Mechanical Systems Technical Assignment 2

Building and Plant Energy Analysis Report

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Mechanical Option
The Waverly on Lake Eola
Orlando, FL
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Executive Summary

This report investigates the mechanical performance of The Waverly on Lake Eola in Orlando, FL. Comparisons of the building to ASHRAE Standard 90.1 compliance and the US Green Building Council's LEED certification program were made. The areas of lost rentable space, annual energy utilization, design load, operating costs, and first-cost of the mechanical system were measured as well.

The Waverly on Lake Eola earned 15 out of a possible 69 LEED points available. 26 points are needed at a bare minimum in order to be certified. Also, since The Waverly uses a 100% outdoor air system, as opposed to a more efficient traditional system, the building fails to meet the pre-requisites to become certified.

Standard 90.1 requires no more than 50% of the building envelope to be glass. The Waverly meets this requirement by having an envelope of 46%. ASHRAE also requires a lighting density of less than 1.1 Watts per square foot in order to save energy. With a design load of 1.5 W/sq-ft, The Waverly fails this requirement.

Since the mechanical systems are mainly on the roof and in between floors, only the vertical ductwork interferes with rentable space. A total of 1,896 sq-ft were lost due to mechanical systems. Upon comparison with the 371,000 building, this lost space is insubstantial.

A lack of the price list for Florida Heat Pumps created a problem with finding the first-cost of the building. This information is on its way and will be filled in upon arrival. The Hourly Analysis Program (HAP) had trouble processing the more than 250 heat pumps in the building, so data on the annual cost and correctness of design have not yet been acquired.

The cost of electricity from Progress Energy in Florida is 4.813 cents/kWh plus a fuel charge of 3.918 cents/kWh. A customer charge of $8.03 per month is a base part of the bill. This will be used in calculations once appropriate HAP analysis can be performed.

LEED Criteria

In recent years, due to energy crises and environmental protection, the ideas of green building and sustainable design have come to the forefront in the building industry. The US Green Building Council (USGBC) created the Leadership in Energy and Environmental Design (LEED) rating system to develop a voluntary, consensus-based national standard for developing high-performance, sustainable buildings. The LEED system helps to define "green building" by establishing a common standard of measurement, recognize leadership in the building industry, and stimulate green competition in order to transform the building market.

The LEED Green Building Certification Rating System currently consists of 6 major categories: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and LEED Innovation Credits. These 6 categories create a checklist with a total of 69 possible points to be earned. Based on the number of points earned a building can earn a bronze, silver, gold, or platinum LEED certified rating.

The Waverly on Lake Eola was not designed with LEED criteria in mind, and would fail to gain a rating level if examined by the USGBC. Since The Waverly was developed as a luxury condominium facility, and already utilizes many expensive features for its residents, LEED certification was not thought of as an important building feature by ZOM development. Keeping the cost down in large residential and office buildings is often more important to the owner than making sure the building is green and sustainable. Since the owner seeks to see a quick return on his investment, the price must be low in order to sell condominiums more quickly. However, The Waverly still manages to meet earn 15 points on the LEED rating system (see chart below), and could have been made to earn the 26 points required to earn a bronze rating with a low cost relative to the total building cost of 38 million dollars.

The main reasons that The Waverly earned points toward LEED certification were the 100% outdoor air throughout the building and the use of floor to ceiling windows in virtually every room in the building. The level of comfort provided by these design criteria is considered healthier for the residents, and is encouraged. However, the use of 100% outdoor air also lost The Waverly a required LEED standard of minimum energy use for HVAC systems, making the building ineligible for certification.

