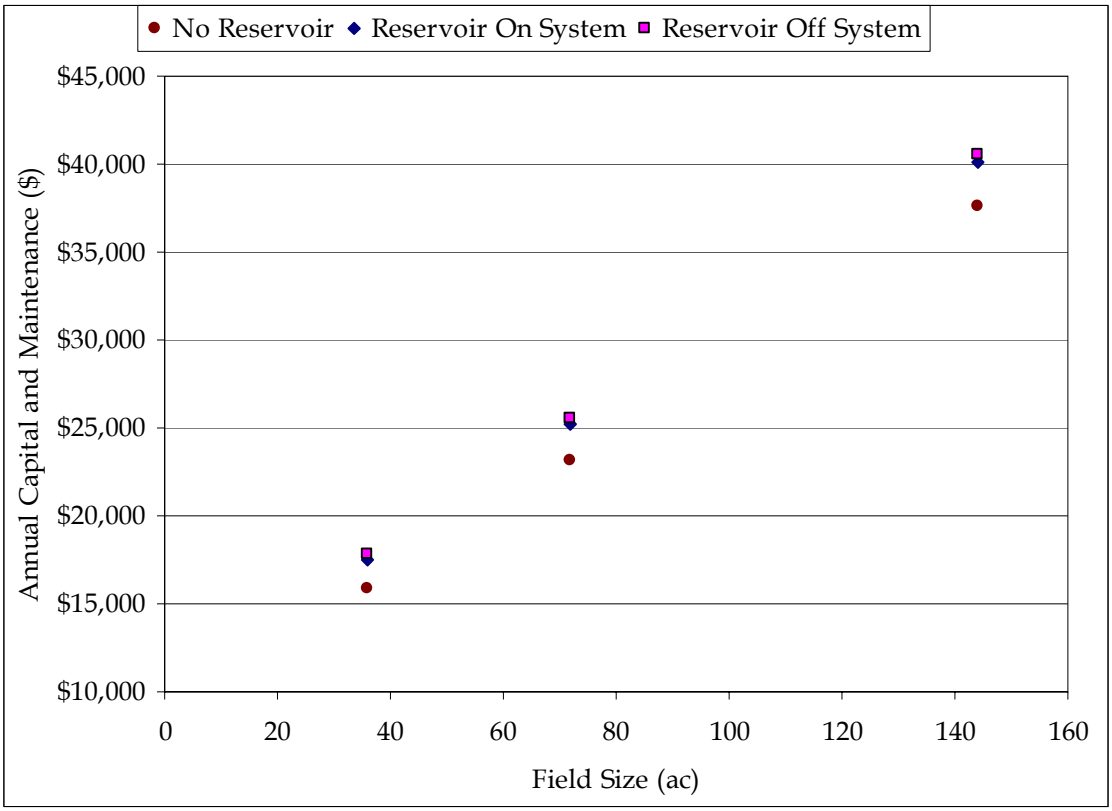

Figure 5.a. Capital and Maintenance Costs for Drip Irrigation

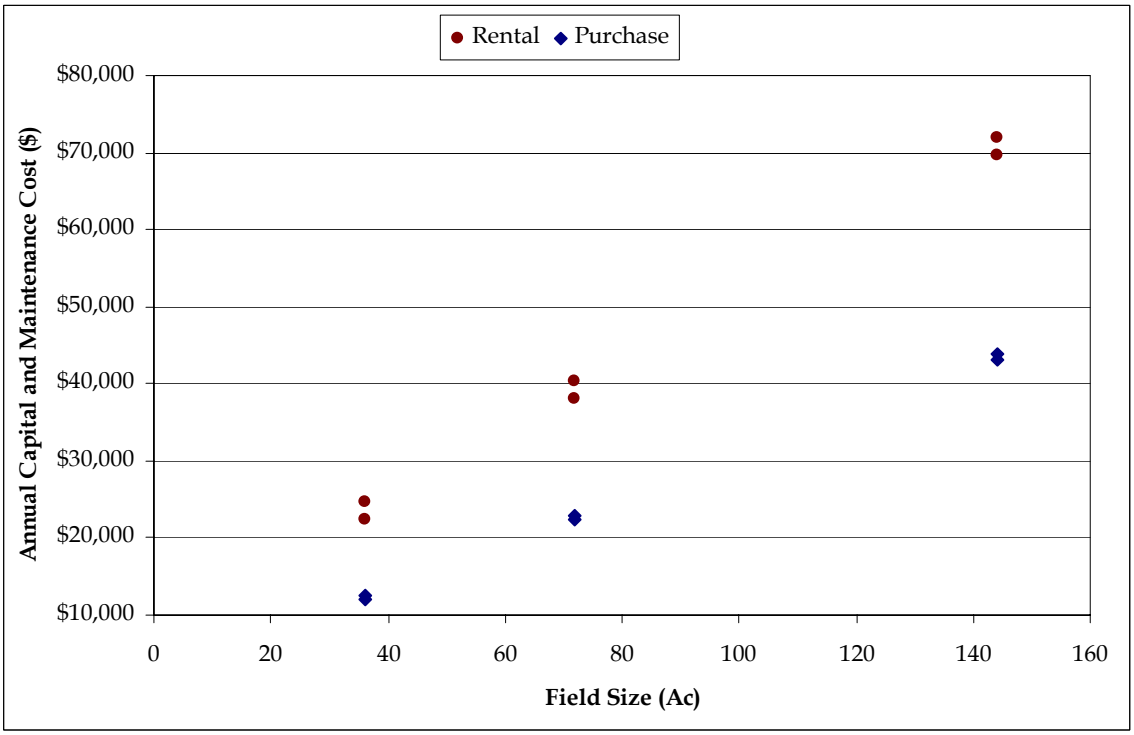

Figure 5.b.1. Capital and Maintenance Costs for Sprinkle Irrigation (No Reservoir)

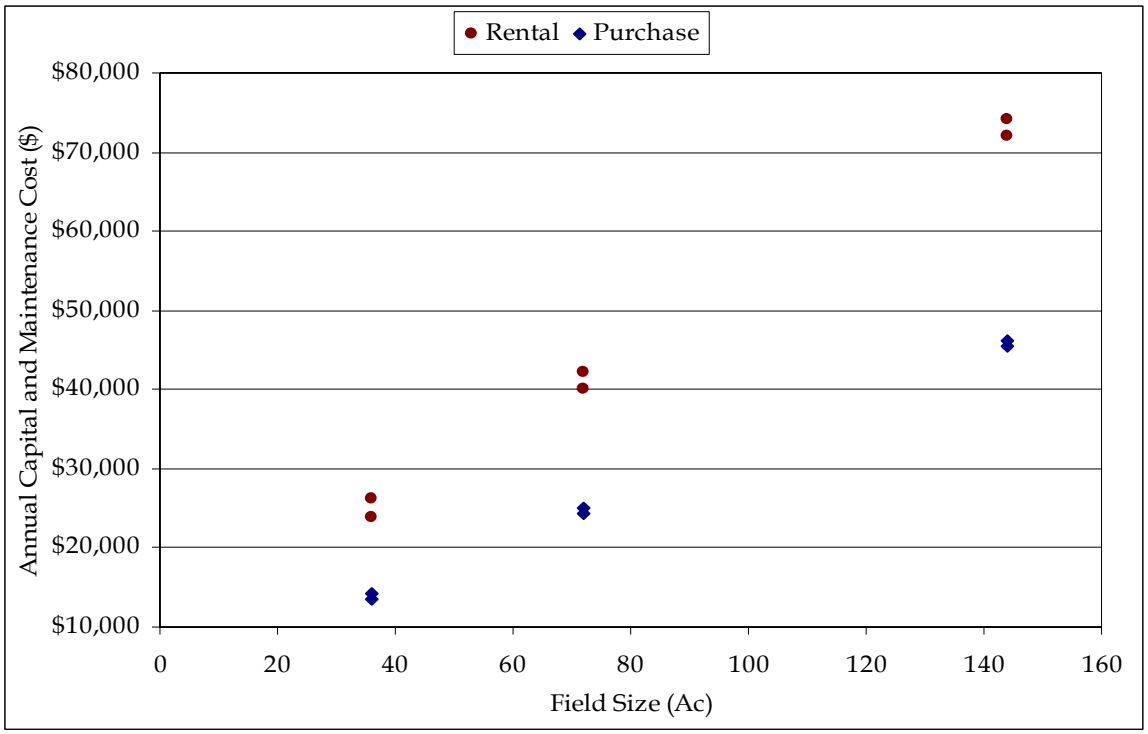

Figure 5.b.2. Capital and Maintenance Costs for Sprinkle Irrigation (Reservoir on System)

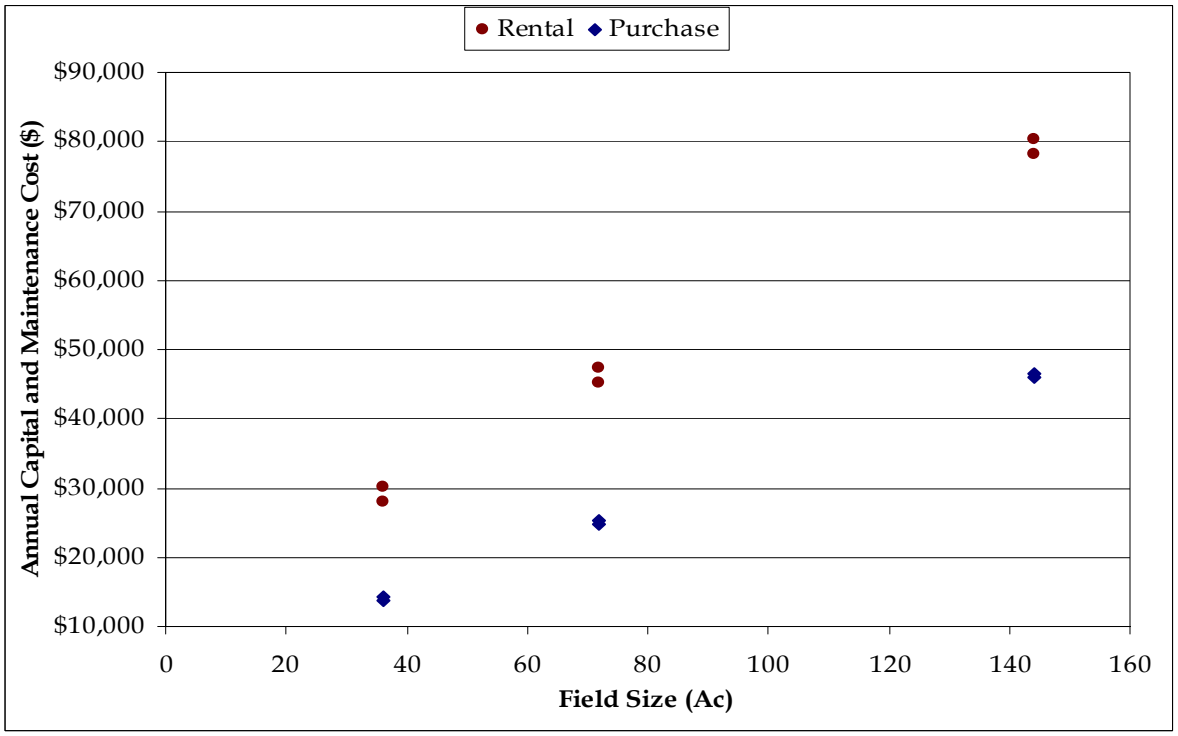

Figure 5.b.3. Capital and Maintenance Costs for Sprinkle Irrigation (Reservoir off System)

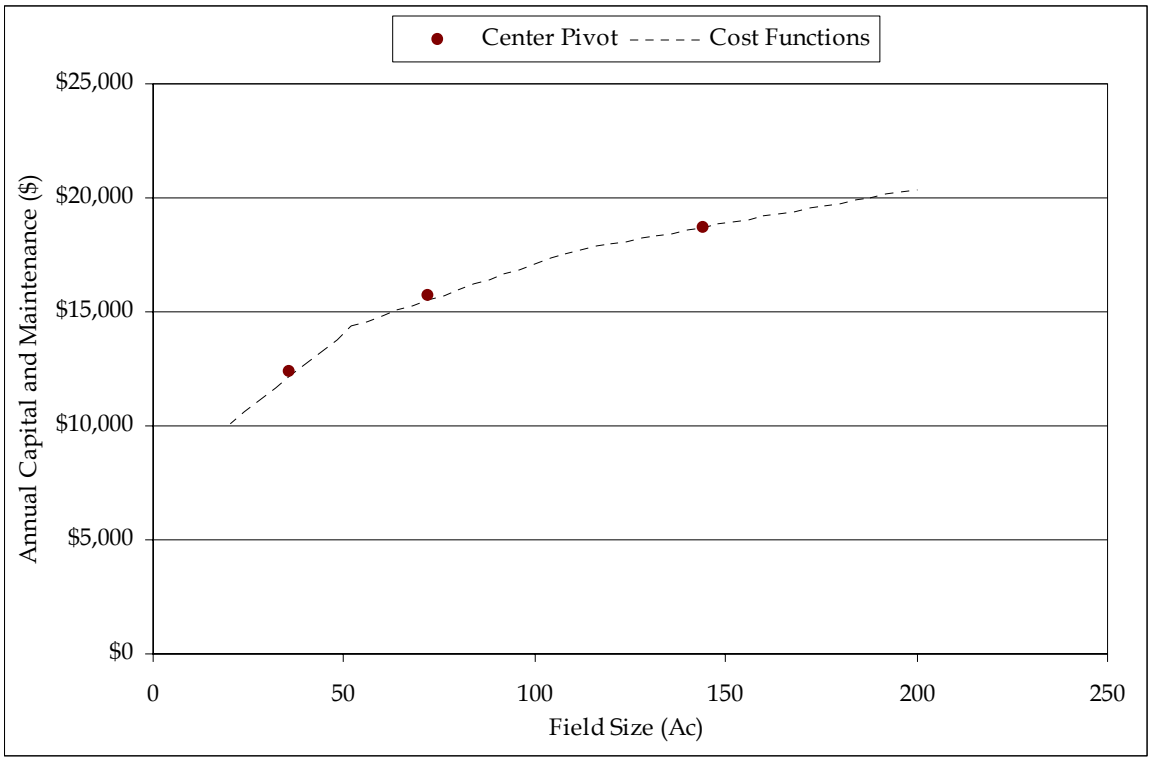

Figure 5.c. Capital and Maintenance Costs for Center Pivot Irrigation

6.2.2.2. Operations Costs

Operations costs for drip irrigation were estimated based on one hour of irrigator labor per four hours of irrigation. Total irrigation hours were estimated based on seasonal water needs and an effective application rate based on a 1,000 gpm pump. Increased supervision and coordination requirements were estimated - along with the cost of an irrigation scheduling consultant due to the importance of crop water use estimation - to effectively operate pressurized irrigation systems to save water. Operations cost estimates for drip irrigation are detailed in Attachment 13.

Operations costs for sprinkle irrigation were estimated based on one hour of irrigator labor per three hours of irrigation. Total irrigation hours were estimated based on seasonal water needs and an effective application rate based on a 2,000 gpm pump. Additionally, three irrigator-hours per acre were included for system setup and retrieval. Increased supervision and coordination requirements were estimated along with the cost of an irrigation scheduling consultant due to the importance of crop water use estimation to effectively operate pressurized irrigation systems to save water. Operations cost estimates for sprinkle irrigation are detailed in Attachment 14.

Operations costs for center pivot irrigation were estimated based on one hour of irrigator labor per 40 hours of irrigation. Total irrigation hours were estimated based on seasonal water needs and an effective application rate based on a 1,200 gpm pump. Increased supervision and coordination requirements were estimated along with the cost of an irrigation-scheduling consultant due to the importance of crop water use estimation to effectively operate pressurized

irrigation systems to save water. Operations cost estimates for center-pivot irrigation are detailed in Attachment 15.

Operations cost functions for each crop type are summarized in Table 14 and Figure 6. Note that all but one of the incremental "per field" costs listed in Table 14 are negative. This is because of the lower labor requirements associated with pressurized irrigation relative to surface irrigation. However, the incremental "per acre" costs are very large, so that incremental operations costs for pressurized irrigation are greater than for surface irrigation, except for very small fields.

Table 14.a. Operations Cost Functions for Drip Irrigation

	Seasonal Operations Cost	
Crop	per Field	per Acre
Alfalfa, Flat	-$1,822.45	$250.78
Alfalfa, Row	-$2,106.10	$250.78
Bermuda	-$2,057.55	$263.12
Field Crops, Flat	-$557.50	$165.77
Field Crops, Row	-$1,505.05	$165.77
Sugar Beets	-$2,563.00	$193.67
Truck Crops	-$1,754.45	$127.42
Wheat	-$281.50	$104.39

Table 14.b. Operations Cost Functions for Sprinkle Irrigation

	Seasonal Operations Cost			
	1000 gpm pump		2000 gpm pump	
Crop	per Field	per Acre	per Field	per Acre
Alfalfa, Flat	-$2,113.75	$756.51	-$2,113.75	$634.82
Alfalfa, Row	-$2,397.40	$756.51	-$2,397.40	$634.82
Bermuda	-$2,348.85	$791.95	-$2,348.85	$664.28
Field Crops, Flat	-$751.70	$512.37	-$751.70	$431.93
Field Crops, Row	-$1,754.45	$512.37	-$1,754.45	$431.93
Sugar Beets	-$2,874.75	$592.49	-$2,874.75	$498.51
Truck Crops	-$1,941.50	$402.23	-$1,941.50	$340.40
Wheat	-$427.15	$336.09	-$427.15	$285.43

Table 14.c. Operations Cost Functions for Center-Pivot Irrigation

Crop	Seasonal Operations Cost	
	per Field	per Acre
Alfalfa, Flat	-$893.74	$197.49
Alfalfa, Row	-$1,177.39	$197.49
Bermuda	-$1,067.97	$207.21
Field Crops, Flat	$69.20	$130.54
Field Crops, Row	-$840.40	$130.54
Sugar Beets	-$1,799.45	$152.51
Truck Crops	-$1,249.90	$100.34
Wheat	$90.54	$82.21

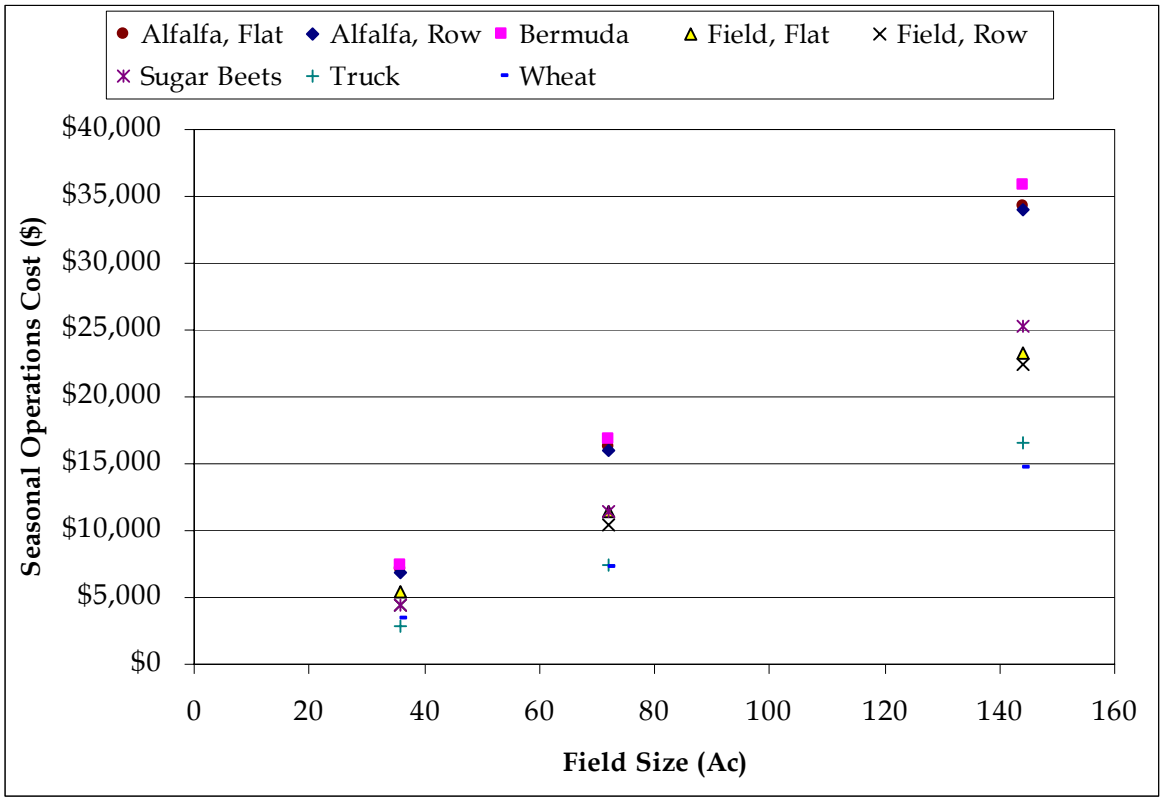

Figure 6.a. Operations Cost Functions for Drip Irrigation

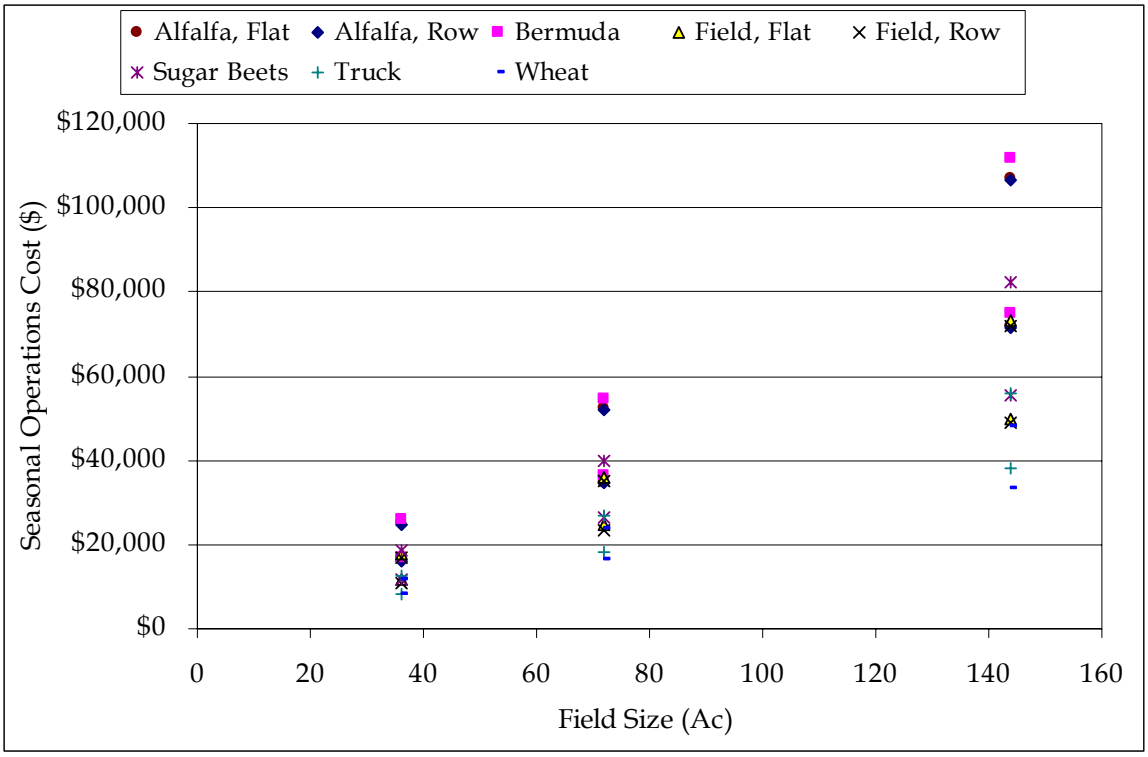

Figure 6.b. Operations Cost Functions for Sprinkle Irrigation

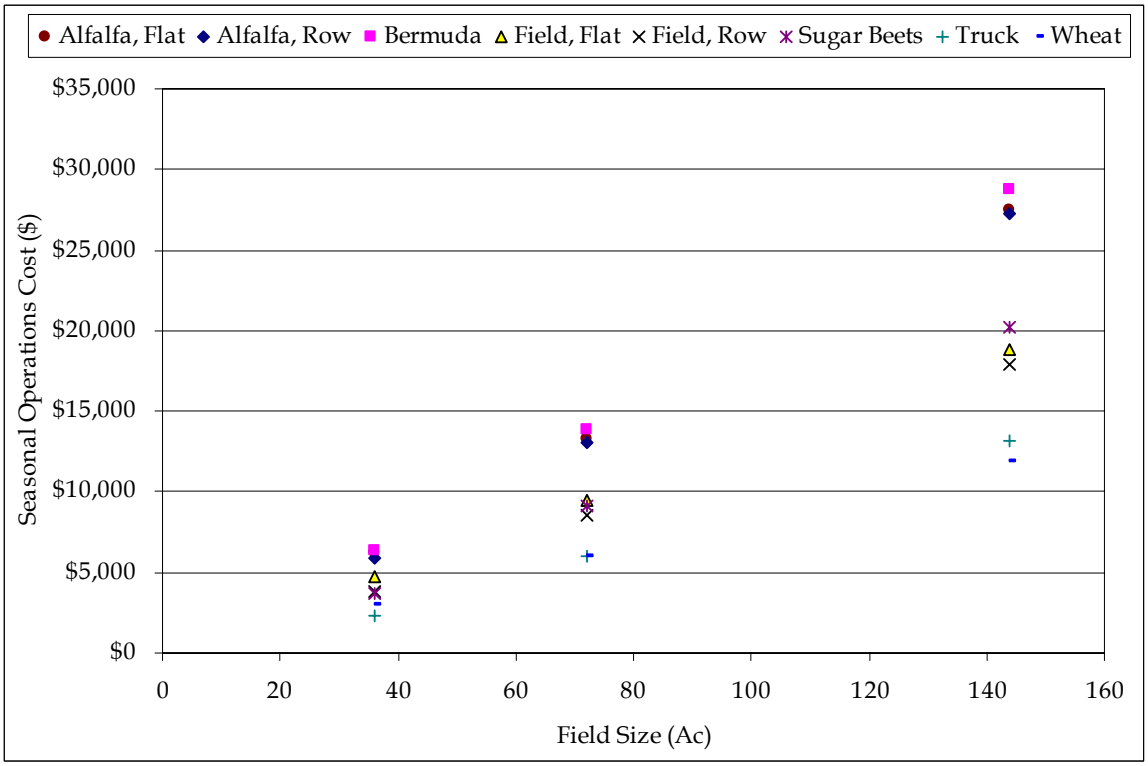

Figure 6.c. Operations Cost Functions for Center-Pivot Irrigation

6.2.2.3. Additional Costs and Benefits

Additional costs and benefits of pressurized irrigation include the cost of lost yields in cropped areas lost to reservoir construction, benefits of increased yields due to improved crop quality and uniformity, and fertilizer savings due to reduced losses.

Reductions in cropped area for drip, sprinkle, and center pivot systems (with cropped corners) with reservoirs were estimated to be 1 percent. The resulting decrease in returns net of harvest costs was calculated in the Demand Generator as described in Appendix 3.f. The decrease in variable production costs was estimated based on Imperial Valley Cooperative Extension crop budgets.

For CMs with an estimated change in marketable yields without a change in crop ET, a percent change in yield was estimated and used to calculate a seasonal change in returns, net of harvest costs, based on agricultural commissioner crop reports. Yield increases are expected for drip and sprinkle irrigation due to improved crop uniformity and quality. Potential yield increases were estimated empirically to be 10 percent based on historical drip and sprinkle adoption rates in the Imperial Valley as described in Attachment 5.

Fertilizer cost savings for pressurized irrigation were calculated as described previously based on average water savings and fertilizer costs.

The estimated additional costs and benefits of pressurized irrigation are summarized in Table 15.

Table 15. Additional Costs and Benefits of Pressurized Irrigation

System Type	Reservoir Present?	Seasonal Additional Costs and Benefits ($/ac)								
		Fertilizer Savings			Yield Increase			Other Production Cost Savings		
Drip	No	$4.07	to	$21.58	$31.81	to	$184.46	$0.00	to	$0.00
	Yes	$0.46	to	$23.06	$0.00	to	$184.46	$0.61	to	$4.07
Sprinkle	No	$2.33	to	$12.85	$31.81	to	$184.46	$0.00	to	$154.75
	Yes	$0.46	to	$14.41	$0.00	to	$184.46	$0.61	to	$158.82
Center-Pivot, Cropped Corners	Yes	$1.08	to	$35.01	$0.00	to	$184.46	$0.61	to	$158.82
Center-Pivot, Non-Cropped Corners	Yes	$0.46	to	$24.73	$0.00	to	$149.88	$11.41	to	$202.13

6.3. Level Basin Irrigation (LVL)

Level basin irrigation is a form of surface irrigation in which zero-grade or nearly zero-grade basins are formed and irrigated so that little if any of the applied water runs off of the field. Relatively large flow rates are required to achieve high uniformity and irrigation efficiency.

Designs and cost estimates were developed for various configurations of level basins in order to evaluate cost-effective basin designs for the Imperial Valley. Cost estimates were combined with water savings estimates to identify cost effective basin configurations from a water savings

perspective. Basin configurations evaluated are listed in Table 16. Ultimately, it was found that 660′ x 220′ basins appear to be the most suited to the Imperial Valley, in general, however, in practice field specific designs are needed prior to selecting basin configuration for individual fields.

Table 16. Level Basin Physical Configurations

Basin Size (L X W)	Field Sizes (Ac)
330' x 330'	36, 72, 144
440' x 220'	72, 144
440' x 330'	72, 144
440' x 440'	72, 144
660' x 220'	36, 72, 144
660' x 330'	36, 72, 144
660' x 440'	36, 72, 144

In addition to the physical configurations of level basin systems, two operational strategies were considered. The first, normal delivery, evaluated the operation of level basin within a delivery schedule defined by 12-hour intervals (e.g., 12-, 24-, or 48-hours), depending upon field size. The second operational strategy, flexible delivery, evaluated the operation of level basins with a flexible shutoff. For cost estimation purposes, delivery durations were estimated for deliveries in multiples of 10 hours (e.g., 10, 20, or 40 hours), depending upon field size.

6.3.1. Applicability

Level basin irrigation is generally applicable across the full range of crops but is best suited to light soils. Level basin has been limited to conservation families with light soils.

6.3.2. Net On-Farm Implementation Costs

6.3.2.1. Capital and Maintenance Costs

Capital components of level basin systems include leveling (regrading) of the field surface, removal of existing head ditches and installation of new head ditches as needed, and installation of ditch outlets to provide water to each basin and drop box structures to allow for drainage of excess water. Ideally, level basin systems do not require drop boxes as no tailwater is produced; however, experiences in the Imperial Valley with level basin have demonstrated the need to provide a means of removing excess water to prevent crop damage and washout. For each physical configuration of level basin, a detailed feasibility-level budget was developed to estimate the total and annual capital cost and the annual maintenance cost (Attachment 16).

Continuous functions of capital and maintenance cost per field and per acre were developed from the detailed level basin cost estimates using a log regression. For each physical configuration (across all three field sizes), the log cost curve was split into three components based on field size. Then, within each field size region, a linear regression was performed to generate a field-size specific estimate of annual capital and maintenance costs. The resulting functions are summarized in Table 17 and Figure 7.

Table 17. Annual Capital and Maintenance Cost Functions for LVL

Basin Size (L X W)	Annual Capital and Maintenance Cost Parameters by Field Size Class					
	36 - 53 ac		54 - 107 ac		108 - 200 ac	
	per Field	per Acre	per Field	per Acre	per Field	per Acre
330X330	$244.48	$337.56	$8,330.75	$197.30	$18,494.35	$102.33
440X220	-	-	-$4,901.03	$345.20	$12,881.37	$179.04
440X330	-	-	-$3,976.54	$296.61	$11,302.94	$153.84
440X440	-	-	-$3,508.41	$271.76	$10,490.63	$140.95
660X220	-$4,997.26	$327.27	$2,842.45	$191.28	$12,696.16	$99.21
660X330	-$4,519.98	$300.07	$2,668.28	$175.39	$11,703.18	$90.97
660X440	-$3,685.57	$259.67	$2,534.93	$151.78	$10,353.45	$78.72

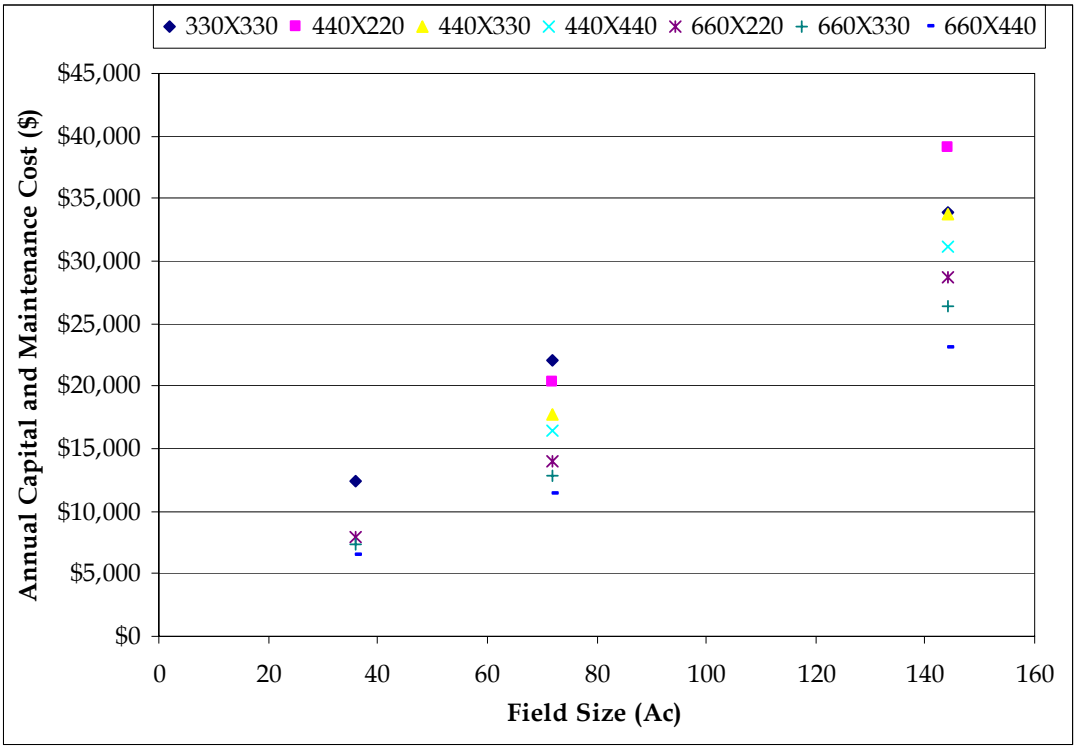

Figure 7. Annual Capital and Maintenance Cost Functions for LVL

6.3.2.2. Operations Costs

Operations costs for level basin irrigation with normal delivery were estimated based on irrigation duration of 12, 24, and 48 hours for 36, 72, and 144-acre fields, respectively. For flexible delivery, irrigation duration was estimated to be 10, 20, or 40 hours for the different field sizes. Event durations were used to estimate irrigator labor requirements and costs. Additionally, foreman and manager labor are expected to increase due to increased supervision and coordination requirements. The cost of an irrigation scheduling consultant was included to account for the need to monitor soil moisture and crop water use to effectively plan irrigation events under level basin irrigation.

Detailed operational cost estimates are provided in Attachment 16. Resulting operations cost functions by crop type are provided in Table 18 and Figure 8.

Table 18. Operations Cost Functions by Crop Type for LVL

	Normal Delivery		Flexible Delivery	
Crop Type	per Field	per Acre	per Field	per Acre
Alfalfa, Flat	-$2,042.25	$60.50	-$2,042.25	$50.42
Alfalfa, Row	-$2,256.40	$64.53	-$2,256.40	$53.78
Bermuda	-$2,256.40	$64.53	-$2,256.40	$53.78
Field Crops, Flat	-$757.35	$36.30	-$757.35	$30.25
Field Crops, Row	-$1,815.30	$36.30	-$1,815.30	$30.25
Sugar Beets	-$2,810.40	$48.40	-$2,810.40	$40.33
Truck Crops	-$1,815.30	$36.30	-$1,815.30	$30.25
Wheat	-$329.05	$28.23	-$329.05	$23.53

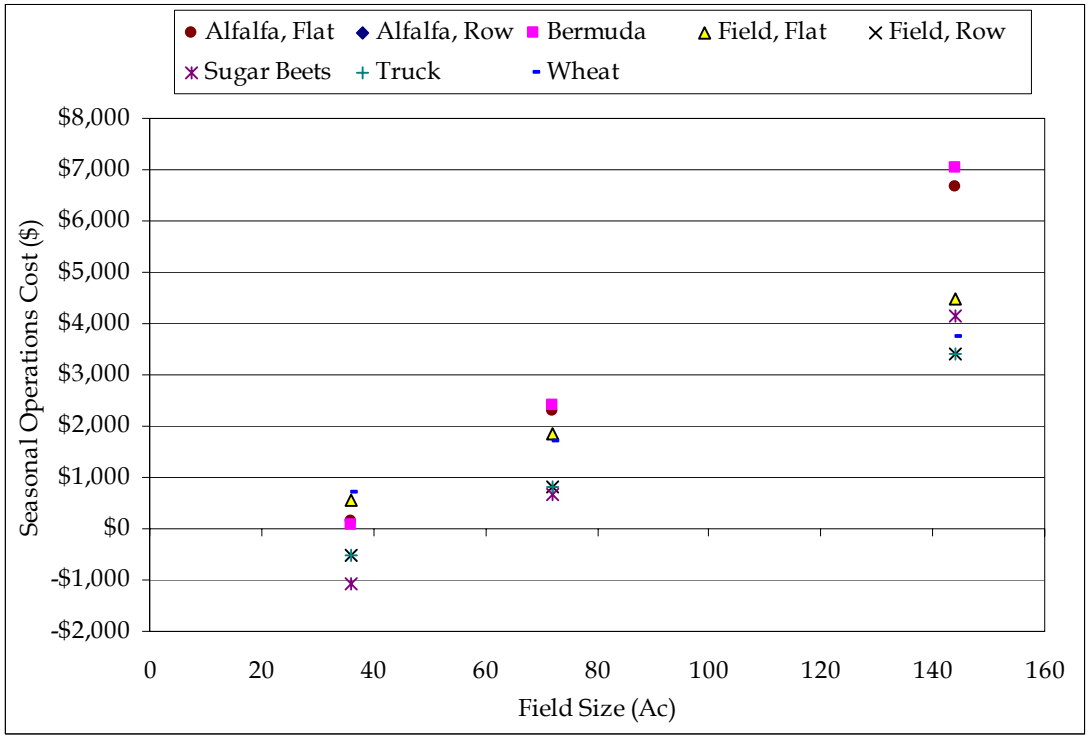

Figure 8.a. Operations Costs by Crop Type and Field Size for LVL, Normal Delivery

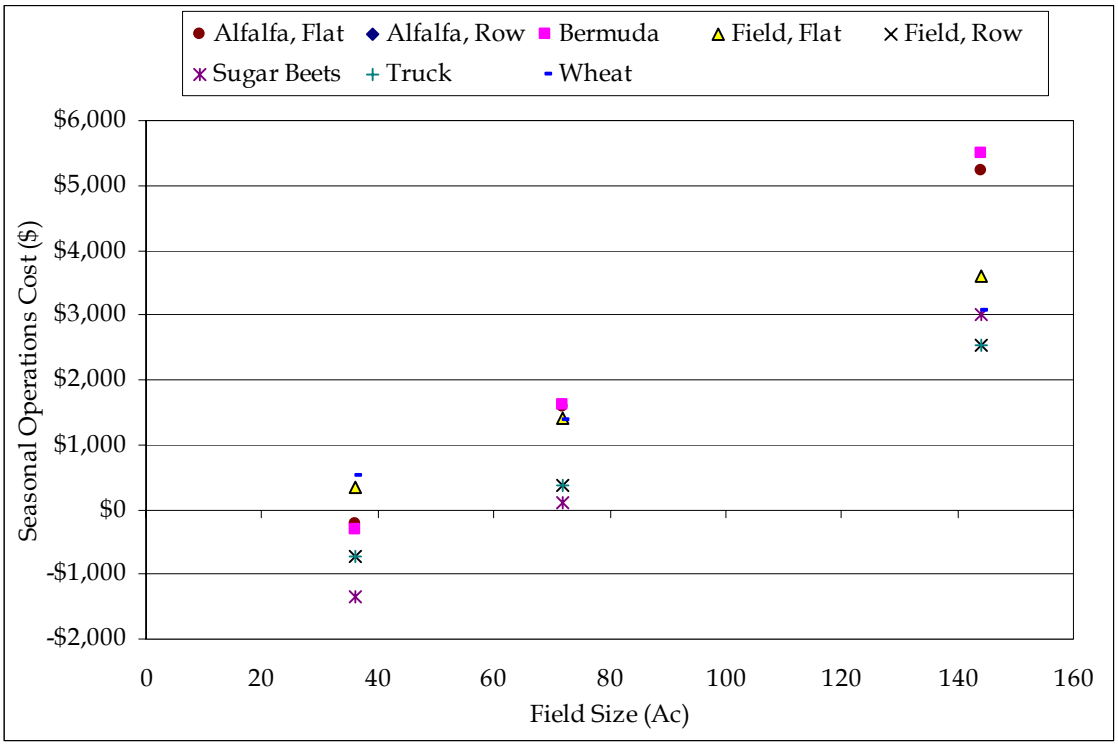

Figure 8.b. Operations Costs by Crop Type and Field Size for LVL, Flexible Delivery

6.3.2.3. Additional Costs and Benefits

Fertilizer savings were estimated based on typical water savings, estimated as described in Appendix 2.e. For LVL, fertilizer savings were estimated to range between $2.17 and $24.97 per acre for a typical season.

Attachment 1
Potential Efficiency Conservation Measures

Introduction

The Definite Plan Team interviewed the managers of a number of IID farming enterprises. The enterprises ranged in size from 600 to approximately 20,000 acres, and ownership patterns ranged from wholly owned to wholly leased enterprises. The Interview Team developed a systematic methodology of organizing the information gained from the interviews, but used a conversational means for engaging the person being interviewed. While the interviews were not formally structured, care was taken to cover a carefully laid out set of topics and subtopics, one of which was their opinions of what conservation efficiency measures would be appropriate for their establishments. The interviews took from two to four hours, with most lasting about three hours and included visits to fields with the manager and observations of the farming enterprise and existing measures implemented to conserve water.

Water Conservation Efficiency Measures

The water conservation efficiency measures that the various managers were using, had used, or thought could be applicable are listed in the following table for the different irrigation application methods.

Table 1. Water Conservation Efficiency Measures for the Different Irrigation Application Methods.

Management Practices that Prevent or Reduce Losses on a Single Field

	Compatible Irrigation Methods			
Name of Practice	**Row**	**Flat**	**Micro**	**Sprinkle**
Scientific irrigation scheduling and event management	✓	✓	✓	✓
Advance uniformity management	✓	✓	*NA*	*NA*
Cutback irrigation	✓	✓	*NA*	*NA*
Furrow dams and end blocking	✓	✓	*NA*	*NA*
Reduced border width	*NA*	✓	*NA*	*NA*
Mulch planting	*NA*	✓	*NA*	*NA*
Soil amendments	✓	✓	✓	✓
Improved pressurized system maintenance	*NA*	*NA*	✓	✓

Physical Improvements that Prevent or Reduce Losses on a Single Field

Name of Practice	Compatible Irrigation Methods			
	Row	Flat	Micro	Sprinkle
Improved grade design	✓	✓	*NA*	*NA*
Precision land leveling	✓	✓	*NA*	*NA*
Reduced run length	✓	✓	*NA*	*NA*
Sprinkler germination	✓	✓	✓	*NA*
Sprinkler irrigation	✓	✓	*NA*	*NA*
Micro irrigation	✓	✓	*NA*	*NA*
On-farm reservoirs	✓	✓	✓	✓
Head ditch lining	✓	✓	*NA*	*NA*
Downstream farm delivery gate control	✓	✓	✓	✓
Gated pipe	✓	*NA*	*NA*	*NA*
Improved pressurized system design	*NA*	*NA*	✓	✓

Physical Improvements that Recover Losses on One or More Fields

Name of Practice	Compatible Irrigation Methods			
	Row	Flat	Micro	Sprinkle
Tailwater recovery systems with reservoirs	✓	✓	*NA*	*NA*
Tailwater recovery systems without reservoirs	✓	✓	*NA*	*NA*
Cascading between fields	✓	✓	*NA*	*NA*
Tile and drain water reuse	✓	✓	✓	✓

✓ = *Applicable*

NA = Not Applicable

Glossary of Water Conservation Measures

The water conservations measures listed in Table 1 are described below. The measures are divided into categories related to: recovery, reduction and elimination of surface irrigation tailwater; reducing overall system losses; and facilitating on-farm water management for both surface and pressurized irrigation systems.

Management Practices that Prevent or Reduce Losses

1. *Scientific Irrigation Scheduling.* This is quantifying the timing and amount of irrigation applications based on a combination of weather data from CIMIS stations, field moisture sampling, crop physiology, and irrigation methods. Scientific irrigation scheduling can result in improved efficiency for: i) surface irrigation by eliminating one or more irrigation events, and adjusting the depth of water applied based on distribution uniformity and soil moisture deficit; and ii) for sprinkle and drip irrigation by adjusting the timing and amount of irrigation to replace the soil moisture deficit.
    a. *Commercial Scheduling Service.* This is a service that is typically based on a per acre charge by field and involves the service provider's field technicians periodically (typically weekly) visiting each field to measure the soil moisture status. The cost is dependent on the scope of services provided and the crop.
    b. *Customized grower managed irrigation scheduling service.* This includes a user-friendly customized (for the specific farm and its fields) computer package and a

personalized training program with follow-up consulting services on an as needed basis.

2. *Scientific event management.* This is the practice of scientifically selecting appropriate inflow rates and cutoff times for surface irrigation to provide adequate and uniform infiltration while minimizing the amount of tailwater produced. The practice involves making observations in advance of and during the initial set of a surface irrigation event, determining the optimum inflow rate and cutoff time for the event, and making necessary adjustments to the inflow rates and cutoff times for subsequent sets. Additionally, the impact on the delivery order is assessed and adjustments are made to the ordered rate, duration, or both. This practice reduces tailwater by allowing the irrigator to increase the uniformity of intake opportunity times (by matching the advance to the recession) and to select the intake opportunity time that provides the targeted infiltration.
    a. *Low-flow irrigation.* This is the practice of using low flows into either furrows or borders to slow down the advance rate to get good water penetration with a minimum of tailwater by providing increased intake opportunity time and increased irrigator control. Low-flow irrigation is most effective on heavy soils where the intake rate declines to near zero following wetting.
    b. *Cutoff irrigation.* This is the practice of cutting the inflow for border or furrow irrigation to zero before the advancing front reaches the end of the field. Cutoff time is selected based on advance and infiltration characteristics to reduce tailwater.
    c. *Water advance signal devices.* These are devices that signal when the surface water flow reaches a certain point. One such device is the Water Buster, which is made by a local entrepreneur, Mark Hamby – Tel number 344-6777.
3. *Advance uniformity management.* Assorted management practices and minor physical improvements that increase the uniformity of advance among furrows or within borders in an irrigation set, thereby reducing the amount of time water must run for the set to finish.
    a. *Headlands layout.* There are number of different ways with significant differences to handle headlands and supplying water to borders and furrows. Some of them result in less water losses than others. The key characteristic of headlands that influences irrigation performance is the ability to achieve uniform advance by regulating flow into individual borders (lands) and furrows. For border-irrigation (without corrugations), a key consideration is the ability to uniformly distribute water across the border. For furrow irrigation, a key consideration is the ability to distribute water in a variable manner to individual rows to generate uniform advance rates for all of the furrows in the irrigation set.
    b. *Spile caps.* One grower has developed a novel form of flow regulation for spiles (row tubes) to replace tablitas. Plastic caps that fit over the furrow tubes have been made with varying diameter holes in them. The caps can be removed or swapped out to regulate flow consistently. The spile caps with different sized holes are color-coded for easy recognition. The caps provide a means of standardizing the regulation of spile flow, potentially increasing irrigator control and advance uniformity.
    c. *Borders with cross berms.* Cross berms may be used to increase advance uniformity for border-irrigated fields (without furrows) with sideslope between borders. Cross berms are constructed to extend from the borders and run perpendicular

to the main fall. However, cross berms may cause problems if the tractor runs into them, possibly damaging the tractor and jeopardizing the operator.

d. *Reducing border widths.* For flat irrigation, narrower borders may provide increased advance uniformity and control. Increased advance uniformity reduces tailwater by reducing the time required for ponding to occur across the border at the cutoff point. Increased control allows the irrigator to more accurately assess the proper cutoff time and to make small adjustments to achieve uniform advance between borders.

4. *Cutback irrigation.* This is the practice of reducing the inflow for border or furrow irrigation to a reduced inflow rate once the advancing front reaches the end of the field. The cutback rate is selected based on infiltration characteristics to reduce tailwater.
5. *Temporary furrow end dams.* This is the practice of using plastic or paper dams at the ends of furrows to back up water to increase intake opportunity time relative to the amount of tailwater produced.
6. *Mulch planting.* The practice of avoiding an irrigation event by planting when the soil moisture is sufficient to germinate the crop. Typically used for wheat.
7. *Soil amendments.* Soil amendments are used to improve soil structure, improving tilth and increasing infiltration. By increasing infiltration, the amount of intake opportunity time required to replenish the soil moisture deficit and provide leaching is reduced, potentially reducing tailwater.
    a. *Chemical and mineral.* This is the practice of applying sulfur, gypsum, or products like polyacrylamide (PAM) to improve infiltration and consequently leaching, especially when applied to the 3rd & 4th – 5th zones in a field.
    b. *Inoculants.* These are dry or liquid preparations of one or more species of microorganism used to: inoculate plants with symbiotic organisms or the soil with desirable organisms, and those that are used as "cover crops" of algae. Martin Biochem is one of the inoculants used by some IID farmers. It costs about $50 to $70/ac/year and is applied to fields during irrigation to improve soil health, infiltration, and plant water uptake. Based on the experience of one Bermuda grass farmer, it improves production and may save as much as one acre-foot of water per acre. This product is distributed locally by Dean Wells, 801-7957 (Cell) 356-5481 (Home).
8. *Improved pressurized system maintenance.* Routine maintenance of a pressurized irrigation system to prevent and repair clogging, pressure imbalance, leaks, and other problems, resulting in increased distribution uniformity.

Physical Improvements that Prevent or Reduce Losses

1. *Reducing main slope.* This is done for row or flat irrigation by either field grading or running rows or borders more nearly on the contour to reduce the slope in the direction of the water flow to between 0.05 and 0.1 percent so there is ample time for water penetration in the 3rd & 4th – 5th zones in a field. (This is the area between approximately 40 percent and 80 percent of the distance from the head to the tail where the least infiltration occurs for graded border or furrow irrigation with blocked or partially blocked ends.)
2. *Precision land leveling.*
    a. *Side slopes.* Many fields in the IID have been precision leveled, but there are considerable differences in the handling of main slopes and side slopes. For flat irrigation on the heavier soils that are not suitable for vegetable crops, it seems

best to have zero side slope and to try to hold the main border slope to less that 0.3 percent. For soils that are suitable for vegetables, side slope should not be eliminated because the best row direction for some vegetable crops is north-south and others east-west.

b. *Touch-up.* Due to erosion and other factors, fields become out-of-level and should be re-leveled from time to time in order to maintain the ability to irrigate them efficiently. Depending on the cropping program and soils, this may be necessary every 5 to 10 years.

c. *Two-dimensional borders.* This is the practice of laying out the borders for a flat crop that is not sensitive to having water stand on the surface for a day (like Bermuda grass). The ends of the borders are laid out so the tailwater from the borders on the upper side of the field runs crosswise to irrigate the lower ends of the downslope borders.

