CASE STUDY

LIHI Denny Park Apartments

Seattle, Washington

Acknowledgements

View of commons area roof deck looking west. Gardens for rain collection from roof at right.

The Carbon Neutral Design Building Case Study project is supported by funding from the American Institute of Architects, the Society of Building Science Educators, an annonymous donor, the Graduate School of the University of Wisconsin-Milwaukee and Better Bricks of the Northwest Energy Efficiency Alliance.

The Runberg Architecture Group, designers of the LIHI Denny Park Apartments, provided construction documents for the project. Michelle Wang, a member of the Runberg Architecture Group design team, provided additional information through an interview in December, 2008. In addition, she gave Michael Utzinger a tour of the apartments in March, 2009.

The property owner, LIHI Denny Park Aparkments, LLC, graciously provided utility bills for natural gas, electricity and water consumption.

A number of University of Wisconsin-Milwaukee graduate students in architecture helped develop the REVIT model, input data into the building case study spread sheet and develop this document. Those students assisting in development of this case study include Allison Mastel, Payman Sadeghi, Leyla Sanati, NJ Unaka and Steve Wolner.

Michael Utzinger and James Wasley, editors
Institute for Ecological Design
University of Wisconsin-Milwaukee
2011

Contents

Denny Park Apartments
View looking south-southeast.

Overview

Location: Seattle, Washington
Building type(s): Multi Family Residential Housing with Ground Floor Commercial and Underground Parking Garage
New construction
Urban setting
Completed January 2006

Denny Park Apartments includes 50 units of affordable rental housing, 4,400 ft^2 of commercial space, and parking for 35 vehicles. The residential portion includes a community room, an office, common laundry facilities, and a common landscaped courtyard. The average residential unit size is 541 net square feet and includes 5 three bedroom, 8 two bedroom, 12 one bedroom and 25 studio units. The urban-infill project also includes new city sidewalks and right-of-way landscaping.

Of the housing units, 40% are reserved for households at or below 30% of the area median income (AMI), 50% are reserved for households at or below 50% AMI, and 10% are reserved for households at or below 60% AMI. The AMI for King County was, in 2004, $70,100 for a family of three.

Environmental Aspects

The mixed-use, urban-infill project was designed to provide opportunities for occupants to live, work, and play in close proximity, and minimize dependence on automobiles.

The project's energy design focused on maximizing daylighting while minimizing western solar gain during the summer months. The building is oriented along an east-west axis, with half the units facing north and half facing south. The common room and courtyard (the heart of the project) are located at the south side of the building, where they are warmed by late-afternoon western sun. To encourage occupants to use the operable windows for natural ventilation and cooling, residential units were not provided with air conditioning. A central natural-gas hydronic system provides heat and hot water.

West facade, Denny Park Apartments.

Innovative planters filter stormwater falling on the project site, releasing it slowly into the municipal system while allowing evaporation and transpiration. Low-flow plumbing fixtures reduce water use indoors.

Materials were selected largely for their cost-effectiveness and durability. A jobsite recycling program led to the recycling of 91% of construction waste, by weight. Indoor air quality is protected by finishes with low chemical emissions and a no-smoking policy for the entire project.

Owner & Occupancy

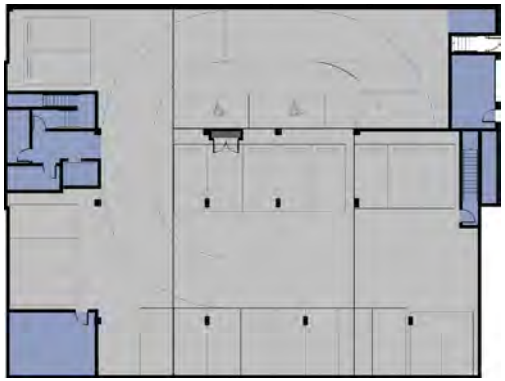
Owned by Low Income Housing Institute, Corporation, nonprofit
Occupants: Individual(s)
Typically occupied by 90 people, 100 hours per person per week; and 20 visitors per week, 3 hours per visitor per week

Level 1 Building Case Study Metrics

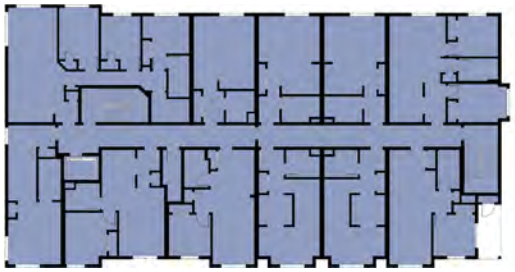
Building Area	Gross Measured Area	
Residential	33,543 SF	[3,116 M²]
Commercial	4,078 SF	[379 M²]
Parking Garage	15,340 SF	[1,425 M²]
Total Building	**52,961 SF**	**[4,920 M²]**
Average Residential Unit	541 SF	[50.3 M²]

The Gross Measured Area is the area of the building (or building sub area) measured to the inside face of the exterior walls. The metrics on this page are calculated without includeing the garage area.

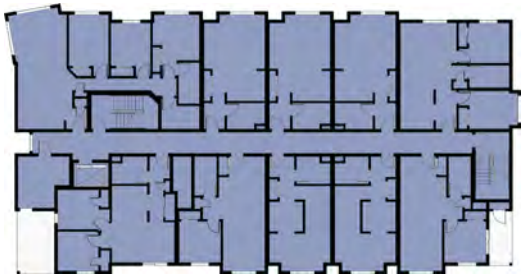
LIHI Denny Park Apartments - Ground Floor



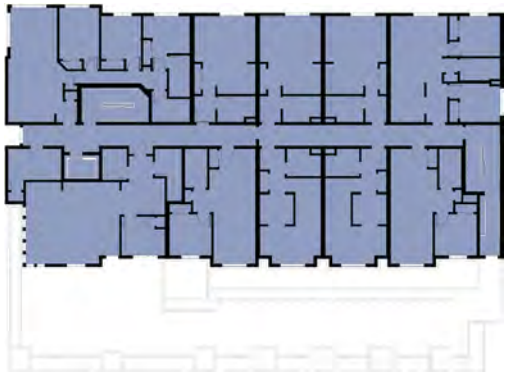
LIHI Denny Park Apartments - Lower Level



LIHI Denny Park Apartments - 6th Floor



LIHI Denny Park Apartments - 3rd thru 5th Floor



LIHI Denny Park Apartments - 2nd Floor

METRICS BASED ON GROSS MEASURED AREA NOT INCLUDING PARKING GARAGE

CONSTRUCTION COST

278.41 $/ SF **2,996.82** $/ M²

216,701 $/ unit

TOTAL ENERGY USE AND COST

11 kWh/ SF-YR

118.4 kWh/ M²-YR

8,561 kWh/ unit-YR

0.52 $/ SF-YR **5.59** $/ M²-YR

404 $/ unit-YR

RENEWABLE ENERGY GENERATED

0 kWh/ SF-YR

WATER USE AND COST

51.9 Gal/ SF-YR **2,115** L/ M²-YR

111 Gal / unit / Day

419 Liter / unit / Day

0.71 $ / SF-YR **7.68** $ / M²-YR

556 $ / unit-YR

CARBON DIOXIDE EMISSIONS

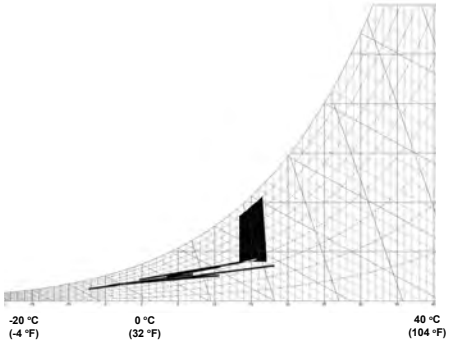
7.49 LB CO_2/ SF-YR

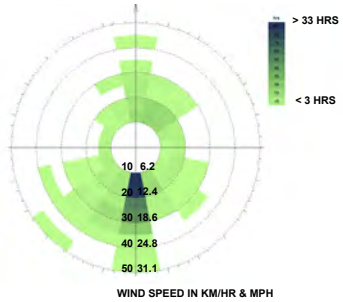
36.6 kg CO_2/ M²-YR

2.91 Ton CO_2/ unit-YR

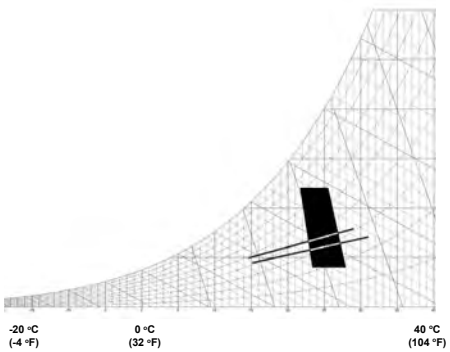
2.65 metric Tonne CO_2/ unit-YR

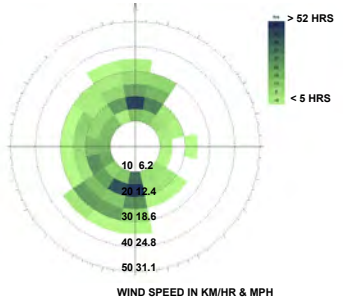
TO CONVERT AREA WEIGHTED METRICS TO INCLUDE THE GROSS MEASURED AREA OF THE PARKING GARAGE, MULTIPLY THE AREA WEIGHTED METRIC OF INTEREST BY 0.7348, THE RATIO OF GROSS MEASURED AREA WITHOUT THE PARKING GARAGE TO GROSS MEASURED AREA WITH THE PARKING GARAGE.



