1995 AGRICULTURAL ENERGY EFFICIENCY INCENTIVES PROGRAM

FIRST YEAR LOAD IMPACT EVALUATION

FINAL REPORT

Study ID No. 965

Prepared for

San Diego Gas & Electric
San Diego, California

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1 INTRODUCTION

1.1 INTRODUCTION

San Diego Gas & Electric (SDG&E) commissioned XENERGY Inc. to evaluate the first year load impacts of measures installed under its *1995 Agricultural Energy Efficiency Incentives (AEEI) Program*. These measures were installed to provide resource value by improving the energy efficiency of the facilities that participated in the *AEEI Program*.

The overall objectives of SDG&E's *1995 Agricultural Energy Efficiency Incentives Program First Year Impact Evaluation* were to:

- evaluate the gross and net load impacts of the measures installed at these facilities; and
- verify the physical installation of the measures identified in the program tracking system.

These objectives were accomplished using the following methodology:

- verifying the physical installation of the measures identified in the program tracking system (electronic and hard copy);
- gathering data through direct measurement, observation, and interviews with site personnel; and
- performing engineering analysis of energy impacts based on the data.

1.2 REPORT ORGANIZATION

The remainder of this report is organized as follows:

Section 2	Results
Section 3	Methodology
Section 4	Site specific analysis reports for Space Heating Measures
Section 5	Site specific analysis reports for Pumping Measures
Appendix A	*"Retroactive Waiver for 1995 Agricultural Energy Efficiency Incentives Program"*
Appendix B	Table 6: Space Heating: Protocols for Reporting of Results of Impact Measurement Studies Used to Support an Earnings Claim, Space Heating
Appendix C	Table 6: Pumping Measures: Protocols for Reporting of Results of Impact Measurement Studies Used to Support an Earnings Claim, Pumping
Appendix D	Table 7: Documentation Protocols for Data Quality and Processing

2 RESULTS

This section presents the results of the *First Year Load Impact Evaluation of SDG&E's 1995 Agricultural Energy Efficiency Incentives Program* for agricultural measures installed during Program Year 1995 (PY95).

2.1 OVERVIEW

Each of the 28 *agricultural* measures installed during PY95 were included in this study. These measures were installed at 11 premises as defined by the Premise ID on SDG&E's program tracking system. Physically, two of the premises, comprising three of the space heating measures, were on the same property. Of these measures, ten were categorized as Pumping Measures, four were Space Heating Measures, and 14 were exit signs. Per SDG&E's "Retroactive Waiver" (Appendix A), the four space heating measures were classified as Space Heating Measures, while the fourteen exit signs were classified as Miscellaneous Measures.

The Space Heating and Pumping Measures were evaluated using engineering models with on-site verification of key engineering inputs. The installation of the Miscellaneous Measures was verified through on-site inspection. Site-specific analyses are documented in Section 4, Space Heating Measures, and Section 5, Pumping Measures.

Section 2.2 presents the results of the First Year Load Impacts for the Space Heating Measures. Section 2.3 presents the results of the First Year Load Impacts for the Pumping Measures. Section 2.4 discusses the findings of the on-site verifications for the Miscellaneous Measures.

2.2 SPACE HEATING MEASURE LOAD IMPACTS

This section presents the estimation of gross impacts of the *Impact Evaluation of SDG&E's 1995 Agricultural Energy Efficiency Incentives Program.* Site-specific engineering models and analysis were used to estimate the impacts for the four agricultural space heating measures installed under SDG&E's 1995 Agricultural Energy Efficiency Incentives Program using the methodology described in Section 3. Table 2-1 presents the results of the evaluation for space heating measures.

2.2.1 Measure Descriptions: Space Heating Measures

Three of the measures were considered new installations; i.e., they did not take the place of existing equipment, and one was a retrofit.

The four space heating measures accounted for *ex ante* natural gas savings of 29,043 therms per year.

Three of the measures were installed at the same site. These measures installed under ID Nos. 14097, 14155 and 14156 were part of a 42,000 square foot greenhouse expansion. Each of these measures was designed to reduce the amount of natural gas space heating required to maintain the greenhouse at the proper growing temperature by increasing the insulation in the greenhouse.

One measure was installed to provide heating for the plants through tubing located near the plants. Hot water is circulated through the tubing, heating the ground and air surrounding the plant. This measure was designed to reduce the use of convection space heating fueled by natural gas by placing the heating source (tubing) close to the plants.

2.2.2 Gross Load Impacts: Space Heating Measures

The gross impact analysis was conducted using site-specific engineering models. The analysis used inputs that were verified by through observation, measurement, monitoring, site interviews, and other records provided during the evaluation. The analysis for each site may be found in Section 4.

The *ex ante* impact estimates were obtained from the program tracking database and the *ex post* estimates were developed through the engineering analyses of this study.

Realization rates were estimated as defined in the Table 6 of the M&E Protocols. The realization rate is defined in Equation 2-1.

$$R = \frac{P}{A} \qquad \text{(Eq. 2-1)}$$

where,

R = *Realization rate for the measure,*

P = *Load impacts estimated by the Study (Ex post impact estimate for the measure), and*

A = *Load impacts filed in a utility's first year earnings claim (Ex ante impact estimate for the measure).*

As shown in Table 2-1, overall, a total of savings of over 42,000 therms was estimated *ex post*. Thus, approximately 46 percent greater therm savings were realized than the *ex ante* natural gas energy savings of 29,043 therms.

2.2.3 Net Load Impacts: Space Heating Measures

The net-to-gross ratio used for this analysis is 0.75 as approved by CADMAC through SDG&E's Retroactive Waiver (Appendix A). Table 2-1 shows the net impacts of the AEEI Space Heating Measures.

Table 2-1
AEEI Space Heating Measures
Load Impacts
PY95

			Ex Ante Gross Impacts				*Ex Post* Gross Impacts		*Ex Post* Net Impacts		
Measure Type	**ID #**	**Measure Description**	**Hours of Operation**	**kWh Saving**	**kW Reduced**	**Therm Savings**	**Therm Savings**	**Real. Rate**	**Net-To-Gross Ratio**	**Net Impacts**	**Real. Rate**
Space Heating	14097*	Thermal Blanket	4,380	0	0	13,718	9,966	0.73	0.75	7,475	0.54
Space Heating	14155*	IR Poly	4,380	0	0	4,942	5,337	1.08	0.75	4,003	0.81
Space Heating	14156*	Wall Insulation	4,380	0	0	5,186	4,799	0.93	0.75	3,599	0.69
Space Heating	14406	Heat Tubing for Main Source of Heating	5,832	0	0	5,197	22,210	4.27	0.75	16,658	3.21
Total Space Heating Load Impacts				0	0	29,043	42,312	1.46		31,734	1.09

* ID #'s 14097, 14155 and 14156 were installed at the same site.

2.2.4 Discrepancy Analysis: Space Heating Measures

The reasons for deviations between *ex ante* and *ex post* load impacts for space heating measures are difficult to identify. For the three measures installed at a single site the total realization rate is 0.84. From a modeling perspective, these results are quite good. The causal reasons for the deviations cannot be specifically identified and the *ex ante* estimates are deemed to be reasonable. The input files for the measures for the DOE-2 model were verified through discussions with industry experts on thermal loads and the manner in which the measures function. The measures are performing essentially as intended and that the deviations are within reasonable tolerances for these types of measures.

The realization rate for the heat tubing (ID No. 14406) was very high, 4.27. Again, the reasons for the differences in the estimations are difficult to pinpoint. Part of the problem is due to the calculations used to estimate the *ex ante* estimates. Some factors may have been left out unintentionally in calculating the savings. The operations of the greenhouse and prevailing climactic conditions may have been influential factors that were not included in the *ex ante* analysis. Nonetheless, natural gas is being saved through the installation of the measure, just more than was originally expected.

2.3 Pumping Measure Load Impacts

This section presents the estimation of gross impacts of the *Impact Evaluation of SDG&E's 1995 Agricultural Energy Efficiency Incentives Program.* Site-specific engineering models and analysis were used to estimate the impacts for the ten (10) agricultural pumping measures installed under SDG&E's 1995 Agricultural Energy Efficiency Incentives Program.

The gross impacts for energy and demand were estimated *ex post*, where appropriate. The *ex post* gross impacts were compared to *ex ante* impact estimates through realization rates for each site. The designated unit of measurement (DUOM) is horsepower per the retroactive waiver approved by CADMAC on September 19, 1996 (Appendix A).

2.3.1 Measure Descriptions

Three projects were considered new installations, three were retrofits of existing equipment, and four were replacements of worn-out equipment.

Nine of the measures were motors purchased through SDG&E's Energy Efficient Motor Program.

Based on the AEEI program tracking system, the measures accounted for almost 275,000 kWh's in total electricity savings and 9.43 kW in demand benefits.

Table 2-2
SDG&E's AEEI Pumping Measures
Load Impacts
PY95

		Ex Ante Impact Estimates			*Ex Post* Gross Impact Estimates			*Ex Post* Net Impacts		
ID #	**Horse-power**	**Hours of Op.**	**kWh Savings**	**kW Reduced**	**Hours of Op.**	**kWh Savings**	**kW Reduced**	**Net-To-Gross**	**kWh Saved**	**kW Reduced**
19010	2@25	4,000	4,800	0.90	674	185	0.13	0.75	139	0.10
19074	60	4,000	4,293	0.80	242	44	0.23	0.75	33	0.17
19086	75	4,000	5,366	1.01	10	13	1.32	0.75	10	0.99
19092	3@75	4,000	16,098	3.03	1,506	6,201	4.41	0.75	4,651	3.31
19119	75	4,000	5,366	1.01	1,551	1,031	0.66	0.75	773	0.50
19176	200	4,000	14,310	2.68	5,096	23,150	4.44	0.75	17,363	3.33
13974	75	8,500	224,530	0	8,760	120,206	0	0.75	90,155	0.00
Total	**760**		**274,763**	**9.43**		**150,830**	**11.19**		**113,123**	**8.39**
Realization Rate						**0.55**	**1.19**		**0.41**	**0.89**

2.3.2 Gross Load Impacts: Pumping Measures

The gross impact analysis was conducted using site-specific engineering models. The analysis used inputs that were verified through observation, measurement, monitoring, site interviews, and other records provided during the evaluation. The analysis for each site may be found in Section 5.

Table 2-2 provides a summary of the gross and net impact analysis. The *ex ante* impact estimates were obtained from the program tracking database and the *ex post* estimates were developed through the engineering analysis of this study.

Realization rates were estimated as defined in the Table 6 of the M&E Protocols. The realization rate is defined Equation 2-1.

As shown in Table 2-2, the gross realization rate was 0.55 for kWh savings. Overall, a total savings of over 150,800 kWh's was estimated *ex post*. Thus, approximately 55 percent of the *ex ante* electricity energy savings were realized during the first year of installation as measured through this study. The result for electric demand impacts was a little different, where a gross realization rate of 1.19 was estimated.

2.3.3 Net Load Impacts: Pumping Measures

The net-to-gross ratio used for this analysis is 0.75 as approved by CADMAC through SDG&E's retroactive waiver (Appendix A). Table 2-2 shows the net load impacts of the AEEI Pumping Measures.

The Designated Unit Of Measurement (DUOM) as allowed by the retroactive waiver for Pumping Measures is horsepower. Table 2-3 shows the impacts per DUOM for gross and net impacts for Pumping Measures.

Table 2-3
AEEI Program Pumping Measures
Gross and Net Impacts Per Designated Unit Of Measurement (DUOM)

	DUOM (Impacts per Horsepower)
Gross kWh per HP	198.4605
Net kWh per HP	148.8454
Gross kW per HP	0.0147
Net kW per HP	0.0110

2.3.4 *Discrepancy Analysis: Pumping Measures*

The primary reason for discrepancies between *ex ante* and *ex post* energy impact estimates for motors was due mainly to differences in the hours of operation. For each measure, except ID No. 13974, the *ex ante* estimates were based on the standard Energy Efficient Motor Program hours of operation of 4,000 hours per year. Since this was a standard value, it was expected that there would be deviations in the hours of operation. The average realization rate for hours of operation was 0.47. This corresponds with the overall realization rate for kWh of 0.55. The lower realization rate for the hours of operation offsets part of the 1.19 realization rate for kW, when the kWh impacts are calculated. The high realization rate for kW is due in part to the loadings on the motor, which were measured to be greater than those used in the *ex ante* estimates.

2.4 Miscellaneous Measures On-Site Verification

The only Miscellaneous Measures in SDG&E's 1995 AEEI Program were 14 exit sign kits. These exit signs were installed at a single facility. The installation of each of the exit sign kits was verified. Table 2-4 shows the *ex ante* energy impacts and the *ex post* verified measure quantities.

Table 2-4
SDG&E's AEEI Miscellaneous Measures
PY95

			Ex Ante				*Ex Post*
Measure Type	**ID No.**	**Measure Description**	**Hours of Operation**	**kWh Savings**	**kW Reduced**	**Quantity**	**Quantity**
Miscellaneous	14274	Exit Sign Kit (LED)	8,760	2,943	0.34	14	14
Total Miscellaneous Measures				**2,943**	**0.34**	**14**	**14**

3 METHODOLOGY

This section describes the methodology used by XENERGY in conducting SDG&E's *1995 Agricultural Energy Efficiency Incentives Program First Year Load Impact Evaluation.*

3.1 OVERVIEW

The approach used to conduct the *Evaluation* utilized end-use **engineering models** with verified input assumptions. Measurements of equipment performance and monitoring of equipment operations were performed to refine the inputs into the engineering models developed for each measure. The methodology used for this study deviates from Table C-6 of *the Protocols and Procedures For the Verification of Costs, Benefits, and Shareholder Earnings From Demand-Side Management Programs* (Protocols) based on the retroactive waiver approved by CADMAC on September 19, 1996 (Appendix A). The retroactive waiver allowed the following:

1. A comparison group did not have to be used to determine net load impacts for the PY95 AEEI Program. In place of a comparison group, a net-to-gross ratio of 0.75 was adopted for these measures.
2. The designated unit of measurement (DUOM) for this impact study for Pumping Measures was horsepower instead of acre foot of water pumped stated in the M&E Protocols.
3. The four heating measures (normally classified as miscellaneous measures) are to be evaluated as a separate end use, Space Heating, using on-site verification of engineering estimates. The heating measures will be evaluated on a savings per project basis.
4. Exit signs will be treated as Miscellaneous Measures per Table C-9, with on-site verification of installation.

3.2 DESCRIPTION OF THE APPROACH

This section describes the approach and tasks used to conduct the site-specific impact studies for the AEEI Program.

3.2.1 Task 1: Gather Available Site Data

Site data were gathered and compiled from available sources. Typically, these sources included hard copies of customer applications, SDG&E workpapers, design reports, invoices, and pre- and post-field surveys. A site profile was developed from which an evaluation plan was designed.

3.2.2 Task 2: Develop Site Evaluation Plan

The initial evaluation plan for each site was developed by XENERGY and submitted to SDG&E for review.

An example of the *general* work flow is displayed as Figure 3-1.

