

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Proposed Action**

**Table GHG-1
Summary of Annual GHG Emissions (Construction, Motor Vehicles, Electricity, Area Sources, Water, Wastewater, and Solid Waste)**

Project	Employees	Construction Emissions	Operational Direct Emissions		Operational Indirect Emissions			Total Operational Emissions	
		Total Construction (MT CO ₂ e)	Motor Vehicles (MT CO ₂ e/yr)	Area Sources (MT CO ₂ e/yr)	Electricity (MT CO ₂ e/yr)	Water (MT CO ₂ e/yr)	Wastewater (MT CO ₂ e/yr)	Annual (MT CO ₂ e/yr)	Per Capita (MT CO ₂ e/person/yr)
Proposed Action	300	766.55	435.48	167.52	20,739.22	0.55	0.07	21,342.84	71.14

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Proposed Action**

**Table GHG-2
Construction GHG Emission Factors**

Equipment Type	CO₂ Emission Factor¹ (kg/gal)	CH₄ Emission Factor^{2,3} (kg/gal)	N₂O Emission Factor^{2,3} (kg/gal)	CO₂ to CO₂e Ratio (GWP CH₄ = 21) (GWP N₂O = 310)
Off-Road	10.15	0.000580	0.000260	0.991
On-Road	10.15	0.000031	0.000029	0.999
Vendor	10.15	0.000031	0.000029	0.999
Autos ⁴	n/a	n/a	n/a	0.950

Sources:

1. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009) 96.
2. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse as Emissions Version 3.1*, (2009) 98, 100.
3. California Energy Commission, *Diesel Use in California, Remarks by Commissioner James D. Boyd*, (2002). It was assumed that heavy duty on-road trucks have a fuel economy of 6 miles per gallon based on this data source.
4. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Emission Facts - Greenhouse Gas Emissions from a Typical Passenger Vehicle (EPA420-F-05-004)*, (2005) 4. Passenger vehicle CO₂ emissions are assumed to be 95% of GHG emissions on a CO₂ equivalent basis.

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Proposed Action**

**Table GHG-3
Construction GHG Emissions**

Construction Year	Equipment Type	Annual CO ₂ Emissions ¹ (Tons CO ₂ /yr)	Annual CO ₂ Emissions (MT CO ₂ /yr)	CO ₂ to CO ₂ e Ratio	Annual CO ₂ e Emissions (MT CO ₂ e/yr)	
Specific Plan (2012)	2010	Off-Road	130.74	118.61	0.991	119.69
	2010	On-Road	14.09	12.78	0.999	12.79
	2010	Vendor	-	-	0.999	-
	2010	Worker/Autos	6.73	6.11	0.950	6.43
	Total 2010		151.56	137.49		138.91
	2011	Off-Road	116.14	105.36	0.991	106.32
	2011	On-Road	-	-	0.999	-
	2011	Vendor	26.45	24.00	0.999	24.02
	2011	Worker/Autos	106.90	96.98	0.950	102.08
	Total 2011		249.49	226.33		232.42
	2012	Off-Road	116.59	105.77	0.991	106.74
	2012	On-Road	-	-	0.999	-
	2012	Vendor	26.55	24.09	0.999	24.11
	2012	Worker/Autos	107.38	97.41	0.950	102.54
	Total 2012		250.52	227.27		233.38
	2013	Off-Road	98.96	89.77	0.991	90.60
2013	On-Road	0.81	0.73	0.999	0.74	
2013	Vendor	13.12	11.90	0.999	11.91	
2013	Worker/Autos	61.35	55.66	0.950	58.59	
Total 2013		174.24	158.07		161.83	
Total					766.55	

Sources:

1. Estimated CO₂ emissions from URBEMIS2007.

Where:

CH ₄	Methane	kg	Kilograms
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
gal	Gallons	yr	Year
GWP	Global warming potential		

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Proposed Action**

**Table GHG-4
Operational Motor Vehicle GHG Emissions**

Land Use	Equipment Type	Annual CO ₂ Emissions ¹ (Tons CO ₂ /yr)	CO ₂ to CO ₂ e Ratio ²	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Proposed Action	Motor Vehicles	456.03	0.950	435.48

Sources:

1. Estimated CO₂ emissions from URBEMIS2007 Environmental Management Software and/or EMFAC2007 mobile source emissions factor model.
2. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Emission Facts - Greenhouse Gas Emissions from a Typical Passenger Vehicle* (EPA420-F-05-004), (2005) 4. Passenger vehicle CO₂ emissions are assumed to be 95% of GHG emissions on a CO₂ equivalent basis.

Where:

CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
MT	Metric ton
yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Proposed Action**

**Table GHG-5
Area Source GHG Emissions**

Phase	CO ₂ Emission Factor ^{1,2} GWP = 1 (kg/MMBtu)	CH ₄ Emission Factor ² GWP = 21 (kg/MMBtu)	N ₂ O Emission Factor ² GWP = 310 (kg/MMBtu)	Annual CO ₂ Emissions ³ (Tons CO ₂ /yr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Proposed Action					
Natural Gas	56.06	0.005	0.0001	183.96	167.29
Landscape Maintenance ⁴	70.88	0.011	0.0006	0.25	0.23
Hearths	56.06	0.0059	0.0001	-	-
Hearths (Wood) ⁵	93.87	0.3514	0.0047	-	-
Subtotal				184.21	167.52

Sources:

1. URBEMIS2007 uses a CO₂ emission factor of 120,000 pounds per million cubic feet. This was converted to kg/MMBtu.
2. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009) 101-103.
3. Estimated CO₂ emissions from URBEMIS2007.
4. Landscape maintenance equipment were assumed to be fueled with motor gasoline.
5. All emission factors for wood burning are provided in the California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009).

