INVESTMENT GRADE AUDIT
ARRA Funded Project

Presented By:

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1.0 Executive Summary

Earlier this year, the Town of Oro Valley (TOV) selected APS Energy Services as an energy partner to promote fiscal responsibility, environmental stewardship and TOV employee well-being. APS Energy Services has been tasked to deliver a 100% Investment Grade Audit Report on November 4, 2009.

This document is meant to provide a 100% Review of the progress findings to TOV and to communicate and obtain feedback as we move toward completion.

This project will utilize ARRA stimulus funding to help pay for the project.

Investment Grade Audit Progress

Since being selected, an example of the advancements the APS Energy Services Team has made follows. It is as a result of this progress and the willingness and enthusiasm shown by TOV that APS Energy Services can confidently say that the overall audit is 'on-target'.

1.1. Key Milestones

The preliminary findings from the audit process indicate there is significant energy, water and operational efficiency cost reduction opportunities, and subsequent pages will outline the findings to-date. To ensure success, the following Table lists key milestones for the Investment Grade Audit process.

Table 1-0. Investment Grade Audit Key Milestones

Key Milestones	Date
Audit Contract Approved	08.19.09
30% Review Report Submitted	09.08.09
60% Review Report Submitted	10.01.09
90% Review Report Submitted	10.21.09
Final Report Submitted	11.04.09
Town Council Meeting	11.18.09
Finalize Contract Negotiations	TBD
Finalize Financing	TBD

2.0 Investment Grade Audit Overview

The Town of Oro Valley has identified 6 buildings totaling over 67,001 square feet to be included as part of this Audit. The purpose of the Investment Grade Audit is to ensure a fundamentally sound project. Through detailed technical evaluation and analysis, the audit identifies energy, water and operational efficiency cost reduction opportunities, as well as renewable energy alternatives, and determines the potential value thereof to maximize facility infrastructure improvements. The team worked with TOV to reconcile any long term plans for use of the facilities with the proposed retrofit projects, other planned projects, compliance with local, State and Federal requirements, as well as, minimizing disruption to occupants during data collection and facility monitoring.

The Investment Grade Audit was designed to accomplish the following:

- Evaluate facility energy using equipment at 6 buildings.
- Provide recommendations to substantially reduce electric, natural gas and water use.
- Replace old and obsolete equipment with the most cost effective, long term solution.
- Standardize energy efficient products across all facilities.
- Make improvements to the environment that positively effect comfort, lighting levels and the health of staff, visitors and residents.
- Locate alternative funding sources to help pay for the improvements.

The results of the Investment Grade Audit and the resulting recommended program, indicate that TOV will realize a total annual cost avoidance of **$58,862**. The cost of the improvements is **$774,350**, providing an attractive **13.1 year payback**. The project is structured to be 100% self-funding from reductions in existing operating budgets, as well as, any stimulus funding or other funding sources available to TOV. These reductions are used to cover the cost of the improvements plus finance costs over the 15 year term.

A detailed Energy Conservation Measures Matrix can be found in Section 4.0 Technical Summary, Table 4-0 ECM Matrix.

Table 2-0. Proposed Energy Conservation Measures Costs and Cost Avoidances

Energy Conservation Measure	Annual Electrical Consumption Savings (kWh)	Annual Electricity Savings $	Annual Natural Gas Savings (Therms)	Annual Natural Gas Savings $	Annual Water Savings (Thousand Gallons)	Annual Water Savings $	Annual Labor Operations Savings $	Rebates $	Total Annual Savings $	All Inclusive Project Cost $	Simple Payback with Energy, Water, Rebates	Simple Payback without Rebates
Town of Oro Valley Library	94,633	$ 10,346	7,277	$ 9,533	77	$ 597	$ 183	$ 7,954	$ 20,659	$ 145,475	9.43	9.51
Town Hall Complex (4 Buildings)	106,254	$ 13,191	1,636	$ 2,142	409	$ 3,121	$ 461	$ 7,417	$ 18,915	$ 473,161	13.62	14.12
Oro Valley PD Main Station	105,408	$ 13,086	3,955	$ 5,181	59	$ 488	$ 533	$ 5,563	$ 19,288	$ 155,714	17.04	17.24
TOTALS:	306,295	$ 36,623	12,868	$ 16,856	545	$4,206	$1,177	$20,934	$ 58,862	$ 774,350		13.16

TOV will realize a carbon footprint reduction by implementing projects that reduce fossil fuel consumption. Electrical generation uses fossil fuel and fossil fuels are also used directly for heating processes. Less energy consumed translates into less power plant production and pollution into the air. The energy cost avoidances for electricity, natural gas and water for the proposed project have been calculated and their environmental benefit recorded in Section 5.0 Environmental Benefits.

- Electricity Reduction: **306,295** kWh/yr (3% Reduction)
- Natural Gas Reduction: **12,868** therms/yr (19% Reduction)
- Water Reduction: **545** Thousands of gallons/yr (3% Reduction)

These annual cost avoidances, once achieved, will produce the following environmental benefits summarized in Table 5-0 Environmental Benefits:

Table 2-1. Environmental Impact		
Type of Pollution	Pollutants Reduced	
Carbon Dioxide (CO_2) Eliminated:	**668,381**	Pounds (lbs)
Sulfur Dioxide (SO_2) Eliminated:	**294**	Pounds (lbs)
Nitric Oxide (NO_x) Eliminated:	**647**	Pounds (lbs)

2.1. Financial Highlights

2.1.1. Financial Summary

APS Energy Services is currently in the 100% Review Phase of the Investment Grade Audit designed to develop operational cost savings measures for TOV.

During the course of the audit, many potential measures were identified and their economics evaluated. APS Energy Services is recommending a package of operating cost saving measures that produce a program that requires no capital in order to implement. Based upon the audit and current utility rates, the identified measures will produce a total first year cost avoidance of **$58,862.** This annual savings stream creates the funding source that pays for the recommended upgrades and efficiency improvements for TOV. Highlights of the program are summarized below:

- First Year Project Savings **$ 58,862**
- 15 Year Project Savings (with escalations) **$ 1,120,049**
- Project Principal Amount **$ 774,350**
- Annual Lease Payment **$ 59,700**
- 15 Year Net Project Savings* **$ 224,542**
- Financing Term Length **15 Years**
- Annual Financing Rate **5.75%**

** Net project savings is based on projected utility rate increases of 2-3% annually.*

2.1.2. Financial Structure

The construction cost to implement the recommended project is **$774,350.** The fixed price and the current tax rate are included as part of the Investment Grade Audit submitted on November 4, 2009.

TOV will be responsible for payment of applicable taxes in connection with the fixed price amount of the Agreement for any adjustments of the tax rate for work performed under this Agreement.

The Program also provides:

- Assistance in obtaining all available utility incentives.
- Assistance in obtaining Federal ARRA Funding
- All work to be performed at a not-to-exceed price.

Based on the accepted Rate Forecast, the following Table found in Section 4.0 summarizes the savings potential of these recommendations. The Existing Annual Utility costs are total city-wide costs.

Table 2-1. Proposed Annual Energy and O&M Savings

Fuel Type	Existing Annual Cost	Proposed Annual Cost Avoidances	Reduction (%)
Electricity	$ 1,193,304	$ 36,623	3.07%
Natural Gas	$ 87,233	$ 16,856	19.32%
Water	$ 144,405	$ 4,206	2.91%
Total Annual Utility Cost Avoidance:		**$ 57,685**	
Annual O&M Cost Avoidance		$ 1,177	
Total Annual Cost Avoidance:		**$ 58,862**	

2.1.3. Implementation Overview

APS Energy Services will coordinate all activities of the multiple professionals and trades in a consistent manner of that TOV has come to expect. Over the last 11 years, APS Energy Services has successfully completed each of our projects while experiencing no contractor-generated change orders. Additionally, and most importantly, APS Energy Services has performed work at similar facilities to that of TOV under tight timeframes and high pressure situations with zero recorded safety incidents.

3.0 Utility Analysis

A utility billing analysis provides an evaluation of opportunities for energy savings. Utility rate issues, utility costs for each of TOV's facilities and overall benchmarking have been utilized in an effort to identify Energy Conservation Measure opportunities.

Base Year for Utility Costs and Usage
The utility base year utilized for this audit is the fiscal year for TOV, July 2008 through June 2009. While the billing for utility services is not exactly contained within those dates, TOV attributes the billing as closely to those days as possible to ensure reconciliation of expenditures during the fiscal year.

3.1. Rate Analysis

The first step of any billing analysis is an assessment of the billing rate and TOV's energy requirements. This ensures that TOV is being billed using the most appropriate tariff for their usage pattern. Depending on the Energy Conservation Measures selected for implementation, additional analysis may be required to determine if a better rate schedule can be applied after the measures are implemented.

Electric service to TOV Facilities is provided by Tucson Electric Power (TEP). The rate structure for specific accounts can be broken down as follows:

- GS-10 is the rate schedule for all facilities with the exception of pumping loads for water utilities.
- PS-43 is the pumping rate schedule for facilities where pumping is the primary load.

Natural gas delivery service for all TOV facilities is supplied by Southwest Gas (SWG). Some facilities use electric heat and do not have natural gas service. A variety of rate schedules apply to the Town of Oro Valley accounts depending on how much gas service is utilized. Specific tariffs include:

- GS-25 Large, Medium, and Small service
- GS-55S Small compressed gas service

The Town of Oro Valley provides potable and reclaimed water service to customers. The reclaimed water service is provided to four (4) golf courses. Potable water is supplied within the service territory to residential and commercial customers.

Please see the Section 3.0 Utility Analysis of the Main Report for the overall City-wide Utility Analysis.

4.0 Technical Report

APS Energy Services is submitting the following Investment Grade Audit of Energy Conservation Measures to TOV. The objective of this report is to identify Energy Conservation Measures that will improve operations and reduce operating and maintenance (O&M) costs through energy saving technologies and practices.

The results of the Audit reveal total electric, gas, operational and maintenance savings opportunities of **$58,862** per year. To achieve these savings, APS Energy Services has identified and recommended a number of Energy Conservation Measures (ECMs).

The recommended Energy Conservation Measures (ECMs) can be found in the following matrix, Table 4-0 ECM Matrix.

Table 4-0. Energy Conservation Measures

Facility	Square Footage	ECM 1 Interior Lighting And Controls	ECM 4 Water Conservation	ECM 6 Solar Water Heating	ECM 7 Rate Analysis	ECM 8 Low E Window Film	ECM 9 Ceiling Fans	ECM 10 Direct Digital Controls	ECM 13 HVAC Zone Control	ECM 14 High Efficiency Packaged Units	ECM 15 Variable Frequency Drives	ECM 17 Demand Controlled Ventilation	ECM 18 Pump/Well Piping Modifications	ECM 19 Premium Efficiency Motor	ECM 20 Data Energy Management
Town of Oro Valley Library	25,000	X	X					X				X		X	X
Administration Building	18,722	X	X			X	X	X	X	X					X
Oro Valley Water Utility Building	2,192	X	X			X		X		X					X
Magistrate Court Building	4,212	X	X			X		X		X					X
Development Services Building	10,000	X	X			X	X	X	X						X
Oro Valley Police Dept. Main Station	6,875	X	X	X		X		X							X

Savings calculations for mechanical projects (HVAC and controls) Energy Conservation Measures are dependent on the schedule and temperature settings of the associated equipment. These settings are determined based on the site survey and interviews with facility personnel.

"Existing Conditions" summarizes the schedules and temperature set points identified during the site survey, while "Proposed Conditions" summarizes the schedules and temperature set points proposed by APS Energy Services. Both existing and proposed schedules and temperature set points have been input to the calculation tools used to determine savings for the HVAC and Energy Management Controls System measures.

Table 4-1. Standards of Operation

			Existing			Proposed		
ITEM #	BLDG #	Building Name	Average HVAC Schedule	Average Heating Occupied Unoccupied Temperatures	Average Cooling Occupied Unoccupied Temperatures	HVAC Schedule	Heating Occupied Unoccupied Temperatures	Cooling Occupied Unoccupied Temperatures
1	1	Town of Oro Valley Library (AHU-1)	06:00 - 22:00 7 Days/Week	74/60	74/85	08:00 - 18:00 M,W,F,S 10:00 - 23:00 T, Th	68/55	75/85
2	1	Town of Oro Valley Library (AHU-2)	06:45 - 22:00 7 Days/Week	74/60	74/80	08:00 - 18:00 M,W,F,S 10:00 - 23:00 T, Th	68/55	75/85
3	2	Administration Building (Manual Thermostats)	24/7	71/71	71/71	07:00 - 18:00 M-F	68/55	75/85
4	2	Administration Building (Programmable)	07:00 - 18:00 M-F	71/67	75/81	07:00 - 18:00 M-F	68/55	75/85
5	3	Oro Valley Water Utility Building	24/7	75/75	75/75	07:00 - 18:00 M-F	68/55	75/85
6	4	Magistrate Court Building	06:00 - 19:00 7 Days/Week	72/69	75/77	07:00 - 1800 M-F	68/55	75/85
7	5	Development Services Building	24/7	73/73	73/73	07:00 - 1800 M-F	68/55	75/85
8	6	Oro Valley Police Dept. Main Station	24/7	74/74	75/75	24/7	68/68	75/75

Notes

1 Libray and Police Station are average of all VAV zones from DDC systems.

2 Six of seven thermostats located in Development Services are manual Thermostats.

Savings calculations for the lighting measure are dependent upon the operating hours of the lighting systems.

Table 4-2. Lighting Hours of Operation

Hour Code	Area Description	Existing Weekly Winter On-Peak Hours	Existing Weekly Winter Off-Peak Hours	Existing Weekly Summer On-Peak Hours	Existing Weekly Summer Off-Peak Hours	Total Existing Annual Hours of Operation	Total Projected Annual Hours of Operation
CELL	Jail Cells	40	86	40	86	6,577	6577
CF	Conf. Room	20	6	20	6	1,344	1344
CF-OS	Conf. Room, add new sensor	20	6	20	6	1,344	854
C-OS	Classrooms- add new sensor	30	10	30	10	2,088	1670
G-OS	Gyms, add new sensor	40	34	40	34	3,863	2588
H	Halls & common areas	40	57	40	57	5,074	5074
H-OS	Hallways, add new sensor	40	57	40	57	5,074	2604
L	Cafeteria	30	10	30	10	2,088	2088
L-OS	Cafeteria, add new sensor	30	10	30	10	2,088	1399
M	Maintenance Areas	40	34	40	34	3,863	3863
O	Offices	30	10	30	10	2,088	2088
OO	Open Office	40	27	40	28	3,515	3515
OO-OS	Open Offices, add new sensor	40	27	40	28	3,515	1977
O-OS	Offices, add new sensor	30	10	30	10	2,088	1121
O-PD	Offices Police Department	40	27	40	28	3,515	3515
O-PD-OS	Offices Police Department, add new sensor	40	27	40	28	3,515	1898
PD	Police Station La Canada	40	103.75	40	103.51	7,500	7500
PDO-OS	Police Station La Canada-Offices, add new sensors	40	103.75	40	103.51	7,500	4125
PDRR-OS	Police Station La Canada-Restrooms, add new sensors	40	103.75	40	103.51	7,500	1875
RR	Restrooms	32	20	33	20	2,738	2738
RR-OS	Restrooms, add new sensor	32	20	33	20	2,738	673
S	Storage Areas	5	5	5	5	522	522
VEND	Vending Machine, add new sensor	40	128	40	128	8,760	4818
W	Warehouse	40	34	40	34	3,863	3863
X	Outside Areas	0	84	0	84	4,385	4385
Z	24 Hour Areas	40	128	40	128	8,760	8760

4.1. Library

Facility Overview

The Town of Oro Valley Library is the largest building located at the La Canada Complex. The 25,000 sq. ft. structure is characterized by its unique copper roof clearstories. The building was constructed in 2002. The hours of operation are 9:00 a.m. to 5:00 p.m. Monday, Wednesday, Friday and Saturday and 11:00 a.m. to 8:00 p.m. on Thursday and Saturday.

The following overview describes the building envelope; lighting; domestic water and water heating; automation and controls; HVAC, and chilled and hot water systems.

Building Envelope

The flat roof structures include white membrane surface over 1.5" rigid insulation on metal decking with R-30 fiberglass batt insulation. Sloped roof construction is steel frame with R-30 fiberglass batt insulation and standing seam copper surface. The ceilings have lay in acoustic tile; exterior walls are 8" CMU with furred insulated interior surface. The expansive clearstory widows are dual tinted glass. Overall the condition of the building envelope is excellent.

