TECHNICAL MEMORANDUM CH2MHILL

Estimates of the Conservation Charge for HB1437 Water Replacement Strategies

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1.0 Introduction

This Technical Memorandum (TM) provides the technical basis for evaluating the conservation charge that Williamson County water users would pay into the Agricultural Water Conservation Fund (AWCF) for each of the water replacement strategies considered. A companion TM, entitled *Evaluation Criteria and Selection Process for HB 1437 Water Replacement Strategies*, outlined the criteria used to compare potential water replacement strategies that will result in "no net loss." Cost was defined in that TM as the conservation charge. The water customers strongly emphasized cost as one of the most important considerations and it was included in the Primary Screening Criteria. Appendix A, which presents the spreadsheets used to calculate each of these components, should be referenced for further details.

2.0 Water Demand Forecast

To determine the amount Lower Colorado River Authority (LCRA) will charge Brazos River Authority (BRA) for the water transferred to Williamson County, the first task is to determine the amount of water that will be transferred. The water cost, to be paid to LCRA, is based on the projected demand as provided by BRA and subsequently adjusted to achieve full utilization of 25,000 acre-feet per year by 2050. This "ultimate" demand projection of 25,000 acre-feet per year is specified in the HB 1437 legislation and is identified in the *Williamson County Water Supply Facilities Plan* as a basis for the recommended facility phasing plan (HDR, 2001b). David Wheelock supplied the BRA projections for Williamson County demand through personal correspondence on April 19, 2004. These projections present yearly demands from 2005 through 2020 (Colorado River water demands were zero for Williamson County prior to 2005), and a separate demand projection for the year 2025. The demand projections increase from 600 acre-feet in 2005 to 15,516 acre-feet in both 2020 and 2025. The demand for the period from 2020 through 2050 is adjusted to reflect a linear annual increase, reaching the maximum use of 25,000 acre-feet per year in 2050.

Figure 1 presents a graphical representation of the water demand projections from 2005 through 2050. Following the figure, Table 1 presents the water demand projections for every fifth year through 2050.

3.0 Water Costs

The costs for Williamson County to obtain water from LCRA are described in HB 1437 and the contract between LCRA and BRA. The water cost for each water replacement strategy is composed of three parts:

- The normal use cost
- The reserve water cost
- The agricultural conservation fund cost

Each of these costs is calculated on a yearly basis.

FIGURE 1
Projected Williamson County Water Demands

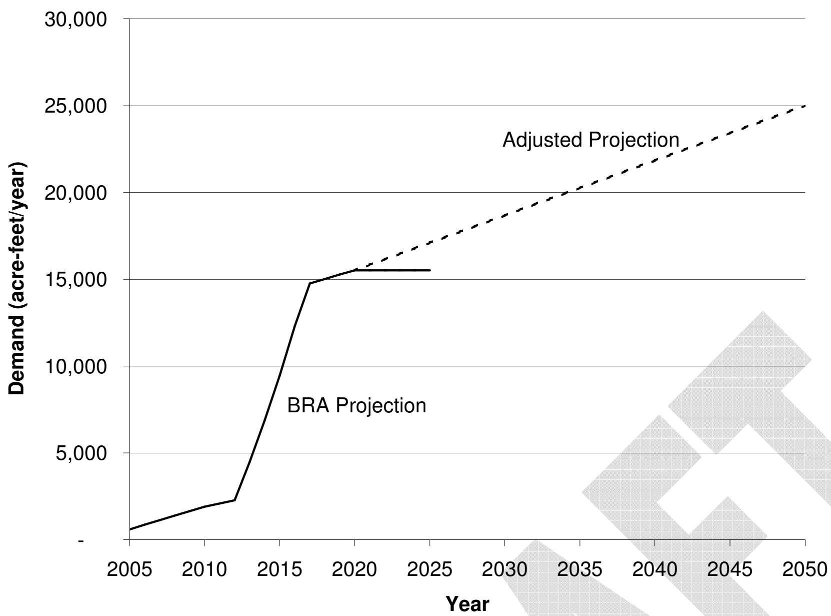

TABLE 1
Water Demands by Entity from the Year 2000 to the Year 2050
Estimates of the Conservation Charge for HB1437 Water Replacement Strategies

Year	CTSUD	Georgetown	Liberty Hill	Round Rock	Total Demand
2000	0.0	0.0	0.0	0.0	0.0
2005	600.0	0.0	0.0	0.0	600.0
2010	1,400.0	0.0	500.0	0.0	1,900.0
2015	2,200.0	0.0	600.0	6,658.0	9,458.0
2020	>3,472	>0.0	>600	>11,444.0	15,516.0
2025[1]	>3,472	>0.0	>600	>11,444.0	17,096.7
2030[1]	>3,472	>0.0	>600	>11,444.0	18,677.3
2035[1]	>3,472	>0.0	>600	>11,444.0	20,258.0
2040[1]	>3,472	>0.0	>600	>11,444.0	21,838.7
2045[1]	>3,472	>0.0	>600	>11,444.0	23,419.3
2050	>3,472	>0.0	>600	>11,444.0	25,000.0

1. The demand projections given by BRA are only projected on a yearly basis through 2025. Therefore, the project team assumed a linear projection between the 2020 projection and the ultimate water demand of 25,000 acre-feet in 2050, which results in the total demands shown between 2021 and 2049. It is assumed that one or more of the Williamson County water users will continue to increase their demands above the level shown for 2020. This is reflected in the shaded portion of the table by the demands shown with a 'greater than' (>) symbol.

3.1 Normal Water Cost

The normal water cost is a flat rate per acre-foot of water used. It was recently increased by the LCRA Board of Directors to $115 per acre-foot from $105 per acre-foot. This is the same rate charged to all LCRA customers for firm water from the Highland Lakes, and is subject to periodic adjustment by the LCRA Board. This rate is common to all water replacement strategies and is calculated by multiplying the rate by the projected demand for a given year.

3.2 Reserve Water Cost

The reserve water cost is also a flat rate, but is based on the total volume committed to a water customer or held in reserve for that customer minus the amount used. The reserve water cost is 50 percent of the normal water cost or $57.50 per acre-foot. This rate is also common to all water replacement strategies and is calculated by multiplying the rate by the unused demand (25,000–projected demand) for a given year.