Evaluation Approach and Methodologies

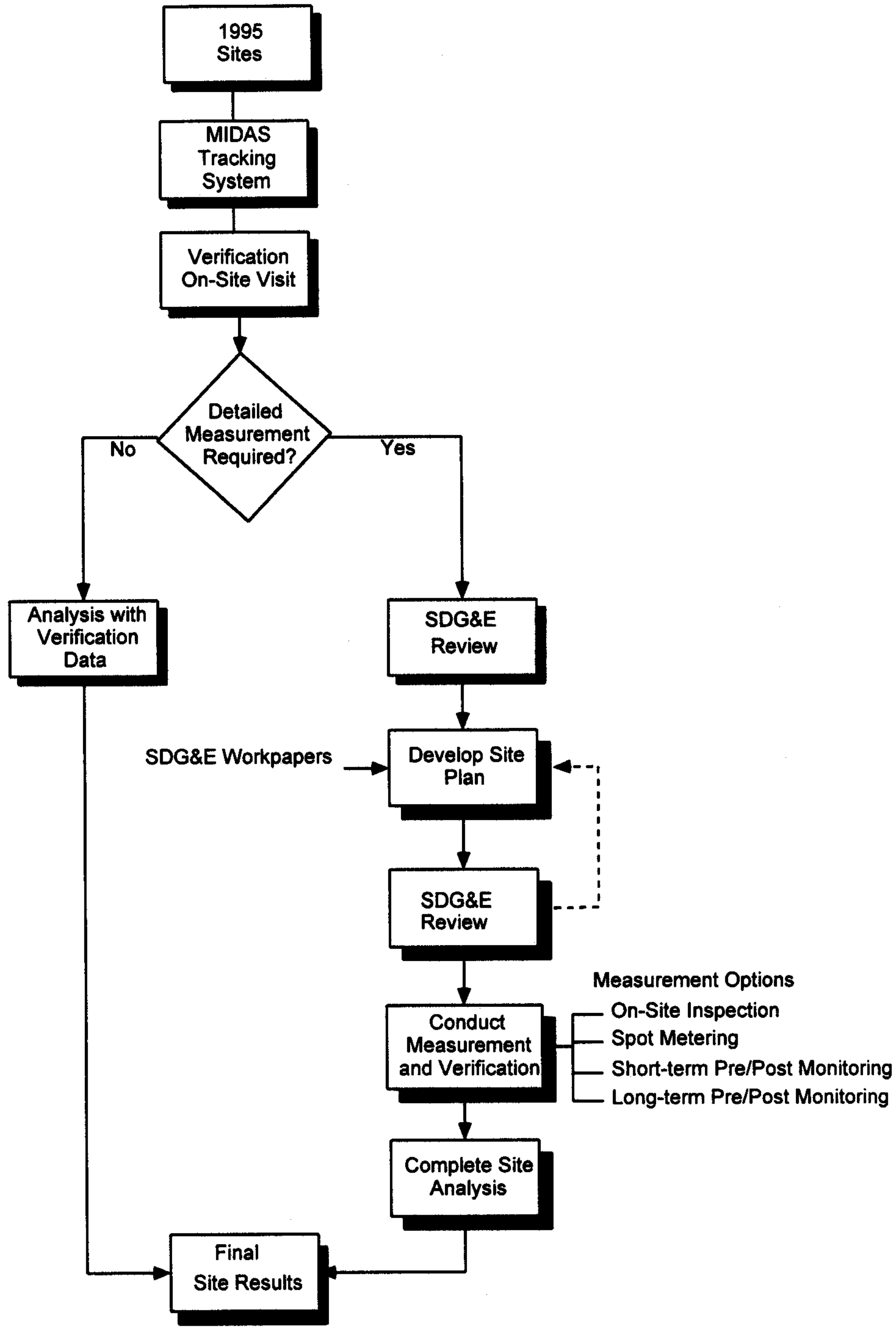
The measurement approach must take into account the various types of technologies, processes, and operations schedules found in the agricultural sector.

To meet the impact measurement needs of this project, appropriate combinations of the following tools were used:

- engineering models and analysis;
- equipment data collection tools and methods;
- on-site surveys; and
- short-term metering and spot measurements.

On-site surveys were conducted to verify the installation of the measures, and to verify or improve the engineering assumptions that were made to estimate *ex ante* load impacts. Previously collected data was used to help reduce the scope of the on-site data collection effort, where feasible. Project documentation provided by SDG&E was the primary source for engineering calculations of *ex ante* energy impact estimates in most cases.

Figure 3-1
General Study Work Flow



3.2.3 *Task 3: Conduct Site-Specific Analysis of AEEI Program Projects*

Site-specific analyses were completed for all participants of *SDG&E's 1995 Agricultural Energy Efficiency Incentives Program* that installed measures classified as agricultural.

Sub-Task 3a: Develop Project-Specific Evaluation Plan

Individual evaluation plans were developed for each AEEI Program participant and summarized in spreadsheet form. Each site plan was developed individually using the appropriate methodology as discussed in Section 3.2.2.

The plan included descriptions of the:

- measure;
- verification methodology;
- verification data requirements; and
- data acquisition plan.

Sub-Task 3b: Determine Gross Site-Specific Impacts

On-Site Data Collection

All on-site data collection activities were conducted during September 1996. Measure installations were verified, measurements were taken to support load impact estimation, and other on-site data were collected via interview with site personnel and inspection of operating records.

Gross impacts were calculated on an individual project basis.

Estimating Base Case Motors For Pumping Measures

For those pumping sites where the new motor was a *retrofit of a working motor*, the description of the old motor from the Energy Efficient Motor Program Customer Enrollment Form ("Enrollment Form") was used as the base case. However, for those motors where: (1) the new motor was *replacing a burned out unit*, (2) for those sites where a *new facility or application* was indicated on the "Enrollment Form," or (3) those measures where the old motor information was not provided on the "Enrollment Form," a base case motor representing an "average" motor that would typically be purchased over the counter was developed using the following procedures.

Baseline (standard) motor efficiency data is obtained from the MotorMaster+ database (Washington State Energy Office, 1996). This database contains cost and efficiency data on more than 10,000 NEMA Design B motors. Baseline motor data was chosen by searching the database for motors with efficiencies less than the NEMA 12-6B standard and selecting the motor with the median efficiency at 100% load. Efficiency and Power Factor curve data were available for load conditions from 25% to 100% in quartile increments.

A site analysis was developed for each project. The report includes the following for each site:

- description of project;
- *ex post* impact estimation methodology;
- *ex ante* impact estimation methodology;
- discussion of differences in methodologies;
- data collection;
- data sources; and
- comparison of *ex post* estimates to *ex ante* initial estimates.

Estimating The Load Impacts For Space Heating Measures

Three space heating measures, ID Nos. 14097, 14155 and 14156, were installed at a single site. Load impacts were estimated by estimating pre- and post-retrofit loads through a DOE-2 simulation model. The base case was developed using the physical configuration and thermal characteristics of the as-built structure, adjusting for the measures installed. The base case was calibrated to an estimate base case load of 42,000 therms per year. This is equivalent to one (1) therm per square foot as used in the program engineering analysis. The load impacts for each measure were estimated through parametric analysis using the calibrated DOE-2 model.

The *ex post* load impact for the fourth space heating measure, ID No. 14406, was estimated using an analysis of gas billing data. It was determined that the gas billing meter for the facility was dedicated to the space heating end use for the greenhouse facility. A regression analysis using weather adjustments was used for this measure.

3.2.4 Task 4: Estimate Total Gross Impacts

Gross impacts were estimated for the PY95 agricultural DSM measures. This includes total gross kW, kWh and Therm impacts, as appropriate. Realization rates were calculated for each type of measure as defined in Table 6 of the M&E Protocols, where it is defined as "the load impacts estimated by the Study, divided by the load impacts filed in a utility's first year earnings claim."

Integrate Site-Specific Gross Impacts

After the individual impacts from each project were estimated, XENERGY aggregated the results to estimate total program gross impacts.

3.2.5 Task 5: Determine Total Net Impacts

A net-to-gross ratio of 0.75 was used to determine net impacts as allowed by the retroactive waiver. The net-to-gross ratio was combined with the gross program savings estimate to calculate the net impacts on a program basis.

4 SPACE HEATING MEASURES

4.1 INTRODUCTION

This section provides the site specific analyses for the space heating measures installed under SDG&E's 1995 Agricultural Energy Efficiency Incentives Program.

4.2 ID NO. 14097, 14155, 14156: SPACE HEATING MEASURES INSTALLED IN ONE GREENHOUSE

Three measures were installed at a single greenhouse facility. These measures were wall insulation, a thermal blanket insulation, and IR polyethylene on an inner layer of double-polyethylene roof.

4.2.1 Facility Information and Base Case Assumptions

The facility is a 49,280 square foot greenhouse located in Fallbrook, California. Of the total floorspace, 43,680 square feet is conditioned greenhouse space and 5,600 square feet is unconditioned space. Evaporative cooling equipment is located in the unconditioned area. Seventy five percent of the greenhouse area is covered with movable light metal tables that are used to hold the greenhouse plants.

Heating is provided by 15 gas-fueled unit heaters, located along the north wall. Each has a capacity of 200 kBtu/hour. The heating setpoint is 72° F. Cooling is provided by an evaporative system and the cooling set point is 82° F. The setpoints are determined by the growing technological requirements, which require temperature conditions between 72° F and 85° F. The heating system is operated year around.

4.2.2 Energy Efficiency Measures Installed

The energy efficiency measures installed are described below.

Wall insulation: Space heat lost was reduced by adding insulation to the greenhouse exterior walls. Several studies showed reductions of nine percent in overall fuel use by installing one-inch thick expanded polystyrene insulation in greenhouses in California. Two-inch thick expanded polystyrene with an overall R-value of 10 was applied to the interior surface of the 1/16-inch galvanized sheet metal to create the exterior walls of the greenhouse part of the facility.

IR polyethylene on inner layer of double-polyethylene roof: This facility already had an energy efficient double polyethylene inflated roof. The lower polyethylene (poly) layer of the double-poly inflated roof was replaced with IR polyethylene. The IR polyethylene layer absorbs infrared rays in the ranges between 7 to 14 microns, which results in increased heat retention during colder weather conditions. Research studies indicated fuel savings of between 14 percent to 18 percent. Greater savings for facilities in San Diego County were projected, since overnight the sky is often clear and the heat losses due to the sky temperature depression are greater. The material called Tri-Layer Greenhouse film is manufactured by Klerk's Plastic Products Manufacturing, Inc., under the brand names Koolite 380 and NGC AC.

Thermal Blanket Insulation: Thermal blanket insulation was put below the roof structure to create a dead air space between the blanket and roof material, approximately 12-feet above the greenhouse floor. Thermal blankets reduce the volume of greenhouse space to be heated and reduce some of the low-temperature radiation heat loss from the greenhouse space. The blanket is 1/8-inch thick opaque plastic with a reflective coating on the interior side. It is manufactured by Agricultural Constructions Limited from Great Britain and is defined by the manufacturer as an automatic, tube driven, truss to truss, flat shaped, single system. The blanket is in place in the evening and withdrawn in the morning, either automatically or manually.

4.2.3 Ex Ante Load Impact Estimation Methodology

The approaches used to estimate the *ex ante* impacts of the three measures are described in this subsection. The estimation of the baseline and impacts are described for each measure.

Wall Insulation: Energy use for a similar building (proxy) was used to estimate base case energy. This building was a 107,568 square foot building with annual gas usage of 114,792 therms per year. This resulted in an energy use index (EUI) of 1.067 therms per square foot per year. The subject building was a 42,000 square foot structure. Annual energy use for the subject building was estimated by multiplying the EUI by the square footage. Thus, the annual energy use was estimated to be 44,814 therms per year.

The efficiency rating of the space heating equipment was 70 percent. The base case insulation had an R-value of 1.0. The retrofit insulation had an R-value of 10.0. Expected heat loss through the walls of a greenhouse was assumed to be nine percent of the total energy. Thus, energy impacts for the measure are shown in Equation 4-1 through 4-4.

$$\begin{aligned} \textit{Heat Loss Through Walls}_{\textit{Base Case}} &= 0.09x44{,}814 \textit{ therms / year} \\ &= 4{,}033 \textit{ therms / year} \end{aligned} \qquad \text{(Eq. 4-1)}$$

$$\begin{aligned} \textit{Heat Loss}_{\textit{Retrofit}} &= \frac{1}{R-value} \textit{xHeat Loss Through Walls}_{\textit{Base Case}} \\ &= \frac{1}{10} x4{,}033 \textit{ therms / year} \\ &= 403 \textit{ therms / year} \end{aligned} \qquad \text{(Eq. 4-2)}$$

$$\begin{aligned} \textit{Heat Loss Reduced} &= \textit{Heat Loss Through Walls}_{\textit{Base Case}} - \textit{Heat Loss}_{\textit{Retrofit}} \\ &= 4{,}033 - 403 \\ &= 3{,}630 \textit{ therms / year} \end{aligned} \quad \textit{(Eq. 4-3)}$$

$$\begin{aligned} \textit{Therm Savings} &= \frac{(\textit{Heat Loss Reduced})}{\textit{Space Heating Efficiency}} \\ &= \frac{(3{,}630)}{0.70} \\ &= 5{,}186 \textit{ therms / year} \end{aligned} \quad \textit{(Eq. 4-4)}$$

IR polyethylene on inner layer of double-polyethylene roof: Base case energy use was taken from the analysis shown for wall insulation in the previous subsection. The base case energy use of 41,184 therms per year was calculated by subtracting *the Heat Loss Reduced* from *Annual Energy Use* of 44,814 therms per year, resulting in 41,184 therms per year. This method ignored the efficiency of the space heating equipment and tended to overstate the base case energy use for this measure.

Research conducted at Cornell University and Rutgers University indicates energy savings due to IR polyethylene of 14 percent and 18 percent, respectively. A conservative value of 12 percent savings was used to estimate *ex ante* impacts. Existing gas consumption was estimated to be 41,184 therms per year. The savings calculations are shown in Equation 4-5.

$$\begin{aligned} \textit{Savings}_{\textit{ex ante}} &= 41{,}184 \textit{ therms / year } x \; 0.12 \\ &= 4{,}942 \textit{ therms / year} \end{aligned} \quad \textit{(Eq. 4-5)}$$

Thermal Blanket Insulation: Natural gas usage for a similar facility (proxy) was used to develop the base case for the subject facility. The construction characteristics of the two buildings were similar. The proxy building was an 84,000 square foot building with a dedicated gas meter and a similar heating system. The annual gas consumption for the proxy building was 78,386 therms per year. The subject building was 42,000 square feet. Annual gas usage was estimated to be half of that for the proxy building. Thus, energy use was estimated at 39,193 therms per year.

Published reports on energy use greenhouses indicated that thermal blankets can reduce energy use by 35 percent to 57 percent. The *ex ante* estimate used the most conservative figure, 35 percent savings. The savings calculations are shown in Equation 4-6.

$$\begin{aligned} \textit{Savings}_{\textit{ex ante}} &= 39{,}193 \textit{ therms / year } x \; 0.35 \\ &= 13{,}718 \textit{ therms / year} \end{aligned} \quad \textit{(Eq. 4-6)}$$

4.2.4 Ex Post Load Impact Estimation Methodology

The site was visited on Monday September 9, 1996. The installation of the retrofit measures was inspected, an interview of facility staff was performed, and an inventory of equipment and the structure were collected during the site visit. This information was used to develop an engineering analysis based on a DOE-2.1E hourly simulation model of the facility. Typical Meteorological Year (TMY) Weather for CEC Zone 10, adjusted for Fallbrook conditions, was used for the simulation.

Since more than one greenhouse were served by the gas meter, gas billing data were not available for only the subject greenhouse. Annual fuel use for two groups of greenhouses located in the same place, and with the same operating pattern was available from the application forms. Both sets of data show consistently a normalized fuel consumption of approximately one (1) therm/square foot/year. This figure is consistent with other available information on annual fuel use for greenhouses in this climate area. The DOE-2.1E simulation for the base case greenhouse was calibrated within nine percent of expected gas consumption based on the assumption of one therm/square foot/year.

The analysis approach comprised the following steps:

1. An on-site visit was conducted on September 9, 1996. Detailed inventory of building physical dimensions, envelope characteristics, loads, and HVAC equipment were collected. Data on operating schedule and control strategy were collected by observation and interview with the facility maintenance staff.
2. Constructed Visual DOE Loads Model of the facility using observed loads and schedules obtained by observation and interview. The DOE model was customized to reflect actual greenhouse zone loads and schedules.
3. Collected manufacturer's data and energy consumption information on the envelope parts influenced by the energy improvement changes. These data were used to refine the DOE input file.
4. Developed a base case model with as-built building characteristics and a subset of models representing the energy efficiency measures applied.

Base Case Building Definition

The base case building reflects the geometrical and the thermal characteristics of the as-built facility except for the energy efficiency improvements. The base case assumptions for the envelope are:

- The exterior walls are assumed to be built of polyethylene material with an R-value of 1.0.
- The roof is made of double polyethylene inflated and is modeled as a fenestration structure with characteristics based on the manufacturer's data (shading coefficient of 0.145 and a U-value of 0.29).

- The floor is 8-inch concrete.
- The wall between the greenhouse and the unconditioned section has R-10 insulation.
- The space heating was modeled with an equivalent heating temperature setpoint of 80° F to reflect the air stratification problems and the space at the perimeter of the greenhouse.

Retrofit Building Definition

Envelope improvement cases include the following changes:

1. The first model differs from the base case by the configuration of the exterior walls. The exterior walls are modeled as-built with an overall R-value = 10.0, which represents 2-inch thick expanded polystyrene insulation.
2. The second model is different from the base case with the replacement of the lower polyethylene layer of the double polyethylene inflated roof with IR polyethylene. Based on the manufacturer's data, an average increase 25 percent increase in the shading coefficient was applied to reflect the characteristics of the IR polyethylene.
3. The third model differs from the base case by the thermal blanket presentation. A typical seasonal operating schedule for the thermal blanket system was developed using the reported operating hours. Based on the literature data, an average reduction of 50 percent in the roof U-value was applied during the period when the thermal blanket is rolled over the greenhouse space. Simultaneously the shading coefficient was reduced by half which applies to the daytime operation of the thermal blanket system.