Where:

CH ₄	Methane	MMBtu	Million British thermal units
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
GWP	Global warming potential	yr	Year
kg	Kilogram		

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Proposed Action**

**Table GHG-6
Electricity Consumption GHG Emissions**

Land Use	Units¹	Electrical Consumption Factor (kW-hr/unit/yr)	Annual Consumption Factor² (MW-hr/yr)	CO₂ Emission Factor³ GWP = 1 (lbs/MW-hr)	CH₄ Emission Factor³ GWP = 21 (lbs/MW-hr)	N₂O Emission Factor³ GWP = 310 (lbs/MW-hr)	Annual CO₂e Emissions (MT CO₂e/yr)
Proposed Action	126,000 gsf	n/a	148,920.00	306.24	0.005	0.002	20,739.22

Sources:

1. Project Applicant.
2. Project Applicant. The facility would require 17 MW of power during 24/7 operation.
3. California Air Resources Board, *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.0, (2008) 174.
The CO₂ factor is for PG&E.

Where:

CH ₄	Methane	lbs	Pounds
CO ₂	Carbon dioxide	MW-hr	Megawatt-hour
CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
gsf	Gross square feet	n/a	Not applicable
GWP	Global warming potential	N ₂ O	Nitrous oxide
kW-hr	Kilowatt-hour	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Proposed Action**

**Table GHG-7
Potable Water Supply, Conveyance, Treatment, and Distribution GHG Emissions**

Land Use	Action	Potable Water Estimate ¹ (MG/yr)	Electrical Consumption Factor ^{2,3} (kW-hr/MG)	Annual Electrical Consumption (MW-hr/yr)	CO ₂ Emission Factor ⁴ GWP = 1 (lbs/MW-hr)	CH ₄ Emission Factor ⁴ GWP = 21 (lbs/MW-hr)	N ₂ O Emission Factor ⁴ GWP = 310 (lbs/MW-hr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Proposed Action	Supply & Conveyance	0.45	9,727	4.35	239.16	0.029	0.011	0.48
Proposed Action	Treatment	0.45	111	0.05	239.16	0.029	0.011	0.01
Proposed Action	Distribution	0.45	1,272	0.57	239.16	0.029	0.011	0.06
Subtotal								0.55

Sources:

1. Section 3.0, Proposed Actions and Alternatives.
2. California Energy Commission, *California's Water-Energy Relationship, Final Staff Report*, CEC-700-2005-011-SF, (2005) 26.
3. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report*, CEC-500-2006-118, (2006) 22.
4. California Air Resources Board, *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.0, (2008) 174.
The CO₂ factor is for East Bay Municipal Utility District.

Where:

CH ₄	Methane	MG	Million gallons
CO ₂	Carbon dioxide	MW-hr	Megawatt-hour
CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
GWP	Global warming potential	n/a	Not applicable
kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Proposed Action**

**Table GHG-8
Wastewater Treatment Electrical Demand GHG Emissions**

Buildout Year	Net Wastewater Generation Rate¹ (MG/yr)	Electrical Demand Factor² (kW-hr/MG)	Annual Demand Factor (MW-hr/yr)	CO₂e Emission Factor³ (lbs/MW-hr)	Annual CO₂e Emissions (MT CO₂e/yr)
Proposed Action	0.35	1,911	0.66	243.18	0.07

Sources:

1. Section 3.0, Proposed Actions and Alternatives.
2. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*. Prepared by Navigant Consulting, Inc., (2006) 22.
3. California Air Resources Board, Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, Version 1.0, (2008) 174.
The CO₂ factor is for East Bay Municipal Utility District.

Where:

BOD5	Biological oxygen demand using a standard 5 day test		
CH ₄	Methane		
CO ₂	Carbon dioxide		
CO ₂ e	Carbon dioxide equivalent	MG	Million gallons
GWP	Global warming potential	MT	Metric ton
kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 1**

**Table GHG-1
Summary of Annual GHG Emissions (Construction, Motor Vehicles, Electricity, Area Sources, Water, Wastewater, and Solid Waste)**

Project	Employees	Construction Emissions	Operational Direct Emissions		Operational Indirect Emissions			Total Operational Emissions	
		Total Construction (MT CO ₂ e)	Motor Vehicles (MT CO ₂ e/yr)	Area Sources (MT CO ₂ e/yr)	Electricity (MT CO ₂ e/yr)	Water (MT CO ₂ e/yr)	Wastewater (MT CO ₂ e/yr)	Annual (MT CO ₂ e/yr)	Per Capita (MT CO ₂ e/person/yr)
Alternative 1	300	748.13	435.48	167.52	20,739.22	0.55	0.07	21,342.84	71.14

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 1**

**Table GHG-2
Construction GHG Emission Factors**

Equipment Type	CO₂ Emission Factor¹ (kg/gal)	CH₄ Emission Factor^{2,3} (kg/gal)	N₂O Emission Factor^{2,3} (kg/gal)	CO₂ to CO₂e Ratio (GWP CH₄ = 21) (GWP N₂O = 310)
Off-Road	10.15	0.000580	0.000260	0.991
On-Road	10.15	0.000031	0.000029	0.999
Vendor	10.15	0.000031	0.000029	0.999
Autos ⁴	n/a	n/a	n/a	0.950

Sources:

1. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009) 96.
2. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse as Emissions Version 3.1*, (2009) 98, 100.
3. California Energy Commission, *Diesel Use in California, Remarks by Commissioner James D. Boyd*, (2002). It was assumed that heavy duty on-road trucks have a fuel economy of 6 miles per gallon based on this data source.
4. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Emission Facts - Greenhouse Gas Emissions from a Typical Passenger Vehicle (EPA420-F-05-004)*, (2005) 4. Passenger vehicle CO₂ emissions are assumed to be 95% of GHG emissions on a CO₂ equivalent basis.