3.3 Agricultural Water Conservation Fund Cost

The third component of the water costs to be paid by BRA and its customers is the Agricultural Water Conservation Fund Cost (AWCFC). The AWCF, as established by the legislature in HB 1437, is to be used to pay all costs (planning, design, construction, operation, maintenance, monitoring, reporting, and administration) for the methods or approaches required to achieve no net loss of water from the lower Colorado River basin. In other words, this is the amount of money available to fund the chosen water replacement strategy. This cost is based on a percentage or surcharge rate multiplied by the sum of the normal and reserve water costs. This percentage is called the conservation charge. The following equation is used to calculate the conservation charge from AWCFC:

AWCFC = Conservation Charge * (Normal Water Cost + Reserve Water Cost)

where, AWCFC = the total cost of a selected water replacement strategy

The LCRA Board sets the Conservation Charge (percentage rate). HB 1437 established the minimum conservation charge at 10 percent. The current conservation charge is set at 25 percent, and has been paid to AWCF since 2001.

Cost estimates for implementing each potential water replacement strategy were developed to calculate the necessary conservation charges. Based on the cost estimate for each water replacement strategy, a conservation charge was determined that will result in maintaining a positive balance in AWCF for the study period while minimizing the final balance.

3.4 Example Water Cost Calculation

To calculate the cost of the water for a given year, the three components described above must be calculated. For a specific year, the components are the following:

Normal Water Cost =Normal Rate * Projected Demand

Reserve Water Cost = Reserve Rate * (25,000 – Projected Demand), or
Reserve Water Cost = 0.5 * Normal Rate * (25,000 – Projected Demand)

AWCFC = Conservation Charge * (Normal Water Cost + Reserve Water Cost)

The total water cost is the sum of these three components.

Total Water Cost = Normal Water Cost + Reserve Water Costs + AWCFC

An example for water cost calculation for the year 2005 is given below.

Parameters
Year: 2005
Estimated Williamson County Demand: 600 acre-feet
Maximum Annual Commitment to Williamson County: 25,000 acre-feet
Current Normal Rate is $115 per acre-foot
Current Conservation Charge is 25%

Calculations
Normal Rate: $115 per acre-foot
Normal Water Cost: 600 * $115 = $69,000

Reserve Charge Rate: $115 * 50% = $57.50 per acre-foot
Reserved Water Volume: 25,000 - 600 = 24,400 acre-feet
Reserved Water Cost: 24,400 * $57.50 = $1,403,000

Current Conservation Charge: 25%
Total Normal plus Reserve Water Cost: $69,000 + $1,403,000 = $1,472,000
Agricultural Water Conservation Fund Cost: 25% * $1,472,000 = $368,000

Total to be Paid to LCRA for the Water: $1,472,000 + $368,000 = $1,840,000

Therefore, the total water cost for the year 2005 is $1,840,000 with $368,000 going to AWCF to fund a water replacement strategy.

4.0 General Cost Assumptions

Numerous cost estimation parameters and assumptions were applied in estimating the implementation costs of each of the water replacement strategies. These parameters and assumptions included the following:

- The amortization period or term of the loan necessary to fund capital cost components was set at 30 years.
- The interest rate for the amortization or loan period for the capital cost components was set at 6 percent.
- The cost for management and monitoring (M&M) is equivalent to one full-time employee at $50,000 per year, and each strategy will require this level of management and monitoring. The one exception to this cost is within the Reduced Irrigation for a Second Crop strategy. A 10 percent administration fee was included in the water cost estimate for this strategy (LCRWPG TM), and, therefore, adding $50,000 per year would have been redundant.
- The interest accrued on the balance of AWCF was 4 percent annually.

- The percentage rate used to determine the net present value of the costs of implementing the strategies was 6 percent.
- Where appropriate, Regional Planning guidance from TWDB was employed. For example:
  - Contractor mobilization, demobilization, bonding, and insurance were lumped together and estimated at 5 percent of the capital cost.
  - Contractor overhead and profit were estimated at 15 percent of the capital cost.
  - Engineering, Administration, Legal, Financing, Bond Counsel, and Contingencies (E, A, L, F, B, C) were lumped together and estimated at 30 percent of total construction costs for pipeline projects and 35 percent for all other capital facilities.
  - Annual operations and maintenance (O&M) costs were calculated as 1.0 percent of the total estimated construction cost for pipelines and as 2.5 percent of total estimated construction costs for pump stations.
  - Power costs are calculated on an annual basis using horsepower input and a power purchase cost of $0.06 per kWh.

5.0 Water Replacement Strategy-Specific Costs

Cost information for the various water replacement strategies was obtained from existing sources or developed from recent experience with similar projects. This information was also cross-checked and validated with the Regional Planning Documents (HDR, 2001a and TC&B, 2000), updated information from the LCRA-SAWS Water Project, interviews with project stakeholders, and other sources.

Factors incorporated in this evaluation include the following:

- Capital Costs
- Management Costs
- Annual O&M Costs
- Power Costs
- Costs Associated with Monitoring and Reporting the Amount of Water Saved or Replaced by the Strategy
- Subsidies that may be Available
- Other Potential Implementation Expenditures, Including Debt Service

It should be noted that a detailed engineering analysis of each of these strategies is outside the scope of this project, so all costs provided are based on preliminary analyses. Therefore, these cost estimates are conceptual “order of magnitude” estimates as defined by the American Association of Cost Engineers (AACE) and should be viewed as having an accuracy of plus 50 percent to minus 30 percent.

5.1 Balancing Reservoirs in an LCRA Irrigation District

For the balancing reservoir water replacement strategy, three reservoirs will be constructed based on increasing demand. Using estimates developed in the Region K Plan (TC&B, 2000), which were re-evaluated for this study, each reservoir is estimated to produce about 4,000 acre-feet per year of savings. Each reservoir will be needed by the time the Williamson County demand exceeds the amount of water saved. Ideally, the first reservoir will be constructed prior to the first water transfer to Williamson County, beginning in 2005. The demand projection indicates that the two additional reservoirs will be needed by 2013 and 2015, respectively, in order to meet the eventual 25,000 acre-feet per year demand.

Based on cost estimates that were developed in the LCRA-SAWS Water Project, each balancing reservoir will cost approximately $2.67 million. This includes contractor mobilization, demobilization, bonding, and insurance; contractor overhead and profit; and engineering, administrative, legal, financing, bond counsel, and contingency costs. These specific allocations are in accordance with Exhibit B of the TWDB *Guidelines for Regional Water Plan Development* (TWDB, 2002). When this cost is amortized over 30 years, the resulting annual cost is $194,200 per year. The associated annual O&M costs per reservoir are estimated at $90,000, and the associated annual management and monitoring throughout the project, regardless of the number of reservoirs, is $50,000 (one full-time employee).

