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Problem Statement #1: Comparison of LEED Credit - V3 to V4

LEED 2009 for New Construction and Major Renovations

Project Checklist

Exposition Transit Corridor Phase 2

Sustainable Sites — Possible Points: 26

Y	?	N	Credit	Title	Points
10	12	4		Sustainable Sites	26
Y			Prereq 1	Construction Activity Pollution Prevention	
	1		Credit 1	Site Selection	1
	5		Credit 2	Development Density and Community Connectivity	5
		1	Credit 3	Brownfield Redevelopment	1
6			Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
	3		Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
	2		Credit 4.4	Alternative Transportation—Parking Capacity	2
	1		Credit 5.1	Site Development—Protect or Restore Habitat	1
1			Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
1			Credit 6.2	Stormwater Design—Quality Control	1
		1	Credit 7.1	Heat Island Effect—Non-roof	1
		1	Credit 7.2	Heat Island Effect—Roof	1
		1	Credit 8	Light Pollution Reduction	1

Water Efficiency — Possible Points: 10

Y	?	N	Credit	Title	Points
10				Water Efficiency	10
Y			Prereq 1	Water Use Reduction—20% Reduction	
4			Credit 1	Water Efficient Landscaping	2 to 4
2			Credit 2	Innovative Wastewater Technologies	2
4			Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere — Possible Points: 35

Y	?	N	Credit	Title	Points
35				Energy and Atmosphere	35
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
19			Credit 1	Optimize Energy Performance	1 to 19
7			Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
3			Credit 5	Measurement and Verification	3
2			Credit 6	Green Power	2

Materials and Resources — Possible Points: 14

Y	?	N	Credit	Title	Points
	7	6		Materials and Resources	14
Y			Prereq 1	Storage and Collection of Recyclables	
		3	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
		1	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
	2		Credit 2	Construction Waste Management	1 to 2
	2		Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	?	N	Credit	Title	Points
	1		Credit 4	Recycled Content	1 to 2
	2		Credit 5	Regional Materials	1 to 2
		1	Credit 6	Rapidly Renewable Materials	1
		1	Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points: 15

Y	?	N	Credit	Title	Points
9		6		Indoor Environmental Quality	15
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	1
1			Credit 3.1	Construction IAQ Management Plan—During Construction	1
1			Credit 3.2	Construction IAQ Management Plan—Before Occupancy	1
		1	Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
		1	Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
		1	Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
1			Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
		1	Credit 6.2	Controllability of Systems—Thermal Comfort	1
		1	Credit 7.1	Thermal Comfort—Design	1
		1	Credit 7.2	Thermal Comfort—Verification	1
1			Credit 8.1	Daylight and Views—Daylight	1
1			Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process — Possible Points: 6

Y	?	N	Credit	Title	Points
6				Innovation and Design Process	6
1			Credit 1.1	Innovation in Design: Specific Title	1
1			Credit 1.2	Innovation in Design: Specific Title	1
1			Credit 1.3	Innovation in Design: Specific Title	1
1			Credit 1.4	Innovation in Design: Specific Title	1
1			Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1

Regional Priority Credits — Possible Points: 4

Y	?	N	Credit	Title	Points
4				Regional Priority Credits	4
1			Credit 1.1	Regional Priority: Specific Credit	1
1			Credit 1.2	Regional Priority: Specific Credit	1
1			Credit 1.3	Regional Priority: Specific Credit	1
1			Credit 1.4	Regional Priority: Specific Credit	1

Total — Possible Points: 110

Y	?	N		Points
74	19	16	Total	110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

LEED v4 for BD+C: New Construction and Major Renovation

Project Checklist

Project Name: Exposition Transit Corridor Phase 2

Date

Y	?	N			
Y			Credit 1	Integrative Process	1
16				**Location and Transportation**	**Possible Points: 16**
16			Credit 1	LEED for Neighborhood Development Location	16
1			Credit 2	Sensitive Land Protection	1
2			Credit 3	High Priority Site	2
5			Credit 4	Surrounding Density and Diverse Uses	5
5			Credit 5	Access to Quality Transit	5
1			Credit 6	Bicycle Facilities	1
1			Credit 7	Reduced Parking Footprint	1
1			Credit 8	Green Vehicles	1
6	**0**	**4**		**Sustainable Sites**	**Possible Points: 10**
Y			Prereq 1	Construction Activity Pollution Prevention	Required
		1	Credit 1	Site Assessment	1
2			Credit 2	Site Development--Protect or Restore Habitat	2
1			Credit 3	Open Space	1
3			Credit 4	Rainwater Management	3
		2	Credit 5	Heat Island Reduction	2
		1	Credit 6	Light Pollution Reduction	1
2	**7**	**2**		**Water Efficiency**	**Possible Points: 11**
Y			Prereq 1	Outdoor Water Use Reduction	Required
Y			Prereq 2	Indoor Water Use Reduction	Required
Y			Prereq 3	Building-Level Water Metering	Required
2			Credit 1	Outdoor Water Use Reduction	2
	6		Credit 2	Indoor Water Use Reduction	6
		2	Credit 3	Cooling Tower Water Use	2
	1		Credit 4	Water Metering	1
33	**0**	**0**		**Energy and Atmosphere**	**Possible Points: 33**
Y			Prereq 1	Fundamental Commissioning and Verification	Required
Y			Prereq 2	Minimum Energy Performance	Required
Y			Prereq 3	Building-Level Energy Metering	Required
Y			Prereq 4	Fundamental Refrigerant Management	Required
6			Credit 1	Enhanced Commissioning	6
# 18			Credit 2	Optimize Energy Performance	18
1			Credit 3	Advanced Energy Metering	1
2			Credit 4	Demand Response	2
3			Credit 5	Renewable Energy Production	3
1			Credit 6	Enhanced Refrigerant Management	1
2			Credit 7	Green Power and Carbon Offsets	2