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 1**

**Table GHG-3
Construction GHG Emissions**

Construction Year	Equipment Type	Annual CO ₂ Emissions ¹ (Tons CO ₂ /yr)	Annual CO ₂ Emissions (MT CO ₂ /yr)	CO ₂ to CO ₂ e Ratio	Annual CO ₂ e Emissions (MT CO ₂ e/yr)	
Specific Plan (2012)	2010	Off-Road	109.54	99.37	0.991	100.28
	2010	On-Road	15.89	14.42	0.999	14.43
	2010	Vendor	-	-	0.999	-
	2010	Worker/Autos	6.06	5.50	0.950	5.79
	Total 2010		131.49	119.29		120.50
	2011	Off-Road	116.14	105.36	0.991	106.32
	2011	On-Road	-	-	0.999	-
	2011	Vendor	26.45	24.00	0.999	24.02
	2011	Worker/Autos	106.90	96.98	0.950	102.08
	Total 2011		249.49	226.33		232.42
	2012	Off-Road	116.59	105.77	0.991	106.74
	2012	On-Road	-	-	0.999	-
	2012	Vendor	26.55	24.09	0.999	24.11
	2012	Worker/Autos	107.38	97.41	0.950	102.54
	Total 2012		250.52	227.27		233.38
	2013	Off-Road	98.96	89.77	0.991	90.60
2013	On-Road	0.81	0.73	0.999	0.74	
2013	Vendor	13.12	11.90	0.999	11.91	
2013	Worker/Autos	61.35	55.66	0.950	58.59	
Total 2013		174.24	158.07		161.83	
Total					748.13	

Sources:

1. Estimated CO₂ emissions from URBEMIS2007.

Where:

CH ₄	Methane	kg	Kilograms
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
gal	Gallons	yr	Year
GWP	Global warming potential		

**Computational Research and Theory Facility
 Evaluation of Global Climate Change Impacts
 Alternative 1**

**Table GHG-4
 Operational Motor Vehicle GHG Emissions**

Land Use	Equipment Type	Annual CO₂ Emissions¹ (Tons CO₂/yr)	CO₂ to CO₂e Ratio²	Annual CO₂e Emissions (MT CO₂e/yr)
Alternative 1	Motor Vehicles	456.03	0.950	435.48

Sources:

1. Estimated CO₂ emissions from URBEMIS2007 Environmental Management Software and/or EMFAC2007 mobile source emissions factor model.
2. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Emission Facts - Greenhouse Gas Emissions from a Typical Passenger Vehicle* (EPA420-F-05-004), (2005) 4. Passenger vehicle CO₂ emissions are assumed to be 95% of GHG emissions on a CO₂ equivalent basis.

Where:

CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
MT	Metric ton
yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 1**

**Table GHG-5
Area Source GHG Emissions**

Phase	CO ₂ Emission Factor ^{1,2} GWP = 1 (kg/MMBtu)	CH ₄ Emission Factor ² GWP = 21 (kg/MMBtu)	N ₂ O Emission Factor ² GWP = 310 (kg/MMBtu)	Annual CO ₂ Emissions ³ (Tons CO ₂ /yr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 1					
Natural Gas	56.06	0.005	0.0001	183.96	167.29
Landscape Maintenance ⁴	70.88	0.011	0.0006	0.25	0.23
Hearths	56.06	0.0059	0.0001	-	-
Hearths (Wood) ⁵	93.87	0.3514	0.0047	-	-
Subtotal				184.21	167.52

Sources:

1. URBEMIS2007 uses a CO₂ emission factor of 120,000 pounds per million cubic feet. This was converted to kg/MMBtu.
2. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009) 101-103.
3. Estimated CO₂ emissions from URBEMIS2007.
4. Landscape maintenance equipment were assumed to be fueled with motor gasoline.
5. All emission factors for wood burning are provided in the California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009).

Where:

CH ₄	Methane	MMBtu	Million British thermal units
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
GWP	Global warming potential	yr	Year
kg	Kilogram		

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 1**

**Table GHG-6
Electricity Consumption GHG Emissions**

Land Use	Units¹	Electrical Consumption Factor (kW-hr/unit/yr)	Annual Consumption Factor² (MW-hr/yr)	CO₂ Emission Factor³ GWP = 1 (lbs/MW-hr)	CH₄ Emission Factor³ GWP = 21 (lbs/MW-hr)	N₂O Emission Factor³ GWP = 310 (lbs/MW-hr)	Annual CO₂e Emissions (MT CO₂e/yr)
Alternative 1	126,000 gsf	n/a	148,920.00	306.24	0.005	0.002	20,739.22

Sources:

1. Project Applicant.
2. Project Applicant. The facility would require 17 MW of power during 24/7 operation.
3. California Air Resources Board, *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.0, (2008) 174.
The CO₂ factor is for PG&E.

