Final Report

Impact Evaluation of Columbia Basin Pilot Irrigation Water Management Project

Prepared for:
Bonneville Power Administration

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Introduction

The Columbia Basin Ground Water Management Area (GWMA) was started in February 1998 by the Washington Administrative Code. It is a complex multi-partner effort to improve and protect ground water quality in the Adams, Franklin, Lincoln, and Grant counties of Washington State. GWMA promotes best management practices, which aim to reduce nitrate transport to the groundwater. GWMA endorses and adopts Scientific Irrigation Scheduling (SIS) or Irrigation Water Management (IWM) as a best management practice (BMP) to prevent or reduce leaching of nitrates through the soil profile and from reaching the groundwater. IWM also helps irrigators reduce the amount of water used in crop production and improve pumping energy use.

GWMA's stated goal for the 2005 growing season was to implement IWM on roughly 10% of total irrigated acreage in the entire four county area, or 88,774 acres. In all, 190 different growers participated in the GWMA program. To offset a portion of its costs and to better leverage implementation of IWM in the area, GWMA applied for a pilot project (project) grant from the Bonneville Power Administration (Bonneville) in early 2005. Bonneville provided $275,000 in funding to finance implementation of IWM on 48,026 acres during the 2005 growing season. The main objective in this evaluation was two-fold:

1. To provide reasonable estimates of "gross" and "net" water and electricity savings resulting from implementation of the project, and

2. To assess the viability and cost-effectiveness of scientific irrigation scheduling as a means for Bonneville to acquire cost-effective conservation savings.

Program Overview

GWMA has established a close working relationship with the six Conservation Districts (CDs) that are located within its boundaries. Each CD is tied to GWMA through "inter-local" agreements that commit them to ensuring that their assigned GWMA projects are carried out and completed. Franklin Conservation District has been designated as the lead fiscal district for bookkeeping and monetary handling of GWMA tasks for all CDs. The CDs are responsible for publicizing GWMA's IWM program and recruiting growers for participation. Once growers sign up for the program, it is the responsibility of the CD to monitor and certify compliance with IWM program standards and provide ongoing technical assistance to growers within their boundaries. The CDs maintain sign-up forms and detailed technical material for growers to help guide them and ensure compliance. They also calculate cost-share amounts and coordinate subsidy payments at the end of the growing season.

GWMA operates its IWM program in conjunction with the Natural Resource Conservation Service (NRCS) IWM EQUIP program. Participating growers are expected to meet or exceed U.S. Department of Agriculture's (USDA)-NRCS practice Code 449-Irrigation Water Management standards. Specifically, these standards mandate that all participating farmers comply with a ten-point set of comprehensive knowledge and performance requirements that include:

1. Measure and document Power Conversion Coefficient (PCC[1]) value for each irrigation system.
2. Have some type of water measurement in place for each field.
3. Use daily crop evapotranspiration (ET) data in the determination of daily water requirements.
4. Monitor soil erosion throughout the season. If appropriate, take measures to control erosion and adjust irrigation accordingly.
5. Supply proof of proper irrigation system design or results from an in-field irrigation system evaluation.
6. Document uniformity of water application by means of aerial photography or other appropriate tests.
7. Install deep soil measurement devices below the crop rooting depth and supply readings to GWMA.
8. Keep and supply records of irrigation water application throughout the season.
9. Take soil moisture readings at least once per week and supply records to GWMA.
10. Ensure that the total season measured average irrigation does not exceed the ideal crop consumptive use by more than 10%.

If the farmer meets all of the requirements, and GWMA can establish that IWM was successfully implemented, the farmer is eligible for a subsidy.

IWM requires that the farmer combine knowledge of the actual soil moisture content, weather conditions, and crop water use to determine the amount and timing of irrigation. While the latter two items are available from a variety of sources, including AgriMet, PAWS, or commercial irrigation service providers, growers are required to install soil moisture measurement devices on site. A farmer generally has two options, depending on the time interval the information is read and transmitted. The more traditional, and currently more widespread, method is referred to as the "standard-time" method. Using this method, the farmer receives weekly soil moisture measurements. Depending on whether the farmer hires a consultant or installs and operates the equipment with internal staff, the average cost per acre for a standard time system ranges from $8 to $12 per acre.

The second method, which has seen an increase in use in the Columbia Basin area over the past few years, is the "real-time" method. Using this method provides the farmer with continuous soil moisture readings data, transmitted to that farmer on a real-time basis. Typical cost for this method ranges from $14 to $20 per acre.

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[1] On a conceptual level, the PCC estimates the amount of energy (kWh) that is required to pump a given a mount of water (acre-feet). The PCC is based on farm-specific pumping data such as the total dynamic head, a function of the lift and discharge pressure, and the efficiency of the pumping system as well as an engineering constant. Specifically, the PCC is defined as: PCC (kWh/acre-ft) = 1.0227 * TDH / Pump Station Efficiency. TDH= Lift + (DP * 2.307).

Based on GWMA's historical records, and accounting for the mix in systems used throughout the Basin, average cost for IWM is estimated at roughly $12 per acre.

To offset a portion of the grower's costs related to implementing IWM, GWMA pays each qualifying farmer a per-acre subsidy of either $4 for the standard-time system or $8 for a real-time system. While GWMA has seen a trend toward using real-time systems over the past few years, GWMA estimates that the average subsidy per acre in the 2005 growing season was $5.73. The evaluation team did not, as part of the scope of this study, explore real-time systems in detail and thus cannot comment on the actual impact of these type of system on efficiency nor their cost/efficiency ratio.

2005 Program Data

As part of the project, GWMA implemented IWM on 48,026 acres during the 2005 growing season. Using self-reported data collected from growers at the end of the growing season, Quantec collected basic farm and crop statistics for approximately 43,000 acres or roughly 90% of the participants. Of the total project acreage for which data was available, the most common crop was potatoes (70%), followed by alfalfa (16%), and sweet corn (5%). This reflects the propensity of growers to implement IWM on fields with cash crops, of which potatoes are a key example. Table 1 provides a summary of the crops and acreage included in the pilot study.

Table 1. Summary of Crop Data

Crop	Total Acres	No. of Fields
Potato	15,318	145
Alfalfa	7,485	70
Sweet Corn	4,197	41
Timothy	3,718	32
Wheat	3,212	27
Corn	1,150	10
Field Corn	1,130	11
Mint	1,070	8
Peas and Sweet Corn	1,056	9
Grass Seed	1,009	9
Blue Grass	847	9
Asparagus	481	4
Beans	400	3
Winter Wheat	374	5
Corn/Wheat	183	2
Spring Wheat	182	2
Onion	155	1
Wheat and Alfalfa	154	1
Onions	136	1
Seed Peas	127	1
Peas	127	1
Timothy/Sweet Corn	127	1
Grain Corn	125	2
Corn Seed	77	1
Sweet Corn Seed	67	1
String Beans	56	1
Spring Hay	24	1
Cherry	17	1
Carrots	12	1
Seed Coral	8	1
TOTAL	**43,024**	**402**

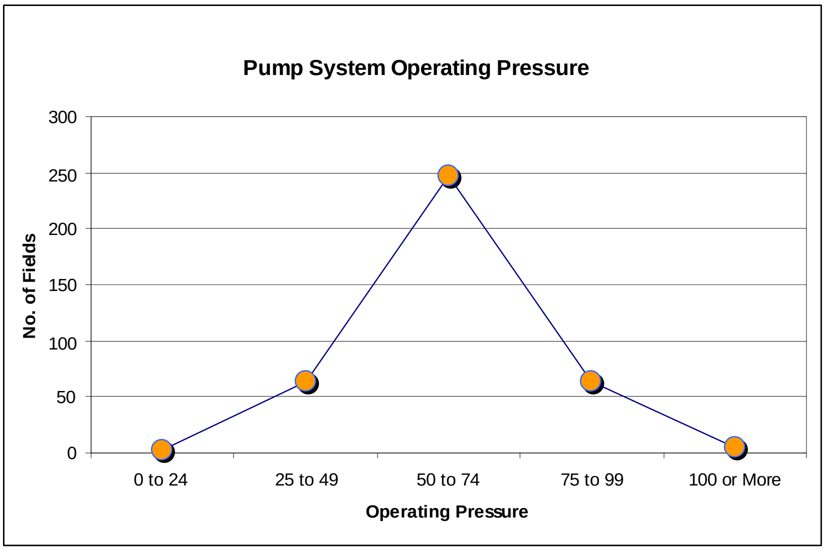
Based on grower information, a number of different pump system set ups are used, however, by far the most common are single pump-single pivot (40%) and multiple pivots-single pump systems (27%). Table 2 shows the project's pump system type breakdown.