Y	?	N			Possible Points
0	4	9	**Materials and Resources**		Possible Points: 13
Y			Prereq 1	Storage and Collection of Recyclables	Required
Y			Prereq 2	Construction and Demolition Waste Management Planning	Required
		5	Credit 1	Building Life-Cycle Impact Reduction	5
	2		Credit 2	Building Product Disclosure and Optimization - Environmental Product Declarations	2
		2	Credit 3	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
		2	Credit 4	Building Product Disclosure and Optimization - Material Ingredients	2
	2		Credit 5	Construction and Demolition Waste Management	2
10	1	4	**Indoor Environmental Quality**		Possible Points: 16
Y			Prereq 1	Minimum Indoor Air Quality Performance	Required
Y			Prereq 2	Environmental Tobacco Smoke Control	Required
2			Credit 1	Enhanced Indoor Air Quality Strategies	2
3			Credit 2	Low-Emitting Materials	3
	1		Credit 3	Construction Indoor Air Quality Management Plan	1
1			Credit 4	Indoor Air Quality Assessment	2
		1	Credit 5	Thermal Comfort	1
		2	Credit 6	Interior Lighting	2
3			Credit 7	Daylight	3
1			Credit 8	Quality Views	1
		1	Credit 9	Acoustic Performance	1
6			**Innovation**		Possible Points: 6
5			Credit 1	Innovation	5
1			Credit 2	LEED Accredited Professional	1
4			**Regional Priority**		Possible Points: 4
1			Credit 1	Regional Priority: Specific Credit	1
1			Credit 2	Regional Priority: Specific Credit	1
1			Credit 3	Regional Priority: Specific Credit	1
1			Credit 4	Regional Priority: Specific Credit	1
77	5	19	**Total**		Possible Points: 110

Certified 40 to 49 points Silver 50 to 59 points Gold 60 to 79 points Platinum 80 to 110

Part 2:

Materials and resources

Storage and Collection of Recyclables:
Prerequisite in both 2009 and V4. Changes from 2009 to V4 are that they added requirement to address batteries, mercury-containing lamps, or electronic waste, and added retail requirement to identify top 4 waste streams to provide recycling collection and storage.

Construction and Demolition Waste Management Planning:
Prerequisite in 2009 but changed to credit 1.1 in V4. Changes from 2009 to V4 are requirements setting a project target for waste management and requirements to report waste diversion rates.

Building Reuse Maintain Existing Walls, Floors, and Roof:
Moved to "Building Life Cycle Impact Reduction" credit in V4.

Building Reuse Maintain Interior Nonstructural Elements:
Moved to "Building Life Cycle Impact Reduction" credit in V4.

Building Life Cycle Impact Reduction:
Credit is now a combination of "Building Reuse Maintain Existing Walls, Floors, and Roof" and "Building Reuse Maintain Interior Nonstructural Elements". Added options for the reuse of historic and blighted buildings and an added option for a whole building life cycle assessment of the project's structure and enclosure

Building Product Disclosure and Optimization Environmental Product Declarations:
New credit in L4. Addresses transparency in environmental life cycle impacts and selecting products with improved life cycles. Structured into disclosure and optimization options. Rewards the use of products with environmental product declarations and products that meet the local products criteria.

Materials Reuse:
Moved to "Building Life Cycle Impact Reduction" credit in V4.

Recycled Content:
Moved to "Building Product Disclosure and Optimization Sourcing of Raw Materials" credit in V4.

Regional Materials:
Moved to "Building Product Disclosure and Optimization" credit in V4

Rapidly Renewable Materials:
Credit removed from 2009 to V4. Rapidly renewable materials addressed by "Building Product Disclosure and Optimization Sourcing of Raw Materials" in V4.

Certified Wood:
Credit requirements moved to "Building Product Disclosure and Optimization Sourcing of Raw Materials".

Building Product Disclosure and Optimization Sourcing of Raw Materials:
New credit in V4. Addresses transparency in raw material sourcing and selecting materials that have been appropriately sourced. Restructured into disclosure and optimization sections. Rewards products from manufacturers that have provided information on land use practices, extraction locations, labor practices, and rewards products that meet the local products criteria.

Building Product Disclosure and Optimization — Material Ingredient Reporting:
New credit in V4. Addresses transparency in material ingredients and selecting products with optimized ingredients. Structured into disclosure and optimization options. Rewards the use of products with ingredient reporting in programs like Health Product Declaration, Cradle 2 Cradle, and others and rewards products that meet the local products criteria. Third option for supply chain optimization.

Construction and Demolition Waste Management:
Added an option for waste reduction strategy. Requires waste diversion from multiple material types. Alternative daily cover no longer counted as diverted waste.

Pros and Cons:

LEED V3 and V4 are similar in many ways but also very different, as noted from above. Each have their strengths and weaknesses, however LEED V4 is an improvement over V3. A major pro of V4 is the absorption of multiple V3 credits into one V4 credit, such as those involved with building reuse. In combination with this V4 added more to the materials category in order to clearly delineate what can be recycled and how to do it. Lastly, V4's overall visual design improves the clarity of the book and navigability is simplified.

Part 3: Based on the above analysis, please provide a recommendation of which rating system the Project should register and comply with and a proposed level of certification (Certified, Silver, Gold, or Platinum)? Please provide rational and documentation to support your decision in your conclusion.