LEED-NC Version 2.1 Registered Project Checklist

The Waverly on Lake Eola
Orlando, FL

Yes	?	No			
			Sustainable Sites		**14** Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
Y			Credit 1	**Site Selection**	1
		N	Credit 2	**Development Density**	1
		N	Credit 3	**Brownfield Redevelopment**	1
Y			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
Y			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		N	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
		N	Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	1
		N	Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
		N	Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
Y		N	Credit 6.1	**Stormwater Management**, Rate and Quantity	1
Y			Credit 6.2	**Stormwater Management**, Treatment	1
Y			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
Y			Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
		N	Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
			Water Efficiency		**5** Points
Y			Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
		N	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		N	Credit 2	**Innovative Wastewater Technologies**	1
		N	Credit 3.1	**Water Use Reduction**, 20% Reduction	1
		N	Credit 3.2	**Water Use Reduction**, 30% Reduction	1

			Energy & Atmosphere		**17** Points

Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
N			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
		N	Credit 1	**Optimize Energy Performance**	1 to 10
		N	Credit 2.1	**Renewable Energy**, 5%	1
		N	Credit 2.2	**Renewable Energy**, 10%	1
		N	Credit 2.3	**Renewable Energy**, 20%	1
		N	Credit 3	**Additional Commissioning**	1
Y			Credit 4	**Ozone Depletion**	1
		N	Credit 5	**Measurement & Verification**	1
		N	Credit 6	**Green Power**	1

continued…

Yes	?	No		
			Materials & Resources	**13** Points

Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		N	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
		N	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
		N	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
		N	Credit 2.1	**Construction Waste Management**, Divert 50%	1
		N	Credit 2.2	**Construction Waste Management**, Divert 75%	1
		N	Credit 3.1	**Resource Reuse**, Specify 5%	1
		N	Credit 3.2	**Resource Reuse**, Specify 10%	1
		N	Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	1
		N	Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	1
Y			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
		N	Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
		N	Credit 6	**Rapidly Renewable Materials**	1
		N	Credit 7	**Certified Wood**	1

Yes	?	No		
			Indoor Environmental Quality	**15** Points

Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
		N	Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
Y			Credit 2	**Ventilation Effectiveness**	1

		N	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
		N	Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
Y			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
		N	Credit 4.2	**Low-Emitting Materials**, Paints	1
		N	Credit 4.3	**Low-Emitting Materials**, Carpet	1
		N	Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	1
		N	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
		N	Credit 6.1	**Controllability of Systems**, Perimeter	1
		N	Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
Y			Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
		N	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
Y			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
Y			Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Yes ? No

			Innovation & Design Process	**5** Points

		N	Credit 1.1	**Innovation in Design**: Provide Specific Title	1
		N	Credit 1.2	**Innovation in Design**: Provide Specific Title	1
		N	Credit 1.3	**Innovation in Design**: Provide Specific Title	1
		N	Credit 1.4	**Innovation in Design**: Provide Specific Title	1
		N	Credit 2	**LEED™ Accredited Professional**	1

Yes ? No

15			**Project Totals (pre-certification estimates)**	**69** Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

ASHRAE Standard 90.1 Compliance

The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) has established standard 90.1 as a guideline for the energy-efficient design of buildings throughout the United States, and the world. This report focuses on the degree that The Waverly on Lake Eola's building envelope complies with the criteria contained in standard 90.1 as well as the compliance of the lighting for the building.

Building Envelope

Standards for the design of building envelopes reside in chapter 5 of ASHRAE standard 90.1. All parts that separate the conditioned interior of the building from the outside air make up the building envelope. This includes the exterior doors, walls, windows, and the roof of the building.

Vertical Glazing:
ASHRAE standard 90.1 requires that the total area of vertical glass on building be less than 50% of the total building envelope. Since floor to ceiling windows dominate the envelope, The Waverly on Lake Eola is on the border of passing this requirement. After calculations of the total wall area and glazing were performed, The Waverly was found to have glass on 46% of the total envelope.
Percentage Glazing: 46% < 50%, therefore building passes requirement.

Total glazing: 75,648.5 ft^2
Total building envelope: 163,200 ft^2

Floors	Glass(sf)	Total (sf)	%
3,4,6-18	4699.5	8496	55.31427
Penthouse	1214	2574	47.16395
20,21	1158	2574	44.98834
5	3769.5	8496	44.36794
2	1305	3096	42.15116
1	1251	3096	40.40698
Roof	0	21846	0
Total	75648.5	163200	46.35325

Climate Characteristics:
Next the climate characteristics of the buildings surrounding area must be studied. Orlando falls in climate zone 1A according to table D-1. The Heating Degree Days (HDD50) and Cooling Degree Days (CDD65) of Orlando, Florida, where The Waverly is located, can be found in standard 90.1. Examining Table D-1 yields that Orlando has an HDD of 686 and a CDD value of 8227.