Where:

CH ₄	Methane	lbs	Pounds
CO ₂	Carbon dioxide	MW-hr	Megawatt-hour
CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
gsf	Gross square feet	n/a	Not applicable
GWP	Global warming potential	N ₂ O	Nitrous oxide
kW-hr	Kilowatt-hour	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 1**

**Table GHG-7
Potable Water Supply, Conveyance, Treatment, and Distribution GHG Emissions**

Land Use	Action	Potable Water Estimate ¹ (MG/yr)	Electrical Consumption Factor ^{2,3} (kW-hr/MG)	Annual Electrical Consumption (MW-hr/yr)	CO ₂ Emission Factor ⁴ GWP = 1 (lbs/MW-hr)	CH ₄ Emission Factor ⁴ GWP = 21 (lbs/MW-hr)	N ₂ O Emission Factor ⁴ GWP = 310 (lbs/MW-hr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 1	Supply & Conveyance	0.45	9,727	4.35	239.16	0.029	0.011	0.48
Alternative 1	Treatment	0.45	111	0.05	239.16	0.029	0.011	0.01
Alternative 1	Distribution	0.45	1,272	0.57	239.16	0.029	0.011	0.06
Subtotal								0.55

Sources:

1. Section 3.0, Proposed Actions and Alternatives.
2. California Energy Commission, *California's Water-Energy Relationship, Final Staff Report*, CEC-700-2005-011-SF, (2005) 26.
3. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report*, CEC-500-2006-118, (2006) 22.
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The CO₂ factor is for East Bay Municipal Utility District.

Where:

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CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
GWP	Global warming potential	n/a	Not applicable
kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 1**

**Table GHG-8
Wastewater Treatment Electrical Demand GHG Emissions**

Buildout Year	Net Wastewater Generation Rate¹ (MG/yr)	Electrical Demand Factor² (kW-hr/MG)	Annual Demand Factor (MW-hr/yr)	CO₂e Emission Factor³ (lbs/MW-hr)	Annual CO₂e Emissions (MT CO₂e/yr)
Alternative 1	0.35	1,911	0.66	243.18	0.07

Sources:

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CH ₄	Methane		
CO ₂	Carbon dioxide		
CO ₂ e	Carbon dioxide equivalent	MG	Million gallons
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kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year

**Computational Research and Theory Facility
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Alternative 2**

**Table GHG-1
Summary of Annual GHG Emissions (Construction, Motor Vehicles, Electricity, Area Sources, Water, Wastewater, and Solid Waste)**

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Alternative 2	300	766.55	967.74	167.52	20,739.22	0.55	0.07	21,875.10	72.92

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**Table GHG-2
Construction GHG Emission Factors**

Equipment Type	CO₂ Emission Factor¹ (kg/gal)	CH₄ Emission Factor^{2,3} (kg/gal)	N₂O Emission Factor^{2,3} (kg/gal)	CO₂ to CO₂e Ratio (GWP CH₄ = 21) (GWP N₂O = 310)
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2013	Worker/Autos	61.35	55.66	0.950	58.59	
Total 2017		174.24	158.07		161.83	
Total					766.55	

Sources:

1. Estimated CO₂ emissions from URBEMIS2007.

Where:

CH ₄	Methane	kg	Kilograms
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
gal	Gallons	yr	Year
GWP	Global warming potential		

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 2**

**Table GHG-4
Operational Motor Vehicle GHG Emissions**

Land Use	Equipment Type	Annual CO ₂ Emissions ¹ (Tons CO ₂ /yr)	CO ₂ to CO ₂ e Ratio ²	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 2	Motor Vehicles	1,013.41	0.950	967.74

Sources:

1. Estimated CO₂ emissions from URBEMIS2007 Environmental Management Software and/or EMFAC2007 mobile source emissions factor model.
2. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Emission Facts - Greenhouse Gas Emissions from a Typical Passenger Vehicle* (EPA420-F-05-004), (2005) 4. Passenger vehicle CO₂ emissions are assumed to be 95% of GHG emissions on a CO₂ equivalent basis.

Where:

CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
MT	Metric ton
yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 2**

**Table GHG-5
Area Source GHG Emissions**

Phase	CO ₂ Emission Factor ^{1,2} GWP = 1 (kg/MMBtu)	CH ₄ Emission Factor ² GWP = 21 (kg/MMBtu)	N ₂ O Emission Factor ² GWP = 310 (kg/MMBtu)	Annual CO ₂ Emissions ³ (Tons CO ₂ /yr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 2					
Natural Gas	56.06	0.005	0.0001	183.96	167.29
Landscape Maintenance ⁴	70.88	0.011	0.0006	0.25	0.23
Hearths	56.06	0.0059	0.0001	-	-
Hearths (Wood) ⁵	93.87	0.3514	0.0047	-	-
Subtotal				184.21	167.52

Sources:

1. URBEMIS2007 uses a CO₂ emission factor of 120,000 pounds per million cubic feet. This was converted to kg/MMBtu.
2. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009) 101-103.
3. Estimated CO₂ emissions from URBEMIS2007.
4. Landscape maintenance equipment were assumed to be fueled with motor gasoline.
5. All emission factors for wood burning are provided in the California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009).

Where:

CH ₄	Methane	MMBtu	Million British thermal units
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
GWP	Global warming potential	yr	Year
kg	Kilogram		

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 2**

**Table GHG-6
Electricity Consumption GHG Emissions**

Land Use	Units¹	Electrical Consumption Factor (kW-hr/unit/yr)	Annual Consumption Factor² (MW-hr/yr)	CO₂ Emission Factor³ GWP = 1 (lbs/MW-hr)	CH₄ Emission Factor³ GWP = 21 (lbs/MW-hr)	N₂O Emission Factor³ GWP = 310 (lbs/MW-hr)	Annual CO₂e Emissions (MT CO₂e/yr)
Alternative 2	126,000 gsf	n/a	148,920.00	306.24	0.005	0.002	20,739.22

Sources:

1. Project Applicant.
2. Project Applicant. The facility would require 17 MW of power during 24/7 operation.
3. California Air Resources Board, *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.0, (2008) 174.
The CO₂ factor is for PG&E.