3. *Reducing run lengths.* This involves cutting the furrow or border run length in half or in thirds, i.e. from half- to quarter-mile runs.
4. *Level basins.* This is the practice of leveling the land so there is no side slope and little or no slope in the direction of flow so all of the water diverted to a basin is infiltrated following each irrigation application. It may be necessary to provide a drainage outlet, particularly on heavy soils with crops like alfalfa that will scald if water is left standing at the ends of the boarders.
5. *Sprinkle irrigation:*
    a. *For leaching.* This is the practice of periodically using portable solid set sprinkle irrigation to leach the accumulated salts from a surface irrigated field.
    d. *For germination.* This is the practice of using portable solid set sprinkle irrigation instead of the surface irrigation system to germinate a new crop.
    e. *For full irrigation.* This is the practice of using sprinkle irrigation throughout the entire crop-growing season. The types of sprinkle irrigation that may be appropriate for various site conditions in IID include:
        i. *Fixed and portable solid set.* These are sprinkles that are closely spaced along portable or buried lateral lines. Because of the need for periodic ripping of most soils in IID, fixed lateral systems are not appropriate.
        ii. *Linear-move.* These are continuously moving sprinkle lateral lines that are either supplied from a ditch and have moving power units or are supplied from a flexible hose that is attached to fixed pressurized supply line.
        iii. *Center-pivot.* These are continuously moving sprinkle laterals that pivot around a fixed supply point to irrigate a circular field. They can be equipped with what is called a corner system so they can irrigate a field that is like a square with rounded corners rather than a circle.
6. *Micro irrigation:*
    b. *Permanent systems*. These are systems with either drip emitters or micro sprayers that have either buried or above ground tubing that stays round when empty.
    c. *Surface drip tape.* These are systems that have closely spaced emitters in thin-wall lay-flat tubing that may be laid on the surface or buried a few inches deep. The tubing is recovered after each crop and may be reused for as many as 3 to 5 seasons.

d. *Subsurface drip*. These are systems that have closely spaced emitters in thin-wall lay flat tubing that is buried 10- to 18-inches below the surface. These systems may be used over multiple cropping seasons.

7. *On-farm reservoirs.* On-farm reservoirs with a capacity of a few acre-feet provide a means for irrigators to compensate for lack of consistency in delivered flows and delivery unsteadiness. They can be used to make small flow adjustments during deliveries and for finish heads when the length of the delivery is not adequate to finish an irrigation cycle. On-farm reservoirs can help irrigators overcome delivery shortcomings and improve application efficiency.
8. *Head ditch lining.* Lining a head ditch with concrete to reduce seepage, weed growth, and leakage while increasing irrigator control.
9. *Downstream farm delivery gate control.* The amount of backpressure on a typical undershot delivery gate can be controlled with a check structure downstream from the farm delivery gate. Irrigators can use this to adjust for delivery unsteadiness resulting from changing water levels in the farm head ditch and the consequent back-pressure on the head gate.
10. *Gated pipe.* While gated pipe is not generally used to save water, it eliminates the ponds at the heads of furrows and borders. The headlands are watered but do not produce a crop. If this space is 24-feet wide for a quarter mile run, the resulting water loss of 24/1200 = 2 percent.
11. *Improved pressurized system design.* Micro or sprinkle irrigation system is designed to equalize pressures throughout the field and to facilitate maintenance, increasing distribution uniformity and system life.

Physical Improvements that Recover Losses

1. *TRS with reservoir*. These are Tailwater Recovery System (TRS) with a fixed pump location and a reservoir to store more than one acre-foot of tailwater. These systems may serve a dual function as a TRS and an on-farm reservoir.
2. *TRS without reservoir*. These are TRSs with portable or fixed pumps and little or no tailwater storage reservoir.
3. *Cascading between fields.* This is the practice of using gravity flow to convey the tailwater from an upper field to irrigate a lower field.
4. *Irrigation with tile and drain water.* This is the practice of using water from sumps or IID drains to irrigate a crop. This practice could be used on some soils for some crops where the quality of drainage water does not jeopardize the field itself or crop production due to salinity, pesticide, health and safety, or other concerns.

Attachment 2
Conservation Measure Compatibility with Conservation Families

Matrices of compatibility between representative conservation measures and conservation families have been developed for each category of conservation measures (Tables 1, 2, 3). Conservation measures are considered compatible that would generally lead to performance improvements if managed to conserve water.

Table 1. Compatibility of Management Practices that Reduce Losses.

Family	Irrigation Scheduling	Event Management	Advance Uniformity Management	Furrow Dams and End Blocking	Improved Pressurized System Maintenance
D H T	✓	*NA*	*NA*	*NA*	✓
D H Tr	✓	*NA*	*NA*	*NA*	✓
D HC T	✓	*NA*	*NA*	*NA*	✓
D HC Tr	✓	*NA*	*NA*	*NA*	✓
D L T	✓	*NA*	*NA*	*NA*	✓
D L Tr	✓	*NA*	*NA*	*NA*	✓
F H A	✓	✓	✓	✓	*NA*
F H B	✓	✓	✓	✓	*NA*
F H L	✓	✓	✓	✓	*NA*
F H S	✓	✓	✓	✓	*NA*
F H Tr	✓	✓	✓	✓	*NA*
F H W	✓	✓	✓	✓	*NA*
F HC A	✓	✓	✓	✓	*NA*
F HC B	✓	✓	✓	✓	*NA*
F HC L	✓	✓	✓	✓	*NA*
F HC S	✓	✓	✓	✓	*NA*
F HC Tr	✓	✓	✓	✓	*NA*
F HC W	✓	✓	✓	✓	*NA*
F L A	✓	✓	✓	✓	*NA*
F L B	✓	✓	✓	✓	*NA*
F L L	✓	✓	✓	✓	*NA*
F L S	✓	✓	✓	✓	*NA*
F L Tr	✓	✓	✓	✓	*NA*
F L W	✓	✓	✓	✓	*NA*
R H A	✓	✓	✓	✓	*NA*
R H L	✓	✓	✓	✓	*NA*
R H SB	✓	✓	✓	✓	*NA*
R H T	✓	✓	✓	✓	*NA*
R HC A	✓	✓	✓	✓	*NA*
R HC L	✓	✓	✓	✓	*NA*
R HC SB	✓	✓	✓	✓	*NA*
R HC T	✓	✓	✓	✓	*NA*
R L A	✓	✓	✓	✓	*NA*
R L L	✓	✓	✓	✓	*NA*
R L SB	✓	✓	✓	✓	*NA*
R L T	✓	✓	✓	✓	*NA*
S H T	✓	*NA*	*NA*	*NA*	✓
S HC T	✓	*NA*	*NA*	*NA*	✓
S L T	✓	*NA*	*NA*	*NA*	✓
S H L	✓	*NA*	*NA*	*NA*	✓
S HC L	✓	*NA*	*NA*	*NA*	✓
S L L	✓	*NA*	*NA*	*NA*	✓

Table 2. Compatibility of Physical Improvements that Reduce Losses.

Family	Improved Grade Design	Precision Land Leveling	Reduced Run Length	Sprinkler Germination	Sprinkler Irrigation	Micro Irrigation	Level Basin Irrigation	On-Farm Reservoirs	Gated Pipe	Improved Pressurized System Design
D H T	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
D H Tr	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
D HC T	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
D HC Tr	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
D L T	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
D L Tr	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
F H A	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F H B	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F H L	✓	✓	✓	*NA*	✓	*NA*	✓	✓	✓	*NA*
F H S	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F H Tr	✓	✓	✓	*NA*	*NA*	*NA*	✓	✓	✓	*NA*
F H W	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F HC A	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F HC B	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F HC L	✓	✓	✓	*NA*	✓	*NA*	✓	✓	✓	*NA*
F HC S	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F HC Tr	✓	✓	✓	*NA*	*NA*	✓	✓	✓	✓	*NA*
F HC W	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F L A	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F L B	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F L L	✓	✓	✓	*NA*	✓	*NA*	✓	✓	✓	*NA*
F L S	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
F L Tr	✓	✓	✓	*NA*	*NA*	✓	✓	✓	✓	*NA*
F L W	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
R H A	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
R H L	✓	✓	✓	*NA*	✓	*NA*	✓	✓	✓	*NA*
R H SB	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
R H T	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
R HC A	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
R HC L	✓	✓	✓	*NA*	✓	*NA*	✓	✓	✓	*NA*
R HC SB	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
R HC T	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
R L A	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
R L L	✓	✓	✓	*NA*	✓	*NA*	✓	✓	✓	*NA*
R L SB	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
R L T	✓	✓	✓	✓	✓	✓	✓	✓	✓	*NA*
S H T	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
S HC T	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
S L T	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
S H L	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
S HC L	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓
S L L	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	✓	*NA*	✓

Table 3. Compatibility of Physical Improvements that Recover Losses.

Family	Tailwater Recovery with Storage	Tailwater Recovery Systems without Storage	Cascading Between Fields	Tile and Drain Water Reuse
D H T	*NA*	*NA*	*NA*	✓
D H Tr	*NA*	*NA*	*NA*	✓
D HC T	*NA*	*NA*	*NA*	✓
D HC Tr	*NA*	*NA*	*NA*	✓
D L T	*NA*	*NA*	*NA*	✓
D L Tr	*NA*	*NA*	*NA*	✓
F H A	✓	✓	✓	✓
F H B	✓	✓	✓	✓
F H L	✓	✓	✓	✓
F H S	✓	✓	✓	✓
F H Tr	✓	✓	✓	✓
F H W	✓	✓	✓	✓
F HC A	✓	✓	✓	✓
F HC B	✓	✓	✓	✓
F HC L	✓	✓	✓	✓
F HC S	✓	✓	✓	✓
F HC Tr	✓	✓	✓	✓
F HC W	✓	✓	✓	✓
F L A	✓	✓	✓	✓
F L B	✓	✓	✓	✓
F L L	✓	✓	✓	✓
F L S	✓	✓	✓	✓
F L Tr	✓	✓	✓	✓
F L W	✓	✓	✓	✓
R H A	✓	✓	✓	✓
R H L	✓	✓	✓	✓
R H SB	✓	✓	✓	✓
R H T	✓	✓	✓	✓
R HC A	✓	✓	✓	✓
R HC L	✓	✓	✓	✓
R HC SB	✓	✓	✓	✓
R HC T	✓	✓	✓	✓
R L A	✓	✓	✓	✓
R L L	✓	✓	✓	✓
R L SB	✓	✓	✓	✓
R L T	✓	✓	✓	✓
S H T	*NA*	*NA*	*NA*	*NA*
S HC T	*NA*	*NA*	*NA*	*NA*
S L T	*NA*	*NA*	*NA*	*NA*
S H L	*NA*	*NA*	*NA*	*NA*
S HC L	*NA*	*NA*	*NA*	*NA*
S L L	*NA*	*NA*	*NA*	*NA*

Attachment 3
Unit Costs, Useful Lives, and Maintenance Cost Estimates for On-Farm Cost Items

Cost Category[A]	Cost Item[B]	Description[C]	Unit Cost					Life (years)			
			Src. 1[D]	Src. 2[E]	Src. 3[F]	Estimate[G]	Unit[H]	Src. 1[I]	Src. 2[J]	Estimate[K]	Maint.[L]
Earthwork	Land Grading	Regrading to modify field slope.	$ 1.30	$ 1.05		**$ 1.20**	cut yd^3	50		**50**	**0%**
Earthwork	Laser Levelling	Laser leveling to smooth a field without changing grade.	$ 75.00	$ 75.00		**$ 75.00**	acre	3		**3**	**0%**
Earthwork	Excavation	Excavation of reservoirs and reverse grade ditches.	$ 5.50	$ 3.86	$ 4.75	**$ 4.70**	cut yd^3	50		**50**	**1%**
Surface Irrigation, General	Lined Head Ditch Removal	Removal of concrete head ditch including disposal or recycling of concrete sections.	$ 2.98	$ 2.72		**$ 2.90**	foot	50		**30**	**0%**
Surface Irrigation, General	New Lined Head Ditch Construction	Construction of lined head ditch including ditch pad, trenching, concrete lining, road crossings, drops, jack gates, and outlets. Typical size is 30" x 2' with 1 1/2" thick concrete.	$ 22.11	$ 18.20		**$ 20.20**	foot	50	50	**30**	**2%**
Surface Irrigation, General	New Lined Carry Ditch Construction	Construction of lined carry ditch including ditch pad, trenching, concrete lining, road crossings, drops, and outlets. Typical size is 30" x 2' with 1 1/2" thick concrete.	$ 17.41	$ 16.93		**$ 17.20**	foot	50	50	**30**	**2%**
Surface Irrigation, Level Basin	Level Basin Head Ditch	Construction of ditch pad, excavation, concrete lining, road crossings, drops, and jack gates for a 36" x 2' head ditch with 1 1/2" thick concrete. Basin turnouts not included.	$ 20.10			**$ 20.10**	foot	50	50	**30**	**2%**
Surface Irrigation, Level Basin	Level Basin Turnout Structure	Installation of concrete turnout structure for basin irrigation including jack gate and energy dissipation.	$ 2,000.00			**$ 2,000.00**	each	50	50	**30**	**2%**
Surface Irrigation, Tailwater Recovery	Diesel Pump, 30 HP, Portable	Purchase of trailer-mounted Diesel pumping plant designed for low-head tailwater recovery pumping applications. Includes engine, pump, trailer, fuel tank, hoses, and intake strainer.	$ 22,000.00			**$ 22,000.00**	each	20	10	**15**	**9%**
Surface Irrigation, Tailwater Recovery	Diesel Pump, 30 HP, Permanent	Purchase and installation of permanent Diesel pumping plant designed for low-head tailwater recovery pumping applications. Includes engine, pump, tank, concrete intake structure, trashrack, sump, plumbing, flow meter, and security enclosure.	$ 27,083.97			**$ 27,100.00**	each	20	10	**15**	**9%**
Surface Irrigation, Tailwater Recovery	Electric Pump, 20 HP	Purchase and installation of permanent electric pumping plant designed for low-head tailwater recovery pumping applications. Includes motor, pump, panel, and flow meter.	$ 17,123.61			**$ 17,100.00**	each	20	15	**20**	**5%**
Surface Irrigation, Tailwater Recovery	Permanent TRS Pumping Plant Structures	Materials and installation for pumping plant structure on permanent TRS including concrete intake structure, trash rack, sump, plumbing, and flow meter.	$ 14,966.09			**$ 15,000.00**	each	50		**50**	**2%**
Surface Irrigation, Tailwater Recovery	Secured Enclosure	Materials and installation for secured enclosure for TRS pumping station that uses Diesel power.	$ 6,293.70			**$ 6,300.00**	each	50		**50**	**2%**
Surface Irrigation, Tailwater Recovery	Tractor, 60 HP	Purchase of small tractor to drive PTO pump for tailwater recovery pumping applications.	$18,154.69	$ 25,000.00		**$ 25,000.00**	each	20	10	**15**	**9%**
Surface Irrigation, Tailwater Recovery	Tractor, 60 HP	Rental of small tractor to drive PTO pump for tailwater recovery pumping applications. (excluding fuel)	$ 40.00			**$ 40.00**	hr				
Surface Irrigation, Tailwater Recovery	PTO Driven Pump	Purchase of trailer-mounted PTO-driven pump for low-head tailwater recovery pumping applications.	$ 7,598.75	$ 7,553.00		**$ 7,580.00**	each	20	10	**15**	**6%**
Surface Irrigation, Tailwater Recovery	Pipeline, 10" Buried PVC	Purchase and installation of buried 10" Class 80 PIP return pipeline.	$ 8.50	$ 7.56	$ 7.64	**$ 7.90**	foot	50	30	**30**	**1%**
Surface Irrigation, Tailwater Recovery	Pipeline, 10" Surface Aluminum	Purchase of 10" Aluminum mainline.	$ 8.75	$ 11.91		**$ 10.30**	foot	15		**15**	**2%**
Surface Irrigation, Tailwater Recovery	Pipeline, 10" Surface PVC	Purchase of 10" UV-protected surface PVC mainline.	$ 12.22	$ 15.74		**$ 14.00**	foot	15		**15**	**2%**
Surface Irrigation, Tailwater Recovery	Pipeline, 12" Buried PVC	Purchase and installation of buried 12" Class 80 PIP return pipeline.	$ 11.15	$ 9.87	$ 9.35	**$ 10.10**	foot	50	30	**30**	**1%**
Surface Irrigation, Drainage	Drain or Cascade Box	Installation of concrete drain box, 3' wide x 5' deep with 14" opening and 12" concrete or plastic outlet pipe.	$ 3,400.00			**$ 3,400.00**	each	50	50	**30**	**2%**

Description of Columns

A. General category into which conservation measure component falls.
B. Name of conservation measure component.
C. Description of conservation measure component.
D to F. Unit cost of component from individual sources.
G. Unit cost of component proposed for planning.
H. Unit to which component cost applies.
I to J. Component economic life from individual sources.
K. Component economic life proposed for planning.
L. Annual maintenance cost expressed as a percentage of component unit cost (Not applicable to time-dependent costs).

Cost Category[A]	Cost Item[B]	Description[C]	Unit Cost					Life (years)			Maint.[L]
			Src. 1[D]	Src. 2[E]	Src. 3[F]	Estimate[G]	Unit[H]	Src. 1[I]	Src. 2[J]	Estimate[K]	
Surface Irrigation, Drainage	Drain or Cascade Box	Installation of concrete drain box, 3' wide x 5' deep with 14" opening and 12" concrete or plastic outlet pipe.	$ 3,400.00			**$ 3,400.00**	each	50	50	**30**	**2%**
Sprinkler Irrigation	Diesel Pumping Plant, 60 HP	Purchase of trailer-mounted Diesel pumping plant and screen filter assembly providing 1000 gpm at 80 psi.	$ 19,000.00	$ 24,995.85		**$ 24,000.00**	each	20	10	**15**	**9%**
Sprinkler Irrigation	Diesel Pumping Plant, 60 HP	Rental of trailer-mounted Diesel pumping plant and screen filter assembly producing 1000 gpm at 80 psi	$ 1,475.00	$ 1,305.00		**$ 1,390.00**	month				
Sprinkler Irrigation	Diesel Pumping Plant, 120 HP	Purchase of trailer-mounted Diesel pumping plant and screen filter assembly providing 2000 gpm at 80 psi.	$ 32,000.00	$ 37,000.00	$ 29,500.00	**$ 32,800.00**	each	20	10	**15**	**9%**
Sprinkler Irrigation	Diesel Pumping Plant, 120 HP	Rental of trailer-mounted Diesel pumping plant and screen filter assembly providing 2000 gpm at 80 psi. (excluding fuel)	$ 1,650.00	$ 1,705.00		**$ 1,680.00**	month				
Sprinkler Irrigation	Electric Pumping Plant, 60 HP	Purchase and installation of permanent electric pumping plant and screen filter assembly designed for sprinkler irrigation (1000 gpm at 80 psi). Includes motor, pump, electrical, and flow meter.	$ 27,165.00			**$ 27,200.00**	each	20	15	**20**	**5%**
Sprinkler Irrigation	Permanent Sprinkler Pumping Plant Structures	Materials and installation for sprinkler pumping plant structure including concrete slab, plumbing, and equipment mountings.	$ 3,000.00			**$ 3,000.00**	each	50		**50**	**2%**
Sprinkler Irrigation	Aluminum Mainline and Laterals	Purchase of 10" aluminum mainline, valve openers, 3" laterals, impact heads and 5/64" nozzles for sprinkler irrigation.	$ 2,300.00	$ 2,300.00		**$ 2,300.00**	acre	15		**15**	**2%**
Sprinkler Irrigation	Aluminum Mainline and Laterals	Rental of 10" aluminum mainline, valve openers, 3" laterals, impact heads and 5/64" nozzles for sprinkler irrigation. Based on a 4-month season.	$ 350.00	$ 370.00		**$ 360.00**	acre-season				
Drip Irrigation	Drip Irrigation Pumping Plant, Portable	Purchase of trailer-mounted Diesel pumping plant and media filter assembly designed for drip irrigation providing 1000 gpm at 40 psi with 4, 48" media filters.	$ 42,000.00			**$ 42,000.00**	each	20	10	**15**	**9%**
Drip Irrigation	Drip Irrigation Pumping Plant, Portable	Rental of trailer-mounted Diesel pumping plant and media filter assembly designed for drip irrigation providing 1000 gpm at 40 psi with 4, 48" media filters. (excluding fuel)	$ 1,800.00			**$ 1,800.00**	month				
Drip Irrigation	Surface Drip System	Materials for row crop surface drip system for 40" beds with 6 mil, 5/8" diameter drip tape and 600' runs. Includes aboveground 8" PVC mainline, 6" layflat submains, misc. valves and fittings. Does not include pump and filter station. Manual control.	$ 650.00			**$ 650.00**	acre	8		8	**6%**
Drip Irrigation	Surface Drip System	Materials for row crop surface drip system for 80" beds with 6 mil, 5/8" diameter drip tape and 600' runs. Includes aboveground 8" PVC mainline, 6" layflat submains, misc. valves and fittings. Does not include pump and filter station. Manual control.	$ 540.00			**$ 540.00**	acre	8		8	**6%**
Labor	Field Laborer	Fully burdened cost of general labor	$ 12.30	$ 11.86		**$ 12.10**	hour				
Labor	Irrigator	Fully burdened cost of irrigation labor	$ 12.30	$ 11.86		**$ 12.10**	hour				
Labor	Tractor Operator	Fully burdened cost of equipment operator	$ 15.75	$ 12.61		**$ 14.20**	hour				
Labor	Irrigation Foreman	Fully burdened cost of irrigation foreman	$ 18.08	$ 23.36		**$ 20.70**	hour				
Labor	Farm Manager	Fully burdened cost of farm manager	$ 23.36	$ 41.91		**$ 41.90**	hour				
Labor	Commercial Irrigation Scheduling	Cost of commercial irrigation scheduling service with soil moisture monitoring and irrigation recommendations.	$ 850.00	$1,500	$ 1,160.00	**$ 1,170.00**	field-season				
Energy	Diesel Fuel	Off-road agricultural Diesel fuel	$ 2.72	$ 2.72		**$ 2.72**	gal				

Description of Columns

A. General category into which conservation measure component falls.
B. Name of conservation measure component.
C. Description of conservation measure component.
D to F. Unit cost of component from individual sources.
G. Unit cost of component proposed for planning.
H. Unit to which component cost applies.
I to J. Component economic life from individual sources.
K. Component economic life proposed for planning.
L. Annual maintenance cost expressed as a percentage of component unit cost (Not applicable to time-dependent costs).

Attachment 4
Capital Cost Adjustment Factors for Grouping of Fields

Introduction
It is anticipated that growers implementing physical improvements such as tailwater recovery systems with reservoirs will take advantage of economies of scale by grouping fields so that one reservoir and pump station can serve a greater number of acres. The analysis described herein provides an estimate of the extent to which fields can be grouped. Capital cost adjustment factors are developed for three field sizes (36 acres, 72 acres, and 144 acres) and used in the detailed CM budgets to adjust the cost of CM components that can be shared by multiple fields.

Methods and Assumptions
A GIS layer was developed delineating individual agricultural fields within IID (Appendix 2.c, Attachment 1). For each field polygon, the gate serving the field was assigned. In many cases, a single gate serves multiple fields. It is anticipated that multiple fields served by a single gate would be likely candidates for consolidation of fields.

A cost adjustment factor was defined for each field as the ratio of field acres to total acres served by the associated gate. This factor was calculated for each field in IID. Then, fields were placed into bins based on field size and the average adjustment factor for each bin was calculated. Cost adjustment factors were selected for the field sizes of interest (36 acres, 72 acres, and 144 acres) and used in the detailed CM budgets to adjust the cost of CM components that can be shared by multiple fields.

Results
The bin-average cost adjustment factors were plotted against field size as shown in Figure 1. Resulting cost adjustment factors for 36, 72, and 144 acre fields are 0.6, 0.75, and 0.91, respectively.

Summary
Adjustment factors were developed to account for growers taking advantage of economies of scale when constructing capital improvements that can serve multiple fields. The factors were developed based on an analysis of field acres relative to total acres served by each gate. Factors were used in detailed CM budgets to adjust the capital costs of appropriate CM components (e.g., reservoirs for tailwater recovery systems).

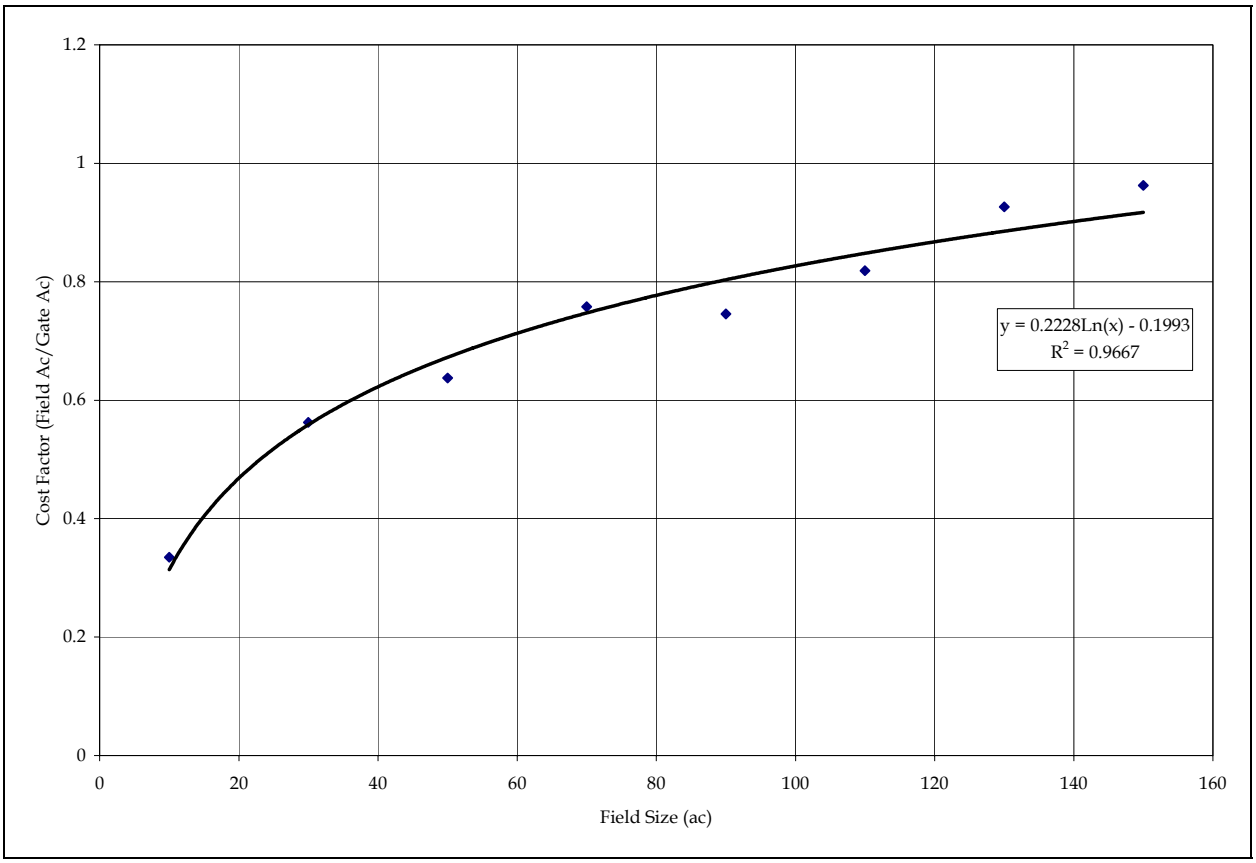

Figure 1. Capital Cost Adjustment Factors

Attachment 5
Potential Yield Increases Resulting from Pressurized Irrigation

Introduction

Historical adoption of drip and sprinkle irrigation in the Imperial Valley suggests that there are production benefits of adopting pressurized irrigation. These benefits may include increased returns due to crop uniformity, quality, and marketable yield as well as decreased production costs such as fertilizer and water. Potential yield increases were estimated based on historical adoption rates of drip and sprinkle irrigation in the Imperial Valley along with estimated returns and cost savings for pressurized irrigation adoption.

Methods and Assumptions

Conservation families using pressurized irrigation include drip irrigated truck crops and sprinkle irrigated truck crops. Historical adoption rates for each family were estimated as the percentage of field-seasons within each crop family with pressurized irrigation. Then, the marginal benefit of adopting pressurized irrigation was estimated as the percentile cost corresponding to adoption of pressurized irrigation. The benefit of adoption specific to yield increase was estimated as the total marginal benefit minus the estimated cost savings due to reduced fertilizer losses. Next, the yield benefit was calculated as a percentage of typical returns, net of harvest costs for each family. Percentage yield boosts were compared among the existing pressurized irrigation families and a single percentage was estimated for adoption of pressurized irrigation. Yield benefits for adoption of pressurized irrigation were then estimated for each surface-irrigated family based on the typical returns net of harvest costs and the percent yield boost.

Results

The portion of truck crop field-seasons within each conservation family are presented in Table 1.

Table 1. Count of Truck Crop Field-Seasons from Period of Analysis (WY98 – WY05)

Family	Seasons
CCVG	3125
CHVG	842
CLVG	1152
DCVG	131
DHVG	67
DLVG	126
RCVG	1991
RHVG	591
RLVG	739
SCVG	465
SHVG	80
SLVG	193
Total	9502
DRIP Total	324
Sprinkle Total	738

Based on the results of Table 1, historical adoption rates for truck crops are 3.4 percent for drip (3.4 percent = 324/9502) and 7.8 percent for sprinkle (7.8 percent = 738/9502). Implementation cost curves (capital, operations, and maintenance costs) for drip and sprinkle irrigation are provided in Figure 1.

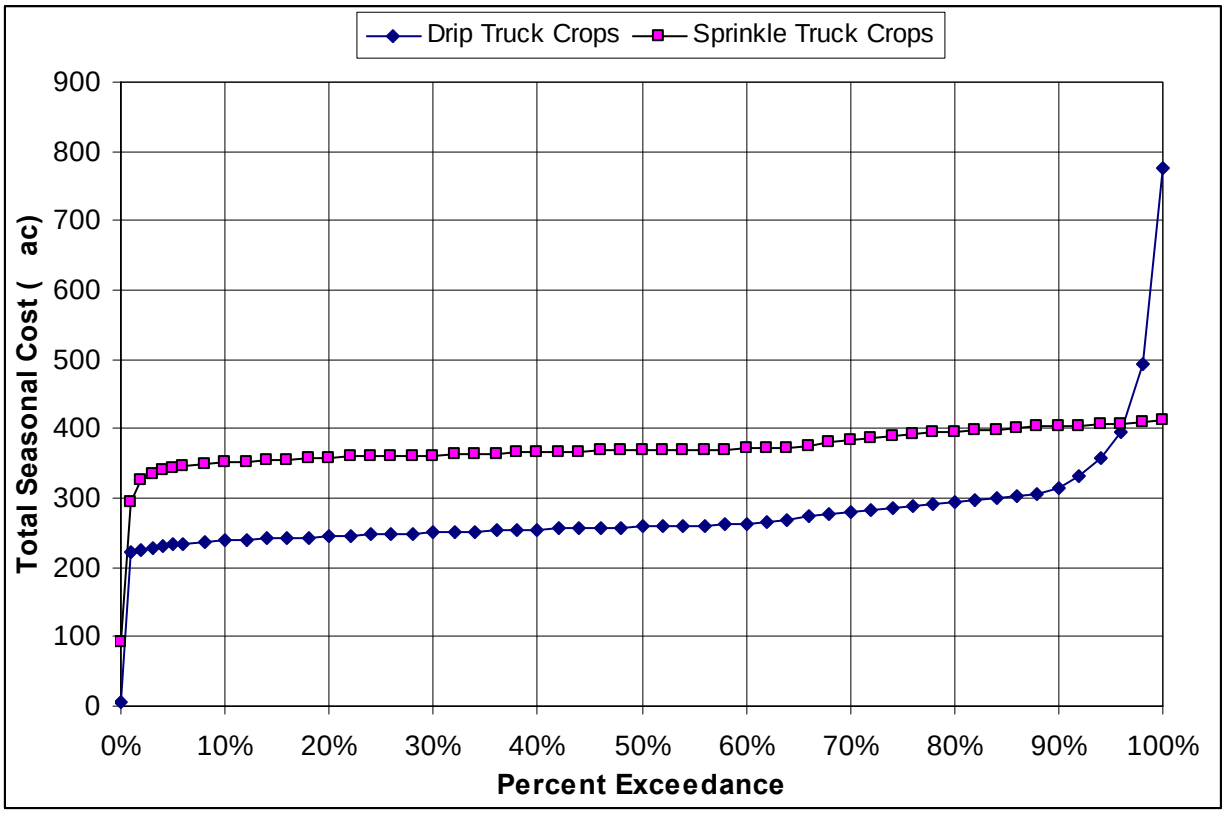

Figure 1. Implementation Cost Curves for Sprinkle Irrigation

The total marginal benefit of drip irrigation was estimated based on the 3.4 percentile cost as $230.01 per acre for a typical season. Based on an estimated typical seasonal fertilizer cost savings of $4.60 per acre, this translates to a seasonal yield benefit of $225.41 per acre. Based on an estimated typical return of $1844.63, this translates into a yield boost of 12 percent.

The total marginal benefit of sprinkle irrigation was estimated based on the 7.8 percentile cost as $348.85 per acre for a typical season. Based on an estimated typical seasonal fertilizer cost savings of $4.74 per acre, this translates to a seasonal yield benefit of $344.11 per acre. Based on an estimated typical return of $1844.63, this translates into a yield boost of 19 percent.

Based on these results, a seasonal additional benefit of 10 percent of yield net of harvest costs was estimated due to marketable yield and quality increases for pressurized irrigation. Then, for each crop family the typical seasonal additional benefit due to yi8eld increases was calculated as 10 percent of the estimated typical returns net of harvest costs as shown in Table 2.

Table 2. Estimated Seasonal Additional Benefits of Pressurized Irrigation by Crop Family

Family	Returns ($/ac)	Additional Benefit ($/ac)
AM	$654.65	$65.47
AN	$637.58	$63.76
BM	$318.07	$31.81
BN	$359.26	$35.93
FD	$775.89	$77.59
SB	$1,587.65	$158.77
VG	$1,844.63	$184.46
WT	$426.45	$42.65

Summary

Pressuirzed irrigation provides benefits in addition to water savings such as increased marketable yield and crop quality. These benefits were estimated empirically based on observed adoption rates of drip and sprinkle irrigation on truck crops in the Imperial Valley. A 10 percent boost in returns net of harvest costs was estimated and multiplied by typical returns net of harvest costs estimated for Imperial Valley crop families to estimate benefits of adoption of pressurized irrigation. Estimated additional season benefits range from approximately $30 to $185 per acre depending upon crop value.

Attachment 6

Earthwork Calculations for Reverse-Grade Tailwater Recovery Ponds and Above Ground On-Farm Reservoirs

Introduction

Earthwork calculations were performed to estimate the amount of excavation required to construct on-farm reservoirs for tailwater recovery ponds and for pressurized irrigation (drip, sprinkle, pivot). Calculations were performed across a range of expected field conditions to develop representative earthwork quantities for cost estimation purposes.

Methods and Assumptions

For tailwater recovery ponds, calculations were made based on reverse grade ponds 0.25 to 0.5 miles in length with a reverse grade of 0.05 percent. Calculations were made across a range of estimated field slopes (0.05 percent, 0.13 percent, and 0.25 percent) representative of the range of slopes encountered in IID. The maximum cut depth was limited to 8 feet. Excavation quantities were estimated using the prismoidal equiation. Calculation results are summarized in Tables 1 and 2 of the following section.

For pressurized irrigation ponds, earthwork calculations were based on a rectangular pond on level ground with an embankment height of 3 feet and a total depth of 9 feet. Calculation results are summarized in Table 3 of the following section.

Results

Calculation results for TRS reservoirs are summarized in Tables 1 and 2.

Table 1. TRS Reservoir Design Parameters and Calculation Results

Ground Slope	Pond Slope	Bottom Width (ft)	Length (ft)	Side slope (_:1)	FB at end (ft)	DW at end (ft)	End Cut (ft)	FB at start (ft)	DW at start (ft)	Start Cut (ft)	Pond Volume (af)	Cut Volume (cy)	Top Width (ft)	Area (ac)
0.05%	0.05%	2	1320	1	0.5	1	1.5	1.2	1.66	2.8	0.13	440	22	0.68
0.13%	0.05%	2	1320	1	0.5	1	1.5	2.2	1.66	3.9	0.13	618	23	0.71
0.25%	0.05%	2	1320	1	0.5	1	1.5	3.8	1.66	5.5	0.13	935	25	0.76
0.05%	0.05%	4	1320	1	0.5	6.2	6.7	1.2	6.86	8.0	2.10	4,115	35	1.05
0.13%	0.05%	7	1320	1	0.5	5.1	5.6	2.2	5.76	8.0	2.05	4,603	37	1.11
0.25%	0.05%	14	1320	1	0.5	3.5	4	3.8	4.16	8.0	2.08	5,870	42	1.27
0.05%	0.05%	14	1320	1	0.5	6.2	6.7	1.2	6.86	8.0	4.08	7,734	45	1.36
0.13%	0.05%	19	1320	1	0.5	5.1	5.6	2.2	5.76	8.0	4.04	8,606	49	1.47
0.25%	0.05%	31	1320	1	0.5	3.5	4	3.8	4.16	8.0	4.05	10,863	59	1.79
0.05%	0.05%	34	1320	1	0.5	6.2	6.7	1.2	6.86	8.0	8.06	14,970	65	1.96
0.13%	0.05%	44	1320	1	0.5	5.1	5.6	2.2	5.76	8.0	8.17	16,945	74	2.23
0.25%	0.05%	66	1320	1	0.5	3.5	4	3.8	4.16	8.0	8.13	21,142	94	2.85
0.05%	0.05%	0	2400	1	0.5	1	1.5	1.7	2.2	3.9	0.14	649	21	1.18
0.13%	0.05%	0	2400	1	0.5	1	1.5	3.6	2.2	5.8	0.14	1,193	23	1.28
0.25%	0.05%	2	2400	1	0.5	0.3	0.8	6.5	1.5	8.0	0.14	2,509	27	1.48
0.05%	0.05%	1	2400	1	0.5	5.1	5.6	1.7	6.3	8.0	2.11	4,732	31	1.69
0.13%	0.05%	6	2400	1	0.5	3.2	3.7	3.6	4.4	8.0	2.06	6,195	34	1.86
0.25%	0.05%	40	2400	1	0.5	0.3	0.8	6.5	1.5	8.0	2.03	17,398	65	3.57
0.05%	0.05%	8	2400	1	0.5	5.1	5.6	1.7	6.3	8.0	4.31	8,975	38	2.07
0.13%	0.05%	16	2400	1	0.5	3.2	3.7	3.6	4.4	8.0	4.15	11,417	44	2.41
0.25%	0.05%	82	2400	1	0.5	0.3	0.8	6.5	1.5	8.0	4.11	33,855	107	5.88
0.05%	0.05%	20	2400	1	0.5	5.1	5.6	1.7	6.3	8.0	8.09	16,249	50	2.73
0.13%	0.05%	35	2400	1	0.5	3.2	3.7	3.6	4.4	8.0	8.14	21,338	63	3.46
0.25%	0.05%	162	2400	1	0.5	0.3	0.8	6.5	1.5	8.0	8.08	65,201	187	10.29

Table 2. TRS Reservoir Summary of Cut Volumes for Various Reservoir Configurations

		1320' Length		2640' Length		Overall	
Pond Volume (af)	Slope (percent)	Cut Volume (cy)	Avg Cut Volume (cy)	Cut Volume (cy)	Avg Cut Volume (cy)	Cut Volume (cy)	Avg Cut Volume (cy)
0.1	0.05	440	664	649	1,450	545	1,057
0.1	0.13	618		1,193		905	
0.1	0.25	935		2,509		1,722	
2	0.05	4,115	4,863	4,732	9,442	4,424	7,152
2	0.13	4,603		6,195		5,399	
2	0.25	5,870		17,398		11,634	
4	0.05	7,734	9,067	8,975	18,082	8,354	13,575
4	0.13	8,606		11,417		10,011	
4	0.25	10,863		33,855		22,359	
8	0.05	14,970	17,686	16,249	34,263	15,610	25,974
8	0.13	16,945		21,338		19,141	
8	0.25	21,142		65,201		43,171	

Due to the inefficiency and excessive earthwork required to construct 0.5 mile reverse grade reservoirs on steeper (0.25 percent) slopes, average earthwork quantities were calculated excluding these values (shown in grey in Table 2) for the development of CM budgets.

Calculations for reservoirs for pressurized irrigation systems are summarized in Table 3.

Table 3. Pressurized Irrigation Reservoir Summary of Design Calculations

Embankment Height:	3	ft		Top Outer Length:	282	ft
Total Depth:	9	ft		Top Outer Width:	157	ft
Outside Toe Length:	300	ft		Top Inner Length:	258	ft
Outside Toe Width:	175	ft		Top Inner Width:	133	ft
Road Width:	12	ft		Bottom Length:	204	ft
Outside Slope:	3	:1		Bottom Width:	79	ft
Inside Slope:	3	:1				
Freeboard:	1	ft				
Dead Storage:	1	ft				
Total Volume:	8243	cy		Cut Volume:	4809	cy
Total Storage:	7015	cy		Shrinkage:	30%	
Active Storage:	6386	cy		Adjusted Cut Volume:	3367	cy
	4.0	af		Required Fill:	1937	cy
				Excess Fill:	1430	cy

Summary

Excavation requirements were estimated for on-farm storage in IID based on a range of pond configurations for both TRS and pressurized irrigation systems. These calculations provided an estimate of the required cut volume for each configuration to support the development of detailed CM implementation budgets.

Attachment 7
Detailed Cost Estimates for Scientific Irrigation Scheduling

A.7.1 Detailed Budget for 36 Acre Field

A.7.1.1 Annual Capital and Maintenance Costs

i = 0%
Field Size = 36 ac

Description
Scientific Irrigation Scheduling (SIS) including "classical" scheduling (ET calculation and soil moisture monitoring) plus surface irrigation evaluation and event design with the objective of maximizing application efficiency, to reduce the gross applied amount relative to the net requirement.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Training										
Irrigator		2 hr[1]	$12.10	$24.20	1	$24	$0.67	0%	$0.00	$0.00
Foreman		2.5 hr[2]	$20.70	$51.75	1	$52	$1.44	0%	$0.00	$0.00
Manager (includes training of employees plus receiving training from extension, university, etc.)		2.5 hr[3]	$41.90	$104.75	1	$105	$2.91	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$180.70		$180.70	$0.55		$0.00	$0.00
		Total Cost:		$361.40		$361.40	$5.57		$0.00	$0.00

Notes/Assumptions
1. Irrigator training requirement estimated based on attendance of 2, 10-hour seminars per year applicable to 10 fields.
2. Foreman training requirement based on attendance of 1, 10-hour seminar every year applicable to 20 fields plus 2 hours of additional irrigator supervision.
3. Manager training requirement estimated based on attendance of 1, 10-hour seminar per year applicable to 20 fields plus 2 hours of additional foreman and irrigator supervision.

A.7.1.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Bermuda	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Wheat	6	7	24	$12.10	$1,694.00	1.33	$2,258.67	$564.67	$15.69
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	1.33	$4,840.00	$1,210.00	$33.61
Field Crops, Flat	5	9	24	$12.10	$2,178.00	1.33	$2,904.00	$726.00	$20.17
Alfalfa, Row	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Field Crops, Row	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Sugar Beets	9	12	36	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$40.33

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields half of the time but will cover only 1 when implementing SIS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	SIS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$1.34
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$2.88
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$1.73
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$3.45

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman while implementing SIS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising SIS events = fields covered / SIS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	SIS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$4.07
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$8.73
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$6.98

Notes
1. Estimated number of hours devoted to each irrigation event related to designing and placing water order.
2. Estimated seasonal total cost for irrigation event design and ordering based on typical number of irrigation events.
3. Estimated number of hours devoted to each irrigation event related to designing and placing water order under SIS.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.7.2 Detailed Budget for 72-Acre Field

A.7.2.1 Annual Capital and Maintenance Costs

i = 0%
Field Size = 72 ac

Description
Scientific Irrigation Scheduling (SIS) including "classical" scheduling (ET calculation and soil moisture monitoring) plus surface irrigation evaluation and event design with the objective of maximizing application efficiency, to reduce the gross applied amount relative to the net requirement.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Training										
Irrigator		2 hr[1]	$12.10	$24.20	1	$24	$0.34	0%	$0.00	$0.00
Foreman		2.5 hr[2]	$20.70	$51.75	1	$52	$0.72	0%	$0.00	$0.00
Manager (includes training of employees plus receiving training from extension, university, etc.)		2.5 hr[3]	$41.90	$104.75	1	$105	$1.45	0%	$0.00	$0.00
			Contingency and Unlisted Items (10%):	$180.70		$180.70	$0.28		$0.00	$0.00
			Total Cost:	$361.40		$361.40	$2.79		$0.00	$0.00

Notes/Assumptions
1. Irrigator training requirement estimated based on attendance of 2, 10-hour seminars per year applicable to 10 fields.
2. Foreman training requirement based on attendance of 1, 10-hour seminar every year applicable to 20 fields plus 2 hours of additional irrigator supervision.
3. Manager training requirement estimated based on attendance of 1, 10-hour seminar per year applicable to 20 fields plus 2 hours of additional foreman and irrigator supervision.

A.7.2.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	48	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$20.17
Bermuda	12	16	32	$12.10	$5,162.67	1.33	$6,883.56	$1,720.89	$23.90
Wheat	6	7	32	$12.10	$2,258.67	1.33	$3,011.56	$752.89	$10.46
Alfalfa, Flat	12	15	32	$12.10	$4,840.00	1.33	$6,453.33	$1,613.33	$22.41
Field Crops, Flat	5	9	32	$12.10	$2,904.00	1.33	$3,872.00	$968.00	$13.44
Alfalfa, Row	12	16	36	$12.10	$5,808.00	1.33	$7,744.00	$1,936.00	$26.89
Field Crops, Row	5	9	42	$12.10	$3,811.50	1.33	$5,082.00	$1,270.50	$17.65
Sugar Beets	9	12	48	$12.10	$5,808.00	1.33	$7,744.00	$1,936.00	$26.89

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields half of the time but will cover only 1 when implementing SIS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	SIS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$1.73
Bermuda	12	9	12	$20.70	$441.60	1.33	$588.80	$147.20	$2.04
Wheat	12	9	12	$20.70	$193.20	1.33	$257.60	$64.40	$0.89
Alfalfa, Flat	12	9	12	$20.70	$414.00	1.33	$552.00	$138.00	$1.92
Field Crops, Flat	12	9	12	$20.70	$248.40	1.33	$331.20	$82.80	$1.15
Alfalfa, Row	12	9	12	$20.70	$496.80	1.33	$662.40	$165.60	$2.30
Field Crops, Row	12	9	12	$20.70	$326.03	1.33	$434.70	$108.68	$1.51
Sugar Beets	12	9	12	$20.70	$496.80	1.33	$662.40	$165.60	$2.30

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman while implementing SIS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising SIS events = fields covered / SIS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	SIS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$2.04
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$4.36
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$3.49

Notes
1. Estimated number of hours devoted to each irrigation event related to designing and placing water order.
2. Estimated seasonal total cost for irrigation event design and ordering based on typical number of irrigation events.
3. Estimated number of hours devoted to each irrigation event related to designing and placing water order under SIS.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.7.3 Detailed Budget for 144-Acre Field

A.7.3.1 Annual Capital and Maintenance Costs

i = 0%
Field Size = 144 ac

Description
Scientific Irrigation Scheduling (SIS) including "classical" scheduling (ET calculation and soil moisture monitoring) plus surface irrigation evaluation and event design with the objective of maximizing application efficiency, to reduce the gross applied amount relative to the net requirement.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Training										
Irrigator		2 hr[1]	$12.10	$24.20	1	$24	$0.17	0%	$0.00	$0.00
Foreman		2.5 hr[2]	$20.70	$51.75	1	$52	$0.36	0%	$0.00	$0.00
Manager (includes training of employees plus receiving training from extension, university, etc.)		2.5 hr[3]	$41.90	$104.75	1	$105	$0.73	0%	$0.00	$0.00
			Contingency and Unlisted Items (10%):	$180.70		$180.70	$0.14		$0.00	$0.00
			Total Cost:	$361.40		$361.40	$1.39		$0.00	$0.00

Notes/Assumptions
1. Irrigator training requirement estimated based on attendance of 2, 10-hour seminars per year applicable to 10 fields.
2. Foreman training requirement based on attendance of 1, 10-hour seminar every year applicable to 20 fields plus 2 hours of additional irrigator supervision.
3. Manager training requirement estimated based on attendance of 1, 10-hour seminar per year applicable to 20 fields plus 2 hours of additional foreman and irrigator supervision.

A.7.3.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	72	$12.10	$6,534.00	1.33	$8,712.00	$2,178.00	$15.13
Bermuda	12	16	56	$12.10	$9,034.67	1.33	$12,046.22	$3,011.56	$20.91
Wheat	6	7	48	$12.10	$3,388.00	1.33	$4,517.33	$1,129.33	$7.84
Alfalfa, Flat	12	15	48	$12.10	$7,260.00	1.33	$9,680.00	$2,420.00	$16.81
Field Crops, Flat	5	9	52	$12.10	$4,719.00	1.33	$6,292.00	$1,573.00	$10.92
Alfalfa, Row	12	16	52	$12.10	$8,389.33	1.33	$11,185.78	$2,796.44	$19.42
Field Crops, Row	5	9	60	$12.10	$5,445.00	1.33	$7,260.00	$1,815.00	$12.60
Sugar Beets	9	12	68	$12.10	$8,228.00	1.33	$10,970.67	$2,742.67	$19.05

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields half of the time but will cover only 1 when implementing SIS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	SIS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$558.90	1.33	$745.20	$186.30	$1.29
Bermuda	12	9	12	$20.70	$772.80	1.33	$1,030.40	$257.60	$1.79
Wheat	12	9	12	$20.70	$289.80	1.33	$386.40	$96.60	$0.67
Alfalfa, Flat	12	9	12	$20.70	$621.00	1.33	$828.00	$207.00	$1.44
Field Crops, Flat	12	9	12	$20.70	$403.65	1.33	$538.20	$134.55	$0.93
Alfalfa, Row	12	9	12	$20.70	$717.60	1.33	$956.80	$239.20	$1.66
Field Crops, Row	12	9	12	$20.70	$465.75	1.33	$621.00	$155.25	$1.08
Sugar Beets	12	9	12	$20.70	$703.80	1.33	$938.40	$234.60	$1.63

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman while implementing SIS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising SIS events = fields covered / SIS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	SIS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$1.02
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$2.18
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$1.75

Notes
1. Estimated number of hours devoted to each irrigation event related to designing and placing water order.
2. Estimated seasonal total cost for irrigation event design and ordering based on typical number of irrigation events.
3. Estimated number of hours devoted to each irrigation event related to designing and placing water order under SIS.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

Attachment 8
Detailed Cost Estimates for Scientific Irrigation Scheduling and Event Management

A.8.1 Detailed Budget for 36-Acre Field

A.8.1.1 Annual Capital and Maintenance Costs

i = 0%
Field Size = 36 ac

Description
Scientific Irrigation Scheduling (SIS) including "classical" scheduling (ET calculation and soil moisture monitoring) plus surface irrigation evaluation and event design with the objective of maximizing application efficiency, to reduce the gross applied amount relative to the net requirement. SEM includes extended event duration and increased monitoring of how the event unfolds to make order adjutments that result in increased application efficiency.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Training										
Irrigator		2 hr[1]	$12.10	$24.20	1	$24	$0.67	0%	$0.00	$0.00
Foreman		2.5 hr[2]	$20.70	$51.75	1	$52	$1.44	0%	$0.00	$0.00
Manager (includes training of employees plus receiving training from extension, university, etc.)		2.5 hr[3]	$41.90	$104.75	1	$105	$2.91	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$180.70		$180.70	$0.55		$0.00	$0.00
		Total Cost:		$361.40		$361.40	$5.57		$0.00	$0.00

Notes/Assumptions
1. Irrigator training requirement estimated based on attendance of 2, 10-hour seminars per year applicable to 10 fields.
2. Foreman training requirement based on attendance of 1, 10-hour seminar every year applicable to 20 fields plus 2 hours of additional irrigator supervision.
3. Manager training requirement estimated based on attendance of 1, 10-hour seminar per year applicable to 20 fields plus 2 hours of additional foreman and irrigator supervision.