Table 2. Pump System Type

System Type	No. of Fields
Single Pump - Single Pivot	40%
Multiple Pivots - Single Pump	27%
Swing Span	26%
Single Pivot	2%
Multiple Pumps-Single Pivots	1%
Multiple Pivots-Multiple Pump	1%
Multiple Pumps	1%
Single Pivot-Multiple Pumps	1%
Single Pump - Multiple Pivots	1%
Multiple Pumps-Multiple Pivot	0%
Total	**100%**

In addition to infomation regarding the type of pump system, the growers were asked to supply the average operating pressure of the pump system. For more than half of the fields, the average pump operating pressure was between 50 and 74 psi. The overall average for all pilot study participants was 63 psi. Figure 1 illustrates the distribution of operating pressure for the pilot study.

Figure 1. Pump System Operating Pressure



Given the purpose of approximating potential reductions in energy use by means of reducing the need to pump water, analyzing the factors most important in determining the connection between water and energy savings is important. Quantec has done this analysis as part of the Phase II report. As part of this work, Quantec conducted a sensitivity analysis to identify the key drivers of energy use associated with pumping. By far the most important driver is suction lift or head, which is the difference in elevation, in feet, from the pumping level of the water source to the pump suction. Among other things, head is primarily dependent on the water source as well as the geological characteristics of a given area (field). Based on available data, approximately 61%

of fields used surface water and 34% used well water[2]. In the case of the GWMA pilot study, average suction lift from the water source to the pivot was 63 feet, with a maximum reported lift of 785 feet. In addition, GWMA provided power conversion coefficient measurements for 82 fields, representing 23% of the project acreage (10,877 areas). These data ultimately formed the basis for developing the energy savings estimates associated with the infield water savings due to implementation of IWM.

Estimated Benefits

To determine pilot project cost effectiveness, estimated total project benefits need to be identified. The primary benefits related to IWM consist of water and electricity savings. Other benefits include increased generation potential in the Bonneville dam network along the Columbia River, reduction in fertilizer use due to less run-off, and a variety of other environmental benefits.

Water

The estimation of average, per acre, water savings is straightforward and based on the following three steps:

1. Using the Washington Irrigation Guide, we identified net water requirements per acre by crop and microclimate.
2. Applying the 10% water savings assumptions (documented in Phase II of this project) to the net water requirement per acre to estimate likely water savings per acre.
3. Dividing total water savings by total acreage of fields in the sample.

Using field information for a sample of 10,205 acres, average water savings per acre are estimated at 3.7 inches. Applying this average to the entire program acreage (48,026) results in a total estimated water savings of 179,137 acre-inch.

Electricity

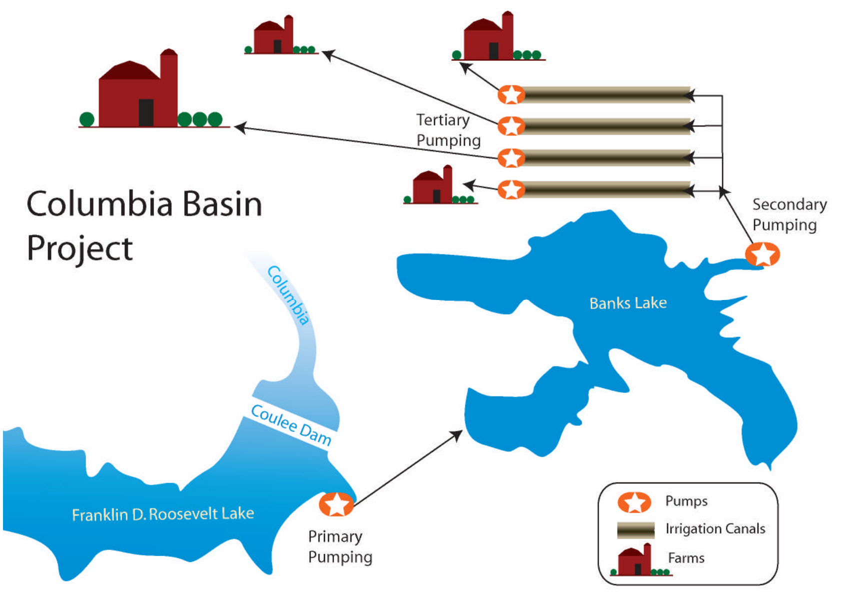
Due to the natural landscape and hydrological conditions of most of the Columbia Basin, large-scale irrigation is required for successful farming in the region. The Columbia Basin spans much of Adams, Franklin, Grant, and Lincoln counties, as well as parts of eastern Oregon. Recent estimates show that there are over 928,000 irrigated acres in the area. Nearly 65% of this acreage is fed by water from the Columbia Basin Project (CBP), while the remaining 35% is irrigated using water from private wells or river pumping stations. Regardless of the source of water, the geography of the area makes the pumping process highly electricity intensive. Specifically, this is due to the difference in elevation between the primary water source and the farms on the Columbia plateau. Therefore, implementing IWM in this area is likely to offer greater electricity savings potential than most other areas in the Northwest. As shown schematically in Figure 2,

[2] Some growers did not provide water source information.

the pumping system for the CBP region can be broken down into three major components: primary pumping, secondary pumping, and tertiary pumping, which involves:

- Primary pumping – Lake Roosevelt to Banks Lake reservoir
- Secondary pumping – Distribution throughout the basin
- Tertiary pumping – Water distribution on the farms

Figure 2. Pumping System Layout Schematic



Primary Pumping represents the electricity used by the Grand Coulee Pump-Generation plant to pump water from Roosevelt Lake to the 1.6 mile-long feeder canal for delivery into Banks Lake. Banks Lake is a 27-mile long reservoir that feeds Columbia River water into the main irrigation canal. In preliminary discussions with the Grand Coulee Pump-Generation Plant and the USBR, we discovered that it was going to be very difficult to disaggregate the actual "pumping" requirements from the "generation" requirements, as well as accounting for pumping requirements to supply water to Banks Lake for water uses other than for irrigation needs. To estimate the potential primary pumping energy savings due to IWM, we used the water balance model developed by the Ephrata office of the U.S. Bureau of Reclamation (USBR) called CBIP-RW. This model is used to project the net irrigation water that needs to be diverted from the Columbia River, and thus, would be available as water behind the dam for generation purposes, as discussed in more detail below. The model is very complex and is based on real system data. The model further serves as a tool to estimate primary pumping energy savings by developing daily water flow profiles at the Main Canal Headworks that approximate daily pumping requirements. See Appendix B for more information.