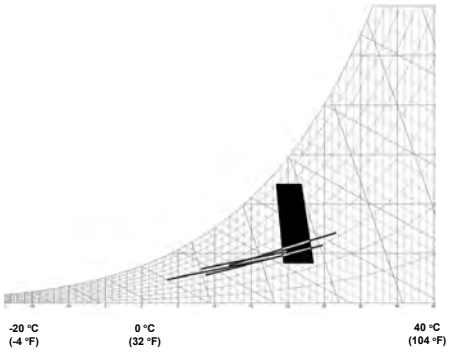


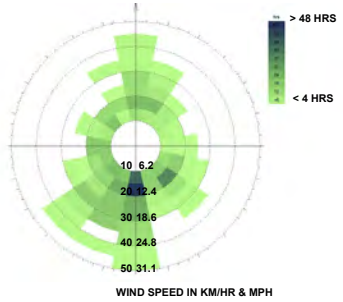
HEATING SEASON: NOV. - MAR. **HEATING SEASON MONTH: JANUARY**



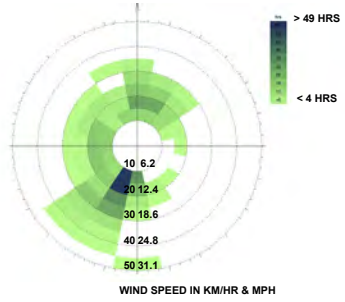


COOLING SEASON: JUL. - AUG. **COOLING SEASON MONTH: JULY**





SWING SEASONS: APRIL - JUNE, SEPT. - T. **SWING MONTH: OCTOBER**

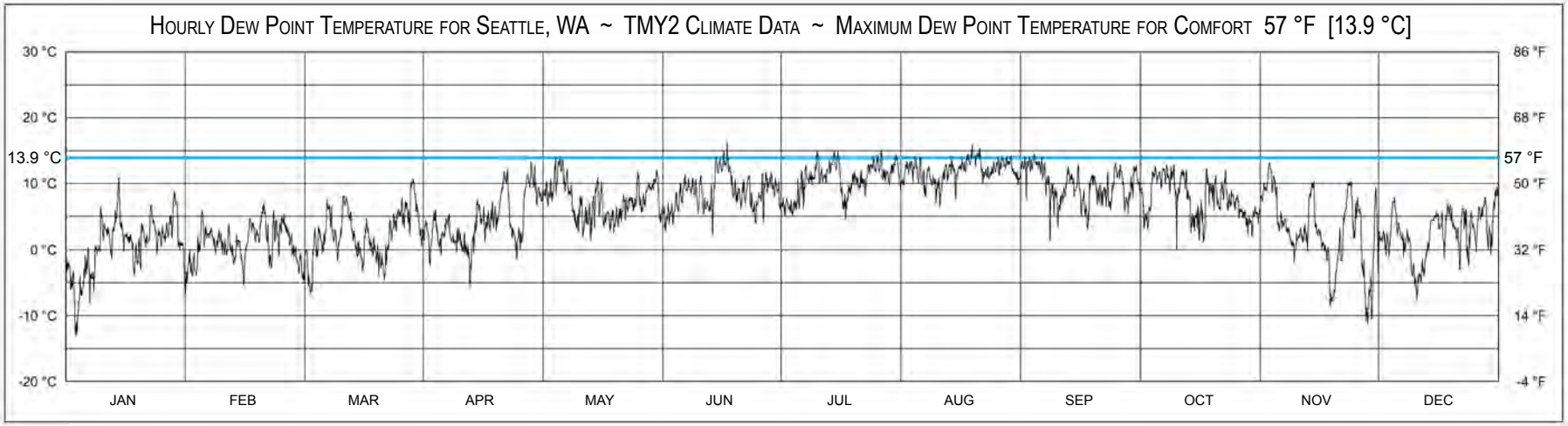


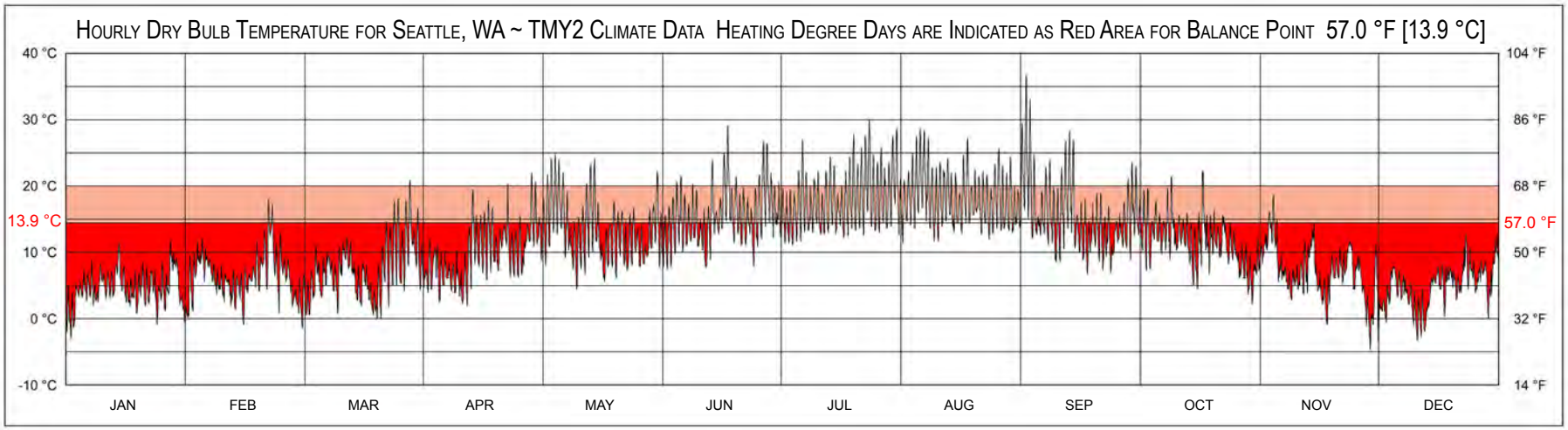
SWING MONTH: MAY

Climate Narrative

The mild climate of the Pacific Coast is modified by the Cascade Mountains and, to a lesser extent, by the Olympic Mountains. The climate is characterized by mild temperatures, a pronounced though not sharply defined rainy season, and considerable cloudiness, particularly during the winter months. The Cascades are very effective in shielding the Seattle-Tacoma area from the cold, dry continental air during the winter and the hot, dry continental air during the summer months. The extremes of temperature that occur in western Washington are the result of the occasional pressure distributions that force the continental air into the Puget Sound area.

But the prevailing southwesterly circulation keeps the average winter daytime temperatures in the 40s and the nighttime readings in the 30s. During the summer, daytime temperatures are usually in the 70s with nighttime lows in the 50s. Extremes of temperatures, both in the winter and summer, are usually of short duration. The dry season is centered around July and early August with July being the driest month of the year. The rainy season extends from October to March with December normally the wettest month, however, precipitation is rather evenly distributed through the winter and early spring months with more than 75 percent of the yearly precipitation falling during the winter wet season. Most of the rainfall in the Seattle area comes from storms common to the middle latitudes. These disturbances are most vigorous during the winter as they move through western Washington. The storm track shifts to the north during the summer and those that reach the State are not the wind and rain producers of the winter months. Local summer afternoon showers and a few thunderstorms occur in the Seattle-Tacoma area but they do not contribute materially to the precipitation.


HOURLY DEW POINT TEMPERATURE FOR SEATTLE, WA ~ TMY2 CLIMATE DATA ~ MAXIMUM DEW POINT TEMPERATURE FOR COMFORT 57 °F [13.9 °C]
30 °C
20 °C
13.9 °C
10 °C
0 °C
-10 °C
-20 °C
86 °F
68 °F
57 °F
50 °F
32 °F
14 °F
-4 °F
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC


HOURLY DRY BULB TEMPERATURE FOR SEATTLE, WA ~ TMY2 CLIMATE DATA HEATING DEGREE DAYS ARE INDICATED AS RED AREA FOR BALANCE POINT 57.0 °F [13.9 °C]
40 °C
30 °C
20 °C
13.9 °C
10 °C
0 °C
-10 °C
104 °F
86 °F
68 °F
57.0 °F
50 °F
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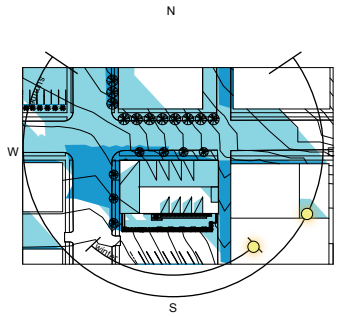

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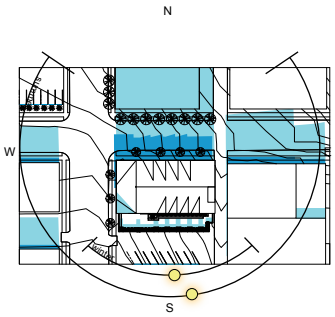
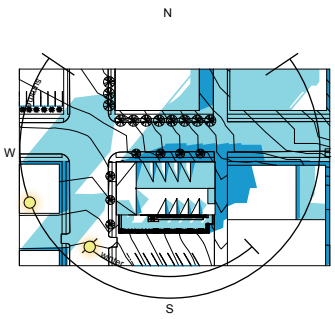


Noon

Summer Azumuth Angles:

Sunrise: 53 degrees

Sunset: 307 degrees



3:00 pm

Winter Azumuth Angles:

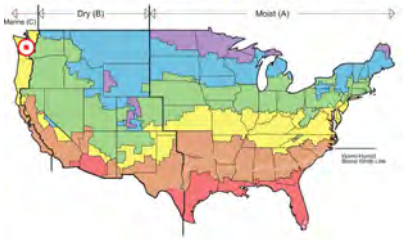
Sunrise: 125 degrees

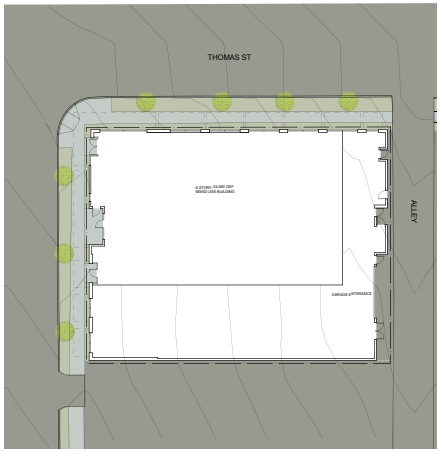
Sunset: 235 degrees

Site Shading Study

June 21

December 21





Source: High Performance Buildings Data Base

The site is an urban infill site on a previously developed industrial and commercial lot. Former uses of the site had resulted in minor soil contamination that was remedied before construction on Denny Park Apartments began.The building planters and sidewalk plantings reinforce the pattern of “green streets” in the neighborhood and the project’s connection to Denny Park. To minimize the project’s contribution to the urban heat-island effect, the team selected metal roofing that meets the Energy Star criteria.