Building Envelope Requirements:
U-values and window criteria are found in Table 5.5-2 in standard 90.1. Architectural data about U-values of the roof, walls and windows have not yet arrived from Graham Gund Architects, and thus cannot be measured at this time. Comparisons to required values will be calculated upon arrival of this information.

Lighting

Standard 90.1 suggests maximum lighting power densities for different space uses in order to save energy. Lighting not only uses energy, but also adds heat to the environment, increasing cooling loads. For this reason ASHRAE suggests maximum wattage per square foot for different spaces.

The Waverly on Lake Eola was designed for a maximum lighting density of 1.5 Watts per square foot. Table 9.5.1 does not make a suggestion for condominium facilities; however, ASHRAE makes a suggestion for hotels. For this comparison it was assumed that The Waverly should be designed in accordance with hotel standards. The maximum lighting power density suggested for hotels is 1.0 watts per square foot according to table 9.5.1. Since 1.5 is the design lighting power density, The Waverly does not meet the ASHRAE maximum requirement of 1.1 watts per square foot for lighting.
LPD: 1.5 W/sq-ft > 1.1 W/sq-ft, therefore building does not pass requirement.

Lost Rentable Space

Since the large mechanical systems for The Waverly on Lake Eola are located on the roof, there is not much rentable space lost due to HVAC systems. Exhaust and supply risers take up some space throughout the building, but not much in comparison to the large condominiums available to residents. There is a mechanical room on the 20th floor; however this is actually on the roof of the 19th floors wave section of the building, and thus is not really accountable for lost rentable space. Below is a chart of the lost space due to ductwork:

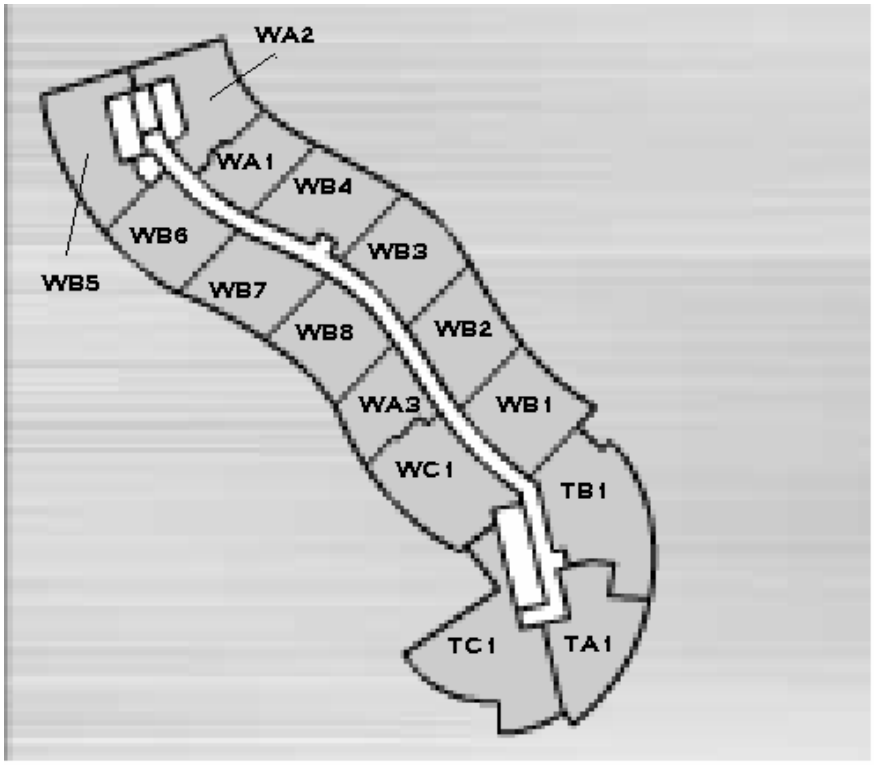
	Dimensions	Area (sq-ft)	# of floors	Use	Lost space (sq-ft)
EF1.1	20x18	2.5	21	exhaust	52.5
EF1.2	20x18	2.5	21	exhaust	52.5
EF1.3	20x18	2.5	21	exhaust	52.5
EF1.4	20x18	2.5	20	exhaust	50
EF1.5	20x18	2.5	21	exhaust	52.5
EF1.6	20x18	2.5	17	exhaust	42.5
EF1.7	20x18	2.5	17	exhaust	42.5
EF1.8	20x18	2.5	17	exhaust	42.5
EF1.9	20x18	2.5	18	exhaust	45
EF1.10	20x18	2.5	17	exhaust	42.5
EF1.11	20x18	2.5	17	exhaust	42.5
EF1.12	20x18	2.5	16	exhaust	40
EF1.13	20x18	2.5	18	exhaust	45
EF2	32x30	6.7	21	exhaust	140.7
EF3	32x30	6.7	20	exhaust	134
EF4	32x30	6.7	20	exhaust	134
EF5	32x30	6.7	17	exhaust	113.9
EF6	32x30	6.7	17	exhaust	113.9
RH1(6)	20x18	15	21	relief	315
RH1(7)	20x18	17.5	18	relief	315
				Total	1869