Using the CBIP-RW model, we developed three scenarios to approximate the likely range in impact on water savings that can be attributed to IWM:

- 10% water savings
- 2% water savings
- No impact from IWM

The 10% water savings model is based on the assumption that IWM is implemented on 100% of the acreage in the CBP. This scenario represents the high scenario. The 2% model represents the expected scenario in that it approximates pilot study program participation in the GWMA area. The no-impact model represents zero participation, i.e. baseline data.

Due to its close approximation of the GWMA pilot study data, we selected the 2% model for the basis of our calculations in the report. Comparison of the 2% model results with the baseline scenario yielded an annual energy savings of roughly 31,302,937[3] kWh. Based on these data and pilot study acreage, electricity savings resulting from primary pumping are estimated at approximately 56.9 kWh per acre.

Secondary Pumping represents pumping power needed throughout the Basin to lift and distribute water from Banks Lake and the Main Canal into a large system of irrigation facilities, including canals and laterals. The Bureau of Reclamation estimates that the irrigation system contains over 300 miles of main canals and about 2,000 miles of laterals. The calculation of electricity savings related to secondary pumping is based on the following assumptions:

- Annual pumping energy ranges from 175 to 200 MWh
- 40% of the pumping plants can reduce operation (variable frequency drive [VFD] operation)
- 10% electricity savings due to IWM
- Applicable to 550,000 acres given that 65% of total irrigation acres are supplied with water from the Columbia Basin River Project

Based on these data, total electric power savings resulting from reduced secondary pumping is estimated at 12 kWh per acre.

3 The daily water flow (cfs) from the CBIP-RW model was converted to acre-feet (1.98347 ac-ft/cfs) for each of the years 2000 through 2003 to determine a typical year. Data for the years prior to 2000 were excluded since the total irrigated acres and hence total water requirements were significantly less. Acre-ft was then converted to pumping requirements by using the conversion factor 1.085 MWh/ac-ft, as obtained from the NWPPC.

Tertiary (Infield) Pumping. Based on findings from Phase II of this study, estimated water savings related to implementing IWM are on average 10%. If less water is needed to raise crops, the farmer will need to pump less water and will thus see a reduction in electricity use. While the potential energy savings vary greatly depending on the required pump lift, findings from Phase II suggest that implementation of IWM will result, on average, in an electricity savings of approximately 13%. This estimate was derived by converting water savings into electricity savings by means of applying a system-specific Power Conversion Coefficient (PCC[4]). For the purposes of this analysis, the amount of electricity savings due to reducing tertiary pumping was estimated by applying each farm's measured PCC to the estimated water savings related to implementing IWM. Using this methodology, the average savings per acre are estimated at 136 kWh per acre.

Transmission and Distribution (T&D) benefit represents the avoided energy generation associated with average transmission and distribution losses on the Bonneville system. Based on Bonneville data, T&D benefits are assumed to be 2.5% and 5%, respectively, for a total of 7.5%. Applying this assumption to all three pumping system stages results in a combined T&D benefit of 14 kWh per acre.

Increased Generation Potential is an estimate of the amount of water saved through IWM that would be available as water behind the dam for generation purposes. The USBR water balance model, as described in the Primary Pumping section above, was used to predict annual water savings, assuming the 2% savings scenario.

Daily average profiles at Grand Coulee Dam from 2000 through 2003 were used to arrive at an annual water savings of 28,850 acre-ft. To convert this amount of water to generation potential, we used a conversion factor of 1,085 MWh per 1,000 acre-ft, which was provided by the Northwest Power Planning Council (NPPC). This is equivalent to 31,302,900 kWh. We then determined a unitized value for the region by dividing by 550,000 acres yielding 57 kWh per acre. We consider this estimate to be conservative as there is additional generation potential at the dams downstream from Grand Coulee Dam that are not reflected in this analysis. Table 3 provides a summary of the estimated water and electricity savings by source.

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[4] On a conceptual level, the PCC estimates the amount of energy (kWh) that is required to pump a given a mount of water (acre-feet). The PCC is based on farm-specific pumping data such as the total dynamic head, a function of the lift and discharge pressure, and the efficiency of the pumping system as well as an engineering constant. Specifically, the PCC is defined as: PCC (kWh/acre-ft) = 1.0227 * TDH / Pump Station Efficiency. TDH= Lift + (DP * 2.307).

Table 3. Summary of Water and Electricity Savings

Water Savings	
Water Savings	3.7 acre-inch
Electricity Savings	
Primary Pumping	57 kWh per acre
Secondary Pumping	12 kWh per acre
Tertiary (Infield) Pumping	136 kWh per acre
T&D Benefit	14 kWh per acre
Total	**219 kWh per acre**
Increased Generation Potential	57 kWh per acre

Combined, the estimated energy savings per acre resulting from the project are 219 kWh. Including an estimate of the energy savings related to the increased generation potential, the total energy savings are 276 kWh per acre. While an accurate estimate of actual energy savings would require a detailed analysis of each field and pump system, applying the total average savings per acre (excluding increased generation potential) to the 48,026 acres generates an estimate energy savings of 10,518 MWh or 1.20 aMW generated by the pilot program.

Cost-Effectiveness Analysis

The project's economic performance is assessed using a benefit-cost analytic framework consistent with the guidelines established by the Northwest Power and Conservation Council. Cost-effectiveness is analyzed from three distinct perspectives: total resource cost (regional perspective), Bonneville, and growers.

Estimated pilot project costs and heretofore calculated benefits are shown in Tables 4 and 5, respectively. Total program costs are a combination of GWMA and Bonneville administration, plus infield installation costs, for a total of $13.56 per acre. Bonneville's contributions amounted to $5.73 per acre to offset the infield installation costs. Avoided energy benefits to participants and the region were calculated assuming an average irrigation retail rate of $0.060[5] per kWh and an avoided energy cost of generation of $0.047[6] per kWh.

Table 4. Project Costs

Program Costs	$/Acre	Total Cost
GWMA Administrative Costs	$1.31	$62,914
Bonneville Administrative Costs	$0.25	$12,000
Infield Installation Costs	$12.0	$576,312
Incentive	**$/Acre**	**Total Cost**
Bonneville Pilot Project Costs	$5.73	$275,000

[5] Represents average cost of electricity per kWh based on data provided by Franklin PUD. Estimate includes energy and peak costs, customer charges and taxes.

[6] Based on information provided by the NPPC, this value is comprised of $0.034/kWh for basic energy and capacity savings, $0.00/kWh conservation credit, $0.007/kWh for deferred T&D capital expenditures, and $0.002/kWh for a carbon risk factor.

Table 5. Project Benefits

Benefits	kWh/Acre	$/Acre	Total Benefit
Primary Pumping	57	$2.67	$128,436
Secondary Pumping	12	$0.56	$27,087
Tertiary (Infield) Pumping	136	$6.41	$307,863
T&D Benefit	14	$0.74	$35,463
Increased Generation Potential	57	$2.68	$128,662
Reduction in Fertilizer Use	NA	$6.00[7]	$627,662

In addition to these benefits, additional benefits not quantified as part of this analysis include reduction in ground water pollution, slowdown in aquifer drawdown, and reduction in water use (and potentially water bills) to farmers. In an effort to quantify the value of water in the region, we analyzed the Department of Ecology's water right's spot market. However, given the small number of transactions, as well as the lack information on final transaction details, this analysis could not be completed as part of this report.

This evaluation assesses the project's cost-effectiveness from the perspectives of the region (total resource-cost test), the growers (participant test), and Bonneville (utility cost test). Table 6 outlines the distribution of costs and benefits from various stakeholder perspectives.