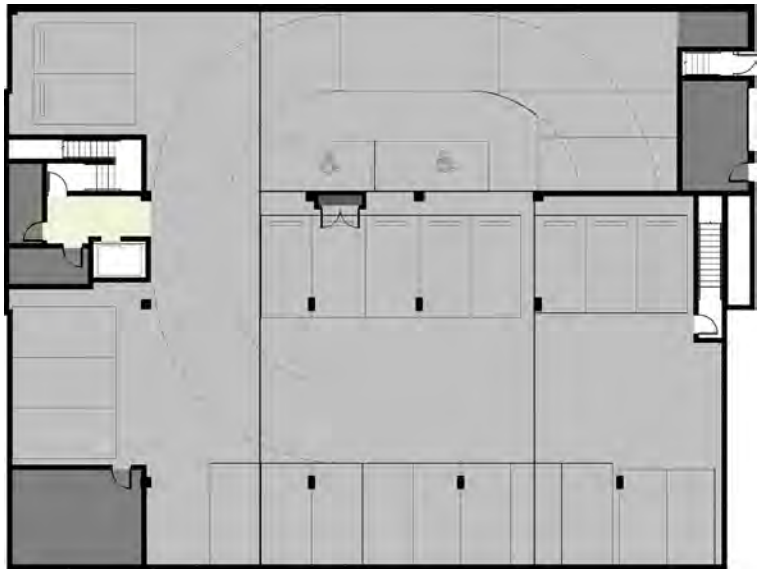
One major feature of the project’s water-management plan is the use of roof stormwater planters; the first of their kind to be approved within the city of Seattle, they were made possible through effort and coordination on the part of the civil engineer, Seattle Public Utilities, and the Seattle Department of Transportation. Rainwater running off of the metal roof is directed to stormwater planters located on the north and south sides of the building, on a raised plaza above commercial spaces, and on the parking garage. A mix of drainage aggregate and organic soil was specially engineered to achieve specific percolation rates. The native plants selected for receiving stormwater are also drought tolerant. The plants and planters permit the rainwater to be released back into the biosphere through evaporation and transpiration, and, after it has been naturally filtered, any overflow is piped into the municipal storm system in a controlled manner. The soil in the sidewalk planting strips at the street level was improved with an engineered structural soil to a minimum depth of 18 inches to allow the groundwater to recharge more quickly. Drip irrigation was provided to help establish the landscaping for the first two years; this system was projected to use 32% less water than a conventional spray system. Low-flow toilets and faucets, Energy Star dishwashers, and front-loading clothes washers reduce water use inside the building.

Level 1 Program Distribution

Ground Floor Entry, Commercial and Upper Level Parking Plan

Commons Room on 2nd floor with access to outdoor south facing court

Provide description of program here.



Lower Level Parking Plan

Key

- Entry / Cirrculation
- Commercial Retail Space
- Mechanical / Storage
- Parking Garage

Level 1 Program Distribution

Continue program description here.

Third, Fourth & Fifth Floor Plan

Second Floor Plan

Sixth Floor Plan

Key

- Studio bedroom / living quarters
- Kitchen
- Bedroom
- Bathroom
- Entry / cirrculation
- Dining / Living quarters
- Mechanical chase/storage
- Common areas

Resource Use and Costs

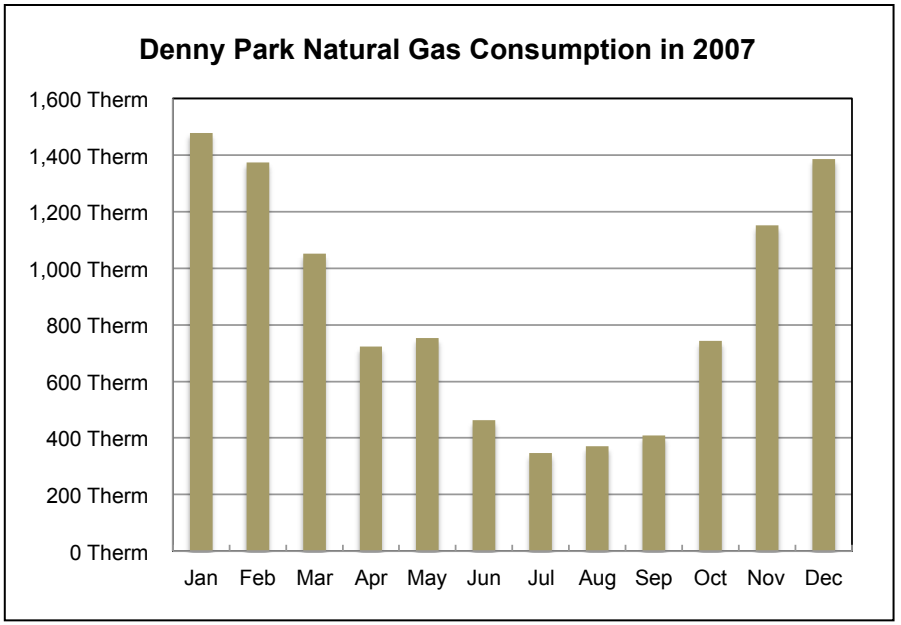
Denny Park Apartments consumes natural gas for space heating and water heating. Electricity provides illumination, mechanical ventilation, cooking and meets plug loads. Water is consumed primarily in the residences, including the common laundries. The total resouce cost for 2007 was $48,157. Each cost component, natural gas, electricity, water and sewer are illusatrated in the graph below.

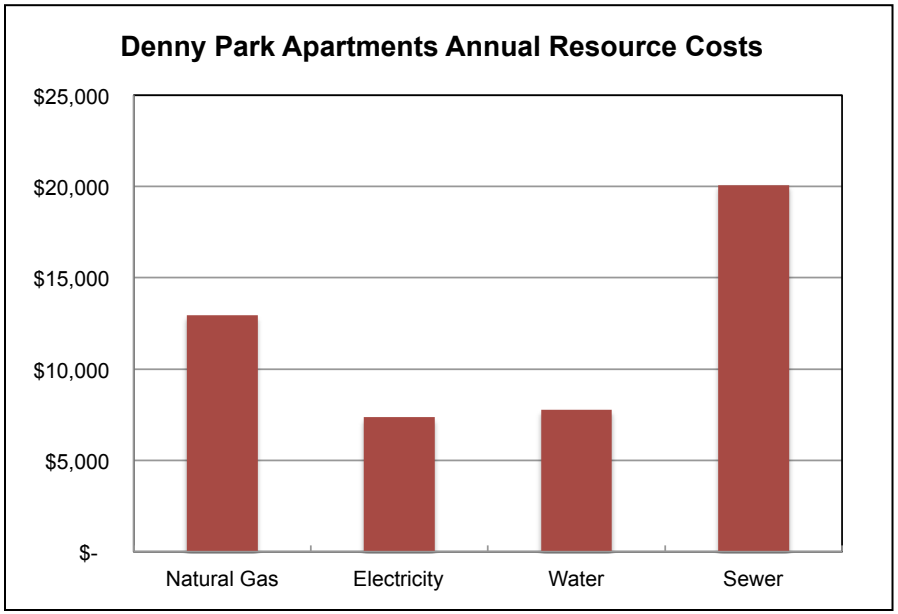
Sewer costs are based on water consumption which was 2,707 ccf in 2007. The combined sewer and water cost was 58% of the total resource bill for Denny Park Apartments.

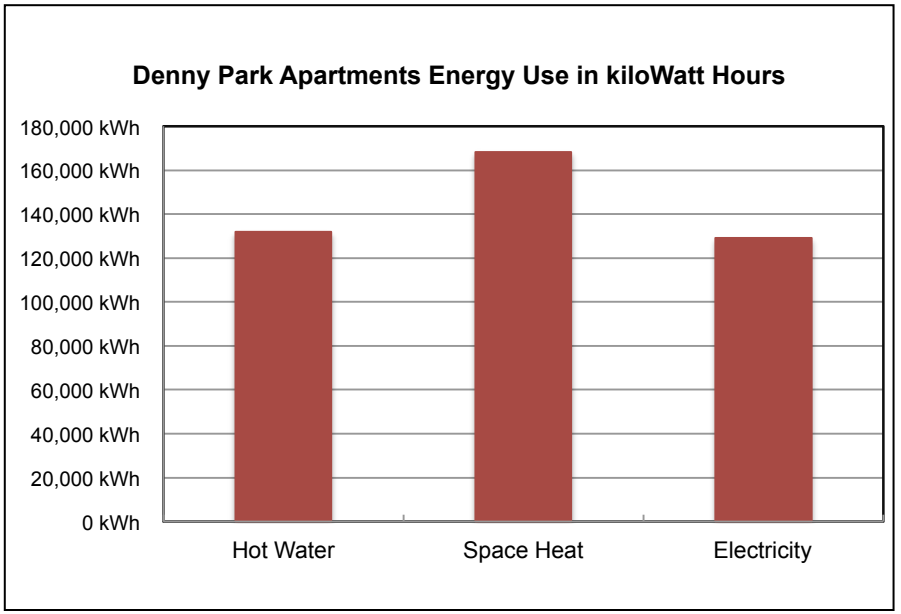
Unit costs are $2.87 per ccf (100 cubic feet of water consumed) for water supply and $7.42 per ccf for sanitary waste handling. Unit energy costs are $0.057 per kWh for electricity and $0.043 per kWh energy equivelent of natural gas ($1.26 per therm of natural gas).

Although natural gas is not submitered, the fraction used for heating water can be estimated by assuming the natural gas use during july, August and September represents only hot water heating. Monthly natural gas use is illustrated at right. Averaging the summer gas use per month and multiplying by 12 gives an estimate of 4,503 therms for hot water heating (44%) and 5,745 therms for space heating (56%).

Natural gas and electricity use are compared in the graph at lower right. All energy consumption is given in kWh. (One therm is equivelent to 29.3 kWh). Electricity (129,160 kWh) and estimated hot water use (131,929 kWh) are nearly equal (30% and 31% of the total annual use). Estimated space heating (168,338 kWh) is roughly 40% of the total annual energy use.