A.8.1.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	2.00	$6,534.00	$3,267.00	$90.75
Bermuda	12	16	24	$12.10	$3,872.00	2.00	$7,744.00	$3,872.00	$107.56
Wheat	6	7	24	$12.10	$1,694.00	2.00	$3,388.00	$1,694.00	$47.06
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	2.00	$7,260.00	$3,630.00	$100.83
Field Crops, Flat	5	9	24	$12.10	$2,178.00	2.00	$4,356.00	$2,178.00	$60.50
Alfalfa, Row	12	16	24	$12.10	$3,872.00	2.00	$7,744.00	$3,872.00	$107.56
Field Crops, Row	5	9	36	$12.10	$3,267.00	2.00	$6,534.00	$3,267.00	$90.75
Sugar Beets	9	12	36	$12.10	$4,356.00	2.00	$8,712.00	$4,356.00	$121.00

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that event duration will increase to allow for order adjustments and improved control of event.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	SIS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	6	12	$20.70	$279.45	2.00	$558.90	$279.45	$7.76
Bermuda	12	6	12	$20.70	$331.20	2.00	$662.40	$331.20	$9.20
Wheat	12	6	12	$20.70	$144.90	2.00	$289.80	$144.90	$4.03
Alfalfa, Flat	12	6	12	$20.70	$310.50	2.00	$621.00	$310.50	$8.63
Field Crops, Flat	12	6	12	$20.70	$186.30	2.00	$372.60	$186.30	$5.18
Alfalfa, Row	12	6	12	$20.70	$331.20	2.00	$662.40	$331.20	$9.20
Field Crops, Row	12	6	12	$20.70	$279.45	2.00	$558.90	$279.45	$7.76
Sugar Beets	12	6	12	$20.70	$372.60	2.00	$745.20	$372.60	$10.35

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman while implementing SIS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for addiitonal supervision of irrigation events and coordination of water order changes with IID.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	SIS&SEM Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$4.07
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$8.73
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$6.98

Notes
1. Estimated number of hours devoted to each irrigation event related to designing and placing water order.
2. Estimated seasonal total cost for irrigation event design and ordering based on typical number of irrigation events.
3. Estimated number of hours devoted to each irrigation event related to designing and placing water order under SIS&SEM.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.8.2 Detailed Budget for 72-Acre Field

A.8.2.1 Annual Capital and Maintenance Costs

i = 0%
Field Size = 72 ac

Description
Scientific Irrigation Scheduling (SIS) including "classical" scheduling (ET calculation and soil moisture monitoring) plus surface irrigation evaluation and event design with the objective of maximizing application efficiency, to reduce the gross applied amount relative to the net requirement. SEM includes extended event duration and increased monitoring of how the event unfolds to make order adjutments that result in increased application efficiency.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Training										
Irrigator		2 hr[1]	$12.10	$24.20	1	$24	$0.34	0%	$0.00	$0.00
Foreman		2.5 hr[2]	$20.70	$51.75	1	$52	$0.72	0%	$0.00	$0.00
Manager (includes training of employees plus receiving training from extension, university, etc.)		2.5 hr[3]	$41.90	$104.75	1	$105	$1.45	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$180.70		$180.70	$0.28		$0.00	$0.00
		Total Cost:		$361.40		$361.40	$2.79		$0.00	$0.00

Notes/Assumptions
1. Irrigator training requirement estimated based on attendance of 2, 10-hour seminars per year applicable to 10 fields.
2. Foreman training requirement based on attendance of 1, 10-hour seminar every year applicable to 20 fields plus 2 hours of additional irrigator supervision.
3. Manager training requirement estimated based on attendance of 1, 10-hour seminar per year applicable to 20 fields plus 2 hours of additional foreman and irrigator supervision.

A.8.2.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	48	$12.10	$4,356.00	2.00	$8,712.00	$4,356.00	$60.50
Bermuda	12	16	32	$12.10	$5,162.67	2.00	$10,325.33	$5,162.67	$71.70
Wheat	6	7	32	$12.10	$2,258.67	2.00	$4,517.33	$2,258.67	$31.37
Alfalfa, Flat	12	15	32	$12.10	$4,840.00	2.00	$9,680.00	$4,840.00	$67.22
Field Crops, Flat	5	9	32	$12.10	$2,904.00	2.00	$5,808.00	$2,904.00	$40.33
Alfalfa, Row	12	16	36	$12.10	$5,808.00	2.00	$11,616.00	$5,808.00	$80.67
Field Crops, Row	5	9	42	$12.10	$3,811.50	2.00	$7,623.00	$3,811.50	$52.94
Sugar Beets	9	12	48	$12.10	$5,808.00	2.00	$11,616.00	$5,808.00	$80.67

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that event duration will increase to allow for order adjustments and improved control of event.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	SIS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	6	12	$20.70	$372.60	2.00	$745.20	$372.60	$5.18
Bermuda	12	6	12	$20.70	$441.60	2.00	$883.20	$441.60	$6.13
Wheat	12	6	12	$20.70	$193.20	2.00	$386.40	$193.20	$2.68
Alfalfa, Flat	12	6	12	$20.70	$414.00	2.00	$828.00	$414.00	$5.75
Field Crops, Flat	12	6	12	$20.70	$248.40	2.00	$496.80	$248.40	$3.45
Alfalfa, Row	12	6	12	$20.70	$496.80	2.00	$993.60	$496.80	$6.90
Field Crops, Row	12	6	12	$20.70	$326.03	2.00	$652.05	$326.03	$4.53
Sugar Beets	12	6	12	$20.70	$496.80	2.00	$993.60	$496.80	$6.90

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman while implementing SIS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for addiitonal supervision of irrigation events and coordination of water order changes with IID.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	SIS&SEM Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$2.04
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$4.36
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$3.49

Notes
1. Estimated number of hours devoted to each irrigation event related to designing and placing water order.
2. Estimated seasonal total cost for irrigation event design and ordering based on typical number of irrigation events.
3. Estimated number of hours devoted to each irrigation event related to designing and placing water order under SIS&SEM.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.8.3 Detailed Budget for 144-Acre Field

A.8.3.1 Annual Capital and Maintenance Costs

i = 0%
Field Size = 144 ac

Description
Scientific Irrigation Scheduling (SIS) including "classical" scheduling (ET calculation and soil moisture monitoring) plus surface irrigation evaluation and event design with the objective of maximizing application efficiency, to reduce the gross applied amount relative to the net requirement. SEM includes extended event duration and increased monitoring of how the event unfolds to make order adjutments that result in increased application efficiency.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Training										
Irrigator		2 hr[1]	$12.10	$24.20	1	$24	$0.17	0%	$0.00	$0.00
Foreman		2.5 hr[2]	$20.70	$51.75	1	$52	$0.36	0%	$0.00	$0.00
Manager (includes training of employees plus receiving training from extension, university, etc.)		2.5 hr[3]	$41.90	$104.75	1	$105	$0.73	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$180.70		$180.70	$0.14		$0.00	$0.00
		Total Cost:		$361.40		$361.40	$1.39		$0.00	$0.00

Notes/Assumptions
1. Irrigator training requirement estimated based on attendance of 2, 10-hour seminars per year applicable to 10 fields.
2. Foreman training requirement based on attendance of 1, 10-hour seminar every year applicable to 20 fields plus 2 hours of additional irrigator supervision.
3. Manager training requirement estimated based on attendance of 1, 10-hour seminar per year applicable to 20 fields plus 2 hours of additional foreman and irrigator supervision.

A.8.3.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	72	$12.10	$6,534.00	2.00	$13,068.00	$6,534.00	$45.38
Bermuda	12	16	56	$12.10	$9,034.67	2.00	$18,069.33	$9,034.67	$62.74
Wheat	6	7	48	$12.10	$3,388.00	2.00	$6,776.00	$3,388.00	$23.53
Alfalfa, Flat	12	15	48	$12.10	$7,260.00	2.00	$14,520.00	$7,260.00	$50.42
Field Crops, Flat	5	9	52	$12.10	$4,719.00	2.00	$9,438.00	$4,719.00	$32.77
Alfalfa, Row	12	16	52	$12.10	$8,389.33	2.00	$16,778.67	$8,389.33	$58.26
Field Crops, Row	5	9	60	$12.10	$5,445.00	2.00	$10,890.00	$5,445.00	$37.81
Sugar Beets	9	12	68	$12.10	$8,228.00	2.00	$16,456.00	$8,228.00	$57.14

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that event duration will increase to allow for order adjustments and improved control of event.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	SIS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	6	12	$20.70	$558.90	2.00	$1,117.80	$558.90	$3.88
Bermuda	12	6	12	$20.70	$772.80	2.00	$1,545.60	$772.80	$5.37
Wheat	12	6	12	$20.70	$289.80	2.00	$579.60	$289.80	$2.01
Alfalfa, Flat	12	6	12	$20.70	$621.00	2.00	$1,242.00	$621.00	$4.31
Field Crops, Flat	12	6	12	$20.70	$403.65	2.00	$807.30	$403.65	$2.80
Alfalfa, Row	12	6	12	$20.70	$717.60	2.00	$1,435.20	$717.60	$4.98
Field Crops, Row	12	6	12	$20.70	$465.75	2.00	$931.50	$465.75	$3.23
Sugar Beets	12	6	12	$20.70	$703.80	2.00	$1,407.60	$703.80	$4.89

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman while implementing SIS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for addiitonal supervision of irrigation events and coordination of water order changes with IID.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	SIS&SEM Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$1.02
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$2.18
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$1.75

Notes
1. Estimated number of hours devoted to each irrigation event related to designing and placing water order.
2. Estimated seasonal total cost for irrigation event design and ordering based on typical number of irrigation events.
3. Estimated number of hours devoted to each irrigation event related to designing and placing water order under SIS&SEM.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

Attachment 9
Detailed Cost Estimates for Minor Management and Physical Improvements

A.9.1 Detailed Budget for 36-Acre Field

A.9.1.1 Annual Capital and Maintenance Costs

i =	0%	
Field Size =	36	ac

Description

Minor management and physical improvements is a "proxy" conservation measure representative of a wide range of low capital and/or management related improvements that increase application efficiency such as increased labor, laser leveling, improved grade design, etc. Costs are estimated based on the on-farm operations costs for SIS.

Annual Capital and Maintenance Costs

NONE

A.9.1.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Bermuda	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Wheat	6	7	24	$12.10	$1,694.00	1.33	$2,258.67	$564.67	$15.69
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	1.33	$4,840.00	$1,210.00	$33.61
Field Crops, Flat	5	9	24	$12.10	$2,178.00	1.33	$2,904.00	$726.00	$20.17
Alfalfa, Row	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Field Crops, Row	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Sugar Beets	9	12	36	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$40.33

Notes

1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that labor intenstiy will increase to improve event management.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	SIS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$1.34
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$2.88
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$1.73
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$3.45

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman while implementing SIS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for additional supervision of irrigation events or other activities to improve irrigation.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	MMP Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$4.07
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$8.73
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$6.98

Notes
1. Estimated number of hours devoted to each irrigation event related to designing and placing water order.
2. Estimated seasonal total cost for irrigation event design and ordering based on typical number of irrigation events.
3. Estimated number of hours devoted to each irrigation event related to improving performance.

A.9.2 Detailed Budget for 72-Acre Field

A.9.2.1 Annual Capital and Maintenance Costs

i = 0%
Field Size = 72 ac

Description
Minor management and physical improvements is a "proxy" conservation measure representative of a wide range of low capital and/or management related improvements that increase application efficiency such as increased labor, laser leveling, improved grade design, etc. Costs are estimated based on the on-farm operations costs for SIS.

Annual Capital and Maintenance Costs

NONE

A.9.2.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	48	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$20.17
Bermuda	12	16	32	$12.10	$5,162.67	1.33	$6,883.56	$1,720.89	$23.90
Wheat	6	7	32	$12.10	$2,258.67	1.33	$3,011.56	$752.89	$10.46
Alfalfa, Flat	12	15	32	$12.10	$4,840.00	1.33	$6,453.33	$1,613.33	$22.41
Field Crops, Flat	5	9	32	$12.10	$2,904.00	1.33	$3,872.00	$968.00	$13.44
Alfalfa, Row	12	16	36	$12.10	$5,808.00	1.33	$7,744.00	$1,936.00	$26.89
Field Crops, Row	5	9	42	$12.10	$3,811.50	1.33	$5,082.00	$1,270.50	$17.65
Sugar Beets	9	12	48	$12.10	$5,808.00	1.33	$7,744.00	$1,936.00	$26.89

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that labor intenstiy will increase to improve event management.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	SIS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	6	12	$20.70	$372.60	2.00	$745.20	$372.60	$5.18
Bermuda	12	6	12	$20.70	$441.60	2.00	$883.20	$441.60	$6.13
Wheat	12	6	12	$20.70	$193.20	2.00	$386.40	$193.20	$2.68
Alfalfa, Flat	12	6	12	$20.70	$414.00	2.00	$828.00	$414.00	$5.75
Field Crops, Flat	12	6	12	$20.70	$248.40	2.00	$496.80	$248.40	$3.45
Alfalfa, Row	12	6	12	$20.70	$496.80	2.00	$993.60	$496.80	$6.90
Field Crops, Row	12	6	12	$20.70	$326.03	2.00	$652.05	$326.03	$4.53
Sugar Beets	12	6	12	$20.70	$496.80	2.00	$993.60	$496.80	$6.90

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman while implementing SIS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for additional supervision of irrigation events or other activities to improve irrigation.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	MMP Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$2.04
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$4.36
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$3.49

Notes
1. Estimated number of hours devoted to each irrigation event related to designing and placing water order.
2. Estimated seasonal total cost for irrigation event design and ordering based on typical number of irrigation events.
3. Estimated number of hours devoted to each irrigation event related to improving performance.

A.9.3 Detailed Budget for 144-Acre Field

A.9.3.1 Annual Capital and Maintenance Costs

i = 0%
Field Size = 144 ac

Description
Minor management and physical improvements is a "proxy" conservation measure representative of a wide range of low capital and/or management related improvements that increase application efficiency such as increased labor, laser leveling, improved grade design, etc. Costs are estimated based on the on-farm operations costs for SIS.

Annual Capital and Maintenance Costs

NONE

A.9.3.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	72	$12.10	$6,534.00	1.33	$8,712.00	$2,178.00	$15.13
Bermuda	12	16	56	$12.10	$9,034.67	1.33	$12,046.22	$3,011.56	$20.91
Wheat	6	7	48	$12.10	$3,388.00	1.33	$4,517.33	$1,129.33	$7.84
Alfalfa, Flat	12	15	48	$12.10	$7,260.00	1.33	$9,680.00	$2,420.00	$16.81
Field Crops, Flat	5	9	52	$12.10	$4,719.00	1.33	$6,292.00	$1,573.00	$10.92
Alfalfa, Row	12	16	52	$12.10	$8,389.33	1.33	$11,185.78	$2,796.44	$19.42
Field Crops, Row	5	9	60	$12.10	$5,445.00	1.33	$7,260.00	$1,815.00	$12.60
Sugar Beets	9	12	68	$12.10	$8,228.00	1.33	$10,970.67	$2,742.67	$19.05

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that labor intenstiy will increase to improve event management.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	SIS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	6	12	$20.70	$558.90	2.00	$1,117.80	$558.90	$3.88
Bermuda	12	6	12	$20.70	$772.80	2.00	$1,545.60	$772.80	$5.37
Wheat	12	6	12	$20.70	$289.80	2.00	$579.60	$289.80	$2.01
Alfalfa, Flat	12	6	12	$20.70	$621.00	2.00	$1,242.00	$621.00	$4.31
Field Crops, Flat	12	6	12	$20.70	$403.65	2.00	$807.30	$403.65	$2.80
Alfalfa, Row	12	6	12	$20.70	$717.60	2.00	$1,435.20	$717.60	$4.98
Field Crops, Row	12	6	12	$20.70	$465.75	2.00	$931.50	$465.75	$3.23
Sugar Beets	12	6	12	$20.70	$703.80	2.00	$1,407.60	$703.80	$4.89

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman while implementing SIS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for additional supervision of irrigation events or other activities to improve irrigation.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	MMP Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$1.02
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$2.18
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$1.75

Notes
1. Estimated number of hours devoted to each irrigation event related to designing and placing water order.
2. Estimated seasonal total cost for irrigation event design and ordering based on typical number of irrigation events.
3. Estimated number of hours devoted to each irrigation event related to improving performance.

Attachment 10
Detailed Cost Estimates for Tailwater Recovery Systems with Minimal Storage

A.10.1 Detailed Budget for 36-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline

A.10.1.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 36 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs trailer mounted Diesel trash pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	664	cy	$4.70	$3,100.00	5	$696	$19.34	1%	$31.00	$0.86
Pump Station										
Trailer-mounted Diesel Pump, up to 3 cfs[1]	1	ea	$7,333.33	$7,333.33	15	$660	$18.32	9%	$660.00	$18.33
Flowmeter	1	ea	$2,400.00	$2,400.00	10	$296	$8.22	2%	$48.00	$1.33
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Pipeline										
Aluminum, 10" Mainline	1320	lf	$10.30	$13,600.00	15	$1,223	$33.98	2%	$272.00	$7.56
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Ditch Grading[2]	6	hr	$145.00	$870.00	5	$195	$5.43	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]	1	ea	$1,400.00	$1,400.00		$154	$4.26	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$2,730.00		$310.00	$9.38		$100.00	$2.81
Total Cost:				$31,433.33		$3,534.00	$98.94		$1,111.00	$30.89

Notes/Assumptions
1. Total pump cost of $22,000 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.1.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Bermuda	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Wheat	6	7	24	$12.10	$1,694.00	1.33	$2,258.67	$564.67	$15.69
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	1.33	$4,840.00	$1,210.00	$33.61
Field Crops, Flat	5	9	24	$12.10	$2,178.00	1.33	$2,904.00	$726.00	$20.17
Alfalfa, Row	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Field Crops, Row	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Sugar Beets	9	12	36	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$40.33

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating TRS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	TRS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$1.34
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$2.88
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$1.73
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$3.45

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman with TRS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising TRS events = fields covered / TRS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	TRS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$4.07
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$8.73
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$6.98

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.11 gal/BHP-hr	2	23	0.6	8.7	6.1	5.8	$2.72	$15.73	0.9	$17.48

Notes
1. Specific fuel consumption based on specifications for Rainbird DV-150 trailer mounted trash pump.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

Adjustment of Operations Costs for Extended Delivery

	Typical Existing Costs per Season				Expected Costs Under Extended Delivery				Incremental Costs of TRS			
Crop Type	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total
Truck Crops	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Bermuda	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Wheat	$1,694.00	$144.90	$146.65	$1,985.55	$3,388.00	$289.80	$293.30	$3,971.10	$1,694.00	$144.90	$146.65	$1,985.55
Alfalfa, Flat	$3,630.00	$310.50	$314.25	$4,254.75	$7,260.00	$621.00	$628.50	$8,509.50	$3,630.00	$310.50	$314.25	$4,254.75
Field Crops, Flat	$2,178.00	$186.30	$188.55	$2,552.85	$4,356.00	$372.60	$377.10	$5,105.70	$2,178.00	$186.30	$188.55	$2,552.85
Alfalfa, Row	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Field Crops, Row	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Sugar Beets	$4,356.00	$372.60	$251.40	$4,980.00	$8,712.00	$745.20	$502.80	$9,960.00	$4,356.00	$372.60	$251.40	$4,980.00

A.10.2 Detailed Budget for 36-Acre Field, PTO-driven Pump, 0.25 Mile Pipeline

A.10.2.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 72 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs tractor-driven PTO pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	664	cy	$4.70	$3,100.00	5	$696	$9.67	1%	$31.00	$0.43
Pump Station										
Tractor-driven PTO pump, up to 3 cfs	1	ea	$2,526.67	$2,526.67	15	$227	$3.16	6%	$151.60	$2.11
Wheel Tractor, 60 HP	1	ea	$8,333.33	$8,333.33	10	$1,027	$14.27	9%	$750.00	$10.42
Flowmeter	1	ea	$2,400.00	$2,400.00	10	$296	$4.11	2%	$48.00	$0.67
Pipeline										
Aluminum, 10" Mainline	1320	lf	$10.30	$13,600.00	15	$1,223	$16.99	2%	$272.00	$3.78
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Ditch Grading[2]	6	hr	$145.00	$870.00	5	$195	$2.71	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]	1	ea	$1,500.00	$1,500.00		$183	$2.55	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$3,080.00		$370.00	$5.60		$130.00	$1.74
Total Cost:				$35,410.00		$4,219.00	$59.06		$1,383.00	$19.14

Notes/Assumptions
1. Total tractor and pump cost of $32,580 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.2.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 36-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline (see Section A.10.1.2)

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.0725 gal/BHP-hr	2	23	0.5	10.4	6.1	4.6	$2.72	$12.44	0.9	$13.82

Notes
1. Specific fuel consumption based on specifications for John Deere 5225 wheel tractor.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

A.10.3 Detailed Budget for 72-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline

A.10.3.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 72 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs trailer mounted Diesel trash pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	767	cy	$4.70	$3,600.00	5	$809	$11.23	1%	$36.00	$0.50
Pump Station										
Trailer-mounted Diesel Pump, up to 3 cfs[1]	1	ea	$7,333.33	$7,333.33	15	$660	$9.16	9%	$660.00	$9.17
Flowmeter	1	ea	$2,400.00	$2,400.00	10	$296	$4.11	2%	$48.00	$0.67
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Pipeline										
Aluminum, 10" Mainline	1320	lf	$10.30	$13,600.00	15	$1,223	$16.99	2%	$272.00	$3.78
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Ditch Grading[2]	12	hr	$145.00	$1,740.00	5	$391	$5.43	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]	1	ea	$1,400.00	$1,400.00		$169	$2.35	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$2,870.00		$340.00	$5.16		$100.00	$1.41
Total Cost:				$32,943.33		$3,887.00	$54.43		$1,116.00	$15.52

Notes/Assumptions
1. Total pump cost of $22,000 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.3.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$15.13
Bermuda	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$17.93
Wheat	6	7	24	$12.10	$1,694.00	1.33	$2,258.67	$564.67	$7.84
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	1.33	$4,840.00	$1,210.00	$16.81
Field Crops, Flat	5	9	24	$12.10	$2,178.00	1.33	$2,904.00	$726.00	$10.08
Alfalfa, Row	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$17.93
Field Crops, Row	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$15.13
Sugar Beets	9	12	36	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$20.17

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating TRS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	TRS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$1.29
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$1.53
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$0.67
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$1.44
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$0.86
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$1.53
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$1.29
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$1.73

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman with TRS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising TRS events = fields covered / TRS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	TRS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$2.04
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$4.36
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$3.49

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.11 gal/BHP-hr	2	23	0.6	8.7	6.1	5.8	$2.72	$15.73	0.9	$17.48

Notes
1. Specific fuel consumption based on specifications for Rainbird DV-150 trailer mounted trash pump.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

Adjustment of Operations Costs for Extended Delivery

	Typical Existing Costs per Season				Expected Costs Under Extended Delivery				Incremental Costs of TRS			
Crop Type	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total
Truck Crops	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Bermuda	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Wheat	$1,694.00	$144.90	$146.65	$1,985.55	$3,388.00	$289.80	$293.30	$3,971.10	$1,694.00	$144.90	$146.65	$1,985.55
Alfalfa, Flat	$3,630.00	$310.50	$314.25	$4,254.75	$7,260.00	$621.00	$628.50	$8,509.50	$3,630.00	$310.50	$314.25	$4,254.75
Field Crops, Flat	$2,178.00	$186.30	$188.55	$2,552.85	$4,356.00	$372.60	$377.10	$5,105.70	$2,178.00	$186.30	$188.55	$2,552.85
Alfalfa, Row	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Field Crops, Row	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Sugar Beets	$4,356.00	$372.60	$251.40	$4,980.00	$8,712.00	$745.20	$502.80	$9,960.00	$4,356.00	$372.60	$251.40	$4,980.00

A.10.4 Detailed Budget for 72-Acre Field, PTO-driven Pump, 0.25 Mile Pipeline

A.10.4.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 72 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs tractor-driven PTO pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation		767 cy	$4.70	$3,600.00	5	$809	$11.23	1%	$36.00	$0.50
Pump Station										
Tractor-driven PTO pump, up to 3 cfs		1 ea	$2,526.67	$2,526.67	15	$227	$3.16	6%	$151.60	$2.11
Wheel Tractor, 60 HP		1 ea	$8,333.33	$8,333.33	10	$1,027	$14.27	9%	$750.00	$10.42
Flowmeter		1 ea	$2,400.00	$2,400.00	10	$296	$4.11	2%	$48.00	$0.67
Pipeline										
Aluminum, 10" Mainline		1320 lf	$10.30	$13,600.00	15	$1,223	$16.99	2%	$272.00	$3.78
		0 ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
		0 ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Ditch Grading[2]		12 hr	$145.00	$1,740.00	5	$391	$5.43	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]		1 ea	$1,600.00	$1,600.00		$199	$2.76	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$3,220.00		$400.00	$6.07		$130.00	$1.75
Total Cost:				$37,020.00		$4,572.00	$64.01		$1,388.00	$19.21

Notes/Assumptions
1. Total tractor and pump cost of $32,580 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.4.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 72-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline (see Section A.10.3.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.0725 gal/BHP-hr	2	23	0.5	10.4	6.1	4.6	$2.72	$12.44	0.9	$13.82

Notes
1. Specific fuel consumption based on specifications for John Deere 5225 wheel tractor.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

A.10.5 Detailed Budget for 72-Acre Field, Trailer Mounted Trash Pump, 0.5 Mile Pipeline

A.10.5.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 72 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs trailer mounted Diesel trash pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	664	cy	$4.70	$3,100.00	5	$696	$9.67	1%	$31.00	$0.43
Pump Station										
Trailer-mounted Diesel Pump, up to 3 cfs[1]	1	ea	$7,333.33	$7,333.33	15	$660	$9.16	9%	$660.00	$9.17
Flowmeter	1	ea	$2,400.00	$2,400.00	10	$296	$4.11	2%	$48.00	$0.67
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Pipeline										
Aluminum, 10" Mainline	2640	lf	$10.30	$27,200.00	15	$2,446	$33.98	2%	$544.00	$7.56
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Ditch Grading[2]	12	hr	$145.00	$1,740.00	5	$391	$5.43	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]	1	ea	$2,100.00	$2,100.00		$224	$3.12	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$4,180.00		$450.00	$6.86		$130.00	$1.78
Total Cost:				$48,053.33		$5,164.00	$72.32		$1,413.00	$19.60

Notes/Assumptions
1. Total pump cost of $22,000 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.5.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 72-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline (see Section A.10.3.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.11 gal/BHP-hr	2	32	0.6	12.1	6.1	8.0	$2.72	$21.88	0.9	$24.31

Notes
1. Specific fuel consumption based on specifications for Rainbird DV-150 trailer mounted trash pump.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

A.10.6 Detailed Budget for 72-Acre Field, PTO-driven Pump, 0.5 Mile Pipeline

A.10.6.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 72 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs tractor-driven PTO pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	664	cy	$4.70	$3,100.00	5	$696	$9.67	1%	$31.00	$0.43
Pump Station										
Tractor-driven PTO pump, up to 3 cfs	1	ea	$2,526.67	$2,526.67	15	$227	$3.16	6%	$151.60	$2.11
Wheel Tractor, 60 HP	1	ea	$8,333.33	$8,333.33	10	$1,027	$14.27	9%	$750.00	$10.42
Flowmeter	1	ea	$2,400.00	$2,400.00	10	$296	$4.11	2%	$48.00	$0.67
Pipeline										
Aluminum, 10" Mainline	2640	lf	$10.30	$27,200.00	15	$2,446	$33.98	2%	$544.00	$7.56
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Ditch Grading[2]	12	hr	$145.00	$1,740.00	5	$391	$5.43	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]	1	ea	$2,300.00	$2,300.00		$254	$3.53	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$4,530.00		$510.00	$7.77		$150.00	$2.12
Total Cost:				$52,130.00		$5,848.00	$81.91		$1,675.00	$23.29

Notes/Assumptions
1. Total tractor and pump cost of $32,580 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.6.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 72-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline (see Section A.10.3.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.0725 gal/BHP-hr	2	32	0.5	14.5	6.1	6.4	$2.72	$17.31	0.9	$19.23

Notes
1. Specific fuel consumption based on specifications for John Deere 5225 wheel tractor.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

A.10.7 Detailed Budget for 144-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline

A.10.7.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 144 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs trailer mounted Diesel trash pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	767	cy	$4.70	$3,600.00	5	$809	$5.62	1%	$36.00	$0.25
Pump Station										
Trailer-mounted Diesel Pump, up to 3 cfs[1]	1	ea	$7,333.33	$7,333.33	15	$660	$4.58	9%	$660.00	$4.58
Flowmeter	1	ea	$2,400.00	$2,400.00	10	$296	$2.05	2%	$48.00	$0.33
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Pipeline										
Aluminum, 10" Mainline	1320	lf	$10.30	$13,600.00	15	$1,223	$8.49	2%	$272.00	$1.89
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	1	ea	$3,400.00	$3,400.00	5	$764	$5.30	2%	$68.00	$0.47
Ditch Grading[2]	20	hr	$145.00	$2,900.00	5	$651	$4.52	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]	1	ea	$1,700.00	$1,700.00		$220	$1.53	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$3,320.00		$440.00	$3.36		$110.00	$0.75
Total Cost:				$38,253.33		$5,063.00	$35.46		$1,194.00	$8.28

Notes/Assumptions
1. Total pump cost of $22,000 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.7.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$7.56
Bermuda	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$8.96
Wheat	6	7	24	$12.10	$1,694.00	1.33	$2,258.67	$564.67	$3.92
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	1.33	$4,840.00	$1,210.00	$8.40
Field Crops, Flat	5	9	24	$12.10	$2,178.00	1.33	$2,904.00	$726.00	$5.04
Alfalfa, Row	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$8.96
Field Crops, Row	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$7.56
Sugar Beets	9	12	36	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$10.08

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating TRS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	TRS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$0.65
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$0.77
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$0.34
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$0.72
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$0.43
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$0.77
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$0.65
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$0.86

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman with TRS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising TRS events = fields covered / TRS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	TRS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$1.02
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$2.18
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$1.75

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.11 gal/BHP-hr	2	23	0.6	8.7	6.1	5.8	$2.72	$15.73	0.9	$17.48

Notes
1. Specific fuel consumption based on specifications for Rainbird DV-150 trailer mounted trash pump.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

Adjustment of Operations Costs for Extended Delivery

	Typical Existing Costs per Season				Expected Costs Under Extended Delivery				Incremental Costs of TRS			
Crop Type	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total
Truck Crops	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Bermuda	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Wheat	$1,694.00	$144.90	$146.65	$1,985.55	$3,388.00	$289.80	$293.30	$3,971.10	$1,694.00	$144.90	$146.65	$1,985.55
Alfalfa, Flat	$3,630.00	$310.50	$314.25	$4,254.75	$7,260.00	$621.00	$628.50	$8,509.50	$3,630.00	$310.50	$314.25	$4,254.75
Field Crops, Flat	$2,178.00	$186.30	$188.55	$2,552.85	$4,356.00	$372.60	$377.10	$5,105.70	$2,178.00	$186.30	$188.55	$2,552.85
Alfalfa, Row	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Field Crops, Row	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Sugar Beets	$4,356.00	$372.60	$251.40	$4,980.00	$8,712.00	$745.20	$502.80	$9,960.00	$4,356.00	$372.60	$251.40	$4,980.00

A.10.8 Detailed Budget for 144-Acre Field, PTO-driven Pump, 0.25 Mile Pipeline

A.10.8.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 72 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs tractor-driven PTO pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	767	cy	$4.70	$3,600.00	5	$809	$11.23	1%	$36.00	$0.50
Pump Station										
Tractor-driven PTO pump, up to 3 cfs	1	ea	$2,526.67	$2,526.67	15	$227	$3.16	6%	$151.60	$2.11
Wheel Tractor, 60 HP	1	ea	$8,333.33	$8,333.33	10	$1,027	$14.27	9%	$750.00	$10.42
Flowmeter	1	ea	$2,400.00	$2,400.00	10	$296	$4.11	2%	$48.00	$0.67
Pipeline										
Aluminum, 10" Mainline	1320	lf	$10.30	$13,600.00	15	$1,223	$16.99	2%	$272.00	$3.78
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	1	ea	$3,400.00	$3,400.00	5	$764	$10.61	2%	$68.00	$0.94
Ditch Grading[2]	20	hr	$145.00	$2,900.00	5	$651	$9.05	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]	1	ea	$1,800.00	$1,800.00		$250	$3.47	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$3,680.00		$500.00	$7.64		$130.00	$1.84
Total Cost:				$42,240.00		$5,747.00	$80.52		$1,456.00	$20.25

Notes/Assumptions
1. Total tractor and pump cost of $32,580 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.8.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 144-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline (see Section A.10.7.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.0725 gal/BHP-hr	2	23	0.5	10.4	6.1	4.6	$2.72	$12.44	0.9	$13.82

Notes
1. Specific fuel consumption based on specifications for John Deere 5225 wheel tractor.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

A.10.9 Detailed Budget for 144-Acre Field, Trailer Mounted Trash Pump, 0.5 Mile Pipeline

A.10.9.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 72 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs trailer mounted Diesel trash pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	767	cy	$4.70	$3,600.00	5	$809	$11.23	1%	$36.00	$0.50
Pump Station										
Trailer-mounted Diesel Pump, up to 3 cfs[1]	1	ea	$7,333.33	$7,333.33	15	$660	$9.16	9%	$660.00	$9.17
Flowmeter	1	ea	$2,400.00	$2,400.00	10	$296	$4.11	2%	$48.00	$0.67
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Pipeline										
Aluminum, 10" Mainline	2640	lf	$10.30	$27,200.00	15	$2,446	$33.98	2%	$544.00	$7.56
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	1	ea	$3,400.00	$3,400.00	5	$764	$10.61	2%	$68.00	$0.94
Ditch Grading[2]	20	hr	$145.00	$2,900.00	5	$651	$9.05	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]	1	ea	$2,300.00	$2,300.00		$281	$3.91	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$4,680.00		$560.00	$8.59		$140.00	$1.88
Total Cost:				$53,813.33		$6,467.00	$90.64		$1,496.00	$20.72

Notes/Assumptions
1. Total pump cost of $22,000 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.9.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 144-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline (see Section A.10.7.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.11 gal/BHP-hr	2	32	0.6	12.1	6.1	8.0	$2.72	$21.88	0.9	$24.31

Notes
1. Specific fuel consumption based on specifications for Rainbird DV-150 trailer mounted trash pump.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

A.10.10 Detailed Budget for 144-Acre Field, PTO-driven Pump, 0.5 Mile Pipeline

A.10.10.1 Annual Capital and Maintenance Costs

i = 4%
Field Size = 72 ac

Description
TRS with 0.1 ac-ft tail ditch and 1-3 cfs tractor-driven PTO pump. Temporary installation with surface 10" aluminum mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	767	cy	$4.70	$3,600.00	5	$809	$11.23	1%	$36.00	$0.50
Pump Station										
Tractor-driven PTO pump, up to 3 cfs	1	ea	$2,526.67	$2,526.67	15	$227	$3.16	6%	$151.60	$2.11
Wheel Tractor, 60 HP	1	ea	$8,333.33	$8,333.33	10	$1,027	$14.27	9%	$750.00	$10.42
Flowmeter	1	ea	$2,400.00	$2,400.00	10	$296	$4.11	2%	$48.00	$0.67
Pipeline										
Aluminum, 10" Mainline	2640	lf	$10.30	$27,200.00	15	$2,446	$33.98	2%	$544.00	$7.56
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	1	ea	$3,400.00	$3,400.00	5	$764	$10.61	2%	$68.00	$0.94
Ditch Grading[2]	20	hr	$145.00	$2,900.00	5	$651	$9.05	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[3]	1	ea	$2,500.00	$2,500.00		$311	$4.32	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$5,040.00		$620.00	$9.50		$160.00	$2.22
Total Cost:				$57,900.00		$7,152.00	$100.22		$1,758.00	$24.41

Notes/Assumptions
1. Total tractor and pump cost of $32,580 divided over 3 fields to represent estimated utilization.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On-Farm admin cost estimated to be 5% of total capital.

A.10.10.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 144-Acre Field, Trailer Mounted Trash Pump, 0.25 Mile Pipeline (see Section A.10.7.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.0725 gal/BHP-hr	2	32	0.5	14.5	6.1	6.4	$2.72	$17.31	0.9	$19.23

Notes
1. Specific fuel consumption based on specifications for John Deere 5225 wheel tractor.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%.
3. Estimated ratio of conserved water (delivery reduction) to water pumped back by TRS.

Attachment 11
Detailed Cost Estimates for Tailwater Recovery Systems with Small Ponds

A.11.1 Detailed Budget for 36-Acre Field, 0.25 Mile Pipeline

A.11.1.1 Annual Capital and Maintenance Costs

i =	4%
Field Size =	36 ac
Cost Adjustment Factor =	0.6

Description
TRS with 4 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	5,440	cy	$4.70	$25,600.00	50	$1,192	$33.10	1%	$256.00	$7.11
Concrete Headwall and 24" x 30' Drain Pipe	0.6	ea	$6,400.00	$3,840.00	50	$179	$4.97	2%	$76.80	$2.13
Trash Rack	0.6	ea	$2,400.00	$1,440.00	15	$130	$3.60	2%	$28.80	$0.80
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.6	ea	$3,400.00	$2,040.00	50	$95	$2.64	2%	$40.80	$1.13
Pump Station										
Sump, 48" x 15'	0.6	ea	$5,650.00	$3,390.00	50	$158	$4.38	2%	$67.80	$1.88
Flowmeter	0.6	ea	$2,400.00	$1,440.00	10	$178	$4.93	2%	$28.80	$0.80
Automatic Oiler	0.6	ea	$350.00	$210.00	15	$19	$0.52	9%	$18.90	$0.53
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.6	ea	$14,500.00	$8,700.00	15	$782	$21.74	9%	$783.00	$21.75
Security Enclosure	0.6	ea	$6,300.00	$3,780.00	50	$176	$4.89	2%	$75.60	$2.10
Pipeline										
PVC, 12" Class 80 PIP	1320	lf	$10.10	$13,300.00	20	$979	$27.18	2%	$266.00	$7.39
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$2,660.00	$2,660.00	20	$196	$5.44	2%	$53.20	$1.48
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	3	ea	$3,400.00	$10,200.00	30	$590	$16.39	2%	$204.00	$5.67
Ditch Grading[2]	6	hr	$145.00	$870.00	50	$40	$1.12	0%	$0.00	$0.00
Miscellaneous										
On-farm Admin[3]	1	ea	$3,900.00	$3,900.00		$236	$6.54	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$7,750.00		$470.00	$14.40		$190.00	$5.28
Total Cost:				$89,120.00		$5,418.00	$151.84		$2,090.00	$58.05

Notes/Assumptions
1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.11.1.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Bermuda	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Wheat	6	7	24	$12.10	$1,694.00	1.33	$2,258.67	$564.67	$15.69
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	1.33	$4,840.00	$1,210.00	$33.61
Field Crops, Flat	5	9	24	$12.10	$2,178.00	1.33	$2,904.00	$726.00	$20.17
Alfalfa, Row	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Field Crops, Row	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Sugar Beets	9	12	36	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$40.33

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating TRS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	TRS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$1.34
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$2.88
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$1.73
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$3.45

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman with TRS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising TRS events = fields covered / TRS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	TRS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$4.07
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$8.73
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$6.98

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068	gal/BHP-hr	3	19	0.6	10.8	4.0	3.0	$2.72	$8.03	0.9	$8.92

Notes

1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

Adjustment of Operations Costs for Extended Delivery

	Typical Existing Costs per Season				Expected Costs Under Extended Delivery				Incremental Costs of TRS			
Crop Type	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total
Truck Crops	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Bermuda	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Wheat	$1,694.00	$144.90	$146.65	$1,985.55	$3,388.00	$289.80	$293.30	$3,971.10	$1,694.00	$144.90	$146.65	$1,985.55
Alfalfa, Flat	$3,630.00	$310.50	$314.25	$4,254.75	$7,260.00	$621.00	$628.50	$8,509.50	$3,630.00	$310.50	$314.25	$4,254.75
Field Crops, Flat	$2,178.00	$186.30	$188.55	$2,552.85	$4,356.00	$372.60	$377.10	$5,105.70	$2,178.00	$186.30	$188.55	$2,552.85
Alfalfa, Row	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Field Crops, Row	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Sugar Beets	$4,356.00	$372.60	$251.40	$4,980.00	$8,712.00	$745.20	$502.80	$9,960.00	$4,356.00	$372.60	$251.40	$4,980.00

A.11.2 Detailed Budget for 72-Acre Field, 0.25 Mile Pipeline

A.11.2.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	72 ac
Description		Cost Adjustment Factor =	0.75

TRS with 4 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	$44,800.00 Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	7,139	cy	$4.70	$33,600.00	50	$1,564	$21.72	1%	$336.00	$4.67
Concrete Headwall and 24" x 30' Drain Pipe	0.75	ea	$6,400.00	$4,800.00	50	$223	$3.10	2%	$96.00	$1.33
Trash Rack	0.75	ea	$2,400.00	$1,800.00	15	$162	$2.25	2%	$36.00	$0.50
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.75	ea	$3,400.00	$2,550.00	50	$119	$1.65	2%	$51.00	$0.71
				$42,750		$2,068	$28.72		$519	
Pump Station										
Sump, 48" x 15'	0.75	ea	$5,650.00	$4,237.50	50	$197	$2.74	2%	$84.75	$1.18
Flowmeter	0.75	ea	$2,400.00	$1,800.00	10	$222	$3.08	2%	$36.00	$0.50
Automatic Oiler	0.75	ea	$350.00	$262.50	15	$24	$0.33	9%	$23.63	$0.33
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.75	ea	$14,500.00	$10,875.00	15	$978	$13.58	9%	$978.75	$13.59
Security Enclosure	0.75	ea	$6,300.00	$4,725.00	50	$220	$3.05	2%	$94.50	$1.31
				$21,900.00		$1,640.85			$1,217.63	
Pipeline										
PVC, 12" Class 80 PIP	1320	lf	$10.10	$13,300.00	20	$979	$13.59	2%	$266.00	$3.69
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$2,660.00	$2,660.00	20	$196	$2.72	2%	$53.20	$0.74
				$15,960.00		$1,174.36			$319.20	
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	4	ea	$3,400.00	$13,600.00	30	$786	$10.92	2%	$272.00	$3.78
Ditch Grading[2]	12	hr	$145.00	$1,740.00	50	$81	$1.12	0%	$0.00	$0.00
				$15,340.00		$867.49			$272.00	
Miscellaneous										
On-farm Admin[3]	1	ea	$8,800.00	$8,800.00		$532	$7.38	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$17,660.00		$1,060.00	$11.95		$440.00	$3.23
			Total Cost:	$218,360.00		$13,093.00	$127.93		$5,096.00	$35.56

Notes/Assumptions

1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.11.2.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	48	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$20.17
Bermuda	12	16	32	$12.10	$5,162.67	1.33	$6,883.56	$1,720.89	$23.90
Wheat	6	7	32	$12.10	$2,258.67	1.33	$3,011.56	$752.89	$10.46
Alfalfa, Flat	12	15	32	$12.10	$4,840.00	1.33	$6,453.33	$1,613.33	$22.41
Field Crops, Flat	5	9	32	$12.10	$2,904.00	1.33	$3,872.00	$968.00	$13.44
Alfalfa, Row	12	16	36	$12.10	$5,808.00	1.33	$7,744.00	$1,936.00	$26.89
Field Crops, Row	5	9	42	$12.10	$3,811.50	1.33	$5,082.00	$1,270.50	$17.65
Sugar Beets	9	12	48	$12.10	$5,808.00	1.33	$7,744.00	$1,936.00	$26.89

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating TRS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	TRS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$1.73
Bermuda	12	9	12	$20.70	$441.60	1.33	$588.80	$147.20	$2.04
Wheat	12	9	12	$20.70	$193.20	1.33	$257.60	$64.40	$0.89
Alfalfa, Flat	12	9	12	$20.70	$414.00	1.33	$552.00	$138.00	$1.92
Field Crops, Flat	12	9	12	$20.70	$248.40	1.33	$331.20	$82.80	$1.15
Alfalfa, Row	12	9	12	$20.70	$496.80	1.33	$662.40	$165.60	$2.30
Field Crops, Row	12	9	12	$20.70	$326.03	1.33	$434.70	$108.68	$1.51
Sugar Beets	12	9	12	$20.70	$496.80	1.33	$662.40	$165.60	$2.30

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman with TRS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising TRS events = fields covered / TRS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	TRS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$2.04
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$4.36
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$3.49

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068 gal/BHP-hr	3	19	0.6	10.8	4.0	3.0	$2.72	$8.03	0.9	$8.92

Notes
1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

Adjustment of Operations Costs for Extended Delivery

	Typical Existing Costs per Season				Expected Costs Under Extended Delivery				Incremental Costs of TRS			
Crop Type	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total
Truck Crops	$4,356.00	$372.60	$188.55	$4,917.15	$8,712.00	$745.20	$377.10	$9,834.30	$4,356.00	$372.60	$188.55	$4,917.15
Bermuda	$5,162.67	$441.60	$335.20	$5,939.47	$10,325.33	$883.20	$670.40	$11,878.93	$5,162.67	$441.60	$335.20	$5,939.47
Wheat	$2,258.67	$193.20	$146.65	$2,598.52	$4,517.33	$386.40	$293.30	$5,197.03	$2,258.67	$193.20	$146.65	$2,598.52
Alfalfa, Flat	$4,840.00	$414.00	$314.25	$5,568.25	$9,680.00	$828.00	$628.50	$11,136.50	$4,840.00	$414.00	$314.25	$5,568.25
Field Crops, Flat	$2,904.00	$248.40	$188.55	$3,340.95	$5,808.00	$496.80	$377.10	$6,681.90	$2,904.00	$248.40	$188.55	$3,340.95
Alfalfa, Row	$5,808.00	$496.80	$335.20	$6,640.00	$11,616.00	$993.60	$670.40	$13,280.00	$5,808.00	$496.80	$335.20	$6,640.00
Field Crops, Row	$3,811.50	$326.03	$188.55	$4,326.08	$7,623.00	$652.05	$377.10	$8,652.15	$3,811.50	$326.03	$188.55	$4,326.08
Sugar Beets	$5,808.00	$496.80	$251.40	$6,556.20	$11,616.00	$993.60	$502.80	$13,112.40	$5,808.00	$496.80	$251.40	$6,556.20

A.11.3 Detailed Budget for 72-Acre Field, 0.5 Mile Pipeline

A.11.3.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	72 ac
Description		Cost Adjustment Factor =	0.75

TRS with 4 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	6,801	cy	$4.70	$32,000.00	50	$1,490	$20.69	1%	$320.00	$4.44
Concrete Headwall and 24" x 30' Drain Pipe	0.75	ea	$6,400.00	$4,800.00	50	$223	$3.10	2%	$96.00	$1.33
Trash Rack	0.75	ea	$2,400.00	$1,800.00	15	$162	$2.25	2%	$36.00	$0.50
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.75	ea	$3,400.00	$2,550.00	50	$119	$1.65	2%	$51.00	$0.71
Pump Station										
Sump, 48" x 15'	0.75	ea	$5,650.00	$4,237.50	50	$197	$2.74	2%	$84.75	$1.18
Flowmeter	0.75	ea	$2,400.00	$1,800.00	10	$222	$3.08	2%	$36.00	$0.50
Automatic Oiler	0.75	ea	$350.00	$262.50	15	$24	$0.33	9%	$23.63	$0.33
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.75	ea	$14,500.00	$10,875.00	15	$978	$13.58	9%	$978.75	$13.59
Security Enclosure	0.75	ea	$6,300.00	$4,725.00	50	$220	$3.05	2%	$94.50	$1.31
Pipeline										
PVC, 12" Class 80 PIP	2640	lf	$10.10	$26,700.00	20	$1,965	$27.29	2%	$534.00	$7.42
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$5,340.00	$5,340.00	20	$393	$5.46	2%	$106.80	$1.48
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	4	ea	$3,400.00	$13,600.00	30	$786	$10.92	2%	$272.00	$3.78
Ditch Grading[2]	12	hr	$145.00	$1,740.00	50	$81	$1.12	0%	$0.00	$0.00
Miscellaneous										
On-farm Admin[3]	1	ea	$5,500.00	$5,500.00		$343	$4.76	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$11,040.00		$690.00	$10.48		$260.00	$3.66
			Total Cost:	$126,970.00		$7,893.00	$110.51		$2,893.00	$40.23

Notes/Assumptions

1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.11.3.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 72-Acre Field, 0.25 Mile Pipeline (see Section A.11.2.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068 gal/BHP-hr	3	26	0.6	14.7	4.0	4.0	$2.72	$10.99	0.9	$12.21

Notes
1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

A.11.4 Detailed Budget for 144-Acre Field, 0.25 Mile Pipeline

A.11.4.1 Annual Capital and Maintenance Costs

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	0.91

Description
TRS with 4 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	8,662	cy	$4.70	$40,700.00	50	$1,895	$13.16	1%	$407.00	$2.83
Concrete Headwall and 24" x 30' Drain Pipe	0.91	ea	$6,400.00	$5,824.00	50	$271	$1.88	2%	$116.48	$0.81
Trash Rack	0.91	ea	$2,400.00	$2,184.00	15	$196	$1.36	2%	$43.68	$0.30
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.91	ea	$3,400.00	$3,094.00	50	$144	$1.00	2%	$61.88	$0.43
Pump Station										
Sump, 48" x 15'	0.91	ea	$5,650.00	$5,141.50	50	$239	$1.66	2%	$102.83	$0.71
Flowmeter	0.91	ea	$2,400.00	$2,184.00	10	$269	$1.87	2%	$43.68	$0.30
Automatic Oiler	0.91	ea	$350.00	$318.50	15	$29	$0.20	9%	$28.67	$0.20
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.91	ea	$14,500.00	$13,195.00	15	$1,187	$8.24	9%	$1,187.55	$8.25
Security Enclosure	0.91	ea	$6,300.00	$5,733.00	50	$267	$1.85	2%	$114.66	$0.80
Pipeline										
PVC, 12" Class 80 PIP	1320	lf	$10.10	$13,300.00	20	$979	$6.80	2%	$266.00	$1.85
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$2,660.00	$2,660.00	20	$196	$1.36	2%	$53.20	$0.37
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	6	ea	$3,400.00	$20,400.00	30	$1,180	$8.19	2%	$408.00	$2.83
Ditch Grading[2]	20	hr	$145.00	$2,900.00	50	$135	$0.94	0%	$0.00	$0.00
Miscellaneous										
On-farm Admin[3]	1	ea	$5,900.00	$5,900.00		$349	$2.43	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$11,760.00		$700.00	$5.34		$280.00	$1.97
Total Cost:				$135,294.00		$8,035.00	$56.28		$3,114.00	$21.65

Notes/Assumptions
1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 20 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.11.4.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	72	$12.10	$6,534.00	1.33	$8,712.00	$2,178.00	$15.13
Bermuda	12	16	56	$12.10	$9,034.67	1.33	$12,046.22	$3,011.56	$20.91
Wheat	6	7	48	$12.10	$3,388.00	1.33	$4,517.33	$1,129.33	$7.84
Alfalfa, Flat	12	15	48	$12.10	$7,260.00	1.33	$9,680.00	$2,420.00	$16.81
Field Crops, Flat	5	9	52	$12.10	$4,719.00	1.33	$6,292.00	$1,573.00	$10.92
Alfalfa, Row	12	16	52	$12.10	$8,389.33	1.33	$11,185.78	$2,796.44	$19.42
Field Crops, Row	5	9	60	$12.10	$5,445.00	1.33	$7,260.00	$1,815.00	$12.60
Sugar Beets	9	12	68	$12.10	$8,228.00	1.33	$10,970.67	$2,742.67	$19.05

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating TRS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	TRS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$558.90	1.33	$745.20	$186.30	$1.29
Bermuda	12	9	12	$20.70	$772.80	1.33	$1,030.40	$257.60	$1.79
Wheat	12	9	12	$20.70	$289.80	1.33	$386.40	$96.60	$0.67
Alfalfa, Flat	12	9	12	$20.70	$621.00	1.33	$828.00	$207.00	$1.44
Field Crops, Flat	12	9	12	$20.70	$403.65	1.33	$538.20	$134.55	$0.93
Alfalfa, Row	12	9	12	$20.70	$717.60	1.33	$956.80	$239.20	$1.66
Field Crops, Row	12	9	12	$20.70	$465.75	1.33	$621.00	$155.25	$1.08
Sugar Beets	12	9	12	$20.70	$703.80	1.33	$938.40	$234.60	$1.63

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman with TRS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising TRS events = fields covered / TRS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	TRS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$1.02
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$2.18
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$1.75

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068 gal/BHP-hr	3	19	0.6	10.8	4.0	3.0	$2.72	$8.03	0.9	$8.92