Therefore, the net present value (NPV) of the cost to implement this strategy is approximately $9.6 million. The estimated cost per acre-foot was calculated by dividing $9.6 million by the total volume (acre-feet) of water replaced over the lifetime of the proposed project, or 452,675 acre-feet. The resulting NPV per acre-foot delivered is $21, which equates to a recommended conservation charge of 34 percent.

5.2 Automated Check Structures and Control Systems in the Garwood Irrigation District

Development of this water replacement strategy was based on using the existing check structures in the Garwood Irrigation District facilities and then adding facilities to enhance their use in water management, reducing the management losses of water from the system. The Garwood District currently has 34 check structures in operation. Of these, three have motorized operators already installed. All other structures have screw-type gates installed on the downstream face of a bridge or culvert that functions as the check structure.

The project will be implemented in three phases, with the timing of these phases based on the estimated Williamson County demand. The first implementation package will be built prior to the first transfer of water to Williamson County, beginning in 2005. Following the current demand curve, the other packages will be implemented in 2015 and 2016.

The capital costs for the improvements were derived from estimates developed for the LCRA-SAWS Water Project. The total capital cost estimate for saving 12,000 acre-feet per year with this strategy is $7.07 million. This includes contractor mobilization, demobilization, bonding, and insurance; contractor overhead and profit; and engineering, administrative, legal, financing, bond counsel, and contingency costs. These allocations comply with Exhibit B of the TWDB *Guidelines for Regional Water Plan Development* (TWDB, 2002).

When the project is implemented in three phases, the first phase capital cost is $1.84 million, while the second and third packages will cost $2.6 million each. Each of these costs is amortized over 30 years, with annual costs of $133,532 and $190,201, respectively. The associated annual O&M costs per implementation phase are estimated at approximately $59,000, and the associated annual management and monitoring throughout the project, regardless of the number of reservoirs, is $50,000 (one full time employee).

Therefore, the NPV of the cost to implement this strategy is approximately $7.7 million, with an estimated NPV per acre-foot of total delivered water of $17. This equates to a recommended conservation charge of 27 percent.

5.3 Laser Land Leveling to Conserve Water in LCRA Irrigation Districts

The initial cost to laser level one acre of land is approximately $306, according to stakeholders familiar with implementing this practice in the irrigation districts of interest. Once the land is leveled, maintenance must occur every nine years, and the cost of this is approximately $100 per acre. Additionally, $50,000 per year is needed for management and monitoring.

This strategy will generally be applied to rice farms, so this calculation must also consider the way that rice farmers typically manage their land. Specifically, the acres farmed for rice in a given year are on a three-year rotation, and it is assumed that approximately 0.75 acre-foot per year of water is saved by leveling one acre of land. In other words, if 25,000 acre-feet of water are needed, 25,000 acre-feet of water divided by 0.75 acre-foot of water saved per acre leveled results in 33,333 acres of land requiring leveling. However, because of the three-year rotation, the actual number of acres that must be leveled is three times 33,333 acres, or 100,000 acres.

To estimate a cost for this strategy, the number of acres leveled is matched to the Williamson County demand as closely as possible through 2050, based on the estimate of 0.75 acre-foot of water saved per acre of land leveled. It is anticipated that the cost for implementing this practice will continue to be supported by the federal government through the Environmental Quality Incentives Program (EQIP). They have paid 50 percent of the land leveling cost through this program over the last several years. This funding is assumed available to cover 50 percent of the cost of the initial land leveling. Therefore, the base cost strategy includes an assumption that the farmer will pay 20 percent of the initial cost of laser land leveling, and that AWCF will fund the remaining 30 percent of the initial cost plus 100 percent of the maintenance, management, and monitoring costs. The NPV of the cost to AWCF is approximately $8.8 million, which results in an NPV per acre-foot delivered of $12. The conservation charge required to cover these costs while maintaining a positive balance in AWCF is 29 percent.

5.4 Groundwater Strategies

Four water replacement strategies incorporate groundwater production as the means of reducing the use of water from Highland Lakes. There are several similar components for each of these strategies. They include development of wells distributed throughout each of the districts, depending on the specific strategy considered. The wells will discharge to the existing irrigation canal system to supplement the flow in the canals.

5.4.1 General Cost Issues

Capital and O&M

The capital costs include the cost of drilling the wells; installing the pumping equipment, piping, controls; and other facilities needed to discharge water to the canal system. A mitigation capital cost for improvements to wells that may be impacted by the increased groundwater demand is also included. The total capital costs were then amortized over 30 years.

The O&M costs include the power cost, maintenance of the wells and related systems, monitoring, and management. An operational mitigation cost is also included to cover the increased power cost that existing groundwater users may incur because of depressed water levels.

Mitigation Costs

Many stakeholders expressed significant concern over the development of groundwater and the effect it may have on existing groundwater users. The study team evaluated existing groundwater models to develop an understanding of the potential impacts new wells or well fields may have on existing wells. By evaluating the recently completed groundwater availability models (GAMs) for the Gulf Coast Aquifer, it was determined that the area under consideration is included in both the Central and Northern GAMs, but as a result of lying so close to the boundary of both GAMs, the groundwater response is not adequately described by either model. Previous modeling performed using a model developed by Alan Dutton of the University of Texas, Bureau of Economic Geology, and applied by CH2M HILL for the Lower Colorado Regional Water Plan (TC&B, 2000) was also considered. It was determined that this model, while it also has some deficiencies, had been applied to groundwater conditions reasonably close to those anticipated for the proposed well fields.

The groundwater model results were evaluated to determine the total area impacted by approximately 20 feet or more of additional drawdown, assuming full development of the supplemental groundwater demand. This area was then compared with the TWDB database to identify the total number of wells within this area that could be impacted. An effort was not made to determine whether the database was complete, or whether the wells included in the database are still used.

A total capital mitigation cost was estimated based on the following assumption: half of the wells within the potential area of impact, over the life of the project, will require major modification or improvement (well workover, deepening, and/or pump replacement). This modification or improvement has an average, estimated cost of approximately $160,000 per well. The total capital mitigation cost was then estimated uniquely for each groundwater option, based on groundwater impact area and the existing well database.

The mitigation costs were allocated proportional to the installation of new wells. A schedule was developed unique to each irrigation district's installation of the new wells in pairs, based on increasing demand for groundwater to offset the increasing Williamson County demand. The total capital cost for mitigation was then divided by the number of pairs of wells to be installed in a district to and sequenced with the new well installation.

An increased O&M cost to cover the increased power cost that results from pumping from deeper wells was also included. This cost was estimated based on the idea that half of the impacted wells will experience an average additional pumping lift of 40 feet. These additional power costs were added to the anticipated annual cost of the associated groundwater strategy.