Where:

CH ₄	Methane	lbs	Pounds
CO ₂	Carbon dioxide	MW-hr	Megawatt-hour
CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
gsf	Gross square feet	n/a	Not applicable
GWP	Global warming potential	N ₂ O	Nitrous oxide
kW-hr	Kilowatt-hour	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 2**

**Table GHG-7
Potable Water Supply, Conveyance, Treatment, and Distribution GHG Emissions**

Land Use	Action	Potable Water Estimate ¹ (MG/yr)	Electrical Consumption Factor ^{2,3} (kW-hr/MG)	Annual Electrical Consumption (MW-hr/yr)	CO ₂ Emission Factor ⁴ GWP = 1 (lbs/MW-hr)	CH ₄ Emission Factor ⁴ GWP = 21 (lbs/MW-hr)	N ₂ O Emission Factor ⁴ GWP = 310 (lbs/MW-hr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 2	Supply & Conveyance	0.45	9,727	4.35	239.16	0.029	0.011	0.48
Alternative 2	Treatment	0.45	111	0.05	239.16	0.029	0.011	0.01
Alternative 2	Distribution	0.45	1,272	0.57	239.16	0.029	0.011	0.06
Subtotal								0.55

Sources:

1. Section 3.0, Proposed Actions and Alternatives.
2. California Energy Commission, *California's Water-Energy Relationship, Final Staff Report*, CEC-700-2005-011-SF, (2005) 26.
3. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report*, CEC-500-2006-118, (2006) 22.
4. California Air Resources Board, *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.0, (2008) 174.
The CO₂ factor is for East Bay Municipal Utility District.

Where:

CH ₄	Methane	MG	Million gallons
CO ₂	Carbon dioxide	MW-hr	Megawatt-hour
CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
GWP	Global warming potential	n/a	Not applicable
kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 2**

**Table GHG-8
Wastewater Treatment Electrical Demand GHG Emissions**

Buildout Year	Net Wastewater Generation Rate¹ (MG/yr)	Electrical Demand Factor² (kW-hr/MG)	Annual Demand Factor (MW-hr/yr)	CO₂e Emission Factor³ (lbs/MW-hr)	Annual CO₂e Emissions (MT CO₂e/yr)
Alternative 2	0.35	1,911	0.66	243.18	0.07

Sources:

1. Section 3.0, Proposed Actions and Alternatives.
2. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*. Prepared by Navigant Consulting, Inc., (2006) 22.
3. California Air Resources Board, Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, Version 1.0, (2008) 174.
The CO₂ factor is for East Bay Municipal Utility District.

Where:

BOD5	Biological oxygen demand using a standard 5 day test		
CH ₄	Methane		
CO ₂	Carbon dioxide		
CO ₂ e	Carbon dioxide equivalent	MG	Million gallons
GWP	Global warming potential	MT	Metric ton
kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 3**

**Table GHG-1
Summary of Annual GHG Emissions (Construction, Motor Vehicles, Electricity, Area Sources, Water, Wastewater, and Solid Waste)**

Project	Employees	Construction Emissions	Operational Direct Emissions		Operational Indirect Emissions			Total Operational Emissions	
		Total Construction (MT CO ₂ e)	Motor Vehicles (MT CO ₂ e/yr)	Area Sources (MT CO ₂ e/yr)	Electricity (MT CO ₂ e/yr)	Water (MT CO ₂ e/yr)	Wastewater (MT CO ₂ e/yr)	Annual (MT CO ₂ e/yr)	Per Capita (MT CO ₂ e/person/yr)
Alternative 3	300	766.55	579.94	167.52	20,739.22	0.55	0.07	21,487.30	71.62

* Annualized over the project lifetime, defined as 30 years.

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 3**

**Table GHG-2
Construction GHG Emission Factors**

Equipment Type	CO₂ Emission Factor¹ (kg/gal)	CH₄ Emission Factor^{2,3} (kg/gal)	N₂O Emission Factor^{2,3} (kg/gal)	CO₂ to CO₂e Ratio (GWP CH₄ = 21) (GWP N₂O = 310)
Off-Road	10.15	0.000580	0.000260	0.991
On-Road	10.15	0.000031	0.000029	0.999
Vendor	10.15	0.000031	0.000029	0.999
Autos ⁴	n/a	n/a	n/a	0.950

Sources:

1. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009) 96.
2. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse as Emissions Version 3.1*, (2009) 98, 100.
3. California Energy Commission, *Diesel Use in California, Remarks by Commissioner James D. Boyd*, (2002). It was assumed that heavy duty on-road trucks have a fuel economy of 6 miles per gallon based on this data source.
4. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Emission Facts - Greenhouse Gas Emissions from a Typical Passenger Vehicle (EPA420-F-05-004)*, (2005) 4. Passenger vehicle CO₂ emissions are assumed to be 95% of GHG emissions on a CO₂ equivalent basis.

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 3**

**Table GHG-3
Construction GHG Emissions**

Construction Year	Equipment Type	Annual CO ₂ Emissions ¹ (Tons CO ₂ /yr)	Annual CO ₂ Emissions (MT CO ₂ /yr)	CO ₂ to CO ₂ e Ratio	Annual CO ₂ e Emissions (MT CO ₂ e/yr)	
Specific Plan (2012)	2010	Off-Road	130.74	118.61	0.991	119.69
	2010	On-Road	14.09	12.78	0.999	12.79
	2010	Vendor	-	-	0.999	-
	2010	Worker/Autos	6.73	6.11	0.950	6.43
	Total 2010		151.56	137.49		138.91
	2011	Off-Road	116.14	105.36	0.991	106.32
	2011	On-Road	-	-	0.999	-
	2011	Vendor	26.45	24.00	0.999	24.02
	2011	Worker/Autos	106.90	96.98	0.950	102.08
	Total 2011		249.49	226.33		232.42
	2012	Off-Road	116.59	105.77	0.991	106.74
	2012	On-Road	-	-	0.999	-
	2012	Vendor	26.55	24.09	0.999	24.11
	2012	Worker/Autos	107.38	97.41	0.950	102.54
	Total 2012		250.52	227.27		233.38
	2013	Off-Road	98.96	89.77	0.991	90.60
2013	On-Road	0.81	0.73	0.999	0.74	
2013	Vendor	13.12	11.90	0.999	11.91	
2013	Worker/Autos	61.35	55.66	0.950	58.59	
Total 2017		174.24	158.07		161.83	
Total					766.55	

