

# CITY OF DOVER, NH



YEAR 1

## SECOND QUARTERLY SAVINGS REPORT

(February 1, 2012 – April 30, 2012)

June 2012



# CITY OF DOVER, NH

## PERFORMANCE CONTRACT

Year 1

### 2<sup>nd</sup> Quarterly M&V Report

Performance Period Dates Covered: February 1, 2012 to April 30, 2012

Reported Savings: Current Fiscal Year (2012) through April 2012

Contract #: 9236-0143

Contract Year #: 1

Annual Guaranteed Energy Savings: \$271,943

Annual O&M Savings: \$13,680

Annual Capital Cost Avoidance: \$33,840

Annual Guarantee: \$319,463

Contract Term: 10-Years

Term Guaranteed Savings: \$3,623,746

Utility Cost Avoidance Escalation Rate: 3.0%

Operations & Maintenance (O&M) Cost Avoidance Escalation Rate: 4.0%

Guarantee Start Date: 11/1/2011

Guarantee End Date: 10/31/2021



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## EXECUTIVE SUMMARY

### Cost Avoidance Summary

The City of Dover, NH and Johnson Controls, Inc. entered into a performance contract in September in 2009. The purpose of this contract is to lessen the energy and energy related costs realized by the City of Dover moving forward. The guaranteed savings portion of the contract (ten years) started on November 1 of 2011 and will end on October 31, 2021.

The original annual savings guarantee of \$304,510 includes \$256,990 in energy cost avoidance, \$13,680 in operations and maintenance (O&M) cost avoidance, and a future capital cost avoidance of \$33,840. This initial savings guarantee was increased from the original amount to \$319,463 due to Change Order (CO) # 9236-0142-CO2 which comprised of a lighting retrofit project at the McConnell Center. The annual guaranteed energy savings amount escalates by 3% and the O&M savings escalates by 4% each year to compensate for inflation. Total term benefits are \$3,623,746.

The following table summarizes the annual guaranteed savings year after year:

City of Dover Annual Guaranteed Cost Savings				
Guarantee Period	Energy Cost Avoidance	O&M Cost Avoidance	Future Capital Cost Avoidance	Total Annual Cost Avoidance
Year 1	\$271,943	\$13,680	\$33,840	\$319,463
Year 2	\$280,169	\$14,227	\$33,840	\$328,236
Year 3	\$288,644	\$14,796	\$33,840	\$337,280
Year 4	\$297,375	\$15,388	\$33,840	\$346,603
Year 5	\$306,371	\$16,004	\$33,840	\$356,214
Year 6	\$315,638	\$16,644	\$33,840	\$366,122
Year 7	\$325,186	\$17,310	\$33,840	\$376,336
Year 8	\$335,023	\$18,002	\$33,840	\$386,865
Year 9	\$345,157	\$18,722	\$33,840	\$397,719
Year 10	\$355,598	\$19,471	\$33,840	\$408,909
<b>Total</b>	<b>\$3,121,103</b>	<b>\$164,244</b>	<b>\$338,400</b>	<b>\$3,623,746</b>

This report is designed to provide another tracking point for the City of Dover in understanding the energy savings of this project. The following report details the status of this project, including guaranteed and verified savings for all Facility Improvement Measures (FIMs) involved.

This report has been created to coincide with the City of Dover's fiscal year (FY) which runs from July through the end of June. Savings in this report are tracked on a fiscal year basis but guaranteed over the course of the performance period year (November – October). Therefore, performance period guaranteed savings coinciding with the reported fiscal year savings will be tracked in Appendix B.

## EXECUTIVE SUMMARY

### Monthly Comparison

Savings are provided on a monthly basis for Dover FY 2012 to date in the table below. The guaranteed savings per Facility Improvement Measure (FIM) represents the amount per FIM that adds up to the total overall annual guarantee. FIM savings are not guaranteed individually; the savings guarantee reflects the whole project. Therefore deficiencies from one FIM can be overcome by another FIM to result in overall project savings.

City of Dover, NH														
FIM #	FIM Description	Fiscal Year 2012 to Date										Total FY to Date Savings	Total YTD Contract Savings	Annual Guarantee
		JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR			
1	Lighting - Fixture Retrofit	\$1,979	\$1,979	\$1,916	\$1,979	\$1,850	\$1,807	\$1,774	\$1,672	\$1,905	\$1,898	\$18,760	\$10,906	\$22,402
	Lighting - Fixture Retrofit (McConnell Ctr)	(1) \$891	(1) \$891	(1) \$862	(1) \$891	(1) \$821	(1) \$795	(1) \$779	(1) \$735	(1) \$846	(1) \$847	\$8,357	\$4,823	\$10,685
2	Lighting - Fixture Control	\$528	\$528	\$511	\$528	\$511	\$528	\$528	\$494	\$528	\$511	\$5,200	\$3,103	\$5,978
	Lighting – Fixture Control (McConnell Ctr)	\$362	\$362	\$351	\$362	\$351	\$362	\$362	\$339	\$362	\$351	\$3,567	\$2,128	\$4,268
3	Building Envelope - Weatherization	\$1,332	\$1,332	\$1,289	\$1,332	\$1,398	\$1,985	\$2,157	\$1,952	\$1,526	\$1,223	\$15,525	\$10,241	\$14,461
4.1	EMS - Building Controls	\$736	\$736	\$712	\$736	\$762	\$1,217	\$1,354	\$1,215	\$853	\$624	\$8,945	\$6,026	\$8,398
4.2	EMS - Building Controls / Optimal Start	\$177	\$177	\$171	\$177	\$186	\$297	\$331	\$297	\$208	\$152	\$2,173	\$1,471	\$2,023
4.3	AHU Upgrade - VFD on Fan	\$0	\$624	\$604	\$624	\$550	\$640	\$663	\$612	\$591	\$543	\$5,452	\$3,599	\$6,615
4.4	Pool Dehumidification - EMS & VFD's	\$981	\$981	\$949	\$981	\$949	\$981	\$981	\$918	\$981	\$949	\$9,651	\$5,759	\$11,203
4.5	Repair Snow Melt Sensor	\$0	\$0	\$0	\$0	\$268	\$554	\$554	\$518	\$554	\$0	\$2,448	\$2,448	\$2,357
6	Water Conservation	\$1,237	\$1,237	\$1,197	\$1,237	\$1,198	\$1,238	\$1,238	\$1,158	\$1,238	\$1,198	\$12,172	\$7,266	\$14,123
9	Vending Machine Controllers	\$82	\$82	\$80	\$82	\$80	\$82	\$82	\$77	\$82	\$80	\$809	\$483	\$936
10	Pool Covers	\$1,158	\$1,158	\$1,120	\$1,158	\$1,120	\$1,158	\$1,158	\$1,083	\$1,158	\$1,120	\$11,391	\$6,797	\$13,223
11	Ice Arena Upgrades	\$17,586	\$14,032	\$17,477	\$10,669	\$4,987	\$5,200	\$4,326	\$3,301	\$5,543	\$5,863	\$88,983	\$29,220	\$95,015
12	Power Factor Correction	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$7,188
13	Energy Efficient Transformers	\$1,357	\$1,357	\$1,313	\$1,357	\$1,313	\$1,357	\$1,357	\$1,270	\$1,357	\$1,313	\$13,353	\$7,968	\$15,430
	Energy Efficient Transformers (Ice Arena)	\$0	\$259	\$250	\$259	\$233	\$240	\$240	\$226	\$240	\$233	\$2,179	\$1,411	\$2,955
14	Aeration Blower Upgrade	\$0	\$944	\$2,833	\$2,927	\$2,833	\$2,927	\$2,927	\$2,738	\$2,820	\$2,511	\$23,461	\$16,757	\$33,432
15	Boiler Replacement	\$0	\$0	\$91	\$189	\$130	\$207	\$230	\$207	\$145	\$53	\$1,251	\$971	\$1,251
<b>ENERGY COST SAVINGS</b>		<b>\$28,406</b>	<b>\$26,680</b>	<b>\$31,726</b>	<b>\$25,488</b>	<b>\$19,540</b>	<b>\$21,577</b>	<b>\$21,041</b>	<b>\$18,812</b>	<b>\$20,938</b>	<b>\$19,469</b>	<b>\$233,676</b>	<b>\$121,376</b>	<b>\$271,943</b>
O&M Cost Avoidance		\$0	\$0	\$0	\$0	\$1,121	\$1,159	\$1,159	\$1,084	\$1,159	\$1,121	\$6,803	\$6,803	\$13,680
Future Capital Cost Avoidance		\$0	\$0	\$0	\$0	\$2,774	\$2,866	\$2,866	\$2,681	\$2,866	\$2,774	\$16,828	\$16,828	\$33,840
<b>TOTAL COST SAVINGS</b>		<b>\$28,406</b>	<b>\$26,680</b>	<b>\$31,726</b>	<b>\$25,488</b>	<b>\$23,435</b>	<b>\$25,602</b>	<b>\$25,066</b>	<b>\$22,577</b>	<b>\$24,962</b>	<b>\$23,364</b>	<b>\$257,307</b>	<b>\$145,007</b>	<b>\$319,463</b>

<sup>(1)</sup> Total \$ Savings have been adjusted from previous reports due to fixture count difference

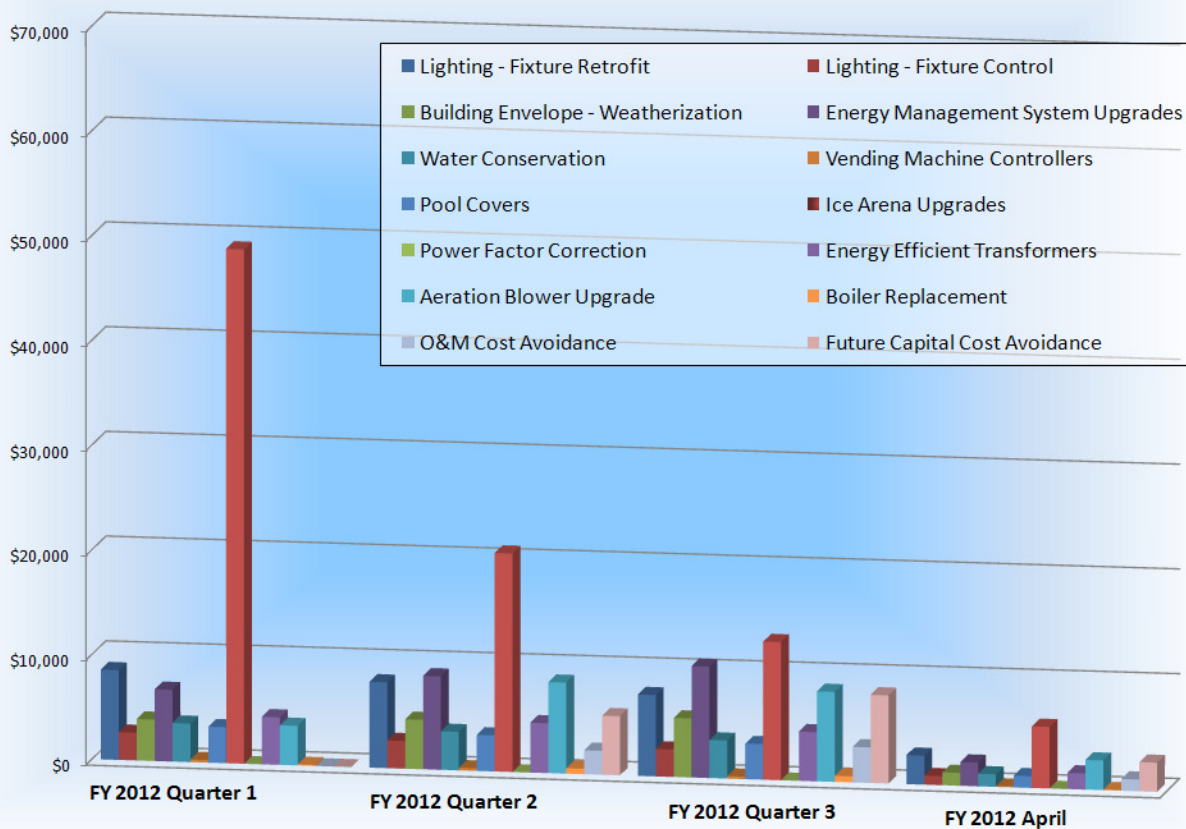
The thicker line separating October & November denotes the change from construction period to the performance period where savings are guaranteed. To date, the total FY savings are \$257,307 with \$145,007 savings in November through April. Savings occurring between July and October are included in FY savings but are not counted towards the annual savings guarantee.

## EXECUTIVE SUMMARY

### Total Fiscal Year to Date Savings

Savings realized by the project during FY2012 through the first three quarters & April totals 683,525 kWh & 1,638 kW (\$83,704), 11,348 MMBTU's (\$147,054) and 987 kGals of water/ sewer savings (\$10,898). Operation and maintenance (O&M) savings and capital cost avoidance stipulated in the performance contract through April 2012 totals \$23,630. FIM 11 Icemax costs are \$7,980. Therefore, the total fiscal YTD savings are broken down by FIM below and amount to \$257,307.

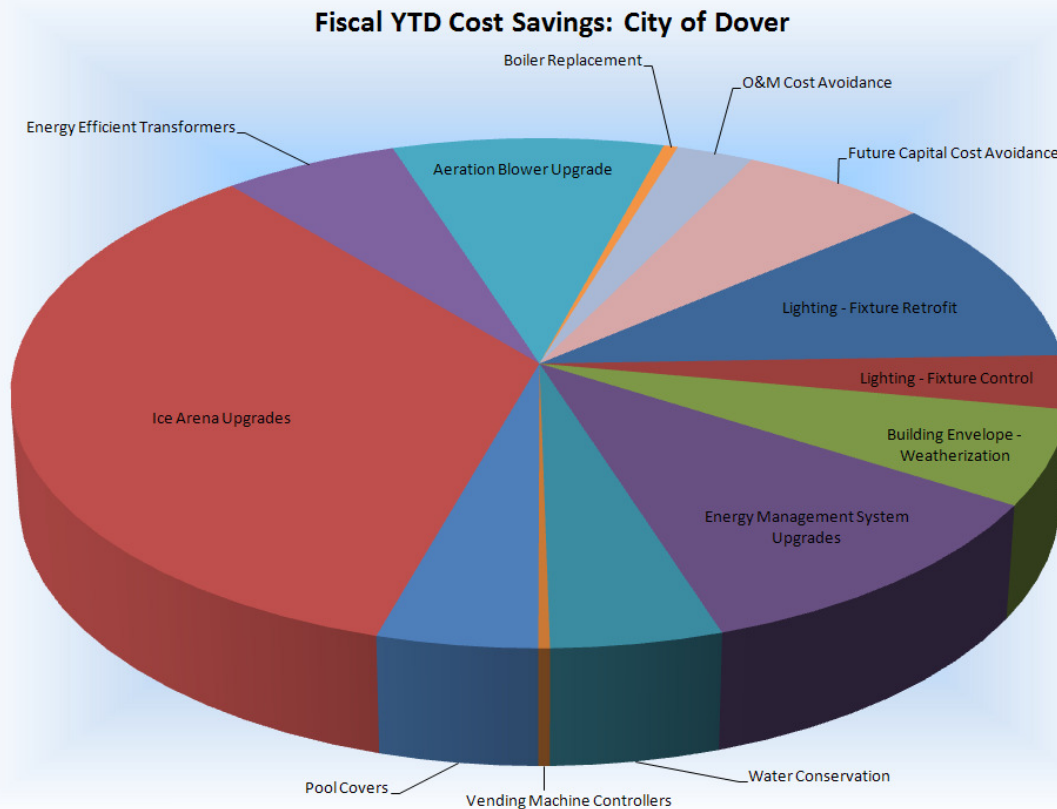
**Fiscal Year to Date Cost Savings: City of Dover**



Thermal Savings consist of savings from Natural Gas (therms), Oil (gallons), and Propane (gallons). In order to provide a basis for comparison, these have all been reported in MMBtu. Conversion factors used in assembling this report are listed below:

- Natural Gas: 1 therm = 0.1 MMBtu
- Oil: 1 gallon = 0.139 MMBtu
- Propane: 1 gallon = 0.0916 MMBtu

## EXECUTIVE SUMMARY



**City of Dover, NH Fiscal Year 2012 to Date Savings**

FIM #	FIM Description	Electricity Savings			Thermal Savings		Water Savings		Total FYTD \$ Savings
		kW	kWh	\$	MMBtu	\$	kgal	\$	
1	Lighting - Fixture Retrofit	1,188	213,569	\$30,363	(243)	(\$3,246)	0	\$0	\$27,117
2	Lighting - Fixture Control	259	75,653	\$8,766	0	\$0	0	\$0	\$8,766
3	Bldg. Envelope - Weatherization	0	3,621	\$389	1,084	\$15,136	0	\$0	\$15,525
4	EMS -Upgrades	0	106,698	\$12,249	1,153	\$16,420	0	\$0	\$28,669
6	Water Conservation	0	0	\$0	137	\$1,867	933	\$10,305	\$12,172
9	Vending Machine Controllers	0	7,040	\$809	0	\$0	0	\$0	\$809
10	Pool Cover	0	38,987	\$4,074	468	\$6,724	54	\$593	\$11,391
11	Ice Arena - Upgrades	(574)	(76,953)	(\$11,940)	8,661	\$108,903	0	\$0	<sup>(2)</sup> \$88,983
12	Power Factor Correction	0	0	\$0	0	\$0	0	\$0	\$0
13	Energy Efficient Transformers	260	123,935	\$15,532	0	\$0	0	\$0	\$15,532
14	Aeration Blower Upgrade	505	190,976	\$23,461	0	\$0	0	\$0	\$23,461
15	Boiler Replacement	0	0	\$0	88	\$1,251	0	\$0	\$1,251
<b>Energy Totals</b>		<b>1,638</b>	<b>683,525</b>	<b>\$83,704</b>	<b>11,348</b>	<b>\$147,054</b>	<b>987</b>	<b>\$10,898</b>	<b>\$233,676</b>
O&M Cost Avoidance		-	-	-	-	-	-	-	\$6,803
Future Capital Cost Avoidance		-	-	-	-	-	-	-	\$16,828
<b>Totals</b>		<b>1,638</b>	<b>683,525</b>	<b>\$83,704</b>	<b>11,348</b>	<b>\$147,054</b>	<b>987</b>	<b>\$10,898</b>	<b>\$257,307</b>

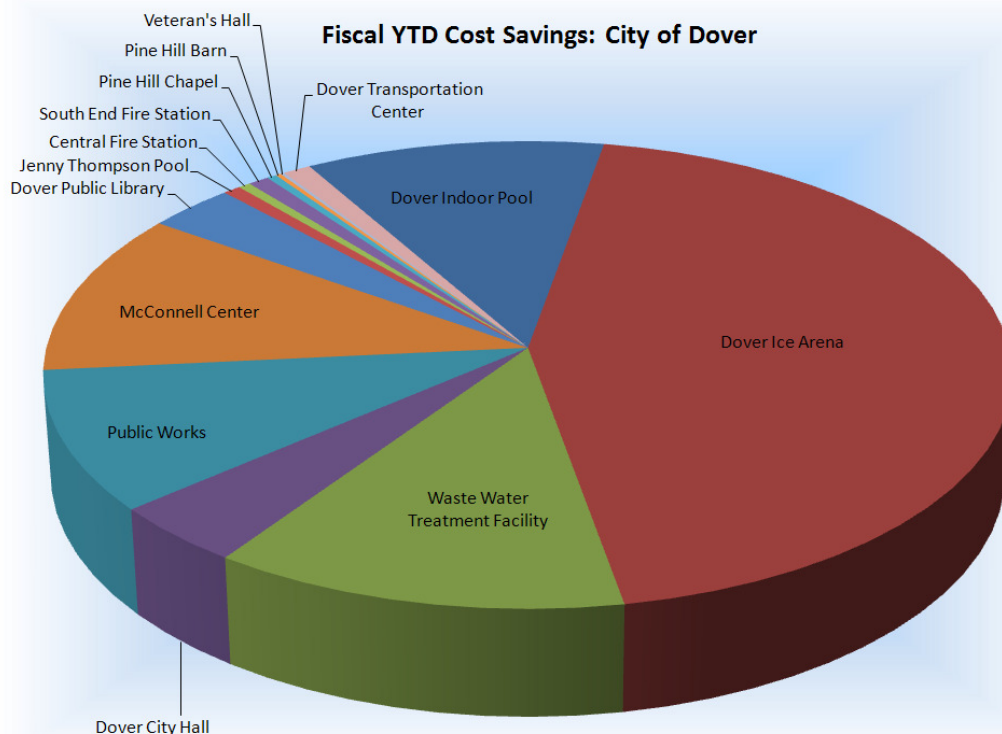
<sup>(2)</sup> Total \$ Savings contains \$7,980 cost of Icemax for FIM 11- Ice Arena Upgrades

## EXECUTIVE SUMMARY

### Energy Savings per Facility

City of Dover, NH Fiscal Year 2012 to Date Savings								
Facility Location	Electricity Savings			Thermal Savings		Water Savings		Total \$ Savings
	kW	kWh	\$	MMBtu	\$	kgal	\$	
Central Fire Station	0	56	\$7	57	\$868	17	\$191	\$1,066
Dover City Hall	125	29,572	\$3,683	196	\$3,265	253	\$2,788	\$9,736
Dover Ice Arena	(363)	(1,933)	(\$2,779)	8,940	\$112,409	199	\$2,202	<sup>(3)</sup> \$103,853
Dover Public Library	85	28,317	\$3,809	186	\$2,631	106	\$1,174	\$7,615
Dover Transportation Ctr.	0	20,051	\$2,448	0	\$0	0	\$0	\$2,448
Indoor Pool	31	103,299	\$11,062	869	\$12,488	234	\$2,581	\$26,132
Jenny Thompson Pool	0	0	\$0	21	\$267	118	\$1,299	\$1,565
McConnell Center	685	135,264	\$19,384	487	\$6,878	0	\$0	\$26,262
Pine Hill Barn	0	0	\$0	27	\$450	0	\$0	\$450
Pine Hill Chapel	0	7	\$1	47	\$790	5	\$60	\$851
Public Works	476	145,019	\$18,554	324	\$3,664	47	\$520	\$22,737
South End Fire Station	0	27	\$4	99	\$1,755	7	\$82	\$1,841
Veterans Hall	0	0	\$0	19	\$344	0	\$0	\$344
Waste Water Treatment Facility	600	223,845	\$27,532	75	\$1,245	0	\$0	\$28,777
<b>Totals</b>	<b>1,638</b>	<b>683,525</b>	<b>\$83,704</b>	<b>11,348</b>	<b>\$147,054</b>	<b>987</b>	<b>\$10,898</b>	<b>\$233,676</b>

<sup>(3)</sup> Total \$ Savings contains \$7,980 cost of Icemax for FIM 11- Ice Arena Upgrades





## EXECUTIVE SUMMARY

Total energy cost savings for the fiscal year to date are broken down by building and by FIM in the table below.