A more detailed model of the groundwater responses in this area will be developed as part of the LCRA-SAWS Water Project. This new model, when available, should be used in future analysis of groundwater mitigation. In addition, local groundwater districts and the LCRA-SAWS Water Project are developing information for existing wells that is more complete. This information will provide a resource for future mitigation analyses.

Uncapitalized Residual

Each groundwater strategy has a number of wells that will be scheduled for installation late in the 45-year planning period, or at least before the 30-year amortization period can be completed. The portion of the amortized costs for capital items that occurs after the end of the planning period results in uncapitalized residual. The project team assumed that all AWCF payments will be discontinued in 2050 and that the ownership of the well(s) will revert to LCRA rather than AWCF. In other words, following 2050, it is assumed that all payments associated with the wells, including capital costs, will be paid by LCRA rather than the Agricultural Water Conservation Fund. The uncapitalized residual is noted but not used to adjust the analysis of an alternative.

5.4.2 Groundwater Development in the Garwood Irrigation District

This water replacement strategy will employ developing groundwater in the Gulf Coast Aquifer in the Garwood Irrigation District. Wells will be drilled, two at a time, into the Gulf Coast Aquifer as needed, based on the Williamson County demand as well as the irrigation needs. The calculation of the number of wells needed was based on an assumed production of 2,700 gallons per minute (gpm) per well, an assumed number of acres required for first-crop rice in this particular irrigation district (peak demand period), and an assumption that the peak flow rate for irrigation water needed to irrigate a rice farm is 10 gpm per acre. It is assumed that zero net water loss occurs as the recovered water travels through the lakes, river, and canals. Based on these calculations, two new wells will have to be in production in each of the following years: 2005, 2012, 2013, 2014, 2015, 2016, 2020, 2028, 2036, and 2045. This will provide enough water to meet the 25,000 acre-feet per year demand in 2050.

Based on previous Regional Planning documents (HDR, 2001), one well plus the associated site piping, site work, pump, design, and permitting, will have a total cost of $371,000. This cost was then amortized over 30 years at 6 percent interest. Power and O&M estimates were also based on the Regional Planning work and the necessary pumping for each individual year. Additionally, as with all other strategies, management and monitoring costs of $50,000 per year are included in the annual expenditures necessary for each project.

The last component of cost calculations associated with this strategy is the cost of mitigation. Since prior groundwater modeling for the Garwood area was not available, the number of wells impacted was proportionally estimated from the size of the Garwood District relative to the Lakeside District and the average well density found in the Lakeside District. From this, the project team estimated the mitigation cost for each pair of new wells at $1.92 million. This was based on the following assumption: half of the 240 wells impacted over the life of the project will require major modification or improvement, costing about $160,000 per well.

The annual costs for this strategy vary by year, based on the number of wells and needed volume of water. The NPV for this strategy is $21.0 million, which results in an NPV per acre-foot delivered of $29, and the recommended conservation charge is 71%. The present worth of the uncapitalized residual is approximately $390,000, or just slightly more than the cost of one well.

5.4.3 Conjunctive Use of Groundwater in the Garwood Irrigation District

The calculations for developing the cost of this strategy employ exactly the same techniques and numbers as the above strategy. However, all costs except the management and monitoring costs are proportionally reduced. Conjunctive use is only anticipated to provide 11,400 acre-feet per year, so all costs were reduced to 45.6 percent (11,400/25,000) of the full development option.

As the number of wells and needed volume of water for this strategy vary by year, so do annual costs. The NPV of the sum of the annual costs for this strategy is $14.1 million, which results in an NPV per acre-foot delivered of $32 and a recommended conservation charge of 50 percent. The present worth of the uncapitalized residual was estimated as approximately $178,000.

5.4.4 Groundwater Development in the Lakeside Irrigation District

Cost calculations for this strategy also followed the same method as the Groundwater Development in the Garwood Irrigation District strategy, but this strategy employs existing wells in addition to newly constructed wells. Capital costs for each new well were assumed the same as for the Garwood groundwater alternative, and O&M and power costs were included for all wells, both existing and new. The key differences between the two strategies are the number of new and total wells needed in the Lakeside area and the cost of mitigation. The number of total required wells is different because the number of first-crop acres and water use for first-crop rice differs slightly between the two irrigation districts. The number of new wells needed is different because there are five existing production wells in the Lakeside Irrigation District, and these five wells have a total, combined flow rate of approximately 12,685 gpm (10,200 acre-feet/year), which is about equal to five of the base capacity wells assumed for all the groundwater strategies. The mitigation cost differs because the number of wells potentially impacted by the new wells is 160 compared to 240 for the Garwood district.

A total of 22 wells at a flow rate of 2,700 gpm are needed to supply 2,178 acre-feet per year, with AWCF funding construction of only 17. The cost of mitigation, power, and O&M, though, will be based on all 22 equivalent wells. The cost of mitigation for every two operational wells was estimated at $1.75 million. The existing wells are sufficient to replace the Williamson County demand through 2012, but mitigation costs will accumulate during these years. Two new wells will be added in 2013, 2014, 2015, 2016, 2020, 2027, 2035, 2042, and one well in 2049. It was assumed that monitoring and management of the program will cost $50,000 (i.e., one FTE) per year.

The annual costs for this strategy vary by year, because the number of wells required and the demand will vary by year. The total NPV of this strategy is $14.8 million, which results in an NPV per acre-foot delivered of $21, and the resulting conservation charge is 50 percent. The present worth of the uncapitalized residual was estimated to be approximately $328,613.

5.4.5 Groundwater Development in the Gulf Coast Irrigation District

Cost calculations for this strategy also followed the same method as the Groundwater Development in the Garwood Irrigation District strategy. Costs for each well were assumed the same as for the Garwood groundwater alternative, including O&M, and power costs. The key difference between the two is the number of wells needed in the Gulf Coast Aquifer, and the cost of mitigation. The number of wells differs because the number of first-crop acres and first-crop rice water use differs between the two irrigation districts. The cost of mitigation differs, because although the number of potentially impacted wells is similar (240), the rate of impact based on the proportion of new wells installed differs. The total number of wells needed in the Gulf Coast Irrigation District is 16, and the cost of mitigation when two new wells are installed was estimated at $2.4 million. Two new wells will need to be added to the system in 2005, 2012, 2014, 2015, 2016, 2027, 2038, and 2049 in order to meet the demand as it grows to 25,000 acre-feet per year in the year 2050. It was assumed that monitoring and management of the program will cost $50,000 (i.e., one FTE) per year.

The annual costs for this strategy vary by year, because the number of wells and needed volume of water vary by year. The total NPV of this strategy is $18.7 million, which results in an NPV per acre-foot delivered of $26, and the recommended conservation charge is 63 percent. The present worth of the uncapitalized residual was estimated to be approximately $477,500.