Ex Post Energy Savings

Annual fuel savings results are presented in Table 4-1. Equation 4-7 was used to calculate the fuel savings resulting for each alternative.

$$Gross\ Savings = Therms_{BaseCase} - Therms_{Retrofit} \qquad (Eq.\ 4\text{-}7)$$

Table 4-1
Fuel Savings Results
ID No. 14097, 14155, 14156

		Ex Ante Impacts	*Ex Post* Impacts	
ID No.	Measure	Therms per Year	Therms per Year	Realization Rate
14156	Wall Insulation	5,186	4,799	0.93
14155	IR Polyethylene	4,942	5,337	1.08
14097	Thermal Blanket	13,718	9,966	0.73
	Total Site	23,846	20,102	0.84

4.2.5 Comparison of Ex Ante and Ex Post Methodologies and Results

Ex ante fuel savings were estimated for each measure separately. By comparison with the *ex post* estimates, the *ex ante* methodology overestimates the therm savings for the wall insulation and thermal blanket measures such that the gross realization rates are 0.93 and 0.74, respectively. The *ex ante* impact estimation methodology for the IR polyethylene measure underestimates the therm savings for the measure such that the gross realization rate is 1.08.

The following summarizes the possible reasons for differences between the *ex ante* and *ex post* calculations:

- The total *ex ante* base case greenhouse fuel use is based on gas usage of similar greenhouse facilities that may have differed somewhat from the subject greenhouse in construction or operation.
- The *ex ante* estimates were based on research results and used savings fractions from those studies. The fractions used were, however, fairly conservative and were not chosen to intentionally inflate savings estimates.
- The *ex post* base case greenhouse fuel use is based on the as-built description that accounts for site specific characteristics that were missing from the *ex ante* analysis.

While there are differences between the *ex ante* and *ex post* impact estimates, the overall absolute and relative savings for the *ex ante* and *ex post* are comparable.

4.3 ID No. 14406: Radiant Hot Water Tubing To Take The Place Of Natural Gas Space Heaters

4.3.1 Facility Information and Base Case Assumptions

This facility is a conditioned (heated) 90,000 square foot greenhouse. Prior to the installation of the measure, the space heating needs of the building were met with natural gas space heaters in combination with radiant hot water tubing heated by a central boiler. Radiant heat tubing is used to circulate hot water produced by the boiler throughout the greenhouse close to the plants, thereby warming the air and replacing heat provided by gas-fired space heaters. The greenhouse is divided into three zones that were of equal size (approximately 30,000 square feet) and have varying amounts of radiant heat tubing. Table 4-2 shows the three zones and the space heating shares.

Table 4-2
Space Heating Shares By Building Zone
ID No. 14406

	Space Heating Share	
Zone	Radiant Tubing	Gas-Fired Space Heaters
1	40%	60%
2	40%	60%
3	75%	25%

4.3.2 Energy Efficiency Measures Installed

It was assumed in the base case system that a fair amount of heat was being lost via air circulation and exhaust air. Supplementing the space heaters with additional radiant hot water tubing would shift the heating load to the central boiler and reduce the gas consumption while continuing to meet the heating need for the plants.

By increasing the share of space heating provided through radiant hot water tubing the facility would save natural gas. Therm savings were based on the following assumptions:

1. By increasing the amount of radiant tubing to their system, heating load would be shifted to the central boiler, which operates more efficiently than the space heaters.
2. By locating the radiant tubing beneath the plants, more heat would reach the plants and less would be lost through diffusion due to exhaust and fresh air circulation.

Zones 1 and 2, representing a total of 60,000 square feet were retrofit with additional radiant tubing. The tubing was laid throughout the space.

4.3.3 Ex Ante Load Impact Estimation Methodology

A customer-prepared estimate was used for the *ex ante* impact estimates. Some monitoring was performed on the greenhouse to determine the run time of the boiler and the space heaters for the three zones. Since there was a portion of the greenhouse where the radiant tubing had already been added, a comparison was possible between the existing and proposed retrofit conditions. A comparison was made using the boiler and space heater run time data for the different zones. Consumption for zones with radiant tubing space heating shares of 40 percent and 75 percent were estimated. The difference between these two consumption estimates was used as the *ex ante* therm savings estimate.

4.3.4 Ex Post Load Impact Estimation Methodology

The site was visited on Tuesday, September 10, 1996. The installation of the retrofit measures was inspected and an interview with facility staff was conducted. Weather data for the region was obtained from the National Weather Service. Gas billing data was obtained for the period December 1994 to September 1996. The gas meter served only this greenhouse and only the equipment affected by this measure.

Thus, the billing data were used to estimate gas savings after adjusting for the impacts of weather on gas usage. A regression model approach to evaluate the impact of the retrofit measure was used for *ex post* impact estimate. Heating degree days were summed for each billing period (month). This information was then compared with monthly billing data.

The regression analysis provided a non-linear model that would reliably predict monthly therm consumption as a function of the square root of the monthly heating degree days. The model also took the measure installation date into consideration.

4.3.5 Comparison of Ex Post and Ex Ante Load Impact Estimates

Table 4-3 shows the *ex ante* and *ex post* energy impact estimates due to the installation of radiant tubing. The realization rate of 4.27 indicates that the *ex ante* estimates were underestimated by a factor of four times.

Table 4-3
Energy Impacts
ID No. 14406

	Gas Savings Therms
Ex Ante Impacts	5,197
Ex Post Impact	22,210
Difference	17,013
Realization Rate	4.27

The possible differences between the *ex ante* load impact estimates and the *ex post* estimates are attributed to the following causes:

1. Inaccurate monitoring data for the *ex ante* estimates.
2. Weather conditions were not considered for the *ex ante* estimates.
3. Changes in boiler performance due to increased load and extreme weather were not considered in the *ex ante* estimates.

The concept and assumptions of why this measure produces therm saving is plausible. However, trying to accurately quantify the advantages of radiant tubing versus space air heating is a difficult task. Effectively, the gas meter provided end use metering, since the gas meter was dedicated to the equipment that provided the space heating for the building (the space heaters and a boiler). Thus, the gas billing data, albeit monthly, accurately represented the operation of the facility in both its *ex ante* and *ex post* configurations. By creating an empirical relationship between weather and facility gas consumption, the conclusion that the new heating system operated more efficiently than originally predicted could be made.

5 PUMPING MEASURES

5.1 INTRODUCTION

This section presents the site-specific analyses for each of the pumping measures installed under SDG&E's 1995 Agricultural Energy Efficiency Incentives Program. Each of the seven participant sites is represented by an identification number (ID No.). A total of ten pumping measures was included in the study. One site had two measures installed and another had three measures installed.

5.2 GENERAL METHODOLOGY

This section provides an overview of the *ex ante* and *ex post* methodologies and general equations for evaluating the load impacts of the pumping measures.

5.2.1 Ex Ante Load Impact Estimation Methodology

Each of the pumping measures except for ID No. 13974, was installed as part of SDG&E's Energy Efficient Motor Rebate Program. Under this program, the nonresidential market in San Diego was targeted. Open Drip-Proof (ODP) and Totally Enclosed Fan-Cooled (TEFC) motors from 1 to 200 HP were included in the program. These motors were single-speed energy efficient motors. A method documented by EPRI[1] was used to estimate *ex ante* impacts for single-speed motors. Equations 5-1 and 5-2 were used to estimate *ex ante* load impacts, using standard assumptions regarding the operations of the motors. Among these assumptions were 4,000 hours of operation annually and rated load factor for base and energy efficient motors of 0.75.

ID No. 13974 was an adjustable speed drive and was installed under SDG&E's C/I Incentives Program. The *ex ante* load impacts were estimated using an engineering analysis.

[1] Electric Power Research Institute, Engineering Methods for Estimating the Impacts of Demand-Side Management Programs, Volume 2: Fundamental Equations for Residential and Commercial End Uses, pp. 3-84 to 3-85.

$$\Delta kWh = units x 0.746 x \left[\frac{hp_{base} x RLF_{base}}{\eta_{base}} - \frac{hp_{ee} x RLF_{ee}}{\eta_{ee}} \right] x FLH, \quad \text{(Eq. 5-1)}$$

where:

ΔkWh = *gross annual energy savings,*
$units$ = *number of motors installed under the program,*
η_{base} = *efficiency of base motor,*
η_{ee} = *efficiency of high-efficiency motor,*
hp_{base} = *horsepower of base motor (hp),*
hp_{ee} = *horsepower of high-efficiency motor (hp),*
RLF_{base} = *rated load factor for the base motor,*
RLF_{ee} = *rated load factor for the high-efficiency motor,*
FLH = *full-load hours, and*
0.746 = *conversion factor (kW / hp).*

Ex ante demand impacts were estimated using Equation 5-2.

$$\Delta kW = units x 0.746 x \left[\frac{hp_{base} x RLF_{base}}{\eta_{base}} - \frac{hp_{ee} x RLF_{ee}}{\eta_{ee}} \right] x DF x CF, \quad \text{(Eq. 5-2)}$$

where:

ΔkW = *gross coincident demand savings,*
$units$ = *number of motors installed under the program,*
η_{base} = *efficiency of base motor,*
η_{ee} = *efficiency of high-efficiency motor,*
hp_{base} = *horsepower of base motor (hp),*
hp_{ee} = *horsepower of high-efficiency motor (hp),*
RLF_{base} = *rated load factor for the base motor,*
RLF_{ee} = *rated load factor for the high-efficiency motor,*
FLH = *full-load hours,*
DF = *demand diversity factor,*
CF = *coincidence factor, and*
0.746 = *conversion factor (kW / hp).*

5.2.2 Ex Post Load Impact Estimation Methodology

Site-specific engineering analysis with verified data on operating characteristics was the basis for *ex post* load impact estimates. Verification of the operating conditions of the pumps was performed through on-site inspections. Operations logs and spot measurements were taken to determine pump loads and operating hours. Interviews with on-site staff were conducted to confirm the site information.

The *ex post* estimation methodology used Equations 5-3 and 5-4 to estimate the load impacts of each of the pumping measures except for ID No. 13974. The methodology for this measure is discussed in Section 5.9.

$$kW\_Savings = Qty * Capacity * \%Load * \left(\frac{1}{Eff_{baseline@load}} - \frac{1}{Eff_{retrofit@load}} \right), \qquad (Eq.\ 5\text{-}3)$$

where:

Qty = *Quantity of retrofit motors,*

$Capacity$ = *Rated Output Horsepower in kW converted from Horsepower (1 kW = 0.7457 HP),*

$\%Load = \left(\frac{Output\ Horsepower\ at\ Actual\ Load\ Conditions}{Rated\ Output\ Horsepower} \right)$,

$Eff_{baseline@load}$ = *Rated Baseline Motor Efficiency at Actual Load Conditions, and*

$Eff_{retrofit@load}$ = *Rated Retrofit Motor Efficiency at Actual Load Conditions.*

$$kWh\_Savings = kW\_Savings * Ann\_Op\_Hours, \qquad (Eq.\ 5\text{-}4)$$

where:

$kW\_Savings$ = *calculated in Equation 5-3, and*

Ann_Op_Hours = *Hours es timated from onsite visit.*

5.3 ID No. 19010 - Two 25 Horsepower Motors

5.3.1 Facility Information

Two 25 horsepower motors were installed on a pump at a water pump station. The system is designed to pump water in a municipal water system that serves a nearby community. The pumps respond to the demand of the system and operate intermittently throughout the day.

The two existing motors were operational. Cost reduction was the primary motivation for motor replacement. Energy efficient motors, rather than standard efficiency motors, were selected to lower operating and energy costs.

The high efficiency motors will deliver the required pumping horsepower at a lower energy cost than the existing standard efficiency motors. Table 5-1 shows a summary of the demand and energy impacts for these motor installations.

Table 5-1
Summary of Demand and Energy Impacts
ID No. 19010

Two 25 Horsepower Motors	Demand kW	Energy Annual kWh	Gas Annual Therms
Ex Ante Impacts	0.90	4,800	0
Ex Post Impacts	0.13	185	0
Difference	0.76	4,615	0
Realization Rate	0.14	0.04	N/A

5.3.2 Ex Ante Load Impact Estimation Methodology

The *ex ante* load impact estimates were calculated using the method described in Section 5.2.1. The *ex ante* estimates utilized Equations 5-1 and 5-2 to evaluate energy savings.

5.3.3 Ex Post Load Impact Estimation Methodology

The site was visited on Monday, September 9, 1996. The motor installation was inspected and an interview with facility staff was conducted. Run hours were obtained from the pump station log for the entire 1995 year and separately for the period starting at March 1, 1995, until September 1, 1996, which reflects new pump operation hours only. Power readings were taken to determine loading characteristics.

This pump station responds to a relatively low demand water system. At any given time during the day, only one of the motors is running. The motors are configured to alternate so that each motor is operating for approximately five (5) minutes per hour.

The pumps are available 24 hours per day, 365 days per year with little seasonal change of the load. Combined total pumping hours for both pumps is four (4) hours per day. Operations and load schedules are shown in Tables 5-2 and 5-3 for summer and winter, respectively.

Table 5-2
Summer Operations and Load Schedule
ID No. 19010

	Summer Weekdays								Summer Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Savings	Avg kW Baseline	Avg kW Retrofit	Avg kW Savings	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
2	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
3	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
4	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
5	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
6	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
7	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
8	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
9	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
10	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
11	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
12	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
13	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
14	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
15	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
16	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
17	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
18	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
19	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
20	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
21	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	0%	100%	7.44	7.31	0.13	0.00	0.00	0.00
22	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
23	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
24	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02

Table 5-3
Winter Operations and Load Schedule
ID No. 19010

	Winter Weekdays								Winter Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Average kW Baseline	Average kW Retrofit	Average kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Average kW Baseline	Average kW Retrofit	Average kW Reduced
1	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
2	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
3	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
4	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
5	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
6	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
7	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
8	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
9	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
10	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
11	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
12	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
13	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
14	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
15	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
16	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
17	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
18	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
19	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
20	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
21	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
22	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
23	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02
24	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02	15%	100%	7.44	7.31	0.13	1.15	1.13	0.02

Baseline Motor

To estimate the savings of an energy efficient motor retrofit, a baseline motor alternative was established. Since this was a retrofit motor, not new or replaced on burn out, it would have been appropriate to use the previously installed motor as the baseline for evaluation. However, since the previous motor nameplate information was unavailable from the Energy Efficient Motor Program Customer Enrollment Form, the following approach was used to define the baseline motor. Baseline (standard) motor efficiency data was obtained from the MotorMaster+ database (Washington State Energy Office 1996). This database contains cost and efficiency data on more than 10,000 NEMA Design B motors. Baseline motor data was chosen by searching the database for motors with efficiencies less than the NEMA 12-6B standard and selecting the motor with the median efficiency at 100% load. Motor characteristics are shown in Table 5-4. Efficiency and power factor data were available for load conditions from 25% to 100%. These data are shown in Table 5-5.

Table 5-4
Motor Characteristics
ID No. 19010

	Rebate Application	Site Verified	Baseline Motor
Manufacturer	U.S. Electric	U.S. Electric	U.S. Electric
Model	ODP-Standard Efficiency	ODP-Premium Efficiency	HIGH/EFF / D
Catalog Number	G89611	889611	E832
Serial Number	X3360483Y02R-2	Y02X33604832R-2	N/A
Type	ODP	ODP	ODP
Nominal Efficiency	93.6%	93.6%	89.5%
Power Factor @ 100%	87.5%	87.5%	82.9%
Horsepower	25	25	25
Speed	1,800	1,780	1,760
Installed Quantity	2	2	N/A
Install Date	2/17/95	2/17/95	N/A
Operation Hours	4,000	673	N/A
End Use	Pump	Pump	N/A
Replaces	Working Motor	Working Motor	N/A
Specific Location	Pump Station	Pump Station	N/A
Available Quantity	1	1	N/A

Table 5-5
Efficiency and Power Factor Values for Baseline and Retrofit Motors
ID No. 19010

	Baseline Motor, 25 HP			Retrofit Motor, 25 HP		
	U.S. Electric HIGH/EFF / D			U.S. Electric ODP-Premium Efficiency		
% Load	**Efficiency**	**Power Factor**	**Input (kW)**	**Efficiency**	**Power Factor**	**Input (kW)**
0%	0.0%	26.4%		0.0%	37.8%	
10%	34.9%	35.0%	5.34	35.5%	45.5%	5.25
20%	69.8%	43.7%	5.34	71.0%	53.2%	5.25
25%	**87.3%**	**48.0%**	**5.34**	**88.7%**	**57.0%**	**5.25**
30%	88.0%	52.3%	6.35	89.7%	60.8%	6.24
40%	89.5%	61.0%	8.34	91.6%	68.5%	8.14
50%	**90.9%**	**69.6%**	**10.25**	**93.6%**	**76.2%**	**9.96**
60%	90.9%	73.4%	12.30	93.6%	79.3%	11.95
70%	91.0%	77.1%	14.34	93.7%	82.4%	13.93
75%	**91.0%**	**79.0%**	**15.36**	**93.7%**	**83.9%**	**14.92**
80%	90.7%	79.8%	16.44	93.7%	84.6%	15.92
90%	90.1%	81.3%	18.62	93.6%	86.1%	17.92
100%	**89.5%**	**82.9%**	**20.83**	**93.6%**	**87.5%**	**19.92**

Installed Motors

The installed motors were verified by an on-site inspection conducted on Monday, September 9, 1996. Motor nameplate data were recorded along with information regarding operation schedule and load conditions. Nameplate and other motor information are shown in Table 5-4. The motor nameplate data were augmented with data corresponding to the installed motor in the MotorMaster+ database (Washington State Energy Office 1996). Efficiency and power factor curve data were available for load conditions from 25% to 100%. These data are shown in Table 5-5.