After analyzing both V4 and LEED 2009 certifications, we recommend that project pursue a LEED V4 registration. This is due in large part on the heavy emphasis on material and resources in LEED 2009. Seeing as how this project is composed of concrete and steel, no organic material was used such as wood or recycled organic substitutes. In LEED V4 under material and resources, the credits are moved into larger categories which give LEED V4 a more appealing stance than LEED 2009.

Problem Statement #2: Life Cycle Sustainability Analysis – Lighting

Part 1: The annual energy usage of each of the lighting fixtures is as follows:

- Fluorescent Fixture X-6A (30w): **50,458kwh**
- Fluorescent Fixture X-6B (40w): **12,614kwh**
- Fluorescent Fixture X-6C (50w): **94,608kwh**
- X-6A Alternative (17.7w): **29,770kwh**
- Lithonia Lighting (24w): **7,568kwh**
- X-6C Alternative (29.5w): **55,819kwh**
- LED High Efficiency T5 (21w): **35,320kwh**
- LED High Efficiency T5 (28w): **8,830kwh**
- LED High Efficiency T5 (35w): **66,226kwh**
- LED High Output T5 (39w): **65,595kwh**
- LED High Output T5 (54w): **17,029kwh**
- LED High Output T5 (80w): **151,373kwh**
- LED T8 (25w): **42,048kwh**
- LED T8 (32w): **10,092kwh**
- LED T8 (40w): **75,686kwh**

Part 2:

Problem Statement 2 Support Information

		FOY Group		McKinstry		Cochran	
Supply and Install (No Mark up)	X-6A	$188	$ 36,096.00	$194	$ 37,248.00	$213	$ 40,896.00
	X-6B	$213	$ 7,668.00	$220	$ 7,920.00	$242	$ 8,712.00
	X-6C	$234	$ 50,544.00	$241	$ 52,056.00	$252	$ 54,432.00
		Total	**$ 94,308.00**	**Total**	**$ 97,224.00**	**Total**	**$ 104,040.00**
Supply and Install - Alternate	X-6A (T5-21W)	$298	$ 57,216.00	$307	$ 58,944.00	$338	$ 64,896.00
	X-6B (T5-28W)	$315	$ 11,340.00	$325	$ 11,700.00	$357.53	$ 12,871.08
	X-6C (T5-35W)	$388	$ 83,808.00	$400	$ 86,400.00	$388	$ 83,808.00
		Total	**$ 152,364.00**	**Total**	**$ 157,044.00**	**Total**	**$ 161,575.08**
Replacement Cost	All	$125		$113		$133	
Alternate Replacement Cost	All	$145		$113		$172	
Overhead		10%		Included		8%	
Profit		5%		Included		5.50%	
Construction Fee		12%		15%		13.50%	
Design Fee		6%		10%		$2,500	
Base Scope		Provide and install branch conduit and conductors for lighting circuits and receptacles Install light fixtures, occupancy sensors		Provide and install branch conduit and conductors for lighting circuits and receptacles Install light fixtures, occupancy sensors provide free maintenance for three years		Electrical Permit LED/ Fluorescent lights per scope document new lighting controls Demo lights for others to take of dispose	
Working Hours		Graveyard Shift		Normal Work Hours		6:30am - 3pm	
Warranty		One-Year from substantial completion		Three-Year from substantial completion		Unknown	

Flouresecent Fixtures	FOY Group		McKinstry		Cochran	
Option 1	Overhead	$ 9,430.80	Overhead	$ -	Overhead	$ 8,323.20
	Profit	$ 4,715.40	Profit	$ -	Profit	$ 5,722.20
	Construction Fee	$ 13,014.50	Construction Fee	$ 14,583.60	Construction Fee	$ 15,941.53
	Design Fee	$ 6,507.25	Design Fee	$ 9,722.40	Design Fee	$ 2,500.00
	Supply & Install	$ 94,308.00	Supply & Install	$ 97,224.00	Supply & Install	$ 104,040.00
	Total Initial Expenditures:	**$ 127,975.96**	**Total Initial Expenditures:**	**$ 121,530.00**	**Total Initial Expenditures:**	**$ 136,526.93**
	Life Cycle (years)	**10**	**Life Cycle (years)**	**10**	**Life Cycle (years)**	**10**
	Maintenance & Replacement Costs *Replace every year*	**$55,500**	**Maintenance & Replacement Costs** *Replace every year*	**$50,172**	**Maintenance & Replacement Costs** *Replace every year*	**$59,052**
	Interest Rate	**1.5%**	**Interest Rate**	**1.5%**	**Interest Rate**	**1.5%**

Notes/ Assumptions:

FOY Group	McKinstry	Cochran
Overhead: (Total Supply & Markup)x10%	*Overhead: Included in Total Supply & Markup*	*Overhead: (Total Supply & Markup) x 8%*
Profit: (Total Supply & Markup)x5%	*Profit: Included in Total Supply & Markup*	*Profit: (Total Supply & Markup)x 5.5%*
Construction Fee: (Total Supply & Markup + Overhead +Profit) x 12%	*Construction Fee: (Total Supply & Markup + Overhead +Profit) x 15%*	*Construction Fee: (Total Supply & Markup + Overhead +Profit) x 13.5%*
Design Fee: (Total Supply & Markup + Overhead +Profit) x 6%	*Design Fee: (Total Supply & Markup + Overhead +Profit) x 10%*	*Design Fee: Fixed fee of $2500*