Notes

1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

Adjustment of Operations Costs for Extended Delivery

	Typical Existing Costs per Season				Expected Costs Under Extended Delivery				Incremental Costs of TRS			
Crop Type	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total
Truck Crops	$6,534.00	$558.90	$188.55	$7,281.45	$13,068.00	$1,117.80	$377.10	$14,562.90	$6,534.00	$558.90	$188.55	$7,281.45
Bermuda	$9,034.67	$772.80	$335.20	$10,142.67	$18,069.33	$1,545.60	$670.40	$20,285.33	$9,034.67	$772.80	$335.20	$10,142.67
Wheat	$3,388.00	$289.80	$146.65	$3,824.45	$6,776.00	$579.60	$293.30	$7,648.90	$3,388.00	$289.80	$146.65	$3,824.45
Alfalfa, Flat	$7,260.00	$621.00	$314.25	$8,195.25	$14,520.00	$1,242.00	$628.50	$16,390.50	$7,260.00	$621.00	$314.25	$8,195.25
Field Crops, Flat	$4,719.00	$403.65	$188.55	$5,311.20	$9,438.00	$807.30	$377.10	$10,622.40	$4,719.00	$403.65	$188.55	$5,311.20
Alfalfa, Row	$8,389.33	$717.60	$335.20	$9,442.13	$16,778.67	$1,435.20	$670.40	$18,884.27	$8,389.33	$717.60	$335.20	$9,442.13
Field Crops, Row	$5,445.00	$465.75	$188.55	$6,099.30	$10,890.00	$931.50	$377.10	$12,198.60	$5,445.00	$465.75	$188.55	$6,099.30
Sugar Beets	$8,228.00	$703.80	$251.40	$9,183.20	$16,456.00	$1,407.60	$502.80	$18,366.40	$8,228.00	$703.80	$251.40	$9,183.20

A.11.5 Detailed Budget for 144-Acre Field, 0.5 Mile Pipeline

A.11.5.1 Annual Capital and Maintenance Costs

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	0.91

Description
TRS with 4 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	8,662	cy	$4.70	$40,700.00	50	$1,895	$13.16	1%	$407.00	$2.83
Concrete Headwall and 24" x 30' Drain Pipe	0.91	ea	$6,400.00	$5,824.00	50	$271	$1.88	2%	$116.48	$0.81
Trash Rack	0.91	ea	$2,400.00	$2,184.00	15	$196	$1.36	2%	$43.68	$0.30
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.91	ea	$3,400.00	$3,094.00	50	$144	$1.00	2%	$61.88	$0.43
Pump Station										
Sump, 48" x 15'	0.91	ea	$5,650.00	$5,141.50	50	$239	$1.66	2%	$102.83	$0.71
Flowmeter	0.91	ea	$2,400.00	$2,184.00	10	$269	$1.87	2%	$43.68	$0.30
Automatic Oiler	0.91	ea	$350.00	$318.50	15	$29	$0.20	9%	$28.67	$0.20
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.91	ea	$14,500.00	$13,195.00	15	$1,187	$8.24	9%	$1,187.55	$8.25
Security Enclosure	0.91	ea	$6,300.00	$5,733.00	50	$267	$1.85	2%	$114.66	$0.80
Pipeline										
PVC, 12" Class 80 PIP	2640	lf	$10.10	$26,700.00	20	$1,965	$13.64	2%	$534.00	$3.71
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$5,340.00	$5,340.00	20	$393	$2.73	2%	$106.80	$0.74
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	6	ea	$3,400.00	$20,400.00	30	$1,180	$8.19	2%	$408.00	$2.83
Ditch Grading[2]	20	hr	$145.00	$2,900.00	50	$135	$0.94	0%	$0.00	$0.00
Miscellaneous										
On-farm Admin[3]	1	ea	$6,700.00	$6,700.00		$408	$2.84	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$13,370.00		$820.00	$6.24		$320.00	$2.19
Total Cost:				$153,784.00		$9,398.00	$65.81		$3,475.00	$24.10

Notes/Assumptions
1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 20 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.11.5.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 72-Acre Field, 0.25 Mile Pipeline (see Section A.11.4.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068 gal/BHP-hr	3	26	0.6	14.7	4.0	4.0	$2.72	$10.99	0.9	$12.21

Notes
1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

Attachment 12
Detailed Cost Estimates for Tailwater Recovery Systems with Large Ponds

A.12.1 Detailed Budget for 36-Acre Field, 0.25 Mile Pipeline

A.12.1.1 Annual Capital and Maintenance Costs

i =	4%
Field Size =	36 ac
Cost Adjustment Factor =	0.6

Description
TRS with 8 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	10,611	cy	$4.70	$49,900.00	50	$2,323	$64.52	1%	$499.00	$13.86
Concrete Headwall and 24" x 30' Drain Pipe	0.6	ea	$6,400.00	$3,840.00	50	$179	$4.97	2%	$76.80	$2.13
Trash Rack	0.6	ea	$2,400.00	$1,440.00	15	$130	$3.60	2%	$28.80	$0.80
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.6	ea	$3,400.00	$2,040.00	50	$95	$2.64	2%	$40.80	$1.13
Pump Station										
Sump, 48" x 15'	0.6	ea	$5,650.00	$3,390.00	50	$158	$4.38	2%	$67.80	$1.88
Flowmeter	0.6	ea	$2,400.00	$1,440.00	10	$178	$4.93	2%	$28.80	$0.80
Automatic Oiler	0.6	ea	$350.00	$210.00	15	$19	$0.52	9%	$18.90	$0.53
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.6	ea	$14,500.00	$8,700.00	15	$782	$21.74	9%	$783.00	$21.75
Security Enclosure	0.6	ea	$6,300.00	$3,780.00	50	$176	$4.89	2%	$75.60	$2.10
Pipeline										
PVC, 12" Class 80 PIP	1320	lf	$10.10	$13,300.00	20	$979	$27.18	2%	$266.00	$7.39
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$2,660.00	$2,660.00	20	$196	$5.44	2%	$53.20	$1.48
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	3	ea	$3,400.00	$10,200.00	30	$590	$16.39	2%	$204.00	$5.67
Ditch Grading[2]	6	hr	$145.00	$870.00	50	$40	$1.12	0%	$0.00	$0.00
Miscellaneous										
On-farm Admin[3]	1	ea	$5,100.00	$5,100.00		$292	$8.12	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$10,180.00		$580.00	$17.86		$210.00	$5.95
Total Cost:				$117,050.00		$6,716.00	$188.29		$2,353.00	$65.47

Notes/Assumptions
1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 6 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.12.1.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Bermuda	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Wheat	6	7	24	$12.10	$1,694.00	1.33	$2,258.67	$564.67	$15.69
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	1.33	$4,840.00	$1,210.00	$33.61
Field Crops, Flat	5	9	24	$12.10	$2,178.00	1.33	$2,904.00	$726.00	$20.17
Alfalfa, Row	12	16	24	$12.10	$3,872.00	1.33	$5,162.67	$1,290.67	$35.85
Field Crops, Row	5	9	36	$12.10	$3,267.00	1.33	$4,356.00	$1,089.00	$30.25
Sugar Beets	9	12	36	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$40.33

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating TRS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	TRS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$1.34
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$2.88
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$1.73
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$3.45

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman with TRS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising TRS events = fields covered / TRS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	TRS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$4.07
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$8.73
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$6.98

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068	gal/BHP-hr	3	19	0.6	10.8	4.0	3.0	$2.72	$8.03	0.9	$8.92

Notes

1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

Adjustment of Operations Costs for Extended Delivery

	Typical Existing Costs per Season				Expected Costs Under Extended Delivery				Incremental Costs of TRS			
Crop Type	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total
Truck Crops	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Bermuda	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Wheat	$1,694.00	$144.90	$146.65	$1,985.55	$3,388.00	$289.80	$293.30	$3,971.10	$1,694.00	$144.90	$146.65	$1,985.55
Alfalfa, Flat	$3,630.00	$310.50	$314.25	$4,254.75	$7,260.00	$621.00	$628.50	$8,509.50	$3,630.00	$310.50	$314.25	$4,254.75
Field Crops, Flat	$2,178.00	$186.30	$188.55	$2,552.85	$4,356.00	$372.60	$377.10	$5,105.70	$2,178.00	$186.30	$188.55	$2,552.85
Alfalfa, Row	$3,872.00	$331.20	$335.20	$4,538.40	$7,744.00	$662.40	$670.40	$9,076.80	$3,872.00	$331.20	$335.20	$4,538.40
Field Crops, Row	$3,267.00	$279.45	$188.55	$3,735.00	$6,534.00	$558.90	$377.10	$7,470.00	$3,267.00	$279.45	$188.55	$3,735.00
Sugar Beets	$4,356.00	$372.60	$251.40	$4,980.00	$8,712.00	$745.20	$502.80	$9,960.00	$4,356.00	$372.60	$251.40	$4,980.00

A.12.2 Detailed Budget for 72-Acre Field, 0.25 Mile Pipeline

A.12.2.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	72 ac
Description		Cost Adjustment Factor =	0.75

TRS with 8 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	13,597	cy	$4.70	$63,900.00	50	$2,975	$41.31	1%	$639.00	$8.88
Concrete Headwall and 24" x 30' Drain Pipe	0.75	ea	$6,400.00	$4,800.00	50	$223	$3.10	2%	$96.00	$1.33
Trash Rack	0.75	ea	$2,400.00	$1,800.00	15	$162	$2.25	2%	$36.00	$0.50
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.75	ea	$3,400.00	$2,550.00	50	$119	$1.65	2%	$51.00	$0.71
Pump Station										
Sump, 48" x 15'	0.75	ea	$5,650.00	$4,237.50	50	$197	$2.74	2%	$84.75	$1.18
Flowmeter	0.75	ea	$2,400.00	$1,800.00	10	$222	$3.08	2%	$36.00	$0.50
Automatic Oiler	0.75	ea	$350.00	$262.50	15	$24	$0.33	9%	$23.63	$0.33
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.75	ea	$14,500.00	$10,875.00	15	$978	$13.58	9%	$978.75	$13.59
Security Enclosure	0.75	ea	$6,300.00	$4,725.00	50	$220	$3.05	2%	$94.50	$1.31
Pipeline										
PVC, 12" Class 80 PIP	1320	lf	$10.10	$13,300.00	20	$979	$13.59	2%	$266.00	$3.69
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$2,660.00	$2,660.00	20	$196	$2.72	2%	$53.20	$0.74
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	5	ea	$3,400.00	$17,000.00	30	$983	$13.65	2%	$340.00	$4.72
Ditch Grading[2]	12	hr	$145.00	$1,740.00	50	$81	$1.12	0%	$0.00	$0.00
Miscellaneous										
On-farm Admin[3]	1	ea	$6,500.00	$6,500.00		$368	$5.11	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$12,970.00		$740.00	$11.24		$270.00	$3.75
Total Cost:				$149,120.00		$8,466.00	$118.54		$2,969.00	$41.23

Notes/Assumptions

1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.12.2.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	48	$12.10	$4,356.00	1.33	$5,808.00	$1,452.00	$20.17
Bermuda	12	16	32	$12.10	$5,162.67	1.33	$6,883.56	$1,720.89	$23.90
Wheat	6	7	32	$12.10	$2,258.67	1.33	$3,011.56	$752.89	$10.46
Alfalfa, Flat	12	15	32	$12.10	$4,840.00	1.33	$6,453.33	$1,613.33	$22.41
Field Crops, Flat	5	9	32	$12.10	$2,904.00	1.33	$3,872.00	$968.00	$13.44
Alfalfa, Row	12	16	36	$12.10	$5,808.00	1.33	$7,744.00	$1,936.00	$26.89
Field Crops, Row	5	9	42	$12.10	$3,811.50	1.33	$5,082.00	$1,270.50	$17.65
Sugar Beets	9	12	48	$12.10	$5,808.00	1.33	$7,744.00	$1,936.00	$26.89

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating TRS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	TRS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$1.73
Bermuda	12	9	12	$20.70	$441.60	1.33	$588.80	$147.20	$2.04
Wheat	12	9	12	$20.70	$193.20	1.33	$257.60	$64.40	$0.89
Alfalfa, Flat	12	9	12	$20.70	$414.00	1.33	$552.00	$138.00	$1.92
Field Crops, Flat	12	9	12	$20.70	$248.40	1.33	$331.20	$82.80	$1.15
Alfalfa, Row	12	9	12	$20.70	$496.80	1.33	$662.40	$165.60	$2.30
Field Crops, Row	12	9	12	$20.70	$326.03	1.33	$434.70	$108.68	$1.51
Sugar Beets	12	9	12	$20.70	$496.80	1.33	$662.40	$165.60	$2.30

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman with TRS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising TRS events = fields covered / TRS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	TRS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$2.04
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$4.36
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$3.49

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068 gal/BHP-hr	3	19	0.6	10.8	4.0	3.0	$2.72	$8.03	0.9	$8.92

Notes

1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

Adjustment of Operations Costs for Extended Delivery

	Typical Existing Costs per Season				Expected Costs Under Extended Delivery				Incremental Costs of TRS			
Crop Type	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total
Truck Crops	$4,356.00	$372.60	$188.55	$4,917.15	$8,712.00	$745.20	$377.10	$9,834.30	$4,356.00	$372.60	$188.55	$4,917.15
Bermuda	$5,162.67	$441.60	$335.20	$5,939.47	$10,325.33	$883.20	$670.40	$11,878.93	$5,162.67	$441.60	$335.20	$5,939.47
Wheat	$2,258.67	$193.20	$146.65	$2,598.52	$4,517.33	$386.40	$293.30	$5,197.03	$2,258.67	$193.20	$146.65	$2,598.52
Alfalfa, Flat	$4,840.00	$414.00	$314.25	$5,568.25	$9,680.00	$828.00	$628.50	$11,136.50	$4,840.00	$414.00	$314.25	$5,568.25
Field Crops, Flat	$2,904.00	$248.40	$188.55	$3,340.95	$5,808.00	$496.80	$377.10	$6,681.90	$2,904.00	$248.40	$188.55	$3,340.95
Alfalfa, Row	$5,808.00	$496.80	$335.20	$6,640.00	$11,616.00	$993.60	$670.40	$13,280.00	$5,808.00	$496.80	$335.20	$6,640.00
Field Crops, Row	$3,811.50	$326.03	$188.55	$4,326.08	$7,623.00	$652.05	$377.10	$8,652.15	$3,811.50	$326.03	$188.55	$4,326.08
Sugar Beets	$5,808.00	$496.80	$251.40	$6,556.20	$11,616.00	$993.60	$502.80	$13,112.40	$5,808.00	$496.80	$251.40	$6,556.20

A.12.3 Detailed Budget for 72-Acre Field, 0.5 Mile Pipeline

A.12.3.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	72 ac
Description		Cost Adjustment Factor =	0.75

TRS with 8 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	13,264	cy	$4.70	$62,300.00	50	$2,900	$40.28	1%	$623.00	$8.65
Concrete Headwall and 24" x 30' Drain Pipe	0.75	ea	$6,400.00	$4,800.00	50	$223	$3.10	2%	$96.00	$1.33
Trash Rack	0.75	ea	$2,400.00	$1,800.00	15	$162	$2.25	2%	$36.00	$0.50
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.75	ea	$3,400.00	$2,550.00	50	$119	$1.65	2%	$51.00	$0.71
Pump Station										
Sump, 48" x 15'	0.75	ea	$5,650.00	$4,237.50	50	$197	$2.74	2%	$84.75	$1.18
Flowmeter	0.75	ea	$2,400.00	$1,800.00	10	$222	$3.08	2%	$36.00	$0.50
Automatic Oiler	0.75	ea	$350.00	$262.50	15	$24	$0.33	9%	$23.63	$0.33
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.75	ea	$14,500.00	$10,875.00	15	$978	$13.58	9%	$978.75	$13.59
Security Enclosure	0.75	ea	$6,300.00	$4,725.00	50	$220	$3.05	2%	$94.50	$1.31
Pipeline										
PVC, 12" Class 80 PIP	2640	lf	$10.10	$26,700.00	20	$1,965	$27.29	2%	$534.00	$7.42
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$5,340.00	$5,340.00	20	$393	$5.46	2%	$106.80	$1.48
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	4	ea	$3,400.00	$13,600.00	30	$786	$10.92	2%	$272.00	$3.78
Ditch Grading[2]	12	hr	$145.00	$1,740.00	50	$81	$1.12	0%	$0.00	$0.00
Miscellaneous										
On-farm Admin[3]	1	ea	$7,000.00	$7,000.00		$414	$5.74	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$14,070.00		$830.00	$12.63		$290.00	$4.08
Total Cost:				$161,800.00		$9,514.00	$133.24		$3,226.00	$44.86

Notes/Assumptions

1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.12.3.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 72-Acre Field, 0.25 Mile Pipeline (see Section A.12.2.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068 gal/BHP-hr	3	26	0.6	14.7	4.0	4.0	$2.72	$10.99	0.9	$12.21

Notes
1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

A.12.4 Detailed Budget for 144-Acre Field, 0.25 Mile Pipeline

A.12.4.1 Annual Capital and Maintenance Costs

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	0.91

Description

TRS with 8 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	16,497	cy	$4.70	$77,500.00	50	$3,608	$25.05	1%	$775.00	$5.38
Concrete Headwall and 24" x 30' Drain Pipe	0.91	ea	$6,400.00	$5,824.00	50	$271	$1.88	2%	$116.48	$0.81
Trash Rack	0.91	ea	$2,400.00	$2,184.00	15	$196	$1.36	2%	$43.68	$0.30
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.91	ea	$3,400.00	$3,094.00	50	$144	$1.00	2%	$61.88	$0.43
Pump Station										
Sump, 48" x 15'	0.91	ea	$5,650.00	$5,141.50	50	$239	$1.66	2%	$102.83	$0.71
Flowmeter	0.91	ea	$2,400.00	$2,184.00	10	$269	$1.87	2%	$43.68	$0.30
Automatic Oiler	0.91	ea	$350.00	$318.50	15	$29	$0.20	9%	$28.67	$0.20
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.91	ea	$14,500.00	$13,195.00	15	$1,187	$8.24	9%	$1,187.55	$8.25
Security Enclosure	0.91	ea	$6,300.00	$5,733.00	50	$267	$1.85	2%	$114.66	$0.80
Pipeline										
PVC, 12" Class 80 PIP	1320	lf	$10.10	$13,300.00	20	$979	$6.80	2%	$266.00	$1.85
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$2,660.00	$2,660.00	20	$196	$1.36	2%	$53.20	$0.37
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	6	ea	$3,400.00	$20,400.00	30	$1,180	$8.19	2%	$408.00	$2.83
Ditch Grading[2]	20	hr	$145.00	$2,900.00	50	$135	$0.94	0%	$0.00	$0.00
Miscellaneous										
On-farm Admin[3]	1	ea	$7,700.00	$7,700.00		$435	$3.02	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$15,440.00		$870.00	$6.65		$320.00	$2.22
Total Cost:				$177,574.00		$10,004.00	$70.08		$3,522.00	$24.46

Notes/Assumptions

1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 20 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.12.4.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	72	$12.10	$6,534.00	1.33	$8,712.00	$2,178.00	$15.13
Bermuda	12	16	56	$12.10	$9,034.67	1.33	$12,046.22	$3,011.56	$20.91
Wheat	6	7	48	$12.10	$3,388.00	1.33	$4,517.33	$1,129.33	$7.84
Alfalfa, Flat	12	15	48	$12.10	$7,260.00	1.33	$9,680.00	$2,420.00	$16.81
Field Crops, Flat	5	9	52	$12.10	$4,719.00	1.33	$6,292.00	$1,573.00	$10.92
Alfalfa, Row	12	16	52	$12.10	$8,389.33	1.33	$11,185.78	$2,796.44	$19.42
Field Crops, Row	5	9	60	$12.10	$5,445.00	1.33	$7,260.00	$1,815.00	$12.60
Sugar Beets	9	12	68	$12.10	$8,228.00	1.33	$10,970.67	$2,742.67	$19.05

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating TRS.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	TRS Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$558.90	1.33	$745.20	$186.30	$1.29
Bermuda	12	9	12	$20.70	$772.80	1.33	$1,030.40	$257.60	$1.79
Wheat	12	9	12	$20.70	$289.80	1.33	$386.40	$96.60	$0.67
Alfalfa, Flat	12	9	12	$20.70	$621.00	1.33	$828.00	$207.00	$1.44
Field Crops, Flat	12	9	12	$20.70	$403.65	1.33	$538.20	$134.55	$0.93
Alfalfa, Row	12	9	12	$20.70	$717.60	1.33	$956.80	$239.20	$1.66
Field Crops, Row	12	9	12	$20.70	$465.75	1.33	$621.00	$155.25	$1.08
Sugar Beets	12	9	12	$20.70	$703.80	1.33	$938.40	$234.60	$1.63

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneouslt spervised by a full-time irrigation foreman with TRS.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising TRS events = fields covered / TRS fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	TRS Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$1.02
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$2.18
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$1.75

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068 gal/BHP-hr	3	19	0.6	10.8	4.0	3.0	$2.72	$8.03	0.9	$8.92

Notes

1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

Adjustment of Operations Costs for Extended Delivery

	Typical Existing Costs per Season				Expected Costs Under Extended Delivery				Incremental Costs of TRS			
Crop Type	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total	Irrigator	Foreman	Manager	Total
Truck Crops	$6,534.00	$558.90	$188.55	$7,281.45	$13,068.00	$1,117.80	$377.10	$14,562.90	$6,534.00	$558.90	$188.55	$7,281.45
Bermuda	$9,034.67	$772.80	$335.20	$10,142.67	$18,069.33	$1,545.60	$670.40	$20,285.33	$9,034.67	$772.80	$335.20	$10,142.67
Wheat	$3,388.00	$289.80	$146.65	$3,824.45	$6,776.00	$579.60	$293.30	$7,648.90	$3,388.00	$289.80	$146.65	$3,824.45
Alfalfa, Flat	$7,260.00	$621.00	$314.25	$8,195.25	$14,520.00	$1,242.00	$628.50	$16,390.50	$7,260.00	$621.00	$314.25	$8,195.25
Field Crops, Flat	$4,719.00	$403.65	$188.55	$5,311.20	$9,438.00	$807.30	$377.10	$10,622.40	$4,719.00	$403.65	$188.55	$5,311.20
Alfalfa, Row	$8,389.33	$717.60	$335.20	$9,442.13	$16,778.67	$1,435.20	$670.40	$18,884.27	$8,389.33	$717.60	$335.20	$9,442.13
Field Crops, Row	$5,445.00	$465.75	$188.55	$6,099.30	$10,890.00	$931.50	$377.10	$12,198.60	$5,445.00	$465.75	$188.55	$6,099.30
Sugar Beets	$8,228.00	$703.80	$251.40	$9,183.20	$16,456.00	$1,407.60	$502.80	$18,366.40	$8,228.00	$703.80	$251.40	$9,183.20

A.12.5 Detailed Budget for 144-Acre Field, 0.5 Mile Pipeline

A.12.5.1 Annual Capital and Maintenance Costs

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	0.91

Description

TRS with 8 ac-ft reservoir and 3 cfs Diesel pump. Permanent installation with buried 12" PVC mainline.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Reverse Grade Pond										
Excavation	16,497	cy	$4.70	$77,500.00	50	$3,608	$25.05	1%	$775.00	$5.38
Concrete Headwall and 24" x 30' Drain Pipe	0.91	ea	$6,400.00	$5,824.00	50	$271	$1.88	2%	$116.48	$0.81
Trash Rack	0.91	ea	$2,400.00	$2,184.00	15	$196	$1.36	2%	$43.68	$0.30
Drain Box, 36" x 5' and 24" x 30' Drain Pipe	0.91	ea	$3,400.00	$3,094.00	50	$144	$1.00	2%	$61.88	$0.43
Pump Station										
Sump, 48" x 15'	0.91	ea	$5,650.00	$5,141.50	50	$239	$1.66	2%	$102.83	$0.71
Flowmeter	0.91	ea	$2,400.00	$2,184.00	10	$269	$1.87	2%	$43.68	$0.30
Automatic Oiler	0.91	ea	$350.00	$318.50	15	$29	$0.20	9%	$28.67	$0.20
Diesel Engine/Pump, 3 cfs @ 20' TDH	0.91	ea	$14,500.00	$13,195.00	15	$1,187	$8.24	9%	$1,187.55	$8.25
Security Enclosure	0.91	ea	$6,300.00	$5,733.00	50	$267	$1.85	2%	$114.66	$0.80
Pipeline										
PVC, 12" Class 80 PIP	2640	lf	$10.10	$26,700.00	20	$1,965	$13.64	2%	$534.00	$3.71
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[1]	1	ea	$5,340.00	$5,340.00	20	$393	$2.73	2%	$106.80	$0.74
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	6	ea	$3,400.00	$20,400.00	30	$1,180	$8.19	2%	$408.00	$2.83
Ditch Grading[2]	20	hr	$145.00	$2,900.00	50	$135	$0.94	0%	$0.00	$0.00
Miscellaneous										
On-farm Admin[3]	1	ea	$8,500.00	$8,500.00		$494	$3.43	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$17,050.00		$990.00	$7.55		$350.00	$2.45
Total Cost:				$196,064.00		$11,367.00	$79.61		$3,873.00	$26.91

Notes/Assumptions

1. Pump discharge plumbing, pipeline fittings and valves estimated as 20% of pipeline costs based on previous IID TRS installations.
2. Ditch grading cost estimated based on 20 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
3. On farm admin cost estimated to be 5% of total capital.
4. Pond and Pump Station Costs adjusted to reflect cost savings of constructing a single pond and pump station to serve multiple fields.

A.12.5.2 Seasonal Operations Costs

Labor costs for normal and extended delivery are the same as for 72-Acre Field, 0.25 Mile Pipeline (see Section A.12.4.2).

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft	Savings Ratio[3]	$/ac-ft Saved
Diesel Fuel	0.068 gal/BHP-hr	3	26	0.6	14.7	4.0	4.0	$2.72	$10.99	0.9	$12.21

Notes
1. Specific fuel consumption based on specifications for Deutz engines.
2. TDH calculated to include pipeline friction losses, minor losses, and required lift for field slopes ranging from 0.05% to 0.25%. Rounded to nearest 5 feet.
3. Ratio of conserved water (delivery reduction) to water pumped back by TRS. Estimated from IID/MWD Water Conservation Agreement CVC Verification Summary Report, 12/01.

Attachment 13
Detailed Cost Estimates for Drip Irrigation
Detailed Cost Estimates for Drip Irrigation without Reservoir

A.13.1 Detailed Budget for 36-Acre Field

A.13.1.1 Annual Capital and Maintenance Costs

	i =	4%
	Field Size =	36 ac
	Cost Adjustment Factor =	0.6

Description
Drip Irrigation with 1000 gpm pump. Pump is trailer mounted.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 40psi[1]	1	ea	$42,000.00	$42,000.00	15	$3,778	$104.93	9%	$3,780.00	$105.00
Drip System										
Mainlines, submains, laterals, valves, vents, fittings	36	ac	$850.00	$30,600.00	8	$4,545	$126.25	6%	$1,836.00	$51.00
Miscellaneous										
On farm admin, 5%	1	ea	$3,630.00	$3,630.00	8	$539	$14.98	0%	$0.00	$0.00
			Contingency and Unlisted Items (10%):	$7,260.00		$830.00	$25.43		$560.00	$15.60
			Total Cost:	$83,490.00		$9,692.00	$271.59		$6,176.00	$171.60

Notes/Assumptions
1. Pump includes inlet and outlet hoses, media filters.
2. Costs of reservoirs have been adjusted based on likelihood of fields being grouped so that one reservoir and pump station serves more than one field.

A.13.1.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Drip Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Drip Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	26	0.25	0.057750076	458	$1,384.43	-$1,882.57	-$52.29
Bermuda	12	16	24	$12.10	$3,872.00	55	0.25	0.057750076	945	$2,858.85	-$1,013.15	-$28.14
Wheat	6	7	24	$12.10	$1,694.00	22	0.25	0.057750076	375	$1,134.18	-$559.82	-$15.55
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	52	0.25	0.057750076	901	$2,724.76	-$905.24	-$25.15
Field Crops, Flat	5	9	24	$12.10	$2,178.00	34	0.25	0.057750076	595	$1,801.11	-$376.89	-$10.47
Alfalfa, Row	12	16	24	$12.10	$3,872.00	52	0.25	0.057750076	901	$2,724.76	-$1,147.24	-$31.87
Field Crops, Row	5	9	36	$12.10	$3,267.00	34	0.25	0.057750076	595	$1,801.11	-$1,465.89	-$40.72
Sugar Beets	9	12	36	$12.10	$4,356.00	40	0.25	0.057750076	696	$2,104.22	-$2,251.78	-$62.55

Notes

1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under drip irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for drip irrigation.

Estimate of Effective Precip Rate

Run length:	1250	ft
Tape Spacing:	3.33	ft
Tape Flow:	0.004	gpm/ft
Pump gpm/set (19 ac):	1012.5	gpm
Pump flow per acre:	52	gpm/ac
Number of sets:	2	
Application Rate:	0.12	in/hr
Effective Precip Rate:	0.06	in/hr

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$538.20	$258.75	$7.19
Bermuda	12	9	12	$20.70	$331.20	1.33	$745.20	$414.00	$11.50
Wheat	12	9	12	$20.70	$144.90	1.33	$303.60	$158.70	$4.41
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$717.60	$407.10	$11.31
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$469.20	$282.90	$7.86
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$717.60	$386.40	$10.73
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$703.80	$424.35	$11.79
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$828.00	$455.40	$12.65

Notes

1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with sprinkler.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / sprinkle fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Drip Hrs/Irr[2]	Drip Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$2.33
Bermuda	0.5	$41.90	$335.20	0.5	27	$565.65	$230.45	$6.40
Wheat	0.5	$41.90	$146.65	0.5	11	$230.45	$83.80	$2.33
Alfalfa, Flat	0.5	$41.90	$314.25	0.5	26	$544.70	$230.45	$6.40
Field Crops, Flat	0.5	$41.90	$188.55	0.5	17	$356.15	$167.60	$4.66
Alfalfa, Row	0.5	$41.90	$335.20	0.5	26	$544.70	$209.50	$5.82
Field Crops, Row	0.5	$41.90	$188.55	0.5	17	$356.15	$167.60	$4.66
Sugar Beets	0.5	$41.90	$251.40	0.5	20	$419.00	$167.60	$4.66

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per sprinkle irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 2" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.0798	gal/BHP-hr	2.2	95	0.7	33.8	5.5	14.9	$2.72	$40.39

Crop	Drip Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	26	$3,202.69	$88.96
Bermuda	55	$6,613.57	$183.71
Wheat	22	$2,623.77	$72.88
Alfalfa, Flat	52	$6,303.35	$175.09
Field Crops, Flat	34	$4,166.62	$115.74
Alfalfa, Row	52	$6,303.35	$175.09
Field Crops, Row	34	$4,166.62	$115.74
Sugar Beets	40	$4,867.83	$135.22

Notes
1. Specific fuel consumption estimated from Rain for Rent literature.
2. TDH estimated based on 40 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.13.2 Detailed Budget for 72-Acre Field

A.13.2.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	72 ac
Description		Cost Adjustment Factor =	0.75
Drip Irrigation with 1000 gpm pump. Pump is trailer mounted.			

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 40psi[1]		1 ea	$42,000.00	$42,000.00	15	$3,778	$52.47	9%	$3,780.00	$52.50
Drip System										
Mainlines, submains, laterals, valves, vents, fittings		72 ac	$850.00	$61,200.00	8	$9,090	$126.25	6%	$3,672.00	$51.00
Miscellaneous										
On farm admin, 5%		1 ea	$5,160.00	$5,160.00	8	$766	$10.64	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$10,320.00		$1,290.00	$19.66		$750.00	$10.35
			Total Cost:	$118,680.00		$14,924.00	$209.02		$8,202.00	$113.85

Notes/Assumptions
1. Pump includes inlet and outlet hoses, media filters.
2. Costs of reservoirs have been adjusted based on likelihood of fields being grouped so that one reservoir and pump station serves more than one field.

A.13.2.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Drip Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Drip Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	26	0.25	0.028875038	915	$2,768.86	-$498.14	-$6.92
Bermuda	12	16	24	$12.10	$3,872.00	55	0.25	0.028875038	1890	$5,717.71	$1,845.71	$25.63
Wheat	6	7	24	$12.10	$1,694.00	22	0.25	0.028875038	750	$2,268.36	$574.36	$7.98
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	52	0.25	0.028875038	1801	$5,449.52	$1,819.52	$25.27
Field Crops, Flat	5	9	24	$12.10	$2,178.00	34	0.25	0.028875038	1191	$3,602.22	$1,424.22	$19.78
Alfalfa, Row	12	16	24	$12.10	$3,872.00	52	0.25	0.028875038	1801	$5,449.52	$1,577.52	$21.91
Field Crops, Row	5	9	36	$12.10	$3,267.00	34	0.25	0.028875038	1191	$3,602.22	$335.22	$4.66
Sugar Beets	9	12	36	$12.10	$4,356.00	40	0.25	0.028875038	1391	$4,208.44	-$147.56	-$2.05

Notes

1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under drip irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for drip irrigation.

Estimate of Effective Precip Rate

Run length:	1250	ft
Tape Spacing:	3.33	ft
Tape Flow:	0.004	gpm/ft
Pump gpm/set (19 ac):	1012.5	gpm
Pump flow per acre:	52	gpm/ac
Number of sets:	4	
Application Rate:	0.12	in/hr
Effective Precip Rate:	0.03	in/hr

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$538.20	$258.75	$3.59
Bermuda	12	9	12	$20.70	$331.20	1.33	$745.20	$414.00	$5.75
Wheat	12	9	12	$20.70	$144.90	1.33	$303.60	$158.70	$2.20
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$717.60	$407.10	$5.65
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$469.20	$282.90	$3.93
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$717.60	$386.40	$5.37
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$703.80	$424.35	$5.89
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$828.00	$455.40	$6.33

Notes

1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with sprinkler.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / sprinkle fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Drip Hrs/Irr[2]	Drip Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$1.16
Bermuda	0.5	$41.90	$335.20	0.5	27	$565.65	$230.45	$3.20
Wheat	0.5	$41.90	$146.65	0.5	11	$230.45	$83.80	$1.16
Alfalfa, Flat	0.5	$41.90	$314.25	0.5	26	$544.70	$230.45	$3.20
Field Crops, Flat	0.5	$41.90	$188.55	0.5	17	$356.15	$167.60	$2.33
Alfalfa, Row	0.5	$41.90	$335.20	0.5	26	$544.70	$209.50	$2.91
Field Crops, Row	0.5	$41.90	$188.55	0.5	17	$356.15	$167.60	$2.33
Sugar Beets	0.5	$41.90	$251.40	0.5	20	$419.00	$167.60	$2.33

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per sprinkle irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 2" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.0798	gal/BHP-hr	2.2	95	0.7	33.8	5.5	14.9	$2.72	$40.39

Crop	Drip Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	26	$6,405.38	$88.96
Bermuda	55	$13,227.13	$183.71
Wheat	22	$5,247.54	$72.88
Alfalfa, Flat	52	$12,606.71	$175.09
Field Crops, Flat	34	$8,333.24	$115.74
Alfalfa, Row	52	$12,606.71	$175.09
Field Crops, Row	34	$8,333.24	$115.74
Sugar Beets	40	$9,735.66	$135.22

Notes
1. Specific fuel consumption estimated from Rain for Rent literature.
2. TDH estimated based on 40 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.13.3 Detailed Budget for 144-Acre Field

A.13.3.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	144 ac
Description		Cost Adjustment Factor =	0.91
Drip Irrigation with 1000 gpm pump. Pump is trailer mounted.			

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 40psi[1]	1	ea	$42,000.00	$42,000.00	15	$3,778	$26.23	9%	$3,780.00	$26.25
Drip System										
Mainlines, submains, laterals, valves, vents, fittings	144	ac	$850.00	$122,400.00	8	$18,180	$126.25	6%	$7,344.00	$51.00
Miscellaneous										
On farm admin, 5%	1	ea	$8,220.00	$8,220.00	8	$1,221	$8.48	0%	$0.00	$0.00
			Contingency and Unlisted Items (10%):	$16,440.00		$2,200.00	$16.77		$1,110.00	$7.73
			Total Cost:	$189,060.00		$25,378.00	$177.73		$12,234.00	$84.98

Notes/Assumptions
1. Pump includes inlet and outlet hoses, media filters.
2. Costs of reservoirs have been adjusted based on likelihood of fields being grouped so that one reservoir and pump station serves more than one field.

A.13.3.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Drip Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Drip Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	26	0.25	0.014437519	1831	$5,537.72	$2,270.72	$15.77
Bermuda	12	16	24	$12.10	$3,872.00	55	0.25	0.014437519	3780	$11,435.41	$7,563.41	$52.52
Wheat	6	7	24	$12.10	$1,694.00	22	0.25	0.014437519	1500	$4,536.72	$2,842.72	$19.74
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	52	0.25	0.014437519	3603	$10,899.03	$7,269.03	$50.48
Field Crops, Flat	5	9	24	$12.10	$2,178.00	34	0.25	0.014437519	2382	$7,204.44	$5,026.44	$34.91
Alfalfa, Row	12	16	24	$12.10	$3,872.00	52	0.25	0.014437519	3603	$10,899.03	$7,027.03	$48.80
Field Crops, Row	5	9	36	$12.10	$3,267.00	34	0.25	0.014437519	2382	$7,204.44	$3,937.44	$27.34
Sugar Beets	9	12	36	$12.10	$4,356.00	40	0.25	0.014437519	2782	$8,416.89	$4,060.89	$28.20

Notes

1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under drip irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for drip irrigation.

Estimate of Effective Precip Rate

Run length:	1250	ft
Tape Spacing:	3.33	ft
Tape Flow:	0.004	gpm/ft
Pump gpm/set (19 ac):	1012.5	gpm
Pump flow per acre:	52	gpm/ac
Number of sets:	8	
Application Rate:	0.12	in/hr
Effective Precip Rate:	0.01	in/hr

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$538.20	$258.75	$1.80
Bermuda	12	9	12	$20.70	$331.20	1.33	$745.20	$414.00	$2.88
Wheat	12	9	12	$20.70	$144.90	1.33	$303.60	$158.70	$1.10
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$717.60	$407.10	$2.83
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$469.20	$282.90	$1.96
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$717.60	$386.40	$2.68
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$703.80	$424.35	$2.95
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$828.00	$455.40	$3.16

Notes

1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with sprinkler.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / sprinkle fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Drip Hrs/Irr[2]	Drip Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$0.58
Bermuda	0.5	$41.90	$335.20	0.5	27	$565.65	$230.45	$1.60
Wheat	0.5	$41.90	$146.65	0.5	11	$230.45	$83.80	$0.58
Alfalfa, Flat	0.5	$41.90	$314.25	0.5	26	$544.70	$230.45	$1.60
Field Crops, Flat	0.5	$41.90	$188.55	0.5	17	$356.15	$167.60	$1.16
Alfalfa, Row	0.5	$41.90	$335.20	0.5	26	$544.70	$209.50	$1.45
Field Crops, Row	0.5	$41.90	$188.55	0.5	17	$356.15	$167.60	$1.16
Sugar Beets	0.5	$41.90	$251.40	0.5	20	$419.00	$167.60	$1.16

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per sprinkle irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 2" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.0798 gal/BHP-hr	2.2	95	0.7	33.8	5.5	14.9	$2.72	$40.39

Crop	Drip Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	26	$12,810.77	$88.96
Bermuda	55	$26,454.27	$183.71
Wheat	22	$10,495.08	$72.88
Alfalfa, Flat	52	$25,213.41	$175.09
Field Crops, Flat	34	$16,666.48	$115.74
Alfalfa, Row	52	$25,213.41	$175.09
Field Crops, Row	34	$16,666.48	$115.74
Sugar Beets	40	$19,471.32	$135.22

Notes
1. Specific fuel consumption estimated from Rain for Rent literature.
2. TDH estimated based on 40 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

Detailed Cost Estimates for Drip Irrigation with Reservoir on System

A.13.4 Detailed Budget for 36-Acre Field

A.13.4.1 Annual Capital and Maintenance Costs

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Drip Irrigation with 1000 gpm pump. Pump is trailer mounted.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 40psi[1]	1	ea	$42,000.00	$42,000.00	15	$3,778	$104.93	9%	$3,780.00	$105.00
Drip System										
Mainlines, submains, laterals, valves, vents, fittings	36	ac	$850.00	$30,600.00	8	$4,545	$126.25	6%	$1,836.00	$51.00
Miscellaneous										
On-farm admin[2]	1	ea	$4,761.50	$4,761.50	8	$707	$19.64	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$9,520.00		$940.00	$28.65		$590.00	$16.48
			Total Cost:	$109,511.50		$11,023.00	$308.74		$6,523.00	$181.27

Notes/Assumptions
1. Pump includes inlet and outlet hoses, media filters.
2. On-farm admin cost estimated to be 5% of total capital.
3. Costs of reservoirs have been adjusted based on likelihood of fields being grouped so that one reservoir and pump station serves more than one field.

A.13.4.2 Seasonal Operations Costs

Operations costs are the same as for 36-Acre Field without Reservoir (see Section A.13.1.2).

A.13.5 Detailed Budget for 72-Acre Field

A.13.5.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	72 ac
Description		Cost Adjustment Factor =	0.75

Drip Irrigation with 1000 gpm pump. Pump is trailer mounted.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 40psi[1]	1	ea	$42,000.00	$42,000.00	15	$3,778	$52.47	9%	$3,780.00	$52.50
Drip System										
Mainlines, submains, laterals, valves, vents, fittings	72	ac	$850.00	$61,200.00	8	$9,090	$126.25	6%	$3,672.00	$51.00
Miscellaneous										
On-farm admin[2]	1	ea	$6,574.38	$6,574.38	8	$976	$13.56	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$13,150.00		$1,420.00	$21.67		$780.00	$10.90
			Total Cost:	$151,211.88		$16,581.00	$232.24		$8,628.00	$119.90

Notes/Assumptions
1. Pump includes inlet and outlet hoses, media filters.
2. On-farm admin cost estimated to be 5% of total capital.
3. Costs of reservoirs have been adjusted based on likelihood of fields being grouped so that one reservoir and pump station serves more than one field.

A.13.5.2 Seasonal Operations Costs

Operations costs are the same as for 72-Acre Field without Reservoir (see Section A.13.2.2).

A.13.6 Detailed Budget for 144-Acre Field

A.13.6.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	144 ac
Description		Cost Adjustment Factor =	0.91
Drip Irrigation with 1000 gpm pump. Pump is trailer mounted.			

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 40psi[1]	1	ea	$42,000.00	$42,000.00	15	$3,778	$26.23	9%	$3,780.00	$26.25
Drip System										
Mainlines, submains, laterals, valves, vents, fittings	144	ac	$850.00	$122,400.00	8	$18,180	$126.25	6%	$7,344.00	$51.00
Miscellaneous										
On-farm admin[2]	1	ea	$9,934.78	$9,934.78	8	$1,476	$10.25	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$19,870.00		$2,360.00	$17.99		$1,160.00	$8.06
		Total Cost:		$228,500.28		$27,389.00	$191.81		$12,764.00	$88.64

Notes/Assumptions
1. Pump includes inlet and outlet hoses, media filters.
2. On-farm admin cost estimated to be 5% of total capital.
3. Costs of reservoirs have been adjusted based on likelihood of fields being grouped so that one reservoir and pump station serves more than one field.

A.13.6.2 Seasonal Operations Costs

Operations costs are the same as for 144-Acre Field without Reservoir (see Section A.13.3.2).

Detailed Cost Estimates for Drip Irrigation with Reservoir off System

A.13.7 Detailed Budget for 36-Acre Field

A.13.7.1 Annual Capital and Maintenance Costs

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Drip Irrigation with 1000 gpm pump. Pump is trailer mounted.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0.6	ea	$5,650.00	$3,390.00	50	$158	$4.38	2%	$67.80	$1.88
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 40psi[1]	1	ea	$42,000.00	$42,000.00	15	$3,778	$104.93	9%	$3,780.00	$105.00
Drip System										
Mainlines, submains, laterals, valves, vents, fittings	36	ac	$850.00	$30,600.00	8	$4,545	$126.25	6%	$1,836.00	$51.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$4,931.00	$4,931.00	8	$732	$20.34	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$9,860.00		$950.00	$29.13		$600.00	$16.67
		Total Cost:		$113,411.00		$11,216.00	$314.30		$6,600.00	$183.35

Notes/Assumptions
1. Pump includes inlet and outlet hoses, media filters.
2. On-farm admin cost estimated to be 5% of total capital.
3. Costs of reservoirs have been adjusted based on likelihood of fields being grouped so that one reservoir and pump station serves more than one field.

A.13.7.2 Seasonal Operations Costs

Operations costs are the same as for 36-Acre Field without Reservoir (see Section A.13.1.2).

A.13.8 Detailed Budget for 72-Acre Field

A.13.8.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	72 ac
Description		Cost Adjustment Factor =	0.75
Drip Irrigation with 1000 gpm pump. Pump is trailer mounted.			

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0.75	ea	$5,650.00	$4,237.50	50	$197	$2.74	2%	$84.75	$1.18
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 40psi[1]	1	ea	$42,000.00	$42,000.00	15	$3,778	$52.47	9%	$3,780.00	$52.50
Drip System										
Mainlines, submains, laterals, valves, vents, fittings	72	ac	$850.00	$61,200.00	8	$9,090	$126.25	6%	$3,672.00	$51.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$6,786.25	$6,786.25	8	$1,008	$14.00	0%	$0.00	$0.00
			Contingency and Unlisted Items (10%):	$13,570.00		$1,440.00	$21.97		$790.00	$11.02
			Total Cost:	$156,081.25		$16,829.00	$235.71		$8,723.00	$121.19

Notes/Assumptions
1. Pump includes inlet and outlet hoses, media filters.
2. On-farm admin cost estimated to be 5% of total capital.
3. Costs of reservoirs have been adjusted based on likelihood of fields being grouped so that one reservoir and pump station serves more than one field.

A.13.8.2 Seasonal Operations Costs

Operations costs are the same as for 72-Acre Field without Reservoir (see Section A.13.2.2).

A.13.9 Detailed Budget for 144-Acre Field

A.13.9.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	144 ac
Description		Cost Adjustment Factor =	0.91
Drip Irrigation with 1000 gpm pump. Pump is trailer mounted.			

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0.91	ea	$5,650.00	$5,141.50	50	$239	$1.66	2%	$102.83	$0.71
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 40psi[1]	1	ea	$42,000.00	$42,000.00	15	$3,778	$26.23	9%	$3,780.00	$26.25
Drip System										
Mainlines, submains, laterals, valves, vents, fittings	144	ac	$850.00	$122,400.00	8	$18,180	$126.25	6%	$7,344.00	$51.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$10,191.85	$10,191.85	8	$1,514	$10.51	0%	$0.00	$0.00
		Contingency and Unlisted Items (10%):		$20,380.00		$2,380.00	$18.18		$1,170.00	$8.13
		Total Cost:		$234,408.85		$27,687.00	$193.92		$12,877.00	$89.43

Notes/Assumptions
1. Pump includes inlet and outlet hoses, media filters.
2. On-farm admin cost estimated to be 5% of total capital.
3. Costs of reservoirs have been adjusted based on likelihood of fields being grouped so that one reservoir and pump station serves more than one field.

A.13.9.2 Seasonal Operations Costs

Operations costs are the same as for 144-Acre Field without Reservoir (see Section A.13.3.2).