Ex Ante Impact Calculations

Equations 5-3 and 5-4 were used calculate *ex post* load impacts. *Ex post* load impact results based on a time-of-use for summer and winter are shown in Tables 5-6 and 5-7, respectively.

Table 5-6
Summer Load Impacts
ID No. 19010

Summer Weekdays (106 days/year)				Summer Weekends & Holidays (47 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	7.44	7.31	0.13				
Max Semi-Peak kW	7.44	7.31	0.13				
Max Off-Peak kW	7.44	7.31	0.13	Max kW (Off-Peak)	7.44	7.31	0.13
Average On-Peak kW	1.15	1.13	0.02				
Average Semi-Peak kW	1.15	1.13	0.02				
Average Off-Peak kW	1.15	1.13	0.02	Average kW (Off-Peak)	1.10	1.08	0.02
Summer kW Coincident w/ System Peak	7.44	7.31	0.13				
Daily Summer On-Peak kWh	8.02	7.88	0.14				
Daily Summer Semi-Peak kWh	10.32	10.13	0.19				
Daily Summer Off-Peak kWh	9.17	9.00	0.17				
Daily kWh	27.51	27.00	0.51	Daily kWh (Off-Peak)	26.37	25.88	0.49
Annual Summer On-Peak kWh	850.58	834.84	15.74				
Annual Summer Semi-Peak kWh	1,093.61	1,073.36	20.25				
Annual Summer Off-Peak kWh	972.10	954.10	18.00				
Annual kWh (Summer Weekdays)	2,916.29	2,862.31	53.98	Annual kWh (Summer Weekends & Holidays)	1,239.19	1,216.26	22.93

Table 5-7
Winter Load Impacts
ID No. 19010

Winter Weekdays (147 days/year)				Winter Weekends & Holidays (65 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	7.44	7.31	0.13				
Max Semi-Peak kW	7.44	7.31	0.13				
Max Off-Peak kW	7.44	7.31	0.13	Max kW (Off-Peak)	7.44	7.31	0.13
Average On-Peak kW	1.15	1.13	0.02				
Average Semi-Peak kW	1.15	1.13	0.02				
Average Off-Peak kW	1.15	1.13	0.02	Average kW (Off-Peak)	1.15	1.13	0.02
Winter kW Coincident w/ System Peak	7.44	7.31	0.13				
Daily Winter On-Peak kWh	3.44	3.38	0.06				
Daily Winter Semi-Peak kWh	14.90	14.63	0.27				
Daily Winter Off-Peak kWh	9.17	9.00	0.17				
Daily kWh	27.51	27.00	0.51	Daily kWh (Off-Peak)	27.51	27.00	0.51
Annual Winter On-Peak kWh	505.54	496.18	9.36				
Annual Winter Semi-Peak kWh	2,190.65	2,150.11	40.54				
Annual Winter Off-Peak kWh	1,348.10	1,323.14	24.96				
Annual kWh (Winter Weekdays)	4,044.29	3,969.42	74.87	Annual kWh (Winter Weekends & Holidays)	1,788.29	1,755.19	33.10

5.3.4 Comparison of Ex Ante and Ex Post Impact Estimates

The *ex ante* impact estimates were greater than the *ex post* impact estimates. *Ex ante* impacts were 0.90 kW and 4,800 kWh for demand and energy impacts, respectively. *Ex post* load impacts were 0.13 kW and 185 kWh for demand and energy impacts, respectively. The gross realization rate for kW reduction was 0.14, while realization rate for annual kWh savings was 0.04.

The differences between the *ex ante* and *ex post* estimates are due to:

- **Operating Hours:** The *ex ante* approach assumed 4,000 operating hours per year for the motors. Based on facility operations records it was determined that the actual annual operating hours are approximately 674 operating hours per motor, thus reducing the kWh savings.
- **Motor Operation:** The *ex ante* estimates were based on motor loading of 75% (i.e., rated load factor of 0.75). Based on on-site spot measurements, it was determined that each

motor actually operates at 35% of full load. The lower actual motor loading resulted in lower demand reduction than expected based on the *ex ante* estimates. This observation has been confirmed by the facility staff based on their long term operating records.

5.4 ID No. 19074 - One 60 Horsepower Motor

5.4.1 Facility Information

One 60 horsepower motor was installed at a water pump station. This motor is installed on a back-up pump in a system designed to pump irrigation water. The pump motor is activated manually by a switch and may operate any time during the day.

The existing motor required replacement. Instead of installing a standard efficiency motor, an energy efficient motor was installed to lower operating costs. The high efficiency motor will deliver the required pumping horsepower at a lower energy cost than a standard efficiency motor.

Table 5-8 shows a summary of the demand and energy impacts for these motor installations.

Table 5-8
Summary of Demand and Energy Impacts
ID No. 19074

One 60 Horsepower Motor	Demand kW	Energy Annual kWh	Gas Annual Therms
***Ex Ante* Impacts**	0.80	4,293	0
***Ex Post* Impacts**	0.23	44	0
Difference	0.57	4,249	0
Realization Rate	0.29	0.01	N/A

5.4.2 Ex Ante Load Impact Estimation Methodology

The *ex ante* load impact estimates were calculated using the method described in Section 5.2.1 The *ex ante* estimates utilized Equations 5-1 and 5-2 to evaluate energy savings.

5.4.3 Ex Post Load Impact Estimation Methodology

An on-site visit of the facility was conducted on Wednesday, September 11, 1996. The installation of the motor was inspected and an interview with facility staff was conducted. Run hours were obtained from the pump station log for the period of March 5, 1995 to September 10, 1996. Power readings were taken to determine loading characteristics.

The pump is available 24 hours a day, 365 days per year with little seasonal change of the load. Since this is a backup pump it runs a limited amount of hours, approximately 240 hours per year.

The operations and load schedule for the motor for summer and winter are shown in Tables 5-9 and 5-10, respectively.

Table 5-9
Summer Operations and Load Schedule
ID No. 19074

	Summer Weekdays								Summer Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
2	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
3	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
4	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
5	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
6	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
7	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
8	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
9	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
10	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
11	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
12	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
13	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
14	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
15	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
16	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
17	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
18	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
19	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
20	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
21	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
22	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
23	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01
24	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.41	0.4	0.01

Table 5-10
Winter Operations and Load Schedule
ID No. 19074

	Winter Weekdays								Winter Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
2	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
3	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
4	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
5	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
6	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
7	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
8	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
9	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
10	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
11	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
12	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
13	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
14	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
15	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
16	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
17	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
18	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
19	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
20	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
21	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
22	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
23	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00
24	3%	100%	14.57	14.34	0.23	0.41	0.40	0.01	3%	100%	14.57	14.34	0.23	0.00	0.00	0.00

Baseline Motor

To estimate the savings of an energy efficient motor, a baseline motor alternative must be established. Baseline (standard) motor efficiency data is obtained from the MotorMaster+ database (Washington State Energy Office 1996). This database contains cost and efficiency data on more than 10,000 NEMA Design B motors. Baseline motor data was chosen by searching the database for motors with efficiencies less than the NEMA 12-6B standard and selecting the motor with the median efficiency at 100% load. Motor characteristics are shown in Table 5-11. Efficiency and power factor curve data were available for load conditions from 50% to 100% in quartile increments. These data are shown in Table 5-12:

Table 5-11
Motor Characteristics
ID No. 19074

	Rebate Application	Site Verified	Baseline Motor
Manufacturer	U.S. Electric	U.S. Electric	Marathon
Model	TEFC-Premium Efficiency	HOS DTY PREM EFF /CTE	Blue Chip, Rigid
Catalog Number	H338	H338	H447
Serial Number	X07X112R435M	X07X112R435M	N/A
Type	TEFC	TEFC	TEFC
Nominal Efficiency	95.0%	95.0%	92.4%
Power Factor @ 100%	N/A	84.2%	85.0%
Horsepower	60	60	60
Speed	1,800	1,785	1,775
Installed Quantity	1	1	N/A*
Install Date	5/5/95	5/5/95	N/A
Operation Hours	4,000	1,500	N/A
End Use	Pump	Pump	N/A
Replaces	Burned Out Motor	Burned Out Motor	N/A
Specific Location	Pump Station	Pump Station	N/A
Available Quantity	1	1	N/A

Table 5-12
Efficiency and Power Factor Values for Baseline and Retrofit Motors
ID No. 19074

	Baseline Motor, 60 HP			Retrofit Motor, 60 HP		
	Marathon			U.S. Electric		
	Blue Chip, Rigid			HOS DTY PREM EFF /CTE		
% Load	**Efficiency**	**Power Factor**	**Input (kW)**	**Efficiency**	**Power Factor**	**Input (kW)**
0%	0.0%	42.0%		0.0%	30.3%	
10%	36.0%	49.2%	12.43	36.6%	38.7%	12.24
20%	72.0%	56.4%	12.43	73.1%	47.2%	12.24
25%	**90.0%**	**60.0%**	**12.43**	**91.4%**	**51.4%**	**12.24**
30%	90.3%	63.6%	14.86	92.0%	55.6%	14.59
40%	91.0%	70.8%	19.66	93.3%	64.1%	19.19
50%	**91.7%**	**78.0%**	**24.40**	**94.5%**	**72.5%**	**23.67**
60%	92.0%	80.4%	29.19	94.7%	75.8%	28.34
70%	92.3%	82.8%	33.95	95.0%	79.1%	32.97
75%	**92.4%**	**84.0%**	**36.32**	**95.1%**	**80.8%**	**35.29**
80%	92.4%	84.2%	38.74	95.1%	81.5%	37.65
90%	92.4%	84.6%	43.58	95.0%	82.8%	42.37
100%	**92.4%**	**85.0%**	**48.42**	**95.0%**	**84.2%**	**47.10**

Installed Motor

The installed motor was verified by an on-site inspection. Motor nameplate data were recorded along with information regarding the operations schedule and load conditions. Nameplate and other motor information are shown in Table 5-11. The motor nameplate data were augmented with data corresponding to the installed motor from the MotorMaster+ database (Washington State Energy Office 1996). Efficiency and power factor curve data were available for load conditions from 25% to 100% in quartile increments. These data are shown in Table 5-12.

Savings Calculations

Equations 5-3 and 5-4 were used to calculate *ex post* kW and kWh impacts. Ex *post* load impacts based on a time-of-use for summer and winter are shown in Tables 5-13 and 5-14, respectively.

Table 5-13
Summer Load Impacts
ID No. 19074

Summer Weekdays (106 days/year)				Summer Weekends & Holidays (47 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	14.57	14.34	0.23				
Max Semi-Peak kW	14.57	14.34	0.23				
Max Off-Peak kW	14.57	14.34	0.23	Max kW (Off-Peak)	14.57	14.34	0.23
Average On-Peak kW	0.35	0.34	0.01				
Average Semi-Peak kW	0.41	0.40	0.01				
Average Off-Peak kW	0.41	0.40	0.01	Average kW (Off-Peak)	0.41	0.4	0.01
Summer kW Coincident w/ System Peak	14.57	14.34	0.23				
Daily Summer On-Peak kWh	2.45	2.41	0.04				
Daily Summer Semi-Peak kWh	3.67	3.61	0.06				
Daily Summer Off-Peak kWh	3.26	3.21	0.05				
Daily kWh	9.38	9.24	0.14	Daily kWh (Off-Peak)	9.79	9.64	0.15
Annual Summer On-Peak kWh	259.4	255.43	3.97				
Annual Summer Semi-Peak kWh	389.1	383.14	5.96				
Annual Summer Off-Peak kWh	345.87	340.57	5.3				
Annual kWh (Summer Weekdays)	994.38	979.15	15.23	Annual kWh (Summer Weekends & Holidays)	460.07	453.03	7.04

Table 5-14
Winter Load Impacts
ID No. 19074

Winter Weekdays (147 days/year)				Winter Weekends & Holidays (65 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	14.57	14.34	0.23				
Max Semi-Peak kW	14.57	14.34	0.23				
Max Off-Peak kW	14.57	14.34	0.23	Max kW (Off-Peak)	14.57	14.34	0.23
Average On-Peak kW	0.41	0.40	0.01				
Average Semi-Peak kW	0.41	0.40	0.01				
Average Off-Peak kW	0.41	0.40	0.01	Average kW (Off-Peak)	0.00	0.00	0.00
Winter kW Coincident w/ System Peak	14.57	14.34	0.23				
Daily Winter On-Peak kWh	1.22	1.20	0.02				
Daily Winter Semi-Peak kWh	5.3	5.22	0.08				
Daily Winter Off-Peak kWh	3.26	3.21	0.05				
Daily kWh	9.79	9.64	0.15	Daily kWh (Off-Peak)	0.00	0.00	0.00
Annual Winter On-Peak kWh	179.87	177.11	2.76				
Annual Winter Semi-Peak kWh	779.43	767.49	11.94				
Annual Winter Off-Peak kWh	479.65	472.30	7.35				
Annual kWh (Winter Weekdays)	1438.95	1,416.91	22.04	Annual kWh (Winter Weekends & Holidays)	0.00	0.00	0.00

5.4.4 Comparison of Ex Ante and Ex Post Load Impact Estimates

In comparing the *ex ante* and *ex post* load impact estimates, the *ex ante* estimates are greater than the *ex post* estimates. *Ex ante* load impacts were 0.80 kW and 4,293 kWh for demand and energy impacts, respectively. *Ex post* load impacts were 0.23 kW and 44 kWh for demand and energy. The gross realization rates were 0.29 for demand impacts and 0.01 kWh savings.

The differences between the *ex ante* and *ex post* load impact estimates are due to:

- **Operating Hours:** The hours of operation used in the *ex ante* estimate was assumed to be 4,000 operating hours per year for the motor. Based on facility operations records, the hours of operation was actually 242 hours per year. The lower annual operating hours resulted in a lower realization rate for energy (kWh savings).
- **Motor Operation:** The *ex ante* estimates were based on a motor loading of 75% (i.e., rated load factor of 0.75). Based on on-site spot measurements, it was determined that

the motor actually operates at 29% of full load. The lower actual motor loading resulted in lower demand reduction than was expected based on the *ex ante* estimates.

5.5 ID No. 19086 - One 75 Horsepower Motor

5.5.1 Facility Information

One 75 horsepower motor was installed at a water pump station. The pump station is located at the base of a reservoir. The system is designed to pump water from the reservoir to nearby areas and/or alternative pump routes during times of a water emergency. An emergency situation has not occurred during the past several years. Subsequently, the system has not been significantly operated. The bulk of the system operation occurs during routine monthly maintenance.

The existing motor burned out and required replacement. Instead of installing a standard efficiency motor, an energy efficient motor was installed to lower operating costs. The high efficiency motor will deliver the required pumping horsepower at a lower energy cost than a standard efficiency motor. Table 5-15 provides a summary of the *ex ante* and *ex post* load impacts for the measure.

Table 5-15
Summary of Demand and Energy Impacts
ID No. 19086

One 75 Horsepower Motor	Demand kW	Energy Annual kWh	Gas Annual Therms
***Ex Ante* Impacts**	1.01	5,366	0
***Ex Post* Impacts**	1.32	13	0
Difference	0.31	5,353	0
Realization Rate	1.31	0.00	N/A

5.5.2 Ex Ante Load Impact Estimation Methodology

The *ex ante* load impact estimates were calculated using the method described in Section 5.2.1 The *ex ante* estimates utilized Equations 5-1 and 5-2 to evaluate energy savings.

5.5.3 Ex Post Load Impact Estimation Methodology

An on-site visit was conducted on Tuesday, September 10, 1996. The installation was inspected and an interview with facility staff was conducted. Since a technician was repairing a valve on the pump system, an electrical power measurement was not made.

During a water emergency situation, under standard operating conditions for the pump, the motor would be pumping approximately 1,500 GPM at 170 feet of head pressure. The nominal pump efficiency was assumed to be 85%. Routine monthly operation and maintenance includes starting up the motor for a short period of time, approximately 10 to 20 minutes. Water emergency situations occur for limited periods once every several years. Considering the monthly maintenance and the relatively infrequent emergency operation, the total run time for this motor was estimated to be 10 hours per year. The operations and load schedule for summer and winter are shown in Tables 5-16 and 5-17, respectively.