Table 4-1-1. Existing Building Envelope

Location	Ceiling/Roof Insulation	Exterior Roof	Wall Insulation	Exterior Walls	Window Type	Window Film	Weather Strip
Library	1.5" Rigid R-30 Fiberglass	Membrane	R-13	CMU	Dual	No	Good

Lighting

The Town of Oro Valley Library's existing interior lighting system consists of 28w T5 lamps and programmed rapid start electronic ballast and 32w T8 lamps and electronic ballast fixtures. HID fixtures are seen mostly on the exterior of the facilities but there are a few facilities that use this type of lighting on their interior as well.

Fixtures that are existing compact fluorescent, LED or T5 are not included in this proposal. These fixtures are documented on the room by room.

Domestic Water and Water Heating

The existing domestic water system consists of floor mount Flushometer toilets flushing at 1.6gpf also wall mounted urinals flushing at 1.0gpf. Other domestic fixtures in use include kitchen sinks and lavatory sinks.

All existing fixtures listed as ZEC, ZLC, or ZHF are either already low consumption, or cannot be retrofit to a lower flow. These existing technologies will not be included as part of this upgrade.

Domestic hot water systems for all of the buildings were found to be in good condition. The following table provides a summary of the units.

Table 4-2-1. Existing Water Heater Inventory

Location	Mfg	Model	Qty	Capacity	Heating Rating
Mechanical Room	AO Smith	DEL 20 1 02	1	19	6000W
Janitor's Closet	AO Smith	DEL 20 1 02	1	19	6000W

Building Automation and Controls

This facility is controlled by a Delta DDC system. The frontend workstation is located in the mechanical room. The control software is Delta ORCAview version 3.3 that was produced in 2006. The DDC system is used to control all of the buildings mechanical systems including the chilled water system, boiler system, air handlers and VAV terminal boxes. The condition of the DDC system is good except as noted below:

- There is no system graphic for the individual zones, air handlers, VAV's, boiler, chiller or pumps.
- The unoccupied schedule is not configured for holidays.
- The control sequences and not optimized for chilled water reset, hot water reset, static pressure reset, optimum start or demand controlled ventilation.
- CO2 measurements taken within the building indicate that the outside air volume is excessive. (The AHU-1 minimum outside air damper position was approximately 25%).
- The mixed air damper link on AHU-2 is disconnected. Therefore, the economizer can't work properly

Air Handling Systems

The library is equipped with two air handlers. Each air handler is single duct variable air volume (VAV) system with terminal reheat. Each supply fan is equipped with a variable frequency drive (VFD). The air handlers were found to be in good condition except as noted below:

- The supply fan motors are standard efficiency motors with Class B insulation. They are not inverter rated for use with the VFDs.
- The outside air damper minimum position on AHU-1 appears to be too far open.
- The mixed air damper linkage on AHU-2 is disconnect and can't work properly.

Table 4-1-3. Air Handler Summary

Unit	Mfg	Model	Fan HP	No. Zones	CFM
AHU - 1	Carrier	39M1STD02K2WCGX1BK	10	11	11,000
AHU - 2	Trane	MCCA035BBK0C0EA	15	14	17,000

Chilled Water System

Chilled water is provided by one packaged air-cooled screw chiller located behind a screen wall adjacent to the electrical and mechanical rooms. The chiller appears to be in good condition but reportedly has had a history of operating issues.

Table 4-1-4. Chiller Summary

Unit	Mfg.	Model	Capacity
CH-1	Trane	RTAA0804XM01A	75 Tons

Boiler System

A single natural draft gas fired boiler is used to serve the reheat coils. The boiler appears to be in good condition except as noted below:

- The boiler was observed to be short cycling while each air handler was operating in cooling mode. This type of cycling results in very poor efficiency and would be minimized with optimized control sequences.

Table 4-1-5. Boiler Summary

Unit	Mfg.	Model	Capacity
B-1	Raypak	H3-0724	726 MBH

Pumping Systems

The library is equipped with two heating pumps and two chilled water pumps. The pumps are configured in a lead/standby configuration. All four pumps appear to be in good condition.

Table 4-1-6. Pump Summary

Unit	Mfg	Ft. Hd.	GPM	HP	VFD
CHWP-1	Bell & Gossett	60	150	5	No
CHWP-2	Bell & Gossett	60	150	5	No
HWP-3	Bell & Gossett	40	60	1.5	No
HWP-4	Bell & Gossett	40	60	1.5	No

Proposed Improvements

ECM 1, 2 & 3 Interior and Exterior Lighting System Upgrade and Controls

The following table summarizes the proposed projects for the Town of Oro Valley Library. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 259 of the 955 fixtures will be retrofitted or replaced with energy efficient components that will reduce electric consumption and improve lumen output at acceptable light levels for each room type. See room by room for specific upgrade.
- Interior linear fluorescent fixtures will be retrofit with 28w T8 lamps and high efficiency multi-volt electronic ballast.
- Specific interior linear fluorescent fixtures will be de-lamped and retrofitted with 28w T8 lamps, high efficiency multi-volt electronic ballast and specular reflector kits.
- U-lamp fixtures will be converted to fixtures utilizing two foot 17w T8 lamps, high efficiency multi-volt electronic ballast and specular reflector kits (some fixtures may not accommodate linear 2' lamps - in this situation T8 U lamps will be installed).
- Incandescent fixtures will be retrofitted or replaced with screw in compact fluorescent lamps, halogen lamps, LED lamps or may be replaced with linear fluorescent fixtures (depending on the application).
- Exterior HID or Incandescent fixtures will be replaced with new T5HO or CFL fixtures (depending on existing situation and application).
- Occupancy sensors (wall and ceiling mount) will be installed in noted rooms (see room by room).

Table 4-1-7. Proposed Lighting

Upgrade Type	Qty
DON'T DO / NOT INCLUDED	696
HALOGEN SCREW IN	42
NEW CFL LUMINAIRE	20
NEW SENSORS	8
NEW T5HO LUMINAIRE	28
REFLECTOR RETROFIT T8/HEB/SPECULAR	45
RETROFIT LED SCREW IN	7
RETROFIT T8/HEB	109
TOTALS:	**955 Fixtures**

ECM 4 Water Conservation

The following table summarizes the proposed projects for The Town of Oro Valley Library. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 9 of the 33 fixtures will be retrofit or replaced with energy efficient components that will reduce water consumption.
- Replacing Low Consumption Urinals 1.0gpf with Ultra Low Consumption Urinals and Flushometer valves 1/8gpf.
- Where applicable, some of the existing fixtures will be retrofit to low consumption level if they are eligible for a retrofit or moderation instead of replacement. Such fixtures include shower heads and moderators are to be installed.

Table 4-1-8. Proposed Domestic Water Upgrades

Upgrade Type	Qty
Retrofit existing sink faucet with 0.5gpm vandal proof spray moderator	3
Retrofit existing sink faucet with 1.5gpm vandal proof spray moderator	3
Replace Existing toilet with 1.6gpf fixture and retrofit existing valve to 1.6gpf	0
Replace Existing toilet with 1.6gpf fixture and retrofit existing valve to 1.6gpf – ADA	0
New Ultra Low Consumption Urinal 1/8gpf	3
Shower Head	0
Shower Head ADA Hand Held	0
Don't Do – High Consumption Required	0
Don't Do – Existing Conditions	0
Don't Do - Low Consumption	24
TOTALS:	**33**

ECM 10 Direct Digital Controls

This measure would recommission the existing Delta DDC. All field devices would be checked for proper installation and repaired if necessary. New programming and graphics features would be installed. The control sequences would be optimized for energy efficiency including, static pressure reset, hot water reset, chilled water reset, optimum start and economizer operation. New trending and alarms would also be installed. The DDC system would utilize the town's wide area network for secure web based access by the facilities department.

The savings associated with this measure are interactive with ECMs 17 and 19 and should be implemented together to maximize savings.

ECM 17 Demand Controlled Ventilation

Measurements of CO2 levels were obtained during the audit. The results of these measurements indicate that the building is operating with a high percentage of outside air. Maintaining the right volume of outside air ventilation is necessary. However, excessive volumes result in high heating and cooling costs. This measure would furnish and install new CO2 sensors throughout the building to control the outside air volume as part of the proposed DDC retrofit project.

The savings associated with this measure are interactive with ECMs 10 and 14 and are implemented together to maximize savings.

ECM 19 Premium Efficiency Motors

The 10 and 15 horsepower standard efficiency supply fan motors would be upgrade to premium efficiency motors under this measure. The new motors would be inverter rated for used with the existing VFDs.

The savings associated with this measure are interactive with ECMs 10 and 17 and are implemented together to maximize savings.

Opportunities Evaluated, But Not Recommended

ECM 11 Central Plant

A central chilled and hot water central plant was evaluated for the Town Hall Complex, Library and Police Station. The eQUEST modeling analysis determined that the interactive savings obtained from the proposed measures resulted in high energy savings thus resulting in a long payback for this measure.

4.2. Town Hall Complex

Facility Overview

The Town Hall Complex includes the Administration Building, Magistrate Court Building, Water Utility Building and Development Services Building. The initial construction occurred in 1991. The Development Services building was constructed in 1999. The Administration addition and Courtroom remodel occurred in 2001. The complex has a combined area of approximately 35,126 square feet. The operating hours are typically Monday through Friday from 8:00 a.m. to 5:00 p.m.

Building Envelope

The building constructions are similar for all four buildings. Roof construction is wood frame with R-30 fiberglass batt insulation, sloped roof surfaces are clay tile, flat surfaces are built up roofing, ceilings are lay in acoustic tile, exterior walls are framed with fiberglass batt insulation and stucco finish, and windows are dual tinted. A limited number of windows in the Administration and Court building have had low-e film installed. Floors are concrete slab on grade. Overall the condition of the building envelope is very good except as noted below:

- Windows located around the perimeter offices are not Low E windows. Occupants reported the uncomfortable heat gain from the sun.

Table 4-2-1. Existing Building Envelope

Location	Ceiling/Roof Insulation	Exterior Roof	Wall Insulation	Exterior Walls	Window Type	Window Film	Weather Strip
Town Hall Complex	R-30 Figerglass	Clay Tile Built Up	Fiberglass Batt	Stucco	Dual	Limited	Good

Lighting – Administration Building

The Town Hall Administration Building's existing interior lighting system consists of 34w T12 lamps and magnetic ballast and 32w T8 lamps and electronic ballast fixtures. HID fixtures are seen mostly on the exterior of the facilities but there are a few facilities that use this type of lighting on their interior as well.

Fixtures that are existing compact fluorescent, LED or T5 are not included in this proposal. These fixtures are documented on the room by room.

Lighting – Development Services Building

The Development Service Building's existing interior lighting system consists of 34w T12 lamps and magnetic ballast and 32w T8 lamps and electronic ballast fixtures. A minimal use of occupancy sensors have been installed throughout the facilities. HID fixtures are seen mostly on the exterior of the facilities but there are a few facilities that use this type of lighting on their interior as well.

Fixtures that are existing compact fluorescent, LED or T5 are not included in this proposal. These fixtures are documented on the room by room.

Lighting – Magistrate Court Building

The Magistrate Court Building's existing interior lighting system consists of 34w T12 lamps and magnetic ballast and 32w T8 lamps and electronic ballast fixtures.

Fixtures that are existing compact fluorescent, LED or T5 are not included in this proposal. These fixtures are documented on the room by room.

Lighting – Water Utility Building

The Water Utility Building's existing interior lighting system consists of 34w T12 lamps and magnetic ballast fixtures. HID fixtures are seen mostly on the exterior of the facilities but there are a few facilities that use this type of lighting on their interior as well.

Fixtures that are existing compact fluorescent, LED or T5 are not included in this proposal. These fixtures are documented on the room by room.

Domestic Water and Water Heating - Administration

The existing domestic water system consists of floor mount toilets flushing at 1.6gpf and 3.5gpf. Also wall mounted urinals flushing at 1.0gpf. Other domestic fixtures in use include kitchen sinks, showers and lavatory sinks.

All existing fixtures listed as ZEC, ZLC, or ZHF are either already low consumption, or cannot be retrofit to a lower flow. These existing technologies will not be included as part of this upgrade.

Domestic Water and Water Heating – Development Services Building

The existing domestic water system consists of floor mount toilets flushing at 1.6gpf. Other domestic fixtures in use include wall mounted urinals, kitchen sinks, showers and lavatory sinks.

All existing fixtures listed as ZEC, ZLC, or ZHF are either already low consumption, or cannot be retrofit to a lower flow. These existing technologies will not be included as part of this upgrade.

Domestic Water and Water Heating – Magistrate Court Building

The existing domestic water system consists of floor mount Flushometer toilets flushing at 3.5gpf. Other domestic fixtures in use include wall mounted urinals, kitchen sinks, showers and lavatory sinks.

All existing fixtures listed as ZEC, ZLC, or ZHF are either already low consumption, or cannot be retrofit to a lower flow. These existing technologies will not be included as part of this upgrade.

Domestic Water and Water Heating – Water Utility Building

The existing domestic water system consists of floor mount Flushometer toilets flushing at 3.5gpf. Other domestic fixtures in use include kitchen sinks, showers and lavatory sinks.

All existing fixtures listed as ZEC, ZLC, or ZHF are either already low consumption, or cannot be retrofit to a lower flow. These existing technologies will not be included as part of this upgrade.

Domestic hot water systems for all of the buildings were found to be in good condition. The following table provides a summary of the units.

Table 4-2-2. Existing Water Heater Inventory

Location	Mfg	Model	Qty	Capacity	Heating Rating
Administration	AO Smith	EL SF 40 104	1	40	5000W
Administration	AO Smith	Name Plate Not Accessible			
Development Services	AO Smith	EL SF 40 104	1	10	2000W
Magistrate Court	AO Smith	EL SF 20	1	20	2500W
Water Utility	AO Smith	EL SF 21	1	20	2500W

Building Automation and Controls

There are no Direct Digital Controls (DDC) or building automation systems. All of the HVAC systems are controlled by either manual or seven-day programmable thermostats. The thermostats appeared to be in good working condition except as noted below:

- The use of manual and programmable thermostats results in excessive runtime and high energy use by the HVAC systems.

Heating and Air Conditioning Systems

The Town Hall Complex is primarily served by packaged gas/electric rooftop units with fixed minimum outside air dampers. The Administration Building also has three small split systems. The units were generally found to be in good condition except as noted below:

- The packaged units located on the Magistrate Court, Water Utility and original Administration buildings are approximately years old and have reached their end of life. These units are relatively inefficient when compared to new high efficiency equipment.
- The perimeter offices located in the Administration and Development Services buildings share common zoning. This prevents individual temperature control of each office space.
- The vaulted ceilings located in the Administration and Development Services buildings have limited air circulation and this results in stratification and was described as “stuffy” by occupants.

Table 4-2-3. HVAC Summary					
Unit	Location	Mfg.	Model	Cooling (tons)	Heating (MBH)
RTU-1	Development Services	Trane	YCH121C3L0AA	10	150
RTU-2	Development Services	Trane	YCH103C3L0AB	9	150
RTU-3	Development Services	Trane	YCD036F3M0AA	3	72
RTU-4	Development Services	Trane	YCH061C3L0BF	5.1	90
RTU-5	Development Services	Trane	YCH049C3L0BF	4.1	90
RTU-6	Development Services	Trane	YCH121C3L0AA	10.1	150
RTU-7	Development Services	Trane	YCD049C3L0BF	4	90
RTU-8	Magistrate Court	Trane	YCH060A3L0AB	5	-
RTU-9	Water Utility	Trane	YCH060A3L0AB	5	-
RTU-10	Water Utility	Trane	YCH048A3L0AA	4	-
RTU-11	Water Utility	Trane	YCH048A3L0AA	4	-
RTU-12	Magistrate Court	Trane	YCH090A3L0AB	7.5	-
RTU-13	Magistrate Court	Trane	YCH075A3L0AB	6	120
RTU-14	Administration	Trane	YCH060A3L0AB	5	-
RTU-15	Administration	Trane	YCH150A3L0AA	12.5	-
RTU-16	Administration	Trane	YCH090A3L0AB	7.5	-
RTU-17	Administration	Trane	YCH060A3L0AB	5	-
RTU-18	Administration	Trane	YCH075A3L0AB	6.3	-
AC-12	Administration	Trane	YCH048A3ELA0	4	60
AC-13	Administration	Trane	YCH048A3ELA0	4	60
AC-14	Administration	Trane	YCH181C3L0BB	15.1	250
AC-15	Administration	Trane	YCH048A3ELA0	4	60
AC-16	Administration	Trane	YCH060A3ELA1	5	60
CU-1	Administration	Carrier	38YH048510DL	4	-
CU-2	Administration	Trane	2TTA2060A3000A	5	-
CU-3	Administration	Trane	2TWR2036A1000	3	-

The nameplates located on the Magistrate Court, Water Utility and the old administration buildings were not readable and therefore the heating MBH was not available.