Table 6. Distribution of Costs and Benefits

	Region	Growers	Bonneville
Costs			
GWMA Administrative Costs	√		
Bonneville Administrative Costs	√		√
Infield Installation Costs	√	√	
Bonneville Incentive to Grower			√
Benefits			
Primary Pumping	√		√
Secondary Pumping	√		√
Tertiary (Infield) Pumping	√	√	√
T&D Benefit	√		√
Increased Generation Potential	√		√
Bonneville Incentive to Grower		√	
Reduction in Fertilizer Use	√	√	

Table 7 shows the preliminary evaluation of total project costs and benefits from the perspectives of the region, total resource cost (TRC), Bonneville (Utility Cost Test), and participants (Participant Cost Test). Considering only energy-related benefits, this analysis finds that for both the growers and Bonneville, the benefits of this project exceed its costs and the project is cost-

[7] Based on estimates provided by GWMA, implementation of IWM is expected to reduce use of fertilizer by 15 pounds per acre. Given an assumed cost of $0.40 per pound, a conservative estimate, the estimate cost savings per acre is $6.

effective from the Bonneville and growers perspectives. Yet, from a regional perspective, the total benefit is less than total cost even if only marginally so.

Table 7. Summary of Costs, Benefits and BC Ratio

Perspective	Costs	Benefits	Net Benefits	BC Ratio
Region	$651,226	$627,510	($23,716)	0.96
Bonneville	$275,000	$627,510	$352,510	2.28
Grower	$576,312	$668,016	$91,704	1.16

However, when non-energy related benefits are included in the analysis, specifically the reduction in fertilizer use due to reduced run-off, the project is cost effective even from the regional perspective. Table 8 summarizes the corresponding benefit-cost ratios.

Table 8. Summary of Costs, Benefits and BC Ratio

Perspective	Costs	Benefits	Net Benefits	BC Ratio
Region	$651,226	$915,666	$264,440	1.41
Bonneville	$275,000	$627,510	$352,510	2.28
Grower	$576,312	$956,172	$379,860	1.66

There are other expected benefits (e.g., reduction in farmers' water bills and other environmental benefits) not quantified as part of this analysis that are expected to further increase the above BC ratios.

Conclusion

When only accounting for the energy-related benefits, our findings indicate that the project is cost-effective from the perspectives of Bonneville and growers but not from a regional resource cost perspective. However, with a BC ratio of 0.96, the project is very close to the required 1.0 ratio for cost effectiveness.

However, when non-energy related benefits such as the reduced use in fertilizer are included, the project is cost-effective from all three perspectives, including the regional.

Appendix A: Columbia Basin Irrigation Project Model and Input Data

Columbia Basin Irrigation Project Model and Input Data

RiverWare software was used to develop a simulation model of the Columbia Basin Irrigation Project, referred to as the CBIP-RW model. The CBIP-RW model runs at a daily timestep, simulating reservoirs, canal and lateral flows, farm deliveries, return flows, groundwater pumping and natural flows within the CBIP. The primary natural inflow is from the Crab Creek watershed. This watershed has surface and subsurface components. The majority of this natural water enters the CBIP via Upper Crab Creek and Rocky Ford Creek. Observed surface inflows from Crab Creek, as measured at Irby, are input to the model. The model was calibrated to simulate Rocky Ford Creek and subsurface inflows from the observed Irby data. A large amount of shallow groundwater pumping occurs within the CBIP. Pumping of this groundwater was calculated based on estimates of current irrigated acres within CBIP, which were assumed to consumptively use 2.5 ft/yr. The CBIP-RW model was calibrated using observed reservoir elevation and surface flow data from 1996 to 2003. Lateral losses and farm efficiencies were calculated outside the model based on analysis of observed diversion, delivery, and waste data from 1996 to 2003. An on-farm efficiency of 71% is used for lands receiving canal water. These estimates of losses and efficiencies were used as input. During calibration of the model, parameters used to control timing and amounts of return flow were adjusted until errors between simulated and observed return flows were minimized.

For the Quantec model runs, the CBIP-RW model was run consecutively for 54 years with observed Upper Crab Creek inflows, average CBIP irrigation demands and efficiencies, and shallow groundwater pumping estimates. Observed inflows were obtained from the USGS Irby gaging station for the period 1950 to 2003. Average CBIP irrigation demands and efficiencies were represented by lateral diversion, losses, spill, deliveries, and farm efficiencies developed from USBR and district data from the period 1990 to 2003. Average diversions for current East High development was based on daily records from 1998-2002, 2004-2005. Pumping of CBIP shallow groundwater was assumed to 100% consumptively use 2.5 feet per year. No changes were made to groundwater pumping in these runs. Each scenario was run with the CBIP-RW model through the 54-year period using these inputs as described below.

For the Quantec runs the consumptive use was held constant by adjusting the on-farm efficiency. The lateral and canal losses were held constant in these runs. RiverWare performs the following calculations:

- Consumptive Use = Farm Delivery*on-farm efficiency
- Return flow = Farm Delivery * (1- on-farm efficiency) * return factor
- Lateral Diversion = Farm Delivery + Lateral seepage + Lateral waste
- Canal Headworks flow = Lateral diversion + canal seepage + canal waste – return flow

No Action – Current Level of Efficiency

The CBIP-RW model was run with no changes to the on-farm efficiency. The on-farm efficiency is 71% in the no-action run.

10% Improvement in On-Farm Efficiency

The CBIP-RW model was run with an assumed improvement in on-farm efficiency of 10% for those lands receiving water from the CBIP canal system. The on-farm efficiency for this was 81%.

2% Improvement in On-Farm Efficiency

The CBIP-RW model was run with an assumed improvement in on-farm efficiency of 2% for those lands receiving water from the CBIP canal system. The on-farm efficiency for this run was 73%.

Data Output

The following data is sent in an accompanying spreadsheet. All data is in cfs.

1) Main Canal Headworks
2) Main Canal at Summer Falls Power Plant
3) West Canal Headworks
4) West Canal at Quincy Chute Power Plant
5) East Low Canal Headworks
6) Potholes Feed (Note: Main Canal and East Low Canal Headworks include Feed.)
7) Potholes Canal Headworks
8) Potholes Canal at R.D. Smith Power Plant
9) Potholes Canal at PEC 66 Power Plant
10) Eltopia Branch Canal at EB 4.6 Power Plant
11) A major lateral which represents pumped flows by a Secondary Pumping Plant

Appendix B: Summary of Data from USBR – CBIP-RW Model

Baseline Run	cfs	acre-ft
2003	1,329,749	2,637,518
2002	1,325,016	2,628,131
2001	1,310,190	2,598,724
2000	1,290,480	2,559,629
avg 2000-03	**1,313,859**	**2,606,001**
2% Water Savings Run		
2003	1,312,998	2,604,293
2002	1,313,737	2,605,759
2001	1,295,021	2,568,636
2000	1,275,497	2,529,911
avg 2000-03	**1,299,313**	**2,577,150**
10% Water Savings Run		
2003	1,263,936	2,506,980
2002	1,265,780	2,510,638
2001	1,239,300	2,458,116
2000	1,229,326	2,438,333
avg 2000-03	**1,249,586**	**2,478,517**

use 2% savings run - correlates with GWMA IWM penetration at 48,000 acres

Total water savings at Head canal:		
Baseline =	2,606,001	
2% savings run =	2,577,150	
difference =	28,851	acre-ft
Convert acre-ft to kWh generation at Grand Coulee dam: (conversion factor from NWPPC)	1.085	MWH/acre-ft
	31,303	MWH
	31,302,937	kWh
	550,000	acres
Unitized water savings benefit =	**56.9**	**kWh/acre**