Sources:

1. Estimated CO₂ emissions from URBEMIS2007.

Where:

CH ₄	Methane	kg	Kilograms
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
gal	Gallons	yr	Year
GWP	Global warming potential		

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 3**

**Table GHG-4
Operational Motor Vehicle GHG Emissions**

Land Use	Equipment Type	Annual CO ₂ Emissions ¹ (Tons CO ₂ /yr)	CO ₂ to CO ₂ e Ratio ²	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 3	Motor Vehicles	607.31	0.950	579.94

Sources:

1. Estimated CO₂ emissions from URBEMIS2007 Environmental Management Software and/or EMFAC2007 mobile source emissions factor model.
2. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Emission Facts - Greenhouse Gas Emissions from a Typical Passenger Vehicle* (EPA420-F-05-004), (2005) 4. Passenger vehicle CO₂ emissions are assumed to be 95% of GHG emissions on a CO₂ equivalent basis.

Where:

CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
MT	Metric ton
yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 3**

**Table GHG-5
Area Source GHG Emissions**

Phase	CO ₂ Emission Factor ^{1,2} GWP = 1 (kg/MMBtu)	CH ₄ Emission Factor ² GWP = 21 (kg/MMBtu)	N ₂ O Emission Factor ² GWP = 310 (kg/MMBtu)	Annual CO ₂ Emissions ³ (Tons CO ₂ /yr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 3					
Natural Gas	56.06	0.005	0.0001	183.96	167.29
Landscape Maintenance ⁴	70.88	0.011	0.0006	0.25	0.23
Hearths	56.06	0.0059	0.0001	-	-
Hearths (Wood) ⁵	93.87	0.3514	0.0047	-	-
Subtotal				184.21	167.52

Sources:

1. URBEMIS2007 uses a CO₂ emission factor of 120,000 pounds per million cubic feet. This was converted to kg/MMBtu.
2. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009) 101-103.
3. Estimated CO₂ emissions from URBEMIS2007.
4. Landscape maintenance equipment were assumed to be fueled with motor gasoline.
5. All emission factors for wood burning are provided in the California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009).

Where:

CH ₄	Methane	MMBtu	Million British thermal units
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
GWP	Global warming potential	yr	Year
kg	Kilogram		

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 3**

**Table GHG-6
Electricity Consumption GHG Emissions**

Land Use	Units ¹	Electrical Consumption Factor (kW-hr/unit/yr)	Annual Consumption Factor ² (MW-hr/yr)	CO ₂ Emission Factor ³ GWP = 1 (lbs/MW-hr)	CH ₄ Emission Factor ³ GWP = 21 (lbs/MW-hr)	N ₂ O Emission Factor ³ GWP = 310 (lbs/MW-hr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 3	126,000 gsf	n/a	148,920.00	306.24	0.005	0.002	20,739.22

Sources:

1. Project Applicant.
2. Project Applicant. The facility would require 17 MW of power during 24/7 operation.
3. California Air Resources Board, *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.0, (2008) 174.
The CO₂ factor is for PG&E.

Where:

CH ₄	Methane	lbs	Pounds
CO ₂	Carbon dioxide	MW-hr	Megawatt-hour
CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
gsf	Gross square feet	n/a	Not applicable
GWP	Global warming potential	N ₂ O	Nitrous oxide
kW-hr	Kilowatt-hour	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 3**

**Table GHG-7
Potable Water Supply, Conveyance, Treatment, and Distribution GHG Emissions**

Land Use	Action	Potable Water Estimate ¹ (MG/yr)	Electrical Consumption Factor ^{2,3} (kW-hr/MG)	Annual Electrical Consumption (MW-hr/yr)	CO ₂ Emission Factor ⁴ GWP = 1 (lbs/MW-hr)	CH ₄ Emission Factor ⁴ GWP = 21 (lbs/MW-hr)	N ₂ O Emission Factor ⁴ GWP = 310 (lbs/MW-hr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 3	Supply & Conveyance	0.45	9,727	4.35	239.16	0.029	0.011	0.48
Alternative 3	Treatment	0.45	111	0.05	239.16	0.029	0.011	0.01
Alternative 3	Distribution	0.45	1,272	0.57	239.16	0.029	0.011	0.06
Subtotal								0.55

Sources:

- Section 3.0, Proposed Actions and Alternatives.
- California Energy Commission, *California's Water-Energy Relationship, Final Staff Report*, CEC-700-2005-011-SF, (2005) 26.
- California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report*, CEC-500-2006-118, (2006) 22.
- California Air Resources Board, *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.0, (2008) 174.
The CO₂ factor is for East Bay Municipal Utility District.