Runberg Architecture Group

1. *Owner commitment to sustainability goals is very important. The owner needs to involve all members of their team, especially the operations/maintenance staff, and develop a plan for ensuring continuity and communicating procedures. In affordable housing, some of the maintenance (particularly landscaping) is often done by residents (as volunteers or as part of a community-building program) who lack the training or information on the proper maintenance of unusual features (e.g., stormwater planters or "structural soil").*

2. *Remember to account for the human dimension and psychological factors. Science may predict that a centralized hot water and hydronic heating system is the most energy-efficient solution; however if residents are not individually responsible for a utility bill for heat and/or hot water, they may not have the incentive to conserve. Incorporate incentives into an educational plan or include a means of submetering the utilities.*

3. *Trash compactors save landfill space!*

4. *At the time of construction of this project (2004), many multifamily residential contractors were not familiar with green building practices. A separate paragraph in each section of the specifications to highlight the sustainable building requirements would have made these requirements easier to find.*

5. *The Owner must continually commit to educating the residents about the sustainable features of the building.*

Level 2 Building Design Variables

ENCLOSURE AREA / GROSS MEASURED AREA

Residential Area	**0.78**
Comercial Area	**1.56**
Parking Garage	**3.93**
Total Building	**0.97**

ENCLOSURE HEAT TRANSFER RATE PER MEASURED FLOOR AREA

Residential Area	**0.07 Btu/ HR-SF-°F**
	0.37 Watt/ M²-°C
Comercial Area	**0.40 Btu/ HR-SF-°F**
	2.29 Watt/ M²-°C
Parking Garage	**4.47 Btu/ HR-SF-°F**
	25.4 Watt/ M²-°C
Total Building	**0.13 Btu/ HR-SF-°F**
	0.72 Watt/ M²-°C

GLAZING AREA PER GROSS MEASURED AREA

SOUTH FACING GLAZING

Residential	**3.5%**
Commercial	**0%**
Parking Garage	**0%**

EAST FACING GLAZING

Residential	**1.1%**
Commercial	**1.7%**
Parking Garage	**0%**

NORTH FACING GLAZING

Residential	**4.2%**
Commercial	**27.0%**
Parking Garage	**0%**

WEST FACING GLAZING

Residential	**2.5%**
Commercial	**11.1%**
Parking Garage	**0%**

TOTAL GLAZING

Residential	**11.3%**
Commercial	**39.9%**
Parking Garage	**0%**

LIGHTING POWER DENSITY

Residential	**.64 Watt/ SF**
Commercial	**Not Provided**
Parking Garage	**Not Provided**

OPERABLE WINDOW AREA PER GROSS MEASURED FLOOR AREA

Residential	**3.3%**
Commercial	**0%**
Parking Garage	**0%**

VENTILATION VARIABLES FOR RESIDENTILA AREA ONLY

OUTDOOR AIR VENTILATION RATE

0.05 CFM/ SF

0.26 L/S-M²

INSTALLED VENTILATION CAPACITY (SUPPLY)

0.65 CFM/ SF

0.26 L/ S-M²

FAN POWER DENSITY

0.40 Watt/ SF

4.26 Watt/ M²

FAN VOLUME FLOW EFFICIENCY

1.6 cfm/ Watt

0.73 L/ S/ W

FAN THERMAL TRANSFER EFFICIENCY

1.7 Btu/ HR-°F-W

3.19 kJ/ HR-°C-W

HEATING VARIABLES

Heating Capacity	**5.51**	**Watt / SF**
	59.3	**Watt/ M²**
Installed Heat Power	**6.01**	**Watt / SF**
	64.7	**Watt/ M²**

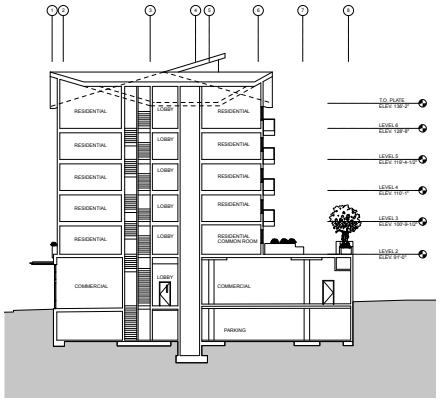
Heating Efficiency **91.2%**

BUILDING BALANCE POINT

57.0 °F

13.9 °C

Level 2 Massing and Orientation



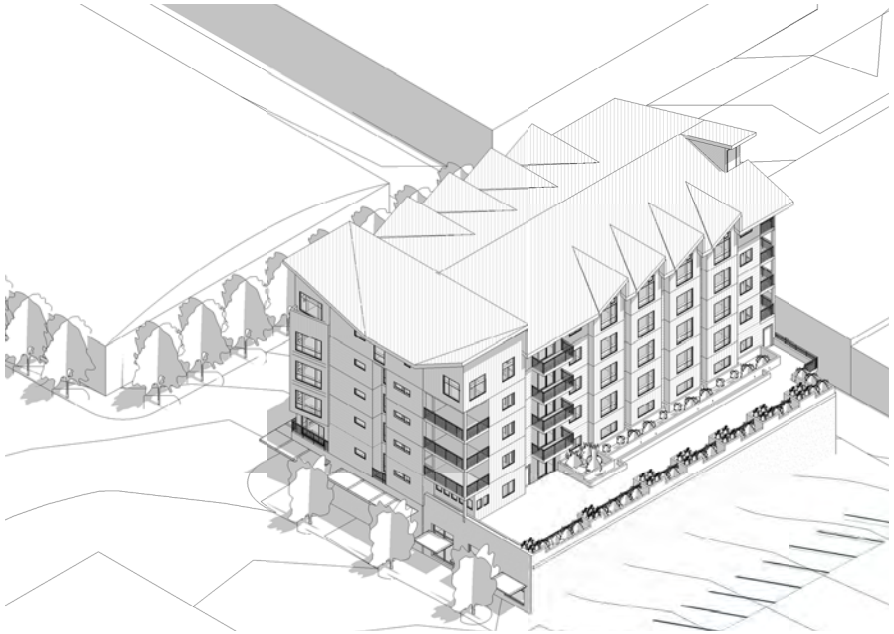
Above: Section through Denny Park Apartments looking east.

Below: Axon of Denny Park Apartments from southeast.

Below Right: Axon of Denny Park Apartments from southwest.

Enclosure Efficiency
Explain design variables for enclosure here

ENCLOSURE AREA / GROSS MEASURED AREA	
Residential Area	**0.78**
Comercial Area	**1.56**
Total Building	**0.97**



Level 2 Envelope: Aperture Distribution

South Elevation

West Elevation

North Elevation

East Elevation

KEY

- Fixed Glazing
- Operable Glazing

GLAZING AREA PER GROSS MEASURED AREA

SOUTH FACING GLAZING

Residential	**3.5%**
Commercial	**0%**
Parking Garage	**0%**

EAST FACING GLAZING

Residential	**1.1%**
Commercial	**1.7%**
Parking Garage	**0%**

NORTH FACING GLAZING

Residential	**4.2%**
Commercial	**27.0%**
Parking Garage	**0%**

WEST FACING GLAZING

Residential	**2.5%**
Commercial	**11.1%**
Parking Garage	**0%**

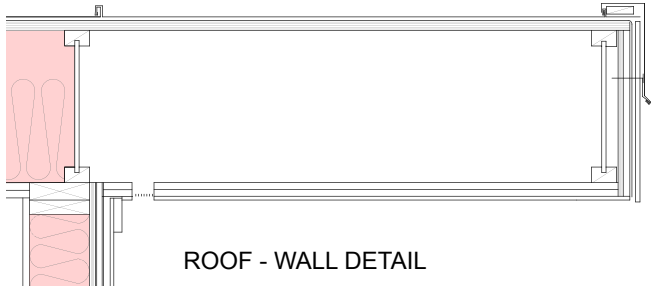
TOTAL GLAZING

Residential	**11.3%**
Commercial	**39.3%**
Parking Garage	**0%**

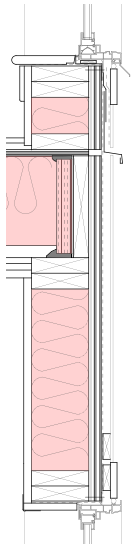
OPERABLE WINDOW AREA PER GROSS MEASURED FLOOR AREA

Residential	**3.3%**
Commercial	**0%**
Parking Garage	**0%**

Envelope- Thermal Enclosure



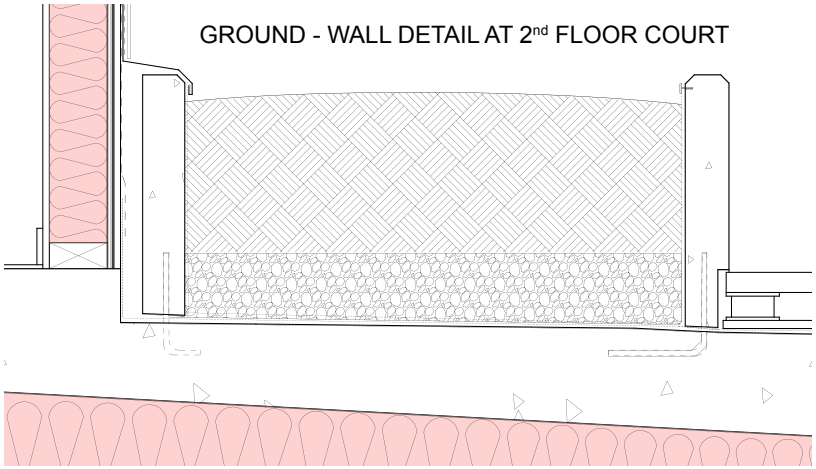
ROOF - WALL DETAIL



GLAZING - WALL DETAIL

FLOOR - WALL DETAIL

GROUND - WALL DETAIL AT 2nd FLOOR COURT

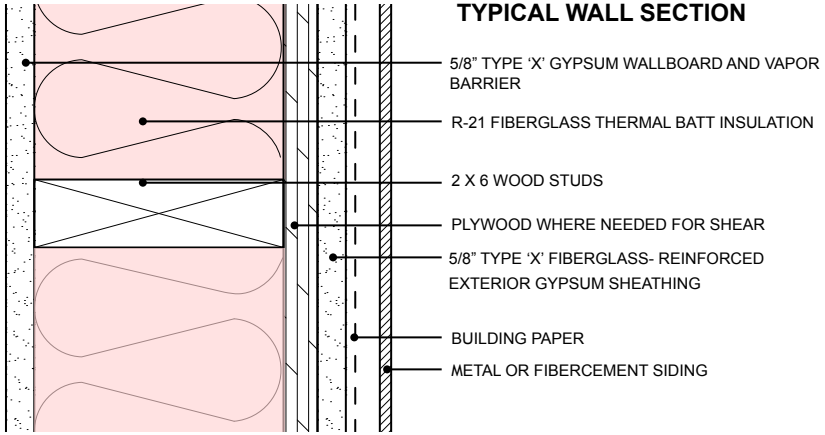


Envelope Variables
Explain design variables for envelope here

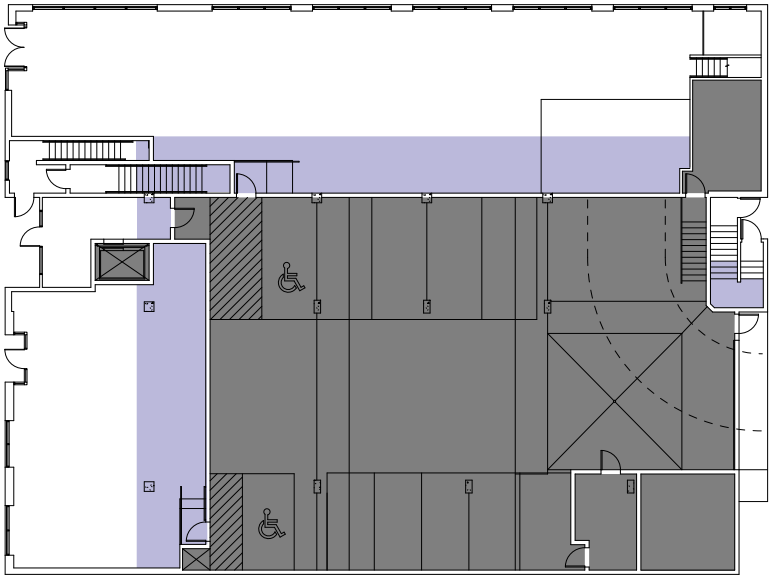
ENCLOSURE HEAT TRANSFER RATE PER GROSS MEASURED FLOOR AREA

Residential Area	**0.07** Btu/ HR-SF-°F **0.37** Watt/ M²-°C
Comercial Area	**0.40** Btu/ HR-SF-°F **2.29** Watt/ M²-°C
Parking Garage	**4.47** Btu/ HR-SF-°F **25.4** Watt/ M²-°C
Total Building	**0.13** Btu/ HR-SF-°F **0.72** Watt/ M²-°C