Appendix C: Estimate for Pumping Energy Savings

Date	No Savings	Daily Flow (CFS)	kWh	2% Savings	Daily Flow (CFS)	kWh	10% Savings	Daily Flow (CFS)	kWh
3/15/2003	2340.86	0.30	2,854,604	2340.8	0.30	2,854,531	2340.59	0.30	2,854,275
3/16/2003	1490.59	0.19	1,817,727	1490.51	0.19	1,817,630	1490.23	0.19	1,817,288
3/17/2003	1490.78	0.19	1,817,959	1490.7	0.19	1,817,861	1490.44	0.19	1,817,544
3/18/2003	1490.71	0.19	1,817,873	1490.64	0.19	1,817,788	1490.38	0.19	1,817,471
3/19/2003	1490.33	0.19	1,817,410	1490.27	0.19	1,817,337	1490.05	0.19	1,817,069
3/20/2003	1490.95	0.19	1,818,166	1490.87	0.19	1,818,069	1490.59	0.19	1,817,727
3/21/2003	1491.17	0.19	1,818,434	1491.1	0.19	1,818,349	1490.84	0.19	1,818,032
3/22/2003	1491.38	0.19	1,818,691	1491.3	0.19	1,818,593	1491.02	0.19	1,818,251
3/23/2003	1498.82	0.19	1,827,763	1498.54	0.19	1,827,422	1497.54	0.19	1,826,202
3/24/2003	1567.82	0.20	1,911,907	1565.89	0.20	1,909,553	1559.12	0.20	1,901,297
3/25/2003	1611.69	0.21	1,965,405	1609.54	0.21	1,962,783	1601.96	0.21	1,953,539
3/26/2003	1668.08	0.22	2,034,171	1665.31	0.22	2,030,793	1655.62	0.21	2,018,976
3/27/2003	1719.1	0.22	2,096,388	1716.31	0.22	2,092,985	1706.52	0.22	2,081,047
3/28/2003	1739.95	0.23	2,121,814	1737.37	0.23	2,118,667	1728.34	0.22	2,107,656
3/29/2003	1793.05	0.23	2,186,567	1790.47	0.23	2,183,421	1781.4	0.23	2,172,361
3/30/2003	1856.84	0.24	2,264,357	1853.72	0.24	2,260,553	1842.78	0.24	2,247,212
3/31/2003	1955.1	0.25	2,384,182	1950.4	0.25	2,378,451	1933.92	0.25	2,358,354
4/1/2003	4288.85	0.56	5,230,116	4277.46	0.55	5,216,226	4237.5	0.55	5,167,497
4/2/2003	4440.67	0.58	5,415,256	4426.34	0.57	5,397,781	4376.11	0.57	5,336,527
4/3/2003	4643.83	0.60	5,663,003	4625.86	0.60	5,641,089	4562.82	0.59	5,564,214
4/4/2003	4826.41	0.63	5,885,654	4805.17	0.62	5,859,752	4730.66	0.61	5,768,889
4/5/2003	5022.46	0.65	6,124,730	4996.97	0.65	6,093,646	4907.57	0.64	5,984,626
4/6/2003	5183.44	0.67	6,321,040	5154.35	0.67	6,285,566	5052.32	0.66	6,161,144
4/7/2003	5344.88	0.69	6,517,911	5312.1	0.69	6,477,937	5197.14	0.67	6,337,747
4/8/2003	5537.92	0.72	6,753,317	5500.59	0.71	6,707,795	5369.67	0.70	6,548,142
4/9/2003	5748.47	0.75	7,010,076	5706.28	0.74	6,958,627	5558.27	0.72	6,778,134
4/10/2003	5869.77	0.76	7,157,998	5824.61	0.76	7,102,927	5666.21	0.74	6,909,763
4/11/2003	6009.87	0.78	7,328,845	5961.35	0.77	7,269,677	5791.15	0.75	7,062,123
4/12/2003	6082.43	0.79	7,417,330	6032.01	0.78	7,355,844	5855.16	0.76	7,140,181

Date	No Savings	Daily Flow (CFS)	kWh	2% Savings	Daily Flow (CFS)	kWh	10% Savings	Daily Flow (CFS)	kWh
4/13/2003	6150.15	0.80	7,499,912	6098.03	0.79	7,436,354	5915.24	0.77	7,213,447
4/14/2003	6222.05	0.81	7,587,592	6167.97	0.80	7,521,643	5978.32	0.78	7,290,371
4/15/2003	6259	0.81	7,632,652	6203.88	0.80	7,565,434	6010.54	0.78	7,329,662
4/16/2003	6289.28	0.82	7,669,577	6233.49	0.81	7,601,543	6037.81	0.78	7,362,917
4/17/2003	6280.04	0.81	7,658,309	6224.69	0.81	7,590,812	6030.17	0.78	7,353,601
4/18/2003	6293.52	0.82	7,674,748	6237.95	0.81	7,606,982	6042.93	0.78	7,369,161
4/19/2003	6322.27	0.82	7,709,807	6265.91	0.81	7,641,078	6068.07	0.79	7,399,818
4/20/2003	6364.68	0.83	7,761,525	6307.24	0.82	7,691,479	6105.77	0.79	7,445,792
4/21/2003	6452.09	0.84	7,868,119	6392.3	0.83	7,795,207	6182.58	0.80	7,539,460
4/22/2003	6555.12	0.85	7,993,760	6492.6	0.84	7,917,519	6273.31	0.81	7,650,102
4/23/2003	6651.48	0.86	8,111,268	6586.36	0.85	8,031,857	6357.97	0.82	7,753,342
4/24/2003	6655.85	0.86	8,116,597	6590.6	0.86	8,037,027	6361.77	0.83	7,757,976
4/25/2003	6632.88	0.86	8,088,586	6568.24	0.85	8,009,760	6341.52	0.82	7,733,282
4/26/2003	6646.24	0.86	8,104,878	6581.21	0.85	8,025,576	6353.11	0.82	7,747,416
4/27/2003	6684.84	0.87	8,151,950	6618.76	0.86	8,071,367	6386.98	0.83	7,788,719
4/28/2003	6784.56	0.88	8,273,555	6715.79	0.87	8,189,692	6474.59	0.84	7,895,557
4/29/2003	6904.52	0.90	8,419,843	6832.51	0.89	8,332,029	6579.97	0.85	8,024,064
4/30/2003	6989.02	0.91	8,522,888	6914.74	0.90	8,432,306	6654.2	0.86	8,114,585
5/1/2003	7136.45	0.93	8,702,674	7057.35	0.92	8,606,214	6779.91	0.88	8,267,885
5/2/2003	7197.62	0.93	8,777,269	7116.85	0.92	8,678,772	6833.55	0.89	8,333,297
5/3/2003	7256.27	0.94	8,848,791	7173.9	0.93	8,748,343	6885	0.89	8,396,039
5/4/2003	7243.08	0.94	8,832,706	7161.07	0.93	8,732,697	6873.46	0.89	8,381,966
5/5/2003	7240.21	0.94	8,829,206	7158.29	0.93	8,729,307	6870.99	0.89	8,378,954
5/6/2003	7331.31	0.95	8,940,299	7246.89	0.94	8,837,352	6950.8	0.90	8,476,280
5/7/2003	7431.15	0.96	9,062,051	7344	0.95	8,955,775	7038.32	0.91	8,583,008
5/8/2003	7419.49	0.96	9,047,832	7332.66	0.95	8,941,946	7028.12	0.91	8,570,569
5/9/2003	7433.3	0.96	9,064,673	7346.11	0.95	8,958,348	7040.31	0.91	8,585,434
5/10/2003	7473.23	0.97	9,113,366	7384.96	0.96	9,005,724	7075.36	0.92	8,628,177
5/11/2003	7419.8	0.96	9,048,210	7332.96	0.95	8,942,312	7028.39	0.91	8,570,898
5/12/2003	7395.09	0.96	9,018,077	7308.95	0.95	8,913,032	7006.83	0.91	8,544,606
5/13/2003	7434.71	0.96	9,066,393	7347.51	0.95	8,960,055	7041.7	0.91	8,587,129
5/14/2003	7443.9	0.97	9,077,599	7356.47	0.95	8,970,981	7049.81	0.91	8,597,019