Attachment 14
Detailed Cost Estimates for Sprinkle Irrigation
Detailed Cost Estimates for Sprinkle Irrigation without Reservoir

A.14.1 Detailed Budget for 36-Acre Field

A.14.1.1 Annual Capital and Maintenance Costs

(Purchase)

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Sprinkler Irrigation with 1000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	1	ea	$8,000.00	$8,000.00	15	$720	$19.99	9%	$720.00	$20.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$2,300.00	$82,800.00	15	$7,447	$206.86	2%	$1,656.00	$46.00
Miscellaneous										
On-farm admin, 5%				$4,540.00		$408.33	$11.34			
			Contingency and Unlisted Items (10%):	$9,080.00		$820.00	$24.95		$240.00	$6.60
			Total Cost:	$104,420.00		$9,395.00	$263.15		$2,616.00	$72.60

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Sprinkler Irrigation with 2000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	1	ea	$10,933.33	$10,933.33	15	$983	$27.32	9%	$984.00	$27.33
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$2,300.00	$82,800.00	15	$7,447	$206.86	2%	$1,656.00	$46.00
Miscellaneous										
On-farm admin, 5%				$4,686.67		$421.52	$11.71			
			Contingency and Unlisted Items (10%):	$9,370.00		$840.00	$25.76		$260.00	$7.33
			Total Cost:	$107,790.00		$9,692.00	$271.65		$2,900.00	$80.67

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

(Rental)

	i =	4%
	Field Size =	36 ac
	Cost Adjustment Factor =	0.6

Description

Sprinkler Irrigation with 1000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	12	mo	$416.67	$5,000.00	1	$5,200	$144.44	9%	$450.00	$12.50
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$360.00	$13,000.00	1	$13,520	$375.56	2%	$260.00	$7.22
Miscellaneous										
On-farm admin, 5%				$900.00		$936.00	$26.00			
			Contingency and Unlisted Items (10%):	$1,800.00		$1,870.00	$57.20		$70.00	$1.97
			Total Cost:	$20,700.00		$21,526.00	$603.20		$780.00	$21.69

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Sprinkler Irrigation with 2000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	12	mo	$560.00	$6,720.00	1	$6,989	$194.13	9%	$604.80	$16.80
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$360.00	$13,000.00	1	$13,520	$375.56	2%	$260.00	$7.22
Miscellaneous										
On-farm admin, 5%				$986.00		$1,025.44	$28.48			
			Contingency and Unlisted Items (10%):	$1,970.00		$2,050.00	$62.67		$90.00	$2.40
			Total Cost:	$22,676.00		$23,584.00	$660.84		$955.00	$26.42

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

A.14.1.2 Seasonal Operations Costs

(1000 gpm pump)

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Sprinkler Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Sprinkler Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	30	0.33	0.055	549	$3,499.74	$232.74	$6.47
Bermuda	12	16	24	$12.10	$3,872.00	62	0.33	0.055	1134	$5,835.23	$1,963.23	$54.53
Wheat	6	7	24	$12.10	$1,694.00	25	0.33	0.055	450	$3,103.34	$1,409.34	$39.15
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	59	0.33	0.055	1081	$5,622.82	$1,992.82	$55.36
Field Crops, Flat	5	9	24	$12.10	$2,178.00	39	0.33	0.055	714	$4,159.76	$1,981.76	$55.05
Alfalfa, Row	12	16	24	$12.10	$3,872.00	59	0.33	0.055	1081	$5,622.82	$1,750.82	$48.63
Field Crops, Row	5	9	36	$12.10	$3,267.00	39	0.33	0.055	714	$4,159.76	$892.76	$24.80
Sugar Beets	9	12	36	$12.10	$4,356.00	46	0.33	0.055	835	$4,639.89	$283.89	$7.89

Notes

1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under sprinkler irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for sprinkler irrigation including 3 hours total per acre for system set up and retrieval.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$414.00	$134.55	$3.74
Bermuda	12	9	12	$20.70	$331.20	1.33	$579.60	$248.40	$6.90
Wheat	12	9	12	$20.70	$144.90	1.33	$220.80	$75.90	$2.11
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$552.00	$241.50	$6.71
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$358.80	$172.50	$4.79
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$552.00	$220.80	$6.13
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$538.20	$258.75	$7.19
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$621.00	$248.40	$6.90

Notes

1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with sprinkler.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / sprinkle fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Sprinkle Hrs/Irr[2]	Sprinkle Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.5	10	$209.50	$20.95	$0.58
Bermuda	0.5	$41.90	$335.20	0.5	21	$439.95	$104.75	$2.91
Wheat	0.5	$41.90	$146.65	0.5	8	$167.60	$20.95	$0.58
Alfalfa, Flat	0.5	$41.90	$314.25	0.5	20	$419.00	$104.75	$2.91
Field Crops, Flat	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$2.33
Alfalfa, Row	0.5	$41.90	$335.20	0.5	20	$419.00	$83.80	$2.33
Field Crops, Row	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$2.33
Sugar Beets	0.5	$41.90	$251.40	0.5	15	$314.25	$62.85	$1.75

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per sprinkle irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 3" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]	Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.1229 gal/BHP-hr	2.2	185	0.7	65.9	5.5	44.6	$2.72	$121.18

Crop	Sprinkler Applied (ir	Fuel $/field	Fuel $/ac
Truck Crops	30	$10,980.66	$305.02
Bermuda	62	$22,675.08	$629.86
Wheat	25	$8,995.78	$249.88
Alfalfa, Flat	59	$21,611.50	$600.32
Field Crops, Flat	39	$14,285.55	$396.82
Alfalfa, Row	59	$21,611.50	$600.32
Field Crops, Row	39	$14,285.55	$396.82
Sugar Beets	46	$16,689.70	$463.60

Notes
1. Specific fuel consumption estimated from Rain for Rent literature.
2. TDH calculated based on pump discharge pressure of 80 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]
Irrigation Scheduling Consultant	$1,170 per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

(2000 gpm pump)

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Sprinkler Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Sprinkler Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	30	0.33	0.11	275	$2,403.27	-$863.73	-$23.99
Bermuda	12	16	24	$12.10	$3,872.00	62	0.33	0.11	567	$3,571.02	-$300.98	-$8.36
Wheat	6	7	24	$12.10	$1,694.00	25	0.33	0.11	225	$2,205.07	$511.07	$14.20
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	59	0.33	0.11	540	$3,464.81	-$165.19	-$4.59
Field Crops, Flat	5	9	24	$12.10	$2,178.00	39	0.33	0.11	357	$2,733.28	$555.28	$15.42
Alfalfa, Row	12	16	24	$12.10	$3,872.00	59	0.33	0.11	540	$3,464.81	-$407.19	-$11.31
Field Crops, Row	5	9	36	$12.10	$3,267.00	39	0.33	0.11	357	$2,733.28	-$533.72	-$14.83
Sugar Beets	9	12	36	$12.10	$4,356.00	46	0.33	0.11	417	$2,973.35	-$1,382.65	-$38.41

Notes

1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under sprinkler irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for sprinkler irrigation including 3 hours total per acre for system set up and retrieval.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$414.00	$134.55	$3.74
Bermuda	12	9	12	$20.70	$331.20	1.33	$579.60	$248.40	$6.90
Wheat	12	9	12	$20.70	$144.90	1.33	$220.80	$75.90	$2.11
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$552.00	$241.50	$6.71
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$358.80	$172.50	$4.79
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$552.00	$220.80	$6.13
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$538.20	$258.75	$7.19
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$621.00	$248.40	$6.90

Notes

1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with sprinkler.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / sprinkle fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Sprinkle Hrs/Irr[2]	Sprinkle Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.5	10	$209.50	$20.95	$0.58
Bermuda	0.5	$41.90	$335.20	0.5	21	$439.95	$104.75	$2.91
Wheat	0.5	$41.90	$146.65	0.5	8	$167.60	$20.95	$0.58
Alfalfa, Flat	0.5	$41.90	$314.25	0.5	20	$419.00	$104.75	$2.91
Field Crops, Flat	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$2.33
Alfalfa, Row	0.5	$41.90	$335.20	0.5	20	$419.00	$83.80	$2.33
Field Crops, Row	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$2.33
Sugar Beets	0.5	$41.90	$251.40	0.5	15	$314.25	$62.85	$1.75

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per sprinkle irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 3" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.0854	gal/BHP-hr	4.4	185	0.7	131.8	2.8	30.9	$2.72	$84.15

Crop	Sprinkler Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	30	$7,625.46	$211.82
Bermuda	62	$15,746.59	$437.41
Wheat	25	$6,247.07	$173.53
Alfalfa, Flat	59	$15,007.99	$416.89
Field Crops, Flat	39	$9,920.52	$275.57
Alfalfa, Row	59	$15,007.99	$416.89
Field Crops, Row	39	$9,920.52	$275.57
Sugar Beets	46	$11,590.07	$321.95

Notes
1. Specific fuel consumption estimated from Rain for Rent literature.
2. TDH calculated based on pump discharge pressure of 80 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.14.2 Detailed Budget for 72-Acre Field

A.14.2.1 Annual Capital and Maintenance Costs
(Purchase)

	i =	4%
	Field Size =	72 ac
Description	Cost Adjustment Factor =	0.75

Sprinkler Irrigation with 1000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	1	ea	$8,000.00	$8,000.00	15	$720	$9.99	9%	$720.00	$10.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$2,300.00	$165,600.00	15	$14,894	$206.86	2%	$3,312.00	$46.00
Miscellaneous										
On-farm admin, 5%				$8,680.00		$780.69	$10.84			
			Contingency and Unlisted Items (10%):	$17,360.00		$1,560.00	$23.85		$400.00	$5.60
			Total Cost:	$199,640.00		$17,954.00	$251.56		$4,432.00	$61.60

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

	i =	4%
	Field Size =	72 ac
Description	Cost Adjustment Factor =	0.75

Sprinkler Irrigation with 2000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	1	ea	$10,933.33	$10,933.33	15	$983	$13.66	9%	$984.00	$13.67
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$2,300.00	$165,600.00	15	$14,894	$206.86	2%	$3,312.00	$46.00
Miscellaneous										
On-farm admin, 5%				$8,826.67		$793.88	$11.03			
			Contingency and Unlisted Items (10%):	$17,650.00		$1,590.00	$24.26		$430.00	$5.97
			Total Cost:	$203,010.00		$18,261.00	$255.81		$4,726.00	$65.63

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

(Rental)

i =	4%	
Field Size =	72	ac
Cost Adjustment Factor =	0.75	

Description

Sprinkler Irrigation with 1000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	12	mo	$416.67	$5,000.00	1	$5,200	$72.22	9%	$450.00	$6.25
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$360.00	$25,900.00	1	$26,936	$374.11	2%	$518.00	$7.19
Miscellaneous										
On-farm admin, 5%				$1,545.00		$1,606.80	$22.32			
			Contingency and Unlisted Items (10%):	$3,090.00		$3,210.00	$49.10		$100.00	$1.34
			Total Cost:	$35,535.00		$36,953.00	$517.75		$1,068.00	$14.79

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

	i =	4%
	Field Size =	72 ac
Description	Cost Adjustment Factor =	0.75

Sprinkler Irrigation with 2000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]		12 mo	$560.00	$6,720.00	1	$6,989	$97.07	9%	$604.80	$8.40
		0 ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
		0 ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
		0 ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings		72 ac	$360.00	$25,900.00	1	$26,936	$374.11	2%	$518.00	$7.19
Miscellaneous										
On-farm admin, 5%				$1,631.00		$1,696.24	$23.56			
			Contingency and Unlisted Items (10%):	$3,260.00		$3,390.00	$51.83		$110.00	$1.56
			Total Cost:	$37,511.00		$39,011.00	$546.57		$1,233.00	$17.15

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

A.14.2.2 Seasonal Operations Costs

(1000 gpm pump)

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Sprinkler Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Sprinkler Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	30	0.33	0.0275	1098	$6,999.48	$3,732.48	$51.84
Bermuda	12	16	24	$12.10	$3,872.00	62	0.33	0.0275	2268	$11,670.46	$7,798.46	$108.31
Wheat	6	7	24	$12.10	$1,694.00	25	0.33	0.0275	900	$6,206.69	$4,512.69	$62.68
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	59	0.33	0.0275	2162	$11,245.64	$7,615.64	$105.77
Field Crops, Flat	5	9	24	$12.10	$2,178.00	39	0.33	0.0275	1429	$8,319.52	$6,141.52	$85.30
Alfalfa, Row	12	16	24	$12.10	$3,872.00	59	0.33	0.0275	2162	$11,245.64	$7,373.64	$102.41
Field Crops, Row	5	9	36	$12.10	$3,267.00	39	0.33	0.0275	1429	$8,319.52	$5,052.52	$70.17
Sugar Beets	9	12	36	$12.10	$4,356.00	46	0.33	0.0275	1669	$9,279.78	$4,923.78	$68.39

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under sprinkler irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for sprinkler irrigation including 3 hours total per acre for system set up and retrieval.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$414.00	$134.55	$1.87
Bermuda	12	9	12	$20.70	$331.20	1.33	$579.60	$248.40	$3.45
Wheat	12	9	12	$20.70	$144.90	1.33	$220.80	$75.90	$1.05
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$552.00	$241.50	$3.35
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$358.80	$172.50	$2.40
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$552.00	$220.80	$3.07
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$538.20	$258.75	$3.59
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$621.00	$248.40	$3.45

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with sprinkler.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / sprinkle fields covered.

(2000 gpm pump)

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Sprinkle Hrs/Irr[2]	Sprinkle Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.5	10	$209.50	$20.95	$0.29
Bermuda	0.5	$41.90	$335.20	0.5	21	$439.95	$104.75	$1.45
Wheat	0.5	$41.90	$146.65	0.5	8	$167.60	$20.95	$0.29
Alfalfa, Flat	0.5	$41.90	$314.25	0.5	20	$419.00	$104.75	$1.45
Field Crops, Flat	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$1.16
Alfalfa, Row	0.5	$41.90	$335.20	0.5	20	$419.00	$83.80	$1.16
Field Crops, Row	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$1.16
Sugar Beets	0.5	$41.90	$251.40	0.5	15	$314.25	$62.85	$0.87

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per sprinkle irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 3" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.1229	gal/BHP-hr	2.2	185	0.7	65.9	5.5	44.6	$2.72	$121.18

Crop	Sprinkler Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	30	$21,961.31	$305.02
Bermuda	62	$45,350.17	$629.86
Wheat	25	$17,991.56	$249.88
Alfalfa, Flat	59	$43,223.00	$600.32
Field Crops, Flat	39	$28,571.10	$396.82
Alfalfa, Row	59	$43,223.00	$600.32
Field Crops, Row	39	$28,571.10	$396.82
Sugar Beets	46	$33,379.40	$463.60

Notes
1. Specific fuel consumption estimated from Rain for Rent literature.
2. TDH calculated based on pump discharge pressure of 80 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Sprinkler Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Sprinkler Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	30	0.33	0.055	549	$4,806.54	$1,539.54	$21.38
Bermuda	12	16	24	$12.10	$3,872.00	62	0.33	0.055	1134	$7,142.03	$3,270.03	$45.42
Wheat	6	7	24	$12.10	$1,694.00	25	0.33	0.055	450	$4,410.14	$2,716.14	$37.72
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	59	0.33	0.055	1081	$6,929.62	$3,299.62	$45.83
Field Crops, Flat	5	9	24	$12.10	$2,178.00	39	0.33	0.055	714	$5,466.56	$3,288.56	$45.67
Alfalfa, Row	12	16	24	$12.10	$3,872.00	59	0.33	0.055	1081	$6,929.62	$3,057.62	$42.47
Field Crops, Row	5	9	36	$12.10	$3,267.00	39	0.33	0.055	714	$5,466.56	$2,199.56	$30.55
Sugar Beets	9	12	36	$12.10	$4,356.00	46	0.33	0.055	835	$5,946.69	$1,590.69	$22.09

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under sprinkler irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for sprinkler irrigation including 3 hours total per acre for system set up and retrieval.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$414.00	$134.55	$1.87
Bermuda	12	9	12	$20.70	$331.20	1.33	$579.60	$248.40	$3.45
Wheat	12	9	12	$20.70	$144.90	1.33	$220.80	$75.90	$1.05
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$552.00	$241.50	$3.35
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$358.80	$172.50	$2.40
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$552.00	$220.80	$3.07
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$538.20	$258.75	$3.59
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$621.00	$248.40	$3.45

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with sprinkler.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / sprinkle fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Sprinkle Hrs/Irr[2]	Sprinkle Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.5	10	$209.50	$20.95	$0.29
Bermuda	0.5	$41.90	$335.20	0.5	21	$439.95	$104.75	$1.45
Wheat	0.5	$41.90	$146.65	0.5	8	$167.60	$20.95	$0.29
Alfalfa, Flat	0.5	$41.90	$314.25	0.5	20	$419.00	$104.75	$1.45
Field Crops, Flat	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$1.16
Alfalfa, Row	0.5	$41.90	$335.20	0.5	20	$419.00	$83.80	$1.16
Field Crops, Row	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$1.16
Sugar Beets	0.5	$41.90	$251.40	0.5	15	$314.25	$62.85	$0.87

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per sprinkle irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 3" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.0854	gal/BHP-hr	4.4	185	0.7	131.8	2.8	30.9	$2.72	$84.15

Crop	Sprinkler Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	30	$15,250.91	$211.82
Bermuda	62	$31,493.17	$437.41
Wheat	25	$12,494.14	$173.53
Alfalfa, Flat	59	$30,015.97	$416.89
Field Crops, Flat	39	$19,841.04	$275.57
Alfalfa, Row	59	$30,015.97	$416.89
Field Crops, Row	39	$19,841.04	$275.57
Sugar Beets	46	$23,180.14	$321.95

Notes
1. Specific fuel consumption estimated from Rain for Rent literature.
2. TDH calculated based on pump discharge pressure of 80 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.14.3 Detailed Budget for 144-Acre Field

A.14.3.1 Annual Capital and Maintenance Costs
(Purchase)

	i =	4%
	Field Size =	144 ac
Description	Cost Adjustment Factor =	0.91

Sprinkler Irrigation with 1000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	1	ea	$8,000.00	$8,000.00	15	$720	$5.00	9%	$720.00	$5.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$2,300.00	$331,200.00	15	$29,788	$206.86	2%	$6,624.00	$46.00
Miscellaneous										
On-farm admin, 5%				$16,960.00		$1,525.40	$10.59			
			Contingency and Unlisted Items (10%):	$33,920.00		$3,050.00	$23.30		$730.00	$5.10
			Total Cost:	$390,080.00		$35,083.00	$245.76		$8,074.00	$56.10

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

	i =	4%
	Field Size =	144 ac
Description	Cost Adjustment Factor =	0.91

Sprinkler Irrigation with 2000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	1	ea	$10,933.33	$10,933.33	15	$983	$6.83	9%	$984.00	$6.83
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$2,300.00	$331,200.00	15	$29,788	$206.86	2%	$6,624.00	$46.00
Miscellaneous										
On-farm admin, 5%				$17,106.67		$1,538.59	$10.68			
		Contingency and Unlisted Items (10%):		$34,210.00		$3,080.00	$23.51		$760.00	$5.28
		Total Cost:		$393,450.00		$35,390.00	$247.88		$8,368.00	$58.12

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

(Rental)

	i =	4%
	Field Size =	144 ac
Description	Cost Adjustment Factor =	0.91

Sprinkler Irrigation with 1000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	12	mo	$416.67	$5,000.00	1	$5,200	$36.11	9%	$450.00	$3.13
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$360.00	$51,800.00	1	$53,872	$374.11	2%	$1,036.00	$7.19
Miscellaneous										
On-farm admin, 5%				$2,840.00		$2,953.60	$20.51			
			Contingency and Unlisted Items (10%):	$5,680.00		$5,910.00	$45.12		$150.00	$1.03
			Total Cost:	$65,320.00		$67,936.00	$475.86		$1,636.00	$11.35

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

	i =	4%
	Field Size =	144 ac
Description	Cost Adjustment Factor =	0.91

Sprinkler Irrigation with 2000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir										
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[1]	12	mo	$560.00	$6,720.00	1	$6,989	$48.53	9%	$604.80	$4.20
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$360.00	$51,800.00	1	$53,872	$374.11	2%	$1,036.00	$7.19
Miscellaneous										
On-farm admin, 5%				$2,926.00		$3,043.04	$21.13			
			Contingency and Unlisted Items (10%):	$5,850.00		$6,090.00	$46.49		$160.00	$1.14
			Total Cost:	$67,296.00		$69,994.00	$490.27		$1,801.00	$12.53

Notes/Assumptions

1. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.
2. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.

A.14.3.2 Seasonal Operations Costs

(1000 gpm pump)

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Sprinkler Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Sprinkler Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	30	0.33	0.01375	2197	$13,998.97	$10,731.97	$74.53
Bermuda	12	16	24	$12.10	$3,872.00	62	0.33	0.01375	4536	$23,340.92	$19,468.92	$135.20
Wheat	6	7	24	$12.10	$1,694.00	25	0.33	0.01375	1800	$12,413.37	$10,719.37	$74.44
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	59	0.33	0.01375	4324	$22,491.29	$18,861.29	$130.98
Field Crops, Flat	5	9	24	$12.10	$2,178.00	39	0.33	0.01375	2858	$16,639.04	$14,461.04	$100.42
Alfalfa, Row	12	16	24	$12.10	$3,872.00	59	0.33	0.01375	4324	$22,491.29	$18,619.29	$129.30
Field Crops, Row	5	9	36	$12.10	$3,267.00	39	0.33	0.01375	2858	$16,639.04	$13,372.04	$92.86
Sugar Beets	9	12	36	$12.10	$4,356.00	46	0.33	0.01375	3339	$18,559.57	$14,203.57	$98.64

Notes

1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under sprinkler irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for sprinkler irrigation including 3 hours total per acre for system set up and retrieval.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$414.00	$134.55	$0.93
Bermuda	12	9	12	$20.70	$331.20	1.33	$579.60	$248.40	$1.73
Wheat	12	9	12	$20.70	$144.90	1.33	$220.80	$75.90	$0.53
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$552.00	$241.50	$1.68
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$358.80	$172.50	$1.20
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$552.00	$220.80	$1.53
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$538.20	$258.75	$1.80
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$621.00	$248.40	$1.73

Notes

1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with sprinkler.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / sprinkle fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Sprinkle Hrs/Irr[2]	Sprinkle Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.5	10	$209.50	$20.95	$0.15
Bermuda	0.5	$41.90	$335.20	0.5	21	$439.95	$104.75	$0.73
Wheat	0.5	$41.90	$146.65	0.5	8	$167.60	$20.95	$0.15
Alfalfa, Flat	0.5	$41.90	$314.25	0.5	20	$419.00	$104.75	$0.73
Field Crops, Flat	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$0.58
Alfalfa, Row	0.5	$41.90	$335.20	0.5	20	$419.00	$83.80	$0.58
Field Crops, Row	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$0.58
Sugar Beets	0.5	$41.90	$251.40	0.5	15	$314.25	$62.85	$0.44

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per sprinkle irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 3" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.1229	gal/BHP-hr	2.2	185	0.7	65.9	5.5	44.6	$2.72	$121.18

Crop	Sprinkler Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	30	$43,922.62	$305.02
Bermuda	62	$90,700.34	$629.86
Wheat	25	$35,983.13	$249.88
Alfalfa, Flat	59	$86,445.99	$600.32
Field Crops, Flat	39	$57,142.21	$396.82
Alfalfa, Row	59	$86,445.99	$600.32
Field Crops, Row	39	$57,142.21	$396.82
Sugar Beets	46	$66,758.81	$463.60

Notes
1. Specific fuel consumption estimated from Rain for Rent literature.
2. TDH calculated based on pump discharge pressure of 80 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

(2000 gpm pump)

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Sprinkler Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Sprinkler Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	30	0.33	0.0275	1098	$9,613.08	$6,346.08	$44.07
Bermuda	12	16	24	$12.10	$3,872.00	62	0.33	0.0275	2268	$14,284.06	$10,412.06	$72.31
Wheat	6	7	24	$12.10	$1,694.00	25	0.33	0.0275	900	$8,820.29	$7,126.29	$49.49
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	59	0.33	0.0275	2162	$13,859.24	$10,229.24	$71.04
Field Crops, Flat	5	9	24	$12.10	$2,178.00	39	0.33	0.0275	1429	$10,933.12	$8,755.12	$60.80
Alfalfa, Row	12	16	24	$12.10	$3,872.00	59	0.33	0.0275	2162	$13,859.24	$9,987.24	$69.36
Field Crops, Row	5	9	36	$12.10	$3,267.00	39	0.33	0.0275	1429	$10,933.12	$7,666.12	$53.24
Sugar Beets	9	12	36	$12.10	$4,356.00	46	0.33	0.0275	1669	$11,893.38	$7,537.38	$52.34

Notes

1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under sprinkler irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for sprinkler irrigation including 3 hours total per acre for system set up and retrieval.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$414.00	$134.55	$0.93
Bermuda	12	9	12	$20.70	$331.20	1.33	$579.60	$248.40	$1.73
Wheat	12	9	12	$20.70	$144.90	1.33	$220.80	$75.90	$0.53
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$552.00	$241.50	$1.68
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$358.80	$172.50	$1.20
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$552.00	$220.80	$1.53
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$538.20	$258.75	$1.80
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$621.00	$248.40	$1.73

Notes

1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with sprinkler.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / sprinkle fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Sprinkle Hrs/Irr[2]	Sprinkle Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.5	10	$209.50	$20.95	$0.15
Bermuda	0.5	$41.90	$335.20	0.5	21	$439.95	$104.75	$0.73
Wheat	0.5	$41.90	$146.65	0.5	8	$167.60	$20.95	$0.15
Alfalfa, Flat	0.5	$41.90	$314.25	0.5	20	$419.00	$104.75	$0.73
Field Crops, Flat	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$0.58
Alfalfa, Row	0.5	$41.90	$335.20	0.5	20	$419.00	$83.80	$0.58
Field Crops, Row	0.5	$41.90	$188.55	0.5	13	$272.35	$83.80	$0.58
Sugar Beets	0.5	$41.90	$251.40	0.5	15	$314.25	$62.85	$0.44

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per sprinkle irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 3" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.0854	gal/BHP-hr	4.4	185	0.7	131.8	2.8	30.9	$2.72	$84.15

Crop	Sprinkler Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	30	$30,501.82	$211.82
Bermuda	62	$62,986.35	$437.41
Wheat	25	$24,988.28	$173.53
Alfalfa, Flat	59	$60,031.94	$416.89
Field Crops, Flat	39	$39,682.09	$275.57
Alfalfa, Row	59	$60,031.94	$416.89
Field Crops, Row	39	$39,682.09	$275.57
Sugar Beets	46	$46,360.28	$321.95

Notes
1. Specific fuel consumption estimated from Rain for Rent literature.
2. TDH calculated based on pump discharge pressure of 80 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

Detailed Cost Estimates for Sprinkle Irrigation with Reservoir on System

A.14.4 Detailed Budget for 36-Acre Field

A.14.4.1 Annual Capital and Maintenance Costs

(Purchase)

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Sprinkler Irrigation with 1000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0	ea	$5,650.00	$0.00	50	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	1	ea	$8,000.00	$8,000.00	15	$720	$19.99	9%	$720.00	$20.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$2,300.00	$82,800.00	15	$7,447	$206.86	2%	$1,656.00	$46.00
Miscellaneous										
On-farm admin, 5%				$5,671.50		$461.00	$12.81			
			Contingency and Unlisted Items (10%):	$11,340.00		$920.00	$28.17		$270.00	$7.48
			Total Cost:	$130,441.50		$10,601.00	$297.09		$2,963.00	$82.27

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

i = 4%
Field Size = 36 ac
Cost Adjustment Factor = 0.6

Description

Sprinkler Irrigation with 2000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0	ea	$5,650.00	$0.00	50	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	1	ea	$10,933.33	$10,933.33	15	$983	$27.32	9%	$984.00	$27.33
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$2,300.00	$82,800.00	15	$7,447	$206.86	2%	$1,656.00	$46.00
Miscellaneous										
On-farm admin, 5%				$5,818.17		$474.20	$13.17			
			Contingency and Unlisted Items (10%):	$11,640.00		$950.00	$28.98		$300.00	$8.21
			Total Cost:	$133,821.50		$10,908.00	$305.59		$3,257.00	$90.34

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.

(Rental)

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Sprinkler Irrigation with 1000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0	ea	$5,650.00	$0.00	1	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	12	mo	$416.67	$5,000.00	1	$5,200	$144.44	9%	$450.00	$12.50
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$360.00	$13,000.00	1	$13,520	$375.56	2%	$260.00	$7.22
Miscellaneous										
On-farm admin, 5%				$2,031.50		$988.67	$27.46			
			Contingency and Unlisted Items (10%):	$4,060.00		$1,980.00	$60.42		$100.00	$2.85
			Total Cost:	$46,721.50		$22,742.00	$637.14		$1,127.00	$31.37

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Sprinkler Irrigation with 2000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0	ea	$5,650.00	$0.00	1	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	12	mo	$560.00	$6,720.00	1	$6,989	$194.13	9%	$604.80	$16.80
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$360.00	$13,000.00	1	$13,520	$375.56	2%	$260.00	$7.22
Miscellaneous										
On-farm admin, 5%				$2,117.50		$1,078.11	$29.95			
			Contingency and Unlisted Items (10%):	$4,240.00		$2,160.00	$65.88		$120.00	$3.28
			Total Cost:	$48,707.50		$24,800.00	$694.78		$1,301.00	$36.10

Notes/Assumptions
1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.

A.14.4.2 Seasonal Operations Costs

Operations costs are the same as for 36-Acre Field without Reservoir (see Section A.14.1.2).

A.14.5 Detailed Budget for 72-Acre Field

A.14.5.1 Annual Capital and Maintenance Costs
(Purchase)

	i =	4%
	Field Size =	72 ac
Description	Cost Adjustment Factor =	0.75

Sprinkler Irrigation with 1000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0	ea	$5,650.00	$0.00	50	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	1	ea	$8,000.00	$8,000.00	15	$720	$9.99	9%	$720.00	$10.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$2,300.00	$165,600.00	15	$14,894	$206.86	2%	$3,312.00	$46.00
Miscellaneous										
On-farm admin, 5%				$10,094.38		$846.53	$11.76			
		Contingency and Unlisted Items (10%):		$20,190.00		$1,690.00	$25.87		$440.00	$6.15
		Total Cost:		$232,171.88		$19,467.00	$272.77		$4,868.00	$67.65

Notes/Assumptions
1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

i = 4%
Field Size = 72 ac
Cost Adjustment Factor = 0.75

Description

Sprinkler Irrigation with 2000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0	ea	$5,650.00	$0.00	50	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	1	ea	$10,933.33	$10,933.33	15	$983	$13.66	9%	$984.00	$13.67
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$2,300.00	$165,600.00	15	$14,894	$206.86	2%	$3,312.00	$46.00
Miscellaneous										
On-farm admin, 5%				$10,241.04		$859.72	$11.94			
			Contingency and Unlisted Items (10%):	$20,480.00		$1,720.00	$26.27		$470.00	$6.52
			Total Cost:	$235,541.88		$19,774.00	$277.02		$5,162.00	$71.68

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.

(Rental)

i = 4%
Field Size = 72 ac
Cost Adjustment Factor = 0.75

Description

Sprinkler Irrigation with 1000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0	ea	$5,650.00	$0.00	1	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	12	mo	$416.67	$5,000.00	1	$5,200	$72.22	9%	$450.00	$6.25
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$360.00	$25,900.00	1	$26,936	$374.11	2%	$518.00	$7.19
Miscellaneous										
On-farm admin, 5%				$2,959.38		$1,672.64	$23.23			
			Contingency and Unlisted Items (10%):	$5,920.00		$3,350.00	$51.11		$140.00	$1.89
			Total Cost:	$68,066.88		$38,475.00	$538.96		$1,504.00	$20.84

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.

	i =	4%
	Field Size =	72 ac
Description	Cost Adjustment Factor =	0.75

Sprinkler Irrigation with 2000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0	ea	$5,650.00	$0.00	1	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	12	mo	$560.00	$6,720.00	1	$6,989	$97.07	9%	$604.80	$8.40
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$360.00	$25,900.00	1	$26,936	$374.11	2%	$518.00	$7.19
Miscellaneous										
On-farm admin, 5%				$3,045.38		$1,762.08	$24.47			
			Contingency and Unlisted Items (10%):	$6,090.00		$3,520.00	$53.84		$150.00	$2.11
			Total Cost:	$70,042.88		$40,524.00	$567.78		$1,669.00	$23.20

Notes/Assumptions
1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.

A.14.5.2 Seasonal Operations Costs

Operations costs are the same as for 72-Acre Field without Reservoir (see Section A.14.2.2).

A.14.6 Detailed Budget for 144-Acre Field

A.14.6.1 Annual Capital and Maintenance Costs
(Purchase)

		i =	4%
		Field Size =	144 ac
Description		Cost Adjustment Factor =	0.91

Sprinkler Irrigation with 1000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0	ea	$5,650.00	$0.00	50	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	1	ea	$8,000.00	$8,000.00	15	$720	$5.00	9%	$720.00	$5.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$2,300.00	$331,200.00	15	$29,788	$206.86	2%	$6,624.00	$46.00
Miscellaneous										
On-farm admin, 5%				$18,674.78		$1,605.22	$11.15			
			Contingency and Unlisted Items (10%):	$37,350.00		$3,210.00	$24.52		$780.00	$5.43
			Total Cost:	$429,520.28		$36,920.00	$258.62		$8,604.00	$59.77

Notes/Assumptions
1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	0.91

Description

Sprinkler Irrigation with 2000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0	ea	$5,650.00	$0.00	50	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 2000 gpm @ 80psi[2]	1	ea	$10,933.33	$10,933.33	15	$983	$6.83	9%	$984.00	$6.83
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$2,300.00	$331,200.00	15	$29,788	$206.86	2%	$6,624.00	$46.00
Miscellaneous										
On-farm admin, 5%				$18,821.44		$1,618.42	$11.24			
			Contingency and Unlisted Items (10%):	$37,640.00		$3,240.00	$24.73		$810.00	$5.62
			Total Cost:	$432,890.28		$37,227.00	$260.74		$8,898.00	$61.78

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.

(Rental)

i = 4%
Field Size = 144 ac
Cost Adjustment Factor = 0.91

Description

Sprinkler Irrigation with 1000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0	ea	$5,650.00	$0.00	1	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	12	mo	$416.67	$5,000.00	1	$5,200	$36.11	9%	$450.00	$3.13
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$360.00	$51,800.00	1	$53,872	$374.11	2%	$1,036.00	$7.19
Miscellaneous										
On-farm admin, 5%				$4,554.78		$3,033.42	$21.07			
			Contingency and Unlisted Items (10%):	$9,110.00		$6,070.00	$46.34		$200.00	$1.37
			Total Cost:	$104,760.28		$69,772.00	$488.72		$2,166.00	$15.02

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.

	i =	4%
	Field Size =	144 ac
Description	Cost Adjustment Factor =	0.91

Sprinkler Irrigation with 2000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0	ea	$5,650.00	$0.00	1	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Trailer mounted Diesel pump, 2000 gpm @ 80psi[2]	12	mo	$560.00	$6,720.00	1	$6,989	$48.53	9%	$604.80	$4.20
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$360.00	$51,800.00	1	$53,872	$374.11	2%	$1,036.00	$7.19
Miscellaneous										
On-farm admin, 5%				$4,640.78		$3,122.86	$21.69			
			Contingency and Unlisted Items (10%):	$9,280.00		$6,250.00	$47.71		$210.00	$1.47
			Total Cost:	$106,736.28		$71,830.00	$503.13		$2,331.00	$16.20

Notes/Assumptions
1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields.

A.14.6.2 Seasonal Operations Costs

Operations costs are the same as for 144-Acre Field without Reservoir (see Section A.14.3.2).

Detailed Cost Estimates for Sprinkle Irrigation with Reservoir off System

A.14.7 Detailed Budget for 36-Acre Field

A.14.7.1 Annual Capital and Maintenance Costs

(Purchase)

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Sprinkler Irrigation with 1000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0.6	ea	$5,650.00	$3,390.00	50	$158	$4.38	2%	$67.80	$1.88
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	1	ea	$8,000.00	$8,000.00	15	$720	$19.99	9%	$720.00	$20.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$2,300.00	$82,800.00	15	$7,447	$206.86	2%	$1,656.00	$46.00
Miscellaneous										
On-farm admin, 5%				$5,841.00		$468.89	$13.02			
			Contingency and Unlisted Items (10%):	$11,680.00		$940.00	$28.65		$280.00	$7.67
			Total Cost:	$134,341.00		$10,787.00	$302.18		$3,040.00	$84.35

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Sprinkler Irrigation with 2000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0.6	ea	$5,650.00	$3,390.00	50	$158	$4.38	2%	$67.80	$1.88
Pump Station										
Trailer mounted Diesel pump, 2000 gpm @ 80psi[2]	1	ea	$10,933.33	$10,933.33	15	$983	$27.32	9%	$984.00	$27.33
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$2,300.00	$82,800.00	15	$7,447	$206.86	2%	$1,656.00	$46.00
Miscellaneous										
On-farm admin, 5%				$5,987.67		$482.09	$13.39			
			Contingency and Unlisted Items (10%):	$11,980.00		$960.00	$29.46		$300.00	$8.40
			Total Cost:	$137,721.00		$11,084.00	$310.68		$3,324.00	$92.41

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.

(Rental)

i = 4%
Field Size = 36 ac
Cost Adjustment Factor = 0.6

Description

Sprinkler Irrigation with 1000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0.6	ea	$5,650.00	$3,390.00	1	$3,526	$97.93	2%	$67.80	$1.88
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	12	mo	$416.67	$5,000.00	1	$5,200	$144.44	9%	$450.00	$12.50
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$360.00	$13,000.00	1	$13,520	$375.56	2%	$260.00	$7.22
Miscellaneous										
On-farm admin, 5%				$2,201.00		$1,164.95	$32.36			
			Contingency and Unlisted Items (10%):	$4,400.00		$2,330.00	$71.19		$110.00	$3.04
			Total Cost:	$50,621.00		$26,794.00	$750.75		$1,204.00	$33.44

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	0.6

Sprinkler Irrigation with 2000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0.6	ea	$5,650.00	$3,390.00	1	$3,526	$97.93	2%	$67.80	$1.88
Pump Station										
Trailer mounted Diesel pump, 2000 gpm @ 80psi[2]	12	mo	$560.00	$6,720.00	1	$6,989	$194.13	9%	$604.80	$16.80
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
	0	ea	$0.00	$0.00	1	$0	$0.00	0%	$0.00	$0.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	36	ac	$360.00	$13,000.00	1	$13,520	$375.56	2%	$260.00	$7.22
Miscellaneous										
On-farm admin, 5%				$2,287.00		$1,254.39	$34.84			
			Contingency and Unlisted Items (10%):	$4,570.00		$2,510.00	$76.66		$120.00	$3.47
			Total Cost:	$52,597.00		$28,852.00	$808.39		$1,369.00	$38.17

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

A.14.7.2 Seasonal Operations Costs

Operations costs are the same as for 36-Acre Field without Reservoir (see Section A.14.1.2).

A.14.8 Detailed Budget for 72-Acre Field

A.14.8.1 Annual Capital and Maintenance Costs
(Purchase)

		i =	4%
		Field Size =	72 ac
Description		Cost Adjustment Factor =	0.75

Sprinkler Irrigation with 1000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0.75	ea	$5,650.00	$4,237.50	50	$197	$2.74	2%	$84.75	$1.18
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	1	ea	$8,000.00	$8,000.00	15	$720	$9.99	9%	$720.00	$10.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$2,300.00	$165,600.00	15	$14,894	$206.86	2%	$3,312.00	$46.00
Miscellaneous										
On-farm admin, 5%				$10,306.25		$856.39	$11.89			
			Contingency and Unlisted Items (10%):	$20,610.00		$1,710.00	$26.17		$450.00	$6.27
			Total Cost:	$237,041.25		$19,694.00	$275.95		$4,963.00	$68.94

Notes/Assumptions
1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

	i =	4%
	Field Size =	72 ac
Description	Cost Adjustment Factor =	0.75

Sprinkler Irrigation with 2000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0.75	ea	$5,650.00	$4,237.50	50	$197	$2.74	2%	$84.75	$1.18
Pump Station										
Trailer mounted Diesel pump, 2000 gpm @ 80psi[2]	1	ea	$10,933.33	$10,933.33	15	$983	$13.66	9%	$984.00	$13.67
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$2,300.00	$165,600.00	15	$14,894	$206.86	2%	$3,312.00	$46.00
Miscellaneous										
On-farm admin, 5%				$10,452.92		$869.58	$12.08			
			Contingency and Unlisted Items (10%):	$20,910.00		$1,740.00	$26.57		$480.00	$6.63
			Total Cost:	$240,421.25		$20,001.00	$280.20		$5,257.00	$72.97

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.

(Rental)

	i =	4%
	Field Size =	72 ac
	Cost Adjustment Factor =	0.75

Description

Sprinkler Irrigation with 1000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0.75	ea	$5,650.00	$4,237.50	1	$4,407	$61.21	2%	$84.75	$1.18
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	12	mo	$416.67	$5,000.00	1	$5,200	$72.22	9%	$450.00	$6.25
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$360.00	$25,900.00	1	$26,936	$374.11	2%	$518.00	$7.19
Miscellaneous										
On-farm admin, 5%				$3,171.25		$1,892.99	$26.29			
			Contingency and Unlisted Items (10%):	$6,340.00		$3,790.00	$57.84		$140.00	$2.01
			Total Cost:	$72,936.25		$43,543.00	$609.96		$1,589.00	$22.13

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

	i =	4%
	Field Size =	72 ac
Description	Cost Adjustment Factor =	0.75

Sprinkler Irrigation with 2000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0.75	ea	$5,650.00	$4,237.50	1	$4,407	$61.21	2%	$84.75	$1.18
Pump Station										
Trailer mounted Diesel pump, 2000 gpm @ 80psi[2]	12	mo	$560.00	$6,720.00	1	$6,989	$97.07	9%	$604.80	$8.40
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	72	ac	$360.00	$25,900.00	1	$26,936	$374.11	2%	$518.00	$7.19
Miscellaneous										
On-farm admin, 5%				$3,257.25		$1,982.43	$27.53			
			Contingency and Unlisted Items (10%):	$6,510.00		$3,960.00	$60.57		$160.00	$2.23
			Total Cost:	$74,912.25		$45,591.00	$638.78		$1,763.00	$24.49

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

A.14.8.2 Seasonal Operations Costs

Operations costs are the same as for 72-Acre Field without Reservoir (see Section A.14.2.2).

A.14.9 Detailed Budget for 144-Acre Field

A.14.9.1 Annual Capital and Maintenance Costs
(Purchase)

		i =	4%
		Field Size =	144 ac
Description		Cost Adjustment Factor =	0.91

Sprinkler Irrigation with 1000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0.91	ea	$5,650.00	$5,141.50	50	$239	$1.66	2%	$102.83	$0.71
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	1	ea	$8,000.00	$8,000.00	15	$720	$5.00	9%	$720.00	$5.00
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$2,300.00	$331,200.00	15	$29,788	$206.86	2%	$6,624.00	$46.00
Miscellaneous										
On-farm admin, 5%				$18,931.85		$1,617.19	$11.23			
			Contingency and Unlisted Items (10%):	$37,860.00		$3,230.00	$24.71		$790.00	$5.50
			Total Cost:	$435,428.85		$37,191.00	$260.55		$8,717.00	$60.55

Notes/Assumptions
1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	0.91

Description

Sprinkler Irrigation with 2000 gpm pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is purchased.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0.91	ea	$5,650.00	$5,141.50	50	$239	$1.66	2%	$102.83	$0.71
Pump Station										
Trailer mounted Diesel pump, 2000 gpm @ 80psi[2]	1	ea	$10,933.33	$10,933.33	15	$983	$6.83	9%	$984.00	$6.83
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$2,300.00	$331,200.00	15	$29,788	$206.86	2%	$6,624.00	$46.00
Miscellaneous										
On-farm admin, 5%				$19,078.52		$1,630.38	$11.32			
			Contingency and Unlisted Items (10%):	$38,160.00		$3,260.00	$24.91		$820.00	$5.69
			Total Cost:	$438,808.85		$37,498.00	$262.67		$9,011.00	$62.57

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.

(Rental)

i = 4%
Field Size = 144 ac
Cost Adjustment Factor = 0.91

Description

Sprinkler Irrigation with 1000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0.91	ea	$5,650.00	$5,141.50	1	$5,347	$37.13	2%	$102.83	$0.71
Pump Station										
Trailer mounted Diesel pump, 1000 gpm @ 80psi[2]	12	mo	$416.67	$5,000.00	1	$5,200	$36.11	9%	$450.00	$3.13
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$360.00	$51,800.00	1	$53,872	$374.11	2%	$1,036.00	$7.19
Miscellaneous										
On-farm admin, 5%				$4,811.85		$3,300.78	$22.92			
			Contingency and Unlisted Items (10%):	$9,620.00		$6,600.00	$50.43		$210.00	$1.44
			Total Cost:	$110,668.85		$75,916.00	$531.79		$2,279.00	$15.80

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $24,000.

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	0.91

Description

Sprinkler Irrigation with 2000 gpm rental pump. Pump is trailer mounted and used on multiple fields. Sprinkler pipe is rented.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0.91	ea	$5,650.00	$5,141.50	1	$5,347	$37.13	2%	$102.83	$0.71
Pump Station										
Trailer mounted Diesel pump, 2000 gpm @ 80psi[2]	12	mo	$560.00	$6,720.00	1	$6,989	$48.53	9%	$604.80	$4.20
Sprinkler Pipe										
Mainlines, laterals, riser, heads, nozzles, fittings	144	ac	$360.00	$51,800.00	1	$53,872	$374.11	2%	$1,036.00	$7.19
Miscellaneous										
On-farm admin, 5%				$4,897.85		$3,390.22	$23.54			
			Contingency and Unlisted Items (10%):	$9,800.00		$6,780.00	$51.80		$220.00	$1.54
			Total Cost:	$112,654.85		$77,975.00	$546.20		$2,444.00	$16.99

Notes/Assumptions

1. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
2. Pump includes inlet and outlet hoses, screen filter. Pump is used for 3 fields. Total pump cost = $32,800.

A.14.9.2 Seasonal Operations Costs

Operations costs are the same as for 144-Acre Field without Reservoir (see Section A.14.3.2).

Attachment 15
Detailed Cost Estimates for Center Pivot Irrigation with Non-Cropped Corners

A.15.1 Detailed Budget for 36-Acre Field

A.15.1.1 Annual Capital and Maintenance Costs

	i =	4%
	Field Size =	36 ac
	Cost Adjustment Factor =	0.6

Description
Center Pivot Irrigation with 1200 gpm pump. Pump is permanently pad-mounted at reservoir.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	2,885	cy	$4.70	$13,600.00	50	$633	$17.59	1%	$136.00	$3.78
Concrete Inlet Structure and Buried Pipe	0.6	ea	$12,050.00	$7,230.00	50	$337	$9.35	2%	$144.60	$4.02
Concrete Pad to Support Pump	0.6	ea	$3,000.00	$1,800.00	50	$84	$2.33	2%	$36.00	$1.00
Overflow Structure	0	ea	$5,650.00	$0.00	50	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Sump, 48" x 15'	0.6	ea	$5,650.00	$3,390.00	50	$158	$4.38	2%	$67.80	$1.88
Flowmeter	0.6	ea	$2,400.00	$1,440.00	10	$178	$4.93	2%	$28.80	$0.80
Automatic Oiler	0.6	ea	$350.00	$210.00	15	$19	$0.52	9%	$18.90	$0.53
Diesel Engine/Pump, 2.7 cfs @ 100' TDH[2]	0.6	ea	$24,000.00	$14,400.00	15	$1,295	$35.98	9%	$1,296.00	$36.00
Security Enclosure	0.6	ea	$6,300.00	$3,780.00	50	$176	$4.89	2%	$75.60	$2.10
Pipeline and Center Pivot System										
Mainline from reservoir to pivot, 10" Class 80 PIP	792	ft	$7.90	$6,300.00	20	$464	$12.88	2%	$126.00	$3.50
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[4]	1	ea	$1,260.00	$1,300.00	20	$96	$2.66	2%	$26.00	$0.72
Pivot system, 1320', low pressure	0.6	ea	$67,700.00	$40,600.00	15	$3,652	$101.43	5%	$2,030.00	$56.39
Miscellaneous										
On-farm admin, 5%				$2,607.50		$167.12	$4.64			
		Contingency and Unlisted Items (10%):		$9,410.00		$710.00	$20.16		$400.00	$11.07
		Total Cost:		$106,067.50		$7,967.00	$221.73		$4,386.00	$121.79

Notes/Assumptions
1. 4 af Reservoir is assumed to be constructed for portion of fields (fields will be joined, or a single reservoir will serve adjacent fields). Quantities adjusted accordingly.
2. Pump includes inlet and outlet hoses, screen filter. Engine equipped with generator to run pivot.
3. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
4. Estimated at 20% of pipeline cost.

A.15.1.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Pivot Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Pivot Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	30	0.025	0.021	1463	$442.70	-$2,824.30	-$78.45
Bermuda	12	16	24	$12.10	$3,872.00	62	0.025	0.021	3022	$914.18	-$2,957.82	-$82.16
Wheat	6	7	24	$12.10	$1,694.00	25	0.025	0.021	1199	$362.68	-$1,331.32	-$36.98
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	59	0.025	0.021	2880	$871.30	-$2,758.70	-$76.63
Field Crops, Flat	5	9	24	$12.10	$2,178.00	39	0.025	0.021	1904	$575.94	-$1,602.06	-$44.50
Alfalfa, Row	12	16	24	$12.10	$3,872.00	59	0.025	0.021	2880	$871.30	-$3,000.70	-$83.35
Field Crops, Row	5	9	36	$12.10	$3,267.00	39	0.025	0.021	1904	$575.94	-$2,691.06	-$74.75
Sugar Beets	9	12	36	$12.10	$4,356.00	46	0.025	0.021	2224	$672.87	-$3,683.13	-$102.31

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under pivot irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for pivot irrigation.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	36	12	$20.70	$279.45	0.33	$621.00	$341.55	$9.49
Bermuda	12	36	12	$20.70	$331.20	0.33	$862.50	$531.30	$14.76
Wheat	12	36	12	$20.70	$144.90	0.33	$338.10	$193.20	$5.37
Alfalfa, Flat	12	36	12	$20.70	$310.50	0.33	$821.10	$510.60	$14.18
Field Crops, Flat	12	36	12	$20.70	$186.30	0.33	$545.10	$358.80	$9.97
Alfalfa, Row	12	36	12	$20.70	$331.20	0.33	$821.10	$489.90	$13.61
Field Crops, Row	12	36	12	$20.70	$279.45	0.33	$817.65	$538.20	$14.95
Sugar Beets	12	36	12	$20.70	$372.60	0.33	$952.20	$579.60	$16.10

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with pivot.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising sprinkler events = fields covered / pivot fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Sprinkle Hrs/Irr[2]	Sprinkle Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.1	60	$251.40	$62.85	$1.75
Bermuda	0.5	$41.90	$335.20	0.1	125	$523.75	$188.55	$5.24
Wheat	0.5	$41.90	$146.65	0.1	49	$205.31	$58.66	$1.63
Alfalfa, Flat	0.5	$41.90	$314.25	0.1	119	$498.61	$184.36	$5.12
Field Crops, Flat	0.5	$41.90	$188.55	0.1	79	$331.01	$142.46	$3.96
Alfalfa, Row	0.5	$41.90	$335.20	0.1	119	$498.61	$163.41	$4.54
Field Crops, Row	0.5	$41.90	$188.55	0.1	79	$331.01	$142.46	$3.96
Sugar Beets	0.5	$41.90	$251.40	0.1	92	$385.48	$134.08	$3.72

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per pivot irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 0.5" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.0921	gal/BHP-hr	2.7	100	0.7	43.7	4.5	18.0	$2.72	$49.06

Crop	Sprinkler Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	30	$3,612.36	$100.34
Bermuda	62	$7,459.54	$207.21
Wheat	25	$2,959.39	$82.21
Alfalfa, Flat	59	$7,109.65	$197.49
Field Crops, Flat	39	$4,699.59	$130.54
Alfalfa, Row	59	$7,109.65	$197.49
Field Crops, Row	39	$4,699.59	$130.54
Sugar Beets	46	$5,490.50	$152.51

Notes
1. Specific fuel consumption estimated from Rain for Rent literature (DV-200).
2. TDH calculated based on pump discharge pressure of 40 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.15.2 Detailed Budget for 72-Acre Field

A.15.2.1 Annual Capital and Maintenance Costs

		i =	4%
		Field Size =	72 ac
Description		Cost Adjustment Factor =	0.75

Center Pivot Irrigation with 1200 gpm pump. Pump is permanently pad-mounted at reservoir.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	3,607	cy	$4.70	$17,000.00	50	$791	$10.99	1%	$170.00	$2.36
Concrete Inlet Structure and Buried Pipe	0.75	ea	$12,050.00	$9,037.50	50	$421	$5.84	2%	$180.75	$2.51
Concrete Pad to Support Pump	0.75	ea	$3,000.00	$2,250.00	50	$105	$1.45	2%	$45.00	$0.63
Overflow Structure	0	ea	$5,650.00	$0.00	50	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Sump, 48" x 15'	0.75	ea	$5,650.00	$4,237.50	50	$197	$2.74	2%	$84.75	$1.18
Flowmeter	0.75	ea	$2,400.00	$1,800.00	10	$222	$3.08	2%	$36.00	$0.50
Automatic Oiler	0.75	ea	$350.00	$262.50	15	$24	$0.33	9%	$23.63	$0.33
Diesel Engine/Pump, 2.7 cfs @ 100' TDH[2]	0.75	ea	$24,000.00	$18,000.00	15	$1,619	$22.49	9%	$1,620.00	$22.50
Security Enclosure	0.75	ea	$6,300.00	$4,725.00	50	$220	$3.05	2%	$94.50	$1.31
Pipeline and Center Pivot System										
Mainline from reservoir to pivot, 10" Class 80 PIP	990	ft	$7.90	$7,821.00	20	$575	$7.99	2%	$156.42	$2.17
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[4]	1	ea	$1,560.00	$1,560.00	20	$115	$1.59	2%	$31.20	$0.43
Pivot system, 1320', low pressure	0.75	ea	$67,700.00	$50,800.00	15	$4,569	$63.46	5%	$2,540.00	$35.28
Miscellaneous										
On-farm admin, 5%				$5,874.68		$442.89	$6.15			
			Contingency and Unlisted Items (10%):	$11,750.00		$890.00	$12.92		$500.00	$6.92
			Total Cost:	$135,118.18		$10,191.00	$142.09		$5,482.00	$76.12

Notes/Assumptions

1. 4 af Reservoir is assumed to be constructed for portion of fields (fields will be joined, or a single reservoir will serve adjacent fields). Quantities adjusted accordingly.
2. Pump includes inlet and outlet hoses, screen filter. Engine equipped with generator to run pivot.
3. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
4. Estimated at 20% of pipeline cost.