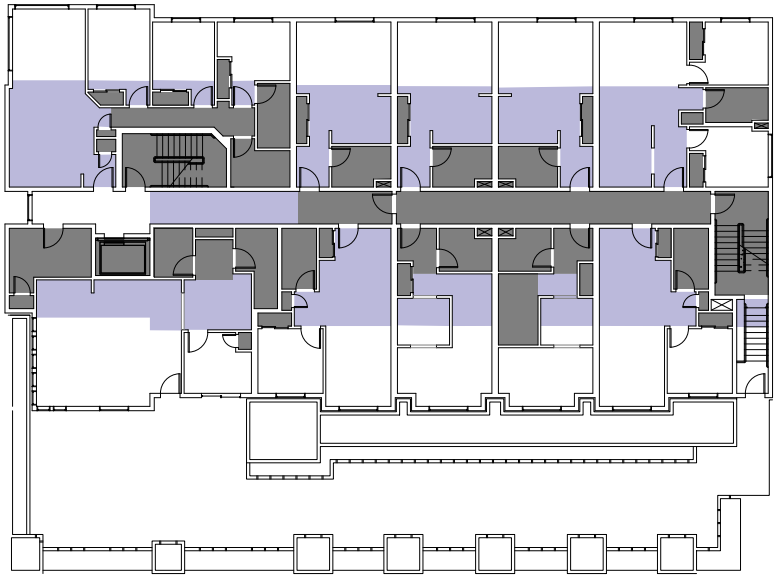
TYPICAL WALL SECTION



Providing Illumination- Daylighting



Ground Floor Daylighting Plan



2nd Floor Daylighting Plan

PRIMARY DAYLIGHTING ZONE AREA PER GROSS MEASURED FLOOR AREA

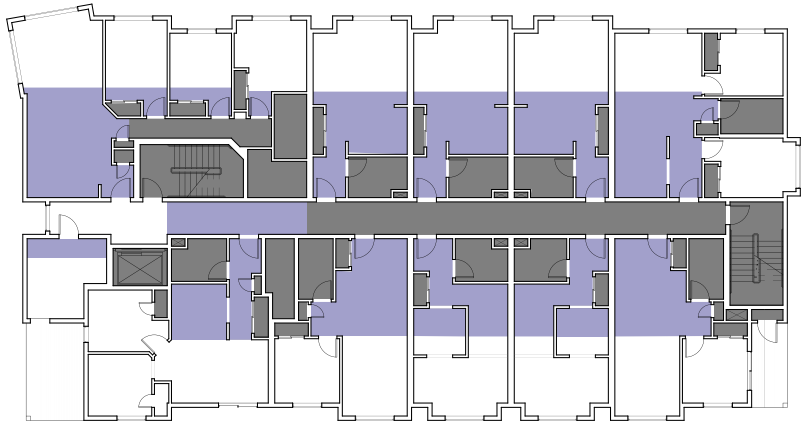
40.2 %

Key

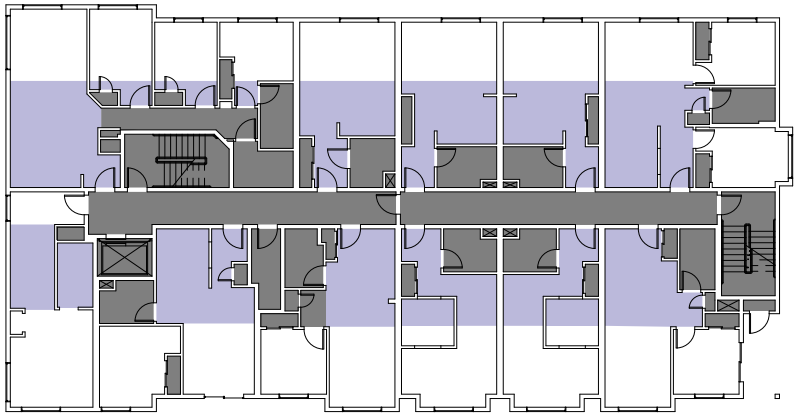
- Primary Daylighting Zone — Within 1.5x window head height range
- Secondary Daylighting Zone — Beyond 1.5x window head height range
- Windowless Zone

BUILDING GLAZING RATIOS PER GROSS MEASURED FLOOR AREA

SOUTH	**3.0%**
EAST	**1.1%**
NORTH	**6.4%**
WEST	**3.3%**
HORIZONTAL	**0.0%**
TOTAL	**13.9%**



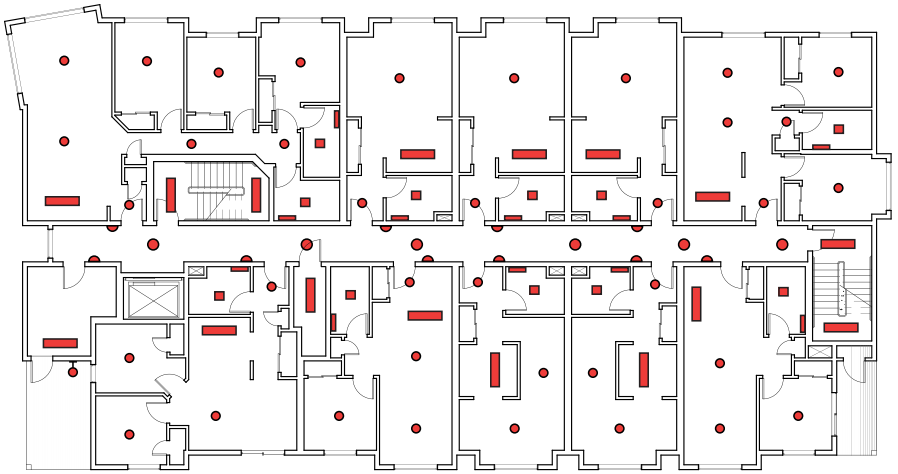
Levels 3-5 Daylighting Plan



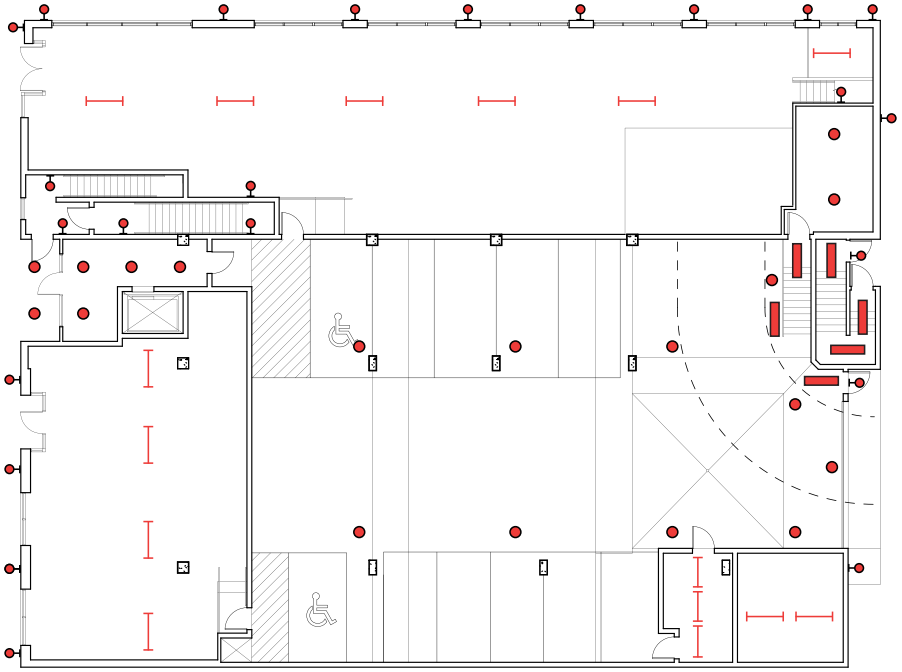
Levels 6 Daylighting Plan

Providing Illumination- Electric Lighting

Electric Illumination
Explain design variables for illumination here



Typical Residential Level



Level 1 Parking

LIGHTING POWER DENSITY

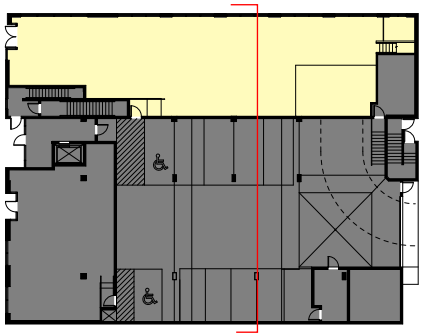
Residential	**.64 Watt/ SF**
Commercial	**Not Provided**
Parking Garage	**Not Provided**

Key

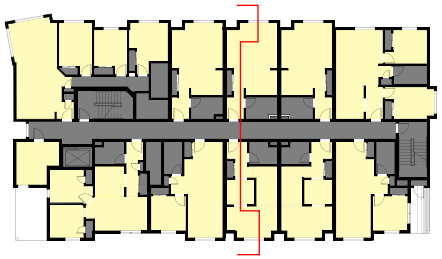
- Downlight
- Bathroom heat lamp
- Wall light
- Wall sconce
- Bathroom light
- Fluorescent fixture
- Strip light

Providing Fresh Air- Natural Ventilation

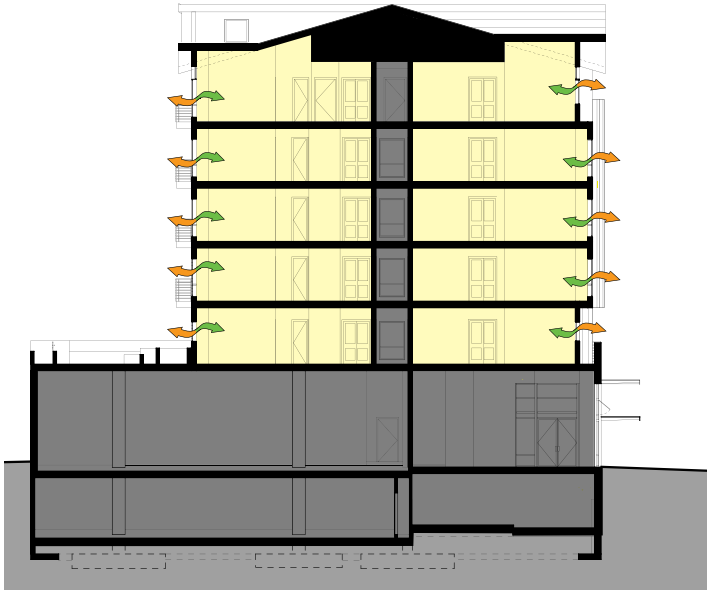
The residential areas of the Denny Park apartments are equipped with operable windows, while the commercial facilities and the parking garage is not. The apartments are ventilated on one side only, due to the double-loaded corridor configuration of the floor plan.