A total of 1896 sq-ft is lost that could have been used as rentable space. Out of an approximate size of 371,000 sq-ft, this is nearly insignificant.

1896 / 371000 < 1%

HAP Analysis

The floor plan below shows the labeling structure used in Carrier's Hourly Analysis Program:



Appendices

TABLE 5.5-2
Building Envelope Requirements For Climate Zone 2 (A,B)

		Nonresidential		Residential		Semiheated	
		Assembly	Insulation Min.	Assembly	Insulation Min.	Assembly	Insulation Min.
	Opaque Elements	**Maximum**	**R-Value**	**Maximum**	**R-Value**	**Maximum**	**R-Value**
Roofs							
	Insulation Entirely above Deck	U-0.063	R-15.0 ci	U-0.063	R-15.0 ci	U-0.218	R-3.8 ci
	Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	U-0.167	R-6.0
	Attic and Other	U-0.034	R-30.0	U-0.027	R-38.0	U-0.081	R-13.0
Walls, Above Grade							
	Mass	U-0.580	NR	U-0.151[a]	R-5.7 ci[a]	U-0.580	NR
	Metal Building	U-0.113	R-13.0	U-0.113	R-13.0	U-0.184	R-6.0
	Steel Framed	U-0.124	R-13.0	U-0.124	R-13.0	U-0.352	NR
	Wood Framed and Other	U-0.089	R-13.0	U-0.089	R-13.0	U-0.292	NR
Wall, Below Grade							
	Below Grade Wall	C-1.140	NR	C-1.140	NR	C-1.140	NR
Floors							
	Mass	U-0.137	R-4.2 ci	U-0.107	R-6.3 ci	U-0.322	NR
	Steel Joist	U-0.052	R-19.0	U-0.052	R-19.0	U-0.350	NR
	Wood Framed and Other	U-0.051	R-19.0	U-0.051	R-19.0	U-0.282	NR
Slab-On-Grade Floors							
	Unheated	F-0.730	NR	F-0.730	NR	F-0.730	NR
	Heated	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors							
	Swinging	U-0.700		U-0.700		U-0.700	
	Non-Swinging	U-1.450		U-1.450		U-1.450	
		Assembly	Assembly Max.	Assembly	Assembly Max.	Assembly	Assembly Max.
		Max. U	SHGC (All	Max. U	SHGC (All	Max. U	SHGC (All
		(Fixed/	Orientations/	(Fixed/	Orientations/	(Fixed/	Orientations/
	Fenestration	**Operable)**	**North-Oriented)**	**Operable)**	**North-Oriented)**	**Operable)**	**North-Oriented)**
Vertical Glazing,% of Wall							
	0-10.0%	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-0.39	U_{fixed}-1.22	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-NR
	10.1-20.0%	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-NR
	20.1-30.0%	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-NR
	30.1-40.0%	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-0.25	U_{fixed}-1.22	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-0.61	U_{oper}-1.27	$SHGC_{north}$-NR
	40.1-50.0%	U_{fixed}-1.22	$SHGC_{all}$-0.17	U_{fixed}-1.22	$SHGC_{all}$-0.17	U_{fixed}-0.98	$SHGC_{all}$-NR
		U_{oper}-1.27	$SHGC_{north}$-0.44	U_{oper}-1.27	$SHGC_{north}$-0.43	U_{oper}-1.02	$SHGC_{north}$-NR
Skylight with Curb, Glass,% of Roof							
	0-2.0%	U_{all}-1.98	$SHGC_{all}$-0.36	U_{all}-1.98	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-NR
	2.1-5.0%	U_{all}-1.98	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-NR
Skylight with Curb, Plastic,% of Roof							
	0-2.0%	U_{all}-1.90	$SHGC_{all}$-0.39	U_{all}-1.90	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-NR
	2.1-5.0%	U_{all}-1.90	$SHGC_{all}$-0.34	U_{all}-1.90	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-NR
Skylight without Curb, All,% of Roof							
	0-2.0%	U_{all}-1.36	$SHGC_{all}$-0.36	U_{all}-1.36	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-NR
	2.1-5.0%	U_{all}-1.36	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-NR
[a]	Exception to A3.1.3.1 applies.						