City of Dover, NH Building Location	FIM 1	FIM 2	FIM 3	FIM 4	FIM 6	FIM 9	FIM 10	FIM 11	FIM 12	FIM 13	FIM 14	FIM 15	Totals / Building
	Lighting Fixtures	Lighting Controls	Building Envelope (Weatherization)	Energy Management System - Upgrades	Water Conservation	Vending Machine Controllers	Pool Cover	Ice Arena Upgrades	Power Factor Correction	Energy Efficient Transformers	Aeration Blower Upgrade	Boiler Replacement	
Central Fire Station			\$832		\$234								\$1,066
Dover City Hall	\$2,317	\$804	\$1,094	\$2,173	\$3,076	\$273							\$9,736
Dover Ice Arena	\$4,235	\$1,152	\$4,283		\$2,755	\$265		<sup>(4)</sup> \$88,983	\$0	\$2,179			\$103,853
Dover Public Library	\$2,771	\$796	\$415	\$1,083	\$1,298							\$1,251	\$7,615
Dover Transportation Ctr.				\$2,448									\$2,448
Indoor Pool	\$956	\$23	\$1,332	\$9,870	\$2,429	\$131	\$11,391						\$26,132
Jenny Thompson Pool					\$1,565								\$1,565
McConnell Center	\$8,357	\$3,567	\$1,193	\$6,823						\$6,323			\$26,262
Pine Hill Barn				\$450									\$450
Pine Hill Chapel			\$548	\$238	\$66								\$851
Public Works	\$8,480	\$2,425	\$2,504	\$5,584	\$637	\$140				\$2,967			\$22,737
South End Fire Station			\$1,729		\$112								\$1,841
Veterans Hall			\$344										\$344
Waste Water Treatment Facility			\$1,252							\$4,064	\$23,461		\$28,777
<b>Totals / FIM</b>	<b>\$27,117</b>	<b>\$8,766</b>	<b>\$15,525</b>	<b>\$28,669</b>	<b>\$12,172</b>	<b>\$809</b>	<b>\$11,391</b>	<b><sup>(4)</sup>\$88,983</b>	<b>\$0</b>	<b>\$15,532</b>	<b>\$23,461</b>	<b>\$1,251</b>	<b>\$233,676</b>

<sup>(4)</sup> Ice Arena & FIM 11 Savings contains \$7,980 cost of Icemax

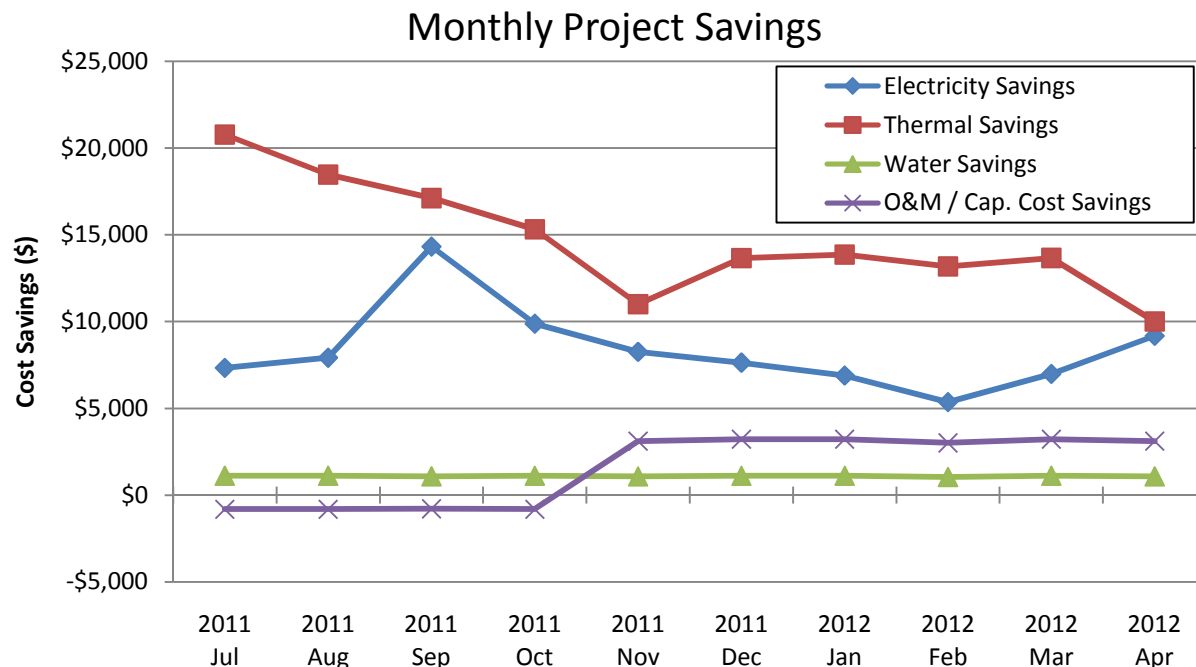
## EXECUTIVE SUMMARY

### Aggregate Monthly FIM Savings

Included below are the total monthly energy unit savings and associated dollar cost savings for all FIMs. The solid line separating October & November denotes the change from construction period to the performance (contract) period where savings are guaranteed. A total contract savings to date row has been added to provide basis for the guaranteed savings tracker which is included in Appendix B.

City of Dover- Performance Contract Savings										
Fiscal Year 2012 to Date Energy Cost Avoidance										
Month	Year	Electric Savings			Thermal Savings		Water Savings		O&M / Cap. Cost Savings <sup>(5)</sup>	Total Cost \$ Savings
		kW	kWh	Cost \$	MMBtu	Cost \$	kGal	Cost \$		
July	2011	147	59,680	\$7,328	1,639	\$20,781	100	\$1,108	(\$811)	\$28,423
August	2011	167	61,642	\$7,912	1,454	\$18,471	100	\$1,108	(\$811)	\$26,697
September	2011	232	120,359	\$14,320	1,334	\$17,119	97	\$1,072	(\$785)	\$31,743
October	2011	187	81,311	\$9,877	1,180	\$15,314	100	\$1,108	(\$811)	\$25,505
November	2011	158	68,367	\$8,250	838	\$11,003	97	\$1,072	\$3,110	\$23,451
December	2011	164	61,242	\$7,627	1,036	\$13,654	100	\$1,108	\$3,214	\$25,619
January	2012	118	57,358	\$6,883	1,049	\$13,861	100	\$1,108	\$3,214	\$25,083
February	2012	128	42,865	\$5,355	1,002	\$13,180	94	\$1,036	\$3,007	\$22,600
March	2012	159	54,990	\$6,975	1,049	\$13,665	100	\$1,108	\$3,214	\$25,098
April	2012	180	75,711	\$9,177	766	\$10,005	97	\$1,072	\$3,110	\$23,719
<b>Total Contract TD</b>		<b>905</b>	<b>360,533</b>	<b>\$44,267</b>	<b>5,740</b>	<b>\$75,368</b>	<b>589</b>	<b>\$6,503</b>	<b>\$18,868</b>	<b>\$145,007</b>
<b>Total Fiscal YTD</b>		<b>1,638</b>	<b>683,525</b>	<b>\$83,704</b>	<b>11,348</b>	<b>\$147,054</b>	<b>987</b>	<b>\$10,898</b>	<b>\$15,650</b>	<b>\$257,307</b>

<sup>(5)</sup> Icemax Cost from FIM 11 included in O&M column in this chart



## FIM DESCRIPTION

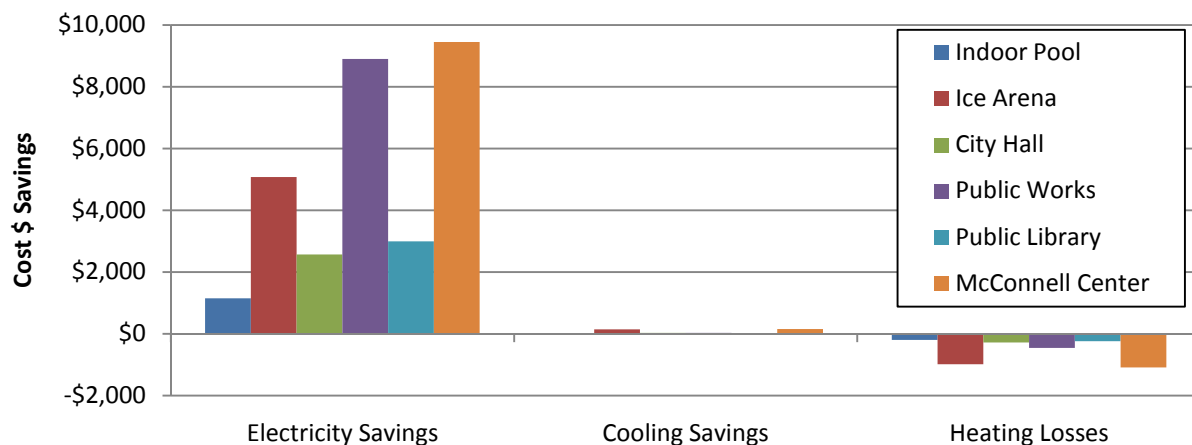
### FIM 1: Lighting – Fixture Retrofit

Lighting can be broken down into three savings parts: Electricity Savings from the replacement of higher power fixtures with more efficient ones, Cooling Savings from less fixture heat being introduced into a cooled space, & Heating Losses from less fixture heat being introduced in a heated space. Annual guaranteed electric savings associated with FIM 1 are 262,508 kWh with a monthly reduction in demand of 118.8 kW. Annual guaranteed heating losses are calculated to be 233 MMBtu resulting in a total guaranteed energy cost savings for FIM 1 of \$33,086.

FIM 1: Lighting – Fixture Retrofit								
FY2012 to Date Energy Cost Savings								
Building	Electricity Savings			Cooling Savings		Heating Losses		Total Cost \$ Savings
	kW	kWh	Cost \$	kWh	Cost \$	MMBtu	Cost \$	
Indoor Pool	30	8,426	\$1,148	24	\$3	(14)	(\$195)	\$956
Ice Arena	118	39,948	\$5,075	1,359	\$144	(78)	(\$983)	\$4,235
City Hall	74	20,654	\$2,572	234	\$29	(17)	(\$285)	\$2,317
Public Works	318	69,611	\$8,906	234	\$30	(40)	(\$456)	\$8,480
Public Library	85	22,234	\$2,991	153	\$21	(17)	(\$240)	\$2,771
McConnell Center <sup>(6)</sup>	563	49,248	\$9,289	1,444	\$155	(77)	(\$1,087)	\$8,357
<b>Totals</b>	<b>1,188</b>	<b>210,120</b>	<b>\$29,982</b>	<b>3,449</b>	<b>\$381</b>	<b>(243)</b>	<b>(\$3,246)</b>	<b>\$27,117</b>

<sup>(6)</sup> McConnell Center included into scope with FIM 1 due to CO # 9236-0142-CO2

FIM 1: FY 2012 to Date Savings



Figures have been adjusted slightly from previous reports to account for fixtures at the McConnell Center which were not originally replaced.

Verified savings are obtained from calculations and verified by measurements of circuit kW on a sample of lighting circuits before and after the retrofit was implemented. Calculation equations have been provided in Appendix C for reference. Hours of operation are stipulated for the contract term as per the contract.

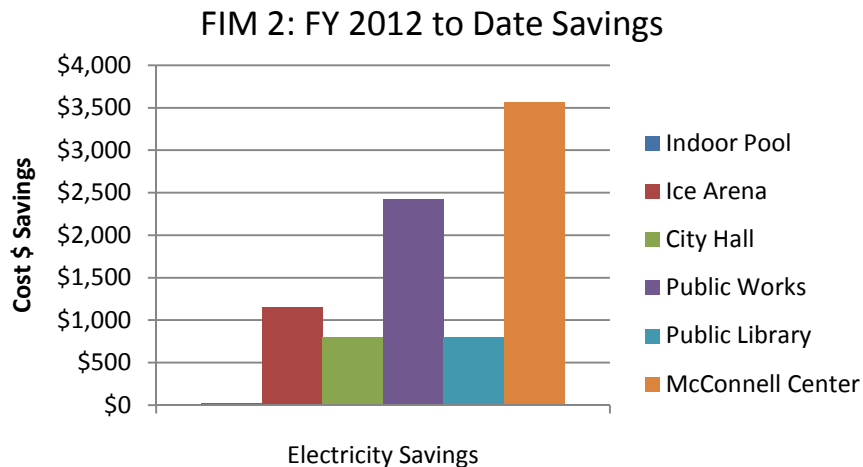
## FIM DESCRIPTION

### FIM 2: Lighting – Fixture Controls

By using occupancy sensors and shutting off lights in unoccupied areas, Dover is guaranteed to save 88,559 kWh per year, with a reduction in demand of 24.8 kW. As per the Detailed Energy Audit (DEA) page 28, FIM 2 annual cost savings are not taken using demand savings. Cost savings are calculated from consumption savings only and are guaranteed to be \$10,246.

FIM 2: Lighting – Fixture Controls				
FY2012 to Date Energy Cost Savings				
Building	Electricity Savings			Total Cost
	kW	kWh	Cost \$	\$ Savings
Indoor Pool	1	217	\$23	\$23
Ice Arena	49	10,865	\$1,152	\$1,152
City Hall	51	6,456	\$804	\$804
Public Works	158	18,954	\$2,425	\$2,425
Public Library	0	5,919	\$796	\$796
McConnell Center <sup>(7)</sup>	0	33,241	\$3,567	\$3,567
<b>Totals</b>	<b>259</b>	<b>75,653</b>	<b>\$8,766</b>	<b>\$8,766</b>

<sup>(7)</sup> McConnell Center included with FIM 2 from CO # 9236-0142-CO2



Additional lighting occupancy sensors were added to the McConnell Center to offset the fixtures which were not installed as originally planned. Savings will begin to be realized starting in June 2012.

For this report, several lighting sensors at the Public Works main building were measured using light sensitivity logging equipment over a one month period to verify the functionality of the sensors. Data obtained verifies the sensors are working correctly and is included in Appendix A for reference.

Verified savings are obtained from calculations which use collected data that tracked occupancy and lighting schedule in areas where equipment is installed. This data is used to verify lighting control savings. Calculation equations used have been provided in the appendix for reference. Fixture wattages under control of the sensors are stipulated as per the contract.

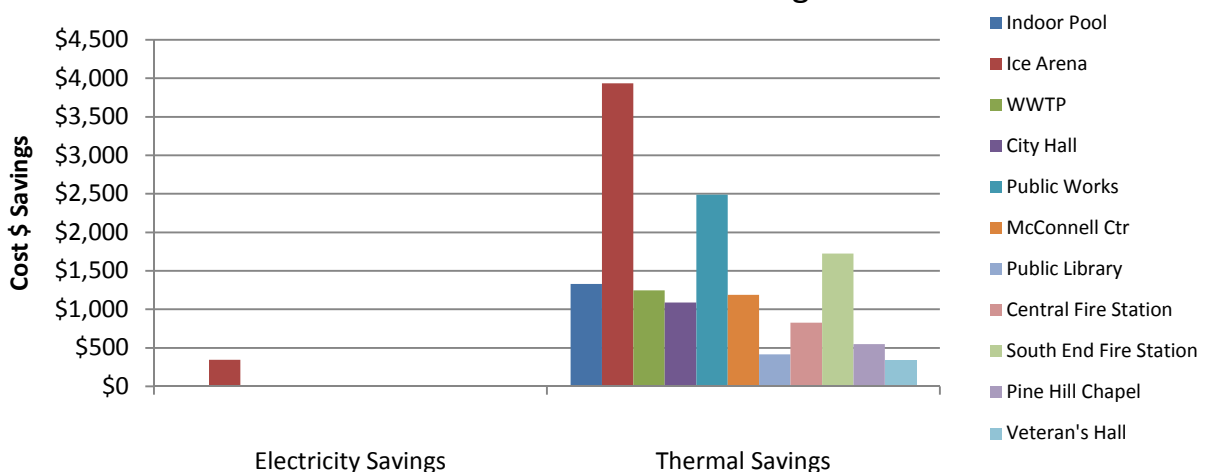
## FIM DESCRIPTION

### FIM 3: Building Envelope- Weatherization

Weatherization savings are determined by the losses of less conditioned air due to seals of gaps and openings in the building. The weatherization portion of the project is guaranteed to save 4,486 kWh of electrical energy and 1,019 MMBtu's in thermal energy, resulting in savings of \$14,461 per year.

FIM 3: Building Envelope- Weatherization						
FY2012 to Date Energy Cost Savings						
Building	Electricity Savings			Thermal Savings		Total Cost \$ Savings
	kW	kWh	Cost \$	MMBtu	Cost \$	
Indoor Pool	0	1	\$0	93	\$1,332	\$1,332
Ice Arena	0	3,264	\$346	314	\$3,937	\$4,283
WWTP	0	67	\$7	75	\$1,245	\$1,252
City Hall	0	39	\$5	65	\$1,089	\$1,094
Public Works	0	106	\$14	220	\$2,490	\$2,504
McConnell Center	0	45	\$5	84	\$1,188	\$1,193
Public Library	0	10	\$1	29	\$414	\$415
Central Fire Station	0	56	\$7	54	\$825	\$832
South End Fire Station	0	27	\$4	98	\$1,725	\$1,729
Pine Hill Chapel	0	7	\$1	33	\$546	\$548
Veteran's Hall	0	0	\$0	19	\$344	\$344
<b>Totals</b>	<b>0</b>	<b>3,621</b>	<b>\$389</b>	<b>1,084</b>	<b>\$15,136</b>	<b>\$15,525</b>

FIM 3: FY 2012 to Date Savings



Weatherization savings are directly from engineering spreadsheet calculations. General formulas used are located in Appendix C. The scope of work has been verified to be complete.

## FIM DESCRIPTION

### FIM 4: Energy Management System (EMS) - Upgrades

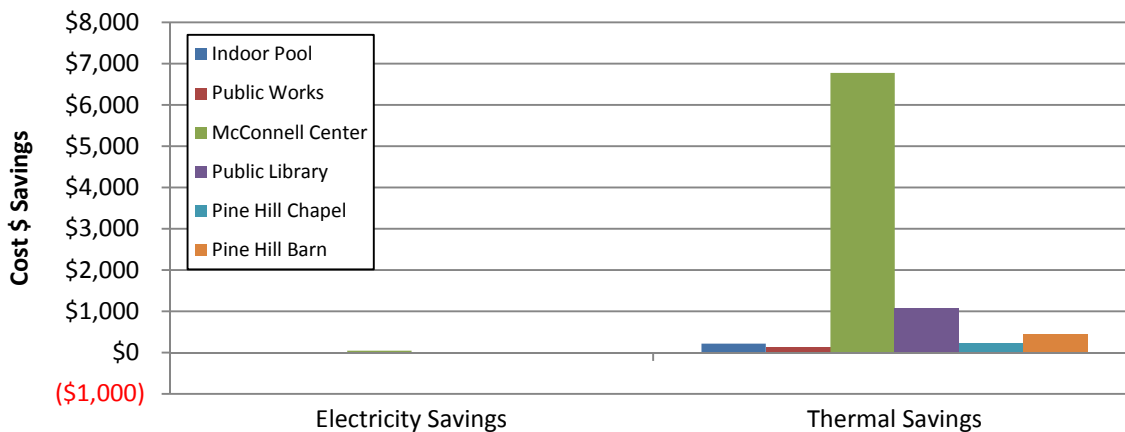
The EMS upgrade project is guaranteed to save 125,107 kWh of electrical energy and 1,138 MMBtu's of thermal energy totaling \$30,597. All sections of this FIM are further broken down as follows:

#### FIM 4.1: EMS- Building Controls

The building controls measure provides savings by providing a run-time schedule to provide a temperature setback when buildings are unoccupied, thus wasting less energy. The guaranteed annual energy savings for this FIM are calculated to be 1,092 kWh and 581 MMBtu's totaling \$8,398.

FIM 4.1: Building Controls						
FY2012 to Date Energy Cost Savings						
Building	Electricity Savings			Thermal Savings		Total Cost \$ Savings
	kW	kWh	Cost \$	MMBtu	Cost \$	
Indoor Pool	0	(2)	(\$0)	15	\$220	\$219
Public Works	0	0	\$0	12	\$132	\$132
McConnell Center	0	424	\$45	480	\$6,777	\$6,823
Public Library	0	0	\$0	77	\$1,083	\$1,083
Pine Hill Chapel	0	0	\$0	14	\$238	\$238
Pine Hill Barn	0	0	\$0	27	\$450	\$450
<b>Totals</b>	<b>0</b>	<b>421</b>	<b>\$45</b>	<b>625</b>	<b>\$8,900</b>	<b>\$8,945</b>

FIM 4.1: FY 2012 to Date Savings



Verified savings are derived from calculations and verified by trending and totalization with FMS. General formulas have been provided in the appendix for reference. Hours of operation, pre-installation control strategies, and pre & post retrofit equipment energy consumption are stipulated.

## FIM DESCRIPTION

### FIM 4.2: EMS- Building Controls / Optimal Start

Savings for Building Controls / Optimal Start are based off of improved starting and running of air systems at the Dover City Hall. By optimizing control, there are realized savings of \$2,023 annually.

FIM 4.2: Building Controls / Optimal Start			
FY2012 to Date Energy Cost Savings			
Building	Thermal Savings		Total Cost \$ Savings
	MMBtu	Cost \$	
City Hall	131	\$2,173	\$2,173

Verified savings are from calculations and tracked with FMS. Formulas have been provided in Appendix C for reference. Hours of operation, pre-installation control strategies, and pre & post retrofit equipment energy consumption are stipulated.

### FIM 4.3: Air Handling Unit Upgrade- VFD on Fan

The upgrade at the Dover Public Works building was installed for the AHU that serves the repair shop. With the VFD in place, the unit is able to slow down air flow based off occupancy. Thus savings are realized by using less energy on the AHU fan and having to condition less air. The completion of this measure was in August of 2011. This measure is expected to save \$6,615 (41,564 kWh & 115 MMBtu's) per year.

FIM 4.3: Air Handling Unit Upgrade - VFD on Fan								
FY2012 to Date Energy Cost Savings								
Building	Electricity Savings			Cooling Savings		Heating Savings		Total Cost \$ Savings
	kW	kWh	Cost \$	kWh	Cost \$	MMBtu	Cost \$	
Public Works	0	30,047	\$3,844	2,707	\$346	122	\$1,380	\$5,452

Verified savings are based off calculations and verified through measurement of fan kW, supply & space air temperatures. Calculations are spreadsheet based and general formulas have been provided in the appendix for reference. Hours of operation and motor power are stipulated.

## FIM DESCRIPTION

### FIM 4.4: Pool Dehumidification- EMS & VFDs

The replacement of the AHU with a new PoolPac™ unit in the Dover Indoor Pool will create savings through the implementation of a temperature setback and slowed fan speeds during unoccupied hours. Additionally, this FIM will eliminate simultaneous heating and cooling in the pool office. These upgrades will save Dover 63,143 kWh and 320 MMBtu's resulting in a savings of \$11,203 annually.

FIM 4.4: Pool Dehumidification - EMS & VFD's						
FY2012 to Date Energy Cost Savings						
Building	Electricity Savings			Thermal Savings		Total Cost \$ Savings
	kW	kWh	Cost \$	MMBtu	Cost \$	
Indoor Pool	0	54,395	\$5,684	276	\$3,967	\$9,651

Verified savings are from engineering spreadsheet calculations and verified through tracking and trending of pool humidity levels using the BAS and loggers. Hours of operation, equipment energy consumption pre & post retrofit, and pool operational temperatures are stipulated.

JCI has conducted a Pool Dehumidification runtime and power study over the past quarter to verify performance of this measure. Data shows that the unit is currently setting back but JCI has found possible additional improvement to the system which can save Dover additional energy. Results and recommendations are published in Appendix A.

### FIM 4.5: Repair Snow Melt Sensor

The snow melt sensor system at the Dover Transportation Center is generally run from mid-November through the end of March; during the winter snow season. By repairing the system and adding sensors to control use, Dover is guaranteed to save \$2,357 per winter.

FIM 4.5: Repair Snow Melt Sensor					
FY2012 to Date Energy Cost Savings					
Building	Electricity Savings			Total Cost \$ Savings	
	kW	kWh	Cost \$		
Dover Transportation Center	0	20,051	\$2,448	\$2,448	

Verified savings are derived from calculations involving power draw of the snow melt system and time-of-use of the system while operated manually. Savings are verified through inspection of post installation hours of operation. Calculations are from spreadsheets located in the DEA. Pre-installation hours of operation are a stipulated variable. A consideration is that savings are a function of the severity of the winter.



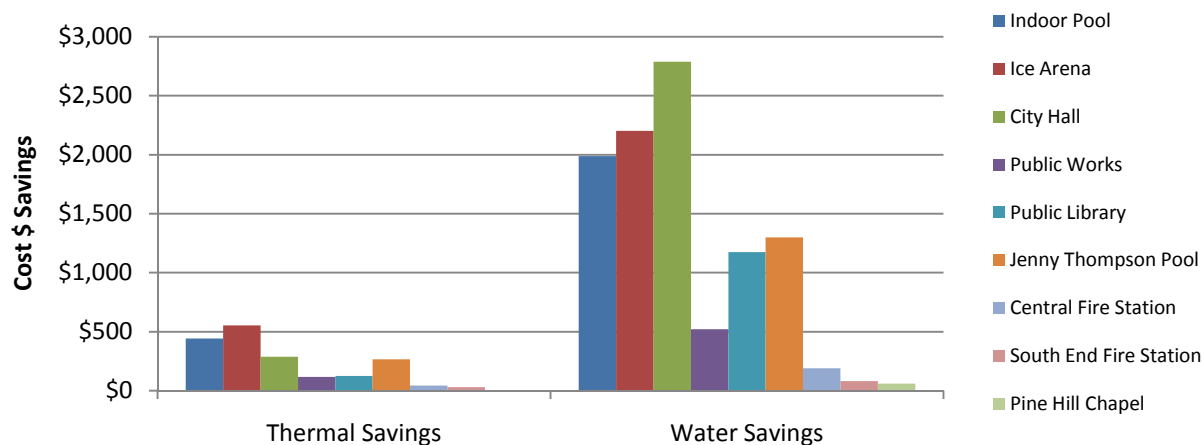
## FIM DESCRIPTION

### FIM 6: Water Conservation

The change in fixtures to more efficient ones will save 1,083 kgals of water annually and 159 MMBtu's in costs associated with heating that water. Total guaranteed savings are \$14,123 annually.