Levels 1 Parking



Typical Residential Floor Plan



BUILDING GLAZING RATIOS PER RESIDENTIAL GROSS NEASURED AREA

11.3%

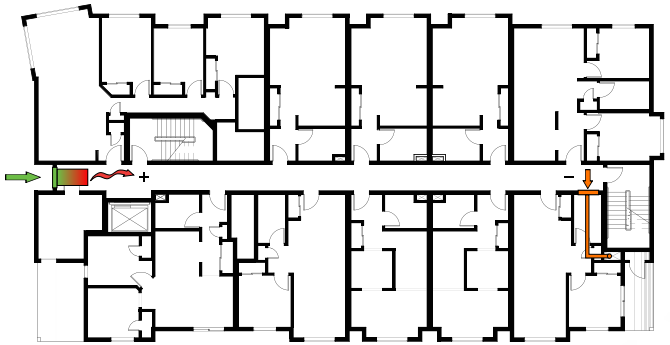
OPERABLE WINDOW AREA PER RESIDENTIAL GROSS NEASURED AREA

3.3%

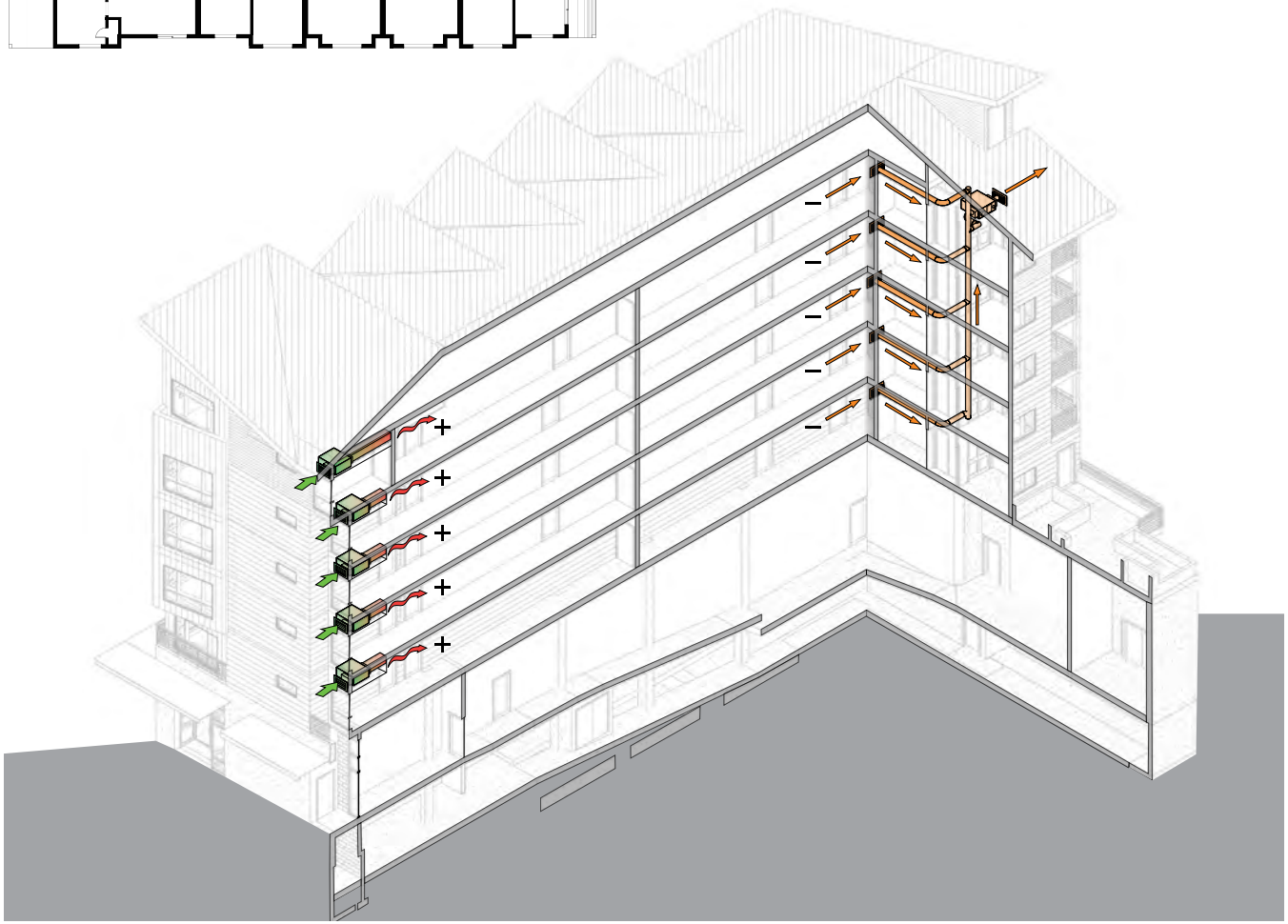
Key

- Primary Natural Ventilation
  Space two or more inlet/outlets and clear cross or stack ventilation paths.
- Secondary Natural Ventilation
  Space with inlets/ outlets on a single face and no clear cross or stack ventilation path when internal doors are closed.
- Not Naturally Ventilated

Providing Fresh Air- Mechanical Ventilation



Fresh Air
Tempered Supply Air- Heating Mode
Exhaust Air



OUTDOOR AIR VENTILATION RATE

0.05 CFM/ SF

0.26 L/ S-M^2

INSTALLED VENTILATION CAPACITY (SUPPLY)

0.65 CFM/ SF

0.26 L/ S-M^2

FAN POWER DENSITY

0.40 Watt/ SF

4.26 Watt/ M^2

FAN VOLUME FLOW EFFICIENCY

1.6 cfm/ Watt

0.73 L/ S/ W

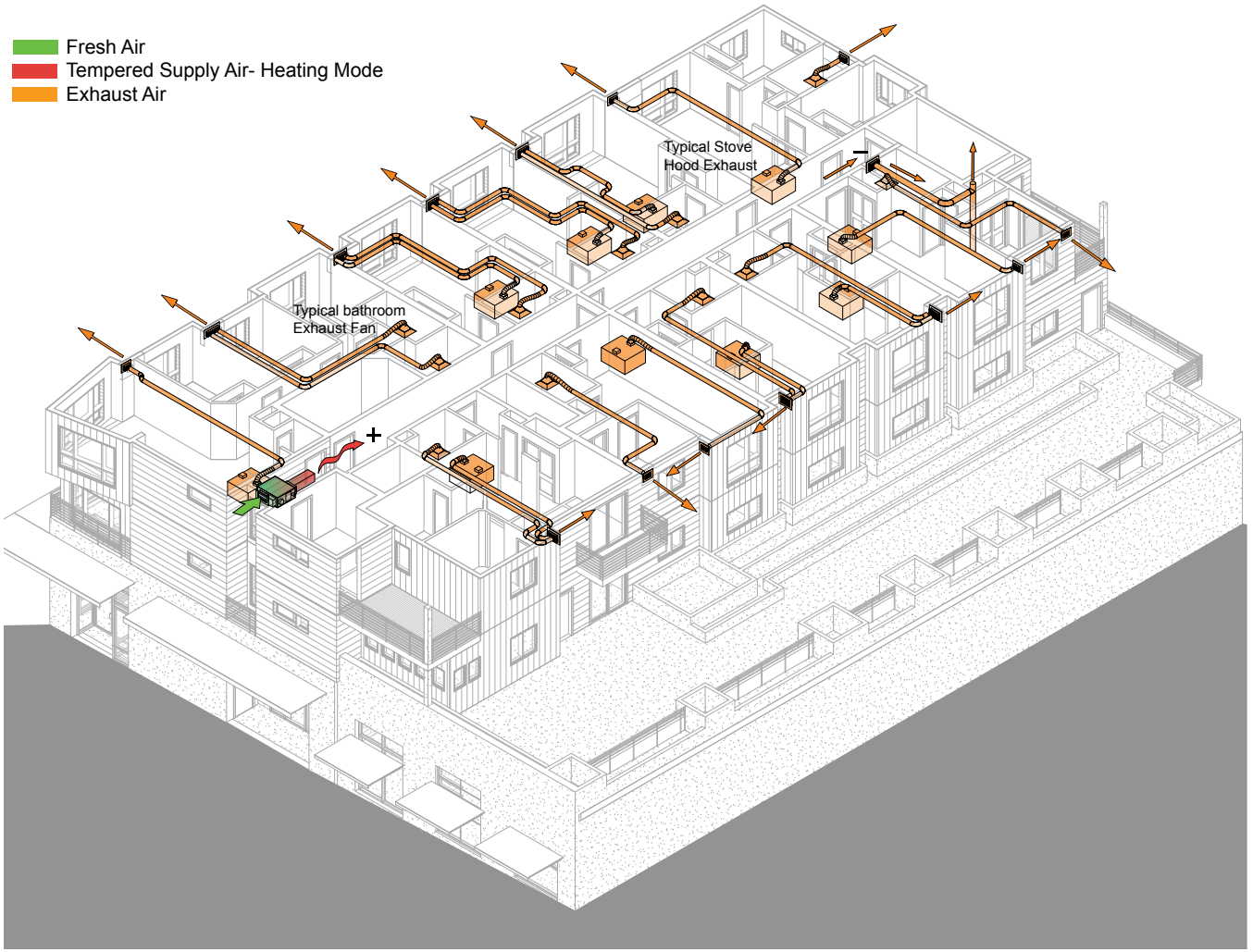
FAN THERMAL TRANSFER EFFICIENCY

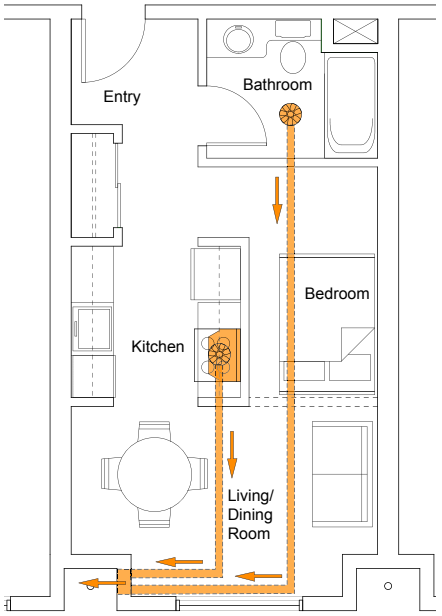
1.7 Btu/ HR-°F-W

3.19 kJ/ HR-°C-W

Exhausting Air- Mechanical Ventilation

Fresh air is brought into the building through vents on the west end of the central hallway, creating a pressurized zone. Air is drawn into the apartments from the pressurized hallway through two exhaust fans located above the kitchen stove and in the bathroom. The fans can be adjusted to allow in more or less air. Air in the hallway that is not brought into an apartment is collected at the east end of the hallway and exhausted.