Where:

CH ₄	Methane	MG	Million gallons
CO ₂	Carbon dioxide	MW-hr	Megawatt-hour
CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
GWP	Global warming potential	n/a	Not applicable
kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 3**

**Table GHG-8
Wastewater Treatment Electrical Demand GHG Emissions**

Buildout Year	Net Wastewater Generation Rate¹ (MG/yr)	Electrical Demand Factor² (kW-hr/MG)	Annual Demand Factor (MW-hr/yr)	CO₂e Emission Factor³ (lbs/MW-hr)	Annual CO₂e Emissions (MT CO₂e/yr)
Alternative 3	0.35	1,911	0.66	243.18	0.07

Sources:

1. Section 3.0, Proposed Actions and Alternatives.
2. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*. Prepared by Navigant Consulting, Inc., (2006) 22.
3. California Air Resources Board, Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, Version 1.0, (2008) 174.
The CO₂ factor is for East Bay Municipal Utility District.

Where:

BOD5	Biological oxygen demand using a standard 5 day test		
CH ₄	Methane		
CO ₂	Carbon dioxide		
CO ₂ e	Carbon dioxide equivalent	MG	Million gallons
GWP	Global warming potential	MT	Metric ton
kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 4**

**Table GHG-1
Summary of Annual GHG Emissions (Construction, Motor Vehicles, Electricity, Area Sources, Water, Wastewater, and Solid Waste)**

Project	Employees	Construction Emissions	Operational Direct Emissions		Operational Indirect Emissions			Total Operational Emissions	
		Total Construction (MT CO ₂ e)	Motor Vehicles (MT CO ₂ e/yr)	Area Sources (MT CO ₂ e/yr)	Electricity (MT CO ₂ e/yr)	Water (MT CO ₂ e/yr)	Wastewater (MT CO ₂ e/yr)	Annual (MT CO ₂ e/yr)	Per Capita (MT CO ₂ e/person/yr)
Alternative 4	300	641.69	775.59	167.52	20,739.22	0.55	0.07	21,682.95	72.28

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 4**

**Table GHG-2
Construction GHG Emission Factors**

Equipment Type	CO₂ Emission Factor¹ (kg/gal)	CH₄ Emission Factor^{2,3} (kg/gal)	N₂O Emission Factor^{2,3} (kg/gal)	CO₂ to CO₂e Ratio (GWP CH₄ = 21) (GWP N₂O = 310)
Off-Road	10.15	0.000580	0.000260	0.991
On-Road	10.15	0.000031	0.000029	0.999
Vendor	10.15	0.000031	0.000029	0.999
Autos ⁴	n/a	n/a	n/a	0.950

Sources:

1. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009) 96.
2. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse as Emissions Version 3.1*, (2009) 98, 100.
3. California Energy Commission, *Diesel Use in California, Remarks by Commissioner James D. Boyd*, (2002). It was assumed that heavy duty on-road trucks have a fuel economy of 6 miles per gallon based on this data source.
4. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Emission Facts - Greenhouse Gas Emissions from a Typical Passenger Vehicle (EPA420-F-05-004)*, (2005) 4. Passenger vehicle CO₂ emissions are assumed to be 95% of GHG emissions on a CO₂ equivalent basis.

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 4**

**Table GHG-3
Construction GHG Emissions**

Construction Year	Equipment Type	Annual CO ₂ Emissions ¹ (Tons CO ₂ /yr)	Annual CO ₂ Emissions (MT CO ₂ /yr)	CO ₂ to CO ₂ e Ratio	Annual CO ₂ e Emissions (MT CO ₂ e/yr)	
Specific Plan (2012)	2010	Off-Road	29.48	26.74	0.991	26.99
	2010	On-Road	-	-	0.999	-
	2010	Vendor	6.71	6.09	0.999	6.09
	2010	Worker/Autos	27.12	24.60	0.950	25.90
	Total 2010		63.31	57.43		58.98
	2011	Off-Road	116.14	105.36	0.991	106.32
	2011	On-Road	-	-	0.999	-
	2011	Vendor	26.45	24.00	0.999	24.02
	2011	Worker/Autos	106.90	96.98	0.950	102.08
	Total 2011		249.49	226.33		232.42
	2012	Off-Road	116.59	105.77	0.991	106.74
	2012	On-Road	-	-	0.999	-
	2012	Vendor	26.55	24.09	0.999	24.11
	2012	Worker/Autos	107.38	97.41	0.950	102.54
	Total 2012		250.52	227.27		233.38
	2013	Off-Road	57.62	52.27	0.991	52.75
2013	On-Road	-	-	0.999	-	
2013	Vendor	13.12	11.90	0.999	11.91	
2013	Worker/Autos	54.71	49.63	0.950	52.24	
Total 2013		125.45	113.81		116.91	
Total					641.69	

Sources:

1. Estimated CO₂ emissions from URBEMIS2007.

Where:

CH ₄	Methane	kg	Kilograms
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
gal	Gallons	yr	Year
GWP	Global warming potential		

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 4**

**Table GHG-4
Operational Motor Vehicle GHG Emissions**

Land Use	Equipment Type	Annual CO ₂ Emissions ¹ (Tons CO ₂ /yr)	CO ₂ to CO ₂ e Ratio ²	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 4	Motor Vehicles	812.19	0.950	775.59

Sources:

1. Estimated CO₂ emissions from URBEMIS2007 Environmental Management Software and/or EMFAC2007 mobile source emissions factor model.
2. U.S. Environmental Protection Agency, Office of Transportation and Air Quality, *Emission Facts - Greenhouse Gas Emissions from a Typical Passenger Vehicle* (EPA420-F-05-004), (2005) 4. Passenger vehicle CO₂ emissions are assumed to be 95% of GHG emissions on a CO₂ equivalent basis.