FIM 6: Water Conservation					
FY2012 to Date Energy Cost Savings					
Building	Thermal Savings		Water Savings		Total Cost \$ Savings
	MMBtu	Cost \$	kGal	Cost \$	
Indoor Pool	31	\$441	180	\$1,988	\$2,429
Ice Arena	44	\$553	199	\$2,202	\$2,755
City Hall	17	\$287	253	\$2,788	\$3,076
Public Works	10	\$117	47	\$520	\$637
Public Library	9	\$124	106	\$1,174	\$1,298
Jenny Thompson Pool	21	\$267	118	\$1,299	\$1,565
Central Fire Station	3	\$43	17	\$191	\$234
South End Fire Station	2	\$30	7	\$82	\$112
Pine Hill Chapel	0	\$6	5	\$60	\$66
<b>Totals</b>	<b>137</b>	<b>\$1,867</b>	<b>933</b>	<b>\$10,305</b>	<b>\$12,172</b>

FIM 6: FY 2012 to Date Savings



Verified savings are obtained from calculations and verified through flow measurements of fixtures before and after retrofit. Calculations have been provided in the appendix for reference. Pre-installation operation and occupancy are stipulated variables.

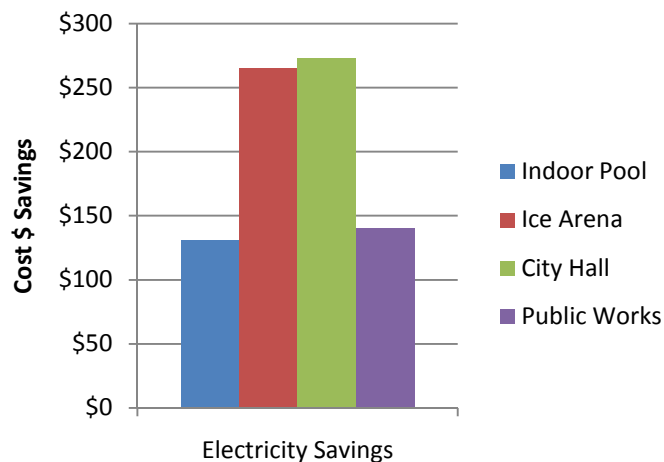
## FIM DESCRIPTION

### FIM 9: Vending Machine Controls

Savings from this FIM are derived from motion sensors which shut off the lights to the vending machine when nobody is around. The annual savings are guaranteed to be 8,146 kWh or \$936.

FIM 9: Vending Machine Controls				
FY2012 to Date Energy Cost Savings				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
Indoor Pool	0	1,252	\$131	\$131
Ice Arena	0	2,503	\$265	\$265
City Hall	0	2,190	\$273	\$273
Public Works	0	1,095	\$140	\$140
<b>Totals</b>	<b>0</b>	<b>7,040</b>	<b>\$809</b>	<b>\$809</b>

FIM 9: FY 2012 to Date Savings



Verified savings for vending machine controls are directly from engineering calculations. Equations used have been provided in the appendix. The scope of work has been verified to be fully implemented.

## FIM DESCRIPTION

### FIM 10: Pool Covers

Covering the pool when it is not in use eliminates heating need and water losses during unoccupied times. The annual savings that Dover can expect to see by using the pool cover is 45,256 kWh, 543 MMBtu's & 62.4 kgals of water, resulting in a cost savings of \$13,223.

FIM 10: Pool Covers								
FY2012 to Date Energy Cost Savings								
Building	Electricity Savings			Thermal Savings		Water Savings		Total Cost \$ Savings
	kW	kWh	Cost \$	MMBtu	Cost \$	kGal	Cost \$	
Indoor Pool	0	38,987	\$4,074	468	\$6,724	54	\$593	\$11,391

Verified savings for the pool covers are directly from engineering calculations. The installation has been inspected for completeness. Operational hours are a stipulated variable.

## FIM DESCRIPTION

### FIM 11: Ice Arena Updates

The Dover Ice Arena updates have been designed to produce an extra 32,649 kWh per year and create 61.8 kW more electrical demand per month in order to save 9,370 MMBtu's of natural gas annually. Resultant cost savings are guaranteed for \$95,015 per year.

FIM 11: Ice Arena Upgrades							
FY2012 to Date Energy Cost Savings							
Building	Electricity Savings			Thermal Savings		Icemax	Total Cost \$ Savings
	kW	kWh	Cost \$	MMBtu	Cost \$	Cost \$	
Ice Arena	(419)	(76,953)	(\$11,940)	8,661	\$108,903	(\$7,980)	\$88,983

This FIM is measured using IPMVP option C which measures performance through the use of utility bill analysis. Monthly utility invoices have been analyzed and accounted for to determine FIM 11 savings. Calculations and supporting documentation can in the FIM 11 section of Appendix A.

FIM 11: Ice Arena Updates consists of the following measures which contribute to arena savings

- FIM 11.1: Low Emissivity Ceiling
- FIM 11.2: Ice Temperature Control Optimization
- FIM 11.3: Dehumidification Controls
- FIM 11.4: Icemax System
- FIM 11.5: Move the Dashers Inboard
- FIM 11.6: Installation of New Chiller
- FIM 11.7: Pumping System – VFD on Pump
- FIM 11.8: Controls Update

Since the implementation of these measures, savings realized over the summer at the Ice Arena are more significant than winter period. This is due to several of the measures providing more savings during warmer weather. For example, the low-e ceiling provides more of a difference in transfer of heat onto the ice surface over the summertime when weather is warmer and the sun's path is higher and longer.

## FIM DESCRIPTION

### **FIM 12: Power Factor Correction**

The power factor correction measure will be implemented at the Dover Ice Arena to correct and prevent low power factor. Other ancillary benefits to be gained by correcting power factor are lower energy losses and better voltage regulation. It was originally calculated that by using the KVAR Energy Savings System the rink will save \$7,188 annually. There are currently no savings for this FIM since work has not been completed.

FIM 12: Power Factor Correction				
FY2012 to Date Energy Cost Savings				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
Ice Arena	0	0	\$0	\$0

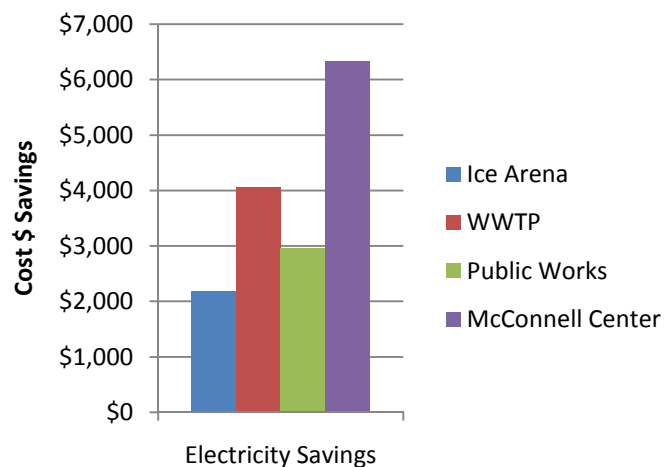
## FIM DESCRIPTION

### FIM 13: Energy Efficient Transformers

Savings associated with FIM 13 are from the replacement of transformers with more efficient ones, thus savings 145,554 kWh annually, with a monthly 25.7 kW reduction in demand. The completion of this measure at the Ice Arena was not completed until August of 2011 while all other buildings were completed in 2010. Annual cost savings are guaranteed at \$18,385 per year.

FIM 13: Transformers				
FY2012 to Date Energy Cost Savings				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
Ice Arena	44	17,081	\$2,179	\$2,179
WWTP	95	32,802	\$4,064	\$4,064
Public Works	0	23,189	\$2,967	\$2,967
McConnell Center	122	50,863	\$6,323	\$6,323
<b>Totals</b>	<b>260</b>	<b>123,935</b>	<b>\$15,532</b>	<b>\$15,532</b>

FIM 13: FY 2012 to Date Savings



Verified savings for transformers are based off calculations and verified through field measurements of power, harmonics, and efficiency. Calculation equations have been provided in the appendix for reference. Operational hours and input power are stipulated variables.

## FIM DESCRIPTION

### FIM 14: Aeration Blowers – Retrofit

This measure is designed to save \$33,432 annually through the replacement of three (3) older positive displacement blowers with new high efficiency turbine blowers. Guaranteed annual energy savings for this FIM are obtained by reducing the electricity consumption by 272,264 kWh and monthly demand by 62.2 kW. The completion date of this measure was in August of 2011. Since the last report, the odor control unit has been completed and a silencer has been added so that the unit can run 24-7 and prevent odiferous concentration in the tanks. The energy usage of this blower has been subtracted from the overall blower savings. More information regarding this subject is provided in the Appendix.

FIM 14: Aeration Blowers Retrofit				
Installation Period Energy Cost Savings				
Building	Electricity Savings			Total Cost \$ Savings
	kW	kWh	Cost \$	
WWTP	505	190,976	\$23,461	\$23,461

Verified savings are obtained from calculations and verified using measurements of power draw on the previous and new system. Methods of calculation have been provided in Appendix C for reference. Pre- installation loading and hours of operation are stipulated variables.

### FIM 15: Boiler Replacement

Savings for this measure are based on an increase in boiler efficiency from the old boiler to the high efficiency gas-fired boiler by approximately 7%. It is assumed that the boiler runs roughly from the middle of September through the middle of April. The annual savings associated with FIM 15 are calculated to be 88 MMBtu's annually or \$1,251.

FIM 15: Boiler Replacement			
Installation Period Energy Cost Savings			
Building	Thermal Savings		Total Cost \$ Savings
	MMBtu	Cost \$	
Public Library	88	\$1,251	\$1,251

Verified savings are obtained from calculations and verified by testing the improved efficiency of the new boiler after emergency replacement of the old one. Calculations have been provided in the appendix for reference. Pre- installation boiler efficiency is a stipulated variable.

## ENVIRONMENTAL BENEFITS

### FY 2012 to Date Savings- Greenhouse Gas Emissions

Total estimated emissions reductions from the project during the first ten months of the fiscal year are as follows:







Estimated Emissions Reductions: Fiscal YTD- Tons of CO <sub>2</sub> -e						
FIM #	Facility Improvement Measure	Electricity	Natural Gas	#2 Fuel Oil	Propane	Total
FIM 1	Lighting Fixtures	81.0	(12.0)	(1.3)	0.0	67.8
FIM 2	Lighting Controls	28.7	0.0	0.0	0.0	28.7
FIM 3	Weatherization	1.4	43.2	12.7	6.2	63.5
FIM 4	EMS Upgrades	40.5	52.1	12.6	0.0	105.2
<i>FIM 4.1</i>	<i>Building Controls</i>	0.2	31.0	3.0	0.0	34.2
<i>FIM 4.2</i>	<i>Building Controls / Optimal Start</i>	0.0	0.0	9.6	0.0	9.6
<i>FIM 4.3</i>	<i>AHU Upgrade – VFD on Fan</i>	12.1	6.5	0.0	0.0	18.6
<i>FIM 4.4</i>	<i>Pool Dehumidification</i>	20.6	14.7	0.0	0.0	35.3
<i>FIM 4.5</i>	<i>Snow Melt Sensor</i>	7.6	0.0	0.0	0.0	7.6
FIM 6	Water Conservation	0.0	6.3	1.3	0.1	7.7
FIM 9	Vending Machine Controls	2.7	0.0	0.0	0.0	2.7
FIM 10	Pool Cover	14.8	24.8	0.0	0.0	39.6
FIM 11	Ice Rink Upgrades	(29.2)	460.0	0.0	0.0	430.8
FIM 12	Power Factor Correction	0.0	0.0	0.0	0.0	0.0
FIM 13	Energy Efficient Transformers	47.0	0.0	0.0	0.0	47.0
FIM 14	Aeration Blower Upgrade	72.5	0.0	0.0	0.0	72.5
FIM 15	Boiler Replacement	0.0	4.7	0.0	0.0	4.7
<b>Totals</b>		<b>259.4</b>	<b>579.1</b>	<b>25.4</b>	<b>6.3</b>	<b>870.1</b>



## ENVIRONMENTAL BENEFITS

### Dover Fiscal YTD Equivalency Savings

The project's reduced emissions would be equivalent to:

CO <sub>2</sub> sequestered by	22,310	tree seedlings grown for 10 years in an urban scenario	
CO <sub>2</sub> sequestered by	198	acres of pine or fir forests	
CO <sub>2</sub> emissions from	159	passenger vehicles	
CO <sub>2</sub> emissions from	2,023	barrels of oil consumed	
CO <sub>2</sub> emissions from the <i>energy</i> use of	77	homes for one year	
CO <sub>2</sub> emissions from burning	5	coal railcars	

*Source:*

All carbon equivalencies extracted directly from the EPA website.

"Greenhouse Gas Equivalencies Calculator." Clean Energy, U.S. Environmental Protection Agency. <[www.epa.gov/oleanenergy/energy-resources/calculator.html](http://www.epa.gov/oleanenergy/energy-resources/calculator.html)> (Aug. 6, 2008).

*Version:*

Energy Project GHG Calculator. USA Version 3.0. January 7, 2009.

## APPENDIX A

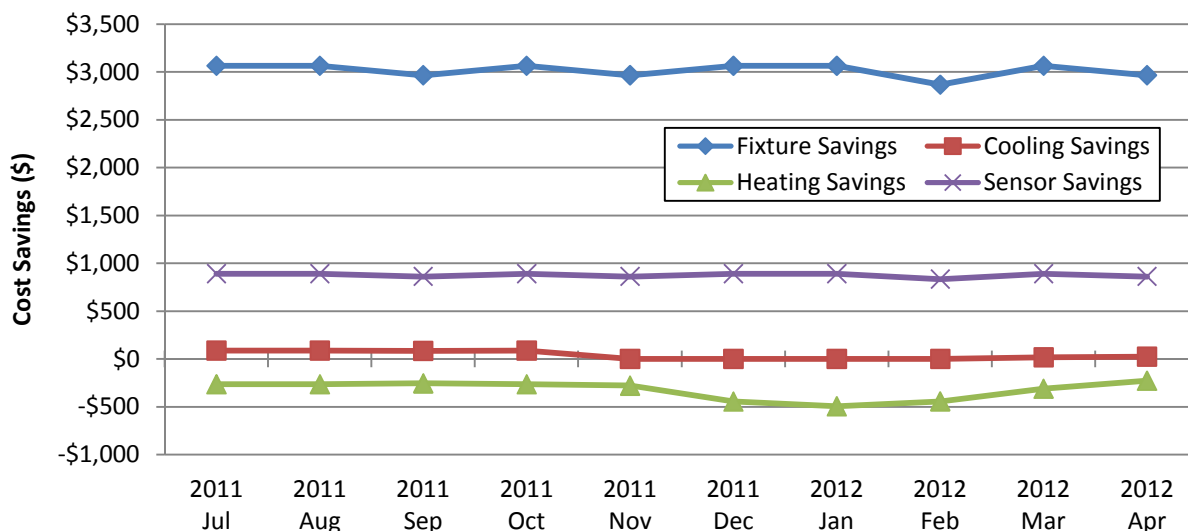
### FIM 1 & 2: Lighting Fixture Retrofit & Controls

In the FIM 1 table below, energy savings are calculated using a combination of weather and days in order to provide a seasonal weighting towards cooling savings and heating losses. McConnell Center savings are included in this chart.

FIM 1: Lighting – Fixture Retrofit									
Fiscal YTD Energy Cost Savings									
Month	Year	Electricity Savings			Cooling Savings		Heating Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	kWh	Cost \$	MMBtu	Cost \$	
July	2011	119	21,356	\$3,047	782	\$86	(20)	(\$264)	\$2,870
August	2011	119	21,356	\$3,047	782	\$86	(20)	(\$264)	\$2,870
September	2011	119	20,668	\$2,949	757	\$84	(19)	(\$255)	\$2,778
October	2011	119	21,356	\$3,047	782	\$86	(20)	(\$264)	\$2,870
November	2011	119	20,668	\$2,949	0	\$0	(21)	(\$279)	\$2,670
December	2011	119	21,356	\$3,047	0	\$0	(33)	(\$445)	\$2,603
January	2012	119	21,356	\$3,047	0	\$0	(37)	(\$495)	\$2,553
February	2012	119	19,979	\$2,851	0	\$0	(33)	(\$444)	\$2,407
March	2012	119	21,356	\$3,047	140	\$16	(23)	(\$311)	\$2,752
April	2012	119	20,668	\$2,949	206	\$23	(17)	(\$227)	\$2,745
<b>Total Contract TD</b>		<b>713</b>	<b>125,383</b>	<b>\$17,891</b>	<b>346</b>	<b>\$38</b>	<b>(165)</b>	<b>(\$2,200)</b>	<b>\$15,729</b>
<b>Total Fiscal YTD</b>		<b>1,188</b>	<b>210,120</b>	<b>\$29,982</b>	<b>3,449</b>	<b>\$381</b>	<b>(243)</b>	<b>(\$3,246)</b>	<b>\$27,117</b>

FIM 1&2 savings are shown monthly below for the Fiscal YTD:

### FIM 1 & 2- Lighting Savings



## APPENDIX A

### FIM 1 & 2: Lighting Fixture Retrofit & Controls

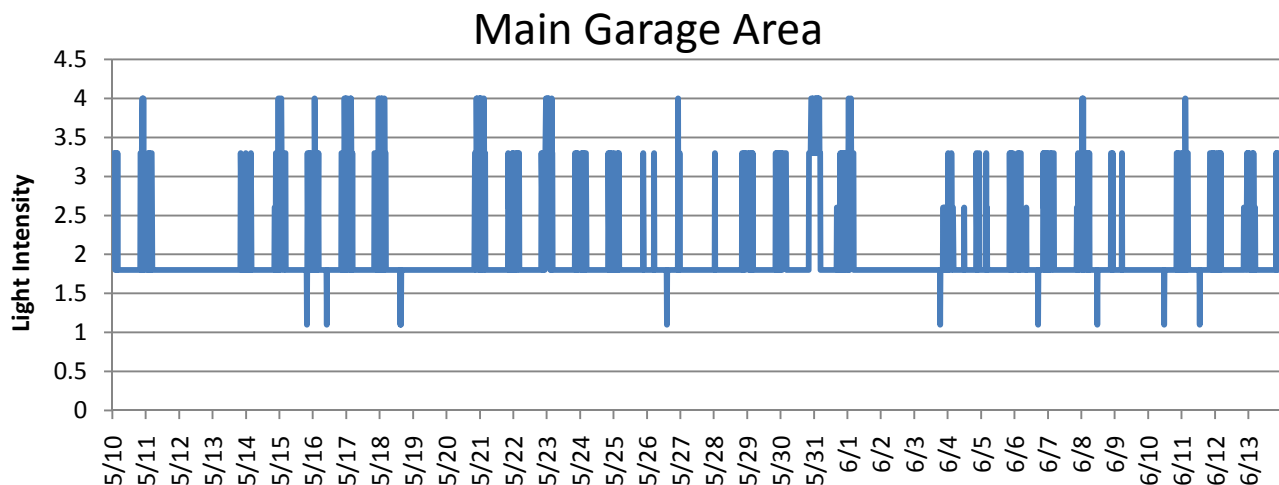
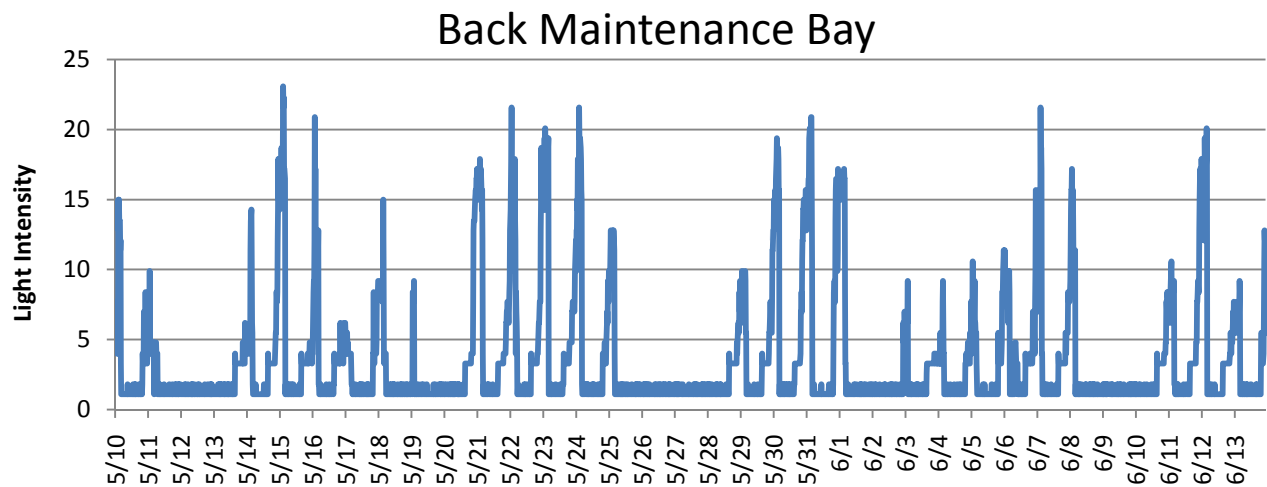
The FIM 2 table breaks down the measure by month over the fiscal year. McConnell Center savings are included in this chart.

FIM 2: Lighting – Fixture Controls					
Fiscal YTD Energy Cost Savings					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
July	2011	26	7,689	\$891	\$891
August	2011	26	7,689	\$891	\$891
September	2011	26	7,441	\$862	\$862
October	2011	26	7,689	\$891	\$891
November	2011	26	7,441	\$862	\$862
December	2011	26	7,689	\$891	\$891
January	2012	26	7,689	\$891	\$891
February	2012	26	7,193	834	\$834
March	2012	26	7,689	891	\$891
April	2012	26	7,441	862	\$862
<b>Total Contract TD</b>		<b>155</b>	<b>45,144</b>	<b>\$5,231</b>	<b>\$5,231</b>
<b>Total Fiscal YTD</b>		<b>259</b>	<b>75,653</b>	<b>\$8,766</b>	<b>\$8,766</b>

## APPENDIX A

### FIM 1 & 2: Lighting Fixture Retrofit & Controls

A lighting sensor validation was conducted at the Public Works building by JCI. Loggers were placed in the two largest rooms against the south walls to prevent any direct sunlight from windows or openings. The results are shown in charts which present light intensity over time.



By looking at both charts, it is evident that on most weekend times, including the Memorial day holiday, the lights are not on for extended periods since the building is not in constant use. Additionally, due to the varied nature of lighting output, there are lights constantly turning on and off as occupied which saves electricity.

According to this data taken from the Public Works building, the sensors are functioning properly and conserving electricity over the course of short and long unoccupied periods.

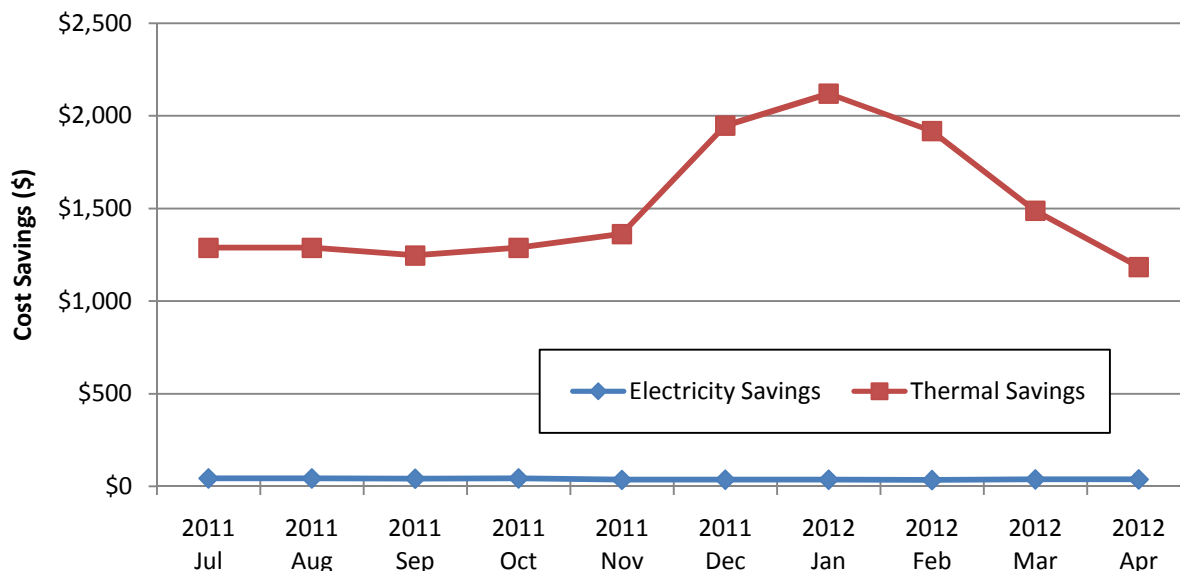
## APPENDIX A

### FIM 3: Weatherization

In the FIM 3 table below, energy savings are calculated using a combination of weather and days in order to provide a seasonal weighting towards cooling and heating savings. As such, cooling savings are more concentrated during warmer weather and heating savings are larger during colder weather when more heating is necessary.