Table 5-16
Summer Operations and Load Schedule
ID No. 19086

	Summer Weekdays								Summer Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
2	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
3	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
4	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
5	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
6	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
7	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
8	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
9	1%	100%	57.22	55.90	1.32	0.57	0.56	0.01	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
10	1%	100%	57.22	55.90	1.32	0.57	0.56	0.01	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
11	1%	100%	57.22	55.90	1.32	0.57	0.56	0.01	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
12	1%	100%	57.22	55.90	1.32	0.57	0.56	0.01	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
13	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
14	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
15	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
16	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
17	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
18	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
19	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
20	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
21	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
22	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
23	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
24	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00

Table 5-17
Winter Operations and Load Schedule
ID No. 19086

	Winter Weekdays								Winter Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
2	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
3	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
4	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
5	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
6	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
7	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
8	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
9	1%	100%	57.22	55.90	1.32	0.57	0.56	0.01	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
10	1%	100%	57.22	55.90	1.32	0.57	0.56	0.01	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
11	1%	100%	57.22	55.90	1.32	0.57	0.56	0.01	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
12	1%	100%	57.22	55.90	1.32	0.57	0.56	0.01	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
13	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
14	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
15	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
16	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
17	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
18	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
19	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
20	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
21	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
22	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
23	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
24	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00

Baseline Motor

To estimate the savings of an energy efficient motor, a baseline motor alternative must be established. Baseline (standard) motor efficiency data is obtained from the MotorMaster+ database (Washington State Energy Office 1996). This database contains cost and efficiency data on more than 10,000 NEMA Design B motors. Baseline motor data were chosen by searching the database for motors with efficiencies less than the NEMA 12-6B standard and selecting the motor with the median efficiency at 100% load. Motor characteristics are shown in Table 5-18. Efficiency and power factor curve data were available for load conditions from 50% to 100% in quartile increments. These data are shown in Table 5-19.

Table 5-18
Motor Characteristics
ID No. 19086

	Rebate Application	Site Verified	Baseline Motor
Manufacturer	Teco	Teco	Toshiba
Model	ASHE / High Eff	ASHE / High Eff	Standard Efficiency
Serial Number	446090005	446090005	N/A
Type	ODP	ODP	ODP
Nominal Efficiency	95.0%	95.0%	92.4%
Power Factor @ 100%	83.5%	83.5%	83.2%
Horsepower	75	75	75
Speed	1,775	1,775	1775
Installed Quantity	1	1	N/A
Install Date	7/23/95	7/23/95	N/A
Operation Hours	4,000	10	N/A
End Use	Pump	Pump	N/A
Replaces	Burn Out	Burn Out	N/A
Specific Location	Pump Station	Pump Station	N/A

Table 5-19
Efficiency and Power Factor Values for Baseline and Retrofit Motors
ID No. 19086

	Baseline Motor, 75 HP			**Retrofit Motor, 75 HP**		
	Toshiba Standard Efficiency			Teco ASHE / High Eff		
% Load	**Efficiency**	**Power Factor**	**Input (kW)**	**Efficiency**	**Power Factor**	**Input (kW)**
0%	0.0%	26.4%		0.0%	37.8%	
10%	46.9%	71.2%	11.94	47.3%	60.7%	11.84
20%	46.9%	72.7%	23.88	47.3%	63.7%	23.67
30%	62.5%	74.3%	26.86	63.0%	66.5%	26.63
40%	78.1%	75.6%	28.65	78.8%	69.1%	28.41
50%	**93.7%**	**76.9%**	**29.84**	**94.5%**	**71.5%**	**29.59**
60%	93.7%	78.7%	35.80	94.9%	74.9%	35.37
70%	93.8%	80.6%	41.75	95.2%	78.3%	41.11
75%	**93.8%**	**81.5%**	**44.72**	**95.4%**	**80.0%**	**43.97**
80%	93.5%	81.8%	47.84	95.3%	80.7%	46.94
90%	93.0%	82.5%	54.15	95.2%	82.1%	52.89
100%	**92.4%**	**83.2%**	**60.53**	**95.0%**	**83.5%**	**58.87**

Installed Motor

The installed motor was verified by an on-site inspection performed by XENERGY Inc. Motor nameplate data were recorded along with information regarding operation schedule and load conditions. Nameplate and other motor information are shown in Table 5-18. The motor nameplate data was augmented with data corresponding to the installed motor in the MotorMaster+ database (Washington State Energy Office 1996). Efficiency and power factor curve data are available for load conditions from 50% to 100% in quartile increments. These data are shown in Table 5-19.

Savings Calculations

Equations 5-3 and 5-4 were used to calculate kW and kWh impacts. Load impact estimates based on a time-of-use for summer and winter are shown in Tables 5-20 and 5-21.

Table 5-20
Summer Load Impacts
ID No. 19086

Summer Weekdays (106 days/year)				**Summer Weekends & Holidays (47 days/year)**			
	Ex Ante	***Ex Post***	**Savings**		***Ex Ante***	***Ex Post***	**Savings**
Max On-Peak kW	57.22	55.90	1.32				
Max Semi-Peak kW	57.22	55.90	1.32				
Max Off-Peak kW	0.00	0.00	0.00	Max kW (Off-Peak)	0.00	0.00	0.00
Average On-Peak kW	0.08	0.08	0.00				
Average Semi-Peak kW	0.19	0.19	0.00				
Average Off-Peak kW	0.00	0.00	0.00	Average kW (Off-Peak)	0.00	0.00	0.00
Summer kW Coincident w/ System Peak	0.00	0.00	0.00				
Daily Summer On-Peak kWh	0.57	0.56	0.01				
Daily Summer Semi-Peak kWh	1.72	1.68	0.04				
Daily Summer Off-Peak kWh	0.00	0.00	0.00				
Daily kWh	2.29	2.24	0.05	Daily kWh (Off-Peak)	0.00	0.00	0.00
Annual Summer On-Peak kWh	60.65	59.25	1.40				
Annual Summer Semi-Peak kWh	181.96	177.76	4.20				
Annual Summer Off-Peak kWh	0.00	0.00	0.00				
Annual kWh (Summer Weekdays)	242.62	237.01	5.61	Annual kWh (Summer Weekends & Holidays)	0.00	0.00	0.00

Table 5-21
Winter Load Impacts
ID No. 19086

Winter Weekdays (147 days/year)				Winter Weekends & Holidays (65 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	0.00	0.00	0.00				
Max Semi-Peak kW	57.22	55.90	1.32				
Max Off-Peak kW	0.00	0.00	0.00	Max kW (Off-Peak)	0.00	0.00	0.00
Average On-Peak kW	0.00	0.00	0.00				
Average Semi-Peak kW	0.16	0.16	0.00				
Average Off-Peak kW	0.00	0.00	0.00	Average kW (Off-Peak)	0.00	0.00	0.00
Winter kW Coincident w/ System Peak	0.00	0.00	0.00				
Daily Winter On-Peak kWh	0.00	0.00	0.00				
Daily Winter Semi-Peak kWh	2.29	2.24	0.05				
Daily Winter Off-Peak kWh	0.00	0.00	0.00				
Daily kWh	2.29	2.24	0.05	Daily kWh (Off-Peak)	0.00	0.00	0.00
Annual Winter On-Peak kWh	0.00	0.00	0.00				
Annual Winter Semi-Peak kWh	336.46	328.68	7.78				
Annual Winter Off-Peak kWh	0.00	0.00	0.00				
Annual kWh (Winter Weekdays)	336.46	328.68	7.78	Annual kWh (Winter Weekends & Holidays)	0.00	0.00	0.00

5.5.4 Comparison of Ex Ante and Ex Post Impact Estimates

The gross realization rate for kW reduced is 1.31 and less than 0.01 for kWh savings.

The *ex ante* methodology assumed a demand reduction of 1.01 kW and hours of operation of 4,000 hours per year. The differences between the *ex ante* and *ex post* estimates are due to:

- **Operating Hours:** The *ex ante* estimate assumed the hours of operation to be 4,000 hours per year. After the *ex post* review of operations logs and the interview with facility staff, it was determined that the actual operating hours are approximately 10 hours per year. The lower hours of operation resulted in the *ex post* estimate lower than the *ex ante.*
- **Motor Operation:** The *ex ante* estimates were based on a motor loading of 75% (i.e., rated load factor of 0.75). Based on the on-site interview, it determined that the motor actually operates at 95% of full load. The higher actual motor loading resulted in higher demand reduction than expected from the *ex ante* estimate.

5.6 ID No. 19092 -Three 75 Horsepower Motors

5.6.1 Facility Information

A new water pumping station was built to meet the irrigation demands of a the nearby college. Instead of installing standard efficiency motors, energy efficient motors were installed to lower future operating costs. Three 75 horsepower motors were installed at a water pump station. The system is designed to pump irrigation water to a pressure grid irrigation system at a nearby college. There is no storage tank for the irrigation water, thus the pumps respond to the demand of the irrigation system, which is operated only during off-peak hours. The motors are staged to provide constant pressure as flow requirements increase or decrease. At any given time during off-peak hours, one out of the three motors is likely to be partially loaded while the other two are either fully loaded or not running at all. The high efficiency motors will deliver the required pumping horsepower at a lower energy cost than standard efficiency motors.

Table 5-22 shows a summary of the demand and energy impacts for these motor installations.

Table 5-22
Summary of Demand and Energy Impacts
ID No. 19092

Three 75 Horsepower Motors	Demand kW	Energy Annual kWh	Gas Annual Therms
Ex Ante Impacts	3.03	16,098	0
Ex Post Impacts	4.41	6,201	0
Difference	1.38	9,897	0
Realization Rate	1.46	0.39	N/A

5.6.2 Ex Ante Load Impact Estimation Methodology

The *ex ante* load impact estimates were calculated using the method described in Section 5.2.1 The *ex ante* estimates utilized Equations 5-1 and 5-2 to evaluate energy savings.

5.6.3 Ex Post Load Impact Estimation Methodology

An on-site visit was conducted on Monday, September 9, 1996. The installation was inspected and an interview with facility staff was conducted. Run hours were obtained from the pump station log that dated back to June 10, 1996. Voltage and current readings were taken to determine loading characteristics.

As there is no storage tank for the irrigation water, the pump station must respond directly to the demand of the irrigation system. The motors are staged to provide constant pressure as flow requirements increase or decrease. At any given time during off-peak hours, one out of the three motors is likely to be partially loaded while the other two are either fully loaded or not running at all.

The pumps are scheduled to operate only during the off-peak hours. During the summer months the pump station delivers approximately 300,000 gallons of water per day. While the station has yet to be operated during the winter, facility staff anticipate that the pump station will only be required to deliver 150,000 gallons of water per day. Summer pumping hours have averaged 5.6 hours per day. The operations and load schedules for summer and winter are shown in Tables 5-23 and 5-24, respectively.

Table 5-23
Summer Operations and Load Schedule
ID No. 19092

	Summer Weekdays								Summer Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66
2	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68
3	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66
4	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68
5	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66
6	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68
7	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66
8	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68
9	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66
10	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68
11	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
12	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
13	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
14	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
15	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
16	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
17	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
18	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
19	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
20	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
21	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
22	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
23	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66	46%	68%	36.54	35.11	1.43	16.81	16.15	0.66
24	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68	46%	100%	53.03	51.56	1.47	24.40	23.72	0.68

Table 5-24
Winter Operations and Load Schedule
ID No. 19092

	Winter Weekdays								Winter Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32
2	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34
3	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32
4	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34
5	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32
6	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34
7	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32
8	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34
9	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32
10	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34
11	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
12	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
13	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
14	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
15	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
16	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
17	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
18	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
19	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
20	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
21	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
22	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00
23	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32	23%	68%	36.54	35.11	1.43	8.40	8.08	0.32
24	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34	23%	100%	53.03	51.56	1.47	12.20	11.86	0.34

Baseline Motor

To estimate the savings of an energy efficient motor, a baseline motor alternative must be established. Baseline (standard) motor efficiency data is obtained from the MotorMaster+ database (Washington State Energy Office 1996). This database contains cost and efficiency data on more than 10,000 NEMA Design B motors. Baseline motor data was chosen by searching the database for motors with efficiencies less than the NEMA 12-6B standard and selecting the motor with the median efficiency at 100% load. Motor characteristics are shown in Table 5-25. Efficiency and power factor curve data are available for load conditions from 50% to 100% in quartile increments. These data are shown in Table 5-26.

Table 5-25
Motor Characteristics
ID No. 19092

	Rebate Application	Site Verified	Baseline Motor
Manufacturer	Reliance	Reliance	Magnetek
Model	365TS	TEFC-XEX Premium Efficiency	Standard Efficiency
Catalog Number	365TS	P36G3305	N701
Serial Number	01MAN24536G001		N/A
Type	TEFC	TEFC	TEFC
Nominal Efficiency	95.4%	95.0%	93.0%
Power Factor @ 100%	86.0%	86.0%	90.0%
Horsepower	75	75	75
Speed	1780	1780	1775
Installed Quantity	3	3	N/A
Install Date	6/30/95	6/30/95	N/A
Operation Hours	4000	1533	N/A
End Use	Pump	Pump	N/A
Replaces	New Facility	New Facility	N/A
Specific Location	Pump Station	Pump Station	N/A

Table 5-26
Motor Efficiency Data
ID No. 19092

	Baseline Motor, 75 HP			Retrofit Motor, 75 HP		
	Magnetek Standard Efficiency			Reliance TEFC-XEX Premium Efficiency		
% Load	**Efficiency**	**Power Factor**	**Input (kW)**	**Efficiency**	**Power Factor**	**Input (kW)**
0%	0.0%	26.4%		0.0%	37.8%	
10%	30.4%	41.4%	18.42	37.2%	46.0%	15.05
20%	60.7%	56.4%	18.42	74.3%	54.1%	15.05
25%	**75.9%**	**63.9%**	**18.42**	**92.9%**	**58.2%**	**15.05**
30%	79.0%	66.6%	21.24	93.3%	62.2%	17.98
40%	85.2%	72.1%	26.26	94.2%	70.3%	23.74
50%	**91.4%**	**77.5%**	**30.59**	**95.1%**	**78.4%**	**29.40**
60%	91.8%	80.4%	36.54	95.2%	80.8%	35.26
70%	92.3%	83.3%	42.42	95.3%	83.2%	41.10
75%	**92.5%**	**84.8%**	**45.35**	**95.3%**	**84.4%**	**44.01**
80%	92.6%	85.8%	48.32	95.2%	84.7%	46.98
90%	92.8%	87.9%	54.24	95.1%	85.4%	52.92
100%	**93.0%**	**90.0%**	**60.14**	**95.0%**	**86.0%**	**58.87**

Installed Motor

The installed motor was verified by on-site inspection. Motor nameplate data were recorded along with information regarding operation schedule and load conditions. Nameplate and other motor information are shown in Table 5-25. The motor nameplate data was augmented with data corresponding to the installed motor in the MotorMaster+ database (Washington State Energy Office 1996). Efficiency and power factor curve data are available for load conditions from 50% to 100% in quartile increments. These data are shown in Table 5-26.

Savings Calculations

XENERGY utilized Equations 5-3 and 5-4 to calculate kW and kWh impacts. Load impact estimates on a time-of-use for summer and winter are shown in Tables 5-27 and 5-28, respectively.

Table 5-27
Summer Load Impacts[1]
ID No. 19092

Summer Weekdays (106 days/year)				Summer Weekends & Holidays (47 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	0.00	0.00	0.00				
Max Semi-Peak kW	53.03	51.56	1.47				
Max Off-Peak kW	53.03	51.56	1.47	Max kW (Off-Peak)	53.03	51.56	1.47
Average On-Peak kW	0.00	0.00	0.00				
Average Semi-Peak kW	9.16	8.86	0.30				
Average Off-Peak kW	20.60	19.94	0.66	Average kW (Off-Peak)	10.30	9.97	0.33
Summer kW Coincident w/ System Peak	0.00	0.00	0.00				
Daily Summer On-Peak kWh	0.00	0.00	0.00				
Daily Summer Semi-Peak kWh	82.40	79.74	2.66				
Daily Summer Off-Peak kWh	164.81	159.49	5.32				
Daily kWh	247.21	239.23	7.98	Daily kWh (Off-Peak)	247.21	239.23	7.98
Annual Summer On-Peak kWh	0.00	0.00	0.00				
Annual Summer Semi-Peak kWh	8,734.86	8,452.88	281.98				
Annual Summer Off-Peak kWh	17,469.72	16,905.75	563.97				
Annual kWh (Summer Weekdays)	26,204.58	25,358.63	845.95	Annual kWh (Summer Weekends & Holidays)	11,619.01	11,243.92	375.09
Notes: (1) Results are for one motor. For three motors, multiply results by three.							