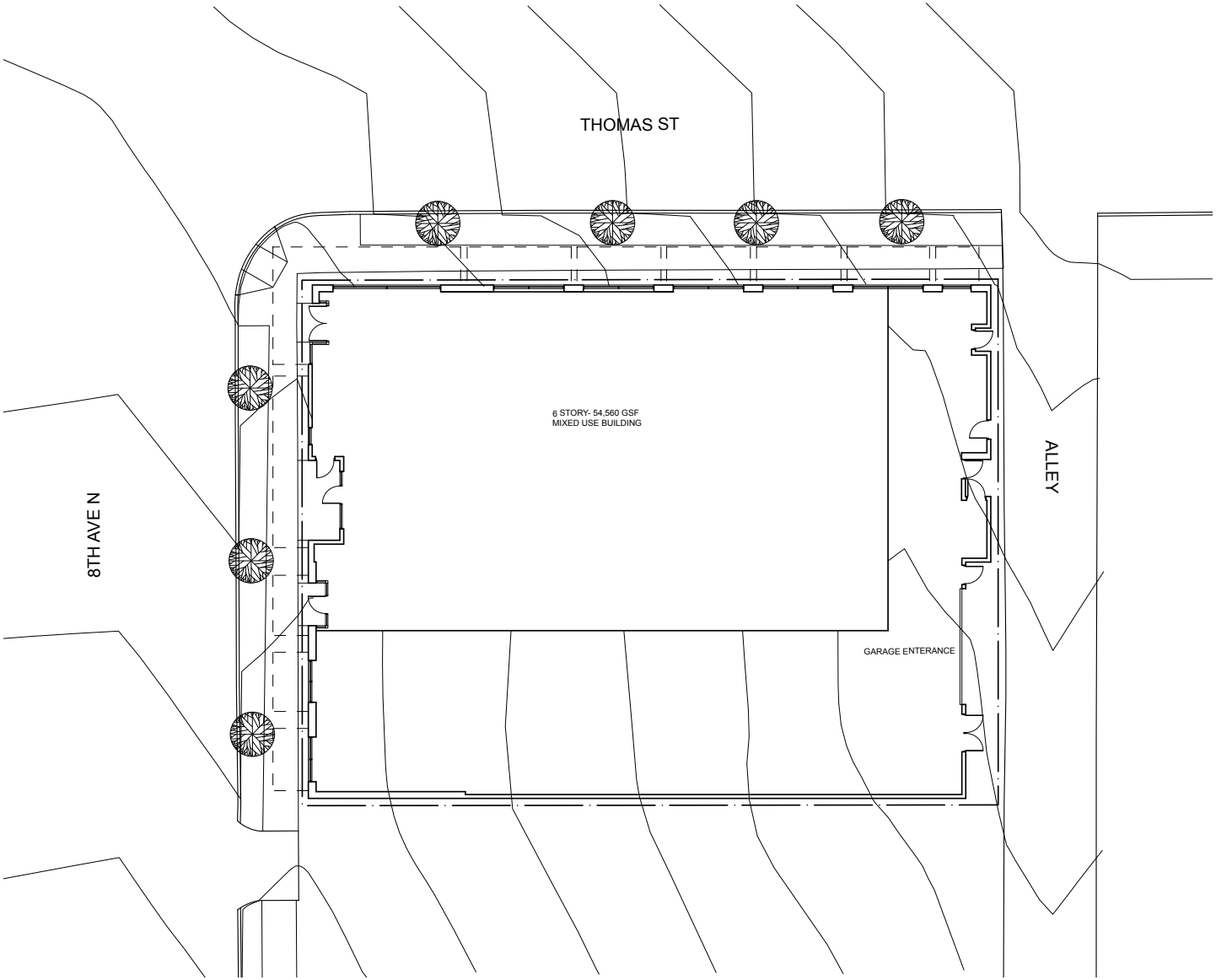
Typical Unit Exhaust Plan

Appendix

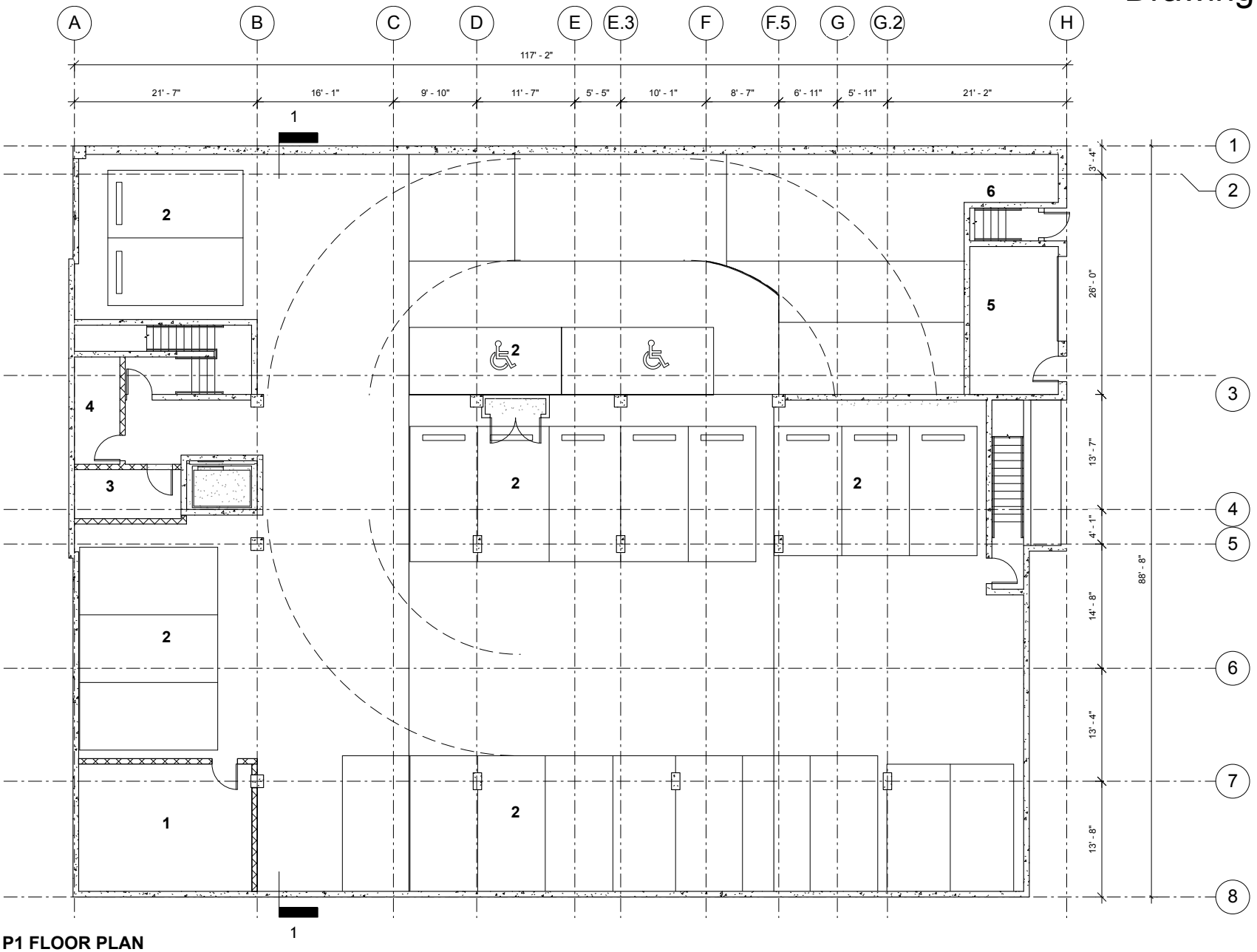
Drawings

Additional Photographs

Sources

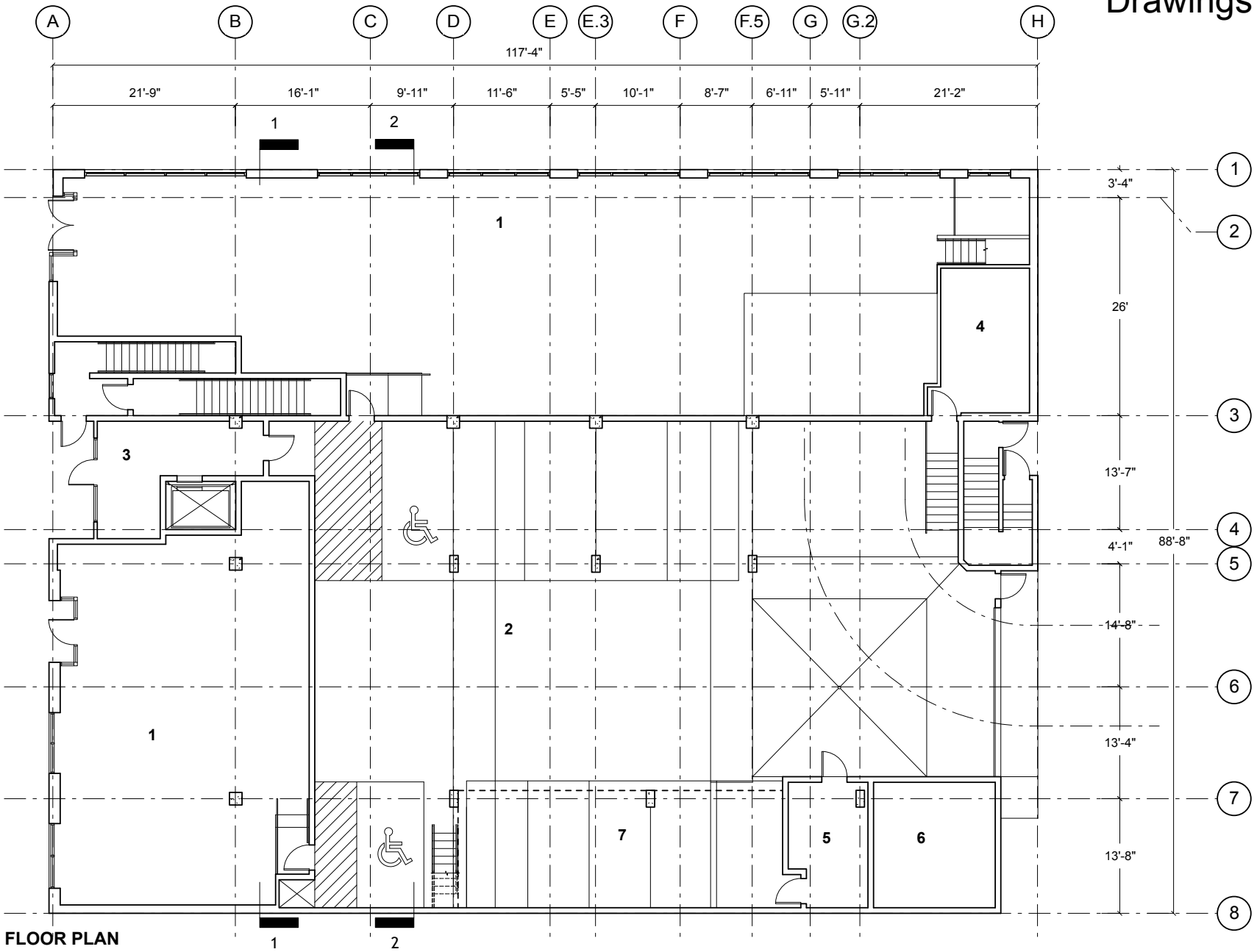

THOMAS ST
6 STORY- 54,560 GSF
MIXED USE BUILDING
8TH AVE N
ALLEY
GARAGE ENTERANCE
N

Site Plan



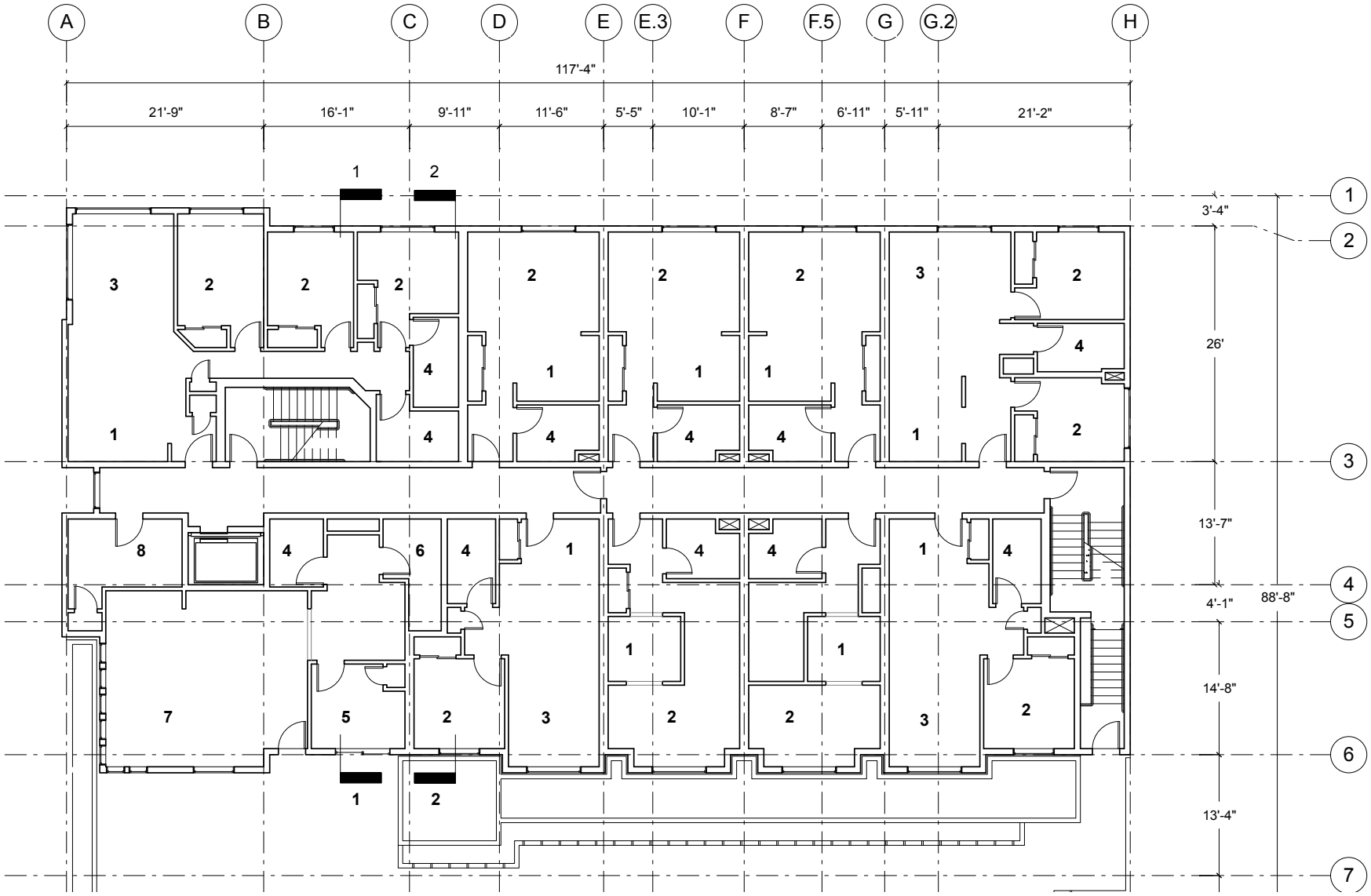