Date	No Savings	Daily Flow (CFS)	kWh	2% Savings	Daily Flow (CFS)	kWh	10% Savings	Daily Flow (CFS)	kWh
5/15/2003	7435.69	0.96	9,067,588	7348.48	0.95	8,961,238	7042.64	0.91	8,588,276
5/16/2003	6989.18	0.91	8,523,083	7359.31	0.95	8,974,445	7052.42	0.91	8,600,202
5/17/2003	5480.43	0.71	6,683,210	7366.89	0.96	8,983,688	7059.17	0.92	8,608,433
5/18/2003	5455.89	0.71	6,653,284	6696.89	0.87	8,166,644	7037.6	0.91	8,582,129
5/19/2003	5403.48	0.70	6,589,372	5317.36	0.69	6,484,351	6991.59	0.91	8,526,022
5/20/2003	5479.29	0.71	6,681,820	5391.1	0.70	6,574,275	7058.04	0.92	8,607,055
5/21/2003	5537.51	0.72	6,752,817	5447.72	0.71	6,643,321	7109.03	0.92	8,669,236
5/22/2003	5517.95	0.72	6,728,965	5428.7	0.70	6,620,127	7091.87	0.92	8,648,310
5/23/2003	5441.46	0.71	6,635,687	5354.32	0.69	6,529,423	7024.87	0.91	8,566,606
5/24/2003	5440.23	0.71	6,634,188	5353.1	0.69	6,527,935	7023.65	0.91	8,565,118
5/25/2003	5451.65	0.71	6,648,114	5364.2	0.70	6,541,471	7033.59	0.91	8,577,239
5/26/2003	5459.64	0.71	6,657,857	5371.96	0.70	6,550,934	7040.54	0.91	8,585,715
5/27/2003	5440.27	0.71	6,634,236	5353.13	0.69	6,527,972	7023.57	0.91	8,565,020
5/28/2003	5474.69	0.71	6,676,210	5386.61	0.70	6,568,800	7053.7	0.92	8,601,763
5/29/2003	5480.59	0.71	6,683,405	5392.35	0.70	6,575,799	6575.52	0.85	8,018,638
5/30/2003	5522.09	0.72	6,734,013	5432.8	0.70	6,625,127	6477.47	0.84	7,899,069
5/31/2003	5601.75	0.73	6,831,156	5510.19	0.71	6,719,502	6548.55	0.85	7,985,749
6/1/2003	5684.12	0.74	6,931,604	5590.13	0.73	6,816,986	5260.49	0.68	6,415,000
6/2/2003	5740.53	0.74	7,000,394	5645.02	0.73	6,883,922	5310.05	0.69	6,475,437
6/3/2003	5966.9	0.77	7,276,445	5865.2	0.76	7,152,425	5508.51	0.71	6,717,453
6/4/2003	6127.56	0.79	7,472,365	6021.45	0.78	7,342,967	5649.3	0.73	6,889,142
6/5/2003	6331.22	0.82	7,720,722	6219.55	0.81	7,584,544	5827.91	0.76	7,106,951
6/6/2003	6531.33	0.85	7,964,749	6414.18	0.83	7,821,889	6003.29	0.78	7,320,821
6/7/2003	6697.77	0.87	8,167,718	6576.05	0.85	8,019,284	6149.16	0.80	7,498,705
6/8/2003	6760.63	0.88	8,244,373	6637.21	0.86	8,093,867	6204.34	0.80	7,565,995
6/9/2003	6756.82	0.88	8,239,727	6633.5	0.86	8,089,342	6200.99	0.80	7,561,910
6/10/2003	6801.56	0.88	8,294,286	6677.03	0.87	8,142,426	6240.27	0.81	7,609,811
6/11/2003	6828.98	0.89	8,327,724	6703.7	0.87	8,174,949	6264.3	0.81	7,639,115
6/12/2003	6850.91	0.89	8,354,467	6725.03	0.87	8,200,960	6283.53	0.82	7,662,565
6/13/2003	6865.96	0.89	8,372,820	6739.74	0.87	8,218,899	6297.04	0.82	7,679,040
6/14/2003	6958.23	0.90	8,485,340	6829.49	0.89	8,328,346	6377.96	0.83	7,777,719
6/15/2003	7127.3	0.92	8,691,516	6993.9	0.91	8,528,839	6526.04	0.85	7,958,298

Date	No Savings	Daily Flow (CFS)	kWh	2% Savings	Daily Flow (CFS)	kWh	10% Savings	Daily Flow (CFS)	kWh
6/16/2003	7315.01	0.95	8,920,422	7176.46	0.93	8,751,465	6690.54	0.87	8,158,901
6/17/2003	7519.04	0.98	9,169,230	7374.91	0.96	8,993,468	6869.38	0.89	8,376,991
6/18/2003	7618.04	0.99	9,289,958	7471.2	0.97	9,110,891	6956.2	0.90	8,482,865
6/19/2003	7623.87	0.99	9,297,067	7476.89	0.97	9,117,830	6961.38	0.90	8,489,182
6/20/2003	7625.27	0.99	9,298,774	7478.24	0.97	9,119,476	6962.57	0.90	8,490,633
6/21/2003	7603.97	0.99	9,272,800	7457.54	0.97	9,094,233	6943.98	0.90	8,467,963
6/22/2003	7582.59	0.98	9,246,727	7436.74	0.96	9,068,868	6925.22	0.90	8,445,086
6/23/2003	7610.49	0.99	9,280,751	7463.88	0.97	9,101,964	6949.67	0.90	8,474,902
6/24/2003	7639.35	0.99	9,315,944	7491.87	0.97	9,136,097	6974.65	0.90	8,505,364
6/25/2003	7619.77	0.99	9,292,067	7472.83	0.97	9,112,879	6957.48	0.90	8,484,426
6/26/2003	7575.99	0.98	9,238,679	7430.27	0.96	9,060,978	6919.18	0.90	8,437,720
6/27/2003	7510.71	0.97	9,159,072	7366.78	0.96	8,983,554	6861.97	0.89	8,367,954
6/28/2003	7494.15	0.97	9,138,878	7350.67	0.95	8,963,908	6847.44	0.89	8,350,235
6/29/2003	7425.6	0.96	9,055,283	7283.99	0.94	8,882,594	6787.3	0.88	8,276,897
6/30/2003	7385.94	0.96	9,006,919	7245.42	0.94	8,835,559	6752.57	0.88	8,234,544
7/1/2003	7458.76	0.97	9,095,721	7316.24	0.95	8,921,922	6816.38	0.88	8,312,359
7/2/2003	7495.28	0.97	9,140,256	7351.75	0.95	8,965,225	6848.36	0.89	8,351,357
7/3/2003	7494.7	0.97	9,139,548	7351.21	0.95	8,964,567	6847.93	0.89	8,350,833
7/4/2003	7430.77	0.96	9,061,588	7289.03	0.95	8,888,740	6791.89	0.88	8,282,494
7/5/2003	7361.01	0.95	8,976,518	7221.18	0.94	8,805,999	6730.76	0.87	8,207,948
7/6/2003	7323.32	0.95	8,930,556	7184.53	0.93	8,761,306	6697.79	0.87	8,167,742
7/7/2003	7361.03	0.95	8,976,542	7221.22	0.94	8,806,048	6730.84	0.87	8,208,045
7/8/2003	7410.15	0.96	9,036,442	7268.99	0.94	8,864,302	6773.92	0.88	8,260,580
7/9/2003	7384.56	0.96	9,005,236	7244.09	0.94	8,833,937	6751.4	0.88	8,233,118
7/10/2003	7402.27	0.96	9,026,833	7261.33	0.94	8,854,961	6767	0.88	8,252,141
7/11/2003	7411.31	0.96	9,037,857	7270.14	0.94	8,865,705	6774.99	0.88	8,261,885
7/12/2003	7489.75	0.97	9,133,512	7346.41	0.95	8,958,713	6843.65	0.89	8,345,614
7/13/2003	7530.78	0.98	9,183,547	7386.32	0.96	9,007,382	6879.66	0.89	8,389,527
7/14/2003	7582.58	0.98	9,246,715	7436.7	0.96	9,068,819	6925.06	0.90	8,444,891
7/15/2003	7635.17	0.99	9,310,847	7487.87	0.97	9,131,219	6971.23	0.90	8,501,193
7/16/2003	7673.86	1.00	9,358,028	7525.53	0.98	9,177,145	7005.31	0.91	8,542,753
7/17/2003	7693.36	1.00	9,381,808	7544.5	0.98	9,200,278	7022.39	0.91	8,563,581