Table 5-28
Winter Load Impacts[1]
ID No. 19092

Winter Weekdays (147 days/year)				Winter Weekends & Holidays (65 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	0.00	0.00	0.00				
Max Semi-Peak kW	53.03	51.56	1.47				
Max Off-Peak kW	53.03	51.56	1.47	Max kW (Off-Peak)	53.03	51.56	1.47
Average On-Peak kW	0.00	0.00	0.00				
Average Semi-Peak kW	3.81	3.70	0.11				
Average Off-Peak kW	10.03	9.70	0.33	Average kW (Off-Peak)	5.15	4.98	0.17
Winter kW Coincident w/ System Peak	0.00	0.00	0.00				
Daily Winter On-Peak kWh	0.00	0.00	0.00				
Daily Winter Semi-Peak kWh	53.40	51.73	1.67				
Daily Winter Off-Peak kWh	70.21	67.88	2.33				
Daily kWh	123.61	119.62	3.99	Daily kWh (Off-Peak)	123.61	119.62	3.99
Annual Winter On-Peak kWh	0.00	0.00	0.00				
Annual Winter Semi-Peak kWh	7,849.79	7,604.56	245.23				
Annual Winter Off-Peak kWh	10,320.37	9,979.02	341.35				
Annual kWh (Winter Weekdays)	18,170.16	17,583.58	586.58	Annual kWh (Winter Weekends & Holidays)	8,034.42	7,775.05	259.37
Notes: (1) Results are for one motor. For three motors, multiply results by three.							

5.6.4 Comparison of Ex Ante and Ex Post Impact Estimates

The *ex ante* estimation methodology assumed a demand reduction of 3.03 kW and an operating schedule of 4,000 hours per year to calculate annual energy usage. The *ex post* estimation methodology measured a demand reduction of 4.41. A realization rate of 1.46 was estimated from these two figures. The verified hours of operation found in the *ex post* evaluation were 1,506 hours per year. These hours had the effect of reducing the kWh savings from the level of the *ex ante* estimate, thereby reducing the realization rate for energy savings. The differences between the *ex ante* and *ex post* load impact estimates are due to:

- **Operating Hours:** The *ex ante* hours of operation were assumed to be 4,000 hours per year for the motors. After an interview with facility staff, it was determined that the actual operating hours are approximately 1,506 hours per year. The lower annual operating hours had a downward effect on the kWh realization rate.

- **Motor Operation:** The *ex ante* estimates were based on a motor loading of 75% (i.e., rated load factor of 0.75). Based on the on-site interview, it was determined that the motors actually operate as high as 95% of full load. The higher actual motor loading resulted in greater demand reductions than the *ex ante* estimate. Another factor that may have affected the level of demand reduction is the fact that these motors are Premium Efficiency (rather than just energy efficient). The efficiency values of the motors may have been higher than the values anticipated by the *ex ante* methodology, resulting in greater demand reduction than expected.

5.7 ID No. 19119 - One 75 Horsepower Motor

5.7.1 *Facility Information*

One 75 horsepower motor was installed at a water pump station. The system is designed to pump water in a municipal water system that serves a nearby community. The pump responds to the demand of the system, which may operate any time during the day.

The existing motor required replacement. Instead of installing a standard efficiency motor, an energy efficient motor was installed to lower operating costs. The high efficiency motor will deliver the required pumping horsepower at a lower energy cost than a standard efficiency motor. Table 5-29 shows a summary of the demand and energy impacts for the motor installation.

Table 5-29
Summary of Demand and Energy Impacts
ID No. 19119

One 75 Horsepower Motor	Demand kW	Energy Annual kWh	Gas Annual Therms
***Ex Ante* Impacts**	1.01	5,366	0
***Ex Post* Impacts**	0.66	1,031	0
Difference	0.35	4,335	0
Realization Rate	0.66	0.19	N/A

5.7.2 *Ex Ante Load Impact Estimation Methodology*

The *ex ante* load impact estimates were calculated using the method described in Section 5.2.1 The *ex ante* estimates utilized Equations 5-1 and 5-2 to evaluate energy savings.

5.7.3 *Ex Post Load Impact Estimation Methodology*

An on-site visit was conducted on Monday, September 9, 1996. The motor installation was inspected and an interview with facility staff was conducted. Run hours were obtained from the pump station log for the year 1996. Power readings were taken to determine loading characteristics.

The pump is available 24 hours per day, 365 days per year with little seasonal change of the load. Pumping hours for the pump has averaged 4.25 hours per day (1,551 hours per year). The operations and load schedules for summer and winter are shown in Tables 5-30 and 5-31, respectively.

Table 5-30
Summer Operation and Load Schedule
ID No. 19119

	Summer Weekdays								Summer Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
2	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
3	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
4	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
5	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
6	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
7	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
8	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
9	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
10	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
11	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
13	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
14	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
15	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
16	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
17	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
18	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
19	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
20	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
21	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
22	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
23	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
24	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12

Table 5-31
Winter Operations and Load Schedule
ID No. 19119

	Winter Weekdays								Winter Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
2	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
3	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
4	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
5	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
6	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
7	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
8	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
9	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
10	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
11	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
13	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
14	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
15	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
16	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
17	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
18	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
19	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
20	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
21	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
22	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
23	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12
24	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12	18%	100%	29.05	28.39	0.66	5.14	5.02	0.12

Baseline Motor

To estimate the savings of an energy efficient motor, a baseline motor alternative must be established. Baseline (standard) motor efficiency data is obtained from the MotorMaster+ database (Washington State Energy Office 1996). This database contains cost and efficiency data on more than 10,000 NEMA Design B motors. Baseline motor data was chosen by searching the database for motors with efficiencies less than the NEMA 12-6B standard and selecting the motor with the median efficiency at 100% load. Motor characteristics are shown in Table 5-32. Efficiency and power factor curve data were available for load conditions from 25% to 100% in quartile increments. These data are shown in Table 5-33.

Table 5-32
Motor Characteristics
ID No. 19119

	Rebate Application	Site Verified	Baseline Motor
Manufacturer	U.S. Electric	U.S. Electric	Toshiba
Model	ODP-Premium Efficiency	ODP-Premium Efficiency	STF EFF
Catalog Number	G75272	675272	B0754VLF3UM
Serial Number	Y06Y1130118R-1	Y06Y1150118R-1	N/A
Type	ODP	ODP	ODP
Nominal Efficiency	95.0%	95.0%	92.4%
Power Factor @ 100%	86.0%	86.0%	83.2%
Horsepower	75	75	75
Speed	1,800	1,785	1,770
Installed Quantity	1	1	N/A
Install Date	7/5/95	7/5/95	N/A
Operation Hours	4,000	1,500	N/A
End Use	Pump	Pump	N/A
Replaces	Burned Out Motor	Burned Out Motor	N/A
Specific Location	Pump Station	Pump Station	N/A

Table 5-33
Motor Efficiency Data
ID No. 19119

	Baseline Motor, 75 HP			**Retrofit Motor, 75 HP**		
	Toshiba STF EFF			U.S. Electric ODP-Premium Efficiency		
% Load	**Efficiency**	**Power Factor**	**Input (kW)**	**Efficiency**	**Power Factor**	**Input (kW)**
0%	0.0%	43.1%		0.0%	44.4%	
10%	36.0%	49.9%	15.54	37.2%	51.4%	15.03
20%	72.0%	56.6%	15.54	74.4%	58.5%	15.03
25%	**90.0%**	**60.0%**	**15.54**	**93.0%**	**62.0%**	**15.03**
30%	90.7%	63.4%	18.49	93.5%	65.5%	17.95
40%	92.2%	70.1%	24.26	94.4%	72.6%	23.70
50%	**93.7%**	**76.9%**	**29.84**	**95.3%**	**79.6%**	**29.34**
60%	93.7%	78.7%	35.80	95.4%	81.8%	35.17
70%	93.8%	80.6%	41.75	95.5%	83.9%	40.98
75%	**93.8%**	**81.5%**	**44.72**	**95.6%**	**85.0%**	**43.88**
80%	93.5%	81.8%	47.84	95.5%	85.3%	46.86
90%	93.0%	82.5%	54.15	95.2%	85.8%	52.85
100%	**92.4%**	**83.2%**	**60.53**	**95.0%**	**86.3%**	**58.87**

Installed Motor

The installed motor was verified by an on-site inspection. Motor nameplate data were recorded along with information regarding operation schedule and load conditions. Nameplate and other motor information are shown in Table 5-32. The motor nameplate data were augmented with data corresponding to the installed motor from the MotorMaster+ database (Washington State Energy Office 1996). Efficiency and power factor curve data were available for load conditions from 25% to 100% in quartile increments. These data are shown in Table 5-33.

Savings Calculations

Equations 5-3 and 5-4 were used to calculate *ex post* kW and kWh impacts. *Ex post* load impact estimates on a time-of-use for summer and winter are shown in Tables 5-34 and 5-35, respectively.

Table 5-34
Summer Load Impacts
ID No. 19119

Summer Weekdays (106 days/year)				Summer Weekends & Holidays (47 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	29.05	28.39	0.66				
Max Semi-Peak kW	29.05	28.39	0.66				
Max Off-Peak kW	29.05	28.39	0.66	Max kW (Off-Peak)	29.05	28.39	0.66
Average On-Peak kW	5.14	5.02	0.12				
Average Semi-Peak kW	5.14	5.02	0.12				
Average Off-Peak kW	5.14	5.02	0.12	Average kW (Off-Peak)	5.14	5.02	0.12
Summer kW Coincident w/ System Peak	29.05	28.39	0.66				
Daily Summer On-Peak kWh	35.99	35.17	0.82				
Daily Summer Semi-Peak kWh	46.28	45.22	1.06				
Daily Summer Off-Peak kWh	41.13	40.19	0.94				
Daily kWh	123.40	120.58	2.82	Daily kWh (Off-Peak)	123.40	120.58	2.82
Annual Summer On-Peak kWh	3,815.27	3,727.95	87.32				
Annual Summer Semi-Peak kWh	4,905.34	4,793.08	112.26				
Annual Summer Off-Peak kWh	4,360.30	4,260.51	99.79				
Annual kWh (Summer Weekdays)	13,080.91	12,781.54	299.37	Annual kWh (Summer Weekends & Holidays)	5,800.03	5,667.29	132.74

Table 5-35
Winter Load Impacts
ID No. 19119

Winter Weekdays (147 days/year)				Winter Weekends & Holidays (65 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	29.05	28.39	0.66				
Max Semi-Peak kW	29.05	28.39	0.66				
Max Off-Peak kW	29.05	28.39	0.66	Max kW (Off-Peak)	29.05	28.39	0.66
Average On-Peak kW	5.14	5.02	0.12				
Average Semi-Peak kW	5.14	5.02	0.12				
Average Off-Peak kW	5.14	5.02	0.12	Average kW (Off-Peak)	5.14	5.02	0.12
Winter kW Coincident w/ System Peak	29.05	28.39	0.66				
Daily Winter On-Peak kWh	15.43	15.07	0.36				
Daily Winter Semi-Peak kWh	66.84	65.31	1.53				
Daily Winter Off-Peak kWh	41.13	40.19	0.94				
Daily kWh	123.40	120.58	2.82	Daily kWh (Off-Peak)	123.40	120.58	2.82
Annual Winter On-Peak kWh	2,267.56	2,215.67	51.89				
Annual Winter Semi-Peak kWh	9,826.11	9,601.23	224.88				
Annual Winter Off-Peak kWh	6,046.84	5,908.45	138.39				
Annual kWh (Winter Weekdays)	18,140.51	17,725.34	415.17	Annual kWh (Winter Weekends & Holidays)	8,021.31	7,837.74	183.57

5.7.4 Comparison of Ex Ante and Ex Post Impact Estimates

The *ex ante* estimation methodology assumed a demand reduction of 1.01 kW and 4,000 operating hours per year to calculate annual energy usage. The *ex post* estimates for demand reduction and energy savings were 0.66 kW reduced and 1,031 kWh saved. The gross realization rates for demand and energy impacts are 0.66 and 0.19, respectively. The differences between the *ex ante* and *ex post* estimates are due to:

- **Operating Hours:** The *ex ante* estimates were based on 4,000 operating hours per year for the motor. Based on facility operation records it was determined that the actual annual motor operating hours are approximately 1,551 hours. This results in lower *ex post* energy savings than the estimated *ex ante* energy savings.
- **Motor Operation:** The *ex ante* estimates were based on a motor loading of 75% (i.e., rated load factor of 0.75). Based on on-site spot measurements, it was determined that each motor actually operated at 48% of full load. This observation has been confirmed

by the facility staff based on their long term operating records. The lower actual motor loading resulted in lower demand reduction.

5.8 ID No. 19176 - One 200 Horsepower Motor

5.8.1 Facility Information

One 200 horsepower motor was installed at a water pump station. The pump system is designed to pump water to a reservoir. The motor operates at a constant load during the off-peak hours only. The existing motor required replacement. Instead of installing a standard efficiency motor, an energy efficient motor was installed to lower operating costs. The high efficiency motor will deliver the required pumping horsepower at a lower energy cost than a standard efficiency motor. Table 5-36 shows a summary of the demand and energy impacts for the motor installation.

Table 5-36
Summary of Demand and Energy Impacts
ID No. 19176

One 200 Horsepower Motor	Demand kW	Energy Annual kWh	Gas Annual Therms
***Ex Ante* Impacts**	2.68	14,310	0
***Ex Post* Impacts**	4.44	23,150	0
Difference	1.76	8,840	0
Realization Rate	1.66	1.62	N/A

5.8.2 Ex Ante Load Impact Estimation Methodology

The *ex ante* load impact estimates were calculated using the method described in Section 5.2.1. The *ex ante* estimates utilized Equations 5-1 and 5-2 to evaluate energy savings.

5.8.3 Ex Post Load Impact Estimation Methodology

A site visit was conducted on Monday, September 11, 1996. The motor installation was inspected and an interview with facility staff was conducted. Run hours were confirmed during the interview with facility staff. Power readings were taken from the utility meter to determine motor loading characteristics.

The pump operates during off-peak hours from 10 p.m. to 8 a.m. on weekdays and operates 24 hours per day during the weekend. It operates at a constant load, pumping water to a reservoir. The operations and load schedule for the motor for summer and winter are shown in Tables 5-37 and 5-38, respectively.

Table 5-37
Summer Motor Operations and Load Schedule
ID No. 19176

	Summer Weekdays								Summer Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
2	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
3	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
4	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
5	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
6	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
7	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
8	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
9	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
10	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
11	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
12	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
13	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
14	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
15	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
16	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
17	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
18	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
19	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
20	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
21	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
22	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
23	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
24	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44

Table 5-38
Winter Motor Operations and Load Schedule
ID No. 19176

	Winter Weekdays								Winter Weekends & Holidays							
Hour of Day	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced	Duty Cycle	Load Factor	Max kW Baseline	Max kW Retrofit	Max kW Reduced	Avg kW Baseline	Avg kW Retrofit	Avg kW Reduced
1	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
2	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
3	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
4	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
5	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
6	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
7	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
8	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
9	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
10	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
11	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
12	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
13	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
14	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
15	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
16	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
17	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
18	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
19	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
20	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
21	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
22	0%	0%	0.00	0.00	0.00	0.00	0.00	0	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
23	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44
24	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44	100%	100%	148.32	143.88	4.44	148.32	143.88	4.44

Baseline Motor

To estimate the savings of an energy efficient motor, a baseline motor alternative must be established. Baseline (standard) motor efficiency data is obtained from the MotorMaster+ database (Washington State Energy Office 1996). This database contains cost and efficiency data on more than 10,000 NEMA Design B motors. Baseline motor data was chosen by searching the database for motors with efficiencies less than the NEMA 12-6B standard and selecting the motor with the median efficiency at 100% load. Motor characteristics are shown in Table 5-39. Efficiency and power factor curve data were available for load conditions ranging from 25% to 100% in quartile increments. These data are shown in Table 5-40.