FIM 3: Weatherization							
Fiscal YTD Energy Cost Savings							
Month	Year	Electricity Savings			Thermal Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	MMBtu	Cost \$	
July	2011	0	396	\$43	93	\$1,288	\$1,332
August	2011	0	396	\$43	93	\$1,288	\$1,332
September	2011	0	383	\$42	90	\$1,247	\$1,289
October	2011	0	396	\$43	93	\$1,288	\$1,332
November	2011	0	332	\$35	98	\$1,363	\$1,398
December	2011	0	343	\$36	138	\$1,948	\$1,985
January	2012	0	343	\$36	150	\$2,121	\$2,157
February	2012	0	321	\$34	136	\$1,918	\$1,952
March	2012	0	358	\$38	107	\$1,488	\$1,526
April	2012	0	353	\$38	86	\$1,185	\$1,223
<b>Total Contract TD</b>		<b>0</b>	<b>2,050</b>	<b>\$218</b>	<b>715</b>	<b>\$10,023</b>	<b>\$10,241</b>
<b>Total Fiscal YTD</b>		<b>0</b>	<b>3,621</b>	<b>\$389</b>	<b>1,084</b>	<b>\$15,136</b>	<b>\$15,525</b>

### FIM 3- Weatherization Savings



## APPENDIX A

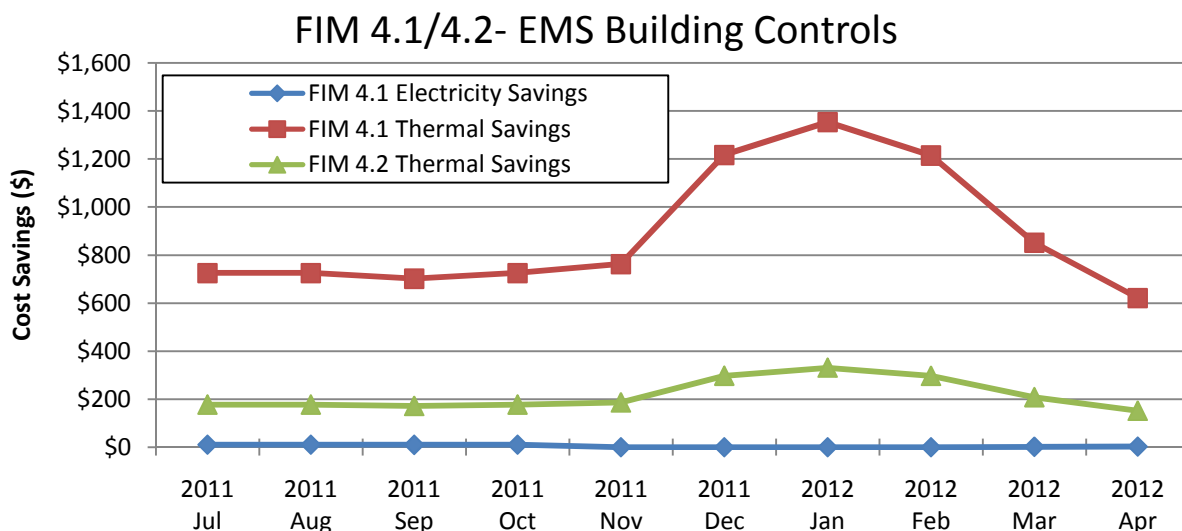
### FIM 4: Energy Management System Upgrades

#### FIM 4.1: EMS – Building Controls & FIM 4.2: EMS – Building Controls / Optimal Start

In the FIM 4.1 & 4.2 table below, weather is used to provide a seasonal weighting towards cooling and heating savings. As such, cooling savings are more concentrated during warmer weather and heating savings are concentrated during colder weather when more heating is necessary.

City of Dover		FIM 4.1: EMS - Building Controls						FIM 4.2: Building Controls / Optimal Start		
Month	Year	Fiscal YTD Energy Cost Savings						Fiscal YTD Energy Cost Savings		
		Electricity Savings			Thermal Savings		Total Cost \$ Savings	Thermal Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	MMBtu	Cost \$		MMBtu	Cost \$	
July	2011	0	96	\$10	51	\$725	\$736	11	\$177	\$177
August	2011	0	96	\$10	51	\$725	\$736	11	\$177	\$177
September	2011	0	92	\$10	49	\$702	\$712	10	\$171	\$171
October	2011	0	96	\$10	51	\$725	\$736	11	\$177	\$177
November	2011	0	0	\$0	54	\$762	\$762	11	\$186	\$186
December	2011	0	0	\$0	85	\$1,217	\$1,217	18	\$297	\$297
January	2012	0	0	\$0	95	\$1,354	\$1,354	20	\$331	\$331
February	2012	0	0	\$0	85	\$1,215	\$1,215	18	\$297	\$297
March	2012	0	17	\$2	60	\$852	\$853	12	\$208	\$208
April	2012	0	25	\$3	44	\$621	\$624	9	\$152	\$152
<b>Total Contract TD</b>		<b>0</b>	<b>42</b>	<b>\$5</b>	<b>423</b>	<b>\$6,022</b>	<b>\$6,026</b>	<b>88</b>	<b>\$1,471</b>	<b>\$1,471</b>
<b>Total Fiscal YTD</b>		<b>0</b>	<b>421</b>	<b>\$45</b>	<b>625</b>	<b>\$8,900</b>	<b>\$8,945</b>	<b>131</b>	<b>\$2,173</b>	<b>\$2,173</b>

FIMs 4.1 & 4.2 are broken down monthly and by type below for FY 2012:



## APPENDIX A

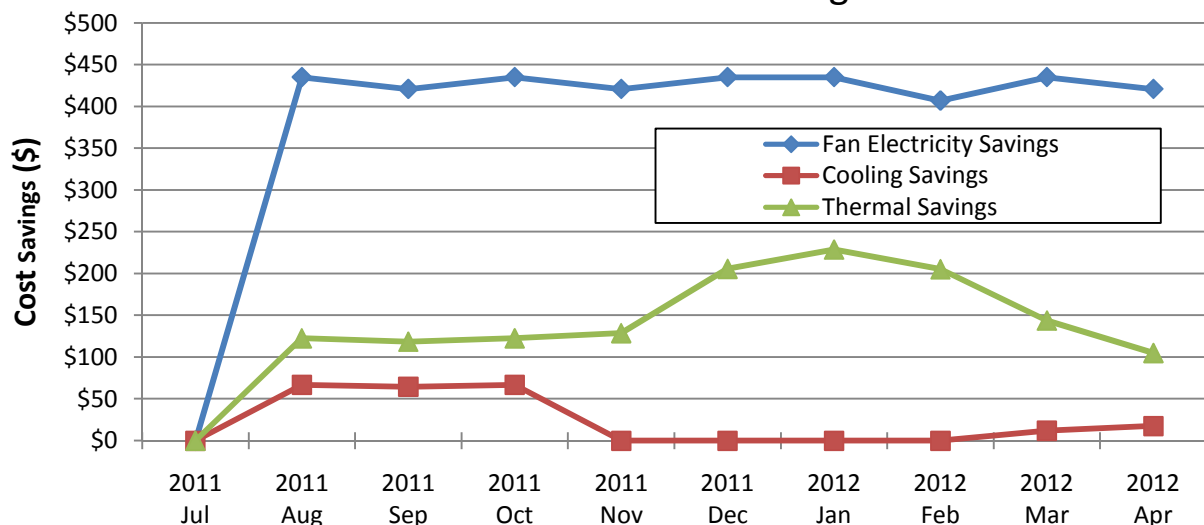
### FIM 4: Energy Management System Upgrades

#### FIM 4.3: AHU Upgrade – VFD on Fan

Savings for fan electricity are based off fan run-time while cooling and heating are weighted based off monthly weather and temperature profiles. The installation was not completed until August 1 leading to no savings during July.

FIM 4.3: AHU Upgrade - VFD on Fan									
Fiscal YTD Energy Cost Avoidance									
Month	Year	Fan Electricity Savings			Cooling Savings		Thermal Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	kWh	Cost \$	MMBtu	Cost \$	
July	2011	0	0	0	0	0	0	0	\$0
August	2011	0	3,399	\$435	523	\$67	11	\$122	\$624
September	2011	0	3,290	\$421	506	\$65	10	\$118	\$604
October	2011	0	3,399	\$435	523	\$67	11	\$122	\$624
November	2011	0	3,290	\$421	0	\$0	11	\$129	\$550
December	2011	0	3,399	\$435	0	\$0	18	\$205	\$640
January	2012	0	3,399	\$435	0	\$0	20	\$229	\$663
February	2012	0	3,180	\$407	0	\$0	18	\$205	\$612
March	2012	0	3,399	\$435	94	\$12	13	\$144	\$591
April	2012	0	3,290	\$421	138	\$18	9	\$105	\$543
<b>Total Contract TD</b>		<b>0</b>	<b>19,958</b>	<b>\$2,553</b>	<b>231</b>	<b>\$30</b>	<b>90</b>	<b>\$1,016</b>	<b>\$3,599</b>
<b>Total Fiscal YTD</b>		<b>0</b>	<b>30,047</b>	<b>\$3,844</b>	<b>1,783</b>	<b>\$228</b>	<b>122</b>	<b>\$1,380</b>	<b>\$5,452</b>

FIM 4.3- VFD on AHU Savings



## APPENDIX A

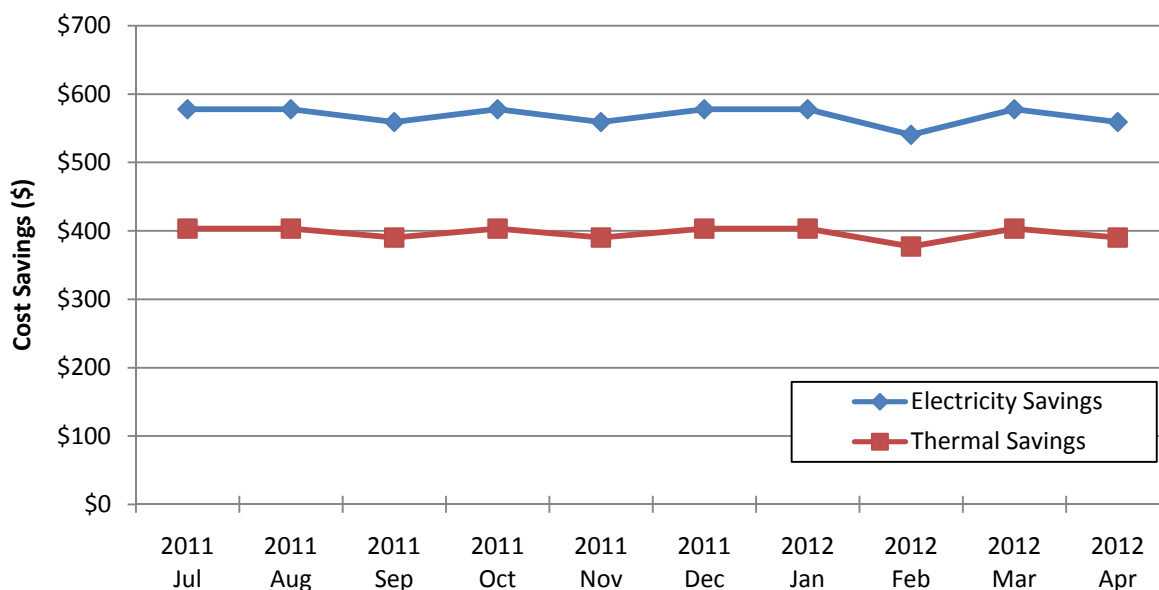
### FIM 4: Energy Management System Upgrades

#### FIM 4.4: Pool Dehumidification – EMS & VFD's

In the FIM 4.4 table below, electricity and thermal savings are realized by the Indoor Pool as follows:

FIM 4.4: Pool Dehumidification - EMS & VFD's							
Fiscal YTD Energy Cost Savings							
Month	Year	Electricity Savings			Thermal Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	MMBtu	Cost \$	
July	2011	0	5,529	\$578	28	\$403	\$981
August	2011	0	5,529	\$578	28	\$403	\$981
September	2011	0	5,350	\$559	27	\$390	\$949
October	2011	0	5,529	\$578	28	\$403	\$981
November	2011	0	5,350	\$559	27	\$390	\$949
December	2011	0	5,529	\$578	28	\$403	\$981
January	2012	0	5,529	\$578	28	\$403	\$981
February	2012	0	5,172	\$540	26	\$377	\$918
March	2012	0	5,529	\$578	28	\$403	\$981
April	2012	0	5,350	\$559	27	\$390	\$949
Total Contract TD		0	32,459	\$3,392	165	\$2,367	\$5,759
Total Fiscal YTD		0	54,395	\$5,684	276	\$3,967	\$9,651

#### FIM 4.4- Pool Dehumidification Savings



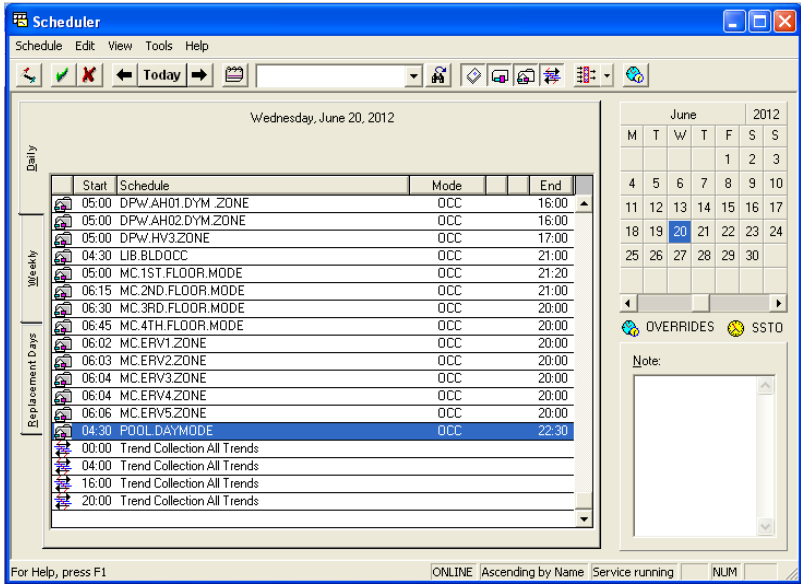
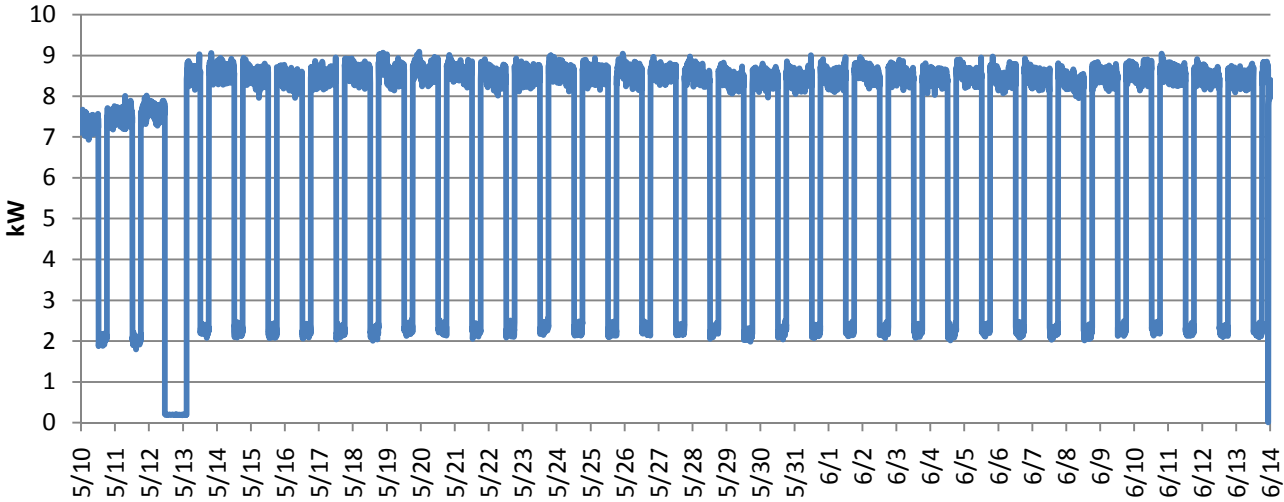


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**FIM 4: Energy Management System Upgrades**

The pool dehumidification unit was examined by JCI over the past quarter. Runtime loggers were placed in the unit to track power draw of the unit over a one month period. The results are shown below:

**Pool Dehumidification Unit- Total kW Draw**



For all seven days a week, the unit is currently set to daytime mode from 4:30AM until 10:30PM which is seen on the BAS system and in the logger data. The current operating hours of the pool are less than the 126 hours per week the unit is set to occupied mode. JCI sees a slight opportunity for further improvement of unit scheduling which will decrease energy usage at the Indoor Pool.

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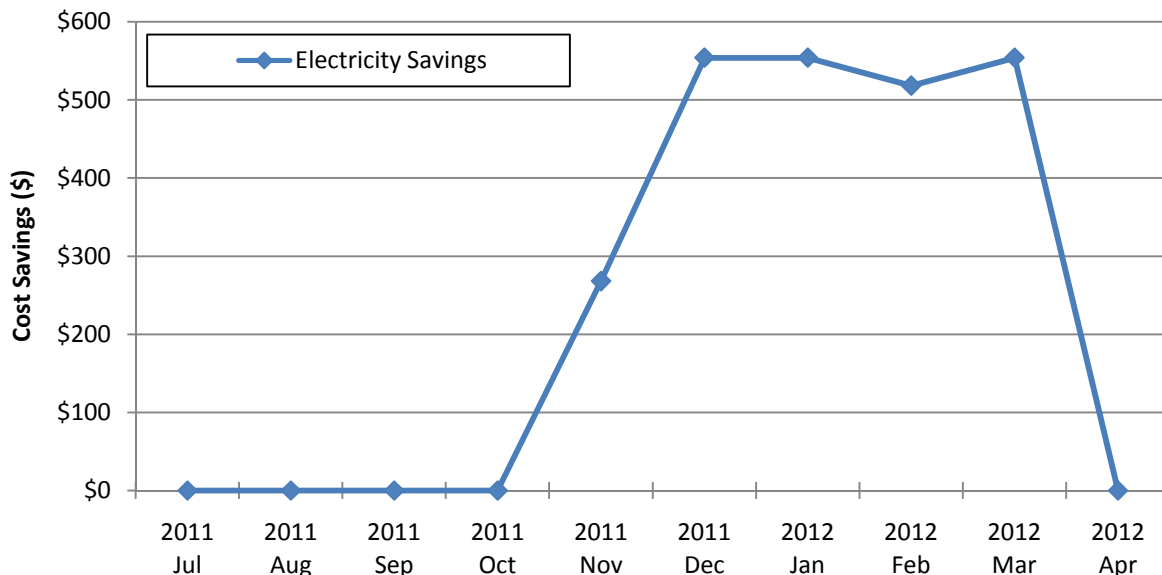
### FIM 4: Energy Management System Upgrades

#### FIM 4.5: Repair Snow Melt Sensor

The snow melt sensor is assumed to be operational from mid November through March during the snow season. Savings are concentrated over that period.

FIM 4.5: Repair Snow Melt Sensor					
Fiscal YTD Energy Cost Savings					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
July	2011	0	0	\$0	\$0
August	2011	0	0	\$0	\$0
September	2011	0	0	\$0	\$0
October	2011	0	0	\$0	\$0
November	2011	0	2,195	\$268	\$268
December	2011	0	4,537	\$554	\$554
January	2012	0	4,537	\$554	\$554
February	2012	0	4,244	\$518	\$518
March	2012	0	4,537	\$554	\$554
April	2012	0	0	\$0	\$0
<b>Total Contract TD</b>		<b>0</b>	<b>20,051</b>	<b>\$2,448</b>	<b>\$2,448</b>
<b>Total Fiscal YTD</b>		<b>0</b>	<b>20,051</b>	<b>\$2,448</b>	<b>\$2,448</b>

**FIM 4.5- Snow Melt Sensor Savings**

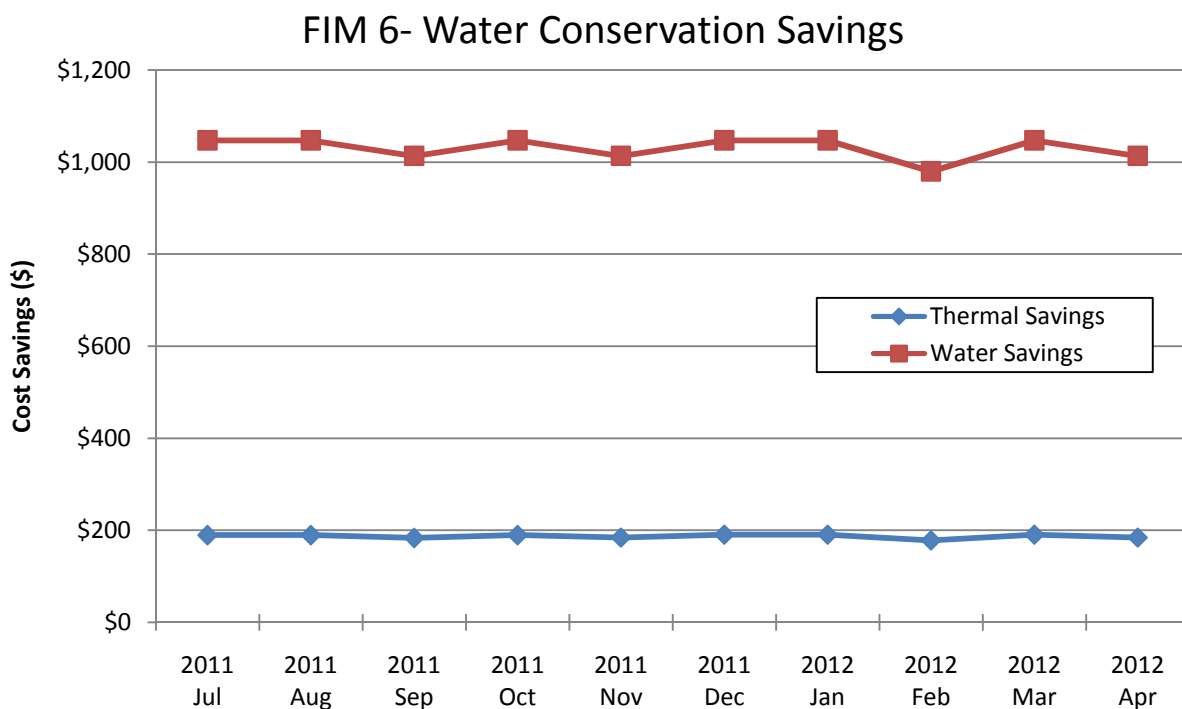


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### FIM 6: Water Conservation

The FIM 6 table and chart breaks down the monthly savings by month over Fiscal Year 2012:

FIM 6: Water Conservation						
Fiscal YTD Energy Cost Savings						
Month	Year	Thermal Savings		Water Savings		Total Cost \$ Savings
		MMBtu	Cost \$	kGal	Cost \$	
July	2011	14	\$189	95	\$1,047	\$1,237
August	2011	14	\$189	95	\$1,047	\$1,237
September	2011	13	\$183	92	\$1,014	\$1,197
October	2011	14	\$189	95	\$1,047	\$1,237
November	2011	13	\$184	92	\$1,014	\$1,198
December	2011	14	\$190	95	\$1,047	\$1,238
January	2012	14	\$190	95	\$1,047	\$1,238
February	2012	13	\$178	89	\$980	\$1,158
March	2012	14	\$190	95	\$1,047	\$1,238
April	2012	13	\$184	92	\$1,014	\$1,198
<b>Total Contract TD</b>		<b>82</b>	<b>\$1,117</b>	<b>557</b>	<b>\$6,149</b>	<b>\$7,266</b>
<b>Total Fiscal YTD</b>		<b>137</b>	<b>\$1,867</b>	<b>933</b>	<b>\$10,305</b>	<b>\$12,172</b>



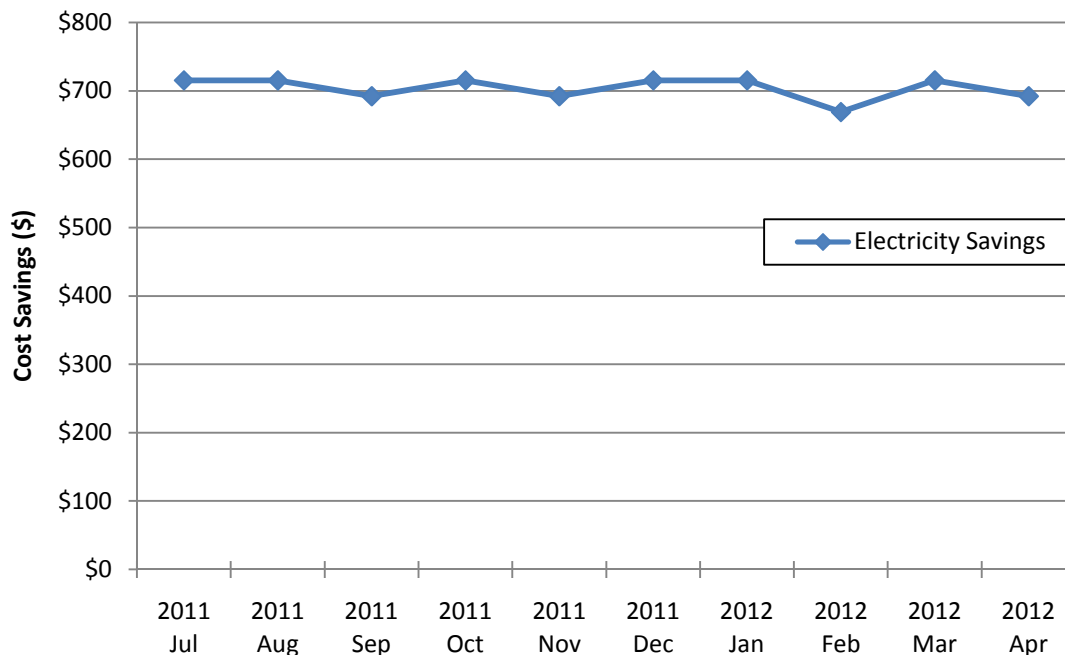
## APPENDIX A

### FIM 9: Vending Machine Controls

The FIM 9 table breaks down the measure by month over the fiscal year.