Proposed Improvements

ECM 1, 2 and 3 Interior & Exterior Lighting System Upgrade and Controls – Administration Building

The following table summarizes the proposed projects for Town of Oro Valley Town Hall Complex. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 276 of the 334 fixtures will be retrofitted or replaced with energy efficient components that will reduce electric consumption and improve lumen output at acceptable light levels for each room type. See room by room for specific upgrade.
- Interior linear fluorescent fixtures will be retrofit with 28w T8 lamps and high efficiency multi-volt electronic ballast.
- Specific interior linear fluorescent fixtures will be de-lamped and retrofitted with 28w T8 lamps, high efficiency multi-volt electronic ballast and specular reflector kits.
- All fixtures with eight foot lamps (slim-line, HO or VHO) will be replaced or converted to fixtures utilizing four foot 28w T8 lamps and high efficiency multi-volt electronic ballast (specular reflector kits will be utilized in converting applications).
- U-lamp fixtures will be converted to fixtures utilizing two foot 17w T8 lamps, high efficiency multi-volt electronic ballast and specular reflector kits (some fixtures may not accommodate linear 2' lamps - in this situation T8 U lamps will be installed).
- Incandescent fixtures will be retrofitted or replaced with screw in compact fluorescent lamps, halogen lamps, LED lamps or may be replaced with linear fluorescent fixtures (depending on the application).
- Exterior HID or Incandescent fixtures will be replaced with new T5HO or CFL fixtures (depending on existing situation and application).
- Parking area lights will be replaced with T5HO Fixtures.
- VendingMiser controls will be installed on all snack and soda vending machines.
- Occupancy sensors (wall and ceiling mount) will be installed in noted rooms (see room by room).

Table 4-2-4. Proposed Lighting

Upgrade Type	Qty
DON'T DO / NOT INCLUDED	58
HALOGEN SCREW IN	8
NEW CFL LUMINAIRE	7
RETROFIT PULSE START METAL HALIDE KIT	5
NEW LED EXIT SIGN	1
NEW SENSORS	40
NEW T5HO LUMINAIRE	3
NEW VENDINGMISERS	1
REFLECTOR RETROFIT T8/HEB/SPECULAR	99
RETROFIT LED SCREW IN	4
RETROFIT T8/HEB	108
TOTALS:	**334 Fixtures**

ECM 1, 2 and 3 Interior & Exterior Lighting System Upgrade and Controls – Development Services Building

The following table summarizes the proposed projects for the Development Services Building. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 178 of the 189 fixtures will be retrofitted or replaced with energy efficient components that will reduce electric consumption and improve lumen output at acceptable light levels for each room type. See room by room for specific upgrade.
- Interior linear fluorescent fixtures will be retrofit with 28w T8 lamps and high efficiency multi-volt electronic ballast.
- Specific interior linear fluorescent fixtures will be de-lamped and retrofitted with 28w T8 lamps, high efficiency multi-volt electronic ballast and specular reflector kits.
- Incandescent fixtures will be retrofitted or replaced with screw in compact fluorescent lamps, halogen lamps, LED lamps or may be replaced with linear fluorescent fixtures (depending on the application).
- Exterior HID or Incandescent fixtures will be replaced with new T5HO or CFL fixtures (depending on existing situation and application) or retrofitted with pulse start metal halide kits.
- Occupancy sensors (wall and ceiling mount) will be installed in noted rooms (see room by room).

Table 4-2-5. Proposed Lighting

Upgrade Type	Qty
DON'T DO / NOT INCLUDED	11
HALOGEN SCREW IN	30
RETROFIT PULSE START METAL HALIDE KIT	17
NEW SENSORS	24
REFLECTOR RETROFIT T8/HEB/SPECULAR	68
RETROFIT T8/HEB	39
TOTALS:	**189 Fixtures**

ECM 1, 2 and 3 Interior & Exterior Lighting System Upgrade and Controls – Magistrate Court Building

The following table summarizes the proposed projects for Magistrate Court Building. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 74 of the 90 fixtures will be retrofitted or replaced with energy efficient components that will reduce electric consumption and improve lumen output at acceptable light levels for each room type. See room by room for specific upgrade.
- Interior linear fluorescent fixtures will be retrofit with 28w T8 lamps and high efficiency multi-volt electronic ballast.
- Specific interior linear fluorescent fixtures will be de-lamped and retrofitted with 28w T8 lamps, high efficiency multi-volt electronic ballast and specular reflector kits.
- Incandescent fixtures will be retrofitted or replaced with screw in compact fluorescent lamps, halogen lamps, LED lamps or may be replaced with linear fluorescent fixtures (depending on the application).
- Occupancy sensors (wall and ceiling mount) will be installed in noted rooms (see room by room).

Table 4-2-6. Proposed Lighting	
Upgrade Type	Qty
DON'T DO / NOT INCLUDED	16
NEW LED EXIT SIGN	1
NEW SENSORS	13
REFLECTOR RETROFIT T8/HEB/SPECULAR	57
RETROFIT T8/HEB	3
TOTALS:	**90 Fixtures**

ECM 1, 2 and 3 Interior & Exterior Lighting System Upgrade and Controls – Water Utility Building

The following table summarizes the proposed projects for Water Utility Building. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 82 of the 83 fixtures will be retrofitted or replaced with energy efficient components that will reduce electric consumption and improve lumen output at acceptable light levels for each room type. See room by room for specific upgrade.
- Interior linear fluorescent fixtures will be retrofit with 28w T8 lamps and high efficiency multi-volt electronic ballast.
- Specific interior linear fluorescent fixtures will be de-lamped and retrofitted with 28w T8 lamps, high efficiency multi-volt electronic ballast and specular reflector kits.
- lamps will be installed).
- Incandescent fixtures will be retrofitted or replaced with screw in compact fluorescent lamps, halogen lamps, LED lamps or may be replaced with linear fluorescent fixtures (depending on the application).
- Exterior HID or Incandescent fixtures will be replaced with new T5HO or CFL fixtures (depending on existing situation and application).
- Occupancy sensors (wall and ceiling mount) will be installed in noted rooms (see room by room).

Table 4-2-7. Proposed Lighting	
Upgrade Type	Qty
DON'T DO / NOT INCLUDED	1
NEW CFL LUMINAIRE	22
NEW LED EXIT SIGN	1
NEW SENSORS	13
REFLECTOR RETROFIT T8/HEB/SPECULAR	44
RETROFIT T8/HEB	2
TOTALS:	**83 Fixtures**

ECM 4 Water Conservation – Administration Building

The following table summarizes the proposed projects for The Town of Oro Valley Administration Building. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 21 of the 27 fixtures will be retrofit or replaced with energy efficient components that will reduce water consumption.
- Replacing high consumption 3.5gpf toilets with low consumption fixtures retrofit existing valve to 1.6gpf
- Replacing Low Consumption Urinals 1.0gpf with Ultra Low Consumption Urinals and Flushometer valves 1/8gpf.
- Where applicable, some of the existing fixtures will be retrofit to low consumption level if they are eligible for a retrofit or moderation instead of replacement. Such fixtures include shower heads and moderators are to be installed.

Table 4-2-8. Proposed Domestic Water Upgrades

Upgrade Type	Qty
Retrofit existing sink faucet with 0.5gpm vandal proof spray moderator	8
Retrofit existing sink faucet with 1.5gpm vandal proof spray moderator	3
Replace Existing toilet with 1.6gpf fixture and retrofit existing valve to 1.6gpf	3
Replace Existing toilet with 1.6gpf fixture and retrofit existing valve to 1.6gpf – ADA	3
New Ultra Low Consumption Urinal 1/8gpf	3
Shower Head	0
Shower Head ADA Hand Held	1
Don't Do – High Consumption Required	0
Don't Do – Existing Conditions	1
Don't Do - Low Consumption	5
TOTALS:	**27**

ECM 4 Water Conservation – Development Services Building

The following table summarizes the proposed projects for The Town of Oro Valley Development Services Building. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 8 of the 14 fixtures will be retrofit or replaced with energy efficient components that will reduce water consumption.
- The domestic water fixture upgrade will include replacing Low Consumption Urinals with Ultra Low Consumption Urinals and Flushometer valves.
- Some of the existing fixtures will be retrofit to flush at the low consumption level if they are eligible for a retrofit or moderation instead of replacement. Such fixtures include sinks, where moderators are to be installed.

Table 4-2-9. Proposed Domestic Water Upgrades	
Upgrade Type	Qty
Retrofit with 1.5 gpm VP laminar flow moderator	2
Retrofit with 0.5 gpm vandal proof spray moderator	4
Don't Do – Existing Conditions	0
Don't Do - Low Consumption	6
New floor mounted elongated bowl retrofit existing valve to 1.6gpf	0
New floor mounted elongated bowl retrofit existing valve to 1.6gpf – ADA -	0
New Ultra Low Consumption Urinal 1/8gpf	2
Shower head handheld ADA	0
TOTALS:	**14**

ECM 4 Water Conservation – Magistrate Court Building

The following table summarizes the proposed projects for The Town of Oro Valley Magistrate Court. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 8 of the 8 fixtures will be retrofit or replaced with energy efficient components that will reduce water consumption.
- The domestic water fixture upgrade will include replacing all bowls currently flushing 3.5 gallons or more with new low consumption, or 1.6 GPF bowls with new flushometers, or where applicable, existing flushometers will be retrofit to flush 1.6 GPF. Low Consumption Urinals with Ultra Low Consumption Urinals and Flushometer valves.
- Some of the existing fixtures will be retrofit to flush at the low consumption level if they are eligible for a retrofit or moderation instead of replacement. Such fixtures include urinals, where valves will be retrofit with new low flush valves, and sinks, where moderators are to be installed.

Table 4-2-10. Proposed Domestic Water Upgrades	
Upgrade Type	Qty
Retrofit with 1.5 gpm VP laminar flow moderator	2
Retrofit with 0.5 gpm vandal proof spray moderator	3
New floor mounted elongated bowl retrofit existing valve to 1.6gpf	1
New floor mounted elongated bowl retrofit existing valve to 1.6gpf – ADA -	2
TOTALS:	**8**

ECM 4 Water Conservation – Water Utility Building

The following table summarizes the proposed projects for The Town of Oro Valley Water Building. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 4 of the 5 fixtures will be retrofit or replaced with energy efficient components that will reduce water consumption.
- Replacing high consumption 3.5gpf toilets with low consumption fixtures retrofit existing valve to 1.6gpf
- Where applicable, some of the existing fixtures will be retrofit to low consumption level if they are eligible for a retrofit or moderation instead of replacement. Such fixtures include shower heads and moderators are to be installed.

Table 4-2-11. Proposed Domestic Water Upgrades	
Upgrade Type	Qty
Retrofit existing sink faucet with 0.5gpm vandal proof spray moderator	1
Retrofit existing sink faucet with 1.5gpm vandal proof spray moderator	1
Replace Existing toilet with 1.6gpf fixture and retrofit existing valve to 1.6gpf	2
Replace Existing toilet with 1.6gpf fixture and retrofit existing valve to 1.6gpf – ADA	0
New Ultra Low Consumption Urinal 1/8gpf	0
Shower Head	0
Shower Head ADA Hand Held	0
Don't Do – High Consumption Required	0
Don't Do – Existing Conditions	0
Don't Do - Low Consumption	1
TOTALS:	**5**

ECM 8 Low E Window Film

This measure would furnish and install Low E window films on all windows located on the Town Hall Complex. The films help reduce heat gain from the sun and can greatly improve the comfort of building occupants. These films also reduce air-conditioning costs. They are applied to the inside surface of each window. Typical films have an emissivity in the range of 0.78 and a shading coefficient of 0.55. Clear or tinted films are available. The use of Low-E films can also help filter UV radiation associated with fading and material damage to the building interior finishing.

ECM 9 Ceiling Fans

Ceiling fans are recommended for the open office vaulted spaces located in the Administration and Development Services buildings. The project would furnish and install four multi-speed, reversible fans in each space. These fans would improve air circulation within these areas resulting in less temperature stratification and improved occupant comfort.

ECM 10 Direct Digital Controls

A DDC system is recommended for all HVAC systems located on the Town Hall Complex. The proposed measure would furnish and install a Delta open protocol BACnet system to control temperature setpoints and schedules. Energy savings would be obtained by controlling the occupied and unoccupied building temperatures and HVAC equipment schedules. The DDC system would utilize the town's wide area network for secure web based access by the facilities department.

The savings associated with this measure are interactive with ECMs 13 and 14 and are implemented together to maximize savings.

ECM 13 HVAC Zone Control

This measure would furnish and install Therma-Fusers on selected perimeter offices located in the Administration and Development Services buildings. Stand Alone Square Therma-Fuser™ diffusers provide individual temperature control to precisely match the comfort requirements of each space. Each Therma-Fuser diffuser is its own VAV zone. The thermostats, actuator and damper are built into the diffuser. A detailed description of the device is included in the cut sheet technical appendix.

The savings associated with this measure are interactive with ECMs 10 and 14 and are implemented together to maximize savings.

ECM 14 High Efficiency Packaged Units

RTUs 8 through 18 are inefficient and have reached their end of service life. New high efficiency replacement units are recommended. The proposed R410a packaged units would have a SEER rating of not less than 13 and would be equipped with economizers for available free cooling.

The savings associated with this measure are interactive with ECMs 12 and 13 and are implemented together to maximize savings.

Opportunities Evaluated, But Not Recommended

ECM 11 Central Plant

A central chilled and hot water central plant was evaluated for the Town Hall Complex, Library and Police Station. The eQUEST modeling analysis determined that the interactive savings obtained from the proposed measures resulted in high energy savings thus resulting in a long payback for this measure.

ECM 12 Cool Roof

The energy savings associated with this measure were considered negligible. The small savings is attributed to the relatively small roof area available for this measure.

4.3. Police Station

Facility Overview

The Town of Oro Valley Police Department Headquarters is located at the La Canada complex. The building was originally constructed in 1994. The Sally Port and Dispatch Office additions were made in 2001 and 2002 respectively. The building is occupied on a 24/7 basis.

The following overview describes the building envelope; lighting; domestic water and water heating; automation and controls; HVAC, and chilled and hot water systems.

Building Envelope

The flat roof structures include a built up reflective painted surface with R-30 fiberglass batt insulation. Sloped roof construction is wood frame and clay tile with R-30 fiberglass batt insulation. The ceilings have lay in acoustic tile; exterior walls are 8" CMU with furred insulated interior surface. Windows are dual tinted glass. Overall the condition of the building envelope is very good.

Table 4-3-1. Existing Building Envelope

Location	Ceiling/Roof Insulation	Exterior Roof	Wall Insulation	Exterior Walls	Window Type	Window Film	Weather Strip
Police	R-30 Fiberglass	Clay Tile Built Up	R-13	CMU	Dual	No	Good

Lighting

The Police Station – La Canada Building's existing interior lighting system consists of 34w T12 lamps and magnetic ballast and 32w T8 lamps and electronic ballast fixtures. HID fixtures are seen mostly on the exterior of the facilities but there are a few facilities that use this type of lighting on their interior as well.

Fixtures that are existing compact fluorescent, LED or T5 are not included in this proposal. These fixtures are documented on the room by room.

Domestic Water and Water Heating

The existing domestic water system consists of floor mount Flushometer toilets flushing at 1.6gpf and existing stainless steel toilets were flushing at 3.5gpf. Also wall mounted urinals flushing at 1.0gpf. Other domestic fixtures in use include kitchen sinks, showers and lavatory sinks.

All existing fixtures listed as ZEC, ZLC, or ZHF are either already low consumption, or cannot be retrofit to a lower flow. These existing technologies will not be included as part of this upgrade.

Domestic hot water systems for all of the buildings were found to be in good condition. The following table provides a summary of the unit.

Table 4-3-2. Existing Water Heater Inventory					
Location	Mfg	Model	Qty	Capacity	Heating Rating
Mechanical Room	AO Smith	BTR 400A 118	1	100	390 MBH

Building Automation and Controls

This facility is controlled by a Johnson Metasys DDC system. The frontend workstation is located near the IT office. The system can only be accessed locally. The DDC system is used to control all of the buildings mechanical systems including the chilled water system, boiler system, air handlers and VAV terminal boxes. The condition of the DDC system appears to be good except as noted below:

- The system is not open protocol, cannot be accessed remotely and appears to have limited functionality.

Air Handling Systems

The Police Department building is equipped with one air handler. It is a single duct variable air volume (VAV) system with terminal reheat. The supply fan is equipped with a variable frequency drive (VFD) and premium efficiency motor. The air handler appears to be in good condition.