Total Initial Expenditures:Sum of Overhead, Profit, Construction Fee, Design Fee, and Supply & Installation

Flouresecent lights to be replaced every year. http://www.nationalbuildersupply.com/blog/buyer-guides/cfl-vs-led-lighting-what-is-the-difference/

Interest Rate assumed to be current inflation rates of 1.5%

Maintenance & Replacement Costs: Replacement Cost x total fixtures per location

LED Fixtures	FOY Group		McKinstry		Cochran	
Option 2	Overhead	$ 15,236.40	Overhead	$ -	Overhead	$ 12,926.01
	Profit	$ 7,618.20	Profit	$ -	Profit	$ 8,886.63
	Construction Fee	$ 21,026.23	Construction Fee	$ 23,556.60	Construction Fee	$ 24,757.34
	Design Fee	$ 10,513.12	Design Fee	$ 15,704.40	Design Fee	$ 2,500.00
	Supply & Install	$ 152,364.00	Supply & Install	$ 157,044.00	Supply & Install	$ 161,575.08
	Total Initial Expenditures:	**$ 206,757.95**	**Total Initial Expenditures:**	**$ 196,305.00**	**Total Initial Expenditures:**	**$ 210,645.06**
	Life Cycle (years)	**10**	**Life Cycle (years)**	**10**	**Life Cycle (years)**	**10**
	Maintenance & Replacement Costs *Replace every 6 years*	**$64,380**	**Maintenance & Replacement Costs** *Replace every 6 years*	**$50,172**	**Maintenance & Replacement Costs** *Replace every 6 years*	**$76,368**
	Interest Rate	**1.5%**	**Interest Rate**	**1.5%**	**Interest Rate**	**1.5%**

Notes/ Assumptions:

FOY Group	McKinstry	Cochran
Overhead: (Total Supply & Markup)x10%	*Overhead: Included in Total Supply & Markup*	*Overhead: (Total Supply & Markup) x 8%*
Profit: (Total Supply & Markup)x5%	*Profit: Included in Total Supply & Markup*	*Profit: (Total Supply & Markup)x 5.5%*
Construction Fee: (Total Supply & Markup + Overhead +Profit) x 12%	*Construction Fee: (Total Supply & Markup + Overhead +Profit) x 15%*	*Construction Fee: (Total Supply & Markup + Overhead +Profit) x 13.5%*
Design Fee: (Total Supply & Markup + Overhead +Profit) x 6%	*Design Fee: (Total Supply & Markup + Overhead +Profit) x 10%*	*Design Fee: Fixed fee of $2500*

Total Initial Expenditures:Sum of Overhead, Profit, Construction Fee, Design Fee, and Supply & Installation

LED lights to be repalced every 6 years. http://www.nationalbuildersupply.com/blog/buyer-guides/cfl-vs-led-lighting-what-is-the-difference/

Maintenance & Replacement Costs: Replacement Cost x total fixtures per location

	# of fixtures	# of locations	Total	Total Fixtures for the poject site
X-6A Located in Westwood, 26th, 17th & 4th ticketing areas & 2 Street stations	32	6	192	444
X-6B Located only at 26th St. Stations	36	1	36	
X-6C Located National Palms, Sepulved, Bundy, Westwood, 17th & 4th St. Stations	36	6	216	

	# of fixtures	# of locations	Total	Total Fixtures for the poject site
X-6A Located in Westwood, 26th, 17th & 4th ticketing areas & 2 Street stations	32	6	192	444
X-6B Located only at 26th St. Stations	36	1	36	
X-6C Located National Palms, Sepulved, Bundy, Westwood, 17th & 4th St. Stations	36	6	216	

Problem Statement 2 Cash Flow Analysis

FOY Group					
Flourescent Fixture		**LED Fixtures**		**(B-A)**	
Cash Flows-		Cash Flows-			
CF0=	$ (127,975.96)	CF0=	$ (206,757.95)	CF0=	$ (78,781.99)
CF1=	($55,500)	CF1=		CF1=	$ 55,500.00
CF2=	($55,500)	CF2=		CF2=	$ 55,500.00
CF3=	($55,500)	CF3=		CF3=	$ 55,500.00
CF4=	($55,500)	CF4=		CF4=	$ 55,500.00
CF5=	($55,500)	CF5=		CF5=	$ 55,500.00
CF6=	($55,500)	CF6=	($64,380)	CF6=	$ (8,880.00)
CF7=	($55,500)	CF7=		CF7=	$ 55,500.00
CF8=	($55,500)	CF8=		CF8=	$ 55,500.00
CF9=	($55,500)	CF9=		CF9=	$ 55,500.00
CF10=	($55,500)	CF10=		CF10=	$ 55,500.00
MARR	1.5%	MARR	1.5%	MARR	1.5%
NPV	($639,807.20)	NPV	($270,186.52)	NPV	$374,171.02
				IROR	68%

McKinstry					
Flourescent Fixture		**LED Fixtures**		**(B-A)**	
Cash Flows-		Cash Flows-			
CF0=	$ (121,530.00)	CF0=	$ (196,305.00)	CF0=	$ (74,775.00)
CF1=	($50,172)	CF1=		CF1=	$ 50,172.00
CF2=	($50,172)	CF2=		CF2=	$ 50,172.00
CF3=	($50,172)	CF3=		CF3=	$ 50,172.00
CF4=	($50,172)	CF4=		CF4=	$ 50,172.00
CF5=	($50,172)	CF5=		CF5=	$ 50,172.00
CF6=	($50,172)	CF6=	($50,172)	CF6=	$ -
CF7=	($50,172)	CF7=		CF7=	$ 50,172.00
CF8=	($50,172)	CF8=		CF8=	$ 50,172.00
CF9=	($50,172)	CF9=		CF9=	$ 50,172.00
CF10=	($50,172)	CF10=		CF10=	$ 50,172.00
MARR	1.5%	MARR	1.5%	MARR	1.5%
NPV	($584,225.44)	NPV	($245,735.54)	NPV	$342,036.03
				IROR	64%