Date	No Savings	Daily Flow (CFS)	kWh	2% Savings	Daily Flow (CFS)	kWh	10% Savings	Daily Flow (CFS)	kWh
7/18/2003	7676.89	1.00	9,361,723	7528.48	0.98	9,180,742	7007.96	0.91	8,545,984
7/19/2003	7603.68	0.99	9,272,446	7457.28	0.97	9,093,916	6943.77	0.90	8,467,707
7/20/2003	7540.53	0.98	9,195,437	7395.86	0.96	9,019,016	6888.45	0.89	8,400,246
7/21/2003	7527.64	0.98	9,179,718	7383.33	0.96	9,003,736	6877.2	0.89	8,386,527
7/22/2003	7560.36	0.98	9,219,619	7415.16	0.96	9,042,552	6905.88	0.90	8,421,501
7/23/2003	7621	0.99	9,293,567	7474.13	0.97	9,114,464	6959.03	0.90	8,486,316
7/24/2003	7673.83	1.00	9,357,992	7525.51	0.98	9,177,120	7005.3	0.91	8,542,741
7/25/2003	7677.47	1.00	9,362,431	7529.04	0.98	9,181,425	7008.48	0.91	8,546,619
7/26/2003	7707.95	1.00	9,399,600	7558.67	0.98	9,217,558	7035.12	0.91	8,579,105
7/27/2003	7661.14	0.99	9,342,517	7513.15	0.97	9,162,048	6994.12	0.91	8,529,107
7/28/2003	7672.91	1.00	9,356,870	7524.6	0.98	9,176,011	7004.44	0.91	8,541,692
7/29/2003	7682.5	1.00	9,368,565	7533.92	0.98	9,187,376	7012.84	0.91	8,551,935
7/30/2003	7639.79	0.99	9,316,481	7492.39	0.97	9,136,731	6975.41	0.90	8,506,291
7/31/2003	7601.06	0.99	9,269,251	7454.72	0.97	9,090,794	6941.46	0.90	8,464,890
8/1/2003	7449.8	0.97	9,084,794	7307.59	0.95	8,911,374	6808.85	0.88	8,303,176
8/2/2003	7334.97	0.95	8,944,763	7195.91	0.93	8,775,183	6708.19	0.87	8,180,424
8/3/2003	7265.96	0.94	8,860,607	7128.81	0.92	8,693,357	6647.77	0.86	8,106,744
8/4/2003	7246.72	0.94	8,837,145	7110.09	0.92	8,670,529	6630.91	0.86	8,086,184
8/5/2003	7223.03	0.94	8,808,255	7087.05	0.92	8,642,432	6610.14	0.86	8,060,856
8/6/2003	7157.04	0.93	8,727,783	7022.83	0.91	8,564,118	6552.12	0.85	7,990,102
8/7/2003	7039.06	0.91	8,583,910	6908.08	0.90	8,424,184	6448.72	0.84	7,864,009
8/8/2003	6958.02	0.90	8,485,084	6829.25	0.89	8,328,053	6377.63	0.83	7,777,317
8/9/2003	6917.26	0.90	8,435,379	6789.6	0.88	8,279,701	6341.87	0.82	7,733,709
8/10/2003	6923.66	0.90	8,443,183	6795.82	0.88	8,287,286	6347.47	0.82	7,740,538
8/11/2003	6949.52	0.90	8,474,719	6820.98	0.88	8,317,968	6370.17	0.83	7,768,220
8/12/2003	7029.77	0.91	8,572,581	6899.01	0.90	8,413,123	6440.43	0.84	7,853,900
8/13/2003	7040.07	0.91	8,585,142	6909.04	0.90	8,425,355	6449.5	0.84	7,864,960
8/14/2003	6981.69	0.91	8,513,949	6852.27	0.89	8,356,125	6398.32	0.83	7,802,548
8/15/2003	6947.47	0.90	8,472,219	6818.97	0.88	8,315,517	6368.29	0.83	7,765,927
8/16/2003	6933.42	0.90	8,455,085	6805.29	0.88	8,298,835	6355.89	0.82	7,750,806
8/17/2003	6881.98	0.89	8,392,356	6755.24	0.88	8,237,800	6310.75	0.82	7,695,759
8/18/2003	6861.57	0.89	8,367,466	6735.4	0.87	8,213,606	6292.89	0.82	7,673,979

Date	No Savings	Daily Flow (CFS)	kWh	2% Savings	Daily Flow (CFS)	kWh	10% Savings	Daily Flow (CFS)	kWh
8/19/2003	6861.97	0.89	8,367,954	6735.77	0.87	8,214,057	6293.17	0.82	7,674,321
8/20/2003	6827.77	0.89	8,326,248	6702.51	0.87	8,173,498	6263.18	0.81	7,637,749
8/21/2003	6742.83	0.87	8,222,667	6619.9	0.86	8,072,758	6188.74	0.80	7,546,972
8/22/2003	6640.9	0.86	8,098,366	6520.74	0.85	7,951,835	6099.32	0.79	7,437,927
8/23/2003	6535.86	0.85	7,970,274	6418.57	0.83	7,827,242	6007.2	0.78	7,325,589
8/24/2003	6382.57	0.83	7,783,341	6269.48	0.81	7,645,432	5872.84	0.76	7,161,742
8/25/2003	6273.36	0.81	7,650,163	6163.27	0.80	7,515,912	5777.14	0.75	7,045,039
8/26/2003	6204.13	0.80	7,565,739	6095.93	0.79	7,433,793	5716.42	0.74	6,970,992
8/27/2003	6112.34	0.79	7,453,804	6006.65	0.78	7,324,919	5635.95	0.73	6,872,862
8/28/2003	6075.91	0.79	7,409,379	5971.21	0.77	7,281,701	5604.01	0.73	6,833,912
8/29/2003	6018.75	0.78	7,339,674	5915.61	0.77	7,213,898	5553.88	0.72	6,772,780
8/30/2003	6478.54	0.84	7,900,374	5801.8	0.75	7,075,111	5451.31	0.71	6,647,699
8/31/2003	6367.33	0.83	7,764,757	5783.36	0.75	7,052,624	5434.7	0.71	6,627,444
9/1/2003	6416.71	0.83	7,824,974	5976.02	0.78	7,287,566	5243.24	0.68	6,393,965
9/2/2003	6379.05	0.83	7,779,049	6286.15	0.82	7,665,760	5210.1	0.68	6,353,551
9/3/2003	6320.5	0.82	7,707,649	6229.19	0.81	7,596,299	5158.74	0.67	6,290,919
9/4/2003	6199.13	0.80	7,559,642	6111.07	0.79	7,452,256	5052.01	0.66	6,160,766
9/5/2003	6031.75	0.78	7,355,527	5948.23	0.77	7,253,677	4905.05	0.64	5,981,553
9/6/2003	5881.46	0.76	7,172,254	5801.99	0.75	7,075,342	4773.04	0.62	5,820,571
9/7/2003	5768.74	0.75	7,034,795	5692.31	0.74	6,941,591	4674.01	0.61	5,699,807
9/8/2003	5701.68	0.74	6,953,018	5627.09	0.73	6,862,057	4615.26	0.60	5,628,163
9/9/2003	5585.25	0.72	6,811,035	5513.86	0.72	6,723,977	4513.26	0.59	5,503,777
9/10/2003	5478.7	0.71	6,681,100	5410.15	0.70	6,597,506	4894.16	0.63	5,968,273
9/11/2003	5398.05	0.70	6,582,750	5331.66	0.69	6,501,790	5098.82	0.66	6,217,849
9/12/2003	5312.99	0.69	6,479,022	5248.94	0.68	6,400,915	5024.28	0.65	6,126,950
9/13/2003	5227.83	0.68	6,375,172	5166.1	0.67	6,299,895	4949.58	0.64	6,035,855
9/14/2003	5143.48	0.67	6,272,310	5083.99	0.66	6,199,764	4875.36	0.63	5,945,347
9/15/2003	5144.54	0.67	6,273,603	5085.03	0.66	6,201,032	4876.3	0.63	5,946,493
9/16/2003	5102.55	0.66	6,222,398	5044.13	0.65	6,151,156	4839.24	0.63	5,901,299
9/17/2003	5023.62	0.65	6,126,145	4967.18	0.64	6,057,318	4769.26	0.62	5,815,961
9/18/2003	4872.97	0.63	5,942,432	4820.46	0.63	5,878,398	4636.32	0.60	5,653,845
9/19/2003	4786.81	0.62	5,837,363	4736.62	0.61	5,776,158	4560.6	0.59	5,561,507