A.15.2.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Pivot Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Pivot Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	30	0.025	0.021	1463	$442.70	-$2,824.30	-$39.23
Bermuda	12	16	24	$12.10	$3,872.00	62	0.025	0.021	3022	$914.18	-$2,957.82	-$41.08
Wheat	6	7	24	$12.10	$1,694.00	25	0.025	0.021	1199	$362.68	-$1,331.32	-$18.49
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	59	0.025	0.021	2880	$871.30	-$2,758.70	-$38.32
Field Crops, Flat	5	9	24	$12.10	$2,178.00	39	0.025	0.021	1904	$575.94	-$1,602.06	-$22.25
Alfalfa, Row	12	16	24	$12.10	$3,872.00	59	0.025	0.021	2880	$871.30	-$3,000.70	-$41.68
Field Crops, Row	5	9	36	$12.10	$3,267.00	39	0.025	0.021	1904	$575.94	-$2,691.06	-$37.38
Sugar Beets	9	12	36	$12.10	$4,356.00	46	0.025	0.021	2224	$672.87	-$3,683.13	-$51.15

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under pivot irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for pivot irrigation.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	36	12	$20.70	$279.45	0.33	$621.00	$341.55	$4.74
Bermuda	12	36	12	$20.70	$331.20	0.33	$862.50	$531.30	$7.38
Wheat	12	36	12	$20.70	$144.90	0.33	$338.10	$193.20	$2.68
Alfalfa, Flat	12	36	12	$20.70	$310.50	0.33	$821.10	$510.60	$7.09
Field Crops, Flat	12	36	12	$20.70	$186.30	0.33	$545.10	$358.80	$4.98
Alfalfa, Row	12	36	12	$20.70	$331.20	0.33	$821.10	$489.90	$6.80
Field Crops, Row	12	36	12	$20.70	$279.45	0.33	$817.65	$538.20	$7.48
Sugar Beets	12	36	12	$20.70	$372.60	0.33	$952.20	$579.60	$8.05

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with pivot.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising pivot events = fields covered / pivot fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Sprinkle Hrs/Irr[2]	Sprinkle Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.1	60	$251.40	$62.85	$0.87
Bermuda	0.5	$41.90	$335.20	0.1	125	$523.75	$188.55	$2.62
Wheat	0.5	$41.90	$146.65	0.1	49	$205.31	$58.66	$0.81
Alfalfa, Flat	0.5	$41.90	$314.25	0.1	119	$498.61	$184.36	$2.56
Field Crops, Flat	0.5	$41.90	$188.55	0.1	79	$331.01	$142.46	$1.98
Alfalfa, Row	0.5	$41.90	$335.20	0.1	119	$498.61	$163.41	$2.27
Field Crops, Row	0.5	$41.90	$188.55	0.1	79	$331.01	$142.46	$1.98
Sugar Beets	0.5	$41.90	$251.40	0.1	92	$385.48	$134.08	$1.86

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per pivot irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 0.5" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.0921	gal/BHP-hr	2.7	100	0.7	43.7	4.5	18.0	$2.72	$49.06

Crop	Sprinkler Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	30	$7,224.73	$100.34
Bermuda	62	$14,919.08	$207.21
Wheat	25	$5,918.78	$82.21
Alfalfa, Flat	59	$14,219.29	$197.49
Field Crops, Flat	39	$9,399.18	$130.54
Alfalfa, Row	59	$14,219.29	$197.49
Field Crops, Row	39	$9,399.18	$130.54
Sugar Beets	46	$10,981.00	$152.51

Notes
1. Specific fuel consumption estimated from Rain for Rent literature (DV-200).
2. TDH calculated based on pump discharge pressure of 40 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.15.3 Detailed Budget for 144-Acre Field

A.15.3.1 Annual Capital and Maintenance Costs

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	0.91

Description
Center Pivot Irrigation with 1200 gpm pump. Pump is permanently pad-mounted at reservoir.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
On-Farm Reservoir[1]										
Excavation	4,376	cy	$4.70	$20,600.00	50	$959	$6.66	1%	$206.00	$1.43
Concrete Inlet Structure and Buried Pipe	0.91	ea	$12,050.00	$10,965.50	50	$510	$3.54	2%	$219.31	$1.52
Concrete Pad to Support Pump	0.91	ea	$3,000.00	$2,730.00	50	$127	$0.88	2%	$54.60	$0.38
Overflow Structure	0	ea	$5,650.00	$0.00	50	$0	$0.00	2%	$0.00	$0.00
Pump Station										
Sump, 48" x 15'	0.91	ea	$5,650.00	$5,141.50	50	$239	$1.66	2%	$102.83	$0.71
Flowmeter	0.91	ea	$2,400.00	$2,184.00	10	$269	$1.87	2%	$43.68	$0.30
Automatic Oiler	0.91	ea	$350.00	$318.50	15	$29	$0.20	9%	$28.67	$0.20
Diesel Engine/Pump, 2.7 cfs @ 100' TDH[2]	0.91	ea	$24,000.00	$21,840.00	15	$1,964	$13.64	9%	$1,965.60	$13.65
Security Enclosure	0.91	ea	$6,300.00	$5,733.00	50	$267	$1.85	2%	$114.66	$0.80
Pipeline and Center Pivot System										
Mainline from reservoir to pivot, 10" Class 80 PIP	1201.2	ft	$7.90	$9,500.00	20	$699	$4.85	2%	$190.00	$1.32
All fittings including steel discharge pipe, valves, transition, thrust blocks, elbows, outlet[4]	1	ea	$1,900.00	$1,900.00	20	$140	$0.97	2%	$38.00	$0.26
Pivot system, 1320', low pressure	0.91	ea	$67,700.00	$61,600.00	15	$5,540	$38.47	5%	$3,080.00	$21.39
Miscellaneous										
On-farm admin, 5%				$3,950.63		$253.20	$1.76			
			Contingency and Unlisted Items (10%):	$14,250.00		$1,070.00	$7.64		$600.00	$4.20
			Total Cost:	$160,713.13		$12,067.00	$84.01		$6,643.00	$46.16

Notes/Assumptions
1. 4 af Reservoir is assumed to be constructed for portion of fields (fields will be joined, or a single reservoir will serve adjacent fields). Quantities adjusted accordingly.
2. Pump includes inlet and outlet hoses, screen filter. Engine equipped with generator to run pivot.
3. Reservoir costs adjusted based on anticipated grouping of fields so that one pump and pond serves multiple fields.
4. Estimated at 20% of pipeline cost.

A.15.3.2 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Pivot Applied (in)[5]	Labor Hrs/ Irr. Hr[6]	Effective Precip Rate[7]	Irrigation Hrs[8]	Pivot Total[9]	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	30	0.025	0.021	1463	$442.70	-$2,824.30	-$19.61
Bermuda	12	16	24	$12.10	$3,872.00	62	0.025	0.021	3022	$914.18	-$2,957.82	-$20.54
Wheat	6	7	24	$12.10	$1,694.00	25	0.025	0.021	1199	$362.68	-$1,331.32	-$9.25
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	59	0.025	0.021	2880	$871.30	-$2,758.70	-$19.16
Field Crops, Flat	5	9	24	$12.10	$2,178.00	39	0.025	0.021	1904	$575.94	-$1,602.06	-$11.13
Alfalfa, Row	12	16	24	$12.10	$3,872.00	59	0.025	0.021	2880	$871.30	-$3,000.70	-$20.84
Field Crops, Row	5	9	36	$12.10	$3,267.00	39	0.025	0.021	1904	$575.94	-$2,691.06	-$18.69
Sugar Beets	9	12	36	$12.10	$4,356.00	46	0.025	0.021	2224	$672.87	-$3,683.13	-$25.58

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of surface irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field for surface irrigation.
5. Estimated gross application under pivot irrigation.
6. Estimated hours of irrigation labor per hour of application.
7. Effective application rate considering pump capacity, field size, and pump flow per acre.
8. Estimated seasonal hours of pump operation.
9. Total estimated labor cost for pivot irrigation.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Sprinkle Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	36	12	$20.70	$279.45	0.33	$621.00	$341.55	$2.37
Bermuda	12	36	12	$20.70	$331.20	0.33	$862.50	$531.30	$3.69
Wheat	12	36	12	$20.70	$144.90	0.33	$338.10	$193.20	$1.34
Alfalfa, Flat	12	36	12	$20.70	$310.50	0.33	$821.10	$510.60	$3.55
Field Crops, Flat	12	36	12	$20.70	$186.30	0.33	$545.10	$358.80	$2.49
Alfalfa, Row	12	36	12	$20.70	$331.20	0.33	$821.10	$489.90	$3.40
Field Crops, Row	12	36	12	$20.70	$279.45	0.33	$817.65	$538.20	$3.74
Sugar Beets	12	36	12	$20.70	$372.60	0.33	$952.20	$579.60	$4.03

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with pivot.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising pivot events = fields covered / pivot fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field	Sprinkle Hrs/Irr[2]	Sprinkle Irrigations[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	0.1	60	$251.40	$62.85	$0.44
Bermuda	0.5	$41.90	$335.20	0.1	125	$523.75	$188.55	$1.31
Wheat	0.5	$41.90	$146.65	0.1	49	$205.31	$58.66	$0.41
Alfalfa, Flat	0.5	$41.90	$314.25	0.1	119	$498.61	$184.36	$1.28
Field Crops, Flat	0.5	$41.90	$188.55	0.1	79	$331.01	$142.46	$0.99
Alfalfa, Row	0.5	$41.90	$335.20	0.1	119	$498.61	$163.41	$1.13
Field Crops, Row	0.5	$41.90	$188.55	0.1	79	$331.01	$142.46	$0.99
Sugar Beets	0.5	$41.90	$251.40	0.1	92	$385.48	$134.08	$0.93

1. Estimated hours of management time needed for water ordering and worker supervision per surface irrigation event.
2. Estimated hours of management time needed for water ordering and worker supervision per pivot irrigation event.
3. Estimated number of seasonal irrigation events based on estimated application of 0.5" per event.

Seasonal Operations Costs: Energy

Description	Specific Consumption[1]		Flow (cfs)	TDH (ft)[2]	OPPE	BHP	hrs/ac-ft	gal/ac-ft	Unit $	$/ac-ft
Diesel Fuel	0.0921	gal/BHP-hr	2.7	100	0.7	43.7	4.5	18.0	$2.72	$49.06

Crop	Sprinkler Applied (in)	Fuel $/field	Fuel $/ac
Truck Crops	30	$14,449.45	$100.34
Bermuda	62	$29,838.16	$207.21
Wheat	25	$11,837.56	$82.21
Alfalfa, Flat	59	$28,438.59	$197.49
Field Crops, Flat	39	$18,798.37	$130.54
Alfalfa, Row	59	$28,438.59	$197.49
Field Crops, Row	39	$18,798.37	$130.54
Sugar Beets	46	$21,961.99	$152.51

Notes
1. Specific fuel consumption estimated from Rain for Rent literature (DV-200).
2. TDH calculated based on pump discharge pressure of 40 psi.

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes
1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

Attachment 16
Detailed Cost Estimates for Level Basin Irrigation

A.16.1 Detailed Budgets for 36-Acre Field

A.16.1.1 Annual Capital and Maintenance Costs, 330′ X 330′ Basins

	i =	4%
	Field Size =	36 ac
Description	Cost Adjustment Factor =	NA

Construction and Operation of a level basin irrigation system on light soils with 330' X 330' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	12,400	cy	$1.20	$14,900.00	50	$694	$19.27	1%	$149.00	$4.14
Laser Leveling	36	ac	$75.00	$2,700.00	50	$126	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	1320	ft	$2.90	$3,828.00	50	$178	$4.95	0%	$0.00	$0.00
Carry Ditch	990	ft	$20.10	$19,899.00	30	$1,151	$31.97	2%	$397.98	$11.06
Head Ditch	2640	ft	$20.10	$53,064.00	30	$3,069	$85.24	2%	$1,061.28	$29.48
Turnouts	16	ea	$2,500.00	$40,000.00	30	$2,313	$64.26	2%	$800.00	$22.22
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	3	ea	$3,400.00	$10,200.00	30	$590	$16.39	2%	$204.00	$5.67
Ditch Grading[1]	24	hr	$145.00	$3,480.00	50	$162	$4.50	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$7,400.00	$7,400.00	50	$344	$9.57	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$14,810.00		$830.00	$25.31		$260.00	$7.26
Total Cost:				$170,281.00		$9,456.00	$264.93		$2,872.00	$79.82

Notes/Assumptions

1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.1.2 Annual Capital and Maintenance Costs, 660′ X 220′ Basins

i = 4%
Field Size = 36 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 660' X 220' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	8,400	cy	$1.20	$10,100.00	50	$470	$13.06	1%	$101.00	$2.81
Laser Leveling	36	ac	$75.00	$2,700.00	50	$126	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	1320	ft	$2.90	$3,828.00	50	$178	$4.95	0%	$0.00	$0.00
Carry Ditch	660	ft	$20.10	$13,266.00	30	$767	$21.31	2%	$265.32	$7.37
Head Ditch	1320	ft	$20.10	$26,532.00	30	$1,534	$42.62	2%	$530.64	$14.74
Turnouts	12	ea	$2,500.00	$30,000.00	30	$1,735	$48.19	2%	$600.00	$16.67
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	2	ea	$3,400.00	$6,800.00	30	$393	$10.92	2%	$136.00	$3.78
Ditch Grading[1]	12	hr	$145.00	$1,740.00	50	$81	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$4,700.00	$4,700.00	50	$219	$6.08	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$9,500.00		$530.00	$16.15		$160.00	$4.54
Total Cost:				$109,166.00		$6,033.00	$169.02		$1,793.00	$49.90

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.1.3 Annual Capital and Maintenance Costs, 660' X 330' Basins

i = 4%
Field Size = 36 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 660' X 330' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	12,400	cy	$1.20	$14,900.00	50	$694	$19.27	1%	$149.00	$4.14
Laser Leveling	36	ac	$75.00	$2,700.00	50	$126	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	1320	ft	$2.90	$3,828.00	50	$178	$4.95	0%	$0.00	$0.00
Carry Ditch	660	ft	$20.10	$13,266.00	30	$767	$21.31	2%	$265.32	$7.37
Head Ditch	1320	ft	$20.10	$26,532.00	30	$1,534	$42.62	2%	$530.64	$14.74
Turnouts	8	ea	$2,500.00	$20,000.00	30	$1,157	$32.13	2%	$400.00	$11.11
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	2	ea	$3,400.00	$6,800.00	30	$393	$10.92	2%	$136.00	$3.78
Ditch Grading[1]	12	hr	$145.00	$1,740.00	50	$81	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$4,500.00	$4,500.00	50	$209	$5.82	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$8,980.00		$490.00	$15.06		$150.00	$4.11
Total Cost:				$103,246.00		$5,629.00	$157.82		$1,631.00	$45.25

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.1.4 Annual Capital and Maintenance Costs, 660' X 440' Basins

i = 4%
Field Size = 36 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 660' X 330' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	8,400	cy	$1.20	$10,100.00	50	$470	$13.06	1%	$101.00	$2.81
Laser Leveling	36	ac	$75.00	$2,700.00	50	$126	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	1320	ft	$2.90	$3,828.00	50	$178	$4.95	0%	$0.00	$0.00
Carry Ditch	660	ft	$20.10	$13,266.00	30	$767	$21.31	2%	$265.32	$7.37
Head Ditch	1320	ft	$20.10	$26,532.00	30	$1,534	$42.62	2%	$530.64	$14.74
Turnouts	6	ea	$2,500.00	$15,000.00	30	$867	$24.10	2%	$300.00	$8.33
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	2	ea	$3,400.00	$6,800.00	30	$393	$10.92	2%	$136.00	$3.78
Ditch Grading[1]	12	hr	$145.00	$1,740.00	50	$81	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$4,000.00	$4,000.00	50	$186	$5.17	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$8,000.00		$440.00	$13.50		$130.00	$3.70
Total Cost:				$91,966.00		$5,043.00	$141.37		$1,463.00	$40.73

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.1.5 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Basin Hrs/Irr[5]	(Flexible Delivery) Adjusted Total	Incremental Increase	Increment per Acre	(Normal Delivery) Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	10.0	$1,089.00	-$2,178.00	-$60.50	$1,306.80	-$1,960.20	-$54.45
Bermuda	12	16	24	$12.10	$3,872.00	10.0	$1,936.00	-$1,936.00	-$53.78	$2,323.20	-$1,548.80	-$43.02
Wheat	6	7	24	$12.10	$1,694.00	10.0	$847.00	-$847.00	-$23.53	$1,016.40	-$677.60	-$18.82
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	10.0	$1,815.00	-$1,815.00	-$50.42	$2,178.00	-$1,452.00	-$40.33
Field Crops, Flat	5	9	24	$12.10	$2,178.00	10.0	$1,089.00	-$1,089.00	-$30.25	$1,306.80	-$871.20	-$24.20
Alfalfa, Row	12	16	24	$12.10	$3,872.00	10.0	$1,936.00	-$1,936.00	-$53.78	$2,323.20	-$1,548.80	-$43.02
Field Crops, Row	5	9	36	$12.10	$3,267.00	10.0	$1,089.00	-$2,178.00	-$60.50	$1,306.80	-$1,960.20	-$54.45
Sugar Beets	9	12	36	$12.10	$4,356.00	10.0	$1,452.00	-$2,904.00	-$80.67	$1,742.40	-$2,613.60	-$72.60

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Estimated event duration under level basin irrigation.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Basin Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$1.34
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$2.88
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$1.73
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$3.07
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$2.59
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$3.45

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with level basin.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising level basin events = fields covered / level basin fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	Basin Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$4.07
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$8.73
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$9.31
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$5.24
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$6.98

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes

1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.16.2 Detailed Budget for 72-Acre Field

A.16.2.1 Annual Capital and Maintenance Costs, 330′ x 330′ Basins

	i =	4%
	Field Size =	72 ac
Description	Cost Adjustment Factor =	NA

Construction and Operation of a level basin irrigation system on light soils with 330' X 330' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	24,800	cy	$1.20	$29,800.00	50	$1,387	$19.27	1%	$298.00	$4.14
Laser Leveling	72	ac	$75.00	$5,400.00	50	$251	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$4.95	0%	$0.00	$0.00
Carry Ditch	990	ft	$20.10	$19,899.00	30	$1,151	$15.98	2%	$397.98	$5.53
Head Ditch	5280	ft	$20.10	$106,128.00	30	$6,137	$85.24	2%	$2,122.56	$29.48
Turnouts	32	ea	$2,500.00	$80,000.00	30	$4,626	$64.26	2%	$1,600.00	$22.22
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	3	ea	$3,400.00	$10,200.00	30	$590	$8.19	2%	$204.00	$2.83
Ditch Grading[1]	36	hr	$145.00	$5,220.00	50	$243	$3.37	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$13,200.00	$13,200.00	50	$614	$8.53	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$26,430.00		$1,470.00	$22.52		$460.00	$6.42
Total Cost:				$303,933.00		$16,827.00	$235.81		$5,083.00	$70.62

Notes/Assumptions

1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.2.2 Annual Capital and Maintenance Costs, 440′ x 220′ Basins

i = 4%
Field Size = 72 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 440' X 220' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	16,500	cy	$1.20	$19,800.00	50	$922	$12.80	1%	$198.00	$2.75
Laser Leveling	72	ac	$75.00	$5,400.00	50	$251	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$4.95	0%	$0.00	$0.00
Carry Ditch	880	ft	$20.10	$17,688.00	30	$1,023	$14.21	2%	$353.76	$4.91
Head Ditch	3960	ft	$20.10	$79,596.00	30	$4,603	$63.93	2%	$1,591.92	$22.11
Turnouts	36	ea	$2,500.00	$90,000.00	30	$5,205	$72.29	2%	$1,800.00	$25.00
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	5	ea	$3,400.00	$17,000.00	30	$983	$13.65	2%	$340.00	$4.72
Ditch Grading[1]	36	hr	$145.00	$5,220.00	50	$243	$3.37	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$12,100.00	$12,100.00	50	$563	$7.82	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$24,240.00		$1,360.00	$20.76		$430.00	$5.95
Total Cost:				$278,700.00		$15,509.00	$217.28		$4,714.00	$65.45

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.2.3 Annual Capital and Maintenance Costs, 440′ x 330′ Basins

i = 4%
Field Size = 72 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 440' X 330' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	16,800	cy	$1.20	$20,200.00	50	$940	$13.06	1%	$202.00	$2.81
Laser Leveling	72	ac	$75.00	$5,400.00	50	$251	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$4.95	0%	$0.00	$0.00
Carry Ditch	880	ft	$20.10	$17,688.00	30	$1,023	$14.21	2%	$353.76	$4.91
Head Ditch	3960	ft	$20.10	$79,596.00	30	$4,603	$63.93	2%	$1,591.92	$22.11
Turnouts	24	ea	$2,500.00	$60,000.00	30	$3,470	$48.19	2%	$1,200.00	$16.67
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	5	ea	$3,400.00	$17,000.00	30	$983	$13.65	2%	$340.00	$4.72
Ditch Grading[1]	36	hr	$145.00	$5,220.00	50	$243	$3.37	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$10,600.00	$10,600.00	50	$493	$6.85	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$21,280.00		$1,190.00	$18.13		$370.00	$5.12
			Total Cost:	$244,640.00		$13,553.00	$189.85		$4,058.00	$56.34

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.2.4 Annual Capital and Maintenance Costs, 440′ x 440′ Basins

i = 4%
Field Size = 72 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 440' X 440' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	16,500	cy	$1.20	$19,800.00	50	$922	$12.80	1%	$198.00	$2.75
Laser Leveling	72	ac	$75.00	$5,400.00	50	$251	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$4.95	0%	$0.00	$0.00
Carry Ditch	880	ft	$20.10	$17,688.00	30	$1,023	$14.21	2%	$353.76	$4.91
Head Ditch	3960	ft	$20.10	$79,596.00	30	$4,603	$63.93	2%	$1,591.92	$22.11
Turnouts	18	ea	$2,500.00	$45,000.00	30	$2,602	$36.14	2%	$900.00	$12.50
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	5	ea	$3,400.00	$17,000.00	30	$983	$13.65	2%	$340.00	$4.72
Ditch Grading[1]	36	hr	$145.00	$5,220.00	50	$243	$3.37	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$9,900.00	$9,900.00	50	$461	$6.40	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$19,740.00		$1,100.00	$16.78		$340.00	$4.70
Total Cost:				$227,000.00		$12,545.00	$175.74		$3,724.00	$51.70

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.2.5 Annual Capital and Maintenance Costs, 660′ x 220′ Basins

i = 4%
Field Size = 72 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 660' X 220' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	16,800	cy	$1.20	$20,200.00	50	$940	$13.06	1%	$202.00	$2.81
Laser Leveling	72	ac	$75.00	$5,400.00	50	$251	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$4.95	0%	$0.00	$0.00
Carry Ditch	660	ft	$20.10	$13,266.00	30	$767	$10.66	2%	$265.32	$3.69
Head Ditch	2640	ft	$20.10	$53,064.00	30	$3,069	$42.62	2%	$1,061.28	$14.74
Turnouts	24	ea	$2,500.00	$60,000.00	30	$3,470	$48.19	2%	$1,200.00	$16.67
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	2	ea	$3,400.00	$6,800.00	30	$393	$5.46	2%	$136.00	$1.89
Ditch Grading[1]	24	hr	$145.00	$3,480.00	50	$162	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$8,500.00	$8,500.00	50	$396	$5.50	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$16,990.00		$940.00	$14.37		$290.00	$3.98
Total Cost:				$195,356.00		$10,745.00	$150.55		$3,155.00	$43.76

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.2.6 Annual Capital and Maintenance Costs, 660′ x 330′ Basins

i = 4%
Field Size = 72 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 660' X 330' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	24,800	cy	$1.20	$29,800.00	50	$1,387	$19.27	1%	$298.00	$4.14
Laser Leveling	72	ac	$75.00	$5,400.00	50	$251	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$4.95	0%	$0.00	$0.00
Carry Ditch	660	ft	$20.10	$13,266.00	30	$767	$10.66	2%	$265.32	$3.69
Head Ditch	2640	ft	$20.10	$53,064.00	30	$3,069	$42.62	2%	$1,061.28	$14.74
Turnouts	16	ea	$2,500.00	$40,000.00	30	$2,313	$32.13	2%	$800.00	$11.11
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	2	ea	$3,400.00	$6,800.00	30	$393	$5.46	2%	$136.00	$1.89
Ditch Grading[1]	24	hr	$145.00	$3,480.00	50	$162	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$8,000.00	$8,000.00	50	$372	$5.17	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$15,950.00		$870.00	$13.29		$260.00	$3.56
Total Cost:				$183,416.00		$9,942.00	$139.29		$2,821.00	$39.12

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.2.7 Annual Capital and Maintenance Costs, 660′ x 440′ Basins

i = 4%
Field Size = 72 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 660' X 440' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	16,800	cy	$1.20	$20,200.00	50	$940	$13.06	1%	$202.00	$2.81
Laser Leveling	72	ac	$75.00	$5,400.00	50	$251	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$4.95	0%	$0.00	$0.00
Carry Ditch	660	ft	$20.10	$13,266.00	30	$767	$10.66	2%	$265.32	$3.69
Head Ditch	2640	ft	$20.10	$53,064.00	30	$3,069	$42.62	2%	$1,061.28	$14.74
Turnouts	12	ea	$2,500.00	$30,000.00	30	$1,735	$24.10	2%	$600.00	$8.33
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	2	ea	$3,400.00	$6,800.00	30	$393	$5.46	2%	$136.00	$1.89
Ditch Grading[1]	24	hr	$145.00	$3,480.00	50	$162	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$7,000.00	$7,000.00	50	$326	$4.53	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$13,990.00		$770.00	$11.72		$230.00	$3.15
Total Cost:				$160,856.00		$8,770.00	$122.83		$2,495.00	$34.60

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.2.8 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Basin Hrs/Irr[5]	(Flexible Delivery) Adjusted Total	Incremental Increase	Increment per Acre	(Normal Delivery) Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	20.0	$2,178.00	-$1,089.00	-$15.13	$1,306.80	-$1,960.20	-$27.23
Bermuda	12	16	24	$12.10	$3,872.00	20.0	$3,872.00	$0.00	$0.00	$4,646.40	$774.40	$10.76
Wheat	6	7	24	$12.10	$1,694.00	20.0	$1,694.00	$0.00	$0.00	$2,032.80	$338.80	$4.71
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	20.0	$3,630.00	$0.00	$0.00	$4,356.00	$726.00	$10.08
Field Crops, Flat	5	9	24	$12.10	$2,178.00	20.0	$2,178.00	$0.00	$0.00	$2,613.60	$435.60	$6.05
Alfalfa, Row	12	16	24	$12.10	$3,872.00	20.0	$3,872.00	$0.00	$0.00	$4,646.40	$774.40	$10.76
Field Crops, Row	5	9	36	$12.10	$3,267.00	20.0	$2,178.00	-$1,089.00	-$15.13	$2,613.60	-$653.40	-$9.08
Sugar Beets	9	12	36	$12.10	$4,356.00	20.0	$2,904.00	-$1,452.00	-$20.17	$3,484.80	-$871.20	-$12.10

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating level basin, however, irrigation will be 24 hours and applied depth will be 5" rather than 3", decreasing irrigation frequency.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Basin Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$1.29
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$1.53
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$0.67
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$1.44
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$0.86
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$1.53
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$1.29
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$1.73

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with level basin.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising level basin events = fields covered / level basin fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	Basin Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$2.04
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$4.36
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$4.66
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$2.62
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$3.49

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes

1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

A.16.3 Detailed Budget for 144-Acre Field

A.16.3.1 Annual Capital and Maintenance Costs, 330′ x 330′ Basins

	i =	4%
	Field Size =	144 ac
Description	Cost Adjustment Factor =	NA

Construction and Operation of a level basin irrigation system on light soils with 330' X 330' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	49,600	cy	$1.20	$59,500.00	50	$2,770	$19.23	1%	$595.00	$4.13
Laser Leveling	144	ac	$75.00	$10,800.00	50	$503	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$2.47	0%	$0.00	$0.00
Carry Ditch	1980	ft	$20.10	$39,798.00	30	$2,302	$15.98	2%	$795.96	$5.53
Head Ditch	5280	ft	$20.10	$106,128.00	30	$6,137	$42.62	2%	$2,122.56	$14.74
Turnouts	64	ea	$2,500.00	$160,000.00	30	$9,253	$64.26	2%	$3,200.00	$22.22
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	5	ea	$3,400.00	$17,000.00	30	$983	$6.83	2%	$340.00	$2.36
Ditch Grading[1]	48	hr	$145.00	$6,960.00	50	$324	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$20,400.00	$20,400.00	50	$950	$6.59	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$40,780.00		$2,260.00	$17.29		$710.00	$4.90
Total Cost:				$469,022.00		$25,837.00	$181.02		$7,764.00	$53.88

Notes/Assumptions

1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.3.2 Annual Capital and Maintenance Costs, 440′ x 220′ Basins

i = 4%
Field Size = 144 ac
Cost Adjustment Factor = NA

Description
Construction and Operation of a level basin irrigation system on light soils with 440' X 220' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	33,000	cy	$1.20	$39,600.00	50	$1,843	$12.80	1%	$396.00	$2.75
Laser Leveling	144	ac	$75.00	$10,800.00	50	$503	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$2.47	0%	$0.00	$0.00
Carry Ditch	2200	ft	$20.10	$44,220.00	30	$2,557	$17.76	2%	$884.40	$6.14
Head Ditch	7920	ft	$20.10	$159,192.00	30	$9,206	$63.93	2%	$3,183.84	$22.11
Turnouts	72	ea	$2,500.00	$180,000.00	30	$10,409	$72.29	2%	$3,600.00	$25.00
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	4	ea	$3,400.00	$13,600.00	30	$786	$5.46	2%	$272.00	$1.89
Ditch Grading[1]	48	hr	$145.00	$6,960.00	50	$324	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$23,100.00	$23,100.00	50	$1,075	$7.47	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$46,200.00		$2,600.00	$19.85		$830.00	$5.79
			Total Cost:	$531,328.00		$29,661.00	$207.77		$9,166.00	$63.68

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.3.3 Annual Capital and Maintenance Costs, 440′ x 330′ Basins

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	NA

Description
Construction and Operation of a level basin irrigation system on light soils with 440' X 330' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	33,600	cy	$1.20	$40,300.00	50	$1,876	$13.03	1%	$403.00	$2.80
Laser Leveling	144	ac	$75.00	$10,800.00	50	$503	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$2.47	0%	$0.00	$0.00
Carry Ditch	2200	ft	$20.10	$44,220.00	30	$2,557	$17.76	2%	$884.40	$6.14
Head Ditch	7920	ft	$20.10	$159,192.00	30	$9,206	$63.93	2%	$3,183.84	$22.11
Turnouts	48	ea	$2,500.00	$120,000.00	30	$6,940	$48.19	2%	$2,400.00	$16.67
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	4	ea	$3,400.00	$13,600.00	30	$786	$5.46	2%	$272.00	$1.89
Ditch Grading[1]	48	hr	$145.00	$6,960.00	50	$324	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$20,100.00	$20,100.00	50	$936	$6.50	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$40,270.00		$2,250.00	$17.22		$710.00	$4.96
Total Cost:				$463,098.00		$25,734.00	$180.31		$7,853.00	$54.57

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.3.4 Annual Capital and Maintenance Costs, 440′ x 440′ Basins

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	NA

Description
Construction and Operation of a level basin irrigation system on light soils with 440' X 440' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	33,000	cy	$1.20	$39,600.00	50	$1,843	$12.80	1%	$396.00	$2.75
Laser Leveling	144	ac	$75.00	$10,800.00	50	$503	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$2.47	0%	$0.00	$0.00
Carry Ditch	2200	ft	$20.10	$44,220.00	30	$2,557	$17.76	2%	$884.40	$6.14
Head Ditch	7920	ft	$20.10	$159,192.00	30	$9,206	$63.93	2%	$3,183.84	$22.11
Turnouts	36	ea	$2,500.00	$90,000.00	30	$5,205	$36.14	2%	$1,800.00	$12.50
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	4	ea	$3,400.00	$13,600.00	30	$786	$5.46	2%	$272.00	$1.89
Ditch Grading[1]	48	hr	$145.00	$6,960.00	50	$324	$2.25	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$18,600.00	$18,600.00	50	$866	$6.01	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$37,200.00		$2,080.00	$15.87		$650.00	$4.54
Total Cost:				$427,828.00		$23,727.00	$166.20		$7,186.00	$49.93

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.3.5 Annual Capital and Maintenance Costs, 660′ x 220′ Basins

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	NA

Description
Construction and Operation of a level basin irrigation system on light soils with 660' X 220' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	33,600	cy	$1.20	$40,300.00	50	$1,876	$13.03	1%	$403.00	$2.80
Laser Leveling	144	ac	$75.00	$10,800.00	50	$503	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$2.47	0%	$0.00	$0.00
Carry Ditch	1980	ft	$20.10	$39,798.00	30	$2,302	$15.98	2%	$795.96	$5.53
Head Ditch	5280	ft	$20.10	$106,128.00	30	$6,137	$42.62	2%	$2,122.56	$14.74
Turnouts	48	ea	$2,500.00	$120,000.00	30	$6,940	$48.19	2%	$2,400.00	$16.67
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	4	ea	$3,400.00	$13,600.00	30	$786	$5.46	2%	$272.00	$1.89
Ditch Grading[1]	36	hr	$145.00	$5,220.00	50	$243	$1.69	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$17,200.00	$17,200.00	50	$801	$5.56	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$34,350.00		$1,910.00	$14.62		$600.00	$4.16
Total Cost:				$395,052.00		$21,854.00	$153.12		$6,594.00	$45.78

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.3.6 Annual Capital and Maintenance Costs, 660′ x 330′ Basins

	i =	4%
	Field Size =	144 ac
Description	Cost Adjustment Factor =	NA

Construction and Operation of a level basin irrigation system on light soils with 660' X 330' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	49,600	cy	$1.20	$59,500.00	50	$2,770	$19.23	1%	$595.00	$4.13
Laser Leveling	144	ac	$75.00	$10,800.00	50	$503	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$2.47	0%	$0.00	$0.00
Carry Ditch	1980	ft	$20.10	$39,798.00	30	$2,302	$15.98	2%	$795.96	$5.53
Head Ditch	5280	ft	$20.10	$106,128.00	30	$6,137	$42.62	2%	$2,122.56	$14.74
Turnouts	32	ea	$2,500.00	$80,000.00	30	$4,626	$32.13	2%	$1,600.00	$11.11
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	4	ea	$3,400.00	$13,600.00	30	$786	$5.46	2%	$272.00	$1.89
Ditch Grading[1]	36	hr	$145.00	$5,220.00	50	$243	$1.69	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$16,100.00	$16,100.00	50	$749	$5.20	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$32,270.00		$1,770.00	$13.54		$540.00	$3.74
Total Cost:				$371,072.00		$20,243.00	$141.82		$5,926.00	$41.14

Notes/Assumptions

1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.3.7 Annual Capital and Maintenance Costs, 660′ x 440′ Basins

	i =	4%
	Field Size =	144 ac
	Cost Adjustment Factor =	NA

Description
Construction and Operation of a level basin irrigation system on light soils with 660' X 440' basins.

Annual Capital and Maintenance Costs

Description	Qty	Unit	$/Unit, Installed	Total $	Life (yr)	Annual Total @i%	Annual per Acre	Maint. %	Annual Maint.	Maint. Per Acre
Land Grading										
Rough Grading	33,600	cy	$1.20	$40,300.00	50	$1,876	$13.03	1%	$403.00	$2.80
Laser Leveling	144	ac	$75.00	$10,800.00	50	$503	$3.49	0%	$0.00	$0.00
Head Ditch and Turnouts										
Decon Existing Head Ditch	2640	ft	$2.90	$7,656.00	50	$356	$2.47	0%	$0.00	$0.00
Carry Ditch	1980	ft	$20.10	$39,798.00	30	$2,302	$15.98	2%	$795.96	$5.53
Head Ditch	5280	ft	$20.10	$106,128.00	30	$6,137	$42.62	2%	$2,122.56	$14.74
Turnouts	24	ea	$2,500.00	$60,000.00	30	$3,470	$24.10	2%	$1,200.00	$8.33
Tailwater Ditch and Drop Boxes										
Drop Box, 36" x 5' and 24" x 30' Drain Pipe	3	ea	$3,400.00	$10,200.00	30	$590	$4.10	2%	$204.00	$1.42
Ditch Grading[1]	36	hr	$145.00	$5,220.00	50	$243	$1.69	0%	$0.00	$0.00
Miscellaneous										
On-Farm Admin[2]	1	ea	$14,000.00	$14,000.00	50	$652	$4.53	0%	$0.00	$0.00
Contingency and Unlisted Items (10%, exclusive of Engineering and Surveying):				$28,010.00		$1,550.00	$11.82		$470.00	$3.28
Total Cost:				$322,112.00		$17,678.00	$123.83		$5,196.00	$36.10

Notes/Assumptions
1. Ditch grading cost estimated based on 12 hrs with laser level and motor grader. Hourly rate $145 estimated from UC 04-05 tillage and harvest rates.
2. On-farm admin cost estimated to be 5% of total capital.

A.16.3.8 Seasonal Operations Costs

Seasonal Operations Costs: Irrigator

Crop Type	Months[1]	Irr[2]	Hrs/Irr[3]	Irrigator Unit $	Total[4]	Basin Hrs/Irr[5]	(Flexible Delivery) Adjusted Total	Incremental Increase	Increment per Acre	(Normal Delivery) Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	5	9	36	$12.10	$3,267.00	40.0	$4,356.00	$1,089.00	$7.56	$5,227.20	$1,960.20	$13.61
Bermuda	12	16	24	$12.10	$3,872.00	40.0	$7,744.00	$3,872.00	$26.89	$9,292.80	$5,420.80	$37.64
Wheat	6	7	24	$12.10	$1,694.00	40.0	$3,388.00	$1,694.00	$11.76	$4,065.60	$2,371.60	$16.47
Alfalfa, Flat	12	15	24	$12.10	$3,630.00	40.0	$7,260.00	$3,630.00	$25.21	$8,712.00	$5,082.00	$35.29
Field Crops, Flat	5	9	24	$12.10	$2,178.00	40.0	$4,356.00	$2,178.00	$15.13	$5,227.20	$3,049.20	$21.18
Alfalfa, Row	12	16	24	$12.10	$3,872.00	40.0	$7,744.00	$3,872.00	$26.89	$9,292.80	$5,420.80	$37.64
Field Crops, Row	5	9	36	$12.10	$3,267.00	40.0	$4,356.00	$1,089.00	$7.56	$5,227.20	$1,960.20	$13.61
Sugar Beets	9	12	36	$12.10	$4,356.00	40.0	$5,808.00	$1,452.00	$10.08	$6,969.60	$2,613.60	$18.15

Notes
1. Typical season length from WY98 single-field gates.
2. Typical number of irrigations from WY98 single-field gates.
3. Typical seasonal average hours per irrigation for 36-acre field from WY98 single-field gates, minus 4 hours per 24 hours for breaks.
4. Total seasonal irrigator cost per field. 4 hours per 24 hours of irrigation deducted to account for break time.
5. Adjustment factor based on assumption that irrigators typically cover 2 fields simultaneously and are paid 1.5 times normal rate but will cover only 1 when operating level basin, however, irrigation will be 24 hours and applied depth will be 5" rather than 3", decreasing irrigation frequency.

Seasonal Operations Costs: Foreman

Crop Type	Fields Covered[1]	Basin Fields Covered[2]	Hours per Day[3]	Foreman Unit $	Total per Field[4]	Adjustment Factor[5]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$0.65
Bermuda	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$0.77
Wheat	12	9	12	$20.70	$144.90	1.33	$193.20	$48.30	$0.34
Alfalfa, Flat	12	9	12	$20.70	$310.50	1.33	$414.00	$103.50	$0.72
Field Crops, Flat	12	9	12	$20.70	$186.30	1.33	$248.40	$62.10	$0.43
Alfalfa, Row	12	9	12	$20.70	$331.20	1.33	$441.60	$110.40	$0.77
Field Crops, Row	12	9	12	$20.70	$279.45	1.33	$372.60	$93.15	$0.65
Sugar Beets	12	9	12	$20.70	$372.60	1.33	$496.80	$124.20	$0.86

Notes
1. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman.
2. Estimated number of irrigation events simultaneously supervised by a full-time irrigation foreman with level basin.
3. Estimated paid hours per day of work.
4. Total seasonal cost per field = hrs/day x unit $ x days/irr x irr/season / fields covered.
5. Adjustment to account for less fields covered when supervising level basin events = fields covered / level basin fields covered.

Seasonal Operations Costs: Manager

Crop Type	Hours per Irrigation[1]	Manager Unit $	Total per Field[2]	Basin Hrs/Irr[3]	Adjusted Total	Incremental Increase	Increment per Acre
Truck Crops	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Bermuda	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Wheat	0.5	$41.90	$146.65	1	$293.30	$146.65	$1.02
Alfalfa, Flat	0.5	$41.90	$314.25	1	$628.50	$314.25	$2.18
Field Crops, Flat	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Alfalfa, Row	0.5	$41.90	$335.20	1	$670.40	$335.20	$2.33
Field Crops, Row	0.5	$41.90	$188.55	1	$377.10	$188.55	$1.31
Sugar Beets	0.5	$41.90	$251.40	1	$502.80	$251.40	$1.75

Seasonal Operations Costs: Consultant

Description	Unit Cost[1]	
Irrigation Scheduling Consultant	$1,170	per field-season

Notes

1. Estimated cost per field-season of providing irrigation scheduling services including crop ET calculation, soil moisture monitoring, and irrigation reccommendations.

Efficiency Conservation Definite Plan

FINAL REPORT

Prepared as part of the

Imperial Irrigation District Efficiency Conservation Definite Plan

May 2007

Definite Plan Team:

Davids Engineering, Inc. and
Keller Bliesner Engineering, LLC,
in association with CONCUR, Inc.,
DAVEY-CAIRO ENGINEERING, INC.,
GEO/Graphics, ITRC,
Western Resource Economics,
Colorado State University and
Utah State University

Efficiency Conservation Definite Plan

FINAL REPORT

Prepared as part of the

Imperial Irrigation District
Efficiency Conservation Definite Plan

May 2007

Definite Plan Team:

Davids Engineering, Inc. and
Keller Bliesner Engineering, LLC,
in association with CONCUR, Inc.,
DAVEY-CAIRO ENGINEERING, INC.,
GEO/Graphics, ITRC,
Western Resource Economics,
Colorado State University and
Utah State University

Acronyms and Abbreviations

AAC	All American Canal
AACE	American Society of Cost Engineers
AE	application efficiency
AF	acre-feet
AFY	acre-feet per year
Bsl	baseline
C	combination
cfs	cubic feet per second
C	heavy-cracking
CI	confidence intervals
CIMIS	California Irrigation Management Information System
CISP	customized irrigation scheduling package
CM	conservation measure
CPC	center-pivot irrigation, cropped
CPN	center-pivot irrigation, non-cropped
CUF	consumptive use fraction
CSU	Colorado State University
CVWD	Coachella Valley Water District
D	drip
DCE	DAVEY-CAIRO ENGINEERING, INC.
Definite Plan	Efficiency Conservation Definite Plan
DG	demand generator
DRP	drip irrigation
DSS	decision support system
DTM	data transfer module
DU	distribution uniformity
DW	delivered water
E	evaporation
EHL	East Highline Canal
ET	evapotranspiration
ET_o	reference evapotranspiration
ET_a	actual crop ET
ET_p	potential crop evapotranspiration
EWMPs	Efficient Water Management Practices
F	Flat
ft	Feet
GCL	geosynthetic clay liner
GIS	Geographic Information System
GPP	grower participation plan
GSM	growing season months
HC	hydraulic conductivity
H	heavy
IID	Imperial Irrigation District

IIDSS	Imperial Irrigation Decision Support System
IMMU	Irrigation Management and Monitoring Unit
ITRC	Irrigation Training and Research Center
KBE	Keller-Bliesner Engineering
LCW	long-crested weirs
LEP	linear extensibility percentage
LVL	level basin irrigation
LLDPE	linear low-density polyethylene
L	light
MAD	management allowed depletion
M&I	municipal and industrial
MMP	minor management and physical improvements
MOU	memorandum of understanding
MoWB	water balance analysis monthly
NB	net benefit
NRCS	Natural Resources Conservation Service
OFTA	On-Farm Technical Advisors
O-FDPs	on-farm water conservation technologies demonstration projects
O-FDP	on-farm water conservation technologies demonstration program
O&M	operation and maintenance
PFM	payment for conservation measures
PO	public outreach
QSA	Quantification Settlement Agreement
R	row
RGRCP	Rubber Gasketed Reinforced Concrete Pipe
RI	row irrigation
SAP	IID business computer system
S	sprinkle
SCADA	Supervisory Control and Data Acquisition
SEBAL®	Surface Energy Balance Algorithm for Land
SEM	scientific irrigation scheduling and event management
SFG	single-field-gate
SIRMOD	Surface Irrigation Modeling and Design
SDI	subsurface drip irrigation
SIS	scientific irrigation scheduling
SPR	sprinkle irrigation
SSURGO	State Soil Survey Geographic Database
STSFG	single-tenant-single-field gates
TaW	tailwater
TRP	tailwater recovery systems with minimal storage
TRPX	tailwater recovery systems with minimal storage, extended delivery
Team	Definite Plan Team
Tgt	target

TRB	tailwater recovery systems with big pond
TRBX	tailwater recovery systems with big pond, extended delivery
TRS	Tailwater Recovery Systems
TRSX	tailwater recovery systems with small pond, extended delivery
Uniform PFM	uniform payment for conservation measures
USBR	United States Bureau of Reclamation
WCC	Water Control Center
WIS	Water Information System
WMP	Water Management Plan
WSM	West Side Main Canal
WST	water study team
WY	water year
WYWB	water balance analysis water year
2TSFG	two-tenant-single-field-gates
3TSFG	three-tenant-single-field-gates

TABLE OF CONTENTS

List of Tables

List of Figures

Appendices (Bound Separately; 9 Volumes Total)

Executive Summary

Overview

In October 2003, the Imperial Irrigation District entered into a package of decisions and agreements known collectively as the Quantification Settlement Agreement and Related Agreements. As part of these agreements, the Imperial Irrigation District (IID) agreed to a long-term transfer of water to the San Diego County Water Authority (SDCWA) and the Coachella Valley Water District (CVWD).

The water for transfer is to be generated through efficiency conservation, including both improvements in IID's delivery system and improvements in on-farm irrigation practices. The required conservation is relatively small initially - 4,000 acre-feet are to be conserved and transferred to CVWD in 2008. By 2026, IID must be conserving and transferring 303,000 acre-feet annually – or nearly one out of every 10 acre-feet of water it historically has diverted from the Colorado River each year. Under the terms of the QSA, at least 130,000 acre-feet of the savings for transfer to the SDCWA must be generated through contracted, on-farm efficiency conservation.

The Efficiency Conservation Definite Plan, referred to throughout this report as the Definite Plan, is intended to identify a range of on-farm actions, delivery system improvements and incentive packages that can produce the water for transfer under the QSA, and to recommend the mix of actions that best meet IID's objectives.

Project Approach

To develop the Definite Plan, an inter-disciplinary team (referred to as the Definite Plan Team, or Team) worked with IID staff and the affected community to explore the issues, develop and evaluate alternatives, and recommend the preferred path forward. A number of important factors shaped the Team's approach.

- ***Consistency with project parameters.*** Many underlying program requirements were laid out in provisions of the QSA and Related Agreements. Other project parameters reflect IID policies or preferences. Key parameters include: (1) meet the agreed-upon transfer ramp-up schedule; (2) generate savings through efficiency conservation only; (3) rely on voluntary and incentive-driven (not mandatory) grower participation; (4) verify water savings; and (5) maximize on-farm contributions to the extent practical. The Team also was mindful that any recommended approach would need to be technically sound, flexible and implementable.

- ***Informed by local perspectives.*** The Team worked closely with Valley growers and landowners to ensure the analysis was informed by local perspectives and experience. A key facet of this effort was the On-Farm Technical Advisors, a group of 13 Valley growers who served as a technical sounding board for the Team. Other outreach efforts included newsletters and a project website; on-farm demonstration projects, public workshops and field days; and a Valley-wide survey of growers and landowners. The Team also met regularly with IID staff.

- ***Analytically rigorous.*** The Team undertook a comprehensive analysis that evaluated on-farm and delivery system conservation potential both separately and in conjunction with one another. It evaluated the potential of a wide range of conservation measures and the viability of different on-farm incentive packages and payment levels. It considered conservation methods currently in use, as well as methods not widely used in the Valley. Finally, it used modeling and other analysis to understand and anticipate the growers' response to incentives and to assess the impact of various changes and approaches on conservation potential, costs and capacity within IID's network of canals and laterals.

Evaluation Results

Factors Shaping Alternatives Evaluation

The first step in the Team's work was to better understand current practices and efficiency conservation opportunities. The analysis yielded important insights. These include:

- IID Water Balance. An examination of IID's water balance - an accounting that balances water inflows with outflows within a specified area, over a specified period of time – identified the potential sources for efficiency conservation savings: 124,000 acre-feet lost as spillage from IID laterals, 86,000 acre-feet of seepage from main canals and laterals, and 433,000 acre-feet discharged as tailwater. It is important to note that these figures represent potential and do not consider cost and other technical issues or constraints that might make seemingly attractive opportunities not feasible or cost-effective.
- Revenue available to pay for conservation savings. A key element of the Definite Plan is cost-effectiveness; the method for generating efficiency conservation savings must fit within the available revenue. Based on the expected transfer revenues and related costs provided by IID, the Team estimated that IID has roughly $300 per acre-foot (in 2006 dollars) to cover all costs associated with the transfer program – including system improvements, on-farm conservation and incentive payments, administration, measurement needs and any contingencies. The Team used this figure as a benchmark when assessing the financial feasibility of the various conservation alternatives under consideration.
- Assessment of current measurement practices. IID routinely collects flow data at every farm delivery gate . In general, the records are quite good for their intended uses, such as for implementing IID's volumetric water charge by account. However, some water delivery records for individual fields and irrigation events contain errors and, depending on the incentive approach selected, could lead to biases and disparities in how growers would be compensated for water savings.
- On-farm conservation potential. On-farm water conservation will represent a major component of the total water conserved as part of the Definite Plan. The Team evaluated current on-farm practices, costs and potential to better assess the overall conservation potential. The analysis highlighted the following:

    - Achieving additional on-farm conservation for the Definite Plan does not mean introducing wholly new technologies as much as spreading awareness and use of measures already known to work.

- A majority of fields in IID will need to participate in the on-farm program to achieve sufficient savings, with water conservation potential and costs varying from field to field due to historical water use, crop grown, soil, and irrigation method.
- Conservation measures that change the irrigation method or capture and reuse tailwater are expected to generate the bulk of on-farm savings, though each participating grower will determine his or her approach to generating efficiency conservation savings.

Collectively, these findings suggest any implementation approach needs to be flexible enough to anticipate and accommodate these varied results.

- Preferred delivery system conservation methods. The Team made a comprehensive review of IID's delivery system – assessing everything from minor actions to line leaky lateral canals to a complete revamping of IID's network of canals, laterals and head-gates. It considered stand-alone actions (those that can be implemented without impacting system operation or on-farm irrigation performance) and inter-related actions (those that influence system operation or farm delivery or are affected by adoption of on-farm conservation measures). The analysis yielded the following findings:

  - Main canal seepage recovery (pumping seepage water collected in parallel drains back to the canal) produces the lowest-cost, stand-alone delivery system water savings, with the potential to conserve between 35,000 and 45,000 acre-feet at $13 to $15 per acre-foot saved.
  - Integrated Information Management (IIM) – focused on utilizing SCADA (Supervisory Control and Data Acquisition) technology to enable real-time lateral spill monitoring and remote operation of lateral headings by zanjeros, together with lateral and main canal regulating storage and other selected system improvements – offered the most cost-effective option, generating between 60,000 and 73,000 acre-feet of water at roughly $160 per acre-foot.
  - Lateral canal lining and other more involved delivery system changes appeared to offer either limited savings or exceed available revenue or both.

- Viable on-farm incentive approaches. The success of the Definite Plan depends heavily on the effectiveness of its on-farm incentive program. As a voluntary program, the incentive structure and payments must be attractive enough to entice widespread grower participation. The Team looked at three kinds of incentive payment options: those that pay for *performance or results* (such as measured reductions in delivered water or tailwater); those that pay for *actions* (such as implementing specific on-farm conservation measures); and *hybrids*, where a portion on the payment is based on results and a portion on actions. The analysis suggested the following:

  - At first glance, an incentive approach based solely on performance or results appears attractive. IID would track savings against a historical benchmark of some kind to determine and pay for conservation savings. In fact, analysis shows that none of the purely performance-based incentive programs appear viable. Neither aggregate water use history by crop nor a tailwater standard can be implemented within the available revenue. An incentive program based on individual delivery gate history is also

problematic as it is likely to result in significant enrollment bias, concerns about perceived fairness of payments, and large payments to growers for fields that may have little or no new conservation.

- The Team considered two different pay-for-conservation measures: uniform (where each field receives the same payment per acre for a given conservation measure adopted), and scaled (where the size of the payment for a given conservation measure varies to account for economies of scale gained on larger fields). The analysis indicates that both approaches appear to be financially feasible. The analysis did, however, highlight one important limitation: The approach provides no direct incentive for growers to operate the conservation measures effectively and achieve their full savings potential.
- Hybrid incentive approaches are intended to combine the better features of both the pay-for-measures and performance-based approaches. The incentive payment would consist of two components. The larger portion of the payment would be based on the conservation measure implemented, and the smaller portion of the payment would be contingent on achieving a measurable level of performance. The intent is to assure that participants actually implement new conservation measures and continue to operate them effectively. As with pay-for-measures, the Team evaluated two different hybrid options: one with uniform payments and one with scaled. In both cases, the approaches appeared viable, with the average hybrid payments falling below the $300 target.

The analysis yielded other important insights as well. Modeling of various implementation strategies highlighted the complexity of the relationship between IID's delivery system and on-farm actions, and underscored the importance of an integrated approach. Growers expressed a number of preferences for the on-farm program, including interest in understanding the potential for different approaches to pay for ongoing conservation. The Team's work also suggested that there is a strong need for "financial headroom" – the difference between the projected cost of implementation and the $300 per acre-foot available revenue figure – as a buffer to address implementation uncertainties, ensure IID can meet its water transfer obligations within the financial means of the program and, if desired, provide some compensation for existing conservation.

Balancing the Mix of On-Farm and System Conservation

The next step in Definite Plan development was to combine the delivery system and on-farm options described above into integrated candidate alternatives able to deliver the required water savings within the available budget.

The Team examined alternatives that assumed seven different mixes of on-farm and delivery system savings levels. These mixes ranged from an approach dependent on generating nearly all savings on-farm to one that sought to generate the maximum practical savings from the IID delivery system. Between these "bookends," five other conservation levels were identified.

At each of these seven levels, the Team sought to identify the least-cost delivery system options, as well as understand the costs and other considerations associated with the four different viable on-farm incentive approaches discussed earlier: Uniform Pay-for-Measures, Scaled Pay-for Measures, Uniform Hybrid and Scaled Hybrid. Altogether, the Team evaluated 28 different alternatives. The results of this analysis are summarized here and in Figure ES-1 below.