Cochran					
Flourescent Fixture		**LED Fixtures**		**(B-A)**	
Cash Flows-		Cash Flows-			
CF0=	$ (136,526.93)	CF0=	$ (210,645.06)	CF0=	$ (74,118.13)
CF1=	($59,052)	CF1=		CF1=	$ 59,052.00
CF2=	($59,052)	CF2=		CF2=	$ 59,052.00
CF3=	($59,052)	CF3=		CF3=	$ 59,052.00
CF4=	($59,052)	CF4=		CF4=	$ 59,052.00
CF5=	($59,052)	CF5=		CF5=	$ 59,052.00
CF6=	($59,052)	CF6=	($76,368)	CF6=	$ (17,316.00)
CF7=	($59,052)	CF7=		CF7=	$ 59,052.00
CF8=	($59,052)	CF8=		CF8=	$ 59,052.00
CF9=	($59,052)	CF9=		CF9=	$ 59,052.00
CF10=	($59,052)	CF10=		CF10=	$ 59,052.00
MARR	1.5%	MARR	1.5%	MARR	1.5%
NPV	($681,115.37)	NPV	($285,884.47)	NPV	$400,628.56
				IROR	77%

Part 3: Based on the Life Cycle Analysis comparison between the fluorescent and LED light fixtures and the three bid submittals, the Cal Poly Sustainable Buildings & LEED Team recommends the selection of **Cochran Inc.** as the electrical subcontractor for light fixtures.

Part 4: Based on information found on Southern California Edison's website there are incentives for using both fluorescent and LED lights. The incentive for using LED lights is $0.08/ kwh and the incentive for using Fluorescent lights is $0.03/kwh; therefore, there is a greater incentive for using LED fixtures over fluorescent fixtures.

Part 5: Based on the technical data provided in the subcontractor bid submittal we suggest that the owner choose the X-6A alternate (17.7w), XWLED 4' Slim LED Wet Light (24w), and the X-6C alternate (29.5w). These alternatives use less kwh annually than the specified fluorescent fixtures.

Problem Statement #3: Carbon Footprinting

Part 1:

1. 2880 C.Y. x 1.07 (waste) = 3082 C.Y.

2. White Castle Concrete

    $64.0 / C.Y. = $184,281.60

    Slip Diamond

    $73.50 / C.Y.= $ 211,635.90

    City Park Concrete

    $63.0/ C.Y. = $181,402.20

3. White Castle Concrete Mix

345 lb/ C.Y. Portland Cement + 345 lb/ C.Y. Fly Ash: CO_2 Emissions 419 lb/ C.Y.

419 lb/ C.Y. * 3082 C.Y. = 1,291,358 pounds of carbon

Transportation

Portland Cement: Inglewood (0)

Fly Ash F: Phoenix (392 Mi.) 17,248 lbs

#57, Fine Aggregate: Long Beach (21 Mi.) 9,244 lbs

White Castle Concrete Plant: Inglewood (11 mi.) 13,560 lbs

Total = 1,331,410 = 665.7 tons of carbon

Slip Diamond

559 lb/ C.Y. Portland Cement + 119 lb/ C.Y. Fly Ash: 728 lb/ C.Y.

728 lb/ C.Y. * 3082 C.Y. = 2,243,696

Transportation:

All Materials: Oxnard, CA (92 Mi.) 4,040 lbs

Cement: Santa Ana, CA (36 Mi.) 1,584 lbs

Fly Ash: Fontana, CA (14 Mi.) 616 lbs

Batch Plant: Ontario, CA (54 Mi.) 66,571 lbs

Total = 2316507 = 1,158 tons of carbon

City Park

779 lb/ C.Y. Portland Cement: 972.34 lb/ C.Y.

973 lb/C.Y. * 3082 C.Y. = 2,998,786 lbs of CO_2

Transportation:

Plant: Ontario, California (54 Mi.) 66,571 lbs

Aggregates: San Gabriel Valley (27 Mi.) 1,188 lbs

Total = 3,066,545 lbs = 1,533 tons of carbon

(Assume)

Concrete Trucks carry 11 C.Y.

Colorado Ave. and 4th St. station account for 10 truckloads of ingredients to the concrete mixing plants.

Concrete delivery and aggregate trucks average 5 mpg (diesel fuel).

1 gallon of diesel fuel emits 22.38 lbs CO_2.

1 gallon of regular gas emits 20 lbs of CO_2.

White Castle Concrete gets Fly Ash from Phoenix, AZ.

4. Due to the sustainability goals of the client, each ton of CO_2 produced has a cost to the project of $40/ton. Update the bid comparison from #2 with this information and recommend the best value supplier for the project.

White Castle Concrete

Original: $64.0 / C.Y. = $184,281.60

Carbon Off-Set: 666 tons *$40 = $26,640

210,922

Slip Diamond

$73.50 / C.Y.= $ 211,635.90

Carbon Off-Set: 1,158 * $40 = $46,320

257,955

City Park Concrete

$63.0/ C.Y. = $181,402.20

Carbon Off-Set: 1,533 * $40 = $61,320

242,722

Including a $40 per carbon ton cost, White Castle Concrete is offers the best value.