5.5 Groundwater from Alcoa

For water to be transported from Alcoa to the irrigation districts, costs will include the new wells, associated piping and pump stations, and fees to Alcoa. All of these costs were included in this analysis. It was assumed that up to 21,523 acre-feet per year of water could be recovered until 2040, when previous commitments for this water will reduce the amount available to 19,000 acre-feet per year. This water will be conveyed via both a pipeline and bed-and-banks transfer.

The pipeline, which will be approximately 36 miles long, is estimated to cost approximately $55 million (based on $7/diameter-inch per linear foot), with an annual O&M cost of approximately $551,200. The discharge structure was estimated at $200,000. Both of these costs were amortized over 30 years.

The groundwater development costs were based on the previous estimates for the Groundwater Development in the Garwood Irrigation District strategy, including power, O&M, and management and monitoring. The estimated flow per well and the timing of well installation were based on data provided by LCRA. In addition, a unit charge of $30 per acre-foot was added to account for the expected fees due to Alcoa. Mitigation costs have not been included in this alternative, but may need further consideration if this strategy becomes one of the strategies satisfying the primary screening criteria (TM 2).

The annual costs for this strategy vary by year as the number of wells and volume of water vary by year. The NPV of this strategy is $72.9 million, which results in an NPV per acre-foot delivered of $110. The present worth of the uncapitalized residual was estimated to be approximately $33,000. The necessary conservation charge will exceed 100 percent in order to cover all of the included costs, without consideration of mitigation.

5.6 Brushy Creek Return Flow

The Brushy Creek Return Flow alternative could generate up to 15,000 acre-feet per year of recovered water due to previous commitments for return flows from the plant. This option requires a 6.5 mile pipeline, pump station, and outlet. Therefore, this option is also fairly capital intensive. The pump station is estimated to be $4.5 million based on recently bid construction projects in Texas. The pipeline is estimated at $7.2 million based on $7/diameter-inch per linear foot, and the outlet is anticipated to be $200,000, similar to the discharge cost for the Alcoa alternative. All of these costs were amortized over 30 years. O&M, power, and management and monitoring were added to the annual expenditures.

The annual costs for this strategy vary by year as the power costs vary by the amount of water transported, up to 15,000 acre-feet. The NPV of the sum of the annual costs for this strategy is $16.7 million, which results in an NPV per acre-foot delivered of $33 and a recommended conservation charge of 71 percent.

5.7 San Bernard Reservoir

The cost of building a reservoir was taken from previous Regional Planning work (TC&B, 2000). The projected capital cost of the reservoir, updated to current construction costs, is $90 million. The safe annual yield for this alternative is greater than the 25,000 acre-feet needed. Transportation of the water was estimated at $72 per acre-foot, based on estimates developed for the Regional Plan. Considering O&M at 6.1 percent of the initial capital cost, and management and monitoring costs at $50,000 per year, the annual cost for the first 30 years (i.e., while debt service is being paid) will be $8.8 million. Once the capital cost has been paid, the annual cost reduces to $450,000 per year.

The NPV of this strategy is $121.7 million, which results in an NPV per acre-foot delivered of $170. The recommended conservation charge is over 100 percent.

5.8 Allen's Creek Reservoir

This option consists of purchasing an unused portion of the water supply in Allen's Creek reservoir, if available, until the City of Houston requires this water to meet their municipal demand. While the cost of the reservoir itself (e.g., permitting, mitigation), will be shared, this source of water will not be permanent and may require a new distribution system and infrastructure. Currently, there is not enough information on this option to develop a cost estimate reflective of the declining water availability to satisfy the increasing demand.

5.9 Urban Irrigation Control System

According to an estimate made by a commercial irrigation services company that specializes in remote control of landscape irrigation systems, the capital expenditure needed to install a new landscape irrigation system sufficient to produce 10,000 acre-feet per year of conservation will be about $10 million. The system is estimated to require replacement every 10 years based on sales of individual properties where the new owners may discontinue the service. Annual O&M is estimated at $500,000, or five percent of the capital cost. Annual management and monitoring is estimated at $50,000 per year as with other strategies. Assuming the system is replaced every 10 years, the annual cost for this option will be $1.9 million.

The NPV of the sum of the annual costs for this strategy is $29.6 million, which results in an NPV per acre-foot delivered of $41; the recommended conservation charge exceeds 100 percent.

5.10 Adjoining Basin Irrigation Water Rights

To develop a cost estimate for the purchase of adjoining basin irrigation water rights, the project team investigated water costs around the state. Term water rights can cost as much as $1,400 per acre foot. Additionally, transportation costs must be incorporated to move this water from an adjoining basin to an irrigation district or the Colorado River. Transportation costs were estimated at $4 million. O&M of the pipelines was estimated as one percent of the transportation costs. Management and monitoring of the water project was estimated at $50,000, as in other alternatives.

It is assumed that this solution could generate up to 25,000 acre-feet of water per year. The NPV of the annual costs for this strategy is $21.0 million, which results in an NPV per acre-foot delivered of $29. The recommended conservation charge is over 100 percent.

Note that, alternatively, the water rights could be leased on an annual basis. The cost of the water rights purchased for annual use must be less than $162 per acre-foot to cost less than the one-time purchase described above.

5.11 Purchase Colorado River Irrigation Water Rights

To develop a cost estimate for the purchase of Colorado River Basin water rights, the same costs for water rights employed in the adjoining basin irrigation water rights strategy were used. No transportation cost was included, although some minor transport may need to occur to move the water within the basin. Management and monitoring was again estimated at $50,000 per year.

It is assumed that this solution could generate up to 25,000 acre-ft of water per year. The NPV of the sum of the annual costs for this strategy is $16.4 million, which results in an NPV per acre-foot delivered of $23. The resulting recommended conservation charge is 85 percent.

Note that, alternatively, the water rights could be leased on an annual basis. The cost of the water rights purchased for annual use must be less than $150 per acre-foot to cost less than the one-time purchase described above.

5.12 Reduced Irrigation for Second Crop

Based on work done in the regional planning study (an LCRWPG TM written by Resource Economics and included in the Regional Plan: TC&B, 2000), the estimated amount of money needed for farmers to take payment rather than farming a second crop of rice is $38 per acre-foot of water per year. Additionally, there is a 10 percent administrative fee per acre-foot assumed per year, which includes the management and monitoring cost.

Based on the Williamson County demand, the NPV of the sum of the annual costs for this strategy is $6.5 million, which results in an NPV per acre-foot delivered of $9, and a recommended conservation charge of 23 percent.