Table 4-3-3. Air Handler Summary					
Unit	Mfg	Model	Fan HP	No. Zones	CFM
AHU-1	Carrier	39LA1312AA5041-	15	20	14,300

Chilled Water System

Chilled water is provided by one packaged air-cooled located behind a screen wall adjacent to the electrical and mechanical rooms. The chiller appears to be in good condition.

Table 4-3-4. Chiller Summary			
Unit	Mfg.	Model	Capacity
CH-1	Carrier	30GT-045---500	45 Tons

Boiler System

A single natural draft gas fired boiler is used to serve the reheat coils. The boiler appears to be in good condition except as noted below:

- The boiler was observed to be short cycling while the air handler was operating in cooling mode. This type of cycling results in very poor efficiency and would be minimized with optimized control sequences.

Table 4-3-5. Boiler Summary			
Unit	Mfg.	Model	Capacity
B-1	Ajax	WG-350	350 MBH

Pumping Systems

The Police Department building is equipped with two heating pumps and two chilled water pumps. The pumps are configured in a lead/standby configuration. All four pumps appear to be in good condition. The chilled water pumps were insulated and the nameplate GPM and head were covered.

Table 4-3-6. Pump Summary

Unit	Mfg	Ft. Hd.	GPM	HP	VFD
HWP-1	Armstrong	40	28	0.75	No
HWP-2	Armstrong	40	28	0.75	No
CHWP-1	Armstrong			1.5	No
CHWP-2	Armstrong			1.5	No

Proposed Improvements

ECM 1, 2 & 3 Interior & Exterior Lighting System Upgrade and Controls

The following table summarizes the proposed projects for Town of Oro Valley Police Station – La Canada Building. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 277 of the 322 fixtures will be retrofitted or replaced with energy efficient components that will reduce electric consumption and improve lumen output at acceptable light levels for each room type. See room by room for specific upgrade.
- Interior linear fluorescent fixtures will be retrofit with 28w T8 lamps and high efficiency multi-volt electronic ballast.
- Specific interior linear fluorescent fixtures will be de-lamped and retrofitted with 28w T8 lamps, high efficiency multi-volt electronic ballast and specular reflector kits.
- U-lamp fixtures will be converted to fixtures utilizing two foot 17w T8 lamps, high efficiency multi-volt electronic ballast and specular reflector kits (some fixtures may not accommodate linear 2' lamps - in this situation T8 U lamps will be installed).
- Incandescent fixtures will be retrofitted or replaced with screw in compact fluorescent lamps, halogen lamps, LED lamps or may be replaced with linear fluorescent fixtures (depending on the application).
- Exterior HID or Incandescent fixtures will be replaced with new T5HO or CFL fixtures (depending on existing situation and application).
- VendingMiser controls will be installed on all snack and soda vending machines.
- Occupancy sensors (wall and ceiling mount) will be installed in noted rooms (see room by room).

Table 4-3-7. Proposed Lighting	
Upgrade Type	Qty
DON'T DO / NOT INCLUDED	45
HALOGEN SCREW IN	6
NEW CFL LUMINAIRE	24
NEW SENSORS	30
NEW VENDINGMISERS	2
REFLECTOR RETROFIT T8/HEB/SPECULAR	48
RETROFIT T8/HEB	167
TOTALS:	**322 Fixtures**

ECM 4 Water Conservation

The following table summarizes the proposed projects for The Town of Oro Valley. This list was reviewed and the projects were selected by the project team as being the best suited for inclusion.

- A total of 25 of the 43 fixtures will be retrofit or replaced with energy efficient components that will reduce water consumption.
- Retrofit high consumption 3.5gpf toilets with low consumption fixtures retrofit existing valve to 2.4gpf
- Replacing Low Consumption Urinals 1.0gpf with Ultra Low Consumption Urinals and Flushometer valves 1/8gpf.
- Where applicable, some of the existing fixtures will be retrofit to low consumption level if they are eligible for a retrofit or moderation instead of replacement. Such fixtures include shower heads and moderators are to be installed.

Table 4-3-8. Proposed Domestic Water Upgrades	
Upgrade Type	Qty
Retrofit existing sink faucet with 0.5gpm vandal proof spray moderator	8
Retrofit existing sink faucet with 1.5gpm vandal proof spray moderator	2
Retrofit Existing stainless steel toilet fixture valve to 2.4gpf	4
Replace Existing toilet with 1.6gpf fixture and retrofit existing valve to 1.6gpf – ADA	0
New Ultra Low Consumption Urinal 1/8gpf	3
Shower Head	6
Shower Head ADA Hand Held	2
Don’t Do – High Consumption Required	0
Don’t Do – Existing Conditions	0
Don't Do - Low Consumption	18
TOTALS:	**43**

ECM 10 Direct Digital Controls

This measure will replace the existing Johnson Metasys DDC. All field devices would be checked for proper installation and repaired if necessary. New programming and graphics features would be installed. The control sequences would be optimized for energy efficiency including, static pressure reset, hot water reset, chilled water reset, optimum start and economizer operation. New trending and alarms would also be installed. The DDC system would utilize the town's wide area network for secure web based access by the facilities department.

The savings associated with this measure are interactive with ECMs 17 and 19 and are implemented together to maximize savings.

Opportunities Evaluated, But Not Recommended

ECM 11 Central Plant

A central chilled and hot water central plant was evaluated for the Town Hall Complex, Library and Police Station. The eQUEST modeling analysis determined that the interactive savings obtained from the proposed measures resulted in high energy savings thus resulting in a long payback for this measure.

5.0 Environmental Benefits

The Town of Oro Valley will realize a carbon footprint reduction by implementing projects that reduce fossil fuel consumption. Electrical generation uses fossil fuel and fossil fuels are also used directly for heating processes. Below is an example of what will be used to document the environmental benefits associated with each building's recommended improvements.

Table 5-0. Environmental Benefits

By reducing your energy use it indirectly lowers energy production at the source. A great deal of the energy, which is consumed your facility(s), is produced by power plants burning fossil fuels. The burning of these fuels contributes to environmental contamination.

According to the United States Environmental Protection Agency, and other groups it can be calculated just how much of the pollutants can be reduced or eliminated based on the amount of energy that is saved. This information differs by area based on sev

Annual kWh saved through project implementation: 306,925

Annual therms saved through project implementation: 12,868

Type Of Pollution	Health Effect	Environmental Effect	Reduction / kWh	Reduction / Therm	Pollutants Reduced
Greenhouse Gasses (CO_2)	Can cause respiratory and other health problems, particularly in children and the elderly.	Climate change on a global scale has been attributed to increased emissions of carbon dioxide (CO_2)	1.657 pounds / kWh	12.5 pounds / therm	669,425 lbs (CO_2) reduced
Volatile Organic Compounds (VOC)	Ozone (smog) effects, cancer and other serious health problems	Ozone (smog) effects plants life included vegetation damage.	0.000061 pounds / kWh	.0005 pounds / therm	25 lbs (VOC) reduced
Nitrogen Oxides (Nox)	Lung damage, respiratory illness, ozone (smog) effects.	Acid rain also causes buildings, statues and monuments to deteriorate.	0.001523 pounds / kWh	.014 pounds / therm	648 lbs (NOx) reduced
Carbon Monoxide (CO)	Reduces ability of blood to bring oxygen to body cells and tissues.	One of the six "criteria pollutants" the US EPA tracks related to power production reduces environmental quality	0.00041 pounds / kWh	.0019 pounds / therm	150 lbs (CO) reduced
Sulfur Dioxide (SO_2)	Respiratory illness, breathing problems, may cause permanent damage to lungs.	Precursor of acid rain, which can damage trees, lakes, and soil; aerosols can reduce visibility.	0.000956 pounds / kWh	.0001 pounds / therm	295 lbs (SO_2) reduced
Particulates (PM10)	Eye, nose, and throat irritation; lung damage; bronchitis, cancer, early death	Source of haze which reduced visibility. Ashes, smoke, soot and dust can dirty and discolor structures	0.00002 pounds / kWh	.0004 pounds / therm	11 lbs (PM10) reduced
Mercury (Hg)	Liver, kidney, and brain damage; neurological and development damage	Accumulates in the food chain.	0.003404 milligrams / kWh	0 or negligible pounds / therm	1,045 Mg of (Hg) reduced

Saving 10,000 kWh is equivalent to the CO_2 emissions avoided by taking 1.3 cars off the road for a year, not burning 808 gallons of gas, emissions from .94 of a typical home, sequestered from planting 182 tree seedlings and letting them grow 10 years, or	Removing	96	cars from the road / year
	Or Not Burning	55,264	Gallons of gas / year
	Or saving enough energy to power	68	typical american homes for a year
	Or the annual environmental benefit of this project is equivalent to planting and growing for 10 years	13,679	trees / year
	Or Avoiding the greenhouse gas emmissions by not landfilling	171	tons of waste / year

Sources: www.cleanerandgreener.org
http://www.epa.gov/cleanenergy/energy-resources/calculator.html

Table 5-1. Environmental Impact		
Type of Poloution	Pollutants Reduced	
Carbon Dioxide (CO_2) Eliminated:	**668,381**	Pounds (lbs)
Sulfur Dioxide (SO_2) Eliminated:	**294**	Pounds (lbs)
Nitric Oxide (NO_X) Eliminated:	**647**	Pounds (lbs)

Table 5-2. Reduction Equivalents	
Reduction is Equivalent to the...	
	annual greenhouse gas emissions from **96** passenger cars, *or*
	CO_2 emissions from **55,213** gallons of gasoline consumed, *or*
	CO_2 emissions from the electricity use of **68** homes for one year, *or*
	planting and growing for 10 years **13,667** trees/year, *or*
	greenhouse gas emissions avoided by recycling **171** tons of waste instead of sending it to the landfill.

6.0 Measurement and Verification

6.1. Introduction

This document contains the energy savings Measurement and Verification (M&V) plan for the Energy Conservation Measures (ECMs) contained in the Town of Oro Valley (TOV) Investment Grade Audit Report (IGA).

A specific M&V Plan is submitted for each ECM to provide a comprehensive overall plan for TOV. Each section provides:

- A description of how the savings shall be verified for each ECM.
- Selection of specific protocol for verification of savings of each ECM.
- Requirements for measurement or other means to establish the ECM savings.

APS Energy Services is responsible for the Investment Grade Audit, pre-retrofit measurement, energy savings calculations, installing equipment and required post retrofit verification as outlined herein. TOV operates and maintains all equipment installed. **Proper operation and maintenance of equipment and systems is critical to long term achievement of energy savings.**

APS Energy Services warrants that for the first year following the date of Substantial Completion (the "Guarantee Period"), TOV, following the schedules and maintaining the comfort levels as set out in this IGA, dated November 4, 2009, shall realize $58,862 in utility and operational cost savings ("Annual Energy Cost Avoidances"), as shown in Table 2-0. However, it is agreed that the operational savings portion of the Annual Energy Cost Avoidances shown are fulfilled upon acceptance of this agreement. Should TOV decide to enter into a service agreement with APS Energy Services for additional years of M&V, the guarantee period will extend for the period of the service agreement.

APS Energy Services agrees to complete or cause its Qualified Provider to complete the M&V Reports and deliver them to TOV within forty-five (45) days of Substantial Completion and prior to the completion of the Warranty Period.

In the event that the M&V Report does not verify the Expected Project Savings in accordance with the M&V Plan, then APS Energy Services, or its subcontractor, shall repair, replace, or substitute the ECM that is not performing at the required level, as identified in the M&V Report. If the sum of the ECMs indicates that the Expected Project Savings are exceeded, then no remedy may be needed. APS Energy Services or its subcontractor shall re-perform the relevant M&V work for the affected ECM(s) and amend or supplement the M&V Report.

If the M&V Report demonstrates that the Work will achieve one hundred percent (100%) of the Expected Project Savings, then APS Energy Services shall have satisfied the energy performance guarantee obligations for the entire guarantee period and TOV shall accept the M&V Report.

If, after the opportunity to make corrections, the M&V Report, as amended, indicates that verified savings are less than the ECM Cost Avoidances for that year as shown in Table 2-0, then APS Energy Services shall pay TOV (within thirty (30) days of receipt of the M&V Report) the shortfall amount for the entire guarantee period. However, under no circumstances will the amount paid for the total of the energy savings shortfalls exceed the principal amount of the contract (Contract Amount). Construction period savings dollars and any prior-year, post-project completion excess savings dollars earned shall be used to offset shortfalls identified for an annual reconciliation. For clarification of calculations, no adjustments will be made for the time value of money.

This Guarantee is subject to the satisfactory performance by TOV of its obligations under this agreement including continued occupancy levels, facilities usage, as well as, operations and maintenance practices at the sites in accordance with Table 4-2, Standards of Operation and Table 4-3, Lighting Operating Hours.

Measurement and Verification (M&V) is a methodology based on standard industry protocol intended to provide reasonable assurance that energy savings calculated are realized over the term of the contract. The development of this M&V plan is based on the IPMVP-2001 (International Performance Measurement and Verification Protocol), the FEMP-1996 (Federal Energy Management Protocol NTIS Publication DE96-000521) and the application of sound engineering and business guidelines to the overall need for verification of energy savings for each ECM. This plan contains methodology that shall cost effectively provide reasonable assurance of equipment savings through stipulated values, short term or spot measurements, and engineering calculations and/or modeling. The necessary components to a well established M & V Plan are:

- Specific identification of each ECM and proposed M & V. Reporting requirements for overall savings.
- Participation of all parties and any necessary coordination with independent review.

6.2. M&V Costs

The costs for the first M&V report are included in the total cost of the project. This includes pre-retrofit measurements, post-retrofit measurements and a final report for TOV. Should TOV elect to sign an additional service agreement to lengthen the term of the guarantee, then additional M&V reports would be done to verify the energy savings. This service agreement would be a separate contract.

Table 6-0. M&V Costs	
Year 1	Included in Project Total Cost

6.3. Overview of M&V Project

The M&V plan provides an agreed upon method of verifying the project results using the most cost efficient approach. The cost of various M&V approaches is balanced against the size of the investment and the savings risk. APS Energy Services' approach to M&V is to use established standard methods of verification, such as the IPMVP and FEMP protocols for M&V. APS Energy Services develops site-specific M&V plans for each measure based on the specific technology of the ECM, APS Energy Services and TOV long-term responsibilities, measurement equipment capabilities, ability to capture and isolate the key variables demonstrating effectiveness of the ECM, and the cost to perform the M&V.

6.3.1. Project Risks and Responsibilities

As recommended by the IPMVP and FEMP Guidelines, APS Energy Services evaluates the contract responsibilities associated with a project when developing the M&V plan. To do this, APS Energy Services has prepared a list of potential project risks and the party responsible for managing those risks. The tables that follow list the financial, equipment performance and operational responsibilities.

Table 6-1. Financial Responsibility Matrix

Financial Factors	Responsible Party	Notes
Interest Rates	Neither	Set by market structure
Energy Prices	Neither	Set by market structure
Savings Methodology	APS Energy Services	
Construction Costs	APS Energy Services	Contract determines overall requirements for construction costs and changes
M&V Costs	APS Energy Services	Depending on methods or alternatives suggested/selected.
Delays	APS Energy Services or Client	Depending on cause

Table 6-2. Equipment Performance Responsibility Matrix

Performance Factors	Responsible Party	Notes
Investment Grade Assessment and Savings Calculations	APS Energy Services	All calculations are provided to M&V Professional.
Investment Grade Assessment, Savings Review, M & V Plan Review	APS Energy Services and Client	Schedule coordination and submittals to APS Energy Services and Client required from all parties.
Field Adjustments to Investment Grade Assessment and Savings Calculations as necessary to enhance project	APS Energy Services and Client	Where necessary, parties shall review and modify ECM to ensure appropriate savings and appropriate payback. M&V requirements shall be incorporated into changes as outlined.
Initial Equipment Performance	APS Energy Services	Upon completion of commissioning and necessary measurements as detailed herein.
Pre and Post Retrofit Measurements	APS Energy Services or M&V Professional	Required as indicated for ECM analysis and as outlined in the M&V plan.
Long-Term Equipment Performance	Client	Tied to Operation and Maintenance.
Engineering Calculations and Adjustments as necessary	APS Energy Services or M&V Professional	As outlined in M&V engineering calculations, modeling, and adjustments may be necessary for each ECM.
Maintenance	Client	Tied to long-term performance.
Operation	Client	Tied to long-term performance.