- Fourteen of the 28 alternatives appear financially viable. These include a mix of incentive approaches, with only the Uniform Hybrid approach proving financially infeasible in nearly all cases.
- Among the feasible alternatives, those grouped between roughly 180,000 to 210,000 acre-feet of on-farm water savings combined with 93,000 to 123,000 acre-feet of delivery system conservation savings afford the greatest financial "headroom" between implementation costs and the $300 available revenue threshold.
- The hybrid approaches are somewhat higher in cost than the pay-for-measures approaches, but hybrid approaches provide better assurance that conservation measures would be operated to their potential. The uniform Pay-for-Measures approach and the uniform hybrid approach are more expensive than the corresponding scaled payment approaches, and are not recommended.
- The System Water for CVWD and Least Cost configurations, both of which include the Integrated Information Management (IIM) inter-related delivery system component combined with seepage interception and/or canal lining, had the lowest costs.

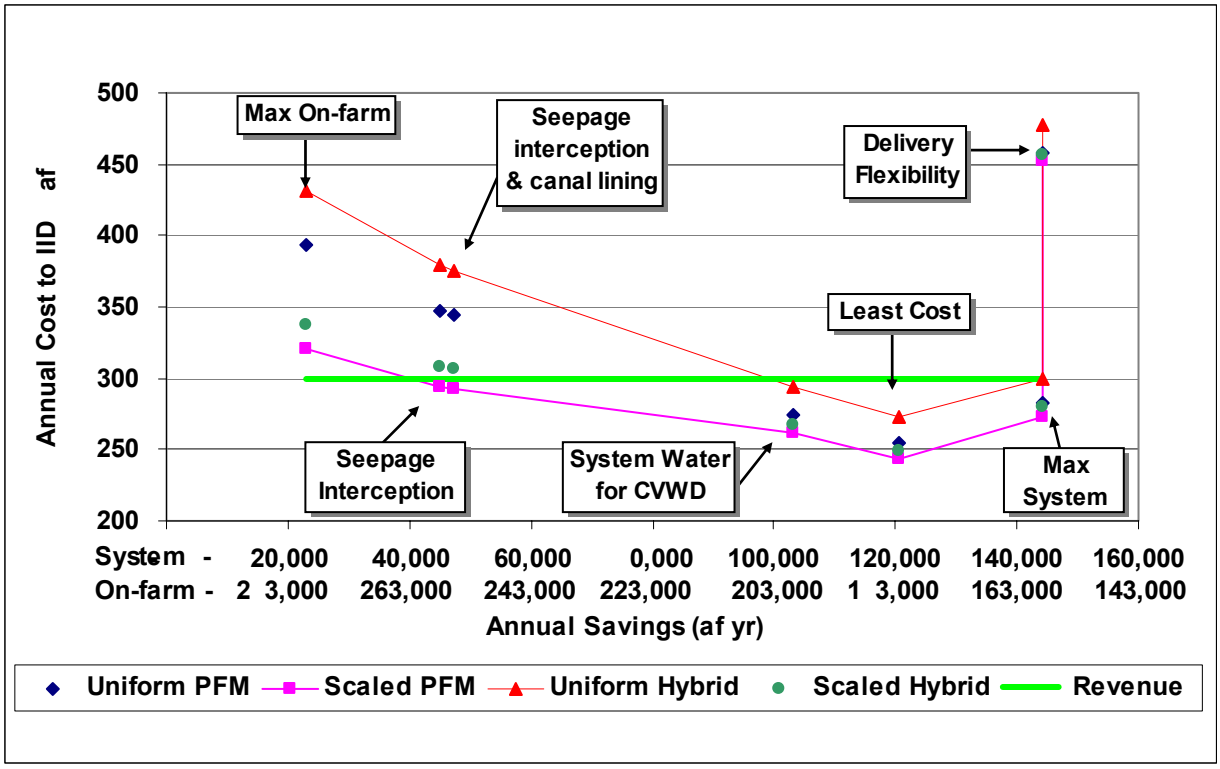

Figure ES-1. Comparison of Integrated Alternatives

Recommendations

The recommendations that follow are based on the analysis of the options available to IID to implement an efficiency conservation program, as described in this report and its appendices. The Team's analysis finds that there are several alternatives that will allow IID to fulfill its water transfer obligations through efficiency conservation and within the limits of available

revenues. The Team found that a number of other alternatives either cannot work or are so marginal that they seriously reduce the prospects for success.

Below is a set of six recommendations that address: (1) the blend of on-farm and delivery system savings that IID should target; (2) the on-farm incentive approach that IID should employ to attract landowners and growers voluntarily into participation; (3) the improvements that should be implemented within the IID delivery system; (4) the need to improve measurement of farm deliveries; (5) provisions for fulfilling IID's early-year (2008 – 2010) water transfer obligations; and (6) near-term actions to ensure IID has sufficient capacity to meet its water transfer obligations. Importantly, recommendations 1 through 4 are not separable; rather, they form an integrated package that cannot be separated without implication to the viability and performance of the overall efficiency conservation program.

- ***Recommendation #1: IID should target on-farm savings in the range of 180,000 to 210,000 acre-feet and delivery system savings ranging from 93,000 to 123,000 acre-feet, at program build-out.***

  - *Rationale.* This mix of efficiency conservation savings provides most of the savings through the on-farm program without imposing unnecessarily high costs that jeopardize the overall financial viability of the efficiency conservation program. Importantly, it affords the "financial headroom" that will give IID the flexibility to deal with inevitable program uncertainties.

- ***Recommendation #2: IID should use the Scaled Pay-for-Measures Hybrid Incentive approach to attract growers voluntarily into the efficiency conservation program and to achieve the targeted on-farm savings.***

  - *Rationale.* The Scaled Pay-for-Measures Hybrid approach offers the best combination of cost-effectiveness, administrative ease and – importantly – the increased likelihood that on-farm conservation measures will be operated at or near their potentials. No other approach is as effective, and each would increase the risk that IID will not be able to meet its future water transfer commitments within the available budget.

- ***Recommendation #3: IID should implement seepage recovery and Integrated Information Management to achieve the targeted delivery system savings, and to enable the targeted on-farm savings.***

  - *Rationale.* The Team's analysis shows that extensive physical modification of the IID delivery system is both extremely expensive and unnecessary for a viable efficiency conservation program. The recommended improvements are a more modest combination of physical and operational changes that will provide cost-effective system savings and provide growers with the improved delivery services needed for implementing the on-farm conservation measures.

- ***Recommendation #4: IID should implement improved measurement of farm deliveries. Consideration should also be given to equipping the farm delivery gates with automatic flow control to hold deliveries steady and radios to enable remote control.***

  - *Rationale*. IID's existing methods of measuring farm water deliveries, while adequate for present water administration purposes, will become inadequate for purposes of verifying on-farm water savings and administering incentive payments based on water use criteria.

- ***Recommendation #5: IID should rely on selected seepage recovery projects and on-farm and delivery system pilot projects to generate early year – 2008 through 2010 – water savings.***

  - *Rationale*. Main canal seepage recovery systems can be constructed easily, provide the ability to scale savings to match the transfer schedule, and are easily verified. However, to the extent on-farm pilot programs produce verified savings, these could be combined with system savings to fulfill early-year water transfer requirements.

- ***Recommendation #6: IID should take a series of steps to ensure it is ready to meet its near-term water transfer obligations.***

  - *Rationale*. Decisions on near-term actions will serve two aims: (1) to ensure IID is ready to meet its most immediate water transfer requirements: and (2) to prepare for launching a more comprehensive program. These actions include both concrete steps to generate near-term water; and on-farm demonstration and system pilot projects to refine longer-term program approaches.

Looking Ahead

The proposed Efficiency Conservation Definite Plan puts forward a set of feasible alternatives that the Team believes can accomplish the targeted savings within the available revenue. It has identified one of these feasible alternatives as the recommended plan, and it has developed a series of related recommendations and near-term actions needed to move forward.

1. Overview

1.1. Background and Purpose of the Efficiency Conservation Definite Plan

In 1998, the Imperial Irrigation District (IID) agreed to a transfer of up to 200,000 acre-feet of water per year to the San Diego County Water Authority (SDCWA), with the water to be generated ultimately through efficiency conservation. In October 2003, provisions of the water transfer agreement were incorporated into a package of decisions and agreements known collectively as the Quantification Settlement Agreement and Related Agreements (QSA). The QSA also included up to 103,000 acre-feet of water per year to be transferred to the Coachella Valley Water District (CVWD). For brevity within this report, this package of agreements will be referred to as the QSA.

The water for transfer is to be generated through efficiency conservation, including both improvements in IID's delivery system and improvements in on-farm irrigation practices. The required conservation is relatively small initially - 4,000 acre-feet are to be conserved and transferred to CVWD in 2008. By 2026, IID must be conserving and transferring 303,000 acre-feet annually – or nearly one out of every 10 acre-feet of water it historically has diverted from the Colorado River each year. Under the terms of the QSA, at least 130,000 acre-feet of the savings for transfer to the SDCWA must be generated through contracted, on-farm actions.

The Efficiency Conservation Definite Plan, referred to throughout this report as the Definite Plan, provides a roadmap for meeting these near- and long-term conservation obligations. Specifically, the Definite Plan seeks to provide answers to the following foundational issues:

- Can the required savings be generated within the financial constraints and other project parameters stipulated by the Agreements?
- What is the most cost-effective, implementable combination of on-farm and IID delivery system changes able to meet the water conservation ramp-up schedule to 303,000 acre-feet?
- What incentive approach will encourage the required amount of on-farm savings, while providing the necessary flexibility to growers?
- What actions are required by IID to effectively move from planning to implementation?

The Definite Plan is intended to identify the combination of delivery system improvements and on-farm actions that can collectively produce the water for transfer under the QSA, and are cost-effective, implementable, verifiable and acceptable to growers, IID and others with a stake in the transfer program. Successful implementation of an efficiency conservation program will allow IID to transfer the water it is committed to under the QSA while maintaining the agricultural productivity and economic health of the Imperial Valley.

1.2. Charge to the Efficiency Conservation Definite Plan Team

To develop the Definite Plan, IID engaged an inter-disciplinary team of consultants (referred to as the Definite Plan Team, or Team) to work closely with staff and the affected community to explore the issues, evaluate alternatives, and recommend the preferred path forward.

The charge to the Team was straightforward: Develop a reliable blueprint for generating transferable water over a period of up to 75 years. IID staff stipulated that the Team develop the plan in a manner rooted in the following key principles and approaches:

- Identify a plan that meets the transfer amounts, schedule, and other requirements of the QSA;
- Assure that at least 130,000 acre-feet per year (at full implementation) is provided through contracted, voluntary on-farm conservation actions;
- Do not count fallowing, crop shifting, or other actions that reduce crop yields as efficiency conservation;
- Use the best available data;
- Actively engage growers and the public in the process;
- Identify and recommend water delivery system changes necessary to support on-farm conservation; and
- Confirm the feasibility, cost-effectiveness and implementability of any possible package of actions.

The results of the Team's work are presented in this report. The report itself is presented in six main sections:

1. ***Overview.*** This section provides background on the Definite Plan. It includes a summary of project purpose and charge to the Team.
2. ***Approach.*** This section provides an overview of the Team's approach to its work. It includes information on the Team, project parameters and the public involvement and technical approach.
3. ***Factors Shaping Alternatives Evaluation.*** This section reviews important factors generated by the analysis and discussions with Valley growers and landowners that shaped the Team's consideration of the various alternatives.
4. ***Alternatives Overview.*** This section summarizes the Team's alternatives evaluation, from identifying viable system and on-farm incentive program components to presenting and evaluating the feasible integrated alternatives.
5. ***Recommended Approach.*** This section presents the Team's recommended approach for implementing the Definite Plan. It includes both near-term and longer-term recommendations.
6. ***Implementation Considerations.*** This section identifies a number of important issues to be considered and addressed as IID moves forward with implementation.

2. Project Approach

2.1. Team Overview

The Definite Plan represents a significant planning and analytical effort. The volumes of water that must be conserved to fulfill IID's water transfer obligations denote levels of system and on-farm performance that will be challenging and costly to achieve.

To successfully take on this challenge, IID – led by Executive Program Manager John Eckhardt – assembled an inter-disciplinary team of experienced professionals from outside and within the Imperial Valley, familiar with Imperial Valley agricultural and irrigation practices, and committed to working with growers and others in IID and the community to generate practical solutions. (See Figure 1 below.)

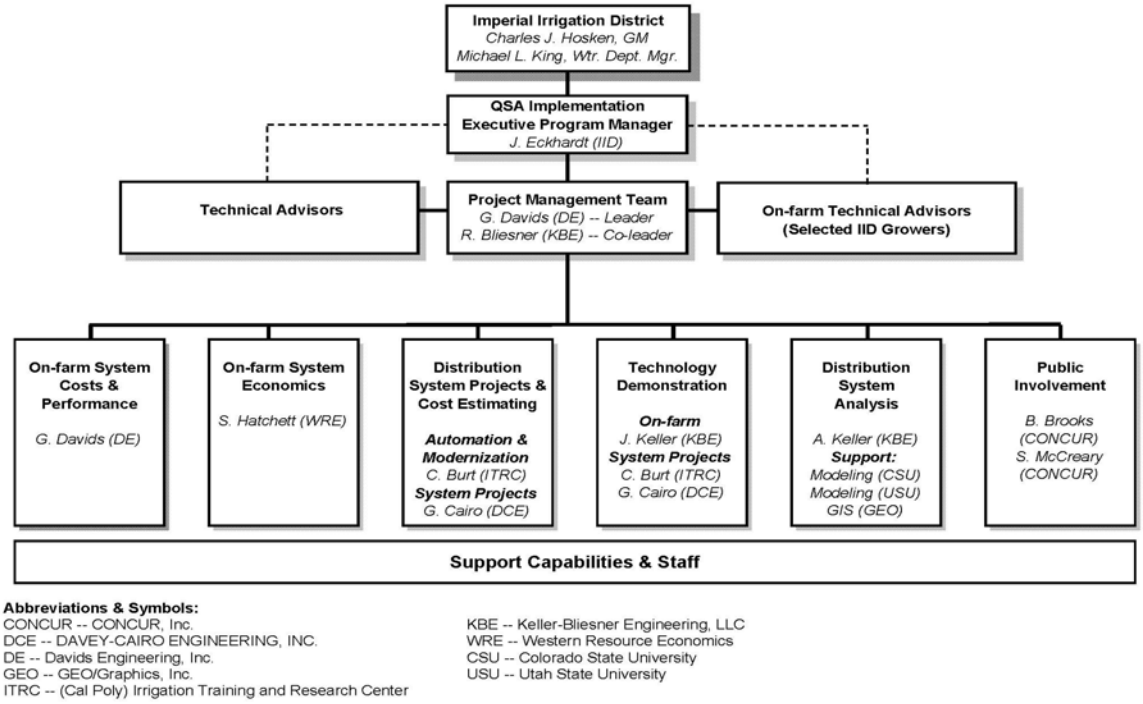

Figure 1. Organization of the Definite Plan Team

The consultant team, headed by the firms of Davids Engineering, Inc. and Keller-Bliesner Engineering, LLC, brought together individuals who collectively contributed the following expertise to the project: irrigation and civil engineering, resource economics, agronomics, planning, geographic information systems (GIS), computer modeling, data management, and public involvement. The members of the Team also have extensive first-hand knowledge of IID; in fact, Team members collectively bring more than 50 person-years of experience working on IID water management issues. Below is a listing of key Team members:

- **John Eckhardt, Executive Program Manager,** is responsible for overseeing all facets of the Quantification Settlement Agreement, including development and implementation of the Definite Plan. **Tina Anderholt Shields**, Assistant Water Department Manager for Resources Planning and Management, serves as Eckhardt's deputy.
- **Davids Engineering, Inc.**, which serves as lead consultant with Keller-Bliesner Engineering, has provided water resources engineering services to irrigation districts and resource management agencies since 1993. The Company has worked frequently on IID projects.
- **Keller-Bliesner Engineering, LLC**, specializes in providing engineering services relating to irrigated agriculture. In the last 25 years, the company has completed well over 150 projects in 20 states and several foreign countries. It also has worked with IID since 1993.
- **Colorado State University,** Water Resources Planning and Management Division, is the developer of MODSIM, the canal/farm-gate network analysis component of the Imperial Irrigation Decision Support System (IIDSS).
- **CONCUR, Inc.,** specializes in strategic planning, stakeholder involvement and conflict resolution. For 17 years, CONCUR has assisted water agencies, growers and communities striving to develop sustainable water infrastructure and conservation initiatives.
- **DAVEY-CAIRO ENGINEERING, INC.,** (DCE) is an established local firm specializing in agricultural and water resources engineering. DCE engages in planning, design, and operation of irrigation and drainage facilities.
- **GEO/Graphics, Inc.,** provides GIS and cartographic services to public and private organizations throughout the western United States.
- **Irrigation Training and Research Center (ITRC)** was established in 1989 at California Polytechnic State University, San Luis Obispo. The Center provides consultation, training and research to promote improvement of irrigation performance throughout the world.
- **Western Resource Economics** provides economic expertise to federal, state and local agencies. The firm specializes in agricultural economics, water resources, and quantitative analysis.

Moreover, and importantly, the Team was supported in its work by both IID staff and growers. This input was essential, as it provided crucial local perspectives and data into the planning process and provided a critical sounding board for the evolving analysis. (See Section 2.3 below for more detail on staff and grower involvement.)

2.2. Project Parameters

The underlying requirements for an incentive-based, on-farm conservation program were laid out in provisions of the water transfer agreement between IID and SDCWA, and were subsequently incorporated into the QSA and related agreements. Others were stipulated by IID policies or preferences.

These parameters are vitally important to understand, as they shape the way the Team both approached its analysis and evaluated the viability of different options and alternatives. Below is an overview of the primary parameters shaping the Team's work.

2.2.1. Design Parameters for Achieving the Efficiency Conservation Targets

As noted earlier, the QSA stipulates a ramp-up schedule for the efficiency conservation-generated savings. The first transfers start in 2008, with IID slated to conserve and transfer 4,000 acre feet; the schedule then increases yearly, reaching 303,000 acre feet by 2026 (Figure 2). Most of the increase occurs between 2012 and 2021, when water savings grow at an average rate of about 27,000 acre-feet per year.

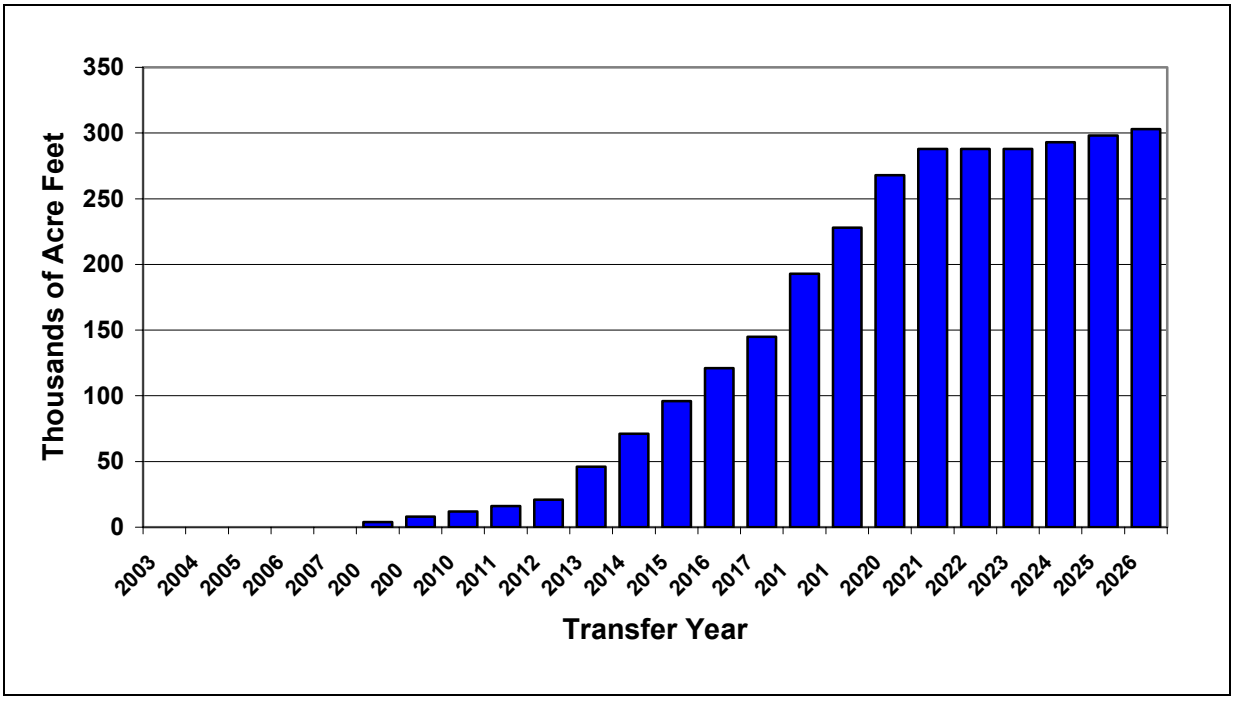

Figure 2. Efficiency Conservation Ramp Up Schedule

Beyond the basic ramp-up schedule, the QSA stipulates that on-farm efficiency conservation must produce annual savings of at least 130,000 acre-feet at build-out for transfer to SDCWA. Growers and IID staff have expressed a preference that on-farm conservation begin as early as practical during the ramp-up.

In addition to the strict quantity and schedule terms in the QSA, IID has articulated a number of other guidelines that significantly shape the Team's approach to the Definite Plan. Most notably, these are:

- All savings must be generated through efficiency conservation; water savings generated through actions such as fallowing, crop-shifting or deliberate deficit irrigation cannot be counted towards satisfying the terms of the QSA.
- Grower participation is voluntary and incentive-driven. The QSA requires that at least 130,000 acre-feet be contracted, on-farm conservation. Therefore, IID has directed the Team to develop an on-farm program based on voluntary participation by growers.
- Growers choose the means of generating on-farm efficiency conservation.
- Water savings must be verifiable.

- The program must be financed through net revenues derived from the water transfers and related QSA provisions.

Some elements in the list above are not necessarily supported by all stakeholders. For example, many growers voice interest in a mandatory (or full) participation model, an approach that would deduct the water needed for transfer from IID's QSA entitlement and spread the balance of the remaining water across eligible IID lands. Such an approach is considered by IID to be beyond the parameters of this study and was not evaluated.

2.2.2. Implementability Requirements

In addition to meeting the design parameters described above, alternatives developed to generate the necessary water savings must also be implementable.

In discussions with IID staff, growers and among the consultant Team itself, the Team developed a list of parameters it refers to as "features of implementability." These features, summarized below, are intended to ensure that any alternative put forward for consideration by the Board is capable of being successfully implemented.

- ***Technically viable.*** Approaches for generating water both on-farm and within the delivery system must be technically sound and capable of working effectively within IID's unique environment. They must take into account the extremes of IID's climate, the physical characteristics of the land, work with the particular crop mix and be capable of functioning within a year-round growing season.
- ***Integrated IID delivery system and on-farm components.*** Many on-farm conservation practices necessitate changes in delivery system features and practices. For example, growers' efforts to reduce or reuse tailwater impact IID delivery schedules, volumes and practices. Similarly, system improvements and constraints impact how and when growers receive their water deliveries. The Definite Plan must anticipate and account for these linkages.
- ***Grower willingness to participate.*** The QSA, as noted above, is grounded in the voluntary participation of growers. This stipulation suggests that an on-farm efficiency conservation program, if it is to be successful, must be attractive enough to elicit the participation of a sufficient number of growers and acreage to generate the necessary on-farm water savings.
- ***Supported by IID water use records.*** IID water use records are key to both identifying the potential savings and managing the Definite Plan process. Any alternative put forward by

Grower Flexibility and the Definite Plan

Farming is a risky enterprise due to potential rapid changes in markets and prices, and in availability and cost of production inputs, not to mention extreme weather, pest infestations, changing government regulations, etc. Survival in a business sense depends on growers being able to adapt quickly to dynamic conditions. Growers emphasized this point in numerous ways, at numerous times, throughout the process of developing the Definite Plan.

Because growers' enrollment in the on-farm efficiency conservation program will be voluntary, their evaluation will consider the degree to which participation will limit their choices regarding crops, irrigation practices and other management decisions. If the conditions are overly constraining, they will not participate. With this in mind, and considering that broad participation will be necessary to achieve ultimate conservation savings, the on-farm component must be flexible. The main provision factored into the Definite Plan is that growers will be able to choose the types of conservation measures that they feel are best suited to their existing and future farming conditions.

the Team must assess the potential for IID's water records – and, in particular, its water delivery records – to support program incentive payment and verification needs.

- ***Flexible/adaptable to changes.*** IID is embarking on a decades-long program. Grower preferences will change. Cropping patterns will shift. IID policies and priorities will evolve. Any approach evaluated and put forward by the Team must be capable of adapting over time to changing conditions.
- ***Risk shared and fairly compensated.*** The Definite Plan entails unavoidable risk. It entails risk for the growers, who must commit to generating savings with new and perhaps unfamiliar conservation measures on their fields. It entails risk for IID, which must meet its commitments to transfer water within a bounded revenue stream. The Team must consider how an alternative affects these risks.
- ***Meets environmental requirements.*** IID previously prepared environmental analyses and documentation covering the water conservation and transfer actions (and other activities) contemplated under the QSA and related agreements. While the documentation covers a wide range of potential impacts, thereby allowing IID wide latitude in implementing its efficiency conservation program, it is nonetheless necessary to ensure that the impacts of Definite Plan alternatives do not fall outside the range analyzed. IID has been leading this aspect of the Definite Plan.

2.2.3. Cost-Effectiveness/Revenue Basis

A key foundational element of the Definite Plan is cost-effectiveness. The method for generating the necessary efficiency conservation savings must fit within the available revenue.

The QSA and related agreements detail the revenues that IID will receive during initial years of the agreement, and specify rules for adjusting those revenues over the remaining years. IID has also estimated associated costs related to the water transfer. Based on the estimated revenue and cost streams provided by IID (see Appendix 4.e. for more discussion), the Team estimated an annual equivalent revenue of approximately $300 per acre-foot of water transferred (expressed in 2006 dollars).

Revenue Projections: How was the $300 in Available Revenue Estimated?

Between 2003 and 2047 when the transfer agreement ends, IID's forecast revenues from water sales to all designated transferees total over $5 billion dollars after deducting payment for early planning and legal fees, Salton Sea mitigation costs and the lost power and water sales revenue from reduced water deliveries. When adjusted to 2006 dollars, the average revenue during the period when annual transfers total 303,000 acre-feet, is $91.8 million dollars per year or $303 per acre-foot. For analysis purposes this has been rounded to $300 per acre-foot or $90.9 million per year. This must pay all of the administration, implementation, operation and incentive costs necessary to generate 303,000 acre-feet of savings. In addition, there is about a $100 million total reserve over the life of the agreement available to cover such things as upfront finance costs for capital outlays that may exceed revenues in the early years of the program.

In other words, over the life of the QSA, IID has roughly $300 per acre-foot to cover all costs associated with the transfer program – from system improvements and on-farm conservation and incentive payments, to administration, measurement needs and any contingencies.

The Team used this figure as a benchmark when assessing the financial feasibility of the various conservation options and alternatives under consideration.

Gaining the Local Perspective

For the Efficiency Conservation Definite Plan to work, it must be grounded in the realities of the Imperial Valley.

Recognizing this imperative, the Team put significant effort into working with local growers and landowners. The heart of this effort was the On-Farm Technical Advisors, a group of thirteen growers and landowners known as the OFTA.

Meeting 10 times over the course of the past year, the OFTA served as a critical sounding board – reacting to various elements of the emerging analysis and providing vital input into the Team's understanding of on-farm conservation opportunities, costs, potential and barriers. Their advice and perspectives were instrumental in facilitating the Team's development of the Definite Plan.

The Team is deeply appreciative of the OFTA's many contributions and their willingness to volunteer so much of their time and perspectives.

2.3. General Project Approach

The Team approached the project mindful of how intensive efficiency conservation will transform the way water is used in the Imperial Valley. The Team was aware of the technical complexity inherent in designing a plan to both generate voluntary on-farm savings and integrate the on-farm and system components. The Team knew of the keen interest in its work among growers and others in the Valley.

Given these considerations, the Team adopted a general project approach grounded in the following principles: (1) *be participatory*, to ensure broad awareness and input and enable stakeholder participation and outreach; (2) *be locally grounded*, to ensure practicality and tap Valley and Team expertise; (3) *be technically integrated*, to ensure that the pieces fit together; and (4) *be analytically rigorous*, to find the optimal (least-cost) or superior solutions.

Below is a brief overview of the basic elements of the project approach.

2.3.1. On-Farm Technical Advisors

The On-Farm Technical Advisors, a standing body comprising more than a dozen active, full time Imperial Valley growers with extensive irrigation management expertise, served as the centerpiece of the project's Grower Participation Plan.

The group, referred to as the OFTA, was created to bring together a representative group of growers who are leaders in the Valley, and hold diverse perspectives, as a technical resource to the Definite Plan Team. Below is a listing of the OFTA members.

On Farm Technical Advisors		
Vince Brooke	Kevin Kenagy	Frank Riddle
Tom Brundy	Alex Jack	Raul Rodriguez
Shelvie Crittendon	Mark McBroom	Ralph Strahm
Craig Elmore	Mark Osterkamp	Danny Walker
Don Emanuelli		

Given the complex and technical nature of the Definite Plan process, the OFTA was designed to provide an opportunity for the Team to have a focused and ongoing discussion with a consistent set of growers. The OFTA met ten times between January 2006 and January 2007.

The meetings were instrumental in gathering grower input into the on-farm aspects of the Definite Plan.

In addition to the OFTA, the Team surveyed all IID growers and landowners at the project outset and met one-on-one with growers throughout the past year. Altogether, thirty-one grower interviews were held, each lasting from one to several hours.

The Team gave important consideration to all information and advice provided to it by the OFTA and survey responses. The information was extremely valuable in helping the Team identify, for example, on-farm incentive approaches that could attract substantial grower participation. In other cases, growers expressed preferences that fell outside of the Team's design parameters. Therefore, the analysis and recommendations contained in this report ultimately represent the analysis and judgment of the Team as informed by the participating growers. More information on the OFTA and other Grower Participation Plan outreach efforts can be found in Appendix 5.

2.3.2. On-Farm Demonstration Projects

Another key element was a series of demonstration projects intended to better understand the extent to which on-farm efficiency conservation measures generate water savings, are effective and can be reliably replicated.

Working cooperatively with 13 growers, the Team launched 15 demonstration projects. Most of the efforts were incorporated into growers' existing irrigation practices, formally monitoring and measuring the results to assess the conservation savings potential. In particular, the efforts sought to: a) develop reliable information regarding the applicability, costs and performance of selected on-farm conservation measures; b) test pilot projects to better understand the need for on-farm incentives; and c) provide a means for gaining grower cooperation and support.

The projects, undertaken in 2006, focused on the following areas: scientific irrigation scheduling and irrigation event management; permanent and portable tailwater reuse systems; on-farm reservoirs; enhanced farm delivery service; pressurized (drip and sprinkler); level basin and gated pipe irrigation with different row lengths.

A more detailed overview on these projects and results are included in Appendix 2f.

2.3.3. Public Outreach

The general Public Outreach effort, while more limited in scope than the grower-focused effort, was nonetheless an important component of the Team's project approach. Agriculture is an important part of the Valley's economy; what occurs on the farm is of interest and importance to the broader community. Accordingly, the public outreach effort was intended to – at strategic junctures – provide updates to and seek feedback from the interested general public and those growers who elected not to participate in grower-specific activities.

Specific strategies included: drafting project newsletters; developing and maintaining a project web site; and conducting periodic public workshops, field days, and other outreach activities.

The focus and results of these efforts are provided in greater detail in Appendix 5.

2.3.4. IID Staff Consultations

The Team worked closely with IID staff throughout the project both to gather pertinent data and insights about IID's system and water users, and to seek their ongoing input and perspectives.

The Team met regularly with Water Department staff to update them on the evolving analysis. The Team also worked closely with staff in the Irrigation Management and Monitoring Unit (IMMU) as it carried out the on-farm demonstration projects. As well, other IID staff were contacted for specific data requests, and field staff were consulted regarding existing system characteristics and ideas for operational improvements. Most broadly, the Team consulted frequently with John Eckhardt on virtually every facet of its work.

2.4. Technical Approach

The overall, fundamental objective of this planning effort is to identify an integrated package of on-farm and system efficiency improvements that can be implemented by landowners, growers and IID to generate the targeted water transfer volumes on the identified time schedules. Inasmuch as the revenues that will be generated by water transfers are fixed by the terms of the QSA and related agreements, it is also important to identify the least-cost (or near least cost) blend of system and on-farm improvements; this will provide the most flexibility to respond to future uncertainties and can provide the greatest net economic benefit to the Imperial Valley.

The Team adopted a technical approach to planning and analysis that developed analytical methods and data, identified and assessed individual system and on-farm conservation measures that could form components of the Definite Plan, and then evaluated how components could fit together to form complete alternatives. Principles guiding the Team's approach included:

- The nature of irrigation water delivery and use is closely inter-related, requiring an approach that analyzes both the on-farm and delivery system conservation potential separately and in conjunction with one another.
- The use of sophisticated modeling is needed to understand and anticipate the impact of various changes and approaches on conservation potential and costs.
- The Team must evaluate the potential of a wide range of conservation measures and the viability of different on-farm incentive packages and payment levels.
- The Team must evaluate methods currently used for conserving water, as well as the potential to revamp IID's entire water delivery system and adapt previously untested approaches.

2.4.1. Technical Approach Elements

To approach this work, the Team first undertook a series of core tasks. These foundational analyses focused on the following areas: 1) developing an updated water balance for IID; 2) characterizing on-farm conservation measures, costs and likely water savings; 3) assessing IID delivery system operational practices, possible changes and associated costs and likely water savings; 4) understanding the interplay between on-farm and delivery system conservation

actions and how that impacts the nature of feasible alternatives; (5) understanding the need and options for improved delivery measurement; 6) identifying and evaluating possible on-farm incentive approaches; and 7) developing evaluation criteria to assess potential alternatives. Basic data to support these efforts were gathered from a wide range of sources – both within the Valley and elsewhere – and then ground-truthed in discussions with IID staff, local growers and others.

Additionally, the Team developed a set of integrated data and analytical tools designed to support water-related decision making at IID. This toolkit, known as the Imperial Irrigation Decision Support System (IIDSS), is the analytical basis for studying the on-farm water conservation ensuing from a variety of incentive structures and on-farm decisions; the system conservation resulting from various canal and operational configurations; the interplay between on-farm and delivery system conservation; and, ultimately, the resulting simulated total canal inflow to IID.

The IIDSS toolkit contains numerous data sets and several models, the most important of which are the Demand Generator and MODSIM and their associated inputs. The Demand Generator models grower decision making in response to incentive approaches to predict what on-farm conservation measures are likely to be selected on a crop-by-crop and field-by-field basis and to estimate the associated costs and benefits. The Demand Generator then modifies historical farm water orders to simulate the change in water demands anticipated from the adoption of its predicted selection of on-farm conservation measures. These modified farm water orders are input to MODSIM, which simulates the flow of water throughout IID's canal delivery system, predicting spills, seepage and evaporation losses associated with various alternative canal and operation configurations.

The Team analyzed the combined conservation potential of a particular on-farm incentive program and canal system configuration by comparing the MODSIM modeled inflow to IID in the All American Canal with that for a different combination of incentive and system alternatives. The principal components of the IIDSS toolkit used to evaluate on-farm incentive and system alternatives are illustrated in Figure 3.

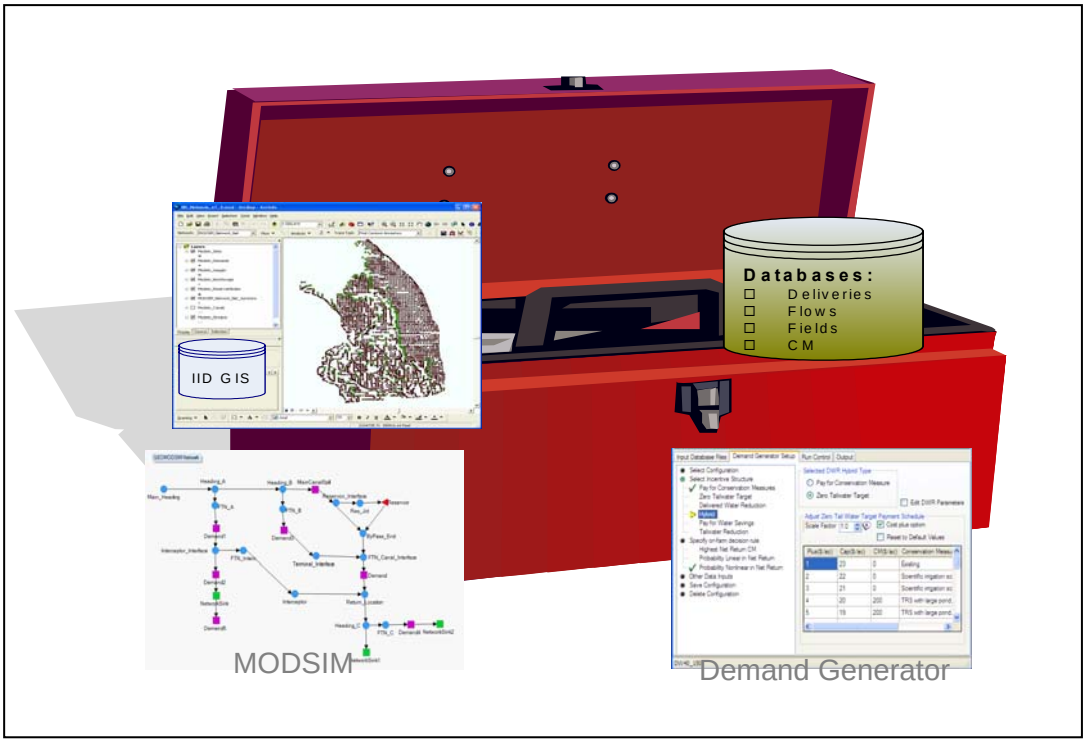

Figure 3. IIDSS Tools to Evaluate On-Farm Incentive and System Alternatives

Finally, using the various data and models developed during the study period, the Team developed discreet alternatives consisting of different mixes of on-farm and delivery system conservation measures and savings levels coupled with various incentive approaches to assess the potential for each to generate the required water within the financial constraints. Each alternative was further evaluated to assess cost and savings potential, likely grower participation rates, implementability and other factors. A recommended approach was identified based on the analysis results. This process is illustrated in Figure 4.

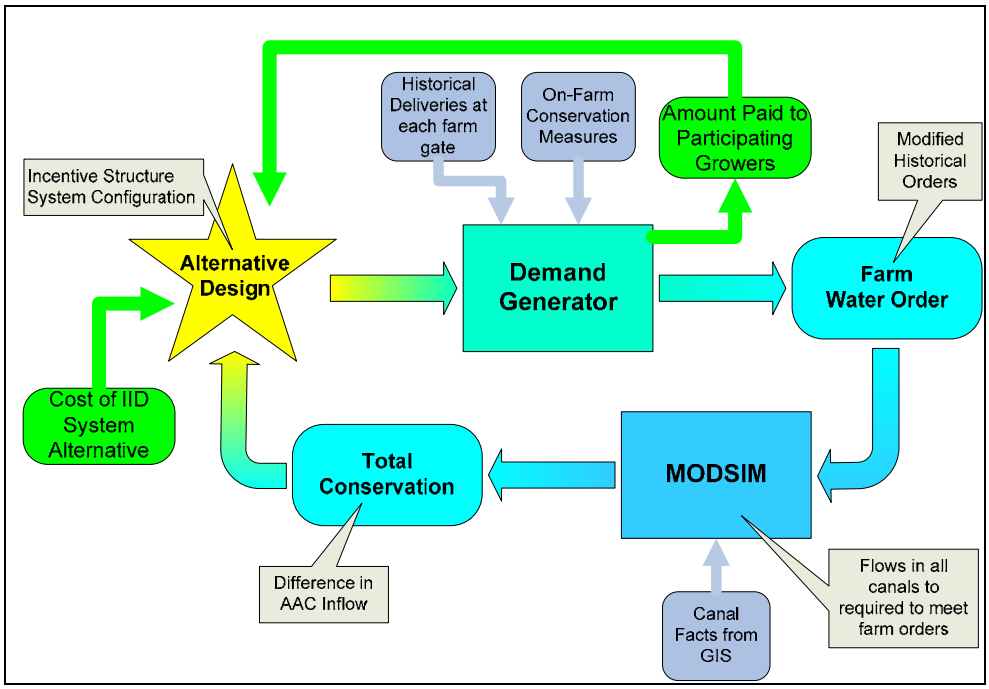

Figure 4. Alternative Design and Evaluation Process using IIDSS

2.4.2. Technical Approach Documentation

The appendices to this report (separately bound) provide a detailed look at each of the analysis steps described above. Follow is a brief description of each appendix.

- ***Appendix 1: IID Delivery System Analyses.*** This appendix, consisting of eleven sections, details the analyses of the IID delivery system relating to efficiency conservation. Collectively, these appendix sections document water conservation opportunities within the delivery system and improvements that assist on-farm water conservation.
- ***Appendix 2: On-Farm Analyses***. This appendix, consisting of seven sections, details the analyses of on-farm irrigation in IID relating to efficiency conservation. Collectively, the sections document the data, analyses and methods used to characterize on-farm water conservation opportunities and costs in IID.
- ***Appendix 3: Imperial Irrigation Decision Support System.*** This appendix, consisting of eleven distinct sections, lays out the elements and workings of the IIDSS toolkit described earlier. Specifically, it provides a detailed explanation of the MODSIM Network Model, the Demand Generator, conveyance loss summary, lateral spillage analysis, lateral hydraulic analysis and rejected water analysis.
- ***Appendix 4: Alternatives Development.*** This appendix, consisting of six sections, describes the development and evaluation of on-farm incentives and examines the combinations of on-farm and delivery system conservation measures and incentive approaches that can best meet the requirements of the QSA. It also includes a section on next steps needed to implement the Definite Plan.
- ***Appendix 5: Public Involvement Overview.*** This appendix describes the Public Involvement Plan developed by the Team to engage growers, landowners and interested

members of the public in the Valley and elsewhere. It describes both the Grower Participation Plan and the Public Outreach effort.

2.4.3. Technical Approach Future Value

As outlined above, numerous studies have been conducted to identify opportunities for water conservation within IID's delivery system and on-farm. The studies have been critical to identification of conservation opportunities and play a major role in the recommendations of the Definite Plan. However, their utility goes beyond this application. Many of the models and data developed are expected to assist IID water managers in, among other things, implementing the Definite Plan, identifying future conservation opportunities, and targeting system improvements to accommodate urbanization of previously farmed lands. The future value of the various studies and models is discussed at the end of Appendices 1, 2, and 3.

3. Factors Shaping Alternatives Evaluation

The Team's primary goal is to build and evaluate alternative packages of on-farm and system improvements to identify the option or options best positioned to meet IID's water transfer obligations.

Many of the Team's most important findings are captured in the Alternatives Overview presented in Section 4. But, before turning to the alternatives evaluation itself, it is instructive and necessary to review a handful of the factors – generated by technical analyses and discussions with Valley growers and landowners – that shaped the Team's consideration of the various alternatives.

3.1. Water Balance

A water balance is an accounting that balances water inflows with outflows within a specified area, over a specified period of time. By looking carefully at the principal water flow paths – how water moves into, through and out of an area – planners can, among other things, gain an important understanding of how water is being used, and where and how it can be conserved.

IID's water balance over the years 1998 through 2005 – developed as part of the Definite Plan process – identifies the potential volume and sources of efficiency conservation savings. The water balance (Figure 5 below) suggests that on-farm and system losses that could be reduced through conservation can total no more than about 640,000 acre-feet assuming hypothetically that there is no constraint on cost nor limits in technology. This includes 124,000 acre-feet lost as spillage from IID laterals, 86,000 acre-feet of seepage from main canals and laterals, and 433,000 acre-feet discharged as tailwater. Another 417,000 is discharged as tilewater, but most of that – excepting some tilewater being generated on sandy soil – is not considered available for conservation because it is needed for leaching salts from the soil.

It is important to recognize that the water balance only identifies *where* to look for savings. It does not consider cost and other technical issues or constraints that might make seemingly attractive opportunities neither technically feasible nor cost-effective. The challenge, then, is to determine what portion of the conservation *potential* can be achieved in a cost-effective manner.

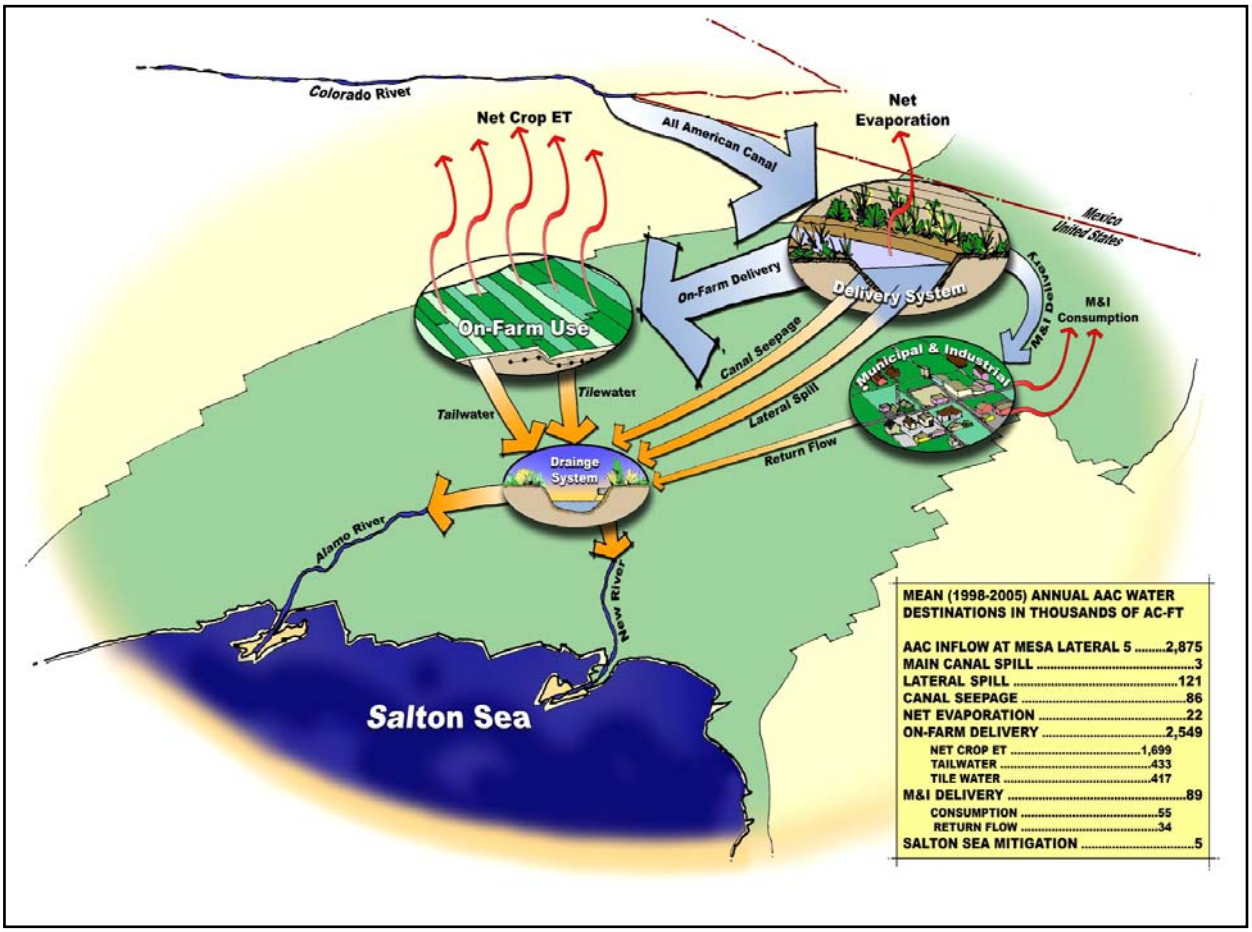

Figure 5. IID Water Balance

3.2. Delivery Measurement

IID routinely collects data on flows at selected locations within the delivery system, water deliveries made to individual farm turnouts and individual fields, crops planted on individual fields, and other information needed for operational reporting purposes. These data provide the foundation for the Definite Plan analyses, and were, therefore, carefully reviewed to gain insights into how they could be used, and, importantly, whether they had limitations that could influence or skew analysis results.

In general, IID's records are quite good for their intended uses, such as for implementing IID's volumetric water charge by account, but do have some important limitations for analytical uses. In particular, it was found that some water delivery records for individual fields and irrigation events can be significantly in error, particularly when associated with gates that serve multiple fields. Other errors appear to be random and, therefore, cancel out when averages are computed. Both kinds of errors can lead to biases and disparities in how growers are compensated for water savings, depending on the incentive approach selected.

To effectively administer the Definite Plan, improved farm delivery measurement is needed. The Definite Plan will rely on delivered water measurement for performance verification and,

for some approaches, the measurement may well provide the basis for a portion of the incentive payment. (Improved farm delivery measurement and flow control benefits other District and grower initiatives also.)

> **Importance of Improved Farm Delivery Measurement**
>
> IID currently measures all water provided to users at farm delivery gates. These measurements, as all measurements, are not perfectly accurate, but they have worked well for the purposes of delivery system management and water billing.
>
> With an on-farm conservation program, growers will receive payments based at least in part on their water use. This will effectively raise the unit value of water to both the District and the grower by a large amount. As any commodity becomes more valuable, the accuracy of measurement becomes more important to buyers and sellers. Both parties (in this case, the District and growers) expect the measurement to provide an accurate basis for payment. The District also needs an accurate means of verifying savings. Improved delivery measurement will satisfy the billing, payment, and verification needs, and will improve water management capability of both the District and growers.

Two types of farm delivery measurement devices have been identified thus far for further evaluation, both of which offer opportunities to improve delivery service as well as measurement accuracy. This would be achieved by automating the measurement device to hold flows constant at the ordered delivery rate, so growers would not have to deal with flow fluctuations as they currently do. Further, the devices could be equipped with radios, so that they could be remotely monitored and controlled by IID. This would enable increased responsiveness to requested flow changes without requiring additional manpower. It is expected that testing and comparison of the two measurement devices will be conducted as the Definite Plan moves toward implementation. (See Appendix 1.h. for a more extensive discussion of measurement needs.)

3.3. On-Farm Conservation Measures

On-farm water conservation will represent a major component of the total water conserved as part of the Definite Plan. Imperial Valley growers will need to collectively conserve at least 130,000 acre-feet and potentially a much larger share of the 303,000 acre-feet needed to satisfy QSA obligations. Conserved water will be generated through implementation of conservation measures rather than through decreased consumptive use (fallowing), with the net effect of maintaining or increasing agricultural production.

Given the important role of on-farm water conservation, the Team dedicated significant resources to understanding current practices and the potential for future savings. Below are some of the key findings associated with this work.

- Discussion with growers, a review of the initial district-wide grower/landowner survey and a review of the on-farm demonstration projects indicate that the agricultural community is already actively engaged in a wide range of conservation measures. Virtually every technique considered as part of the Definite Plan is already in place somewhere in the Valley. Thus, achieving additional on-farm conservation for the Definite Plan does not mean introducing wholly new technologies as much as spreading awareness and use of measures already known to work.
- Currently, as a group, IID growers manage water quite well on average, although substantial performance variation exists among fields. Based on the analysis of on-farm

water use conducted as part of the Definite Plan, it is estimated that two-thirds of the water delivered to farms is consumed as crop ET. The remaining unconsumed quantity includes only a portion that is preventable or recoverable (primarily tailwater). Most tilewater is needed to control root zone salinity and maintain crop production. However, appreciable differences in water use and losses (tailwater and tilewater) exist among fields due to differences in management practices, field physical characteristics and layouts, and delivery characteristics. Conservation will be achieved by reducing losses on all participating fields, with the potential for water savings varying from field to field based on additional factors including historical water use, crops grown, soil, and irrigation method. It is anticipated that a majority of fields will need to participate in the conservation program to meet QSA obligations.

- On-farm conservation measures fall broadly into two categories: *irrigation management* improvements with associated minor (or no) capital investment requirements, and *irrigation system* improvements that generally require significant capital investment.
- On-farm water use following conservation measure implementation was estimated across a range of representative conservation measures based on a combination of physical modeling, on-farm demonstration studies, and collective professional judgment. In general, the primary flow paths affected by conservation measure implementation were delivered water and tailwater. However, in some cases, tilewater and crop ET changes are expected to occur. Based on the analysis, the Team estimated significant potential to generate on-farm conservation savings. Key findings include:

Tailwater Reuse and Food Safety

Recent events have heightened public concern over food safety. Whether risks to food safety are real or perceived, growers cannot afford to compromise consumer confidence in their food supply. There is a public perception that recycling irrigation water, for example tailwater reuse, could contaminate crops that come in direct contact with the recycled water. Thus, tailwater reuse and other on-farm conservation measures that recycle irrigation water may not be viable options for some root and leafy vegetable crops.