Where:

CO ₂	Carbon dioxide
CO ₂ e	Carbon dioxide equivalent
MT	Metric ton
yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 4**

**Table GHG-5
Area Source GHG Emissions**

Phase	CO ₂ Emission Factor ^{1,2} GWP = 1 (kg/MMBtu)	CH ₄ Emission Factor ² GWP = 21 (kg/MMBtu)	N ₂ O Emission Factor ² GWP = 310 (kg/MMBtu)	Annual CO ₂ Emissions ³ (Tons CO ₂ /yr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 4					
Natural Gas	56.06	0.005	0.0001	183.96	167.29
Landscape Maintenance ⁴	70.88	0.011	0.0006	0.25	0.23
Hearths	56.06	0.0059	0.0001	-	-
Hearths (Wood) ⁵	93.87	0.3514	0.0047	-	-
Subtotal				184.21	167.52

Sources:

1. URBEMIS2007 uses a CO₂ emission factor of 120,000 pounds per million cubic feet. This was converted to kg/MMBtu.
2. California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009) 101-103.
3. Estimated CO₂ emissions from URBEMIS2007.
4. Landscape maintenance equipment were assumed to be fueled with motor gasoline.
5. All emission factors for wood burning are provided in the California Climate Action Registry, *General Reporting Protocol: Reporting Entity-Wide Greenhouse Gas Emissions Version 3.1*, (2009).

Where:

CH ₄	Methane	MMBtu	Million British thermal units
CO ₂	Carbon dioxide	MT	Metric ton
CO ₂ e	Carbon dioxide equivalent	N ₂ O	Nitrous oxide
GWP	Global warming potential	yr	Year
kg	Kilogram		

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 4**

**Table GHG-6
Electricity Consumption GHG Emissions**

Land Use	Units¹	Electrical Consumption Factor (kW-hr/unit/yr)	Annual Consumption Factor² (MW-hr/yr)	CO₂ Emission Factor³ GWP = 1 (lbs/MW-hr)	CH₄ Emission Factor³ GWP = 21 (lbs/MW-hr)	N₂O Emission Factor³ GWP = 310 (lbs/MW-hr)	Annual CO₂e Emissions (MT CO₂e/yr)
Alternative 4	126,000 gsf	n/a	148,920.00	306.24	0.005	0.002	20,739.22

Sources:

1. Project Applicant.
2. Project Applicant. The facility would require 17 MW of power during 24/7 operation.
3. California Air Resources Board, *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.0, (2008) 174.
The CO₂ factor is for PG&E.

Where:

CH ₄	Methane	lbs	Pounds
CO ₂	Carbon dioxide	MW-hr	Megawatt-hour
CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
gsf	Gross square feet	n/a	Not applicable
GWP	Global warming potential	N ₂ O	Nitrous oxide
kW-hr	Kilowatt-hour	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 4**

**Table GHG-7
Potable Water Supply, Conveyance, Treatment, and Distribution GHG Emissions**

Land Use	Action	Potable Water Estimate ¹ (MG/yr)	Electrical Consumption Factor ^{2,3} (kW-hr/MG)	Annual Electrical Consumption (MW-hr/yr)	CO ₂ Emission Factor ⁴ GWP = 1 (lbs/MW-hr)	CH ₄ Emission Factor ⁴ GWP = 21 (lbs/MW-hr)	N ₂ O Emission Factor ⁴ GWP = 310 (lbs/MW-hr)	Annual CO ₂ e Emissions (MT CO ₂ e/yr)
Alternative 4	Supply & Conveyance	0.45	9,727	4.35	239.16	0.029	0.011	0.48
Alternative 4	Treatment	0.45	111	0.05	239.16	0.029	0.011	0.01
Alternative 4	Distribution	0.45	1,272	0.57	239.16	0.029	0.011	0.06
Subtotal								0.55

Sources:

- Section 3.0, Proposed Actions and Alternatives.
- California Energy Commission, *California's Water-Energy Relationship, Final Staff Report*, CEC-700-2005-011-SF, (2005) 26.
- California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report*, CEC-500-2006-118, (2006) 22.
- California Air Resources Board, *Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories*, Version 1.0, (2008) 174.
The CO₂ factor is for East Bay Municipal Utility District.

Where:

CH ₄	Methane	MG	Million gallons
CO ₂	Carbon dioxide	MW-hr	Megawatt-hour
CO ₂ e	Carbon dioxide equivalent	MT	Metric ton
GWP	Global warming potential	n/a	Not applicable
kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year

**Computational Research and Theory Facility
Evaluation of Global Climate Change Impacts
Alternative 4**

**Table GHG-8
Wastewater Treatment Electrical Demand GHG Emissions**

Buildout Year	Net Wastewater Generation Rate¹ (MG/yr)	Electrical Demand Factor² (kW-hr/MG)	Annual Demand Factor (MW-hr/yr)	CO₂e Emission Factor³ (lbs/MW-hr)	Annual CO₂e Emissions (MT CO₂e/yr)
Alternative 4	0.35	1,911	0.66	243.18	0.07

Sources:

1. Section 3.0, Proposed Actions and Alternatives.
2. California Energy Commission, *Refining Estimates of Water-Related Energy Use in California, PIER Final Project Report (CEC-500-2006-118)*. Prepared by Navigant Consulting, Inc., (2006) 22.
3. California Air Resources Board, Local Government Operations Protocol for the Quantification and Reporting of Greenhouse Gas Emissions Inventories, Version 1.0, (2008) 174.
The CO₂ factor is for East Bay Municipal Utility District.

Where:

BOD5	Biological oxygen demand using a standard 5 day test		
CH ₄	Methane		
CO ₂	Carbon dioxide		
CO ₂ e	Carbon dioxide equivalent	MG	Million gallons
GWP	Global warming potential	MT	Metric ton
kW-hr	Kilowatt-hour	N ₂ O	Nitrous oxide
lbs	Pounds	yr	Year