Part 2: Local vs. Out of Town Labor

1.

LA: 3,15,110.4 lbs

Riverside: 2,067,912 lbs

Oceanside: 1,831,579.2 lbs

Part 2:

The two workers from LA total their carbon to 393.91 lbs CO2 emissions, followed by the three people in Riverside emitting 2,584.89 lbs CO2 emissions, then followed by the 2,289.474 lbs CO2 emissions total to 5,268.274 lbs CO2 emissions.

If all seven workers lived within 15 miles of the project, the total carbon emitted would be 1,292.83 lbs CO2 emissions.

If the workers from each respective city carpooled their total carbon is 2,203.311 lbs CO2 emissions. After subtracting the total carbon from question 1 from the total CO2 emissions mentioned above, the total carbon saved by carpooling is 3,064.963 lbs CO2 emissions.

Problem Statement 4: Water Collection and Usage

Part 1: The amount of water that the site landscape areas requires for the peak watering month is 15,510 gallons. This landscape water requirement assumes that the plant coefficient of 0.5, a peak watering month of July and an evapotransporartion rate of 6.

Procedure:
WaterSense Water Budget Data Finder. Project Zip Code: 90404
Square Footage of Landscaped Area for Site: 5,562sf

Page	Street/ Intersection	Planting Condition	Planting Callout SQ FT	Tree Well	Irrigation Sleeve LF	Irrigation Mainline LF	Irrigation P.O.C. Meter Size	Irrigation P.O.C. Water Type
L-007	Colorado Ave.	C	3826		60	425	IR2: 1.5"	R
		C	1737					
			5563		60			

Baseline Calculation

Landscaped area (sq ft)	5,563

Table: Peak watering month

Determine the peak watering month at the project location by entering the monthly rainfall and evapotranspiration rate in the table below. The month with the highest watering demand is the peak watering month.

	Monthly Rainfall (in)	Monthly ETo (in)	Watering Demand (in)
January	3	6	3
February	3	6	3
March	2	6	4
April	1	6	5
May	1	6	5
June	0	6	6
July	0	6	6
August	0	6	6
September	0	6	6
October	1	6	5
November	1	6	5
December	2	6	4
Peak watering month			June
Peak watering demand (in)			6
Peak watering month ETo (in)			6
Baseline landscape water use (gal/month)			15,510

Part 2:
In order to not require supplemental water at any point during the year the cistern will need to be:
61,257 gallons
Assumptions: assume water is need for the 4 summer months without rainfall
Equation: (Sqft of Lot) * (Annual Rainfall Inches) = (Sqft rain) Convert to (Sqinches rain) convert inches of rain to gallons

Part 3: Capacity of the cistern is: **8,580 cubic feet**

Based on the capacity shown above, the amount of supplemental water per month would be:
6930 Cubic Feet

Assume bike module “C” is 858sf

Problem Statement #5: On-Site Renewable Energy

Part1:

	TOS Booth	C/S Booth
Energy Demand (kBtu/sqft-yr):	380.19	240
Solar radiation (kwh/m2-day)	6.1	**Performance ratio**
	Energy efficieny	0.75
Sunpower x-series	21.50%	
Grape Solar	13.88%	
Sunmodule plus	16.40%	
	Cost	
Sunpower x-series	$465/panel	
Grape Solar	$150/panel	
Sunmodule Plus	$450 /panel	
Roof area	**Square feet (SF)**	**Square meters (m2)**
TOS booth	434	40.31991936
C/S building	704	65.40374016
	Solar Panel area (m2)	
Sunpower x-series	1.630714	
Grape solar	0.6834	
Sunmodule Plus	1.592925	

1. Given:

Sample calculation (Sunpower x-series):

Amount of energy per solar panel:

$$\left(\frac{6.1kwh}{m^2\,day}\right)(1.6307m^2)(21.5\%)(.75)\left(\frac{365days}{1year}\right)\left(\frac{3.4121416331kBtu}{1kwh}\right)=\left(\frac{1997.68kBtu}{1year}\right)$$

Amount of energy needed:

$$\left[\left(\frac{380.19kBtu}{sqft\ yr}\right)(434sqft)+\left(\frac{240kBtu}{sgft\ yr}\right)(704sqft)\right]*8\%=\frac{26{,}716.8kBtu}{1year}$$

Amount of solar panels needed:

$$\left(\frac{26{,}716kBtu}{1year}\right)*\left(\frac{1year}{1997.68kBtu}\right)=14\ panels$$

Cost of solar panels:

$$(156\ panels)\left(\frac{\$465}{1panel}\right) = \$6,218.90$$

Total Energy Usage (kBtu/yr)	TOS booth	C/S building
	165002.46	168960

Amount of energy needed (kBtu/yr)	TOS booth	C/S building
	13200.1968	13516.8

Energy output (kwh/day)	per panel	Energy output (kwh/yr)	per panel	Energy output (kbtu/yr)	per panel
Sunpower x-series	1.60401106		585.4640363		1997.686213
Grape Solar	0.43396583		158.3975294		540.4748047
Sunmodule plus	1.19517163		436.237644		1488.504627