Table 6-3. Operational Responsibility Matrix

Operational Factors	Responsible Party	Notes
Major Facility Changes	Client	Facility changes affect many of the ECMs considered for this plan. The M&V plan as presented herein assumes existing usage patterns except where explicitly stated. Client shall inform designated APS Energy Services Representative of any changes to facilit
Operating Hours	Client	This is stipulated and/or developed for the ECMs considered herein based on information provided by Client.
Load	Client	See analysis methodology descriptions.
User Participation	Client	Baseline conditions assumed.

Project risks can be broadly divided into two main categories: performance risk and usage risk.

Performance Risk

Performance risk is the uncertainty associated with achieving a specified level of equipment performance. It can result from poor baseline definition, inappropriate equipment selection, improper commissioning, or other equipment-related factors. Because APS Energy Services assumes responsibility for equipment and system performance by ensuring that equipment at installation is performing acceptably, unrealized savings resulting from poor equipment performance is a risk that APS Energy Services assumes. To validate performance, APS Energy Services shall perform all functions related to M&V as outlined herein for each ECM.

Another factor of performance risk is long term equipment performance. Long term equipment performance depends on how well the equipment is maintained and operated. Because TOV is responsible for ongoing equipment operation and maintenance for this project, TOV assumes the long term equipment performance risk.

Usage Risk

Usage risk is the uncertainty associated with how well the equipment operating hours or load factors are known when the savings are initially guaranteed. It refers to how often equipment is used, the time of day that it is used and at what levels the equipment is loaded. Savings fluctuate depending on how many hours equipment is used or how many BTUs of heating or cooling are provided. Usage is often related to weather, human behavior, occupancy, and/or other factors beyond either party's control. Usage risk is mitigated to some extent by establishing an appropriate baseline with which to assess ECM savings. The following techniques are effective in mitigating some usage risk:

- ***Field Measurements:*** APS Energy Services provides a level of assurance related to engineering assumptions by performing some field measurements. ECMs such as efficient motor replacement and lighting provide some field measurements for specific variables. Using these

measurements provides a better assurance of the overall savings from full implementation of any ECM.

- ***Calibration of Models:*** Where appropriate models can be calibrated using field measurements or other appropriate data to arrive at more accurate models.

- ***Industry Standards:*** Software or industry standards provide a basis for establishing baseline energy consumption for equipment and systems. Such standards lower the overall range for error and mitigate the usage risk to some extent.

- ***Sound Engineering:*** Knowledge of systems, equipment usage, and other sound engineering fundamentals provide some mitigation of usage risk.

Other factors related to usage risk cannot be easily measured or assessed. While some information may be available, these factors may not lend themselves to any reasonable assurance of accuracy through the techniques described above. APS Energy Services cannot assume responsibility for such factors, and therefore a stipulation or agreement to usage of an agreed value for these factors is necessary. Such factors include:

- ***Operating Hours:*** While some data may be available, in general operating hours are assessed and agreed to by stipulation.

- ***Weather Data:*** Weather affects many ECM calculations. Because upcoming weather is not a certainty, the use of 30-year average weather data is typically stipulated. For the calibrated modeling, APS Energy Services provides some mitigation by utilizing actual weather data as related to utility billing or metered data. This provides a more direct calibration to actual information. Savings analysis is completed using normalized 30-year weather data to provide the most accurate savings projections.

- ***Other Operating Related Factors:*** Factors related to operating conditions and usage of equipment may be stipulated if detailed data or information is not available.

Once both parties stipulate a value, it becomes the value used for both the baseline and ECM savings calculations. Values are often stipulated because the cost to monitor and analyze the variable outweighs TOV savings by implementation of the ECM, and often the increased accuracy by measurement and analyzing the variable is minimal.

6.3.2. Measurement and Verification Models

Methods of M&V vary in accordance with the type of project, level of assurance of savings, cost and availability of data, financing constraints, and energy costs. The methods selected must be cost effective given the financial savings to TOV. The methods used for the ECMs detailed herein were selected to minimize M&V costs while still providing a reasonable assurance of the savings calculations.

The IPMVP-2001 guideline provides the following options related to methodology for M&V:

6.3.2.1. Option A – Partially Measured Retrofit Isolation

Option A uses a combination of stipulated and measured factors to calculate baseline usage and savings associated with the ECM. Spot or short-term measurement would be used for the measured values. Stipulated values are supported by TOV input, historical data or manufacturer data.

- Baseline and savings calculations are provided through engineering calculations, component or system models.
- Depending on number of points measured, Option A provides the least cost alternative to M&V.

6.3.2.2. Option B – Retrofit Isolation

Option B provides for measurement to provide data for assessing values or variables. Spot or short-term measurement, taken at the component and/or system level are taken when variations in factors can be accounted for or eliminated. Continuous measurement at the component and/or system level can also be used to account for the variations in factors over time.

- Baseline and savings calculations are provided through engineering calculations, component or system models.
- Cost is variable depending on the points measured, and the term of the measurement process used. Option B provides a better scenario for ECMs where a small number of factors can be accurately measured with a measurement plan.

6.3.2.3. Option C – Whole Building

Option C involves the use of utility meters or whole building sub-metering to assess the energy performance of the entire building. After an ECM is implemented the billing data is assessed in accordance with an approved plan to determine actual ECM savings.

- Baseline is established through utility data and engineering/regression analysis.
- Engineering calculations or modeling initially provides estimated ECM savings.
- Actual ECM savings are based on the utility or metered data. Savings must be adjusted for changes in building operation and variables assumed in the engineering calculations or modeling (such as weather, occupancy, etc.).
- Cost of this approach is variable based on the availability of utility data, sub-metered data, and overall savings guarantee. If the metered data is used for a savings guarantee, all variables related to building performance must be measured and adjusted, usually on an annual basis. Option C usually requires a substantial amount of time and effort to establish the baseline, and especially track the savings of any specific ECM on a building or metered total basis.

6.3.2.4. Option D – Calibrated Computer Simulation

Option D uses computer-modeling techniques to provide an engineering model of component and/or system performance. The inputs to the computer simulation may be made by engineering estimates, short or long term measurements, and utility or other metered data. Once the model is properly calibrated it is used for the establishment of the baseline and savings by changing appropriate inputs.

- Baseline is established through a calibration process for the computer modeling. Appropriate measurements and inputs are reflected against regression analysis for the metered data.
- Once the model is calibrated and the baseline established, inputs are varied for the proposed ECM to establish savings.
- Actual ECM savings are stipulated based on the computer model. There may be follow up calibration of the model with the ECM in place to affirm the overall building simulation model.
- Cost of this method varies based on the complexity and accuracy of model desired, availability of data and overall measurement required.

6.3.2.5. Option S – Stipulated Savings

Option S entirely uses stipulated factors to calculate baseline usage and savings associated with the ECM. Stipulated values are supported by Client input, historical data, or manufacturer data. The savings can then be calculated by computer building simulations or engineering calculations.

The IPMVP and FEMP guideline is similar to the IPMVP –2001 protocol except that it allows for full stipulation of all variables in Option A. This type of approach is applicable where the savings for any ECM do not justify the cost of measurement of any variable for purposes of compliance with the IPMVP protocol. In order to determine the most effective method of M&V for any particular project or ECM, the following considerations must be taken into account:

- ***What are the expected annual savings for the ECM in comparison with the estimated cost to verify the ECM savings****?* It would not be cost effective, for example, to verify savings for a lighting retrofit when the M&V cost exceeded the annual savings for implementing the measure.

- ***What data is readily available?*** The data availability is important in deciding the appropriate methodology. If data is not readily available it shall likely lead to additional stipulation or additional M&V cost. Again, the overall data availability may increase the M&V cost and time frame for ECM savings verification.

- ***What level of assurance is required?*** Complex modeling and measurement is not necessary if the level of assurance required is met by a lower cost M&V option. For example, lighting retrofit savings can be calculated with little or no measurement with a very small potential for error. Installing long-term measurement and expending the time and capital to model the lighting retrofit within the building would not provide any greater level of assurance than simple calculations and spot measurements.

- ***Is there a critical project path?*** Time is usually a critical factor in all projects. Time required for completion may dictate an alternate M&V option. If data is not available, it may not be possible to monitor all factors for a long period of time in order to establish a baseline under Options C or D. This may dictate using Options A or B due to project timing constraints. Option D may be applied if the calibration time can be accommodated with the project schedule.

For the ECMs covered under this M&V plan, Table 6-4, Selected M&V Options, summarizes the proposed IPMVP Options selected:

Table 6-4. Selected M&V Options

Facility	Square Footage	ECM 1 Interior Lighting And Controls	ECM 4 Water Conservation	ECM 6 Solar Water Heating	ECM 7 Rate Analysis	ECM 8 Low E Window Film	ECM 9 Ceiling Fans	ECM 10 Direct Digital Controls	ECM 13 HVAC Zone Control	ECM 14 High Efficiency Packaged Units	ECM 15 Variable Frequency Drives	ECM 17 Demand Controlled Ventilation	ECM 18 Pump/Well Piping Modifications	ECM 19 Premium Efficiency Motor	ECM 20 Data Energy Management
Town of Oro Valley Library	25,000	A	S					D				S		S	S
Administration Building	18,722	A	S			S	S	D	D	S					S
Oro Valley Water Utility Building	2,192	A	S			S		S		S					S
Magistrate Court Building	4,212	A	S			S		S		S					S
Development Services Building	10,000	A	S			S	S	S	S						S
Oro Valley Police Dept. Main Station	6,875	A	S	D		S		D							S

The particular option selected for each ECM was based on a number of related issues including:

- ECM projected energy savings and ECM cost.
- ECM savings and cost related to overall project cost avoidances and cost.
- Accuracy issues over measurement in any particular measure.
- Overall cost of Measurement and Verification to provide a reasonable assurance of savings.

In general,

- *Savings ($/yr) = ($/yr (existing system)) - ($/yr (Post ECM)) +or- Adjustments*
- *Simple Payback (yrs) = Project Cost ($)/Savings ($/yr)*

The baseline and the post-installation energy use depend on various system and external factors, such as energy demand, operating hours, weather conditions, motor loading, energy rates, and occupancy. Development of the baseline, post ECM consumption, cost avoidances and simple payback for each ECM covered by this M&V plan includes:

- ***Stipulated Values:*** These values are important in the overall calculations for energy consumption, financial calculations, and operating conditions. APS Energy Services and TOV have agreed to these values for purposes of establishing savings.

- ***Developed/Measured Values:*** These are the values determined by spot or short-term measurement. Values are determined based on a sound engineering approach to variable determination. Both values used for baseline consumption and values to be measured/ determined as part of the post ECM implementation is detailed.

- ***Assumptions:*** Some values that are assumed in order to calculate energy use are necessary in certain circumstances.

- ***Calculations:*** The necessary calculations for baseline energy and demand usage, the calculation of the energy and demand components with implementation of the ECM, the calculation of costs, and annual savings are the primary tool for assessing the estimated and actual savings of any ECM.

- ***Instrumentation:*** The type and specifications, if applicable, for any instrumentation used for developed/measured values is provided to ensure appropriate meters and measurement equipment is used for specified applications.

- ***Pre Retrofit Measurements:*** Each ECM has a section detailing the measurements required prior to the retrofit. These measurements are used to establish the baseline or adjustments required to establish an accurate baseline.

- ***Post Retrofit Measurements:*** Each ECM has a section that details the measurements required if any after the retrofit is completed. This section is utilized to detail the type of measurements required for verification of the energy savings calculations.

- ***Adjustments:*** Each ECM has a section for adjustments. This section includes possible adjustments to the actual Investment Grade Assessment and energy information, appropriate adjustments to the M&V plan, and adjustments to any savings guarantee. This section is utilized to anticipate changes necessary due to field conditions and provide an appropriate response in the verification of actual energy and cost avoidances.

- ***Commissioning:*** Each ECM has a section regarding the commissioning process. This provides the detail for how the savings will be verified upon project completion, and the type of inspection that will be completed, and the billing method for verified savings. This section is utilized to provide a standard approach for each ECM upon project completion.

6.3.3. Measurement and Verification Documentation and Implementation

The M&V process continues during design, construction, commissioning, and the measurement phase. The following are the major steps in the technical M&V process:

6.3.3.1. Engineering Review

Engineering calculations of savings and documented supporting assumptions have been reviewed. Critical engineering parameters and facility or system characteristics have been identified and verified with TOV. Sources of weather data, facility occupancy schedules, manufacturer operational specifications, utility rate schedules and other assumptions are clearly identified in this M&V plan. Average historical weather data is used to account for any variations that may occur over the life of the contract. Occupancy schedules are verified and reviewed by TOV. The engineering methods used to calculate the energy savings are clearly documented in this plan. All savings calculations and operational or maintenance savings should be reviewed and accepted by TOV.

6.3.3.2. Design Review

The design documents are reviewed to ensure that they meet the requirements of the ECMs.

6.3.3.3. Construction Review

Equipment shop drawings are reviewed to ensure that they meet the design intent. Site visits are made to ensure that the ECM is built in accordance with the specifications.

6.3.3.4. Commissioning

After installation is complete, the ECM equipment and systems are fully commissioned and functional tests are conducted to verify performance. An appropriate Measurement and Verification Specialist will perform all formal commissioning on HVAC and DDC systems

where Option A is selected. The appropriate Measurement and Verification Specialist will provide a commissioning report which must be attached to any final M&V Report. This requirement includes all re-commissioning of existing buildings.

6.3.3.5. Measurements

As detailed herein, measurements may be required for ECM savings verification. For all measurements, Appropriate Measurement and Verification Specialist shall have a certified and assume responsible charge.

6.3.3.6. On-Site Inspections

On-site post-installation inspections are conducted during or after commissioning to ensure proper equipment operation. During these inspections, APS Energy Services performs a final verification of ECM data, such as equipment ratings, quantities and applications. Diagnostic measurements are also collected, as necessary. Short-term-interval data may be monitored as well.

6.3.3.7. Project-Specific Impact Assessments

For some measures, site-specific evaluations are performed using metering and instrumentation. The exact measurements taken depend on the particular technology. Also, the measurement time period varies depending on the characteristics of the technology and its use.

In accordance with the IPMVP and FEMP Guidelines, the following outline for each measure has been established to clearly indicate each of the specific parameters, protocols, objectives and overall plan for Measurement and Verification.

- References to the Investment Grade Assessment
- Introduction
- Stipulated Values
- Measured/Developed Values
- Assumptions
- Calculations
- Instrumentation
- Post Retrofit Measurements
- Adjustments
- Interactive Effects
- Commissioning

APS Energy Services will follow the agreed-upon M&V protocols for the measurement period and will prepare post-installation reports with supporting documentation for TOV. The cost of M&V is included in the project cash flow requirements and reduces the net cost avoidances. Therefore, APS Energy Services is careful to match the complexity of the M&V approach to the available cost avoidances to maintain the cost-effectiveness of the measure.

6.3.3.8. Follow-On Report

The Follow-On M&V report shall be performed by an appropriate Measurement and Verification Specialist. The follow on reporting requirements are dictated by:

- Contractual obligations between APS Energy Services and TOV.
- Additional requirements as deemed necessary or part of overall customer service between APS Energy Services and TOV.

The Follow-On Report shall be submitted to TOV within 90 days of the anniversary date of the final M&V Report (date of final M&V Report shall be considered final data when all parties have signed and approved the report) submitted in accordance with this Plan. TOV may assign the follow on work to an individual other than the Appropriate Measurement and Verification Specialist with written approval. Should TOV assign any M&V work to an individual other than the Measurement and Verification Specialist, the Measurement and Verification Specialist assumes no liability for any savings or M&V work completed to date.

6.4. Global Assumptions and Definitions

6.4.1. Global Data

The global data in the Table that follows was used to calculate the energy savings in the Investment Grade Audit, and will be used in all Measurement and Verification calculations.

Table 6-5. Technical Reference Definitions

Data Type	Values Assumed	Source	Notes
Demand and Energy Pricing ($/kW, $/kWH)	Client has electrical service provided by XXX. For this analysis, the savings methodology described in detail herein was utilized for purposes of establishing the annual dollar cost avoidances.	Electric rates and tariffs, Client provided billing data or other reliable sources as detailed herein.	Savings Methodology and information contained herein.
Propane	Client has propane service provided by XXX Propane. For this analysis, the savings methodology described in detail herein was utilized for purposes of establishing the annual dollar cost avoidances.	Propane rates and tariffs, Client provided billing data or other reliable sources as detailed herein.	Savings Methodology and information contained herein.
Baseline Year	2008-2009 (most current full billing year): Where necessary and as detailed in the Investment Grade Audit, the data provided may have been modified or adjusted due to lack of data or due to data timing.	Client provided data or authorization to acquire data.	The billing data utilized reflects the most current consumption history available.