5.13 Capture of Municipal Stormwater

The project team did not develop cost information for the alternative entitled "Capture of Municipal Stormwater." To be able to impound this water, water rights would have to be obtained. These water rights will not be granted, since they would impact previously adjudicated water rights of senior water rights holders. The water available under this scenario is zero.

5.14 Desalination

Two sources were employed in determining the potential cost for a Gulf of Mexico desalination plant and related systems. The first is entitled, "Large-Scale Demonstration: Seawater Desalination in Texas". This report was prepared by TWDB and was presented to the Office of the Governor in December of 2002. In it, the estimated costs of the top three proposals submitted to TWDB for the Desalination Initiative are presented. These estimates, which included direct construction costs, indirect development costs, debt service, power costs, annual operating and maintenance costs, were identified as $1,011 and $1,219 per acre-foot. Note that these costs are for treatment only and do not include the required conveyance costs that must be considered when using desalination water for the irrigation districts of interest.

A more recent water treatment plant constructed in Tampa, Florida, also provided data for estimating the cost of desalination options. The water treatment plant in Tampa was designed to produce 25 million gallons per day of water desalinated from the Gulf of Mexico. This treatment plant is said to be one of the least expensive desalination plants in the world, and will produce water at a cost of $857 per acre-foot. Again, this is treatment only and does not include what will be substantial water transportation costs.

Therefore, due to the high cost per acre-foot for the water that will result from adding considerable pipeline and pump station costs to an already high treatment cost, this water replacement strategy was not investigated further.

5.15 Canal Lining

The project team did not develop a detailed cost scenario for this strategy. Existing information obtained from District operators suggests that if every canal in all four relevant irrigation districts were lined, the resulting water savings will be a total of approximately 4,000 acre-feet per year. The material for installing a membrane type of liner to line all 1,100 miles of the LCRA-owned canals will cost about $230 million. The amortized cost of the liner will be about $4,000 per acre-foot. This cost will make the required conservation charge far in excess of 100 percent. If all this water savings could be attributed to a project that will line 10 percent of all canals, the cost will be reduced to $400 per acre-foot, which also results in a conservation charge greater than 100 percent. Detailed studies will need to be performed to identify the best canal segments to line. Some assessment work will be performed as part of the LCRA-SAWS Water Project and it is recommended that this strategy be revisited, as more information becomes available.

6.0 Water Replacement Strategy Cost Summary

Table 2 summarizes the costs of each alternative for comparative purposes. Table 2 identifies each strategy, as well as the associated NPV, total cost per acre-foot of water generated, annual cost per acre-foot of water generated, and the conservation charge that will be necessary to fund the approach.

TABLE 2
Water Replacement Strategy Cost Summary
Conservation Charge and Cost Estimates of Water Replacement Strategies

ID	Water Replacement Strategy	Net Present Value (millions)	NPV per Acre-Foot Delivered[1]	Recommended Conservation Charge
1	Balancing Reservoirs in an LCRA Irrigation District	$9.6	$21	34%
2	Automated Check Structures and Control Systems in the Garwood Irrigation District	$7.7	$17	27%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts[2]	$8.8	$12	29%
4	Groundwater Development in the Garwood Irrigation District	$21.0	$29	71%[3]
5	Conjunctive Use of Groundwater in the Garwood Irrigation District	$14.1	$32	50%[3]
6	Groundwater Development in the Lakeside Irrigation District	$14.8	$21	50%[3]
7	Groundwater Development in the Gulf Coast Irrigation District	$18.7	$26	63%[3]
8	Groundwater from Alcoa	$72.9	$110	Over 100%
9	Brushy Creek Return Flow	$16.7	$33	71%
10	San Bernard Reservoir	$121.7	$170	Over 100%
11	Allen's Creek Reservoir	Insufficient information available.		
12	Urban Irrigation Control System	$29.6	$41	Over 100%
13	Adjoining Basin Irrigation Water Rights	$21.0	$29	Over 100%
14	Purchase Colorado River Irrigation Water Rights	$16.4	$23	85%
15	Reduced Irrigation for Second Crop	$6.5	$9	23%

TABLE 2
Water Replacement Strategy Cost Summary
Conservation Charge and Cost Estimates of Water Replacement Strategies

ID	Water Replacement Strategy	Net Present Value (millions)	NPV per Acre-Foot Delivered[1]	Recommended Conservation Charge
16	Capture of Municipal Stormwater	The yield from this strategy will be zero as this water is already adjudicated to other water right holders.		
17	Desalination	Costs for this strategy are known to be about $1,000 per acre-foot for the most cost efficient projects in the US, without including additional costs for conveyance. The recommended conservation charge will be far in excess of 100%.		
18	Canal Lining	Lining 10% of canals will cost $23 million for material alone and savings are estimated at 4,000 acre-feet per year. The amortized cost will exceed $400 per acre-foot, making the recommended conservation charge exceed 100%.		

1. This is the total NPV of the cost of the water replacement strategy divided by total water replaced over the lifetime of the project.
2. The "base case" analyzed in relation to Laser Land Leveling to Conserve Water in LCRA Irrigation Districts included the assumption that the cost for implementation will be divided as follows: 50% funded by the Environmental Quality Incentives Program (EQIP), 20% funded by farmers, and 30% funded by AWCF.
3. Note that mitigation costs are included in the calculation of the conservation charge. Refer to Section 5.4 for a description of the mitigation cost components.

7.0 Implementation Alternatives for Selected Strategies

As was described in TM2, alternatives to the implementation scenarios described above (in other words, the "base cases"), were also investigated by the project team. These implementation alternatives can be divided into two categories: long-term and short-term. The following section describes the cost implications of some alternative implementation options.

7.1 Long-Term Implementation Alternatives

If BRA chooses to expedite projects to implement the full 25,000 acre-feet of replacement water within the first five years, they will have the flexibility to use this capacity to meet either the already identified demands or other demands in Williamson County. Therefore, for water replacement strategies where implementation could be accelerated, a conservation charge for a full, expedited implementation was estimated, but the expected demand sequence was not modified. This essentially gives a "worst case" scenario in which the water demand does not accelerate as rapidly as the replacement water is developed.

7.1.1 Expedited Implementation

Balancing Reservoirs in an LCRA Irrigation District

This scenario assumes that all balancing reservoir infrastructure required for the entire 12,000 acre-feet of water savings will be built by 2005. The capital cost to install three reservoirs is estimated at just over $8 million, and the associated O&M costs are $270,000 per year. The annual management and monitoring costs remain at $50,000. The resulting total annual cost for the first 30 years, in which the debt service is being paid, is $902,572. Following the first 30 years, the annual cost is $320,000. This results in a NPV of $13 million, and an NPV per acre-foot of water replaced of $29. This equates to a recommended conservation charge of 55 percent.