Table 5-39
Motor Characteristics
ID No. 19176

	Rebate Application	Site Verified	Baseline Motor
Manufacturer	U.S. Electric	U.S. Electric	U.S. Electric
Model	ODP-High Eff /R	ODP-Premium Eff /RE	ODP-High Eff /R
Catalog Number	G71912	G71912	E241
Serial Number	X00X125R633R3	X08X123R633R-2	N/A
Type	ODP	ODP	ODP
Nominal Efficiency	96.2%	96.2%	93.0%
Power Factor @ 100%	N/A	84.6%	89.1%
Horsepower	200	200	200
Speed	1,780	1,780	1775
Installed Quantity	1	1	N/A
Install Date	8/30/95	7/5/95	N/A
Operation Hours	4,000	5,096	N/A
End Use	Booster Pump	Pump	N/A
Replaces	Burned Out Motor	Burned Out Motor	N/A
Specific Location	Pump Station	Pump Station	N/A
Available Quantity	1	1	N/A

Table 5-40
Motor Efficiency Data
ID No. 19176

	Baseline Motor, 200 HP			Retrofit Motor, 200 HP		
	U.S. Electric ODP-High Eff /R			U.S. Electric ODP-Premium Eff /RE		
% Load	Efficiency	Power Factor	Input (kW)	Efficiency	Power Factor	Input (kW)
0%	0.0%	53.4%		0.0%	33.0%	
10%	36.6%	59.6%	40.79	37.7%	41.3%	39.58
20%	73.1%	65.8%	40.79	75.4%	49.6%	39.58
25%	**91.4%**	**68.9%**	**40.79**	**94.2%**	**53.8%**	**39.58**
30%	91.9%	72.0%	48.68	94.6%	58.0%	47.31
40%	93.0%	78.2%	64.17	95.3%	66.3%	62.57
50%	**94.0%**	**84.4%**	**79.33**	**96.1%**	**74.6%**	**77.60**
60%	94.0%	86.0%	95.20	96.2%	77.6%	93.00
70%	94.0%	87.6%	111.06	96.3%	80.5%	108.36
75%	**94.0%**	**88.4%**	**118.99**	**96.4%**	**82.0%**	**116.03**
80%	93.8%	88.5%	127.20	96.4%	82.5%	123.82
90%	93.4%	88.8%	143.71	96.3%	83.6%	139.41
100%	**93.0%**	**89.1%**	**160.37**	**96.2%**	**84.6%**	**155.03**

Installed Motor

The installed motor was verified by on-site inspection. Motor nameplate data were recorded along with information regarding operations schedule and load conditions. Nameplate and other motor information are shown in Table 5-39. The motor nameplate data was augmented with data corresponding to the installed motor in the MotorMaster+ database (Washington State Energy Office, 1996). Efficiency and power factor curve data were available for load conditions from 25% to 100% in quartile increments. These data are shown in Table 5-40.

Savings Calculations

Equations 5-3 and 5-4 were utilized to calculate *ex post* kW and kWh impacts. *Ex post* load impact estimates on a time-of-use for summer and winter are shown in Tables 5-41 and 5-42, respectively.

Table 5-41
Summer Load Impacts
ID No. 19176

Summer Weekdays (106 days/year)				Summer Weekends & Holidays (47 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	148.32	143.88	4.44				
Max Semi-Peak kW	148.32	143.88	4.44				
Max Off-Peak kW	0.00	0.00	0.00	Max kW (Off-Peak)	148.32	143.88	4.44
Average On-Peak kW	32.96	31.97	0.99				
Average Semi-Peak kW	148.32	143.88	4.44				
Average Off-Peak kW	0.00	0.00	0.00	Average kW (Off-Peak)	148.32	143.88	4.44
Summer kW Coincident w/ System Peak	0.00	0.00	0.00				
Daily Summer On-Peak kWh	296.63	287.76	8.87				
Daily Summer Semi-Peak kWh	1,186.54	1,151.04	35.50				
Daily Summer Off-Peak kWh	1,483.17	1,438.80	44.37				
Daily kWh	0.00	0.00	0.00	Daily kWh (Off-Peak)	3,559.61	3,453.13	106.48
Annual Summer On-Peak kWh	31,443.19	30,502.63	940.56				
Annual Summer Semi-Peak kWh	125,772.75	122,010.54	3,762.21				
Annual Summer Off-Peak kWh	157,215.93	152,513.17	4,702.76				
Annual kWh (Summer Weekdays)	157,215.93	152,513.17	4,702.76	Annual kWh (Summer Weekends & Holidays)	167,301.48	162,297.03	5,004.45

Table 5-42
Winter Load Impacts
ID No. 19176

Winter Weekdays (147 days/year)				Winter Weekends & Holidays (65 days/year)			
	Ex Ante	*Ex Post*	Savings		*Ex Ante*	*Ex Post*	Savings
Max On-Peak kW	0.00	0.00	0.00				
Max Semi-Peak kW	148.32	143.88	4.44				
Max Off-Peak kW	148.32	143.88	4.44	Max kW (Off-Peak)	148.32	143.88	4.44
Average On-Peak kW	0.00	0.00	0.00				
Average Semi-Peak kW	34.23	30.83	3.40				
Average Off-Peak kW	148.32	143.88	4.44	Average kW (Off-Peak)	148.32	143.88	4.44
Winter kW Coincident w/ System Peak	0.00	0.00	0.00				
Daily Winter On-Peak kWh	0.00	0.00	0.00				
Daily Winter Semi-Peak kWh	444.95	431.64	13.31				
Daily Winter Off-Peak kWh	1,038.22	1,007.16	31.06				
Daily kWh	1,483.17	1,438.80	44.37	Daily kWh (Off-Peak)	3,559.61	3,453.13	106.48
Annual Winter On-Peak kWh	0.00	0.00	0.00				
Annual Winter Semi-Peak kWh	65,407.76	63,451.23	1,956.53				
Annual Winter Off-Peak kWh	152,618.11	148,052.88	4,565.23				
Annual kWh (Winter Weekdays)	218,025.87	211,504.11	6,521.76	Annual kWh (Winter Weekends & Holidays)	231,374.39	224,453.34	6,921.05

5.8.4 Comparison of Ex Ante and Ex Post Impact Estimates

The *ex ante* estimation methodology assumed a demand reduction of 2.68 kW and an operating schedule of 4,000 hours per year to estimate annual energy usage of 14,310 kWh. The *ex post* estimates were based on a demand reduction of 4.44 kW and 5,096 hours per year. These findings produced energy savings of 23,150 kWh per year. The differences between the *ex ante* and *ex post* estimates are due to:

- **Operating Hours:** The *ex ante* analysis assumed 4,000 operating hours per year for the motor. Based on facility operation records it was determined that the actual annual motor operating hours are approximately 5,096 operating hours. The higher *ex post* annual operating hours had an upward effect on the realization rate for energy.
- **Motor Operation:** The *ex ante* estimates were based on a motor loading of 75% (i.e., rated load factor of 0.75). Based on spot measurements, it was determined that the motor actually operates at 93% of full load. The higher motor loading resulted in greater demand reduction than expected from the *ex ante* estimates.

5.9 ID No. 13974 - Adjustable Speed Drive

5.9.1 Facility Information

This wastewater treatment plant incorporates a trickling filter process where treated waste water is circulated by a 75 HP pump that operates at a constant speed of 1,170 RPM. The output volume is controlled by a throttling valve at the discharge of the pump. Flow is reduced by throttling the valve, which raises the discharge pressure. According to the certified pump curve provided in the application the pump load increases slightly with reduced flow.

The installation of the adjustable speed drive on the pump allowed the elimination of the throttling valve. The pump's discharge is varied by increasing or decreasing the pump speed (RPM) according to demand.

The adjustable speed drive installed on the trickling filter pump motor reduced power consumption while the system is operating at less than 100%. The system power consumption was reduced as the pump flow rate decreased. In the base case system, power consumption actually increased slightly as the flow was decreased. This was due to the fact that power consumption of the pump due to friction varies with speed raised to the third power (i.e., RPM^3, where RPM is equal to motor speed), a small reduction in the flow will give a substantial savings in energy use. The decrease in power consumption at loads less than 100% are enough to offset the efficiency losses of the adjustable speed drive. At lower speed the power savings are fairly large.

Table 5-43 provides a summary of the *ex ante* and *ex post* load impacts for this measure.

Table 5-43
Summary of Demand and Energy Impacts
ID No. 13974

	Demand kW	Energy Annual kWh	Gas Annual Therms
***Ex Ante* Impacts**	0	224,530	N/A
***Ex Post* Impacts**	0	120,206	N/A
Difference	0	104,324	N/A
Realization Rate	0.00	0.54	N/A

5.9.2 Ex Ante Load Impact Estimation Methodology

The *ex ante* energy savings calculations used a pump energy savings software analysis provided by the customer. The input is based on the assumed frequency distribution of the flow rates. It was assumed that the pump operated at 70% of the maximum flow rate 42% of the time, and 60% of the maximum flow rate 58% of the time. The input also includes the motor brake HP, assumed annual operating hours, and the efficiencies of the motor and adjustable speed drive.

5.9.3 *Ex Post Load Impact Estimation Methodology*

An on-site visit was conducted on Wednesday, September 11, 1996. The adjustable speed drive installation was inspected, and an interview with facility staff was conducted. Run hours and average daily flow rates in gallons per minute (GPM) were obtained from the pump operation log for the period January 1, 1996 to August 31, 1996, as shown in Tables 5-44 through 5-46. Power readings were read from the adjustable speed drive's digital readout at full speed (maximum load) to determine loading characteristics. The *ex post* methodology assumed a constant pump efficiency.

Table 5-44
Pump Operation Log Data
Average Daily Flow Rates
ID No. 13974

	Average Daily Flow Rates, GPM (00's)							
	Winter				Summer			
Day of Month	Jan 96	Feb 96	Mar 96	Apr 96	May 96	Jun 96	Jul 96	Aug 96
1	41	42	41	42	43	43	44	46
2	41	42	42	42	41	42	44	46
3	40	42	41	42	42	42	44	48
4	30	42	42	42	42	42	44	48
5	38	41	41	42	42	44	46	48
6	41	35	41	42	42	44	43	48
7	42	40	42	43	43	44	43	48
8	40	41	41	42	43	44	43	48
9	40	41	41	42	42	44	43	48
10	40	41	41	41	41	44	43	48
11	40	41	41	42	42	44	43	48
12	40	42	42	42	42	44	43	48
13	40	41	41	42	42	44	43	47
14	41	40	40	41	42	44	43	46
15	41	41	41	42	42	44	43	46
16	40	41	41	42	42	44	43	46
17	40	41	41	42	42	43	43	48
18	39	41	41	42	43	44	43	47
19	39	41	41	42	42	44	43	47
20	40	41	40	41	42	44	43	47
21	41	41	40	41	42	43	43	46
22	41	44	40	41	42	43	43	47
23	40	41	40	41	42	44	44	47
24	41	41	40	41	42	43	44	47
25	41	40	41	42	42	43	44	47
26	41	42	40	41	41	43	44	47
27	42	43	40	42	43	43	44	48
28	40	42	40	42	44	43	44	48
29	38	41	41	42	42	43	48	48
30	39		41	42	42	43	48	48
31	40		41		42		48	48

Table 5-45
Pump Operations Log Data
Summer Flow Rate Frequency Distribution
ID No. 13974

Summer Frequencies		
GPM	Days of Average Flow	% Occurrence
4,100	2	1.6%
4,200	25	20.5%
4,300	33	27.0%
4,400	27	22.1%
4,600	7	5.7%
4,700	9	7.4%
4,800	19	15.6%
	122	100.0%

Table 5-46
Pump Operations Log Data
Winter Flow Rate Frequency Distribution
ID No. 13974

Winter Frequencies		
GPM	Days of Average Flow	% Occurrence
3,000	1	0.8%
3,500	1	0.8%
3,800	2	1.7%
3,900	3	2.5%
4,000	25	20.7%
4,100	52	43.0%
4,200	34	28.1%
4,300	2	1.7%
4,400	1	0.8%
	121	100.0%

From the pump operations log, it was determined that the pump runs continuously, and the maximum flow rate is 4,800 GPM. Using the eight month flow rate records available, the distribution of the load has been calculated using Equations 5-5 through 5-8. Through these equations loadings at various flow rates were calculated. The results are shown in Table 5-47.

(Eq. 5.5)

$$\sigma = \Delta H + F_{\max} * \left(\frac{GPM}{GPM_{\max}}\right)^2,$$

where:

σ = *Total pump head (feet),*

ΔH = *Elevation gain (feet),*

$F_{\max}$ = *Pressure due to friction at maximum flow(feet),*

GPM = *Flow rate (gallons per minute), and*

$GPM_{\max}$ = *Maximum flow rate (gallons per minute).*

(Eq. 5.6)

$$P_{ps} = \frac{\sigma * GPM}{1715 * 2.31 * \eta_{pump}},$$

where,

P_{ps} = Pump shaft Horsepower,

σ = Pump head (feet),

GPM = Flow rate (GPM), and

η_{pump} = Motor efficiency.

(Eq. 5.7)

$$P_m = \frac{P_{ps}}{\eta_{motor}} * 0.746,$$

where:

P_m = *Motor input power (kW),*

P_{ps} = *Pump shaft horsepower, and*

η_{motor} = *Motor efficiency.*

(Eq. 5.8)

$$P_{vfd} = \frac{P_{ps}}{\eta_{motor} * \eta_{vfd}} * 0.746,$$

where:

P_m = *Motor input power (kW),*

P_{ps} = *Pump shaft horsepower,*

η_{motor} = *Motor efficiency, and*

η_{vfd} = *Variable frequency drive efficiency*

Table 5-47
***Ex Post* Load Impacts**
ID No. 13974

				Baseline			Retrofit				Savings	
Occurrence	Annual Hours	Flow Rate	Flow Rate	Pump Shaft Power	Motor Input Power	Annual Energy	Head Pressure	Pump Shaft Power	VFD Input Power	Annual Energy	Demand	Energy
%	Hours	%	GPM	HP	kW	kWh	Feet	HP	kW	kWh	kW	kWh
1.6%	60	85.4%	4,100	66.6	54.1	3,259	35.8	43.6	37.3	2,245	16.9	1,015
20.5%	752	87.5%	4,200	66.0	53.7	40,385	36.6	45.7	39.1	29,410	14.6	10,975
27.0%	993	89.6%	4,300	65.4	53.2	52,837	37.5	47.8	40.9	40,667	12.3	12,170
22.1%	813	91.7%	4,400	64.8	52.7	42,845	38.3	50.1	42.9	34,836	9.9	8,009
5.7%	211	95.8%	4,600	63.7	51.8	10,908	40.1	54.8	46.9	9,885	4.9	1,023
7.4%	271	97.9%	4,700	63.1	51.3	13,896	41.1	57.3	49.0	13,286	2.3	610
15.6%	572	100.0%	4,800	62.5	50.8	29,065	42.0	59.9	51.2	29,306	-0.4	-241
	Weighted Averages	**92.1%**	**4,423**	**64.7**	**52.6**			**50.8**	**43.5**		**9.1**	
0.8%	42	62.5%	3,000	73.0	59.4	2,496	28.0	24.9	21.3	897	38.0	1,599
0.8%	42	72.9%	3,500	70.1	57.0	2,396	31.2	32.5	27.8	1,168	29.2	1,228
1.7%	84	79.2%	3,800	68.3	55.6	4,673	33.4	37.7	32.3	2,715	23.3	1,959
2.5%	126	81.3%	3,900	67.8	55.1	6,950	34.2	39.6	33.9	4,275	21.2	2,675
20.7%	1,051	83.3%	4,000	67.2	54.6	57,418	35.0	41.5	35.6	37,382	19.1	20,036
43.0%	2,187	85.4%	4,100	66.6	54.1	118,393	35.8	43.6	37.3	81,541	16.9	36,852
28.1%	1,430	87.5%	4,200	66.0	53.7	76,733	36.6	45.7	39.1	55,880	14.6	20,852
1.7%	84	89.6%	4,300	65.4	53.2	4,474	37.5	47.8	40.9	3,443	12.3	1,030
0.8%	42	91.7%	4,400	64.8	52.7	2,217	38.3	50.1	42.9	1,803	9.9	414
	Weighted Averages	**85.2%**	**4,089**	**66.6**	**54.2**		**35.7**	**43.4**	**37.2**		**17.0**	
	Total					**468,947**				**348,741**		**120,206**

5.9.4 Comparison of Ex Ante and Ex Post Impact Estimates

The *ex ante* methodology estimated a 0 kW reduction. There are periods when the pump operates at 100% load with the adjustable speed drive. This results in no demand reduction. The *ex post* estimate is the same as the *ex ante.*

The *ex ante* estimate of energy savings was 224,530 kWh per year. The *ex post* estimate was 120,206 kWh per year. This resulted in a realization rate of 0.54. The primary reason for the difference in energy savings is difference in the load conditions at which the motor was operating. The *ex ante* analysis assumed that the system operated at between 60% and 70% of maximum load. The inspections of the facility records show that the system operates closer to maximum load. The average summer load was 92% and the average winter load was 85%. This results in higher system consumption than predicted by the *ex ante* estimate.

SAN DIEGO GAS & ELECTRIC
RETROACTIVE WAIVER FOR
1995 AGRICULTURAL ENERGY EFFICIENCY INCENTIVES PROGRAM
Approved September 19,1996

REQUEST

This waiver requests that SDG&E be allowed to do the following:

1. Not use a comparison group to determine net load impacts for the PY95 AEEI Program. In lieu of a comparison group, a net-to-gross ratio of 0.75 will be adopted or these measures.
2. Be exempted from reporting the results for the AEEI Program designated unit of measurement (DUOM), load impacts per acre foot of water pumped. Instead SDG&E proposes to report load impacts per horsepower as the DUOM for the motors that were installed under this program. These motors were purchased through the motor retail program and as such it was not possible to acquire the necessary information to satisfy the Protocol-established DUOM.
3. Evaluate the 4 heating measures (normally classified as miscellaneous measures) as a separate end use with on-site verification of engineering estimates. The heating measures will be evaluated on a savings per project.
4. Exit signs will be treated as miscellaneous measures per Table C-9.