6.4.2. Buildings Considered

Section 4.0, Technical Report, details the buildings considered for M&V and included in the Investment Grade Audit. This Plan also includes a table detailing the proposed ECM by building for additional reference.

6.5. Lighting System Upgrade M&V

6.5.1. Introduction

This Measurement and Verification Plan (M&V) is specific to all lighting system improvements.

6.5.2. M&V Protocol

For this ECM, IPMVP Protocol – Option A shall be utilized. This option provides for the measurement of at least one variable pre and post retrofit with other variables allowed for stipulation. For this retrofit, the wattage of the fixtures shall be measured. A random sample of each of the fixture types will be measured. The same sample will be used both pre and post retrofit. Wattage shall be measured with an appropriate instrument that is properly calibrated.

Light Levels
A representative sample of the light levels shall be measured. Where rooms have similar or identical lighting design, it is not required that each room be measured. Where room lighting design differs substantially the light levels shall be measured for each type of lighting design. Any light level measured where ambient light affects reading shall be adjusted by measuring the space with and without fixtures to determine appropriate fixture contribution to all levels. Light levels shall be

measured by an appropriate instrument that is properly calibrated. Light level measurements apply to both pre and post retrofit areas and shall include work surface and overall range. Where rooms do not have a specific work surface, only room range shall be measured.

Documentation
All areas measured shall be documented. The data shall indicate areas that do not meet IESNA standard light level requirements. All instrumentation used shall be clearly documented.

6.5.3. Stipulated Values

Operating Hours are stipulated for purposes of M&V. Please refer to Table 4-2 for specific operating hours for each fixture and location. Use of rates or conversions from units to economic values is stipulated as outlined in the Investment Grade Audit.

6.5.4. Developed/Measured Values

Wattages shall be measured as outlined herein. The other input variables shall be developed by the M&V professional.

6.5.5. Assumptions

Other than the stipulations and developed/measured values, certain assumptions are necessary with this option. Specifically:

- It is assumed that the calculations shall be appropriate to establish the verified savings.
- ***Light Level Measurement Guidelines:*** Work Surfaces or "At Task" shall be defined as: "Work Surfaces or location "At Task" shall be specific areas within occupied areas where occupants are intended to perform specific functions. For general office areas, the desk or surface where visual tasks are performed shall constitute the appropriate work surface. For shop or maintenance areas, appropriate work surfaces such as benches, tool areas, or storage locations shall be considered acceptable work surfaces. For normally unoccupied areas or areas where no visual work is performed, an area located four feet from the floor surface directly between light fixtures shall constitute appropriate work surface for purposes of light level measurements.

  Light levels must comply with IESNA standards or pre retrofit measurements, whichever is less.
- ***IESNA Standards:*** Reference Illuminating Engineering Society of North America recommended lighting practices and standards handbook. IESNA standards shall provide general lighting guidelines.

6.5.6. Calculations

The calculations for the baseline energy consumption and post retrofit savings provide the basis for the overall financial viability of the ECM. Savings calculations shall utilize the Investment Grade Audit documented savings calculation but include the "verified" wattage for both existing and retrofit fixtures.

6.5.7. Instrumentation

None required.

6.5.8. Pre Retrofit Measurements

None required.

6.5.9. Post Retrofit Measurements

None required.

6.5.10. Adjustments

For this ECM the following adjustments are allowed for purposes of Measurement and Verification:

- Lamp wattages and calculated resultant savings verified by provisions of this plan may be with + or – 10% due to metering accuracy.
- Foot-candle readings verified by provisions of this plan may be within + or – 10% due to metering and location of reading accuracy.
- Light level requirements may be modified as detailed in this plan.
- Changes in actual construction including number and/or type of fixtures. All changes shall be clearly documented and provided to the M&V professional.

6.5.11. Interactive Effects

Interactive effects are those effects due to the relationship of the ECM to other variables. For example, lower lighting wattage results in increased heating requirements and lower air conditioning requirements. The Investment Grade Audit included these interactive effects. The M&V shall utilize the actual wattages and the same input for interactive effects calculation.

6.5.12. Commissioning

Commissioning shall consist of inspections, and a final savings verification report. Inspections shall consist of:

- During the construction phase of the project, APS Energy Services shall keep a detailed record of the quantity and types of fixtures retrofitted and fixtures installed in each building. A post construction inspection is required by the responsible M&V party.
- After lighting modifications have been made, the installations shall be inspected to verify the retrofit counts by fixture code.
- Additional inspections as required due to modifications and/or adjustments covered under this Plan shall be made subsequent to completion.

6.6. DDC Controls M&V – Option D

6.6.1. Introduction

This Measurement and Verification Plan (M&V) is specific to the DDC system repair or installation.

6.6.2. M&V Protocol

For this ECM, Option D was selected. Because the methodology used for the savings calculation is not based on any verifiable measurements, Option D provides a calibrated computer model as the savings verification.

6.6.3. Stipulated Values

For purposes of establishing the verified savings the following may be considered stipulated:

1. Utility data and weather data are considered stipulated. Unless required, 30 year average weather data shall be used for calibration and savings calculations. If the baseline cannot be calibrated with average weather data, APS Energy Services shall supply actual weather and utility data for a set period of not less than 12 months to establish the calibrated baseline model.
2. Any other necessary engineering adjustments required to provide accuracy to savings verification.
3. Monitoring data may be substituted for utility data where recommended by modeling party

6.6.4. Developed/Measured Values

Since the methodology used for savings calculations cannot be readily converted to field measurements, this plan requires a model to establish the baseline and predict the savings. As required by Option D, specific variables are developed with the model including building envelope, operating schedules, lighting input as required herein, and field/standard assessments of systems, components, and ventilation.

6.6.5. Assumptions

Other than the stipulations and developed/measured values certain assumptions are necessary with this Option. Specifically:

1. It is assumed the person performing the modeling activity has knowledge of the facilities and software necessary to accurately provide a calibrated computer model.
2. It is assumed that a calibrated model is a good predictor of energy savings.

6.6.6. Calculations

6.6.6.1. Baseline Calculations

Baseline shall be established by calibrating the model within accuracy developed by APS Energy Services. The model must either comply with all requirements of this guideline, or exceptions must be approved by the M & V professional on a case by case basis.

6.6.6.2. Cost Avoidance Calculations

Cost Avoidances are calculated based on the following information for the appropriate ECM. Overall savings are:

Total Annual Savings ($/yr) = Baseline ($/yr) – Post Retrofit ($/yr) + O/M Savings + Adjustments

Adjustments may be required for weather, other input assumptions, and particular factors where documented by the modeler or Appropriate Measurement and Verification Specialist.

Once the model has been appropriately calibrated, savings including interactive effects are provided by the output of several iterations for each recommended improvement.

6.6.7. Instrumentation

The following instrumentation may be required:

1. Calibrated monitor(s) for service entrance and HVAC equipment.
2. RPM meter for loading on any/all pumping equipment.
3. Factory testing or certification may be required for HVAC replacement options.
4. True RMS watt meter for spot measurements as required.
5. Calibrated temperature logger or other device for outside air.

6.6.8. Pre Retrofit Measurements

None Required

6.6.9. Post Retrofit Measurements

None Required

6.6.10. Adjustments

Adjustments may be required for a variety of variables, and meter accuracy. The M & V professional shall document all error sources and provide recommendations on adjustments necessary to establish accurate verified savings figures.

6.6.11. Interactive Effects

The simplified savings calculations were not based on interactive effects. The option described herein provides interactive effects by proper modeling techniques for each recommended improvement.

6.6.12. Commissioning

Commissioning shall consist of the following requirements:

- A review and approval of all calculations for baseline and savings shall be completed by the M & V Professional.

A final savings verification report shall be provided for each building upon completion of all commissioning steps.

6.7. HVAC Zone Control M&V – Option D

6.7.1. Introduction

This Measurement and Verification Plan (M&V) is specific to the HVAC Zone Control.

6.7.2. M&V Protocol

For this ECM, Option D was selected. Because the methodology used for the savings calculation is not based on any verifiable measurements, Option D provides a calibrated computer model as the savings verification.

6.7.3. Stipulated Values

For purposes of establishing the verified savings the following may be considered stipulated:

1. Utility data and weather data are considered stipulated. Unless required, 30 year average weather data shall be used for calibration and savings calculations. If the baseline cannot be calibrated with average weather data, APS Energy Services shall supply actual weather and utility data for a set period of not less than 12 months to establish the calibrated baseline model.
2. Any other necessary engineering adjustments required to provide accuracy to savings verification.
3. Monitoring data may be substituted for utility data where recommended by modeling party.

6.7.4. Developed/Measured Values

Since the methodology used for savings calculations cannot be readily converted to field measurements, this plan requires a model to establish the baseline and predict the savings. As required by Option D, specific variables are developed with the model including building envelope, operating schedules, lighting input as required herein, and field/standard assessments of systems, components, and ventilation.

6.7.5. Assumptions

Other than the stipulations and developed/measured values certain assumptions are necessary with this Option. Specifically:

1. It is assumed the person performing the modeling activity has knowledge of the facilities and software necessary to accurately provide a calibrated computer model.
2. It is assumed that a calibrated model is a good predictor of energy savings.

6.7.6. Calculations

6.7.6.1. Baseline Calculations

Baseline shall be established by calibrating the model within accuracy developed by APS Energy Services. The model must either comply with all requirements of this guideline, or exceptions must be approved by the M & V professional on a case by case basis.

6.7.6.2. Savings Calculations

Once the model has been appropriately calibrated, savings including interactive effects are provided by the output of several iterations for each recommended improvement.

6.7.7. Instrumentation

None Required.

6.7.8. Pre Retrofit Measurements

None required.

6.7.9. Post Retrofit Measurements

None Required.

6.7.10. Adjustments

Adjustments may be required for a variety of variables, and meter accuracy. The M & V professional shall document all error sources and provide recommendations on adjustments necessary to establish accurate verified savings figures.

6.7.11. Interactive Effects

The option described herein provides interactive effects by proper modeling techniques for each recommended improvement.

6.7.12. Commissioning

Commissioning shall consist of the following requirements:

- A review and approval of all calculations for baseline and savings shall be completed by the M & V Professional.

A final savings verification report shall be provided for each building upon completion of all commissioning steps.

6.8. Stipulated Savings ECMs M&V

6.8.1. Introduction

This Measurement and Verification Plan is specific to the following ECMs covered for TOV and detailed in the Investment Grade Audit. Specifically covered are:

- Water Conservation
- Rate Analysis
- Low E Window Film
- Ceiling Fans
- DDC Controls
- HVAC Zone Control
- High Efficiency Package Units
- Demand Controlled Ventilation
- Pump/Well Piping Modifications
- Premium Efficiency Motors
- Data Energy Management

6.8.2. M&V Protocol

This plan recognizes these projects as suitable for stipulation. No IPMVP protocol applies to these ECMs, and FEMP Option A applies as complete stipulation of savings.

6.8.3. Stipulated Values

All values are considered stipulated for these ECMs.

6.8.4. Developed/Measured Values

The necessary inputs for calculation of savings were developed to provide assurance that there are adequate savings to justify recommending installation of the proposed ECM.

6.8.5. Assumptions

Any necessary assumptions or stipulated values used are considered acceptable for calculation of savings for these ECM.

6.8.6. Calculations

Refer to the appropriate details in the Investment Grade Assessment and Technical Appendices.

6.8.7. Instrumentation

None required.

6.8.8. Pre Retrofit Measurements

None required.

6.8.9. Post Retrofit Measurements

None required.

6.8.10. Adjustments

The baseline and savings are stipulated. However, significant deviations in the actual construction may require an adjustment at the time of final verification. Appropriate Measurement and Verification Specialist shall determine any necessary adjustments subsequent to the acceptance of the ECM installation.

6.8.11. Interactive Effects

None required.

6.8.12. Commissioning

Necessary construction review and submittal of final inspection report shall be submitted to Appropriate Measurement and Verification Specialist for acceptance and approval. Appropriate Measurement and Verification Specialist shall determine any necessary adjustments and provide a final summary in the M&V report for all stipulated ECM.

7.0 Commissioning

7.1. Overview

7.1.1. Abbreviations

The following are common abbreviations used in this document.

DE – Design Engineer
CA – Commissioning Authority
CC – Controls Contractor
Cx – Commissioning
Cx Plan – Commissioning Plan Document
EC – Electrical Contractor
ECM – Energy Conservation Measure
TC PM – Owner Project Manager
FT – Functional Performance Test
Mfr – Manufacturer/Supplier
MC – Mechanical Contractor
O&M – Operations and Maintenance
PC – Pre-Functional Checklist
PM – APS Energy Services Project Manager
CM – APS Energy Services Construction Mgr
Subs – Subcontractors to APS Energy Services

7.1.2. Purpose of the Commissioning Plan

- Provide direction for the development of the Cx specifications by the DE during the latter part of the design phase.
- Provide direction for the commissioning process during construction, particularly providing guidance for resolving problem issues and providing details that were not fully developed during design such as scheduling, participation of various parties of this particular project, actual lines of reporting and approvals, coordination, finalizing functional tests, etc.

This plan does not provide a detailed specification of required testing procedures. The detailed testing requirements and procedures would be included in the Project Specifications. Additional details regarding functional and pre-functional testing would be developed during construction when start-up sequencing is better understood.

7.1.3. Commissioning Scope

Commissioning is a systematic process of ensuring that all completed ECMs perform according to the design intent and owner's operational needs. Commissioning during construction of this project is intended to achieve the following specific objectives:

- Ensure that applicable equipment and systems are received as specified and installed properly and receive adequate operational checkout by the installing contractors prior to being put into operation.
- Verify and document that equipment and systems are performing properly and fulfill the contract intent.
- Ensure that O&M and record documentation are complete.
- Ensure that Owner's operating personnel are adequately trained.

7.1.4. Commissioned Systems

The following systems could be commissioned in this project:

- Lighting Retrofits interior and exterior
- Computer Power Management
- Vending Machine Control
- DDC Addition and Re-commissioning

7.2. Cx Team Data (Primary Parties)

Table 7-0. Commissioning Team Data

Team Member	Company and Contact Names	Office Phone	Mobile Phone	Fax	Email
Owner/CCI PM					
Construction Manager					
Project Manager					
Commissioning Authority					
Design Engineer					
Mechanical Contractor					
Electrical Contractor					
Controls Contractor					

7.2.1. Roles and Responsibilities

The members of the commissioning team could consist of the TC PM, APS Energy Services CM/PM, CA, DE and an assigned representative of the MC, EC, CC and any other installing sub or supplier of equipment.

7.2.2. General Management Plan

The CA could be provided by APS Energy Services for this project. In general, the CA coordinates the commissioning activities. The CA's responsibilities including all other contractors' commissioning responsibilities would be detailed in the specification developed and issued for the project. The specifications would take contractual precedence over the Cx plan. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract documents. Refer to the management protocols in Section 8.3.5.

7.2.3. General Description of Roles

CA: Coordinates the Cx process, reviews and comments on the specifications and tests and verifies performance tests.

CM: Facilitates the Cx process, approves test plans and signs-off on performance.

Subs: Demonstrates proper system performance, comments on proposed pre-functional and functional tests, conducts and documents pre-functional inspection and functional tests and conducts training.

DE: Writes specifications including commissioning requirements, prepares all required drawings, answers RFIs, writes addendums to specifications, reviews submittals, performs construction observation, approves O&M manuals, assists in resolving problems and participates, as required, in training.

PM: Facilitates and supports the Cx process and gives final approval of the Cx work.

Mfr: The equipment manufacturers and vendors provide documentation to facilitate the commissioning work, perform contracted startup and participate in training.

7.3. Commissioning Process

7.3.1. Commissioning Scope Meeting

A commissioning scope meeting could be planned and could be conducted by the CA within 30 days of the beginning of construction. In attendance could be representatives of MC, CM, CA, PM, DE,

MC, EC and CC. At the meeting commissioning parties would be introduced, the commissioning process reviewed and management and reporting lines confirmed. The flow of documents and which submittal data would be required by the CA would be discussed. The Cx Plan would be reviewed, process questions addressed, lines of reporting and communications determined and the work products list discussed. Also discussed would be the general list of each party's responsibilities, who is responsible to develop the startup plan for each piece of equipment and/or system, and the proposed commissioning schedule. The outcome of the meeting is intended to be increased understanding by all parties of the commissioning process and their respective responsibilities. The meeting provides the CA additional information needed to finalize the Cx Plan, including the commissioning schedule.

7.3.2. Final Construction Phase Commissioning Plan

The Cx Plan for the Construction Phase would be finalized during the project construction after actual startup sequencing/phasing is understood.

7.3.3. Site Observation

The CA, DE and the Owner's PM could make periodic visits to the site to witness equipment and system installations.