FIM 9: Vending Machine Controls					
Fiscal YTD Energy Cost Savings					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
July	2011	0	716	\$82	\$82
August	2011	0	716	\$82	\$82
September	2011	0	692	\$80	\$80
October	2011	0	716	\$82	\$82
November	2011	0	692	\$80	\$80
December	2011	0	716	\$82	\$82
January	2012	0	716	\$82	\$82
February	2012	0	669	\$77	\$77
March	2012	0	716	\$82	\$82
April	2012	0	692	\$80	\$80
<b>Total Contract TD</b>		<b>0</b>	<b>4,201</b>	<b>\$483</b>	<b>\$483</b>
<b>Total Fiscal YTD</b>		<b>0</b>	<b>7,040</b>	<b>\$809</b>	<b>\$809</b>

### FIM 9- Vending Controls Savings

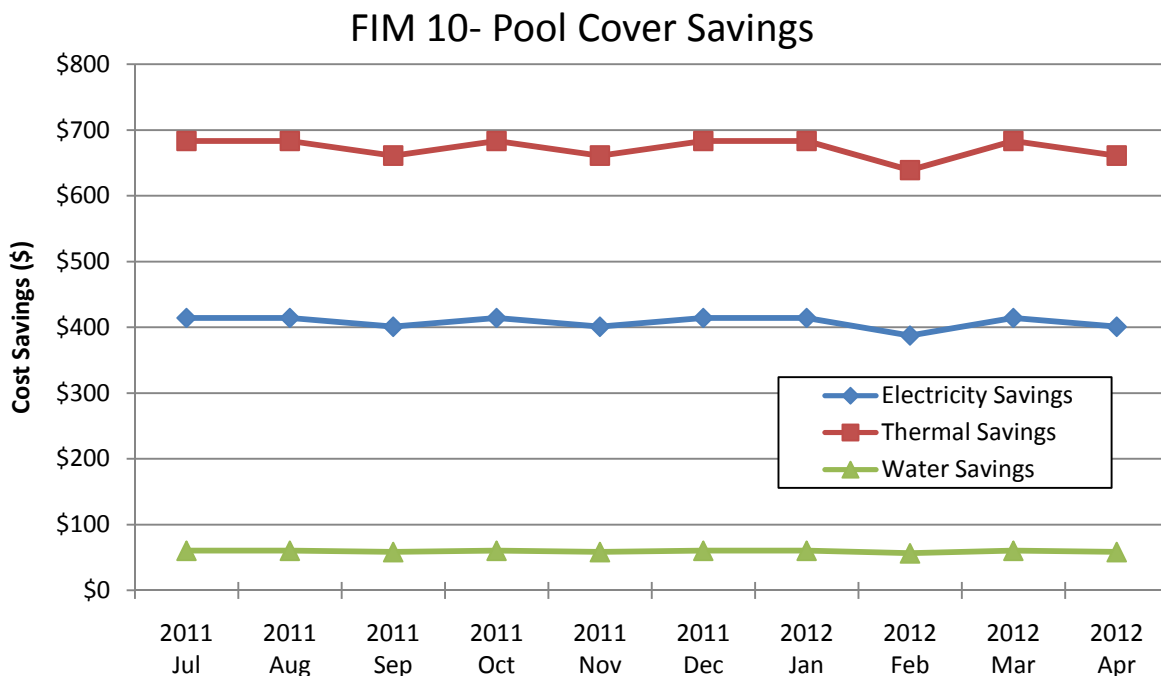


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### FIM 10: Pool Cover

The following FIM 10 table and chart break down the measure by month over the fiscal year to date.

FIM 10: Pool Cover									
Fiscal YTD Energy Cost Savings									
Month	Year	Electricity Savings			Thermal Savings		Water Savings		Total Cost \$ Savings
		kW	kWh	Cost \$	MMBtu	Cost \$	kGal	Cost \$	
July	2011	0	3,963	\$414	48	\$683	5.5	\$60	\$1,158
August	2011	0	3,963	\$414	48	\$683	5.5	\$60	\$1,158
September	2011	0	3,835	\$401	46	\$661	5.3	\$58	\$1,120
October	2011	0	3,963	\$414	48	\$683	5.5	\$60	\$1,158
November	2011	0	3,835	\$401	46	\$661	5.3	\$58	\$1,120
December	2011	0	3,963	\$414	48	\$683	5.5	\$60	\$1,158
January	2012	0	3,963	\$414	48	\$683	5.5	\$60	\$1,158
February	2012	0	3,707	\$387	44	\$639	5.1	\$56	\$1,083
March	2012	0	3,963	\$414	48	\$683	5.5	\$60	\$1,158
April	2012	0	3,835	\$401	46	\$661	5.3	\$58	\$1,120
<b>Total Contract TD</b>		<b>0</b>	<b>23,264</b>	<b>\$2,431</b>	<b>279</b>	<b>\$4,012</b>	<b>32</b>	<b>\$354</b>	<b>\$6,797</b>
<b>Total Fiscal YTD</b>		<b>0</b>	<b>38,987</b>	<b>\$4,074</b>	<b>468</b>	<b>\$6,724</b>	<b>54</b>	<b>\$593</b>	<b>\$11,391</b>



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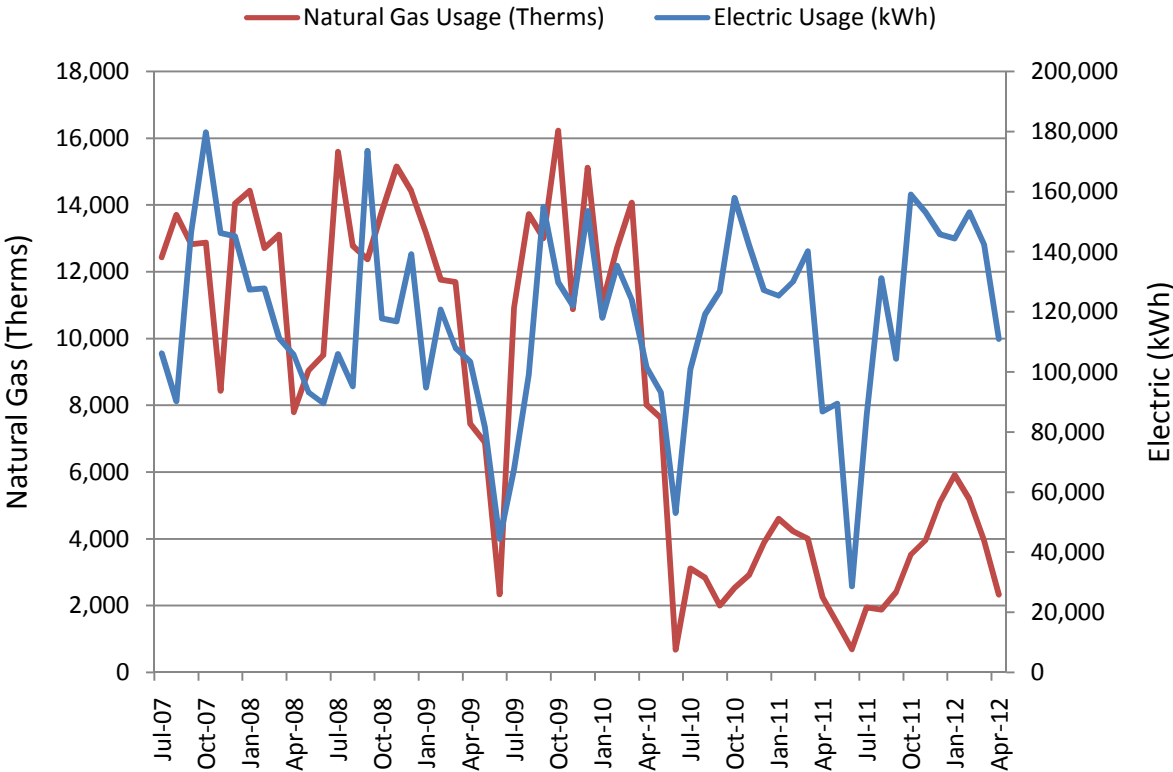
### FIM 11: Ice Arena Upgrades

Overall Utility Comparison

The Ice Arena part of this project consists of many items that together will achieve savings. The measurement method of FIM 11 is done via entire building utility comparison analysis. This analysis compares the usage of electricity and natural gas before and after the changes occurred. It applies the change in utilities use to track the effectiveness and calculate the savings of the work done.

The natural gas and electric usage are affected by the measures implemented at the Ice Arena. There is a complex relationship between the two usages. Below is a graph showing the history of both since July 2007. As a note, most FIM 11 work was completed between June and September 2010.

### Dover Ice Arena- Monthly Electric & Gas Usage



## APPENDIX A

### FIM 11: Ice Arena Upgrades

As part of the utility bill comparison, normalization of utility data is done through the use of Metrix software. This takes weather history and other entered variables into account in order to provide bills in different years and scenarios on an equal playing field. Weather degree days have been provided in Appendix B.

The one entered variable needed in this case is shown below. In order to properly take into account the load seen by the chillers and rink scheduling, this 'Chiller- Ice Hours' variable was created and used in the regression analysis performed. Below is the simple calculation table and equations used to create the variable.

Dover Ice Arena Chiller- Ice Hours Variable Calculation						
Month	Avail Hours	Arena 1	Arena 2	Ice Hours	2nd Rink Startup	Chiller- Ice Hours
August	744	100%	0%	744	0	744
September	720	100%	23%	888	540	1,428
October	744	100%	100%	1,488	186	1,674
November	720	100%	100%	1,440	0	1,440
December	744	100%	100%	1,488	0	1,488
January	744	100%	100%	1,488	0	1,488
February	696	100%	100%	1,392	0	1,392
March	744	100%	100%	1,488	0	1,488
April	720	100%	0%	720	0	720
May	744	100%	0%	744	0	744
June	720	0%	0%	0	0	0
July	744	100%	0%	744	0	744

$$\text{Ice Hours} = \text{Available Hours} \times (\text{Arena 1} + \text{Arena 2})$$

$$\text{Chiller-Ice Hours} = \text{Ice Hours} + \text{2nd Rink Startup}$$

$$\text{2nd Rink Startup}_{\text{Sept.}} = \frac{168 \frac{\text{Hours}}{\text{Week}} \times 30 \frac{\text{Days}}{\text{Month}} \times \frac{3}{4} \text{ Months Run Time}}{7 \frac{\text{Days}}{\text{Week}}}$$

$$\text{2nd Rink Startup}_{\text{Oct.}} = \frac{168 \frac{\text{Hours}}{\text{Week}} \times 31 \frac{\text{Days}}{\text{Month}} \times \frac{1}{4} \text{ Months Run Time}}{7 \frac{\text{Days}}{\text{Week}}}$$

## APPENDIX A

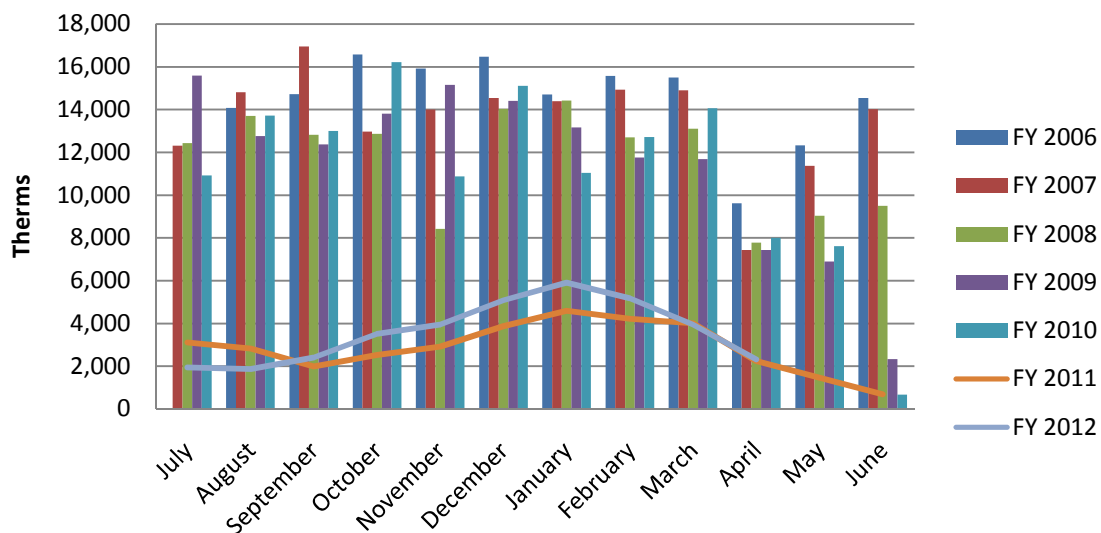
### FIM 11: Ice Arena Upgrades- Natural Gas

#### Natural Gas

Savings from FIM 11 are realized through comparison of utility bills. Below is the natural gas usage per month obtained from bills over the baseline year through the current date. Baseline data in the chart below is in green and year 1 contract data is in yellow.

Dover Ice Arena Natural Gas Billable Usage (Therms)						
Month	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13
August	13,703	12,769	13,718	2,828	1,869	-
September	12,817	12,369	13,008	1,995	2,403	-
October	12,869	13,804	16,225	2,527	3,522	-
November	8,430	15,155	10,880	2,917	3,956	-
December	14,039	14,410	15,114	3,875	5,092	-
January	14,419	13,171	11,041	4,593	5,911	-
February	12,708	11,754	12,717	4,225	5,183	-
March	13,110	11,687	14,072	4,003	3,955	-
April	7,784	7,441	8,006	2,246	2,323	-
May	9,038	6,892	7,616	1,470	-	-
June	9,495	2,336	675	688	-	-
July	15,589	10,925	3,110	1,943	-	-

### Dover Ice Arena- Monthly Natural Gas Usage





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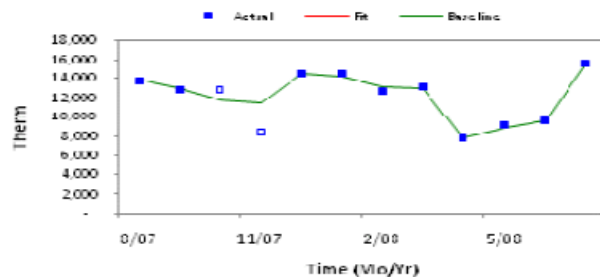
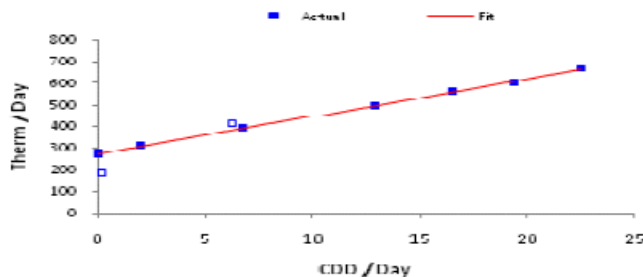
### FIM 11: Ice Arena Upgrades- Natural Gas

Using Metrix regression analysis software, a natural gas usage baseline was developed for the Ice Arena to be used in comparing bills with different weather and arena usage. The meter tuning contract for natural gas is included below. This provides the calculation of how the FIM 11 baseline for natural gas was developed.

#### Meter Tuning Contract

**Project: Dover, NH**  
**Area: Dover Ice Arena**  
**Account: 4170121-4061358**

**Site: Dover, NH**  
**Meter: Natural Gas**  
**Unit: Therm(Qty OnPk)**



From	To	# Days	Reading	Incl?	HDD	CDD	Chiller-Ice Hours	Offset	Baseline	Deviation
08/01/07	08/31/07	31	13,703	<input checked="" type="checkbox"/>	29.5	601.0	744	-	13,869	1.2%
09/01/07	09/30/07	30	12,817	<input checked="" type="checkbox"/>	109.0	386.0	1,428	-	12,980	1.3%
10/01/07	10/31/07	31	12,869	<input type="checkbox"/>	293.0	192.5	1,674	-	11,844	-8.0%
11/01/07	11/30/07	30	8,430	<input type="checkbox"/>	782.5	4.5	1,440	-	11,437	35.7%
12/01/07	12/31/07	31	14,439	<input checked="" type="checkbox"/>	1162.5	0.0	1,488	-	14,368	-0.5%
01/01/08	01/31/08	31	14,419	<input checked="" type="checkbox"/>	1134.5	0.5	1,488	-	14,168	-1.7%
02/01/08	02/29/08	29	12,708	<input checked="" type="checkbox"/>	1051.5	0.0	1,392	-	13,173	3.7%
03/01/08	03/31/08	31	13,110	<input checked="" type="checkbox"/>	970.5	0.0	1,488	-	12,941	-1.3%
04/01/08	04/30/08	30	7,784	<input checked="" type="checkbox"/>	491.5	58.5	720	-	7,829	0.6%
05/01/08	05/31/08	31	9,038	<input checked="" type="checkbox"/>	258.0	210.0	744	-	8,815	-2.5%
06/01/08	06/30/08	30	9,495	<input checked="" type="checkbox"/>	38.0	496.5	-	-	9,644	1.6%
07/01/08	07/31/08	31	15,589	<input checked="" type="checkbox"/>	0.0	697.5	744	-	15,316	-1.8%
<b>Sum/Average/Max</b>		<b>366</b>	<b>144,401</b>		<b>6320.5</b>	<b>2647.0</b>	<b>13,350</b>	<b>-</b>	<b>146,383</b>	<b>0% +/- 1.9%</b>

**Natural Gas (Account # 4170121-4061358): Tuning Period is 366 days from 8/1/2007 until 7/31/2008.**  
 Below is the equation used to calculate the Baseline values for the tuning period and all future periods:  

$$\text{Baseline (Therm)} = 26.26 \times \# \text{Days} + 7.43 \times \text{HDD} + 17.27 \times \text{CDD} + 3.3 \times \text{Chiller-Ice Hours}$$

The Baseline Equation has a Net Mean Bias of 0% and a Monthly Mean Error of +/-1.9%. The underlying regression has a  $R^2=0.991$   
 Baseline Costs are calculated using Average Total Cost/Consumption, but no less than \$1.242132/ Therm.

**Explanations and Assumptions:**

(empty checkbox) under 'Incl?' indicates that the bill is excluded from the regression. However the Baseline Equation is always applied for all billing periods, even those excluded from the regression.

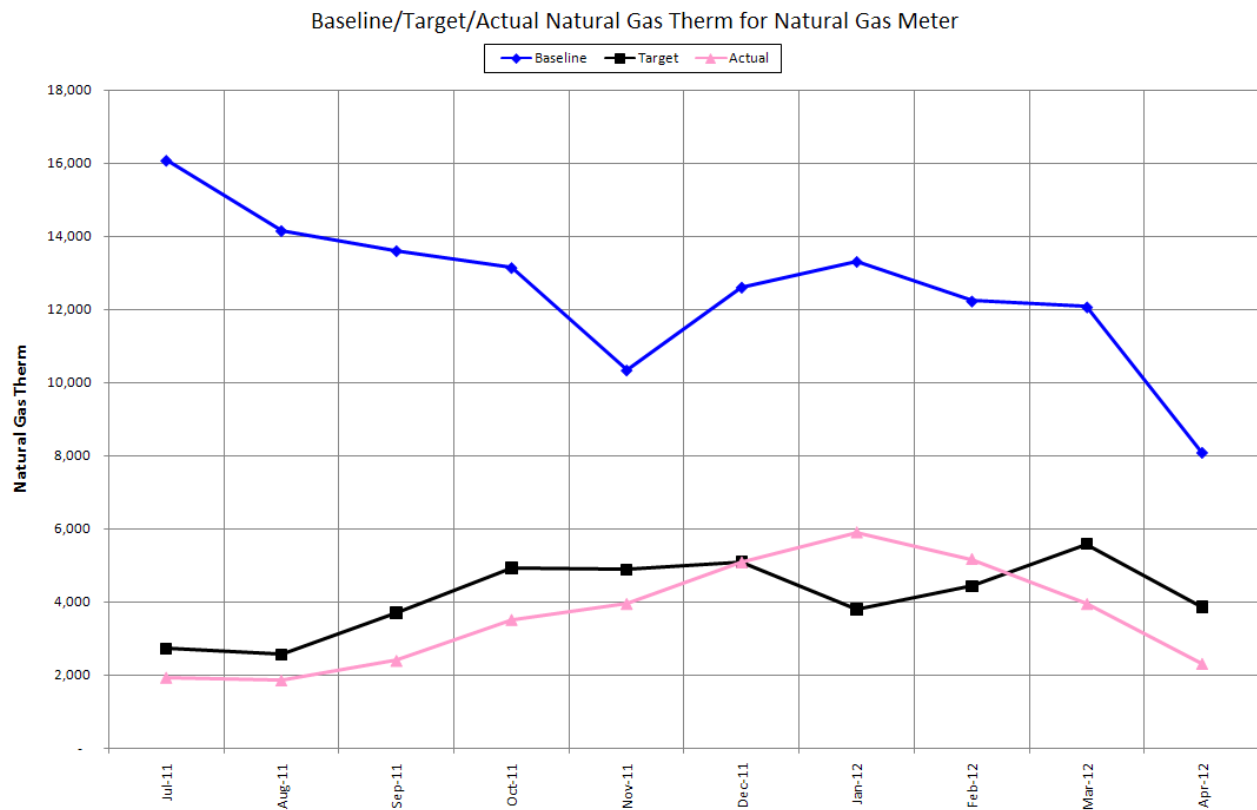
HDD = Heating Degree-Days calculated for ROCHESTERNH for a 63.0 F° balance point.  
 CDD = Cooling Degree-Days calculated for ROCHESTERNH for a 49.0 F° balance point.  
 Multiplier is derived from Modification(s) in effect during the tuning period and is replicated annually for all future periods.

The regression has a  $R^2$  value of 0.991 excluding two of the twelve baseline points, which is exceptionally better than required. As per the contract, the natural gas baseline is within 1.4% of the actual utility data complying with the necessary 2% mark.