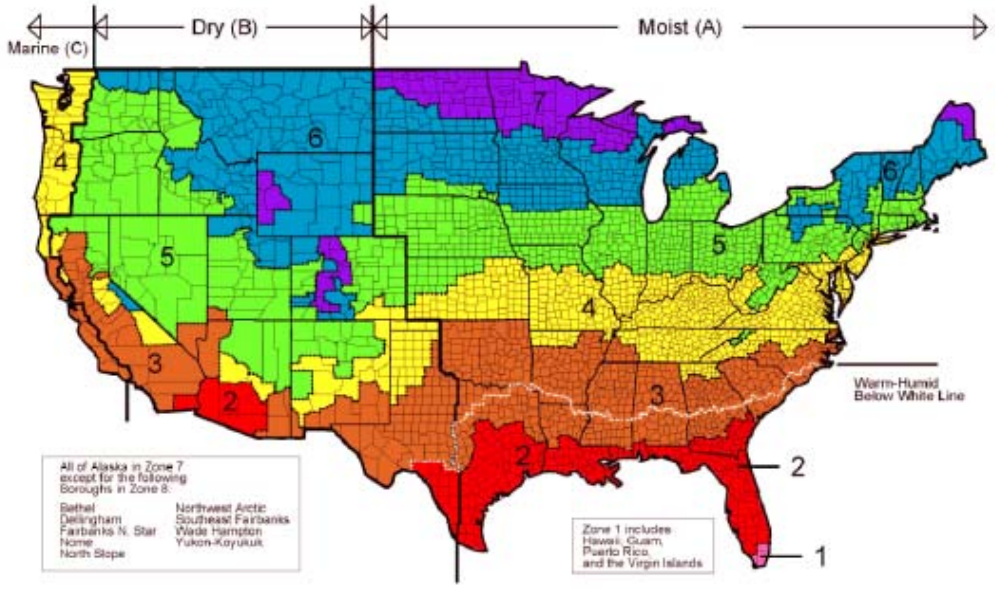


Figure B-1 Climate zones for United States locations.

TABLE 9.5.1 Lighting Power Densities Using the Building Area Method

Building Area Type[a]	Lighting Power Density (W/ft2)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Health Care-Clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multi-Family	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

[a] In cases where both general building area type and a specific building area type are listed, the specific building area type shall apply.