BACKGROUND

SDG&E has identified 11 participants in the program who installed a total of 28 measures. Of the 28 measures installed, 10 were motors for pumping purposes, 4 were heating measures for greenhouses, and 14 were exit signs. The heating measures and the exit signs, installed by 4 participants, are classified as miscellaneous under M&E Protocols Table C-9. The 10 pump motors, installed by only 7 participants, would be studied under Table C-6 using a simplified engineering model. This will involve the use of premise-specific engineering models that are adjusted to reflect post-installation hours of operation and other related equipment characteristics. SDG&E proposes to use the verification method similar to that described in Table C-5 for Industrial Motors, instead of direct end use metering.

In order to meet the revised M&E Miscellaneous Protocol Table C-9 of having less than 15 percent of the program's resource benefits, net (RBn) evaluated as miscellaneous measures, SDG&E requests that the 4 heating measures installed at greenhouses be evaluated ex post with an on-site verification of engineering estimates. The remaining miscellaneous measures would then account for less than 2 percent of the PY95 AEEI Program's RBn.

SDG&E's 1995 Agricultural EEI Program has RBn of $231,000 and an associated earnings claim of $48,000. SDG&E requests that this waiver be granted given the small number of participants and low eamings claim.

B

TABLE 6: SPACE HEATING

SAN DIEGO GAS & ELECTRIC
M&E PROTOCOLS TABLE 6 - RESULTS USED TO SUPPORT PY95 SECOND EARNINGS CLAIM FOR AGRICULTURAL ENERGY EFFICIENCY INCENTIVES PROGRAM
FIRST YEAR LOAD IMPACT EVALUATION, JANUARY 1997, STUDY ID NO. 965

Designated Unit of Measurement: Load Impacts per Participant
End Use: Space Heating

				5. A. 90% Confidence Level				5. B. 80% Confidence Level			
				Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
1. Average Participant Group and Average Comaprison Group		Part Group	Comp Group	Part Group	Part Group	Comp Group	Comp Group	Part Group	Part Group	Comp Group	Comp Group
A. Pre-install usage:	Pre-install kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Pre-install kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Base kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Base kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Base kW/ designated unit of measurement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Base kWh/ designated unit of measurement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B. Impact year usage:	Impact Yr kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Impact Yr kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Impact Yr kW/designated unit	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Impact Yr kWh/designated unit	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2. Average Net and Gross End Use Load Impacts		Avg Gross	Avg Net	Avg Gross	Avg Gross	Avg Net	Avg Net	Avg Gross	Avg Gross	Avg Net	Avg Net
	A. i. Load Impacts - kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	A. ii. Load Impacts - kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	A. iii. Load Impacts - therm	10,578	7,934	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	B. i. Load Impacts/designated unit - kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	B. ii. Load Impacts/designated unit - kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	B. iii. Load Impacts/designated unit - therm	10,578	7,934	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	C. i. a. % change in usage - Part Grp - kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	C. i. b. % change in usage - Part Grp - kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	C. ii. a. % change in usage - Comp Grp - kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	C. ii. b. % change in usage - Comp Grp - kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D. Realization Rate:	D.A. i. Load Impacts - kW, realization rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.A. ii. Load Impacts - kWh, realization rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.A. iii. Load Impacts - therm, realization rate	1.46	1.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.B. i. Load Impacts/designated unit - kW, real rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.B. ii. Load Impacts/designated unit - kWh, real rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.B. iii. Load Impacts/designated unit - therm, real rate	1.46	1.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3. Net-to-Gross Ratios		Ratio		Ratio	Ratio			Ratio	Ratio		
	A. i. Average Load Impacts - kW	N/A		N/A	N/A			N/A	N/A		
	A. ii. Average Load Impacts - kWh	N/A		N/A	N/A			N/A	N/A		
	A. iii. Average Load Impacts - therm	0.75		N/A	N/A			N/A	N/A		
	B. i. Avg Load Impacts/designated unit of measurement - kW	N/A		N/A	N/A			N/A	N/A		
	B. ii. Avg Load Impacts/designated unit of measurement - kWh	N/A		N/A	N/A			N/A	N/A		
	B. iii. Avg Net Load Impacts/designated unit of measurement - therm	0.75		N/A	N/A			N/A	N/A		
	C. i. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kW	N/A		N/A	N/A			N/A	N/A		
	C. ii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kWh	N/A		N/A	N/A			N/A	N/A		
	C. iii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - therm	N/A		N/A	N/A			N/A	N/A		
4. Designated Unit Intermediate Data		Part Group	Comp Group	Part Group	Part Group	Comp Group	Comp Group	Part Group	Part Group	Comp Group	Comp Group
	A. Pre-install average value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	B. Post-install average value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6. Measure Count Data		Number									
	A. Number of measures installed by participants in Part Group	4									
	B. Number of measures installed by all program participants in the 12 months of the program year	4									
	C. Number of measures installed by Comp Group	N/A									
7. Market Segment Data		SIC	Percent								
	Distribution by 3 digit SIC	018	100%								

C

TABLE 6: PUMPING

SAN DIEGO GAS & ELECTRIC
M&E PROTOCOLS TABLE 6 - RESULTS USED TO SUPPORT PY95 SECOND EARNINGS CLAIM FOR AGRICULTURAL ENERGY EFFICIENCY INCENTIVES PROGRAM
FIRST YEAR LOAD IMPACT EVALUATION, JANUARY 1997, STUDY ID NO. 965

Designated Unit of Measurement: Load Impacts per Horsepower
End Use: Pumping

				5. A. 90% Confidence Level				5. B. 80% Confidence Level			
				Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
1. Average Participant Group and Average Comparison Group		Part Group	Comp Group	Part Group	Part Group	Comp Group	Comp Group	Part Group	Part Group	Comp Group	Comp Group
A. Pre-install usage:	Pre-install kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Pre-install kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Base kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Base kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Base kW/ designated unit of measurement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Base kWh/ designated unit of measurement	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
B. Impact year usage:	Impact Yr kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Impact Yr kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Impact Yr kW/designated unit	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Impact Yr kWh/designated unit	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2. Average Net and Gross End Use Load Impacts		Avg Gross	Avg Net	Avg Gross	Avg Gross	Avg Net	Avg Net	Avg Gross	Avg Gross	Avg Net	Avg Net
	A. i. Load Impacts - kW	1.5986	1.1986	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	A. ii. Load Impacts - kWh	21,543	16,160	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	A. iii. Load Impacts - therm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	B. i. Load Impacts/designated unit - kW	0.0147	0.0110	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	B. ii. Load Impacts/designated unit - kWh	198.5	148.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	B. iii. Load Impacts/designated unit - therm	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	C. i. a. % change in usage - Part Grp - kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	C. i. b. % change in usage - Part Grp - kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	C. ii. a. % change in usage - Comp Grp - kW	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	C. ii. b. % change in usage - Comp Grp - kWh	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
D. Realization Rate:	D.A. i. Load Impacts - kW, realization rate	1.18	0.89	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.A. ii. Load Impacts - kWh, realization rate	0.55	0.41	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.A. iii. Load Impacts - therm, realization rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.B. i. Load Impacts/designated unit - kW, real rate	1.18	0.89	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.B. ii. Load Impacts/designated unit - kWh, real rate	0.55	0.41	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	D.B. iii. Load Impacts/designated unit - therm, real rate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3. Net-to-Gross Ratios		Ratio		Ratio	Ratio			Ratio	Ratio		
	A. i. Average Load Impacts - kW	0.75		N/A	N/A			N/A	N/A		
	A. ii. Average Load Impacts - kWh	0.75		N/A	N/A			N/A	N/A		
	A. iii. Average Load Impacts - therm	N/A		N/A	N/A			N/A	N/A		
	B. i. Avg Load Impacts/designated unit of measurement - kW	0.75		N/A	N/A			N/A	N/A		
	B. ii. Avg Load Impacts/designated unit of measurement - kWh	0.75		N/A	N/A			N/A	N/A		
	B. iii. Avg Net Load Impacts/designated unit of measurement - therm	N/A		N/A	N/A			N/A	N/A		
	C. i. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kW	N/A		N/A	N/A			N/A	N/A		
	C. ii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - kWh	N/A		N/A	N/A			N/A	N/A		
	C. iii. Avg Load Impacts based on % chg in usage in Impact year relative to Base usage in Impact year - therm	N/A		N/A	N/A			N/A	N/A		
4. Designated Unit Intermediate Data		Part Group	Comp Group	Part Group	Part Group	Comp Group	Comp Group	Part Group	Part Group	Comp Group	Comp Group
	A. Pre-install average value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	B. Post-install average value	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6. Measure Count Data		Number									
	A. Number of measures installed by participants in Part Group	10									
	B. Number of measures installed by all program participants in the 12 months of the program year	10									
	C. Number of measures installed by Comp Group	N/A									
7. Market Segment Data		SIC	Percent								
	Distribution by 3 digit SIC	494	90%								
		019	10%								

M&E PROTOCOLS TABLE 7
DATA QUALITY AND PROCESSING DOCUMENTATION
For 1995 Agricultural Energy Efficiency Incentives Program
First Year Load Impact Evaluation
January 1997
Study ID No. 965

A. OVERVIEW INFORMATION

1. **Study Title and Study ID:** 1995 Agricultural Energy Efficiency Incentives Program: First Year Load Impact Evaluation, January 1997, Study ID No. 965.

2. **Program, Program Year(s), and Program Description (design):** 1995 Agricultural Energy Efficiency Incentives Program for the 1995 program year. The Program is designed to help agricultural customers control energy costs by providing incentives for the installation of energy efficient equipment at their facilities.

3. **End Uses and/or Measures Covered:** All end uses combined disaggregated by space heating, pumping, and miscellaneous.

4. **Methods and models used:** Site-specific simplified engineering models for pumping measures with verified inputs. Space heating measures were evaluated using *ex post* on-site verification of engineering estimates.

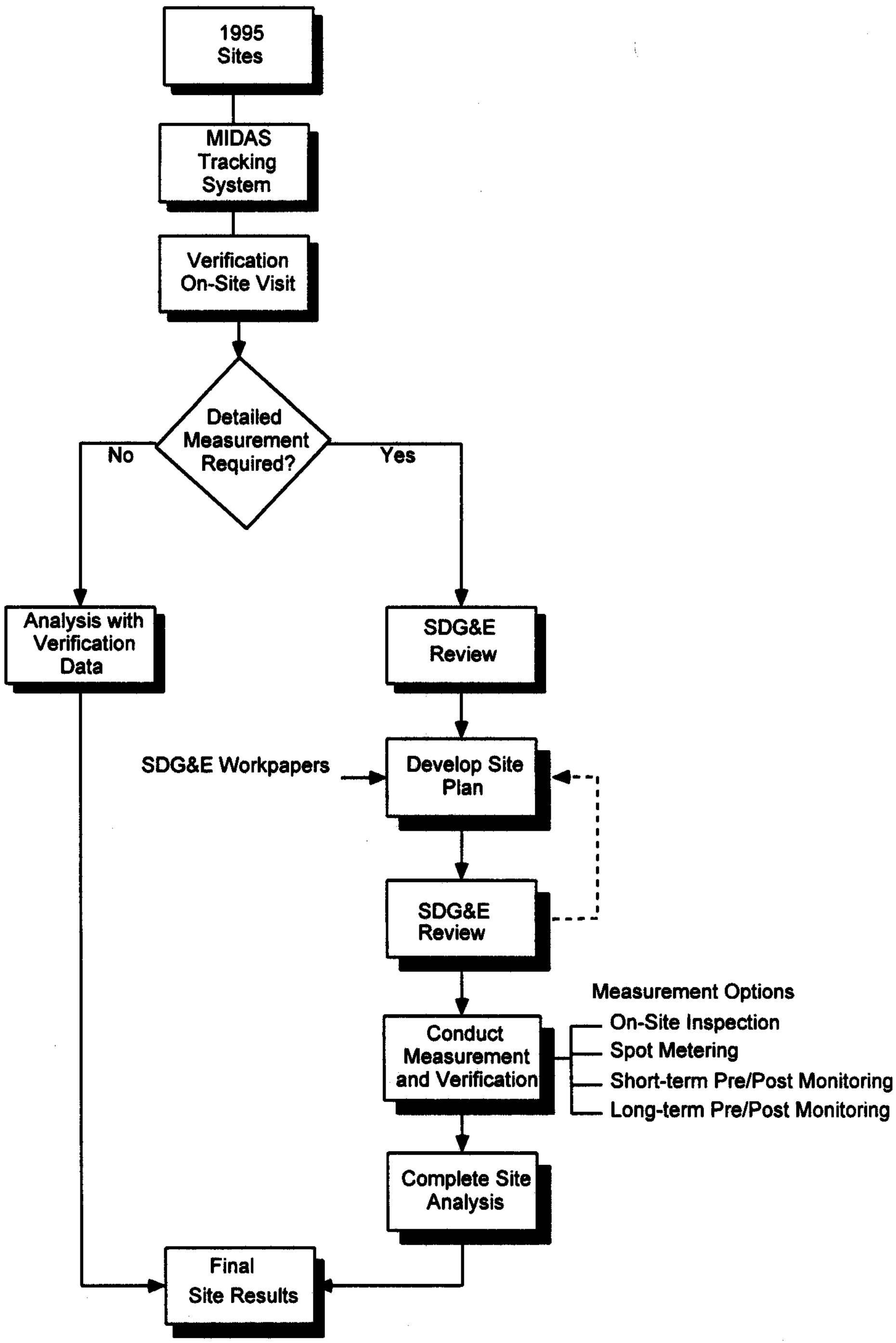
5. **Participant and comparison group definition:** For the load impact analysis, the participants in the 1995 Agricultural Energy Efficiency Incentives Program are defined as having at least one of the aforementioned measures installed. Per SDG&E's retroactive waiver a comparison group was not required for this evaluation.

6. **Analysis sample size:**

Electric Participant Sample for 1995 Agricultural Energy Efficiency Incentives Program			Gas Participant Sample for 1995 Agricultural Energy Efficiency Incentives Program			
Measure Type	**No. of Participants**	**No. of Measures**	**Measure Type**	**No. of Participants**	**No. of Projects**	**No. of Measures**
Space Heating	0	0	**Space Heating**	3	4	4
Pumping	7	10	**Pumping**	0	0	0
Miscellaneous	1	14	**Miscellaneous**	0	0	0
Total	8	24	**Total**	3	4	4

B. DATABASE MANAGEMENT

1. Flow Charts:



2. **Data sources:** the data came from the following sources:

- Customer name, address, appliance saturation, installed measures, and participation date from the program tracking database.
- Electric and gas consumption history, where applicable, from the Customer Master File.
- Typical Meteorological Year Weather Data from NOAA files (for DOE-2.1E building simulations, ID Nos. 14097, 14155, and 14156).
- Daily high and low temperatures from the National Weather Service (for ID No. 14406).
- *Ex ante* engineering assumptions and analyses from program project files.
- *Ex post* on-site survey data.

3. **Data Attrition:**

   a. **Participant Sample - Load Impact Analysis**

   No attrition.

   b. **Nonparticipant Sample - Load Impact Analysis**

   Not applicable.

4. **Data Quality Checks**

   Not applicable for this evaluation.

5. **All data collected** for this analysis were utilized.

C. SAMPLING

1. **Sampling procedures and protocols:** A census of participants was conducted.

2. **Survey information:** On-site inspections were conducted that included a review of operations logs, interviews of on-site staff, and measurements of the measures in operation.

3. **Statistical Descriptions:** Not applicable.

D. DATA SCREENING AND ANALYSIS

1. **Outliers:** Not applicable.

   Missing data points: Not applicable.

   Weather adjustments were implicit in the engineering models used in the evaluation.

2. **"Background" variables:** Not applicable.

3. **Screening procedures:** Not applicable.

4. **Regression statistics:** Not applicable.

5. **Specification:**

   a. Not applicable.

   b. Not applicable.

   c. Not applicable.

   d. Not applicable.

   e. Not applicable.

6. **Error in measuring variables:** On-site observation of measure installation and on-site measurements were taken to mitigate possible errors from project files.

7. **Autocorrelation:** Not applicable.

8. **Heteroskedasticity:** Not applicable.

9. **Collinearity:** Not applicable.

10. **Influential data points:** Not applicable.

11. **Missing Data:** Not applicable.

12. **Precision:** Not applicable. Standard errors and other statistically based measures of precision are not applicable to the site-specific engineering analyses employed in this analysis.

E. Data Interpretation and Application

1. **Calculation of net impacts:** Not applicable.

2. **Processes, choices made and rationale for E.1:** Not applicable.