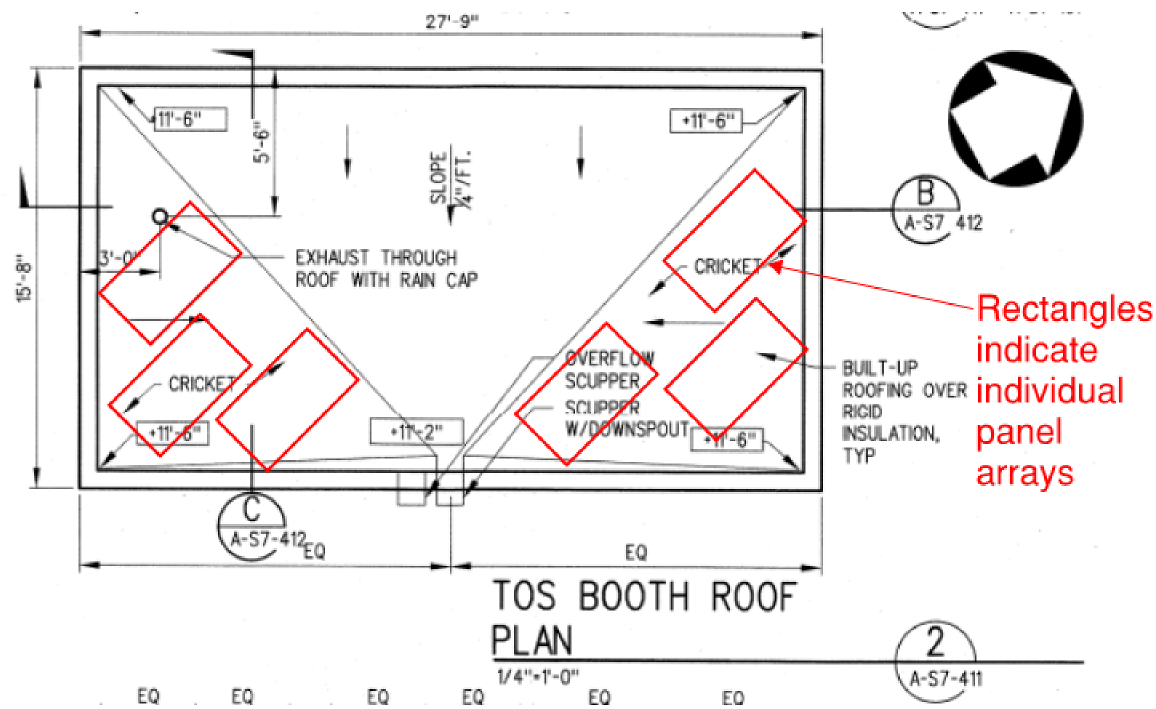
number of panels needed:	TOS booth	C/S building
Sunpower x-series	7	7
Grape Solar	24	25
Sunmodule plus	9	9

Cost:	TOS booth	C/S building
Sunpower x-series	$ 3,072.60	$ 3,146.30
Grape Solar	$ 3,663.50	$ 3,751.37
Sunmodule plus	$ 3,990.64	$ 4,086.36

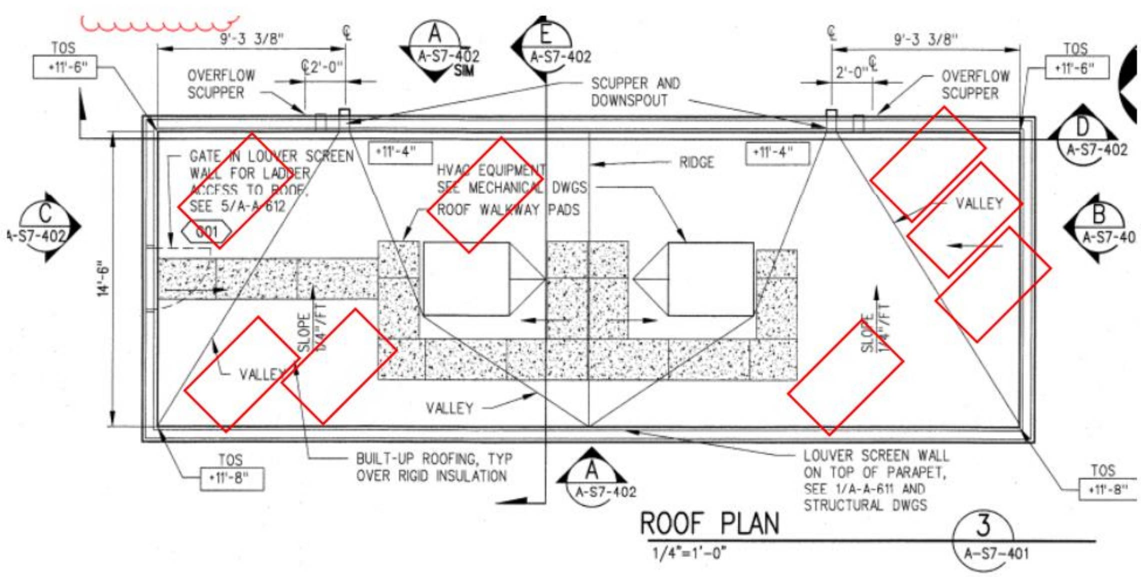
Total	Sun power x-series	Grape solar	Sunmodule plus
Number of panels:	14	49	18
Cost:	$ 6,218.90	$ 7,414.87	$ 8,077.00

The following drawings indicate the preliminary layout of the solar panel arrays. The intent was to keep the slope the panels toward true south, to absorb the maximum amount of solar radiation, and to avoid ceiling fixtures such as walkways and mechanical installations.