Automated Check Structures and Control Systems in the Garwood Irrigation District

This scenario assumes that all infrastructure associated with an automated system and required for the entire 12,000 acre-feet of water savings will be built by 2005. The capital cost to install the structural improvements in the Garwood Irrigation District is estimated at $7.07 million, and the associated O&M costs are $176,855 per year. The annual management and monitoring costs remain at $50,000. The resulting total annual cost for the first 30 years, in which the debt service is being paid, is $513,934. Following the first 30 years, the annual cost is $226,855. This results in a NPV of $10.6 million, an estimated NPV per acre-foot of total water delivered $23, and a recommended conservation charge of 44 percent.

Laser Leveling to Conserve Water in LCRA Irrigation Districts

For this cost scenario, the project team assumed an expedited implementation, one in which all acres requiring leveling to match the ultimate goal of 25,000 acre-feet of water saved are leveled within the first three years of implementation. Following those first three years, only maintenance, management, and monitoring costs are incurred. Again, this scenario assumes EQIP funding available for 50 percent of the initial cost of leveling, with the farmer paying 20 percent, thus leaving AWCF to pay for 30 percent of the initial leveling and 100 percent of the maintenance, management, and monitoring costs. The NPV of this option is $20.5 million, which results in an NPV per acre-foot delivered of $29. The resulting conservation charge will exceed 100 percent.

7.1.2 Alternative Funding Scenarios for Laser Land Leveling to Conserve Water in Irrigation Districts

EQIP funding has not been solidified for the laser land leveling strategy as of yet. Therefore, the project team performed cost calculations for potential alternative funding options for this strategy. In the first, the project team assumed a phased approach similar to that presented in Section 5.3 of this TM. In other words, this cost scenario is phased to match the Williamson County demand. However, the project team assumed no EQIP funding is available; thus, the farmer pays for 20 percent of the initial cost of laser leveling and AWCF will fund the remaining 80 percent of the initial cost plus 100 percent of the maintenance, management, and monitoring costs. The NPV of this scenario is then $14.8 million, which results in an NPV per acre-foot delivered of $21. The resulting conservation charge will be 53 percent.

Alternatively, in the next cost scenario analyzed, the project team assumed no EQIP funding is available, but the farmer pays for 50 percent of the initial cost of laser leveling similar to the current EQIP funding program without AWCF. The AWCF will fund the remaining 50 percent of the initial cost plus 100 percent of the maintenance, management, and monitoring costs. A phased approach, like that above, is still followed. The NPV of this scenario is then

$11.2 million, which results in an NPV per acre-foot delivered of $16. The resulting conservation charge will be 37 percent.

The next two cost scenarios repeat the funding alternatives just described, but also assume the expedited implementation approach, as described in Section 7.1.1. In the first of these, the project team assumed no EQIP funding is available. The farmer will fund 20 percent of the initial cost of laser leveling, and AWCF will fund the remaining 80 percent of the initial cost of laser leveling, as well as 100 percent of the maintenance, management, and monitoring costs. The NPV of this scenario is then $34.2 million, which results in an NPV per acre-foot delivered of $48. The resulting conservation charge will exceed 100 percent.

A final analysis was done, assuming expedited implementation in the first three years and no EQIP funding. The farmer will fund 50 percent of the initial cost of laser leveling, and AWCF will pay for the remaining 50 percent of the initial cost of laser leveling, as well as 100 percent of the maintenance, management, and monitoring costs. The NPV of this scenario is then $26.0 million, which results in an NPV per acre-foot delivered of $36. The resulting conservation charge will exceed 100 percent.

Table 3 presents a summary of each of the long term implementation alternatives described previously.

TABLE 3
Long Term Implementation Alternatives Cost Summary
Conservation Charge and Cost Estimates of Water Replacement Strategies

ID	Water Replacement Strategy	Phased or Expedited?	Percent Funded by EQIP	Percent Funded by the Farmer	Percent Funded by AWCF	Net Present Value (millions)	NPV per Acre-Foot Delivered*	Recommended Conservation Charge
1	Balancing Reservoirs in an LCRA Irrigation District	Expedited	N/A	N/A	N/A	$13	$29	55%
2	Automated Check Structures and Control Systems in the Garwood Irrigation District	Expedited	N/A	N/A	N/A	$10.6	$23	44%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	Expedited	50%	20%	30%	$20.5	$29	Over 100%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	Phased	0	20%	80%	$14.8	$21	53%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	Phased	0	50%	50%	$11.2	$16	37%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	Expedited	0	20%	80%	$34.2	$48	Over 100%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	Expedited	0	50%	50%	$26	$36	Over 100%

*Total NPV of option divided by total water recovered over the lifetime of the project.

7.2 Short-Term Implementation Alternatives

BRA may also choose to end the contract period with LCRA in the year 2010 and only desire the amount of water projected as the Williamson County demand in that same year, or 1,900 acre-feet per year. Therefore, for the recommended water replacement strategies in which this was possible, a conservation charge for a partial, or 5-year implementation, was estimated. Additionally, two scenarios were developed for each strategy that was previously evaluated for alternative funding approaches with short-term implementation. One scenario includes an existing, supplementary well; the other does not. In application, the actual cost of implementing one of these strategies on a short-term basis will be between these two scenarios, because the well will probably be needed but use will be limited.

The definition of "no net loss" states that the amount of water that must be developed or conserved to match the Williamson County demand for a given year must be implemented the year before that demand is realized. Therefore, at the end of every year, the amount of water conserved in the previous year will be compared to the Williamson County demand for the current year. If the Williamson County demand is greater than the water developed or conserved in the previous year, the deficit must be compensated with a supplementary source. The "best case" situation will be such that the strategy does in fact replace the amount of water intended, and the supplementary well will not be needed. The "worst case" scenario will be that the supplementary well will be used at full production. The more probable situation is somewhere in between, and the two costs have been provided as the limits of a range.

The following section describes the cost analyses associated with the short-term implementation alternatives.

7.2.1 Short-Term Implementation, to Include a Supplementary Source

Automated Check Structures and Control Systems in the Garwood Irrigation District

As a well may be needed to supplement the irrigation water in the case that the automated system does not save as much water as anticipated in a given year, the project team investigated a short-term implementation scenario that included a supplementary well in the Lakeside Irrigation District. As wells are available in this District currently, the cost of a new well is not included in this estimate. The annual mitigation cost ($40,000, discussed in more detail related to the groundwater options), and the well O&M costs, which vary depending upon the amount of water drawn from the well in a given year, have been added to the costs of adding the automated system. The NPV of this scenario is $2.83 million, which results in an NPV per acre-foot delivered of $378. The recommended conservation charge is 32 percent.