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### FIM 11: Ice Arena Upgrades- Natural Gas

This regression analysis graph was run for natural gas usage. The three lines shown represent the calculated baseline (blue), target utility use based off calculations and guarantees (black), and actual ice arena utility use from utility invoices (pink).

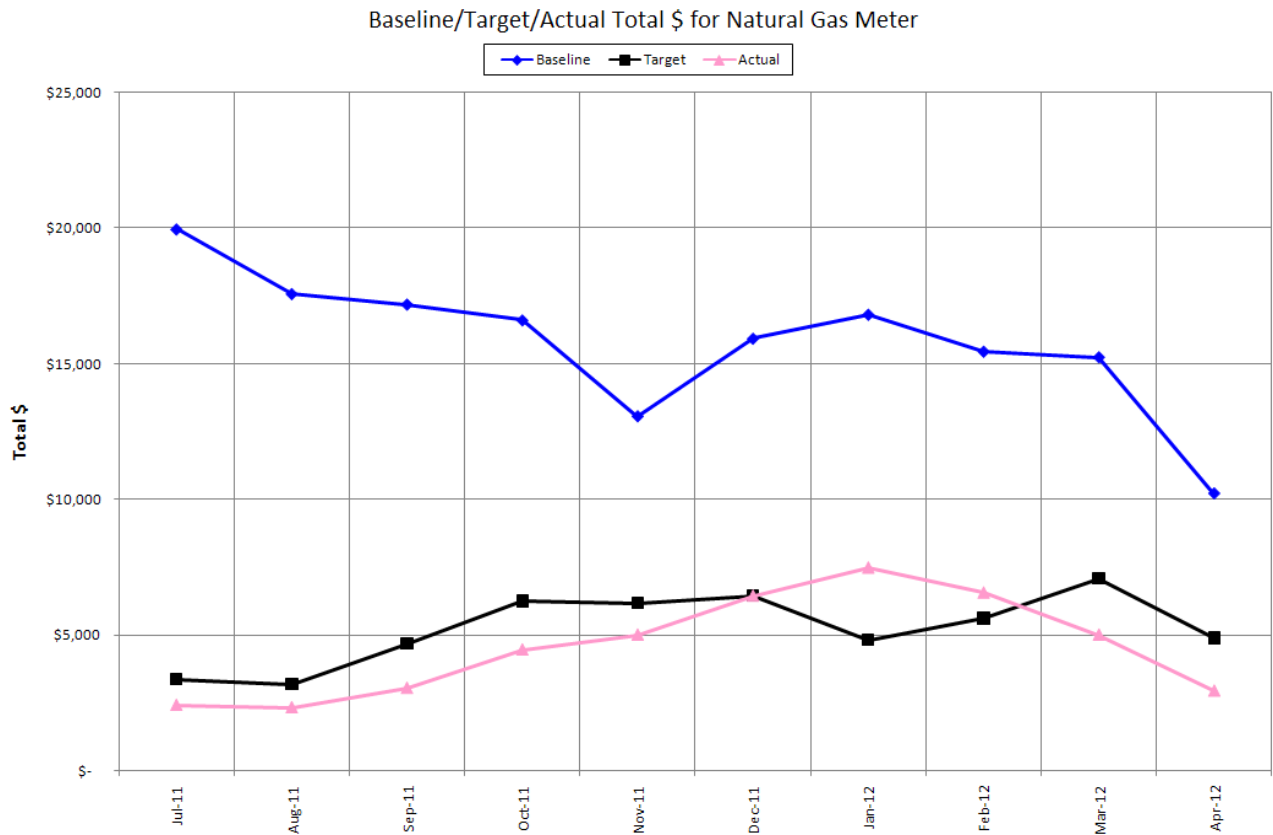


Scenario	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total
Baseline	16,076	14,150	13,600	13,138	10,331	12,602	13,305	12,222	12,059	8,075	125,557
Target	2,715	2,568	3,704	4,929	4,889	5,090	3,802	4,437	5,587	3,862	41,582
Actual	1,943	1,869	2,403	3,522	3,956	5,092	5,911	5,183	3,955	2,323	36,157
Savings	14,133	12,281	11,197	9,616	6,374	7,509	7,394	7,039	8,104	5,752	89,400

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Natural Gas

This regression analysis graph was run for natural gas cost. The three lines shown represent the calculated baseline (blue), target utility use based off calculations and guarantees (black), and actual ice arena utility use from utility invoices (pink).



Scenario	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total
Baseline	\$ 19,968	\$ 17,576	\$ 17,187	\$ 16,603	\$ 13,055	\$ 15,926	\$ 16,814	\$ 15,446	\$ 15,240	\$ 10,205	\$ 158,022
Target	\$ 3,372	\$ 3,189	\$ 4,681	\$ 6,229	\$ 6,179	\$ 6,433	\$ 4,804	\$ 5,607	\$ 7,060	\$ 4,881	\$ 52,435
Actual	\$ 2,413	\$ 2,322	\$ 3,037	\$ 4,451	\$ 5,000	\$ 6,435	\$ 7,470	\$ 6,550	\$ 4,998	\$ 2,936	\$ 45,612
Savings	\$ 17,555	\$ 15,255	\$ 14,150	\$ 12,152	\$ 8,056	\$ 9,490	\$ 9,344	\$ 8,896	\$ 10,242	\$ 7,269	\$ 112,409

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### FIM 11: Ice Arena Upgrades- Natural Gas

Since there are measures included at the Ice Arena that are not to be measured by utility bill analysis, they must be subtracted from the overall savings as to not be counted twice. Below is a table of Fiscal YTD natural gas savings from all other measures at the Ice Arena:

FIM 11: Ice Arena Upgrades		
Fiscal YTD Savings from Other FIMs		
FIM #	Thermal Savings	
	MMBtu	Cost \$
1	(78)	(\$983)
2	0	\$0
3	314	\$3,937
6	44	\$553
9	0	\$0
12	0	\$0
13	0	\$0
<b>Total</b>	<b>279</b>	<b>\$3,507</b>

Natural Gas consumption savings from the analysis are 89,400 therms fiscal year to date. Of those, as seen in the table above, 2,794 therms are from different measures within this project. So the total reported savings from FIM 11 in Fiscal Year 2012 to Date is 86,606 therms.

The natural gas cost savings from the analysis are \$112,409 with \$3,507 in savings coming from other FIMs. By isolating and removing savings from the other measures, the total FIM 11 natural gas utility analysis cost savings is \$108,903.

FIM 11: Ice Arena Upgrades		
Fiscal YTD Energy Cost Savings		
Building	Thermal Savings	
	MMBtu	Cost \$
Ice Arena	8,661	\$108,903

## APPENDIX A

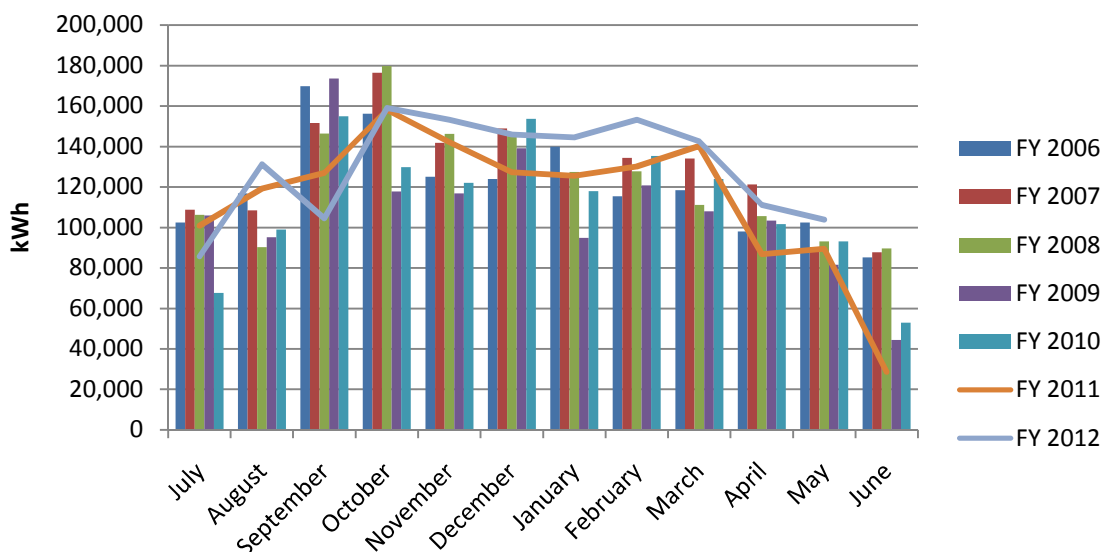
### FIM 11: Ice Arena Upgrades- Electric

Electric

Savings from FIM 11 were obtained through utility bill analysis. Below is the electric consumption per month obtained from bills for the baseline year through the installation period. Baseline data is in green and year 1 contract data is in yellow.

Dover Ice Arena Electric Consumption (kWh)						
Month	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13
September	146,400	173,600	155,000	126,800	104,400	-
October	179,800	117,800	129,800	158,000	159,000	-
November	146,200	116,800	122,000	142,000	153,200	-
December	145,200	139,200	153,600	127,200	145,800	-
January	127,400	94,800	118,000	125,400	144,400	-
February	127,800	120,800	135,400	130,000	153,200	-
March	111,200	108,000	124,000	140,200	142,400	-
April	105,600	103,400	101,600	86,800	111,000	-
May	93,200	81,600	93,200	89,400	103,800	-
June	89,600	44,400	53,000	28,600	-	-
July	106,000	67,600	100,800	85,600	-	-
August	95,200	99,000	119,200	131,200	-	-

### Dover Ice Arena- Monthly Electricity Usage



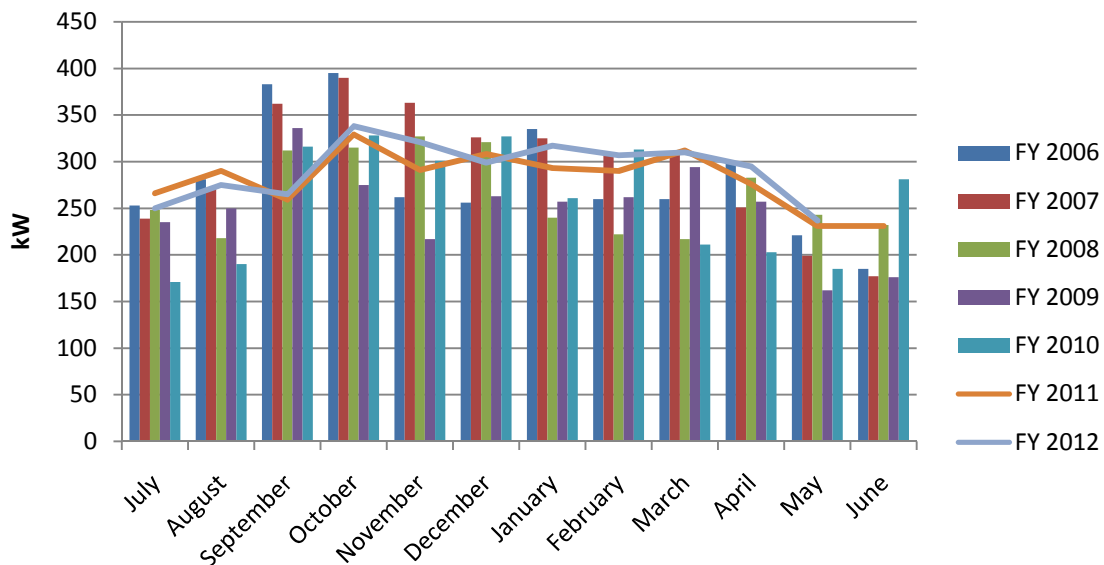
## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

Below is the electric demand per month obtained from bills from the baseline year through the installation period. Baseline data is in **green** and year 1 contract data is in **yellow**.

Dover Ice Arena Electric Demand (kW)						
Month	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13
September	312	336	316	259	265	-
October	315	275	328	329	338	-
November	327	217	301	291	321	-
December	321	263	327	308	299	-
January	240	257	261	293	317	-
February	222	262	313	290	307	-
March	217	294	211	312	310	-
April	283	257	203	276	295	-
May	243	162	185	231	237	-
June	232	176	281	231	-	-
July	235	171	266	250	-	-
August	250	190	290	275	-	-

### Dover Ice Arena- Monthly Electricity Demand



## APPENDIX A

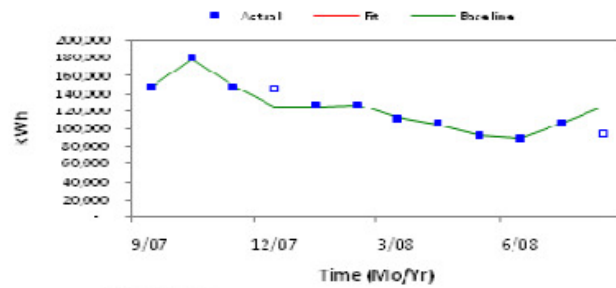
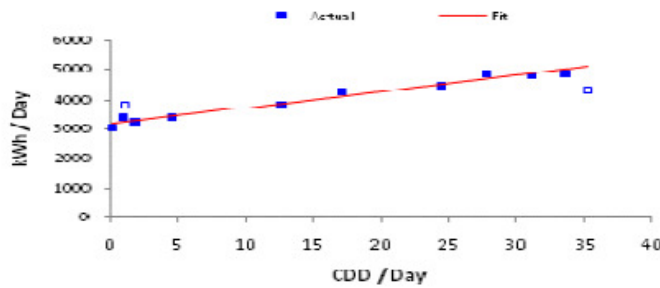
### FIM 11: Ice Arena Upgrades- Electric

Using Metrix regression analysis software, a electric consumption baseline was developed for the Ice Arena to be used in comparing bills with different weather and arena usage. The meter tuning contract for electric kWh is included below. This provides the calculation of how the baseline for electric consumption was developed.

#### Meter Tuning Contract

**Project:** Dover, NH  
**Area:** Dover Ice Arena  
**Account:** 8000626-01-6-2

**Site:** Dover, NH  
**Meter:** Electric  
**Unit:** kWh(Qty OnPk)



From	To	# Days	Reading	Incl?	HDD	CDD	Chiller-Ice Hours	Offset	Baseline	Deviation
08/14/07	09/13/07	31	146,400	<input checked="" type="checkbox"/>	0.0	964.5	1,065	-	147,571	0.8%
09/14/07	10/15/07	32	179,800	<input checked="" type="checkbox"/>	0.0	782.5	1,619	-	177,848	-1.1%
10/16/07	11/14/07	30	146,200	<input checked="" type="checkbox"/>	0.0	381.5	1,536	-	147,868	1.1%
11/15/07	12/15/07	31	145,200	<input type="checkbox"/>	0.0	36.5	1,488	-	125,102	-13.8%
12/16/07	01/15/08	31	127,400	<input checked="" type="checkbox"/>	0.0	57.0	1,488	-	126,276	-0.9%
01/16/08	02/16/08	32	127,800	<input checked="" type="checkbox"/>	0.0	6.0	1,536	-	127,322	-0.4%
02/17/08	03/15/08	28	111,200	<input checked="" type="checkbox"/>	0.0	27.5	1,344	-	112,682	1.3%
03/16/08	04/15/08	31	105,600	<input checked="" type="checkbox"/>	0.0	143.5	1,128	-	105,096	-0.5%
04/16/08	05/14/08	29	93,200	<input checked="" type="checkbox"/>	0.0	495.0	696	-	92,904	-0.3%
05/15/08	06/12/08	29	89,600	<input checked="" type="checkbox"/>	0.0	805.5	408	-	89,784	0.2%
06/13/08	07/15/08	33	106,000	<input checked="" type="checkbox"/>	0.0	1113.0	360	-	105,849	-0.1%
07/16/08	08/13/08	29	95,200	<input type="checkbox"/>	0.0	1024.5	696	-	123,239	29.5%
<b>Sum/Average/Max</b>		<b>366</b>	<b>1,473,600</b>		<b>0.0</b>	<b>5837.0</b>	<b>13,364</b>	<b>-</b>	<b>1,481,540</b>	<b>0% +/- 0.9%</b>

**Electric (Account # 8000626-01-6-2): Tuning Period is 366 days from 8/14/2007 until 8/13/2008.**

Below is the equation used to calculate the Baseline values for the tuning period and all future periods:

$$\text{Baseline (kWh)} = 483.36 \times \# \text{Days} + 57.29 \times \text{CDD} + 72.6 \times \text{Chiller-Ice Hours}$$

The Baseline Equation has a Net Mean Bias of 0% and a Monthly Mean Error of +/-0.9%. The underlying regression has a  $R^2=0.998$   
 Baseline Costs are calculated using Average Cost/Consumption, but no less than \$0.106/ kWh.

**Explanations and Assumptions:**

(empty checkbox) under 'Incl?' indicates that the bill is excluded from the regression. However the Baseline Equation is always applied for all billing periods, even those excluded from the regression.

CDD = Cooling Degree-Days calculated for ROCHESTERNH for a 34.0 F<sup>a</sup> balance point.

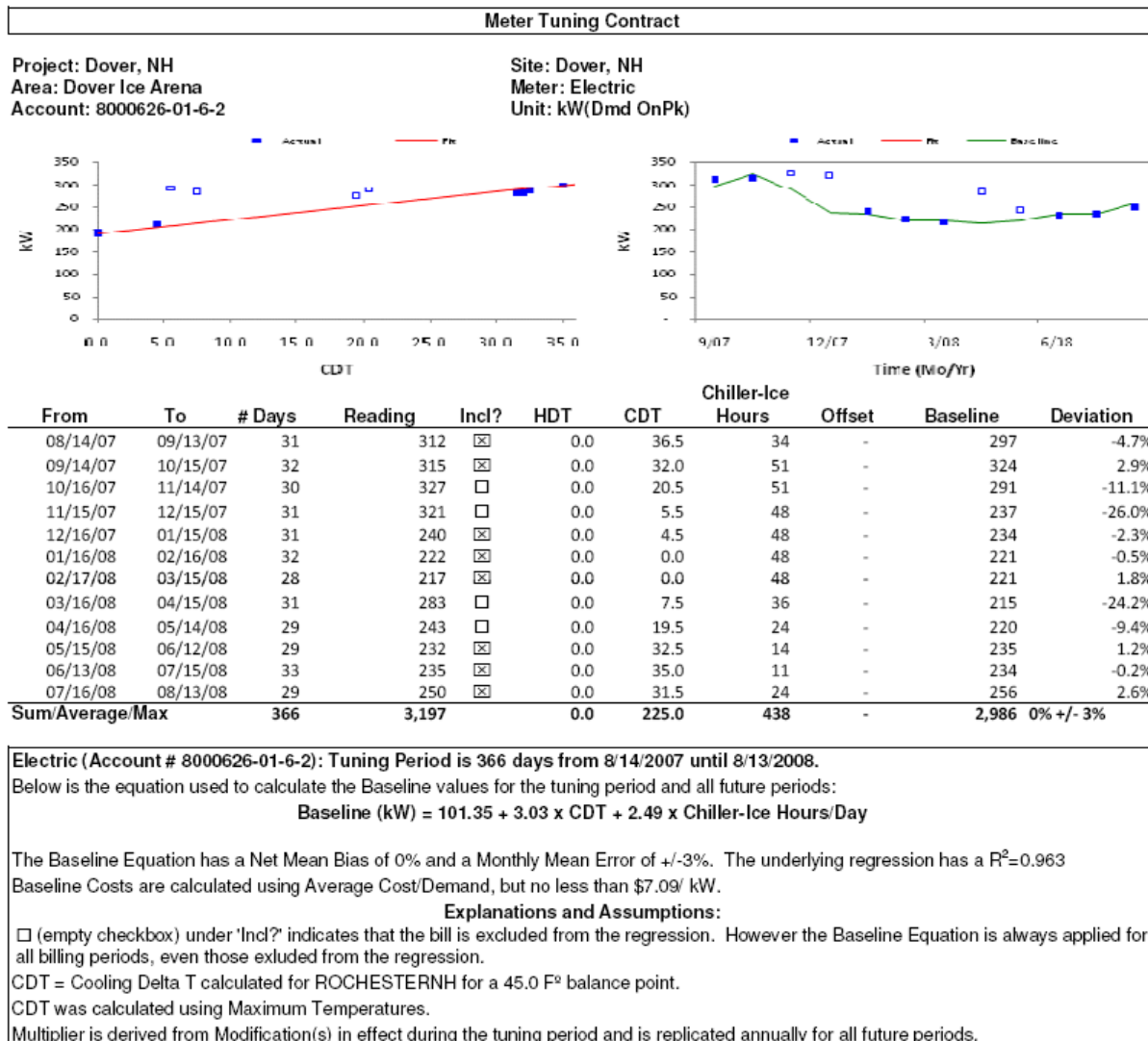
Multiplier is derived from Modification(s) in effect during the tuning period and is replicated annually for all future periods.

The regression has a  $R^2$  value of 0.998 excluding two of the twelve baseline points, which is exceptionally better than required. As per the contract, the electric consumption baseline is within 0.5% of the actual utility data complying with the necessary 2% mark.

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

Using Metrix regression analysis software, a electric demand baseline was developed for the Ice Arena to be used in comparing bills with different weather and arena usage. The meter tuning contract for electric kW is included below. This provides the calculation of how the baseline for electric demand was developed.



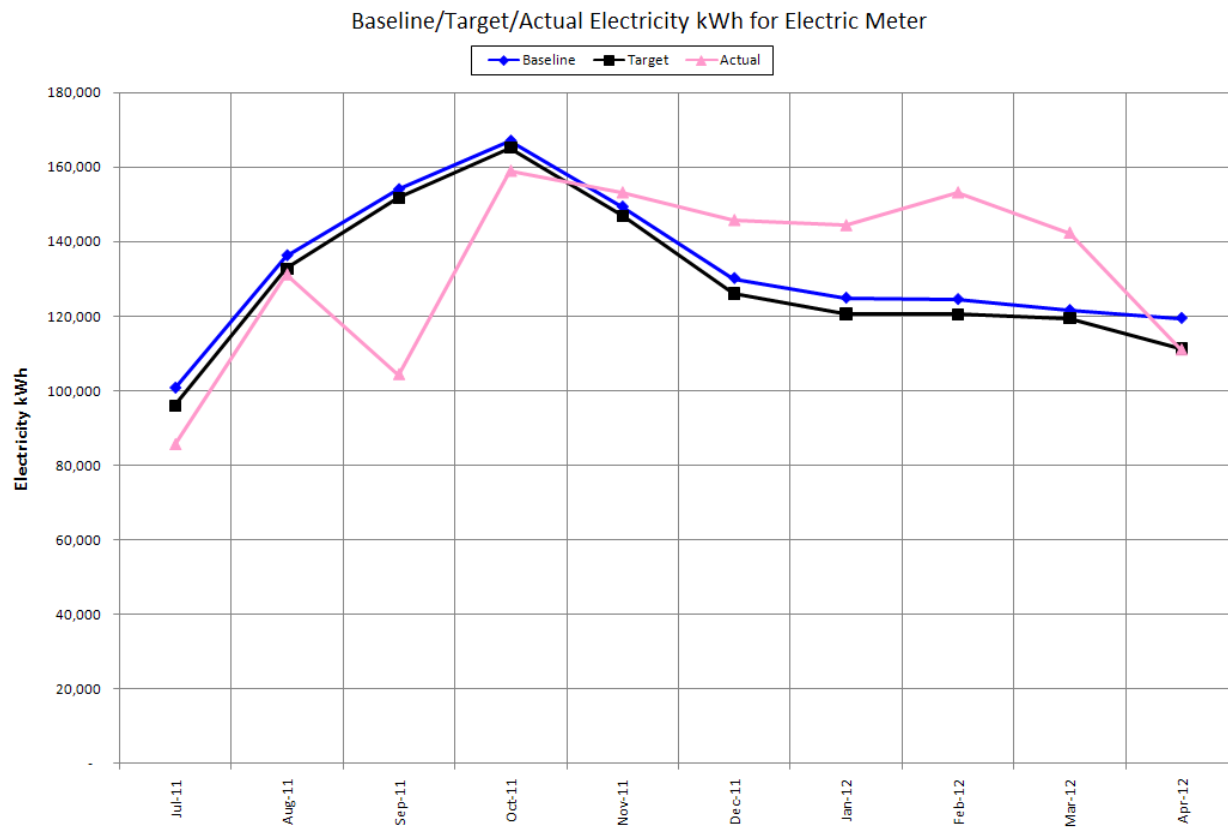
The regression has a  $R^2$  value of 0.963 excluding four of the twelve baseline points, which is better than required. The electric consumption baseline is within 6.6% of the actual utility data. Since demand is not as cut and dry as other measures, it is difficult to determine a solution that would fall within the 2% difference. The difference of 4.6% is on the lower end of the baseline which in the end benefits the City of Dover. Johnson Controls accepts this difference and believes it is the best and most sensible option moving forward.



## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

This regression analysis graph was run for electric kWh consumption. The three lines shown represent the calculated baseline (blue), target utility use based off calculations and guarantees (black), and actual ice arena utility use from utility invoices (pink).

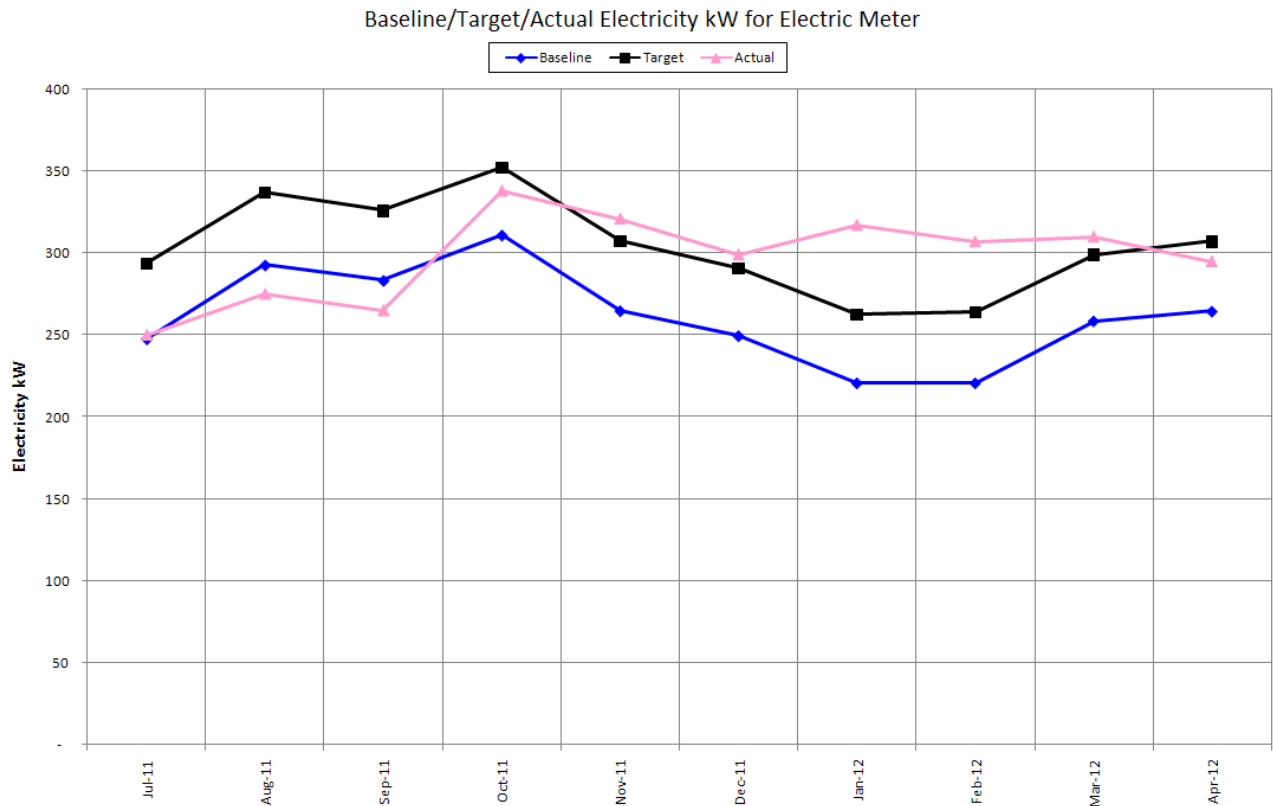


Scenario	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total
Baseline	100,732	136,312	154,077	167,076	149,372	130,185	124,901	124,529	121,605	119,476	1,328,267
Target	96,145	132,760	151,801	165,163	146,969	126,173	120,703	120,526	119,510	111,344	1,291,093
Actual	85,600	131,200	104,400	159,000	153,200	145,800	144,400	153,200	142,400	111,000	1,330,200
Savings	15,132	5,112	49,677	8,076	(3,828)	(15,615)	(19,499)	(28,671)	(20,795)	8,476	(1,933)

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

This regression analysis was run for electric kW demand. The three lines shown represent the calculated baseline (blue), target utility use based off calculations and guarantees (black), and actual ice arena utility use from utility invoices (pink).

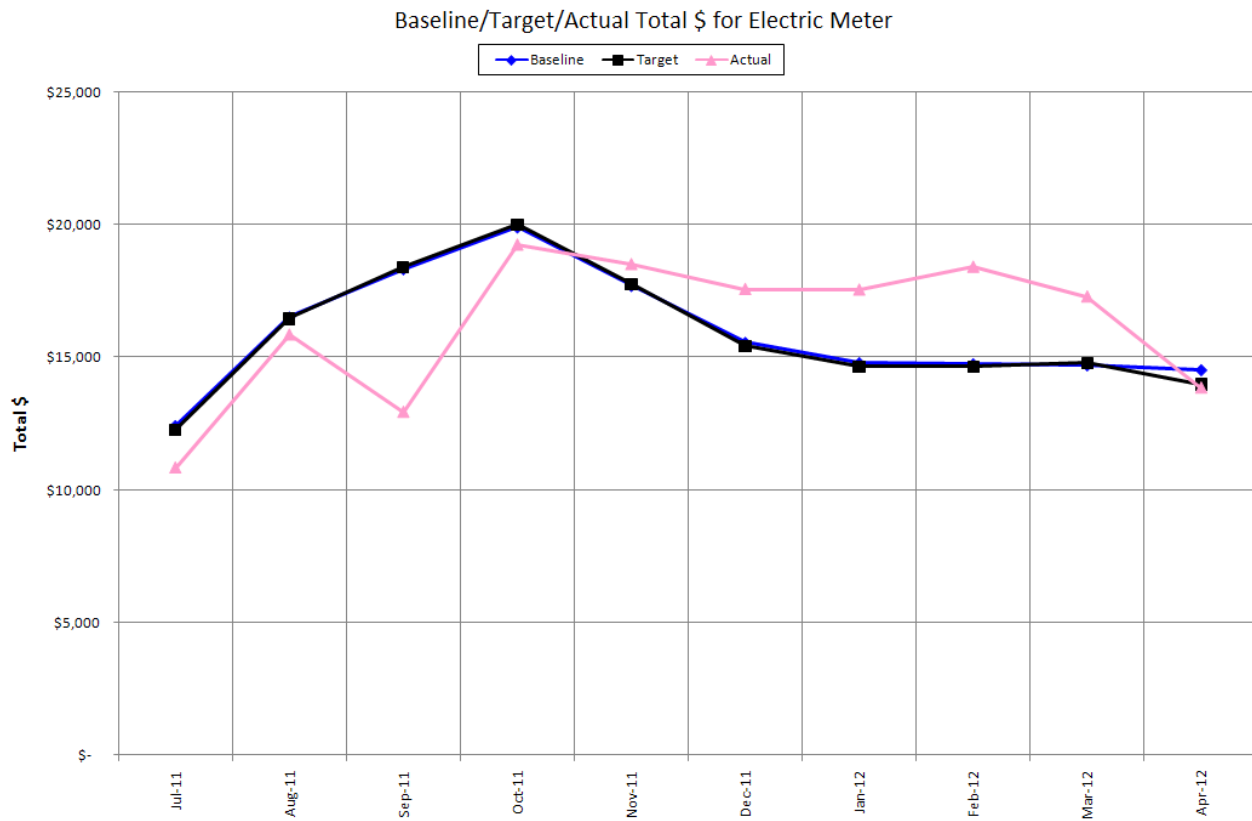


Scenario	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total
Baseline	248	293	283	311	265	250	221	221	259	265	2,614
Target	294	337	326	352	308	291	263	264	299	307	3,042
Actual	250	275	265	338	321	299	317	307	310	295	2,977
Savings	(2)	18	18	(27)	(56)	(49)	(96)	(86)	(51)	(30)	(363)

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

This regression analysis was run for electric cost which includes both demand and consumption. The three lines shown represent the calculated baseline (blue), target utility use based off calculations and guarantees (black), and actual ice arena utility use from utility invoices (pink).



Scenario	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	Total
Baseline	\$ 12,434	\$ 16,524	\$ 18,341	\$ 19,915	\$ 17,711	\$ 15,569	\$ 14,805	\$ 14,766	\$ 14,724	\$ 14,540	\$ 159,329
Target	\$ 12,276	\$ 16,464	\$ 18,403	\$ 20,006	\$ 17,760	\$ 15,437	\$ 14,658	\$ 14,650	\$ 14,790	\$ 13,981	\$ 158,425
Actual	\$ 10,846	\$ 15,857	\$ 12,945	\$ 19,250	\$ 18,515	\$ 17,575	\$ 17,554	\$ 18,416	\$ 17,292	\$ 13,858	\$ 162,108
Savings	\$ 1,588	\$ 667	\$ 5,396	\$ 665	\$ (804)	\$ (2,006)	\$ (2,749)	\$ (3,650)	\$ (2,568)	\$ 682	\$ (2,779)

## APPENDIX A

### FIM 11: Ice Arena Upgrades- Electric

Again, since there are measures included at the Ice Arena that are not to be measured by utility bill analysis, they need to be subtracted from the overall savings as to not be counted twice. Below is a table of electric Fiscal YTD savings from all other FIMs at the Ice Arena:

FIM 11: Ice Arena Upgrades			
Fiscal YTD Savings from Other FIMs			
FIM #	Electricity Savings		
	kW	kWh	Cost \$
1	118	41,307	\$5,219
2	49	10,865	\$1,152
3	0	3,264	\$346
6	0	0	\$0
9	0	2,503	\$265
12	0	0	\$0
13	44	17,081	\$2,179
<b>Total</b>	<b>211</b>	<b>75,020</b>	<b>\$9,160</b>

Electric consumption savings from the analysis is a negative 1,933 kWh. Additionally 75,020 kWh are from different measures within this project. So the total reported additional usage from FIM 11 is 76,953 kWh.

Similarly, the electric demand savings from the graphical analysis are a 363 kW increase. 211 kW were saved from other measures not to be included in the FIM 11 utility bill analysis. This leaves a demand increase of 574 kW over the reporting period.

Lastly, electric cost savings from the regression analysis are a negative \$2,779. Savings from other measures total electric savings of \$9,160. By isolating and removing the other FIM cost savings, the total FIM 11 electric utility analysis additional cost usage is \$11,940.

FIM 11: Ice Arena Upgrades			
Fiscal YTD Energy Cost Savings			
Building	Electricity Savings		
	kW	kWh	Cost \$
Ice Arena	(574)	(76,953)	(\$11,940)

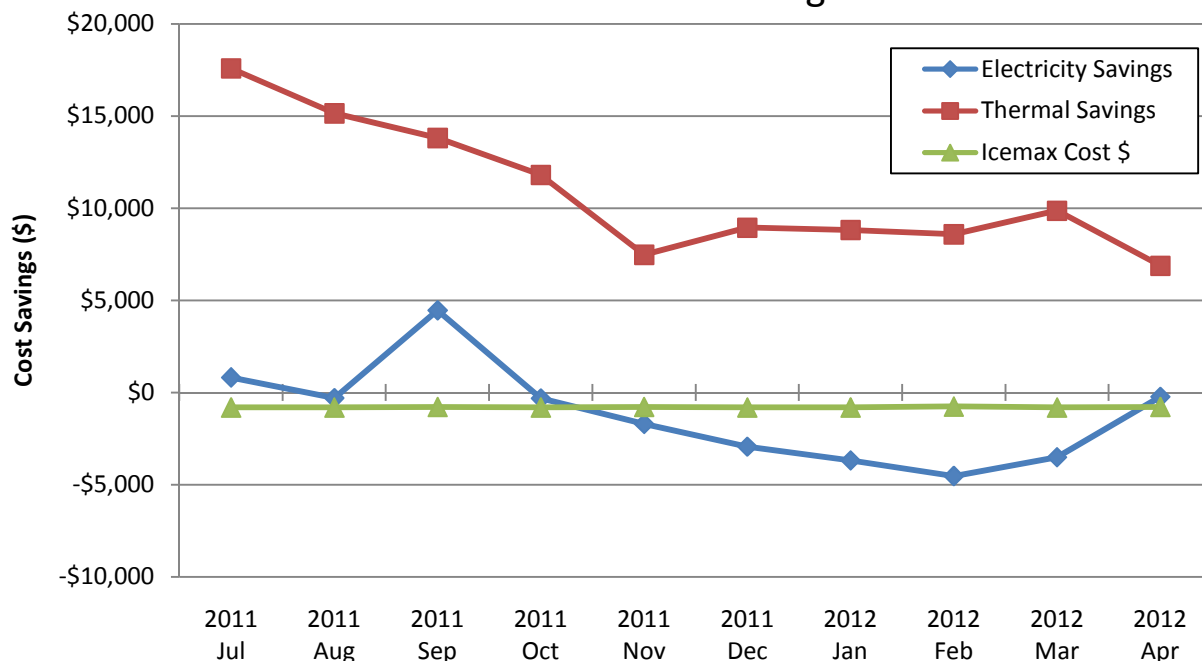
## APPENDIX A

### FIM 11: Ice Arena Upgrades

Breaking out the energy savings on a monthly basis and combining all previous figures, the total FIM 11 savings for FY 2012 to Date are listed below:

FIM 11: Ice Arena Upgrades								
Fiscal YTD Energy Cost Savings								
Month	Year	Electricity Savings			Thermal Savings		Icemax Cost \$	Total Cost \$ Savings
		kW	kWh	Cost \$	MMBtu	Cost \$		
July	2011	(19)	8,293	\$818	1,415	\$17,578	(\$811)	\$17,586
August	2011	(4)	(3,289)	(\$302)	1,219	\$15,146	(\$811)	\$14,032
September	2011	(3)	41,894	\$4,452	1,100	\$13,809	(\$785)	\$17,477
October	2011	(49)	231	(\$320)	931	\$11,800	(\$811)	\$10,669
November	2011	(78)	(10,887)	(\$1,704)	589	\$7,476	(\$785)	\$4,987
December	2011	(71)	(22,923)	(\$2,935)	706	\$8,946	(\$811)	\$5,200
January	2012	(118)	(26,807)	(\$3,678)	695	\$8,815	(\$811)	\$4,326
February	2012	(108)	(35,869)	(\$4,528)	680	\$8,588	(\$759)	\$3,301
March	2012	(73)	(28,544)	(\$3,510)	780	\$9,864	(\$811)	\$5,543
April	2012	(52)	948	(\$233)	544	\$6,881	(\$785)	\$5,863
<b>Total Contract TD</b>		<b>(499)</b>	<b>(124,082)</b>	<b>(\$16,588)</b>	<b>3,995</b>	<b>\$50,570</b>	<b>(\$8,791)</b>	<b>\$25,191</b>
<b>Total Fiscal YTD</b>		<b>(574)</b>	<b>(76,953)</b>	<b>(\$11,940)</b>	<b>8,661</b>	<b>\$108,903</b>	<b>(\$7,980)</b>	<b>\$88,983</b>

### FIM 11- Ice Arena Savings



## APPENDIX A

### FIM 12: Power Factor Correction

Savings for FIM 12 will be obtained from the date of installation acceptance going forward. However, since this measure is not complete, there are no savings to report.

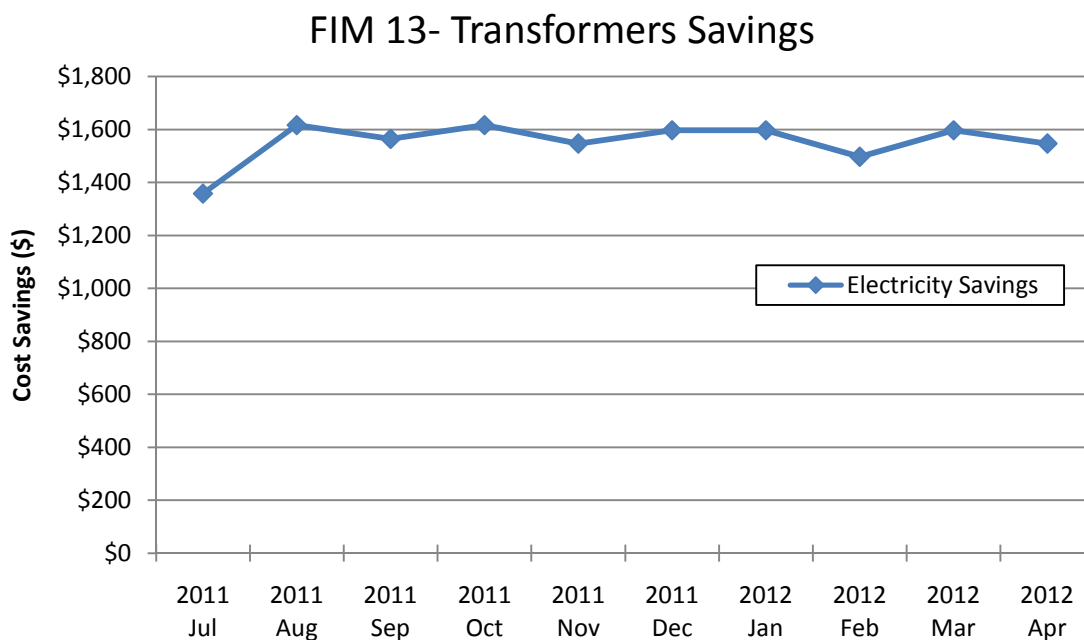
FIM 12: Power Factor Correction					
Fiscal YTD Energy Cost Savings					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
<b>Total</b>		<b>0</b>	<b>0</b>	<b>\$0</b>	<b>\$0</b>

## APPENDIX A

### FIM 13: Transformers

The FIM 13 table breaks down the measure by month over the fiscal year. Savings for the replacement of transformers come from two different completion dates. The Ice Arena was completed in August 2011 and the rest of the buildings associated with FIM 13 were completed in August of 2010.

FIM 13: Transformers					
Fiscal YTD Energy Cost Savings					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
July	2011	22	10,861	\$1,357	\$1,357
August	2011	27	12,793	\$1,616	\$1,616
September	2011	27	12,380	\$1,564	\$1,564
October	2011	27	12,793	\$1,616	\$1,616
November	2011	27	12,380	\$1,546	\$1,546
December	2011	27	12,793	\$1,597	\$1,597
January	2012	27	12,793	\$1,597	\$1,597
February	2012	27	11,968	\$1,496	\$1,496
March	2012	27	12,793	\$1,597	\$1,597
April	2012	27	12,380	\$1,546	\$1,546
<b>Total Contract TD</b>		<b>159</b>	<b>75,108</b>	<b>\$9,379</b>	<b>\$9,379</b>
<b>Total Fiscal YTD</b>		<b>260</b>	<b>123,935</b>	<b>\$15,532</b>	<b>\$15,532</b>

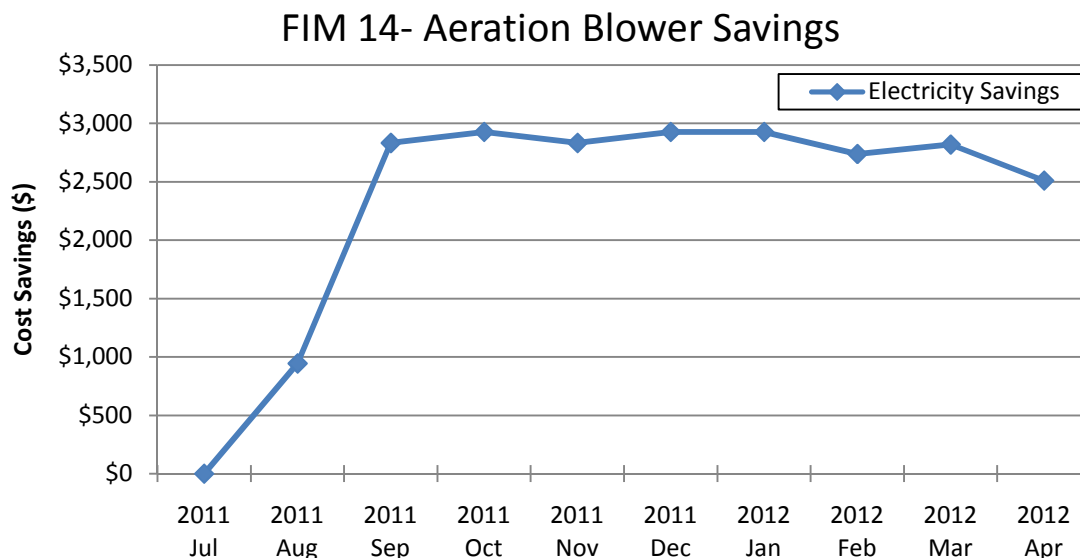


## APPENDIX A

### FIM 14: Aeration Blower Upgrade

The FIM 14 table breaks down the measure by month over the fiscal year. The aeration blowers at the waste water treatment facility were completed in August 2011. The silencer was added to the unit in March 2012 allowing for the recommended 24-7 run time to control odors. This has been included in the savings below.

FIM 14: Aeration Blower Upgrade					
Fiscal YTD Energy Cost Savings					
Month	Year	Electricity Savings			Total Cost \$ Savings
		kW	kWh	Cost \$	
July	2011	0	0	\$0	\$0
August	2011	0	7,690	\$944	\$944
September	2011	64	23,070	\$2,833	\$2,833
October	2011	64	23,839	\$2,927	\$2,927
November	2011	64	23,070	\$2,833	\$2,833
December	2011	64	23,839	\$2,927	\$2,927
January	2012	64	23,839	\$2,927	\$2,927
February	2012	64	22,301	\$2,738	\$2,738
March	2012	60	22,944	\$2,820	\$2,820
April	2012	60	20,384	\$2,511	\$2,511
<b>Total Contract TD</b>		<b>377</b>	<b>136,377</b>	<b>\$16,757</b>	<b>\$16,757</b>
<b>Total Fiscal YTD</b>		<b>505</b>	<b>190,976</b>	<b>\$23,461</b>	<b>\$23,461</b>





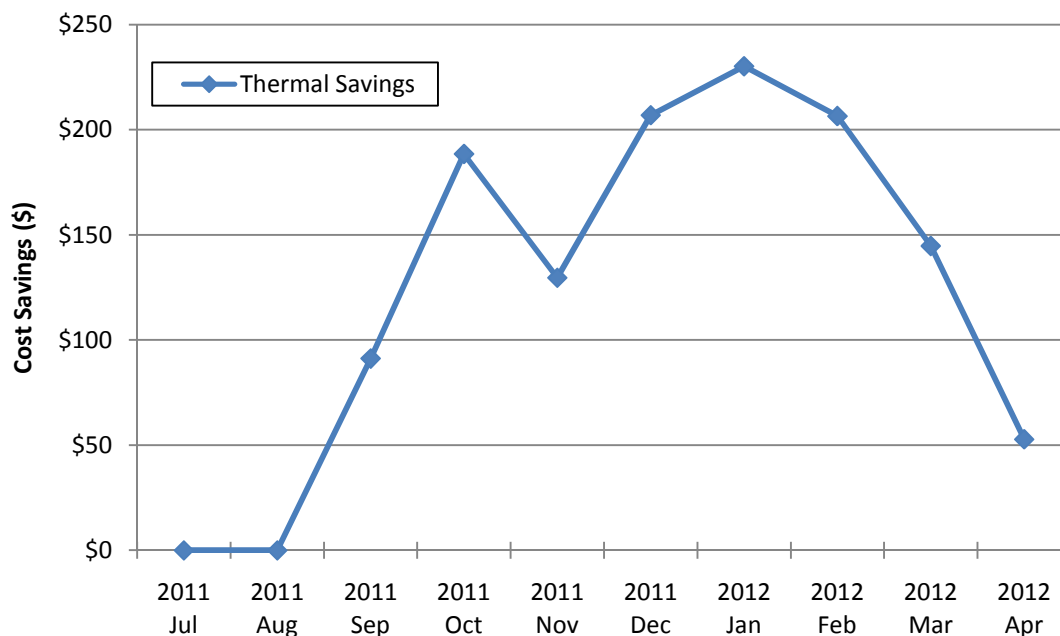
## APPENDIX A

### FIM 15: Boiler Replacement

Annual savings are concentrated over the winter months from mid September through mid April with a partial weighting for weather over that time.