TOS Booth Roof Plan:



C/S Building Roof Plan:



2. The sunpower X21-345 model provides the best value for the customer. Assuming that maintenance and installation of the three different solar panel arrays will be the same, the overall cost of the cost of purchasing the panels for the sunpower X21-345 model is the lowest. While having the highest cost per panel, they have a higher solar panel capture efficiency and square footage than the other models, meaning that fewer must be purchased to meet the clients minimum goal of eight percent energy offset.

3. a. In order to capture the maximum amount of solar energy, solar panels should be placed facing true south.

b. The solar declination of the Los Angeles area in which the Exposition Light Rail Project indicates that true south is 12.24° E.

c. The most efficient re-orientation of the panel array is to tilt to an 11.6° tilt on March 30, and a 49.8° tilt on September 12.

<u>Part 2.</u>

Remaining energy(kBtu/yr)	307245.4632
Energy generated per panel:	2663.581617
number of panels needed:	115
cost of panels:	$53,637.98
slab cost:	$11,014.20
total installation cost:	$64,652.18

Insert cost value analysis table.

Assumptions:

1. Maintenance, and electricity payments are calculated on a yearly basis
2. The MARR is assumed to be 5%
    a. The justification for this is that the transit center is a government facility, so they have to break even as opposed to make a profit
3. The cost of the solar panels is $53,637.98
4. Cost of placing concrete slab to support solar panels is $11,014.20
    a. This value was calculated using RS means
5. Cost of maintenance is per year $94,352.85
    a. This is given by the national renewable energy laboratory
6. Savings created by installing solar panels are $178,746.24
    a. This value was generated by multiplying the value given by the us energy administration, 17 cents per kwh by the amount of remaining

Year	0	1	2	3	4	5	6	7	8	9	10
Income											
		$ 178,746.24	$ 178,746.24	$ 178,746.24	$ 178,746.24	$ 178,746.24	$ 178,746.24	$ 178,746.24	$ 178,746.24	$ 178,746.24	$ 178,746.24
Expenses											
	$ 53,637.98	$ 94,352.85	$ 94,352.85	$ 94,352.85	$ 94,352.85	$ 94,352.85	$ 94,352.85	$ 94,352.85	$ 94,352.85	$ 94,352.85	$ 94,352.85
	$ 11,014.20										
Net Cash Flow											
	$ (64,652.18)	$ 84,393.39	$ 84,393.39	$ 84,393.39	$ 84,393.39	$ 84,393.39	$ 84,393.39	$ 84,393.39	$ 84,393.39	$ 84,393.39	$ 84,393.39

MARR	5%	per year

NPV	$18,801.15	$92,269.77	$165,171.95	$234,602.60	$300,727.03	$363,702.68	$423,679.49	$480,800.26	$535,200.99	$587,011.21
Payback Period: Between Year 0 and year 1										

The payment period of the system is almost immediate, with positive gains achieved by the end of year one.

The total projected maintenance costs add up to $1,186,760 at the end of the ten year lease, which is the projects lifetime.

Unknown FV	
Nper	10
PMT	$94,352.85
PV	$ -
FV	($1,186,760.01)
i	5%

Part 3:

Biofuel-based electric systems:

Biofuel-based electric systems use organic materials, such as plant matter, in order to conduct electricity. This system cuts dependence on fossil fuels, while also promoting the local economy by recycling the waste from local farms and businesses. Biofuels could prove to be a viable option for the Exposition line due to Santa Monica's biofuel incentives already in place. Cooking and Oil Grease Recycling bins are available in downtown Santa Monica parking structures for local restaurants to dispose of their fats, oils, and grease free of charge. With a biofuel-based electric system put in place, the station could potentially run at net zero, while at the same time minimizing city waste.

Geothermal energy systems:

Geothermal energy systems utilize the layer of hot and molten rock, magma, under the earth's crust in order to heat water into steam and drive electric generators. There are three different approaches to harnessing geothermal energy. The first directs the steam directly through a turbine, then into a condenser where the steam is condensed into water. In a second approach, very hot water is depressurized into steam, which then drives the turbine. The third approach, the hot water is passed through a heat exchanger, where it heats a second liquid in a closed loop. The most viable approach for the 4th street/Columbus station would be the third approach due to the location of where the well would be built. Even though this could be accomplished, it would not only result in a very expensive alternative energy source but it'd also be a major eyesore.

Hydroelectric power systems:

Hydropower is the energy produced from the moving flow of water from sources like streams and rivers. Small scale hydroelectric projects can be implemented if there are water resources and transmission infrastructure are available. Due to the projects location and lack of source water via rivers and streams, this type of power is not suitable for this site.

Micro wind turbines:

Micro wind turbines utilize the local wind currents by spinning and thus rotating an electric turbine. The city of Santa Monica has, on average, 7 mph of wind daily. This a substantial amount of wind to power the turbines and provide enough energy for the station. The micro turbines can also become a more aesthetically pleasing option opposed to typical photovoltaic cells. With the added fact that these turbines can power the station even on a cloudy day it makes this renewable energy is the most viable option of the four.

<u>Addendum #1 – Bonus Question</u>

Problem 1:
780,000 passengers per day
Compared other light rail riderships and populations projections to LA lightrail in 2030.

Problem 2:
It would save 374,000 gallons a day.
Assumptions: Population of LA 2030 = 14 million. Average miles per gallon of cars = 20mpg. Everyone is driving from LA to Santa Monica.

Problem 3:

1. Increase road tolls to promote use of public transit
2. Club memberships pass/ticket for frequent riders
    a. discounts on tickets
    b. coupons for outlets and stores
3. More security measures for passenger's safety
4. Make stops at popular locations such as colleges, other schools, grocery outlets, DMV, etc…