7.3.4. Miscellaneous Meetings

The CA is planned to attend selected planning and jobsite meetings in order to remain informed on construction progress and to update parties involved in commissioning. The CM and PM would provide the CA with information regarding substitutions, RFIs, change orders and any DE supplemental instructions that may affect commissioning of equipment, systems or the commissioning schedule. The CA may review construction meeting minutes, change orders and/or DE supplemental instructions for the same purpose.

Later during construction, necessary meetings between various commissioning team parties would be scheduled by the CA through the CM as required.

7.3.5. Miscellaneous Management Protocols

Table 7-1. Miscellaneous Management Protocols

Changes in Specified Sequences of Operation	Protocol
For requests for information (RFI) or formal documentation requests:	The CA goes first through the CM.
For minor or verbal information and clarifications:	The CA goes direct to the informed party.
For notifying contractors of deficiencies:	The CA documents deficiencies through the CM, but may discuss deficiency issues with contractors prior to notifying the CM.
For scheduling functional tests or training:	The CA may provide input for and do some coordination of training and testing, but scheduling and content shall be coordinated by the CM.
For scheduling commissioning meetings:	The CA selects the date and schedules through the CM.
For making a request for changes to the scope of the contract documents:	The CA may recommend changes to the Owner's PM who shall authorize or reject them. The CA has no authority to issue change orders.
Changes in specified sequences of operation:	The CA may not make changes to the specified sequences without approval from the DE.
Subs disagreeing with comments or interpretations by the CA shall:	Try and resolve with the CA first, then work through the PM who will work with the CA directly or through the CM to resolve the situation

7.3.6. Progress Reporting and Logs

At the beginning of construction, the CM would provide the CA with monthly commissioning progress reports. These reports would summarize the commissioning activities of the prior periods. Thirty (30) days prior to startup of the first piece of major equipment or system, the frequency of the progress reports would be increased to twice per month until startup is completed. Thirty (30) days before

functional testing begins, weekly progress reports would be provided until functional testing and all non-conformance issues are resolved. The CM may increase the reporting frequency as needed. The CA can comment on the progress reports which may contain an update of the schedule with a list of requested schedule changes and new items added to the schedule, a list of new and outstanding deficiencies, a description of commissioning activities planned and results to date, commissioning documentation, etc. The CA would keep a log of all commissioning related issues that require current or future attention and the CA would track the status of documentation and testing for each piece of equipment and/or system. The "Issues Log" should be sent to the CM by the CA on an as needed basis.

The CA would regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling issues through memos, progress reports, etc.

7.3.7. Initial Submittals and Documentation

7.3.7.1. Standard Submittals

The design team would provide all Subs responsible for commissioned equipment with final commissioning documentation requirements for their respective equipment and/or systems through the CM. Drafts of the required documentation requirements would be provided within the specifications so that contractors understand and include their Cx scope at time of bidding. This equipment commissioning requirement typically includes pre-functional readiness forms, installation and startup procedures, O&M data, performance data and control drawings. The CA reviews and approves submissions relative to commissioning issues expressed in the contract documents.

7.3.7.2. Special Submittals, Notifications and Clarifications

The Subs, CM/PM or DE notify the CA of any new design intent or operating parameter changes, added control strategies and/or sequences of operation or other change order items that may affect commissioned systems. Thirty (30) days prior to performing owner-contracted tests, Subs provide the CA full details of the procedures. This should include final coordination between the MC, EC and CC trades.

The submittals to the CA do not constitute compliance of submittals for the O&M manuals. Documentation requirements for the O&M manuals are discussed further herein.

The CA may request additional design narrative from the DE and from the CC depending on how complete the documentation was which was provided with the bid documents. The CA may submit written RFIs to contractors through the CM or address them directly for clarification as needed.

7.3.8. Pre-Functional Checklists, Tests and Start-Up

Pre-functional checklists (PC) are important to ensure that the equipment and systems are installed, connected and operational and that the functional performance testing (FT) may proceed safely and without unnecessary delays. Each piece of equipment should receive pre-functional checkout by the Contractor prior to formal functional performance testing of equipment or systems. Pre-functional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g. controls in place, sensors calibrated, etc.). However, some pre-functional checklist items entail simple testing of the function of the component, a piece of equipment or system (e.g. checking rotation of motors, measuring voltage imbalance, etc.). The word pre-functional refers to before functional testing. Pre-functional checklists augment and are combined with the manufacturer's startup checklist.

The CM should obtain, review, approve or reject and forward to the CA startup plans from the Subs for all systems which are to be commissioned. These plans should include all pre-functional and functional tests and schedules for completing the same. This project requires that the pre-functional procedures and checklists be documented in writing by the installing contractor or technician. The CA should verify a specific percentage (as agreed upon with Owner) of the completed pre-functional checklists. In the event that deficiencies are found in the reported checklists the CM should direct the appropriate Subcontractor to re-conduct the pre-functional checkout and should re-submit the results.

7.3.8.1. Start-Up Plan

The CA should assist the commissioning team members responsible for startup in developing detailed startup plans for all equipment and/or systems.

The following procedures would be used for this project:

- Each subcontractor should adapt and enhance their representative pre-functional checklists (PC) and functional performance testing (FT) procedures.
- The CM should obtain startup plans, including final pre-functional and functional test plans from each subcontractor. The CM should review these and forward them with an accurate project schedule to the CA, Owner and DE.
- The CA should review startup plans relative to obtaining manufacturer installation, startup and checkout data, including actual field checkout sheets used by the field technicians.
- The DE and Owner should provide review comments to the CA who should then consolidate these with his review comments and distribute them back to the CM for the subs requirements as appropriate.

7.3.8.2. Execution of Checklists and Start-Up

Four weeks prior to startup, the Subs and vendors would schedule startup and initial checkout with the CM/PM and CA. The startup and initial checkout would be directed and executed by the Subs or vendors. The CA, Owner and CM, if necessary, should observe the procedures for select components or systems and a sampling strategy may be used at the CA's discretion.

To document the process of startup and checkout, the site technician performing the line item task should initial and date each procedure in the Startup Plan and should check off items on the pre-functional and manufacturer field checkout sheets as they are completed. Only individuals having direct knowledge of a line item being completed should check or initial the forms.

7.3.8.3. Deficiencies and Non-Performance

The Subs should clearly list all outstanding items of the initial startup and pre-functional procedures that were not completed successfully at the bottom of the procedures form or on an attached sheet. The procedures form and deficiencies should be provided to the CA and CM within two days of test completion. The CA should work with the Subs and Vendors to correct and retest deficiencies or uncompleted items involving the CM and others as necessary. The installing Subs or Vendors should correct all areas that are deficient or incomplete according to the checklists and tests.

7.3.8.4. Phased Commissioning

This project would require each Energy Conservation Measure to be independently commissioned. The schedule would dictate the sequence of the commissioning.

7.3.8.5. Controls Check-Out Plan

Within 60 days of the scheduled construction phase completion, the Controls Contractor (CC) should develop and submit a written step-by-step plan to the CA that describes the process they intend to follow in checking out the control system and the forms on which they would document the process.

All CA required controls pre-functional checklists, calibrations, startup and selected functional tests of the system should be completed and approved by the CA. The CC should execute the tests and trend logs specified and remain on site for assistance for mechanical system functional tests as specified.

7.3.9. Development of Functional Test and Verification Procedures

7.3.9.1. Overview

Functional testing is the dynamic testing of systems, rather than just components, under various levels of operation. The systems are run through all of the control system's sequences of operation and components are verified to be responding as the sequences specify. The CA develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is usually performed by the installing contractor or vendor.

7.3.9.2. Development of Tests

The specification would provide specific functional testing scope for each piece of commissioned equipment. A draft of the functional and pre-functional testing procedures and process would be found in the specifications.

Functional testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using the control systems trend log capabilities or by stand-alone data loggers.

7.3.10. Execution of Functional Testing Procedures

7.3.10.1. Overview and Process

The CA should approve the schedule for functional tests through the CM/PM and affected Subs. For any given system, prior to performing functional testing, the CA should wait until the pre-functional checklist has been submitted with the necessary signatures, confirming that the system is ready for functional testing. The CA should verify the functional testing of all equipment and systems according to the specifications and the Cx plan. The Subs should execute and document the tests. The control system should be commissioned before it is used to verify performance of other components or systems. Testing proceeds from components to subsystems to systems and finally to interlocks and connection between systems.

7.3.10.2. Deficiencies and Retesting

The CM should provide the CA with functional testing results for all systems. Corrections of minor deficiencies identified are made during the tests at the discretion of the CA. Deficiencies or non-conformance issues should be noted and reported to the CM. Subs should correct deficiencies and notify the CA of the corrections. The Subcontractor should schedule retesting through the CM. Decisions regarding deficiencies and corrections would be made by the CM and the Subs. For areas in dispute, final authority resides with

the Owner. The CA should recommend acceptance or rejection of each test to the CM. The CM should give final approval on each test.

7.3.10.3. Facility Staff Participation

The Owner's facilities operating and maintenance (O&M) staff are encouraged to attend and witness the testing process.

7.3.11. O&M Manuals and Warranties

7.3.11.1. Standard O&M Manuals

The CM should obtain written warranties from the equipment manufacturers and contractors, O&M manuals from subs and review O&M manuals, documentation and as-builts for systems that were commissioned to verify compliance with the specifications. The CA should recommend approval and acceptance of these sections of the O&M manuals to the CM. The CA should also review each equipment warranty.

7.3.11.2. Commissioning Record

The CA would compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed three ring binders and deliver to the CM and to be included with the O&M manuals. The format would be as follows:

- Commissioning plan
- Final commissioning report
- Issues log
- Pre-functional and functional test results

7.3.12. Training and Orientation of Owner Personnel

7.3.12.1. Overall Plan

After reviewing the specifications and after interviewing facility staff, if necessary, the Owner and CA would fill out a table listing all the equipment for which training would be provided.

7.3.12.2. Specific Training Agendas

For each piece if equipment or system for which training is provided, the CA and CM would agree on a training agenda and participants.

7.3.12.3. Training Record

The CM should video tape record the training and log all participants. Copies of the training material, video and attendee log should be provided to Owner.

7.3.13. Schedule

7.3.13.1. General Issues

The following sequential priorities would be followed:

- Equipment is not "temporarily" started until pre-functional checklist items and all manufacturer's pre-functional procedures are completed, safeties are in place and system/component operating integrity issues have been addressed.

- Functional testing is not begun until pre-functional, startup and controls are complete.
- The control system and equipment it controls are not functionally tested until all points have been calibrated and pre-functional testing is completed and trend logging completed and approved.

7.3.13.2. Project Schedule

Table 7-2. Project Schedule

Task/Activity	Estimated Start Date	Estimated End Date
Initial scoping meeting and final plan		
Submittals obtained and reviewed		
Begin construction site visits/inspections		
Pre-functional forms developed and distributed		
Startup and initial checkout plans		
Startup and initial checkout executed		
Functional performance tests		
O&M documentation review and verification		
Training and training verification		
Final commissioning report		

7.4. Commissioning Documents

Commissioning documents, including Pre-Functional and Functional Commissioning Check Sheets, for a number of the recommended Energy Conservation Measures will be provided in the future. This plan does not provide a detailed specification of required testing procedures. The detailed testing requirements and procedures will be included in the Project Specifications. Additional details regarding functional and pre-functional testing will be developed during construction when start-up sequencing is better understood.

8.0 Project Approach

The Construction Management Team is dedicated to safety (of employees, subcontractors and Client personnel, visitors and residents), budget, schedule and quality control. This team ensures that the project is implemented as engineered and designed to meet or exceed Client's expectations by focusing on the components of project management that determine the success of a project.

The purpose of the Project Approach is to provide an outline of the steps necessary to construct the project. High-level components of the Project Approach follow:

- Prior to the commencement of the Investment Grade Audit, a kick-off meeting is held to include the Project Development Lead; Audit Project Manager; Engineering and Design Lead; and Construction Project Manager. At this time, Client expectations and preliminary scope of work are clearly defined for the Audit and Construction Teams.

- Upon review of the audit plan and all team members are in concurrence with the scope and deliverables, a kick-off meeting with the Client's key personnel is arranged to review the approach to the audit, the Client expectations and the logistics of the audit.

- Following the completion of the Investment Grade Audit and the Client's acceptance of the subsequent proposal to construct the specific Energy Conservation Measures (ECMs), APS Energy Services' Construction Team begins the implementation of the Construction Project.

- At the completion of the Construction Project, the APS Energy Services Construction Project Manager documents acceptance and Final Completion of the project with the Client, outlines the warranty process and delivers all pertinent Operations & Maintenance Manuals.

8.1. Project Organizational Chart

- Senior Project Manager: Randy Drake
- Project Engineering Lead: Matt Baker
- Sub-Contractors and Suppliers Include: Advanced Controls Corp., Trane and Climate Conditioning Systems

8.2. Construction Safety & Health

Safety in the workplace is a core value of APS Energy Services and is of the highest priority in the performance of construction projects. In addition to APS Energy Services' Safety Manual, a copy of which will be provided to the Client, site specific safety plans will be required from each subcontractor that detail their job hazard analyses as they relate to their respective scope of work and location. Each of the major tasks will be identified and safe work practices will be documented. Periodic training of the subcontractor's personnel onsite will be conducted as required by the subcontractor's designated safety officer. The OSHA 29CFR1926 Construction Standards will be strictly enforced and followed by subcontractors. Applicable requirements of the Client's safety and security policy will be incorporated into the site specific safety plans and copies of these will be maintained in the project trailer or office. The APS Energy Services Construction Manager will house onsite all subcontractor Material Safety Data Sheets (MSDS) for any pre-approved chemicals or potentially hazardous materials which will be utilized in the performance of the work. All subcontractors will be required to incorporate a fire prevention and protection plan for their construction activities. Weekly safety meetings for all subcontractors will be conducted onsite and documented in the Daily Log. A first aid and blood-borne pathogen kit will be maintained in the job trailer or office for treating any minor cuts or abrasions. In addition to required Federal and State postings, emergency phone numbers and the address of the nearest hospital will be posted in the job site trailer or office.

8.3. Onsite Mobilization (job trailer(s), office, storage)

The job site trailer or Client office will contain the OSHA, EEO, Right-to-Work and other required Federal, State and Local posters/notices. The Project Organization Chart with phone numbers will be posted on the wall. A copy of the project scope of work, any plans and specifications will be maintained, as well as the submittal logs, MSDS, Site Specific Safety Plan, permits and licenses, Daily Log, RFI log, and Change Order Log. Any necessary personal protective equipment (PPE) will also be stored in the job site trailer or office for APS Energy Services personnel. The most current project schedule will also be posted on the wall. A phone/fax/printer/copier will be set up for project data communication. If necessary, temporary power and a phone/data line will be installed. Portable toilets/wash stations will be set up onsite where the approved site plan permits.

8.4. Project Documentation

A Project Documentation Library will be maintained onsite in the job trailer or designated Client office used as a base of operations for the APS Energy Services Construction Manager. Its purpose is to organize the project data into a manageable system for administering the construction operations. The library will contain copies of the Client contract; all APS Energy Services subcontracts; purchase orders; the Master Project Schedule; safety meeting reports; site specific safety plans; the Daily Project Log; incident reports; a copy of the APS Energy Services Safety Manual; weekly Client meeting minutes and action items; punch lists; signed substantial and final completion certificates; start-up reports; applicable testing and balancing reports; commissioning reports; operations and maintenance manuals; and any other pertinent project documentation. Other binders or manuals at the site may include: MSDS, RFI Log, Change Order Log, Submittal Log and Equipment Purchase Order Log.

8.5. Master Project Schedule

The Master Project Schedule (MPS) is developed during the course of the Investment Grade Audit utilizing Microsoft Project scheduling software. It is finalized after review and approval by the Client prior to execution of the construction contract, and contains all major milestone completion dates during the life of the project, with subset categories for the activities and tasks that make up each milestone. The APS Energy Services Construction Manager is the owner of the MPS; updating it as the work progresses. All subcontractors will have a copy of the MPS, providing the Construction Manager with any schedule change information that may be anticipated as it relates to their scope of work. Client facility utility shutdowns and interruptions will be clearly shown on the schedule and requested in advance so as not to create a greater inconvenience than necessary to accomplish the work. The MPS will be reviewed, and changes made, during the weekly progress meeting with the Client and all principle subcontractors.

APS Energy Services utilizes the Critical Path Method for construction scheduling by integrating realistic construction tasks developed from a proper work breakdown structure with the associated time-phased cost estimates and the personnel/material/ equipment resources needed to perform each task. By applying this method of construction scheduling, APS Energy Services is able to: manage the critical path to ensure the project is completed on time, identify potential impacts to the schedule in advance, manage equipment lead-times, procurement and deliveries, direct subcontractors more effectively and control the overall project cost and duration throughout all phases of implementation.