Date	No Savings	Daily Flow (CFS)	kWh	2% Savings	Daily Flow (CFS)	kWh	10% Savings	Daily Flow (CFS)	kWh
9/20/2003	4744.75	0.62	5,786,072	4695.56	0.61	5,726,086	4523.04	0.59	5,515,703
9/21/2003	4684.59	0.61	5,712,709	4636.95	0.60	5,654,613	4469.88	0.58	5,450,877
9/22/2003	4645.84	0.60	5,665,454	4599.21	0.60	5,608,590	4435.63	0.58	5,409,110
9/23/2003	4636.38	0.60	5,653,918	4589.96	0.60	5,597,310	4427.12	0.57	5,398,732
9/24/2003	4634.51	0.60	5,651,638	4588.17	0.60	5,595,127	4425.63	0.57	5,396,915
9/25/2003	4593.06	0.60	5,601,091	4547.87	0.59	5,545,983	4389.36	0.57	5,352,685
9/26/2003	4588.24	0.60	5,595,213	4543.18	0.59	5,540,264	4385.14	0.57	5,347,539
9/27/2003	4588.94	0.60	5,596,066	4543.84	0.59	5,541,068	4385.64	0.57	5,348,149
9/28/2003	4568.09	0.59	5,570,641	4523.5	0.59	5,516,264	4367.12	0.57	5,325,564
9/29/2003	4590.89	0.60	5,598,444	4545.64	0.59	5,543,263	4386.92	0.57	5,349,709
9/30/2003	4606.11	0.60	5,617,005	4560.43	0.59	5,561,299	4400.2	0.57	5,365,904
10/1/2003	4403.17	0.57	5,369,526	4359.41	0.57	5,316,162	4205.92	0.55	5,128,986
10/2/2003	4405.15	0.57	5,371,940	4361.37	0.57	5,318,552	4207.83	0.55	5,131,315
10/3/2003	4361.6	0.57	5,318,833	4318.81	0.56	5,266,652	4168.76	0.54	5,083,670
10/4/2003	4345.73	0.56	5,299,480	4303.32	0.56	5,247,762	4154.57	0.54	5,066,366
10/5/2003	4338.73	0.56	5,290,943	4296.59	0.56	5,239,555	4148.78	0.54	5,059,305
10/6/2003	4334.01	0.56	5,285,187	4292.03	0.56	5,233,994	4144.77	0.54	5,054,415
10/7/2003	4292.24	0.56	5,234,250	4251.39	0.55	5,184,435	4108.14	0.53	5,009,746
10/8/2003	4284.26	0.56	5,224,519	4243.55	0.55	5,174,874	4100.76	0.53	5,000,746
10/9/2003	4261.98	0.55	5,197,349	4221.86	0.55	5,148,424	4081.14	0.53	4,976,820
10/10/2003	4230.17	0.55	5,158,558	4190.83	0.54	5,110,584	4052.87	0.53	4,942,346
10/11/2003	4192.45	0.54	5,112,560	4154.1	0.54	5,065,793	4019.61	0.52	4,901,787
10/12/2003	4158.41	0.54	5,071,049	4120.86	0.53	5,025,258	3989.17	0.52	4,864,666
10/13/2003	4129.89	0.54	5,036,270	4092.99	0.53	4,991,271	3963.56	0.51	4,833,435
10/14/2003	4038.98	0.52	4,925,408	4004.22	0.52	4,883,019	3882.32	0.50	4,734,366
10/15/2003	3848.56	0.50	4,693,197	3818.51	0.50	4,656,552	3713.11	0.48	4,528,020
10/16/2003	3781.23	0.49	4,611,090	3752.75	0.49	4,576,359	3652.86	0.47	4,454,547
10/17/2003	3764.6	0.49	4,590,810	3736.5	0.48	4,556,543	3637.94	0.47	4,436,352
10/18/2003	3741.69	0.49	4,562,872	3714.07	0.48	4,529,190	3617.21	0.47	4,411,073
10/19/2003	3744.06	0.49	4,565,762	3716.32	0.48	4,531,934	3619.04	0.47	4,413,304
10/20/2003	3756.41	0.49	4,580,823	3728.31	0.48	4,546,556	3629.78	0.47	4,426,401
10/21/2003	3714.22	0.48	4,529,373	3687.09	0.48	4,496,289	3591.94	0.47	4,380,257

Date	No Savings	Daily Flow (CFS)	kWh	2% Savings	Daily Flow (CFS)	kWh	10% Savings	Daily Flow (CFS)	kWh
10/22/2003	3392.14	0.44	4,136,607	3371.81	0.44	4,111,815	3300.26	0.43	4,024,562
10/23/2003	2745.15	0.36	3,347,623	2737.17	0.36	3,337,892	2709.18	0.35	3,303,759
10/24/2003	2572.01	0.33	3,136,484	2566.32	0.33	3,129,546	2546.35	0.33	3,105,193
10/25/2003	2327.05	0.30	2,837,764	2324.2	0.30	2,834,288	2314.23	0.30	2,822,130
10/26/2003	2133.72	0.28	2,602,004	2131.88	0.28	2,599,760	2125.43	0.28	2,591,894
10/27/2003	2058.47	0.27	2,510,239	2056.9	0.27	2,508,324	2051.39	0.27	2,501,605
10/28/2003	2051.02	0.27	2,501,154	2049.44	0.27	2,499,227	2043.91	0.27	2,492,483
10/29/2003	2030.29	0.26	2,475,874	2028.76	0.26	2,474,008	2023.39	0.26	2,467,460
10/30/2003	2025.13	0.26	2,469,582	2023.68	0.26	2,467,813	2018.59	0.26	2,461,606
10/31/2003	2009.48	0.26	2,450,497	2008.03	0.26	2,448,729	2002.94	0.26	2,442,522