Laser Land Leveling to Conserve Water in Irrigation Districts

For the following cost scenario, the project team assumed short-term implementation and the use of an existing well in the Lakeside Irrigation District to supplement the irrigation water in the case that the laser leveling does not save as much water as anticipated in a given year. Therefore, the annual mitigation cost ($40,000, discussed in more detail related to the groundwater strategies), and the well O&M costs, which vary depending upon the amount of water drawn from the well in a given year, have been added to the costs of leveling and maintaining the rice-farmed land. Leveling is expedited in this scenario, with the leveling required being completed in the first three years (beginning in 2005) as opposed to over the entire five-year implementation. Monitoring and management costs are included but no maintenance is needed in the first five years.

The project team assumed EQIP funding was available for 50 percent of the initial cost of leveling, the farmers will fund 20 percent of the initial cost of leveling, and AWCF will fund the remaining 30 percent of the initial leveling and all of the maintenance. The NPV of this option is $1.08 million, which results in an NPV per acre-foot delivered of $144, and the recommended conservation charge is 10 percent.

7.2.2 Short-Term Implementation, Without a Supplementary Source

Automated Check Structures and Control Systems in the Garwood Irrigation District

Without a supplementary source of water to compensate for any water conservation deficit and a short-term implementation, the NPV of the implementation of the automated check structures and associated infrastructure is $2.6 million. This results in an NPV per acre-foot delivered of $349, and a recommended conservation charge of 29 percent.

Laser Land Leveling to Conserve Water in Irrigation Districts

The next cost scenario investigated follows a phased approach based on the Williamson County demand, but in this scenario, it is assumed that BRA chooses to end the contract term in 2010, based on the demand projected for that same year. If this is the case, the number of acres leveled need only be the estimated Williamson County demand in 2010 (1,900 acre-feet) divided by 0.75, or 2,533 acres. Following the previous patterns, this scenario assumes, for the initial cost of laser leveling, a 50 percent level of EQIP funding, a 20 percent level of farmer funding, leaving the remaining 30 percent of the initial cost and all of the maintenance to be funded by AWCF. The NPV of this scenario is $812,400, which results in an NPV per acre-foot delivered of $108. The recommended conservation charge is 10 percent.

7.2.3 Short-Term Implementation using Alternative Funding Sources for Laser Land Leveling to Conserve Water in Irrigation Districts

As future EQIP funding cannot be confirmed, the short-term strategies, both with and without a supplementary well, were investigated based on different funding options for the laser land leveling strategy.

First, the different funding options were applied to the short-term implementation approach that employs a supplementary well. The project team assumed no EQIP funding will be available, the farmers will fund 20 percent of the initial cost of leveling, and AWCF will fund the remaining 80 percent of the initial leveling and all of the maintenance. The NPV of this option is $2.12 million, which results in an NPV per acre-foot delivered of $282, and the recommended conservation charge is 35 percent.

Next, the project team assumed no EQIP funding will be available, the farmers will fund 50 percent of the initial cost of leveling, and AWCF will fund the remaining 50 percent of the initial leveling and all of the maintenance. The NPV of this option is $1.50 million, which results in an NPV per acre-foot delivered of $199, and the recommended conservation charge is 20 percent.

The different funding options were applied to the short-term implementation approach without a supplementary well. The project team assumed no EQIP funding will be available, the farmer will fund 20 percent of the initial cost of laser leveling, and AWCF will fund the remaining 80 percent of this initial cost plus all of the maintenance. The NPV of this scenario is $1.8 million. This results in an NPV per acre-foot delivered of $234. The resulting conservation charge will be 17 percent.

Then the project team assumed no EQIP funding will be available, the farmer will fund 50 percent of the initial cost of laser leveling, and AWCF will fund the remaining 50 percent of this initial cost plus all of the maintenance. The NPV of this scenario is $1.2 million. This results in an NPV per acre-foot delivered of $159. The resulting conservation charge will be 10 percent.

Two final short-term strategies were formulated to achieve 3,500 acre-feet per year of conservation savings. In both approaches laser leveling is used and the area to be laser-leveled to conserve water is based on the estimate that each acre laser leveled is likely to save an average of 0.75 acre feet of irrigation water per year.

- In one approach only laser land leveling will be implemented. This would require leveling 4,667 acres each year for three years, resulting in 14,000 acres leveled.
- In the alternate approach a combination of laser leveling 2,000 acres each year for three years would conserve about 1,500 acre-feet per year, and automation of check structures with control systems in the Garwood District would be implemented to conserve 2,000 acre-feet per year.

For these strategies the implementation period is also extended to 2012 and the first maintenance leveling operation for laser leveled land that will occur after three farming cycles is included in the funding to assure that the practices that are initially implemented are fully sustainable.

Table 4 presents a summary of each of the short term implementation alternatives described previously.

TABLE 4
Short Term Implementation Alternatives Cost Summary
Conservation Charge and Cost Estimates of Water Replacement Strategies

ID	Water Replacement Strategy	Supplementary Well Included?	Percent Funded by EQIP	Percent Funded by the Farmer	Percent Funded by AWCF	Net Present Value (millions)	NPV per Acre-Foot Delivered*	Recommended Conservation Charge
2	Automated Check Structures and Control Systems in the Garwood Irrigation District	Yes	N/A	N/A	N/A	$2.83	$378	32%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	Yes	50%	20%	30%	$1.08	$144	10%
2	Automated Check Structures and Control Systems in the Garwood Irrigation District	No	N/A	N/A	N/A	$2.62	$349	29%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	No	50%	20%	30%	$0.81	$108	10%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	Yes	0	20%	80%	$2.11	$282	35%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	Yes	0	50%	50%	$1.50	$199	20%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	No	0	20%	80%	$1.76	$234	17%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts	No	0	50%	50%	$1.19	$159	10%
3	Laser Land Leveling to Conserve Water in LCRA Irrigation Districts-end at 2012	Yes (600 acre-ft)	50%	20%	30%	$2.38	$100	21%
2/3	Combination of Laser Land leveling and Automated Check Structures and Control Systems	Yes (600 acre-ft)	50% (LLL)	20% (LLL)	30% (LLL)	$2.76	$125	25%

*Total NPV of option divided by total water recovered over the lifetime of the project.

8.0 References

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Attachment A
Cost Calculation Spreadsheets