This approach to project scheduling allows APS Energy Services' Project Managers, subcontractors, design professionals, and the Client to utilize the project schedule as a communication tool by relating project activities with intervals, responsibilities, impacts, costs and overall execution versus contractual expectations and documenting such information. In addition, the project schedule serves as a method of demonstrating measured progress and milestones to the original baseline schedule.

To avoid potential problems with the project schedule, APS Energy Services utilizes the critical path identified in the project schedule to communicate responsible activities to subcontractors and/or vendors. By

communicating the project schedule, each party will know, in advance, their specific role in the project and the impact their role has on subsequent activities.

The project team will utilize the project construction schedule to identify potential schedule impacts early and regularly. When slippage is identified in the overall project schedule, APS Energy Services investigates where this slippage derived and works with all relevant parties' to implement solutions and bring the schedule back on track. If a contractor is at fault for such delay in the project, APS Energy Services will work with them to develop and institute a recovery plan at the contractor's expense.

8.6. Engineered Drawings and Specifications

Certain portions of the scope of work may require engineered drawings and specifications. The Project Engineering Lead or Sr. Project Manager, depending on the size and complexity of the project, will direct the specific third party engineering resources to provide any stamped drawings and/or specifications necessary to construct the project. The intent is to conduct 30%, 60% and 90% reviews of the design with the Client and the Engineering and Construction Teams. Some of these reviews may be accomplished during the Investment Grade Audit phase, depending on the scope of work and level of pre-design necessary. Once the drawings and specifications have been accepted by all parties, and approved by the Client, 100% Issue for Construction (IFC) sets are delivered to the Client, APS Energy Services' Construction Management Team, and appropriate subcontractors so that the specified work may commence.

8.7. Commissioning Plan

The purpose of the Commissioning Plan is to provide direction for the development of the specifications by the design engineer during the design phase. It also provides direction for the commissioning process during construction, particularly providing guidance for resolving problem issues and providing details that were not fully developed during design such as scheduling; participation of various parties of this particular project; actual lines of reporting and approvals; coordination; finalizing functional tests; etc. Commissioning is a systematic process of ensuring that all completed ECMs perform according to the design intent and Client's operational needs. Commissioning during construction of the project is intended to achieve the following specific objectives: 1) ensure that applicable equipment and systems are delivered as specified and installed properly, and receive adequate operational checkout by the installing contractors prior to being put into operation; 2) verify and document that equipment and systems are performing properly and fulfill the contract intent; 3) ensure that O&M Manuals and record documentation are complete; and 4) ensure that Client's operating personnel are adequately trained.

8.8. Quality Assurance and Quality Control (QA/QC)

In general, the purpose of QA/QC is to establish checks and balances to ensure the intended systems are designed with consideration of the Client's operational needs and maintenance requirements, and that the systems are constructed in a safe and efficient manner. The Commissioning Plan incorporates QA/QC as one of its functions of project oversight. The Construction and Engineering Teams work together to ensure that the subcontractors install new equipment and systems in accordance with the scope of work. They also ensure that the quality of engineering and construction operations is maintained through the life of the project.

8.9. Construction Permits and Inspections

The APS Energy Services Construction Manager will review local codes and ordinances to determine what portions of the work, if any, may require permits. This also includes any permits required by the Client's Facility Management. Typically, this requirement is investigated and confirmed during the Investment Grade Audit phase so that the longest lead times for procurement of permits can be factored into the MPS and not cause a potential delay to the project schedule for completion. Inspections will be scheduled with the appropriate Authority Having Jurisdiction (AHJ) for activities that may include pipe welds, pressure tests, electrical switchgear and component installations, concrete foundations and pads, structural steel erections, etc.

8.10. Pre-Construction Submittals

Submittals will be provided to the Client for every piece of new equipment to be installed as part of the construction project's scope of work. Once each submittal is reviewed and approved by the Client and the APS Energy Services Engineering Lead or Third Party Engineer, the subcontractor and/or equipment vendor will be notified that the subject equipment has been approved for procurement. A copy of the approved submittals will be kept by the APS Energy Services Construction Manager in the onsite trailer or office.

8.11. APS Energy Services' Direct Equipment Purchasing

In order to achieve the best possible pricing on major equipment, APS Energy Services may purchase direct from the manufacturer. Once selected by the APS Energy Services Sr. Project Manager and approved by the Client, the APS Energy Services Manager of Construction Services will approve all purchases of major equipment for the construction project. Equipment logs will be maintained to ensure that new purchases will be tracked for committed lead times to the project site by the manufacturer. As previously stated, submittals will be required for review and approval prior to release of the equipment from the vendor.

8.12. Project Cost Control and Payments

The APS Energy Services Construction Manager will closely monitor each subcontractor's daily installation efforts to ensure that the Client's scope of work is implemented without deviation. Where previously unforeseen circumstances prevent the scope from being installed as specified, or the Client elects to alter or add to the agreed scope of work, the APS Energy Services Construction Manager, Engineering Lead and the subcontractor's project manager will thoroughly investigate opportunities for value engineering in order to avoid or reduce additional costs to construct. As work progresses, the APS Energy Services Construction Manager will confirm that subcontractor's installed work is in accordance with the approved scope and/or changes. All submitted project subcontractor and vendor invoices will be reviewed and verified for accuracy by the Construction Manager, then subsequently approved for payment by the Sr. Project Manager. Progress payment invoices from subcontractors will include partial lien releases.

APS Energy Services focuses on forecasts to maintain control of project costs. This forecast begins with a budget derived from the contractual construction estimate. This budget is integrated with the construction schedule to apply time phasing for project costs and relevant work breakdown structures. During the construction phase, incurred costs are evaluated against the baseline budget, future commitments and measured progress to predict at-completion costs and allow the Project Manager to make effective decisions to mitigate any cost variances.

Using industry rate standards along with confirmation from local suppliers and subcontractors, APS Energy Services puts together a realistic project estimate covering all aspects of the construction process. The budget is subdivided into smaller categories, so that corrective action can be taken whenever budgeted and actual values differ. Corrective actions may be in the form of procedural changes such as value engineering or scope modifications.

8.13. APS Energy Services' Construction Management

APS Energy Services will staff the construction project with an adequate number of experienced employee and contract Construction Managers in relation to the size, logistics, subcontractor work shifts and complexity of the project. Overall onsite management authority for daily construction work will rest with the Lead Construction Manager. He will support and direct the other Construction Managers in the performance of their duties. Depending on the size of the project, the Lead Construction Manager may report to an onsite or offsite Project Manager, who in turn will report to a Sr. Project Manager. Ultimate responsibility for all APS Energy Services construction projects rests with the APS Energy Services Manager of Construction Services.

8.14. APS Energy Services' Subcontractor Supervision

APS Energy Services will maintain an onsite full-time Construction Manager(s) during the construction of the project. The Construction Manager(s) will be responsible for the supervision of our subcontractors and equipment vendors at all times that work is being performed on the Client's property, ensuring that they follow applicable safety guidelines, security access and escort requirements, and established working hours/shifts. Any and all project related communication from the subcontractors and vendors will come through the APS Energy Services Construction Manager. Additionally, the Construction Manager(s) will inspect the subcontractor's work for it's compliance with the approved specifications and scope, and that the construction schedule is maintained. All personnel visiting the construction site will be required to sign-in at the APS Energy Services jobsite trailer or office, before being allowed to enter the work areas.

8.15. Onsite Materials and Equipment Management

All materials and equipment shipped to the site will be inspected and the receipt of same acknowledged on the packing slips. In the case of APS Energy Services purchased equipment, the Construction Manager will perform this function; the specific subcontractor purchased equipment will be inspected by both the subcontractor and the APS Energy Services Construction Manager. If damage is identified, it will be photo-documented, with details entered into the Daily Log. The APS Energy Services or subcontractor's project manager will be notified and a return equipment or material authorization will be secured. The equipment or materials will be returned promptly if they require replacement. Repairs to the materials or equipment by factory-authorized technicians will be made if their assurance of remediation is deemed acceptable and approved by the Client. Copies of the shipping receipts will be kept in the Project Documentation Library at the jobsite. All of the APS Energy Services and subcontractor purchased materials and equipment will be stored in secured areas on or offsite until ready for installation.

8.16. Changes in Scope and Client Approvals

The construction project will be built in accordance with the approved scope of work, including any drawings and specifications. When changes are desired by the Client, the request to change the scope will be documented in an RFI (request for information) letter from the Client's Representative to the APS Energy Services Construction Manager, in order to clarify the exact scope desired for the requested change. In the case of an RFI from a subcontractor, the same RFI format will also be used, and sent to the APS Energy Services Construction Manager, with a copy to the APS Energy Services Project Manager. The RFI may include a request for proposal for a change in scope, material, equipment, method, or schedule. The APS Energy Services Project Manager will obtain clarification from the Lead Engineer and/or Client's Representative, and then issues an RFI response to the subcontractor. An RFI log will be maintained at the site trailer or office, with a copy held at the APS Energy Services Project Manager's office. The APS Energy Services Lead Engineer will be notified of the changes so that changes to the record documents can be kept current. The APS Energy Services Project Manager is responsible for directing any changes in scope.

8.17. Substantial Completion and Punch List

Substantial Completion is the stage in the progress of the work when the work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Client can occupy or utilize the work for its intended purpose. It is also the date of commencement of applicable warranties required by the Contract Documents. As they approach Substantial Completion, each subcontractor will create a punch list for their scope of work. This will be accomplished through an inspection of the installed work, conducted by the APS Energy Services Construction Manager, the Client's Representative, and the subcontractor's project manager. The punch lists from each subcontractor will be incorporated into the APS Energy Services Substantial Completion Certificate to the Client, in addition to any other outstanding items that the Client's Representative may have documented. The APS Energy Services Construction Manager and the Client's Representative will then execute the Certificate of Substantial Completion.

8.18. Client's Key Personnel Training

Trained and informed staff and operation and maintenance personnel can make a difference between energy performance contracting projects that exceed savings targets and those that require continuous program resolution and extra staff. To ensure the performance contracting process is successful, Client facilities staff and the Project Team will work together as partners with the common objective of protecting the performance contract investment while optimizing savings. To this end, training will play a critical role in arming the individual facility operations staff with an understanding of every aspect of the program.

Client training will be performed by the major equipment vendor representatives and the direct digital controls subcontractor(s) for the installed systems. Training will be scheduled in advance and confirmed with the Client's designated personnel. All training sessions will be documented with a sign-in sheet that clearly shows those in attendance, the date and time of the training, the training provider and the specific training curriculum covered. Depending on the complexity of the system and/or the practice of the specific trainer, demonstrated practical operation of the system and a knowledge check may be required of Client's designated personnel in order to verify a working understanding of the installed system and information covered.

8.19. Operations and Maintenance Manuals

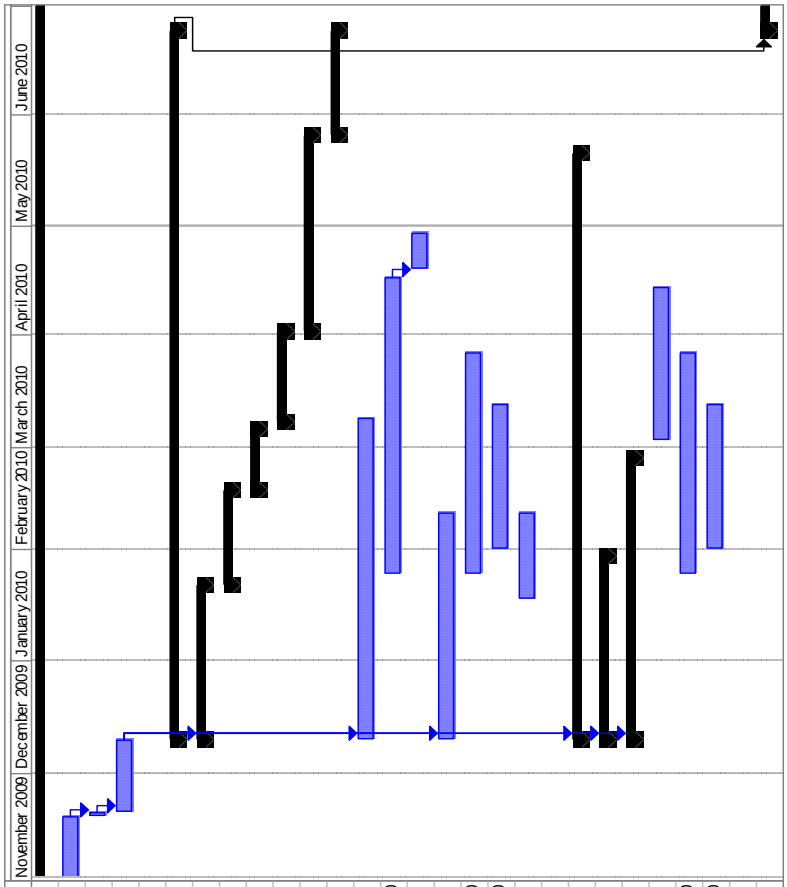
As equipment is received at the site, the respective operations and maintenance manuals will be inserted into the Client's Project O&M Manual Binder(s). Any equipment with moving parts will have a manual. The direct digital controls submittal including point's lists, control component details and the sequences of operation will be included. As-built drawings for installed systems will also be provided for mechanical, electrical and plumbing improvements. The O&M manuals and as-builts will be delivered to the Client prior to the execution of the Certificate of Final Completion.

8.20. Equipment Warranties

Manufacturer's warranties for new equipment and systems installed as part of the construction project will be provided to the Client either as part of the O&M Manuals, or separately in the form of a new equipment list showing the start and expiration dates of the applicable warranties.

8.21. Final Completion and Project Close Out

Once all documented punch list items have been accomplished following Substantial Completion, and O&M Manuals, as-builts and equipment warranty information has been delivered to the Client, the Certificate of Final Completion will be executed by the APS Energy Services Construction and Project Managers, and the Client's Representatives. This officially closes the construction project. Demobilization of the APS Energy Services trailer or site office may have already begun as appropriate, or will begin at this time. All Client access keys and cards will be returned to and signed for as received by the Client.

9.0 Schedule

ID	Task Name	Duration	Start	Finish
1	**Town of Oro Valley ARRA**	**216 days**	**Mon 11/2/09**	**Mon 8/30/10**
2	100% Board Presentation	13 days	Mon 11/2/09	Wed 11/18/09
3	Board Approval	1 day	Thu 11/19/09	Thu 11/19/09
4	Final Contract	14 days	Fri 11/20/09	Wed 12/9/09
5				
6	**Lighting**	**140 days**	**Thu 12/10/09**	**Wed 6/23/10**
7	**Administration Building (334)**	**31 days**	**Thu 12/10/09**	**Thu 1/21/10**
11	**Courts (90)**	**18 days**	**Fri 1/22/10**	**Tue 2/16/10**
15	**Water Building (83)**	**13 days**	**Wed 2/17/10**	**Fri 3/5/10**
19	**Community Development (189)**	**19 days**	**Mon 3/8/10**	**Thu 4/1/10**
23	**Library (955)**	**38 days**	**Fri 4/2/10**	**Tue 5/25/10**
27	**Police Station La Canada (322)**	**21 days**	**Wed 5/26/10**	**Wed 6/23/10**
31	HVAC Upgrades	63 days	Thu 12/10/09	Mon 3/8/10
32	DDC Upgrades	60 days	Mon 1/25/10	Fri 4/16/10
33	Ceiling Fans	8 days	Mon 4/19/10	Wed 4/28/10
34	Solar Water Heating	45 days	Thu 12/10/09	Wed 2/10/10
35	Water Conservation	45 days	Mon 1/25/10	Fri 3/26/10
36	Data Energy Management	30 days	Mon 2/1/10	Fri 3/12/10
37	Premium Efficiency Motors	18 days	Mon 1/18/10	Wed 2/10/10
38				
39	**Lighting**	**116 days**	**Thu 12/10/09**	**Thu 5/20/10**
73	**Water Modifications**	**37 days**	**Thu 12/10/09**	**Fri 1/29/10**
77	**JDK Park Pool**	**56 days**	**Thu 12/10/09**	**Thu 2/25/10**
80	DDC Upgrades	30 days	Wed 3/3/10	Tue 4/13/10
81	Water Conservation	45 days	Mon 1/25/10	Fri 3/26/10
82	Data Energy Management	30 days	Mon 2/1/10	Fri 3/12/10
83				
84	**Close Out**	**48 days**	**Thu 6/24/10**	**Mon 8/30/10**