The range of conservation measures the Team evaluated for the Definite Plan include those, such as drip and sprinkle irrigation with primary water, that are safe for vegetable production. These food safe methods of efficient irrigation are represented in sufficient quantity within the Definite Plan analysis to serve the vegetable acreage and realize the expected on-farm conservation potential at the projected cost.

  - Water savings resulting from conservation measure adoption vary from field to field, from measure to measure, and over time.
  - Management-based conservation measures are expected to result in savings of between 0.1 and 1.4 acre-feet per acre annually with a typical savings on the order of 0.3 – 0.5 acre-feet per acre depending upon the field and specific measure.
  - Tailwater recovery based conservation measures are expected to result in savings of between 0.1 and 2.6 acre-feet per acre annually with a typical savings on the order of 0.4 – 0.8 acre-feet per acre.
  - Pressurized irrigation systems (drip and sprinkler) are expected to result in savings of between 0.1 and 2.1 acre-feet per acre annually with a typical savings on the order of 0.6 – 0.9 acre-feet per acre.
  - Basin irrigation systems are expected to result in savings of between 0.2 and 2.1 acre-feet per acre annually with a typical savings on the order of 0.9 acre-feet per acre.

The conservation estimates reflect only the on-farm savings and do not include the effect that on-farm irrigation changes can have on the delivery system. For some methods, the net savings are actually lower because they induce delivery system losses that cannot be captured. The Definite Plan Team has accounted for this in its analysis of on-farm and delivery system integration.

- A major element of the Definite Plan Team's work involved estimating the incremental costs of conservation measures that growers could adopt in response to financial incentives to conserve water. Estimation of costs of conservation measure adoption above and beyond baseline irrigation costs was approached by developing an extensive list of potential measures and then selecting a smaller number for development of conceptual designs and costs. For each measure, the baseline cost of irrigation using conventional practices and the cost of irrigation following adoption were estimated, with the difference representing the incremental cost. Cost estimates included the major components of capital, maintenance and operations. Other factors considered were costs or benefits due to yield changes, fertilizer cost savings and water cost savings. All costs were indexed to 2006. Key findings related to cost are:

  - Incremental costs of conservation measure adoption vary widely due to a number of factors including field size, baseline irrigation costs, and differing costs of individual conservation measures.
  - Management-based conservation measures are expected to result in a net cost to growers of between $15 and $310 per acre per year with a typical cost of $60 per acre per year.
  - Tailwater recovery based conservation measures are expected to result in a net cost to growers of between $80 and $510 per acre per year with a typical cost of $260 per acre per year.
  - Pressurized irrigation conservation measures are expected to result in a net cost to growers of between $320 and $930 per acre per year with a typical cost of $550 per acre per year.
  - Basin irrigation is expected to result in a net cost to growers of between $150 and $300 per acre per year with a typical cost of $240 per acre per year.

On-Farm Demonstrations

The on-farm demonstration projects offered the Definite Plan Team an opportunity to better understand the effectiveness and replicability of various on-farm efficiency conservation practices.

Working with willing growers and staff from the District Irrigation Management and Monitoring Unit (IMMU), the Team monitored and evaluated a range of conservation practices – from tailwater reuse systems and drip irrigation, to scientific irrigation scheduling and level basin irrigation.

The projects offered Team members an opportunity to work closely with growers and better understand their perspectives. Moreover, the Team was able to:

- Gain practical knowledge about grower's management and labor needs and willingness to engage in the various conservation technologies.
- Gain important information about costs and water conservation savings potential of the technologies.
- Demonstrate to the IID community and growers that the Definite Planning process utilizes practical field experience.

3.4. IID Delivery System

The Team conducted a comprehensive review of IID's delivery system – assessing everything from minor actions to line leaky canals to a complete revamping of IID's network of canals, laterals and water control structure. It considered stand-alone actions (those that can be implemented without impacting system operation or on-farm irrigation performance) and inter-related actions (those that influence system operation or farm delivery or are affected by adoption of on-farm conservation measures). The analysis yielded the following foundational findings:

- Lateral canal lining is limited in potential because the most cost-effective lateral lining opportunities were realized under earlier IID conservation initiatives, including the 1988 IID-Metropolitan Water District conservation and transfer program. In fact, the analysis suggests that canal lining will yield just 3,000 acre-feet of savings, with the costs associated with individual lining projects ranging from $100 to $500 per acre-foot.
- A substantial amount of seepage occurs from the unlined main canals in the IID system, particularly in areas of highly permeable soils. Installation of pumping plants in existing interceptor drains along these unlined main canals, and returning their seepage water back to them, like IID has already done along some canal reaches, has the potential to conserve between 35,000 and 45,000 acre-feet at $13 to $15 per acre-foot saved. This seepage recovery represents the lowest-cost delivery system water savings. The project elements also can be installed individually and quickly for incremental savings to match conservation ramp-up requirements. As well, the savings are readily verifiable by use of totalizing flow meters to measure the volume of interceptor drain water pumped.
- The system modernization studies described in Appendix 1i form the heart of the work to identify inter-related improvement opportunities. The Team examined six basic alternatives to generate savings and improve IID delivery service (listed in order of increasing cost and complexity): 1) Integrated Information Management (IIM); 2) spill recovery with no lateral reservoirs; 3) spill recovery with lateral reservoirs; 4) spill recovery with no lateral reservoirs plus IIM; 5) spill recovery with lateral reservoirs plus IIM; and 6) delivery shutoff flexibility. Unlike the stand-alone options, these measures are mutually exclusive and cannot be combined. Three options proved most promising:

    - Integrated Information Management (IIM) – focused on utilizing SCADA (Supervisory Control and Data Acquisition) technology to enable real-time lateral spill monitoring and remote operation of lateral headings by zanjeros, together new lateral regulating reservoirs, new and enlarged main canal regulating reservoirs, and other selected system improvements – offered the most cost-effective option, generating between 60,000 and 73,000 acre-feet of water at roughly $160 per acre-foot.
    - Spill recovery with lateral reservoirs – an approach involving major infrastructure construction, expansion of automation and remote monitoring (SCADA), adjusting water management practices and installing small zanjero-controlled reservoirs - is estimated to generate roughly 85,000 acre-feet in savings at $211 per acre-foot.
    - Spill recovery coupled with lateral reservoirs and IIM – in essence, a combination of the two previous alternatives – is estimated to generate approximately 96,000 acre-feet of conserved water at a cost of $270 per-acre-foot saved.

In addition to capturing about 60% of the historical system losses, these three inter-related projects can capture more than half (about 58%) of the water rejected (i.e., turned back by early shutoff or changed delivery rate) by some on-farm conservation measures. The Team's analysis of on-farm measures accounted for the ability of these delivery system options to recover a portion of the rejected water.

The Team and IID staff conducted a demonstration on the Malva 1 lateral to refine cost estimates, construction methods, and functionality of some of the components of these projects. The results of this demonstration were valuable in fully defining these inter-related delivery system improvement opportunities.

3.5. On-Farm Incentive Programs

The success of the Definite Plan depends heavily on the effectiveness of its on-farm incentive program. As a voluntary program, the incentive structure and payments must be attractive enough to entice widespread grower participation. This is particularly essential because on-farm actions will need to generate at least 130,000 acre-feet of savings and likely much more if IID is to meet its water transfer obligation at build-out.

Most broadly, the Team looked at three kinds of incentive payment options: those that pay for *performance or results* (such as measured reductions in delivered water or tailwater); those that pay for *actions* (such as implementing on-farm conservation measures) and *hybrids*, where a portion on the payment is based on results and a portion on actions.

Based on discussions with growers and extensive modeling within the Demand Generator to assess the potential for the different approaches to elicit sufficient participation and water savings within the financial constraints, the Team found that only some of the incentive program options under consideration appear viable. Below is a summary of those findings.

- *Performance- or results-based incentives.* At first glance, an incentive approach based solely on performance or results appears to make good sense. IID would track savings

Challenges of a Results-Based Incentive Approach

To understand the ramifications of an incentive-driven program, the Team tested a variety of different on-farm incentive structures. One, referred to as a results-based approach, involves paying growers if their water use reaches or drops below specified levels. Though it sounds straightforward, the example below shows how costs can quickly skyrocket and there are no easy fixes.

Let's say that $200 is offered for every acre-foot of water under a threshold of 6.0 acre-feet per acre. For a 100-acre field that was using 6.0 acre-feet per acre and reduced its use to 5.5 acre-feet per acre, the payment basis would be 0.5 acre-feet per acre, or 50 acre-feet for the 100-acre field, and the total payment would be $10,000.

Now consider a second 100-acre field that is already using just 5.5 acre-feet per acre, thereby qualifying for the same $10,000 payment without having to do anything different. The combined effect of these two fields would be $20,000 paid out for only 50 acre-feet of water savings. Thus, the actual cost to the program would be $400 per acre-foot of savings, or basically double the per acre-foot amount offered.

Why pay those fields already using water below the desired threshold? For one thing, there is a perceived equity issue. Many believe that it's unfair for IID to distinguish among growers: if you're below the threshold, the argument goes, you should get paid. For another, there is a serious practical constraint. Given the way IID has compiled water use records in the past (designed to bill for water, not track precise field-by-field usage), the District is not able to meaningfully distinguish between growers who are already at the desired water-use threshold and those who are exceeding it.

The problem is equally vexing with incentives based on a tailwater standard.

against a benchmark of some kind to determine and pay for conservation savings. In fact, the approach is highly problematic for several reasons. First, given the nature of IID's historical water delivery records – some of the individual gate histories contain non-trivial errors at the individual field level due to recording errors, moving water between gates, and gates that serve multiple fields – it is difficult to know with certainty each field's water delivery history. Second, most fields do not have a history of growing every crop that might be grown on it in the future. Third, even if the payment were based on performance relative to an aggregate water delivery by crop (say, the average or median historical delivered water for each crop), the program would inevitably pay incentives to growers with fields already meeting the agreed-upon standard. While this may or may not be objectionable from a policy perspective, it is extremely problematic from a financial perspective. This can also lead to equity and enrollment concerns. Approaches that pay only based on performance also could induce fallowing, crop shifting, and other behavior that reduces crop production. As a result of analysis, the Team determined the following:

- Adopting an incentive program based on individual delivery gate history is likely to result in significant enrollment bias, concerns about perceived fairness of payments, and large payments to growers for fields that may have little or no real conservation. A program to examine, and adjust as needed, any errors in individual gate records (a "certification" process) can reduce but not eliminate the problems.
- Adopting an incentive program based on an aggregate water use history by crop would cost more than $400 per-acre-foot saved – significantly beyond the $300 per acre-foot expected to be available to pay for conservation. An aggregate, per-acre water use across all crops (i.e., a straightline benchmark) would be even worse because all low water use crops could be enrolled and receive payment for no real conservation.
- Adopting an incentive program based on a tailwater standard – whether based on the tailwater fraction, volume, or zero tailwater option – would cost between $350 and $500 per-acre-foot saved; again, well beyond the $300 per-acre-foot target. Moreover, a tailwater approach adds new measurement and monitoring requirements (both farm deliveries and tailwater must be tracked), and the relationship between tailwater reduction and delivered water reduction is uncertain.

Limitations of a Tailwater Incentive Approach

At first glance, basing an on-farm conservation incentive program on reduction in tailwater seems attractive. The water balance shows that reduction in tailwater is the primary source of on-farm conservation potential, so why not measure tailwater and pay farmers to reduce it? It turns out that there are several problems that make this approach unattractive. Here are a few:

- The fixed baseline made necessary by lack of tailwater history means a lot of money is paid out to growers with tailwater already below the baseline.
- Payment is based on performance, not cost, so all growers are paid the same amount for the same savings. To get enough conservation water, growers with higher costs must be enticed to participate, increasing the payment to everyone and greatly increasing total program costs.
- A complete tailwater measurement plan must be added, increasing cost and administrative challenges.
- Sometimes the reduction in delivered water is much less than in tailwater, especially on sandy soils, so estimating true conservation is difficult.

Based on these results, the Team deemed approaches that pay incentives based solely on performance to be not viable, and did not carry them forward for further analysis.

- *Incentives based on payment for conservation measures.* Under this approach, water users would be paid to implement specific conservation measures. Measurement of acreage applying the practice would be required. Water users could select from a set of approved practices or could submit their own proposals for on-farm practices that best suit their individual operations. Water users would be responsible for performing practices as specified in an agreement and would be paid on that basis, rather than based on achieving certain water use levels.

  In its analysis, the Team considered two different pay-for-conservation measures: uniform (where each field receives the same payment per acre for a given conservation measure adopted), and scaled (where the size of the payment for a given conservation measure varies to account for economies of scale gained on larger fields, and possibly other factors). In both cases, pay-for-conservation measures proved financially feasible. To achieve 200,000 acre-feet of savings, the pay-for-conservation measure approach ranged from $240 per-acre-foot-saved for scaled payments to $260 per-acre foot with the uniform payments. At that level of total savings, the program would need to enroll over 60% of acreage in the Valley. The Team's analysis indicates that heavy adoption of tailwater recovery systems and, to a lesser extent, drip irrigation is needed to achieve average payments of $240-260 per acre-foot saved. Of course, under the envisioned flexible program, growers may adopt the conservation measures they feel are best suited to their operations.

  Based on these results, the Team deemed both pay-for-measures approaches viable. The analysis did, however, highlight some concerns. Most significantly, approaches that pay growers based solely on the conservation measure implemented are not likely to provide adequate incentive for growers to operate the measure effectively and achieve the full savings potential. This is a serious drawback.

Uncertainty

All farming and water supply decisions are made in the face of uncertainty, and it is a concern both to the District and to growers. The future can bring remarkable and unanticipated changes in agricultural markets, technology, and general economic conditions. Growers' response to an on-farm incentive program is also uncertain – will they participate, which conservation measures will they use, how much water will be saved?

Decisions on implementing the Definite Plan will affect the District and its water users for up to 75 years. This report has attempted to frame the uncertainty in its analysis and discussion of alternatives. The recommended approach needs to recognize and plan for uncertainty: incentive payments must compensate growers for risk; program costs must include a contingency for unanticipated changes; and adaptive management must provide flexibility to adjust to uncertain events and to new information, both in the near term and over the life of the plan.

- *Hybrid incentive approaches.* Hybrid incentive approaches are intended to combine the desirable features of both the pay-for-measures and performance-based approaches. The incentive payment would consist of two components. The larger portion of the payment would be based on the conservation measure implemented, and the smaller portion of the payment would be contingent on achieving a measurable level of performance. The intent is

to assure that participants actually implement new conservation measures and continue to operate them effectively.

As with pay-for-measures, the Team evaluated two different hybrid options: one with uniform payments and one with scaled. In both cases, the average hybrid payments fell below the $300 per-acre-foot funding level, with costs of about $255 per acre-foot for scaled and $295 per acre-foot for uniform to achieve 200,000 acre-feet of savings. At that level of total savings, the program would need to enroll over 60% of acreage in the Valley. Again, like the pay-for-measures option, the analysis suggests heavy use of tailwater recovery systems to generate the efficiency conservation savings.

The team deemed both hybrid incentive approaches viable for further evaluation.

It is worth noting that the Team did not evaluate a bidding-based incentive approach. First, growers expressed a strong preference for a standardized incentive program in which all participants in similar circumstances agreeing to implement the same conservation measure would receive the same payment. Second, bidding systems tend to converge over time because participants will observe what the "market" rate for conserved water is, and will adjust their bids accordingly. This is not much of an issue for one-time bids, but can be anticipated to occur in a program of extended duration. Finally, a bid system can place an administrative burden on IID to verify detailed cost information provided by hundreds of participants for thousands of fields. Nevertheless, a bidding system could be implemented as part of a pay-for measures or a hybrid approach.

3.6. IID Delivery System-On Farm Integration

The interplay between IID's delivery system and on-farm actions is dynamic: delivery system actions determine the level of service that IID can provide to growers, and on-farm actions determine the level of service needed to accomplish targeted on-farm water conservation. Clearly the two must be closely coordinated. Additionally, on-farm and delivery system per-acre foot costs vary dramatically depending on the volume of conservation savings to be generated; the higher the needed savings from either on-farm or delivery system, the higher the costs, as more expensive conservation measures must be deployed to reach beyond the "low-hanging fruit."
Given the range of costs estimated for the different components, the best combinations of on-farm savings and delivery system savings are likely to fall somewhere in the middle.

The objective of alternatives development is to identify alternatives that represent the range of on-

Paying for Ongoing Conservation

The on-farm conservation program will pay growers and landowners to reduce water use by changing their irrigation methods. Some growers have already incorporated irrigation methods that use less water to grow a crop. An important question for the District is: should the new program provide some compensation to those who have already adopted water-conserving irrigation methods?

This question raises difficult issues of fairness and practicality. First, ongoing conservation has already been implemented, so it does not represent new water conservation - should the program pay for that? Yet, refusing to pay for ongoing conservation has the appearance of penalizing growers that have already conserved water and rewarding those that have not. Further, existing conservation usually relies on equipment that will need replacement or services that can be halted. If not compensated, these growers may not replace the equipment or continue the services, which would offset some program savings.

farm conservation volumes from the maximum to the minimum possible, obtaining the remaining conservation from least-cost delivery system measures. This process leads to identification of the least-cost combinations of on-farm and delivery system savings.

3.7. Implementation Uncertainties

The Team's work to-date suggests the potential to generate the required efficiency conservation savings – both on-farm and in IID's delivery system – within the available revenue. However, the analysis and conversations with growers and others also suggest there are significant unknowns that make it difficult to project with certainty exactly how the program will be implemented. On-farm per-acre cost and savings projections, for example, indicate that high levels of grower participation and significant adoption of conservation measures with large savings per acre will be needed. They also suggest that growers' participation is quite sensitive to the level of incentive payments. To the extent that these projections vary in practice, costs for achieving efficiency conservation could change.

Similarly, system delivery improvements necessitate a significant change in the way zanjeros conduct their work. To the extent zanjeros are slow to change practices, savings levels could be lower, leading to higher per-acre costs for delivery system savings. While the Team has tried to account for such uncertainties in its modeling and sensitivity analyses to assess the impact of changes in enrollment, payment levels and other key factors, the Team also recognizes that it is impossible to predict with certainty exactly how the program will evolve. For that reason, the Team strongly recommends that any alternative adopted by the Board build in "financial headroom" – the difference between the projected cost of implementation and the $300 per acre-foot available revenue figures – as a buffer to address implementation unknowns and ensure IID can meet its water transfer obligations within the financial means of the program.

3.8. Grower Preferences

Finally, discussions with the OFTA, one-on-one meetings with growers and a review of the district-wide survey results suggest that growers have strong preferences regarding an incentive program. Grower feedback centered around several key preferences: (1) avoid incentive programs based on growers bidding against one another; rather, design a program where all growers are offered the same participation terms; (2) structure the program to be flexible and enable growers to select their preferred efficiency conservation measures; (3) evaluate the potential to pay for ongoing conservation; and, (4) make incentive payments large enough to offset the perceived risks and hassles of participation.

4. Alternatives Overview

4.1. Approach to Alternatives Analysis

As described above, the challenge is to identify the combination of on-farm and delivery system conservation measures that can best meet the requirements of the QSA and related agreements. But what does "best" mean?

At the most basic level, packages of on-farm and delivery system improvements must be able to generate the required savings within the financial constraints - thus the emphasis on least-cost formulations. It must also satisfy a key QSA-related design parameter: That on-farm efficiency conservation measures generate between 130,000 and 303,000 acre-feet of the transferable water. But, beyond these imperatives, there are other important considerations. Is an alternative easily implemented? Does it account for and balance the inherent risks to growers and IID? Do the on-farm and system elements work together? Are grower participation and on-farm savings sufficient? Can the savings be verified in a credible manner? Are the implementation uncertainties manageable?

The first goal of the analysis was to determine how different bundles of on-farm and delivery system actions performed at various conservation levels. These conservation levels – described more fully in section 4.2 – ranged from an approach that generated nearly all savings on-farm to one that sought to generate the maximum practical savings from the IID delivery system. Between these "bookends," five other conservation levels were identified, making seven altogether.

For each level of on-farm conservation within the bookends, the Team then sought to identify the least-cost mix of delivery system improvements. It further sought to understand the cost and other impacts associated with generating the on-farm savings through the various on-farm incentive program options. (Inevitably, this process is iterative, since the delivery system approaches are shaped by the interaction with different on-farm savings levels.) Finally, the Team added in measurement, administration and contingency costs to calculate the total costs associated with generating the necessary savings at each of the seven conservation levels. These various steps – and the resulting conclusions – are more fully detailed in the sections below.

On-Farm/Delivery System Integration

It is a well understood fact in the Imperial Valley that the manner in which water is delivered to the farms affects irrigation practices and performance. The rules that control water ordering restrict the options of the growers and the system capacity limits the ability to deliver the desired flows to all users at the same time. What may be less understood is the impact of on-farm irrigation on system operation. Adjusting deliveries during an order, turning a delivery off early or extending a delivery influences canal flows, delivery to others and system spills.

For maximum on-farm irrigation savings, it would be desirable to have more flexibility in the way water is delivered so the precise amount of water needed could be delivered at exactly the right time. With widespread adoption of conservation measures, the flow of water in the delivery system could be dramatically affected unless changes to the system are made to deal with the on-farm changes. While it is not cost effective to change the system to give total flexibility to the water users, making critical changes is cost-effective and necessary. So, the best conservation programs would adopt reasonable system changes designed to augment and support on-farm conservation and system rules that would encourage cooperative conservation.

4.1.1. Conservation Mixes

Cost is a primary consideration for developing an efficiency conservation program, but it is not the only one. Some options may be low-cost, but have other implementation limitations. Some approaches may carry a higher price tag, but may offer IID and growers more flexibility to manage risk and deal with difficult to predict implementation considerations.

To ensure the Team explored the full range of possibilities and assessed the interplay between on-farm and delivery system actions, the Team identified seven conservation mixes for analysis. Each of these – listed in Table 1 below – relies on a different mix of delivery system and on-farm savings.

Table 1. Definite Plan Conservation-Level Alternatives Selected for Analysis

Conservation Mix Alternative	On-farm Conservation acre-feet	System Conservation acre-feet	Total Conservation acre-feet
1. Maximum on-farm	280,000	23,000	303,000
2. On-farm plus seepage interception	258,100	44,900	303,000
3. On-farm, seepage interception and least cost canal lining	255,720	47,280	303,000
4. System water for CVWD	200,000	103,000	303,000
5. Least-cost combination	182,340	120,660	303,000
6. Maximum delivery system	158,800	144,200	303,000
7. Maximum delivery system with delivery flexibility	158,800	144,200	303,000

4.1.2. Least-Cost Delivery System Options at Different Conservation Mixes

Past water conservation programs within IID have addressed improvements to both the IID delivery system and to on–farm systems, with primary emphasis on the IID delivery system. Major delivery system conservation measures include concrete lining of laterals for seepage reduction and construction of lateral interceptor canals to collect water previously spilled and route it to reservoirs or other canals for use lower in the system. Additionally, reservoirs and pumping plants, together with extensive upgrading of facilities automation, have been implemented to reduce main canal spillage and improve water delivery service.

The Definite Plan is different from previous conservation programs in that on-farm conservation carries a higher priority, with delivery system improvements identified that complement the on-farm actions. With emphasis on on-farm water savings, delivery system conservation measures must be low-cost and/or include elements that support on-farm conservation. While the same kinds of delivery system physical improvements considered in past conservation programs are explored for the Definite Plan, additional options aimed at improving system management are also included.

As noted in Section 3 (Factors Shaping Alternatives Evaluation), the Team evaluated numerous options for conserving water within IID's delivery system – including projects to line leaky

canals, recover canal seepage, and completely revamp IID's network of canals, laterals, reservoirs, water control structures and information systems. It considered stand-alone actions (those that can be implemented without impacting system operation or on-farm irrigation performance) and inter-related actions (those that influence system operation or farm delivery or are affected by adoption of on-farm conservation measures). A more thorough description of this analysis can be found in Appendix 4.

Based on the analysis of the costs and savings associated with these different conservation measures, the Team identified the following least-cost options for generating the necessary delivery system savings and on-farm conservation support at each of the seven different conservation mixes:

1. **Maximum on-farm.** Relies on only the lowest-cost seepage interception to generate 23,000 acre-feet in delivery system savings
2. **On-farm plus seepage interception.** Assumes inclusion of all seepage interception projects to generate 44,900 acre-feet in delivery system savings.
3. **On-farm, seepage interception and least cost canal lining.** Assumes inclusion of all seepage interception projects plus canal linings to generate 47,280 acre-feet in delivery system savings.
4. **System water for CVWD.** Requires implementation of Integrated Information Management (IIM) to achieve 63,000 acre-feet of savings plus 40,000 acre-feet of seepage interception to generate 103,000 acre-feet in delivery system savings.
5. **Least-cost combination.** Identifies the least-cost mix of on-farm and delivery system actions; 120,660 acre-feet in delivery system savings generated through seepage interception (44,900 acre-feet), canal lining (2,380 acre-feet) and IIM (73,380 acre-feet).
6. **Maximum delivery system.** Generates 144,200 acre-feet in delivery system savings through maximum seepage interception, canal lining and an interrelated component that includes spill interception with lateral reservoirs combined with IIM.
7. **Maximum delivery system with delivery flexibility.** Implements the most aggressive delivery system measures to generate 144,200 acre-feet in delivery system savings; provides additional flexibility to improve on-farm performance.

4.1.3. On-Farm Incentive Program Approaches

As described in Section 3, four distinct incentive approaches – Uniform Payment for Conservation Measures, Uniform Pay for Measures Hybrid, Scaled Payment for Conservation Measures and Scaled Pay for Measures Hybrid – were recommended for inclusion in the alternatives evaluation. Table 2 summarizes the comparative advantages and disadvantages of these four options. The first three rows are based, at least to some extent, on a quantitative analysis. The remaining rows summarize the Team's discussion and qualitative comparisons among the options, including the pros and cons and limitations. The clearest trade-offs among the approaches involve cost-effectiveness and risk, the complexity of program administration, and monitoring and verification.

Table 2. Summary Comparison of On-Farm Incentive Approaches

	Uniform Payment for Conservation Measures	Uniform PFM Hybrid	Scaled Payment for Conservation Measures	Scaled PFM Hybrid
Ability to provide sufficient savings for The Definite Plan	Able to provide savings, based on analysis	Able to provide savings, based on analysis	Able to provide savings, based on analysis	Able to provide savings, based on analysis
Cost-Effectiveness and financial risk	2nd to highest estimated payment for on-farm CMs	Highest estimated payment for on-farm CMs - at the limit of available funds, no margin for unexpected costs	Lowest estimated payment for on-farm CMs – allows larger margin for unexpected costs	2nd to lowest estimated payment for on-farm CMs – allows some margin for unexpected costs and other risks
Water savings variability and risk	Likely highest risk – no performance-based incentive payment	Hybrid provides better structure to encourage real savings, but overall payments are highest	Low payments per acre provide added margin for mid-year adjustment–no performance-based incentive payment	Hybrid provides better structure to encourage real savings, but overall payments are higher
Propensity to encourage crop switching or fallowing	Little or no risk	DW-based payments provide small risk	Little or no risk	DW-based payments provide small risk
Ability to include payment for existing conservation	Could pay for O&M, replacement costs of existing systems	Could pay for O&M, replacement costs of existing systems; performance-based payments could be applied to existing conservation	Could pay for O&M, replacement costs of existing systems	Could pay for O&M, replacement costs of existing systems; performance-based payments could be applied to existing conservation
Acceptability to growers and landowners	No clear differences/small preference for simpler, uniform payments	No clear differences/small preference for simpler, uniform payments	No clear differences/small preference for simpler, uniform payments	No clear differences/small preference for simpler, uniform payments
Program enrollment and payment	Easiest to implement – simple payment schedule	More complex – payment schedule and DW-based payments	More detailed payment schedule than uniform PFM, less complex than hybrids	Most complex – detailed payment schedule and DW-based payments
Program initiation and ramp-up	No clear differences	No clear differences	No clear differences	No clear differences
Flexibility to respond to changing conditions	Depends largely on CMs selected by growers	Depends largely on CMs selected by growers, slightly more flexible – hybrid payment can be adjusted	Depends largely on CMs selected by growers	Depends largely on CMs selected by growers, slightly more flexible – hybrid payment can be adjusted
Verification, measurement, and monitoring	Requires measurement, monitoring, performance standards for effective operation	Requires measurement; performance-based payments provide operation incentive and may lower monitoring costs	Requires measurement, monitoring, performance standards for effective operation.	Requires measurement; performance-based payments provide operation incentive and may lower monitoring costs

- Uniform Payment for Conservation Measures is relatively low in payments, thus posing a lower financial risk because it leaves a larger margin for unanticipated costs. It is the easiest to administer, but poses a challenge to guarantee that conservation measures are effectively operated to provide real savings.
- Uniform Pay for Measures Hybrid is more complex to administer and poses the highest financial risk because of its higher cost. The performance-based payment provides greater assurance of on-going, effective operation of conservation measures.
- Scaled Payment for Conservation Measures has the lowest estimated payments and so provides the lowest financial risk. It is moderately complex to administer and poses a challenge to guarantee that conservation measures are effectively operated to provide real savings.
- Scaled Pay for Measures Hybrid is relatively low in payments (lower financial risk), but is the most complex to administer. The performance-based payment provides greater assurance of on-going, effective operation of conservation measures.

Energy Sources for On-Farm Conservation

Many of the conservation measures growers will consider adopting require energy to operate. Examples include tailwater recovery systems with pumps and pressurized irrigation systems. Currently, primary sources of energy for pumping used by growers in the Imperial Valley are diesel and electricity. Alternative energy sources not commonly used in the Valley could be utilized in some cases to meet the needs of growers installing new tailwater recovery and irrigation systems. These additional energy sources may include natural gas, solar power, or others. The need for alternative energy sources may be driven by cost (scarcity) and by environmental considerations.

In addition to exploring alternative energy, it is anticipated that growers will seek opportunities to limit energy consumption by reducing energy needs for pumped systems or by eliminating pumping through the use of gravity, where feasible. For example, growers may eliminate pumping through the use of gravity-fed large diameter plastic gated pipe rather than pump-fed aluminum gated pipe, or they may recover and re-apply tailwater through the use of cascading rather than pumpback systems. Pressurized irrigation systems may be designed to operate with low pressure emitters or to reduce losses in system components such as pipes and filters.

4.2. Alternatives Evaluation

4.2.1. Candidate Integrated Alternatives

Key to the Definite Plan is the careful integration of delivery system and on-farm conservation components. Alternatives are combinations of on-farm and system components that meet the water savings targets and financial constraints, are integrated, and are implementable.

Each of the four viable on-farm incentive approaches described above is combined with the least-cost delivery system measures included in each of the seven conservation mixes described earlier to form an alternative. The costs of these alternatives – 28 in all – are compared to available revenue to determine financial feasibility. Those alternatives deemed viable – in other words, those able to generate the required conservation savings within the available revenue – are evaluated against three primary evaluation criteria: cost and financial risk; ease of implementation and administration; and verification of savings.

The recommended alternative is defined as the recommended range of on-farm/system conservation split, the delivery system conservation options that support that range, and the preferred on-farm incentive approach.

4.2.2. Available Revenue

As noted above, one key method for evaluating the various integrated alternatives is to compare their costs to the available revenue. To do so, program administration and implementation costs must be added to each alternative. Costs for improved farm delivery measurement and program administration costs are estimated, with a contingency factor to cover uncertainty in the cost of those components.

To effectively administer the Definite Plan, improved farm delivery measurement is needed. The Definite Plan will rely on delivered water measurement for performance verification and, for some alternatives, may require measurement to provide the basis for a portion of the incentive payment. (Improved farm delivery measurement and flow control benefits other District and grower initiatives also.) Appendix 1.c. describes the potential field delivery measurement requirements. The Team estimates that $40 per acre-foot of conserved water is needed to implement improved field delivery measurement, and recommends that the budget include that amount. The final selection of measurement approach awaits results of comparative testing and feasibility analysis, which will provide a more refined cost estimate.

A detailed plan for program administration has not been developed because it depends upon the final implementation plan. However, a review of potential costs suggests a budget of $10 per acre-foot of conserved water is adequate for conservation verification and program management.

Due to uncertainty in the cost estimates for measurement and administration, a cost contingency of $17 per acre-foot is also recommended. This is sufficient to cover the high-end estimate of system measurement cost and program administration costs. Thus the total basic Definite Plan implementation cost is estimated at $67 per acre-foot of conserved water. Given the available revenue cited earlier in this report – approximately $300 per acre-foot saved – that leaves about $233 per acre-foot saved to cover the costs of all delivery system and on-farm conservation measures implemented.

4.2.3. Results

The graph of the alternatives presented in Figure 6 – each with the common measurement, administration and contingency costs of $67 per acre-foot already added in – shows a wide range of costs for conserving 303,000 acre-feet. Following is a brief summary of the results (more detailed results are provided in Appendix 4.e.):

- Fourteen of the 28 alternatives analyzed have costs at or below the available revenue of $300 per-acre foot saved and can be considered for evaluation and possible adoption as the recommended approach. All Scaled Pay-for-Measures incentive alternatives fell below the $300 threshold except for the Maximum On-Farm alternative.
- Fourteen of the 28 alternatives exceeded the $300 threshold and are not considered viable alternatives for consideration in Definite Plan implementation. More than half of the

Uniform Pay-for-Measures Hybrid alternatives exceeded the $300 limit. Uniform Pay-for-Measures fared second worst, with the cost of four of its seven alternatives exceeding the available revenue.

- A number of alternatives provided significant "headroom" between the alternative's cost and the available revenue. Most promising were some of the Least Cost and System Water for CVWD (conservation mixes #5 and #4) alternatives, whose costs for most of the incentive options were between $243 and $268 per acre-foot – well below the $300 threshold.
- Including a hybrid component with some of the incentive pay-for-measures approaches raised the cost across-the-board, but hybrid approaches provide better assurance that conservation measures would be operated to their potential.
- Configurations encompassing the IIM inter-related delivery system component combined with seepage interception (Least Cost, conservation mix #5) or IIM plus seepage interception and canal lining (System Water for CVWD, conservation mix #4) had the lowest costs.

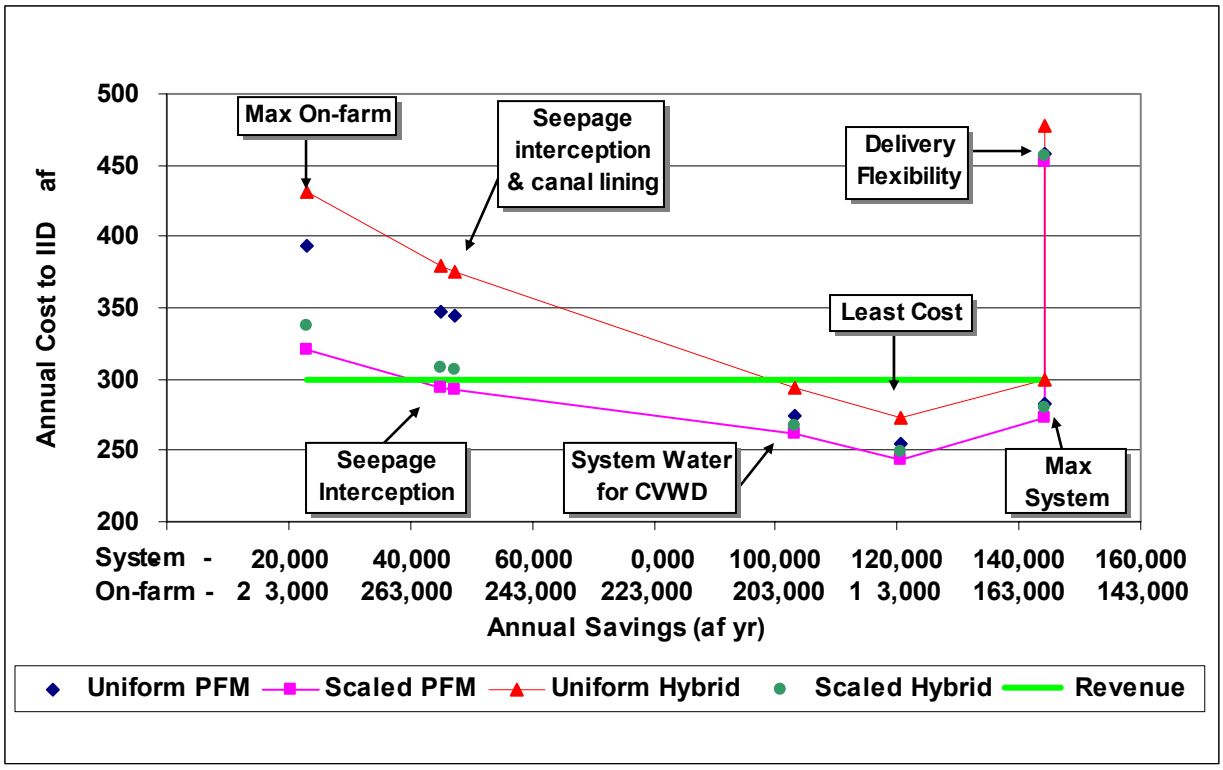

Figure 6. Comparison of Integrated Alternatives

Based on these findings, the Team believes there are five integrated alternatives that are particularly strong candidates. These are: Least-Cost (conservation mix #5) with Uniform PFM, Scaled PFM and Scaled Hybrid; and System Water for CVWD (conservation mix #4) with Scaled PFM and Scaled Hybrid.

These alternatives suggest an optimal mix of between roughly 180,000 to 210,000 acre-feet of on-farm water savings combined with 93,000 to 123,000 acre-feet of delivery system conservation

savings. Table 3 presents the range of conservation savings by component and average water savings costs over this preferred range.

Table 3. Component Savings and Average Costs Over Preferred Range of Savings

Conservation Component	Low On-farm Savings acre-feet	High On-farm Savings acre-feet	Average Cost at 180,000 acre-feet on-farm savings $/acre-foot	Average Cost at 210,000 acre-feet on-farm savings $/acre-foot
IIM	75,720*	53,000	$136	$189
Seepage Interception	44,900	40,000	$15	$15
Canal Lining	2,380	0	$202	$0
On-Farm	180,000	210,000	$240	$256
Total or overall average	303,000	303,000	$247	$279

* For purposes of displaying the preferred range of savings, this value is about 2,340 acre-feet larger than the estimated savings from IIM presented in Appendix 4.b. If IIM ultimately proves unable to provide this level of savings, the on-farm component would increase to make up the difference.

4.2.4. Results Evaluation

Section 4.1.3 presents a set of criteria used to compare on-farm incentive approaches (these criteria are defined in greater detail in Appendix 4.d). All four of the candidate incentive approaches are viable and could be combined with system components within the range shown in Table 3 to form viable complete alternatives. Many of the criteria used in Section 4.1.3 to compare the on-farm incentive approaches do not indicate significant differences among them. The important distinguishing criteria among the incentive approaches fall into three categories: cost and financial risk; ease of implementation and administration; and verification of savings. These same criteria are applied below to compare the complete integrated alternatives.

Total cost and financial risk. This criterion addresses the following questions:

> What is the total cost of the alternative and how does that compare to the available revenue? How much financial margin is available for the program to respond to uncertainty?

For each of the incentive program approaches, the Least-Cost Combination (conservation mix #5) and System Water for CVWD (conservation mix #4) configurations are the lowest cost. As a result, they also provide the greatest margin for the program to respond to unexpectedly high costs, low revenues, or low on-farm participation. The higher margin also provides IID room to consider, if desired, some compensation to growers that have already been conserving water (to reward and encourage them to continue).

Among the incentive approaches, the estimated cost of the uniform payment hybrid is near the available revenue, so it presents a significant financial risk. The other three approaches provide greater margin.

Ease of implementation and administration.

> Is the alternative especially difficult to implement? Issues include program initiation and ramp-up, and the complexity of calculating and administering incentive payments.

No major differences appear among the incentive approaches. The scaled payment approaches will require some additional up-front analysis to develop final schedules and rules for payments to growers, including decisions on specific field characteristics (size, slope, etc.) to use for calculating payments. Both hybrid payment approaches will require additional evaluation of the most appropriate way to measure performance as a basis for payment.

System components that require more complex, integrated operational changes will be more difficult to implement and perhaps more difficult to administer.

Verification of savings.

> Does the structure of the program encourage effective operation to produce verifiable savings from the on-farm component?

Incentive approaches that pay growers based in part on measured performance are preferred to approaches that pay based solely on the implementation of a conservation measure. They provide growers with a built-in incentive to conserve water, and can avoid some of the monitoring that can be required in a strict pay-for measures approach. Therefore, the two hybrid incentive approaches are preferred based on this criterion.

Regardless of the incentive approach, on-farm savings are expected to be somewhat more difficult to verify quantitatively than system savings. All else being equal, alternatives with lower volumes of on-farm savings and higher volumes of system savings will be easier to verify. Savings from seepage recovery is relatively easy to verify. Savings from integrated operational changes, such as IIM, will be more difficult. Between the two lowest-cost alternatives, the Least Cost alternative (conservation mix #5) ranks slightly better than System Water for CVWD alternatives (conservation mix #4).

5. Recommendations

5.1. Overview

The Definite Plan Team was charged with the following objective: Develop a reliable, credible and technically sound blueprint for generating transferable water over a period of up to 75 years.

Below is a set of recommendations that the Definite Plan Team believes will best position IID to meet those commitments. The first five recommendations address the basic structure of IID's efficiency conservation program, while the sixth addresses near-term actions that map out how IID could move forward with its efficiency conservation program. All of these are considered essential.

Because decisions involving the Definite Plan are linked to other IID activities and issues that have not been analyzed by the Team, a decision timeframe has not been provided; we assume that staff will be advising the Board in this regard. It is clear, though, that IID must move expeditiously if it is to fulfill its water transfer obligations beginning next year (2008).

5.2. Recommendations

The following recommendations represent the Team's conclusions about how IID can best fulfill its water transfer obligations under the QSA, within the limits of available revenues. The recommendations are based on the analysis of the options available to IID to implement an efficiency conservation program, as described in this report and its appendices.

The Team's analysis reveals that there are a few good options that would serve IID well, and others that either cannot work or are so marginal that they seriously reduce the prospects for success. The recommendations address: 1) the blend of on-farm and delivery system savings that IID should target; 2) the on-farm incentive approach that IID should employ to attract landowners and growers voluntarily into participation; 3) the improvements that should be implemented within the IID delivery system; 4) the need to improve measurement of farm deliveries; 5) provisions for fulfilling IID's early-year (2008 – 2010) water transfer obligations; and 6) near-term actions to ensure IID has sufficient capacity to meet its water transfer obligations. Each of these is discussed in the following sections.

Importantly, recommendations 1 through 4 are not separable; rather, they form an integrated package that cannot be separated without implication to the viability and performance of the overall efficiency conservation program.

5.2.1. Blend of On-farm and Delivery System Savings

The Team's analysis reveals that the cost of saving water, both on-farm and in the IID delivery system, depend on the target volume of savings; the more water targeted, the higher the unit (per acre-foot) cost. In fact, at the margins, costs rise very sharply, and targeting too much on-farm or system savings imposes unnecessarily high costs that jeopardize the overall financial viability of the efficiency conservation program. Staying within certain ranges limits costs to levels below the average $300 per acre-feet foot revenue available from water transfer proceeds. In the 180,000 to 210,000 acre-foot range for on-farm savings, costs are at their lowest, with per-

acre-foot costs ranging from $240 to $256. Increasing on-farm savings further causes costs to rise dramatically. A shift to a greater emphasis on delivery system savings also causes overall average costs to rise, plus the program fails to maximize the on-farm component. Importantly, the farther below the available revenue threshold costs are, the more "financial headroom" IID will have to deal with inevitable program uncertainties. If no unexpected costs materialize, IID could potentially return up to the full $300 per acre-foot to IID landowners and growers; however, IID is strongly advised to maintain a contingency fund during the early program years to deal effectively with cost uncertainties and conservation shortfalls.

Recommendation #1: IID should target on-farm savings in the range of 180,000 to 210,000 acre-feet and delivery system savings ranging from 93,000 to 123,000 acre-feet, at program build out.

5.2.2. On-farm Incentive Approach

The Team's analysis and evaluation reveals that on-farm incentive approaches based solely on paying for conserved water are unworkable. This is due primarily to how growers would elect to enroll fields in the program, resulting in too much money being paid out for fields that already meet water conservation targets, and/or for fields that have low conservation measure implementation costs. These problems are aggravated by historical data issues. The Team strongly recommends that IID avoid these approaches.

Four approaches based wholly or primarily on paying landowners and/or growers to implement conservation measures are considered viable. These are: 1) Uniform Payment for Conservation Measures, 2) Uniform Pay for Measures Hybrid, 3) Scaled Payment for Conservation Measures and 4) Scaled Pay for Measures Hybrid (see Section 3). One of these approaches – Scaled Pay for Measures Hybrid – offers the best combination of cost-effectiveness, assurance that on-farm conservation measures will be operated at or near their potentials, and administrative ease. Importantly, the hybrid approach includes an ongoing incentive for growers to use conservation measures at or near their potential, and the scaled payment provision limits payments for conservation measure implementation to workable levels. No other approach is as effective, and each increases the risk that IID will not be able to meet its future water transfer commitments within the available budget.

Recommendation #2: IID should use the Scaled Pay for Measures Hybrid Incentive approach to attract growers voluntarily into the efficiency conservation program and to achieve the targeted on-farm savings.

5.2.3. Delivery System Improvements

The Team's analysis shows that extensive physical modification of the IID delivery system is both extremely expensive and unnecessary for a viable efficiency conservation program. Relatively modest improvements that include a strategic combination of physical and operational changes will save the targeted system savings and enable the targeted on-farm savings. These improvements include main canal seepage recovery and a package of improvements called Integrated Information Management (IIM).

Seepage recovery offers a number of attractive advantages, the main ones being its low cost – about $15 per acre-foot for up to 44,900 acre-feet of annual savings – and its scalable and easily verifiable savings. IIM features real-time lateral spill monitoring and automation of lateral

headings, which, together, provide zanjeros with both the information and capability to operate laterals with less spillage while providing the increased delivery flexibility needed to enable on-farm savings. Additionally, new lateral regulating reservoirs would be placed selectively, new main canal regulating reservoirs would be constructed and existing ones enlarged, and other selected system improvements would be made. IIM has the potential to save up to 76,000 acre-feet at costs up to $189 per acre-foot. The relatively low blended cost of delivery system savings increases the per acre-foot amount that IID can pay for on-farm savings. IIM denotes a substantial change in IID operations procedures, especially at the lateral level.

Recommendation #3: IID should implement seepage recovery and Integrated Information Management to achieve the IID delivery system savings, and to enable the targeted on-farm savings.

5.2.4. Farm Delivery Measurement

IID's existing methods of measuring farm water deliveries, while adequate for present water and billing administration purposes, will become inadequate for purposes of verifying on-farm water savings and administering incentive payments based on water use criteria. This is because as water takes on higher value or becomes scarce (e.g., due to equitable distribution), and measurement of smaller volume changes are utilized, the error in some delivery records will become intolerable; growers and IID will want to be certain that measurement is sufficiently accurate. For development of the Definite Plan, two possible measurement approaches were identified, both of which provide accurate measurement and have the potential for automation and remote control of farm delivery rates.

Recommendation #4: IID should implement improved measurement of farm deliveries pending comparative performance tests of the two devices identified thus far. Consideration should be given to equipping the devices with automatic flow control to hold deliveries steady and radios to enable remote control.

5.2.5. Early-year Efficiency Conservation Savings

Beginning next year – 2008 – IID must generate at least 4,000 acre-feet of efficiency conservation savings, ramping to 8,000 acre-feet in 2009 and 12,000 acre-feet in 2010. A relatively sure way to generate the necessary savings is with delivery system improvements, particularly main canal seepage recovery, because the various individual seepage recovery projects can be constructed easily, they provide the ability to scale savings to match the transfer schedule, and they are readily verified. Seepage recovery also carries a very low cost, which reduces IID's need to borrow money to get the program running. By comparison, on-farm savings are less certain because they involve grower participation, they are more difficult to verify, and they are more costly.

However, the majority of water savings must eventually be produced on-farm, and, importantly, there is high interest among growers in accelerating the on-farm component of the program. Therefore, IID and growers should initiate on-farm conservation efforts as soon as is practical. This will involve pilot programs to test incentive structures, payment rates, performance monitoring, verification requirements, and other elements. To the extent that on-farm pilot programs succeed in producing verified water savings, these could be combined with system savings (possibly with higher priority) to fulfill early-year water transfer requirements.

Similarly, considering the significant changes involved with adoption of Integrated Information Management (see Recommendation #3), IID needs to demonstrate IIM at full scale. This will involve equipping at least one full lateral, and preferably one or two complete zanjero runs, with real time spillage monitoring, automated lateral headings, and associated mobile communications and computer equipment. Once successfully demonstrated, the system could be expanded to cover additional portions of the IID delivery system. Here, too, any verified water savings could be used to fulfill early-year water transfer obligations.

This approach assures that the least-cost delivery system savings are brought on-line first, but also offers the opportunity, through on-farm pilot programs, to bring on-farm contributions into the mix as early as possible. Any excess conserved water could be used for other purposes designated by IID, such as inadvertent overrun paybacks.

Recommendation #5: IID should rely on selected seepage recovery projects and on-farm and delivery system pilot projects to generate early year – 2008 through 2010 – water savings.

5.2.6. Important Near-term Actions

IID's water transfer obligations begin slowly; just 4,000 acre-feet is scheduled to be transferred in 2008. However, by 2013 IID is committed to transferring nearly 50,000 acre-feet and just three years after that, the figure exceeds 100,000 acre-feet. Moreover, there is strong interest within the grower community to ensure that a significant portion of those early-year savings be generated on-farm.

Given these approaching commitments, the Team strongly recommends that IID take a number of near-term actions. These actions have two primary aims: (1) to ensure that IID is ready to meet its most immediate water transfer requirements; and (2) to prepare IID to launch a more comprehensive program just a few years down the road. These actions include both concrete steps to generate near-term water and demonstration projects and pilots to refine longer-term program approaches.

Below is a recommended list of near-term actions.

For Delivery System Component

- Prepare designs, plans and specifications for construction of selected seepage interception systems capable of producing at least 4,000 acre-feet of savings by 2008, 8,000 acre-feet by 2009 and 12,000 acre-feet by 2010. Construct selected interception systems.
- Design and develop cost estimates for a pilot test of Integrated Information Management (IIM) at the scale of one or more complete zanjero runs. Implement pilot test in selected areas.

For On-Farm Component

- Conduct a pilot on-farm conservation program featuring selected conservation measures, including scientific irrigation scheduling, scientific event management and tailwater recovery systems. Use the pilot program to evaluate how incentive payments affect participation rates, performance, and other aspects of implementation.

- Continue on-farm technology demonstrations in cooperation with willing growers, focusing on refinement of the costs and water savings of conservation measures, and the interaction between IID delivery system and on-farm operations.
- Conduct field trials to test alternative continuous farm delivery measurement devices, leading to identification of detailed measurement specifications and reliable estimates of capital, operations and maintenance costs.

For Administration
- Develop a prototype information system for tracking enrollment, payments and water savings for the pilot on-farm conservation program.
- Develop contract language for IID-grower-landowner agreements.
- Initiate financial planning needed to support cash flow requirements, including studies and documentation to support debt financing, if needed.

Once the Board confirms its approach for moving forward, substantial work remains to develop more detailed implementation plans. For example, IID must develop a long-term strategy to verify conservation savings. It must also develop a schedule of activities from initial ramp-up to full build-out. These and other longer-term implementation considerations are described more fully in Appendix 4.f. For the near-term, however, the Team believes the actions outlined above offer a wise and targeted course for moving forward.

Recommendation #6: IID should take a series of steps to ensure it is ready to meet its near-term water transfer obligations.

5.3. Looking Ahead

The proposed Efficiency Conservation Definite Plan puts forward a set of feasible alternatives that the Team believes can accomplish the targeted savings within the available revenue. It has identified one of these feasible alternatives as the recommended plan. And it has stepped out a series of related recommendations and near-term actions needed to move forward.

The Team appreciates the opportunity to have worked with IID, growers and landowners, and the community at-large on its development of the Definite Plan, and is available to provide continued assistance as needed.