FIM 15: Boiler Replacement				
Fiscal YTD Energy Cost Savings				
Month	Year	Thermal Savings		Total Cost \$ Savings
		MMBTU	Cost \$	
July	2011	0	\$0	\$0
August	2011	0	\$0	\$0
September	2011	6	\$91	\$91
October	2011	13	\$189	\$189
November	2011	9	\$130	\$130
December	2011	15	\$207	\$207
January	2012	16	\$230	\$230
February	2012	15	\$207	\$207
March	2012	10	\$145	\$145
April	2012	4	\$53	\$53
<b>Total Contract TD</b>		<b>69</b>	<b>\$971</b>	<b>\$971</b>
<b>Total Fiscal YTD</b>		<b>88</b>	<b>\$1,251</b>	<b>\$1,251</b>

### FIM 15- Boiler Replacement Savings



## APPENDIX B

### Performance Contract Project Progress

City of Dover- Year 1 Performance Contracting Tracking			
Quarter	<sup>(8)</sup> Annual Guaranteed Savings	Total Reported Savings	Percentage Savings of Guarantee
1 (N,D,J)	-	<sup>(9)</sup> \$74,103	23.2%
2 (F,M,A)	-	\$70,904	22.2%
3 (M,J,J)	-	N/A	N/A
4 (A,S,O)	-	N/A	N/A
Total	\$319,463	\$145,007	45.4%

<sup>(8)</sup> Annual guaranteed savings are guaranteed on an annual basis

<sup>(9)</sup> Number has been edited from previous reported values due to McConnell Center lighting count

Year 1 total reported savings to date include November 2011 through January 2012 as per the November 1<sup>st</sup> start date of the performance period.

City of Dover Performance Contracting Tracking			
Period	<sup>(10)</sup> Total Guaranteed Savings	Reported Savings to Date	Performance Contract Savings
Installation	\$0	\$400,730	\$0
Year 1	\$319,463	\$145,007	\$145,007
Year 2	\$328,236		
Year 3	\$337,280		
Year 4	\$346,603		
Year 5	\$356,214		
Year 6	\$366,122		
Year 7	\$376,336		
Year 8	\$386,865		
Year 9	\$397,719		
Year 10	\$408,909		
<b>Total Contract</b>	<b>\$3,623,746</b>	<b>N/A</b>	<b>\$145,007</b>

<sup>(10)</sup> Guaranteed Savings baseline has been adjusted from original contract to reflect CO # 9236-0142-CO2 associated with the McConnell Center (added lighting and lighting controls)

As mentioned in the report, savings for the Ice Arena which are a substantial part of the entire project are seen as slightly weighted into the summer months. This is expected to bring the project back to close to overall even in the upcoming six months of the contract year based off previous measurements and utility usage history. The following report will provide a good indication of the savings during warmer months when only one ice sheet is used at the arena.

## APPENDIX B

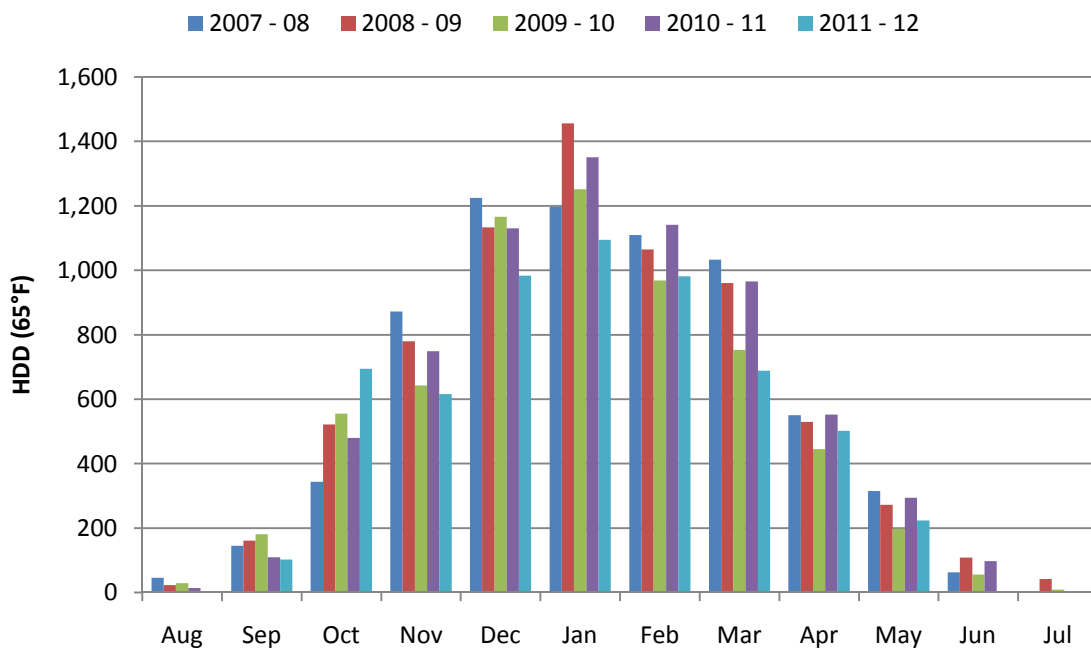
### Weather Degree Days

Weather data obtained from Skyhaven Airport Weather Station, Rochester, NH for Base 65°F.

Rochester, NH Weather Heating Degree Days (Base 65°F)

Report Period	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13
August	46.0	23.0	29.0	14.0	3.5	
September	145.5	160.5	181.0	109.0	102.0	
October	344.0	521.5	555.0	480.0	694.0	
November	872.5	780.0	643.0	749.0	616.0	
December	1,224.5	1,133.0	1,166.0	1,130.5	983.5	
January	1,196.5	1,456.0	1,251.5	1,350.5	1,094.0	
February	1,109.5	1,064.5	968.5	1,141.5	981.5	
March	1,032.5	960.5	752.5	965.5	688.0	
April	550.5	529.0	445.0	552.5	502.0	
May	315.0	272.5	197.5	294.0	223.5	
June	63.0	108.5	55.5	97.0		
July	0.0	41.5	8.5	0.0		

The baseline period is highlighted in green and year 1 contract period is yellow.

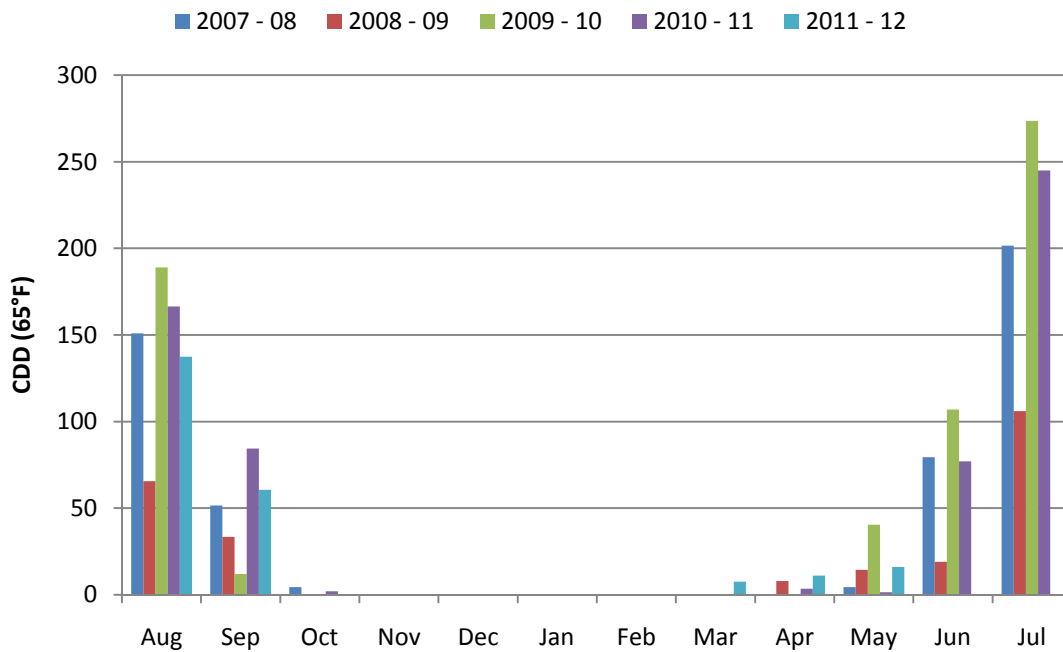


## APPENDIX B

Rochester, NH Weather Cooling Degree Days (Base 65°F)

Report Period	2007 - 08	2008 - 09	2009 - 10	2010 - 11	2011 - 12	2012 - 13
August	151.0	65.5	189.0	166.5	137.5	
September	51.5	33.5	12.0	84.5	60.5	
October	4.5	0.0	0.0	2.0	0.0	
November	0.0	0.0	0.0	0.0	0.0	
December	0.0	0.0	0.0	0.0	0.0	
January	0.0	0.0	0.0	0.0	0.0	
February	0.0	0.0	0.0	0.0	0.0	
March	0.0	0.0	0.0	0.0	7.5	
April	0.0	8.0	0.0	3.5	11.0	
May	4.5	14.5	40.5	1.5	16.0	
June	79.5	19.0	107.0	77.0		
July	201.5	106.0	273.5	245.0		

The baseline period is highlighted in green and year 1 contract period is yellow.



## APPENDIX B

### Utility Rate Schedule

Contractual utility rates were used in calculating savings throughout this report. Utility rates were obtained from Schedule C: Part III of the contract.

Rate Summary Table							
City of Dover, NH Building Location	Electric		Natural Gas \$/Therm	Oil \$/Therm	Propane \$/Therm	Water \$/HCF	Sewer \$/HCF
	\$/kW	\$/kWh					
Indoor Pool	\$8.82	\$0.104	\$1.437	-	-	\$3.75	\$4.51
Dover Ice Arena	\$7.09	\$0.105	\$1.264	-	-		
Waste Water Treatment Facility	\$7.03	\$0.119	-	\$1.667	-		
Dover City Hall	-	\$0.125	-	\$1.667	-		
Public Works	-	\$0.128	\$1.128	-	-		
McConnell Center	\$7.10	\$0.107	\$1.412	-	-		
Dover Public Library	-	\$0.135	\$1.414	-	-		
Jenny Thompson Pool	-	\$0.126	\$1.349	-	-		
Central Fire Station	-	\$0.125	\$1.528	-	-		
South End Fire Station	-	\$0.128	-	-	\$1.768		
Pine Hill Chapel	-	\$0.169	-	\$1.667	-		
Pine Hill Barn	-	\$0.200	-	\$1.667	-		
Veterans Hall	-	\$1.650	\$1.803	-	-		
Dover Train Station	-	\$0.122	\$1.913	-	-		

Note: Unblended cost if demand charges are available, if not blended cost

## APPENDIX B

### Glossary

Actual Utility Usage (FIM 11)- Amount of electricity or natural gas used; Obtained from invoices received through utility companies

Baseline- The adjusted pre-retrofit bills (usually one year) used to compare to the post-retrofit energy usage in order to provide a basis for calculating savings; can be adjusted for variables such as weather, hours, etc.

Construction Period- The period between the commencement date and the first day of the month following the date of Substantial Completion

Contract Savings- Savings obtained over the course of the contract, in this case from the start of Year 1

Cost Avoidance- Dollars that would have been spent if the energy conservation measures had not been installed.

Degree Day- A unit of measurement equal to a difference of one degree between the mean outdoor temperature on a certain day and a reference temperature (can be summed monthly or yearly). For example, an outdoor temperature of 30°F would be 35 Heating Degree Days with a base temperature of 65°F.

FIM- Facility improvement measure, sometimes referred to as energy conservation measure (ECM)

Fiscal Year Savings- Savings occurring over the course of a fiscal year; Dover's runs from July through June

Guarantee Period- The period of time typically after the date of Substantial Completion. This period starts the reporting and monitoring of the performance contract.

Guaranteed Savings- The amount of savings guaranteed to be achieved.

Installation Savings- FIMs installed during the construction period and being of beneficial use prior to the date of Substantial Completion are monitored to determine savings.

Savings to Date- Savings obtained through a portion of a period

Substantial Completion- Sufficient materials and services have been provided to permit the intended benefit from the work. This term can apply to individual measures and the overall project.

Target Savings- Savings figures estimated to be achieved, determined by calculations and measurements

## APPENDIX C

### **FIM 1- Lighting: Formulas & Calculations Used**

$$\text{Lighting kW Savings} = \sum (\text{Fixture Wattage}_{\text{Pre}} - \text{Retrofit Fixture Wattage}_{\text{Post}})$$

$$\text{Lighting kWh Savings} = \sum (\text{Lighting kW Savings} \times \text{Hours of Operation})$$

$$\text{kWh Cooling Savings}_{\text{Period}} = \frac{\text{CDD}_{\text{Period}}}{\text{CDD}_{\text{Annual}}} \times \text{kWh Cooling Savings}_{\text{Annual}}$$

$$\text{MMBtu Heating Losses}_{\text{Period}} = \frac{\text{HDD}_{\text{Period}}}{\text{HDD}_{\text{Annual}}} \times \text{MMBtu Heating Losses}_{\text{Annual}}$$

### **FIM 2- Lighting Controls: Formulas & Calculations Used**

$$\text{Lighting Controls kWh Savings} = \sum \text{Retrofit Fixture Wattage}_{\text{Post}} \times (\text{Lighting Runtime}_{\text{Pre}} - \text{Hours of Occupancy})$$

### **FIM 3- Weatherization: Formulas & Calculations Used**

Spreadsheet based- General Formulas used include:

$$\text{CFM}_{\text{Infiltration}} [\text{Winter}] = \text{Wind Speed} \times \text{Area of Cracks} \times \% \text{ Area Heated} \times \% \text{ Windward Diversity}$$

$$\text{CFM}_{\text{Infiltration}} [\text{Summer}] = \text{Wind Speed} \times \text{Area of Cracks} \times \% \text{ Area with AC} \times \% \text{ Windward Diversity}$$

$$\text{Existing Btu Saved}_{\text{Occupied}} = 1.08 \times \text{CFM}_{\text{Infiltration}} \times \Delta T \times \text{Bin Hours}_{\text{Occupied}}$$

$$\text{Existing Btu Saved}_{\text{Unoccupied}} = 1.08 \times \text{CFM}_{\text{Infiltration}} \times \Delta T \times \text{Bin Hours}_{\text{Unoccupied}}$$

$$\text{kWh Saved} = \frac{\text{Cooling Btu Saved} \times 12}{12,000 \frac{\text{Btu}}{\text{Ton}} \times \text{EER}}$$

$$\text{MMBtu Saved} = \frac{\text{Heating Btu Saved}}{1 \times 10^6 \frac{\text{Btu}}{\text{MMBtu}} \times \text{Boiler Efficiency} (\%)}$$

## APPENDIX C

### **FIM 4.1- EMS Building Controls: Formulas & Calculations Used**

Spreadsheet based- General Formulas used include:

$$\text{Cooling kWh} = \frac{(\text{Envelope Load} + \text{Infiltration Load}) \times \frac{1 \times 10^6 \text{ Btu}}{\text{MMBtu}} \times \text{Cooling} \frac{\text{kW}}{\text{Ton}}}{12,000 \frac{\text{Tons}}{\frac{\text{Btu}}{\text{Hr}}}}$$

$$\text{Heating MMBtu} = \frac{(\text{Envelope Load} + \text{Infiltration Load})}{\text{Boiler Efficiency (\%)}}$$

$$\begin{aligned} \text{Envelope Load} = & \frac{1}{\text{Rvalue}} \times \text{Exposed Area} \times \left[ \sum (\text{Air Temp}_{\text{Outdoor}} - \text{Setpoint}_{\text{Occupied}}) \times \text{Occupied Hours} \right. \\ & \left. + \sum (\text{Air Temp}_{\text{Outdoor}} - \text{Setpoint}_{\text{Unoccupied}}) \times \text{Unoccupied Hours} \right] \end{aligned}$$

$$\begin{aligned} \text{Infiltration Load} = & \frac{1.08 \times \text{Infiltration CFM}}{1 \times 10^6} \times \left[ \sum (\text{Air Temp}_{\text{Outdoor}} - \text{Setpoint}_{\text{Occupied}}) \times \text{Occupied Hours} \right. \\ & \left. + \sum (\text{Air Temp}_{\text{Outdoor}} - \text{Setpoint}_{\text{Unoccupied}}) \times \text{Unoccupied Hours} \right] \end{aligned}$$

### **FIM 4.2- EMS Building Controls/ Optimal Start: Formulas & Calculations Used**

Spreadsheet based- General Formulas used include:

$$\text{Baseline MMBtu} = 1.08 \times \text{CFM} \times \% \text{ Speed at Warmup} \times (\text{Air Temp}_{\text{Outdoor}} - \text{Air Temp}_{\text{Room}}) \times \text{Warmup Hours}$$

$$\text{Proposed MMBtu} = \frac{\frac{\text{Envelope Load} + \text{Infiltration Load}}{1 \times 10^6} \times \text{Warmup Hours}}{\text{Morning Run Hours}}$$

$$\text{Warmup Hours} = \text{Hours before Occupancy Unit Ventilators Turned to Occupied Mode}$$

$$\text{MMBtu Savings} = \frac{\text{Baseline MMBtu} - \text{Propose MMBtu}}{\text{Boiler Efficiency (\%)}}$$



## APPENDIX C

### **FIM 4.3-AHU Upgrade / VFD on Fan: Formulas & Calculations Used**

Spreadsheet based- General Formulas used include:

$$\text{Cooling kWh} = \frac{\left( \text{Sensible Cooling} \left( \frac{\text{Btu}}{\text{Hr}} \right) + \text{Latent Cooling} \left( \frac{\text{Btu}}{\text{Hr}} \right) \right) \times \text{Cooling} \frac{\text{kW}}{\text{Ton}} \times \text{Bin Hours}}{12,000 \frac{\text{Tons}}{\frac{\text{Btu}}{\text{Hr}}}}$$

$$\text{Sensible Cooling} \left( \frac{\text{Btu}}{\text{Hr}} \right) = 1.08 \times \text{CFM}_{\text{Mixed Air}} \times (\text{Temp}_{\text{Mixed Air}} - \text{Temp}_{\text{Cooling Coil}})$$

$$\text{Latent Cooling} \left( \frac{\text{Btu}}{\text{Hr}} \right) = 0.68 \times \text{CFM}_{\text{Mixed Air}} \times (\text{Relative Humidity}_{\text{Mixed Air}} - \text{RH Setpoint}_{\text{Discharge Air}})$$

$$\text{Heating MMBtu} = \frac{\text{Preheat} \left( \frac{\text{Btu}}{\text{Hr}} \right) + \text{Reheat} \left( \frac{\text{Btu}}{\text{Hr}} \right)}{1 \times 10^6 \text{ Boiler Efficiency (\%)}} \times \text{Bin Hours}$$

$$\text{Preheat} \left( \frac{\text{Btu}}{\text{Hr}} \right) = 1.08 \times \text{CFM}_{\text{Mixed Air}} \times (\text{Temp}_{\text{Preheat Coil}} - \text{Temp}_{\text{Mixed Air}})$$

$$\text{Reheat} \left( \frac{\text{Btu}}{\text{Hr}} \right) [\text{Cooling Season}] = 1.08 \times \text{CFM}_{\text{Mixed Air}} \times (\text{Temp}_{\text{Discharge Air; Summer}} - \text{Temp}_{\text{Cooling Coil}})$$

$$\begin{aligned} \text{Reheat} \left( \frac{\text{Btu}}{\text{Hr}} \right) [\text{Heating Season}] \\ = 1.08 \times \text{CFM}_{\text{Mixed Air}} \times [\text{Temp}_{\text{Discharge Air; Winter}} - \text{Max}(\text{Temp}_{\text{Preheat Coil}}, \text{Temp}_{\text{Mixed Air}})] \end{aligned}$$

$$\text{CFM}_{\text{Mixed Air}} = \text{CFM}_{\text{Total Supply}} \times \% \text{ Fan Speed}$$

$$\text{Temp}_{\text{Mixed Air}} = \frac{\text{CFM}_{\text{Outside Air}}}{\text{CFM}_{\text{Mixed Air}}} \times \text{Temp}_{\text{Outside Air}} + \frac{\text{CFM}_{\text{Return Air}}}{\text{CFM}_{\text{Mixed Air}}} \times \text{Temp}_{\text{Return Air}}$$

$$\text{Relative Humidity}_{\text{Mixed Air}} = \frac{\text{CFM}_{\text{Outside Air}}}{\text{CFM}_{\text{Mixed Air}}} \times \text{RH}_{\text{Outside Air}} + \frac{\text{CFM}_{\text{Return Air}}}{\text{CFM}_{\text{Mixed Air}}} \times \text{RH}_{\text{Return Air}}$$

## APPENDIX C

### **FIM 4.4- Pool Dehumidification: Formulas & Calculations Used**

Spreadsheet based-

See DEA Appendix for Calculations

### **FIM 4.5- Snow Melt Sensor: Formulas & Calculations Used**

Spreadsheet based-

See DEA Appendix for Calculations

### **FIM 6- Water Conservation: Formulas & Calculations Used**

$$\text{Water Savings} = \sum (\text{Fixture Water Flow}_{\text{Pre}} - \text{Retrofit Fixture Water Flow}_{\text{Post}})$$

$$\text{Water Cost Savings} = \sum (\text{Water Savings}) \times \text{Fixture Usage}$$

## APPENDIX C

### **FIM 9- Vending Controls: Formulas & Calculations Used**

$$\text{Electric Savings} = \sum (\text{Energy Usage}_{\text{Pre}} - \text{Energy Usage}_{\text{Post}})$$

$$\text{Energy Usage} = \sum (\text{Lighting kWh} + \text{Compressor kWh})$$

$$\text{Lighting}_{\text{Pre}} \text{ kWh} = \sum (\text{Lighting kW} \times \text{Hours per Day} \times \text{Days per Year})$$

$$\text{Lighting}_{\text{Post}} \text{ kWh} = \sum \text{Lighting kW} \times (\text{Hours}_{\text{Occupied}} + (\text{Hours}_{\text{Unoccupied}} \times \text{Night Duty Cycle}))$$

$$\text{Compressor Hours}_{\text{Post}} = \sum (\text{Hours}_{\text{Occupied}} \times \text{Existing Duty Cycle}) + (\text{Hours}_{\text{Unoccupied}} \times \text{Night Duty Cycle})$$

$$\text{Compressor}_{\text{Pre}} \text{ kWh} = \sum \left( \frac{\text{Volts} \times \text{Amps} \times 80\% \text{ P.F.}}{\frac{1,000 \text{ W}}{1 \text{ kW}}} - \text{Lighting kW} \right) \times \frac{\text{Hours}_{\text{Pre}}}{\text{Year}} \times \text{Duty Cycle}$$

$$\text{Compressor}_{\text{Post}} \text{ kWh} = \sum \left( \frac{\text{Volts} \times \text{Amps} \times 80\% \text{ P.F.}}{\frac{1,000 \text{ W}}{1 \text{ kW}}} - \text{Lighting kW} \right) \times \frac{\text{Compressor Hours}_{\text{Post}}}{\text{Year}}$$

### **FIM 10- Pool Cover: Formulas & Calculations Used**

Spreadsheet based-

See DEA Appendix for Calculations

### **FIM 11- Ice Arena Upgrades: Formulas & Calculations Used**

Savings based on Utility Invoices & Metrix Meter Tuning Contracts contained in report.

## APPENDIX C

### **FIM 12- Power Factor: Formulas & Calculations Used**

No Current Savings

### **FIM 13- Transformers: Formulas & Calculations Used**

$$\text{Electric Savings} = \sum (\text{Transformer Losses}_{\text{Pre}} - \text{Transformer Losses}_{\text{Post}})$$

$$\text{Transformer Losses} = \sum [\text{kVA} \times \text{Load} \times \text{Load Factor} \times (\frac{1}{\% \text{ Efficiency}} - 1)]$$

### **FIM 14- Aeration Blowers: Formulas & Calculations Used**

$$\text{Electric Savings} = \text{kWh Use}_{\text{Pre}} - \text{kWh Use}_{\text{Post}}$$

$$\text{kWh Use} = \frac{\text{Voltage} \times \text{Amperage} \times \text{PF} \times \sqrt{3}}{\frac{1,000 \text{ W}}{\text{kW}}} \times \text{Hours}$$

### **FIM 15- Boiler Replacement: Formulas & Calculations Used**

$$\text{Fuel Savings} = \text{Fuel Usage} \times \frac{\text{Fuel to Heat Efficiency}_{\text{Pre}}}{\text{Fuel to Heat Efficiency}_{\text{Post}}}$$

$$\text{Fuel to Heat Efficiency (\%)} = \text{Combustion Efficiency} \times (1 - \text{Radiant Jacket Losses}) \times (1 - \text{Distribution Losses})$$