LEVEL P1 FLOOR PLAN

1 Bike Storage
2 Parking
3 Elevator Machine Room
4 Water/ Sprinkler Mechanical Room
5 Trash/ Recycling
6 Mechanical Room



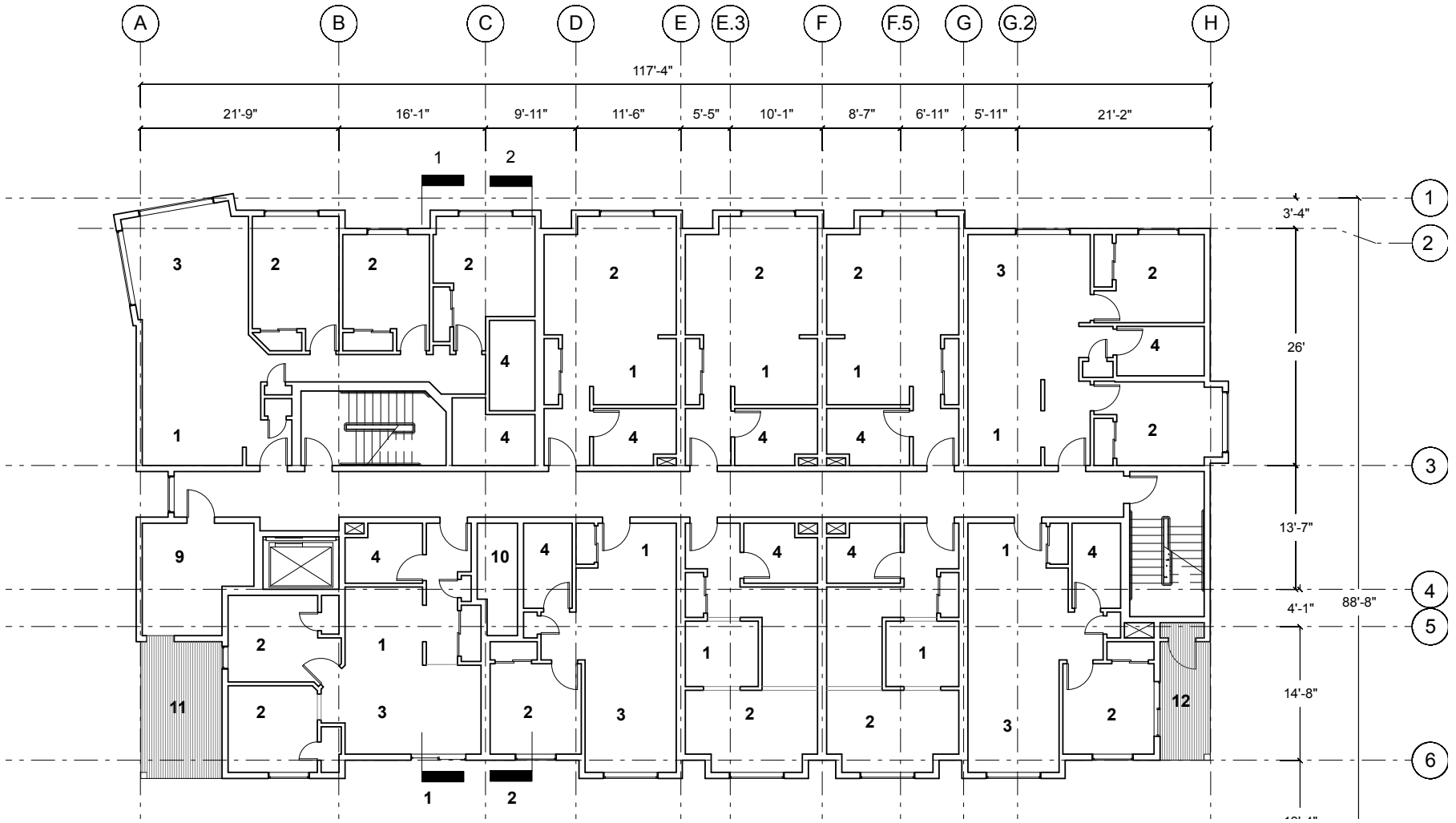
LEVEL 1 FLOOR PLAN

1 Retail Space
2 Parking
3 Apartment Lobby
4 Mechanical Equipment
5 Electrical Room
6 Transformer Vault
7 Mechanical Mezzanine Above



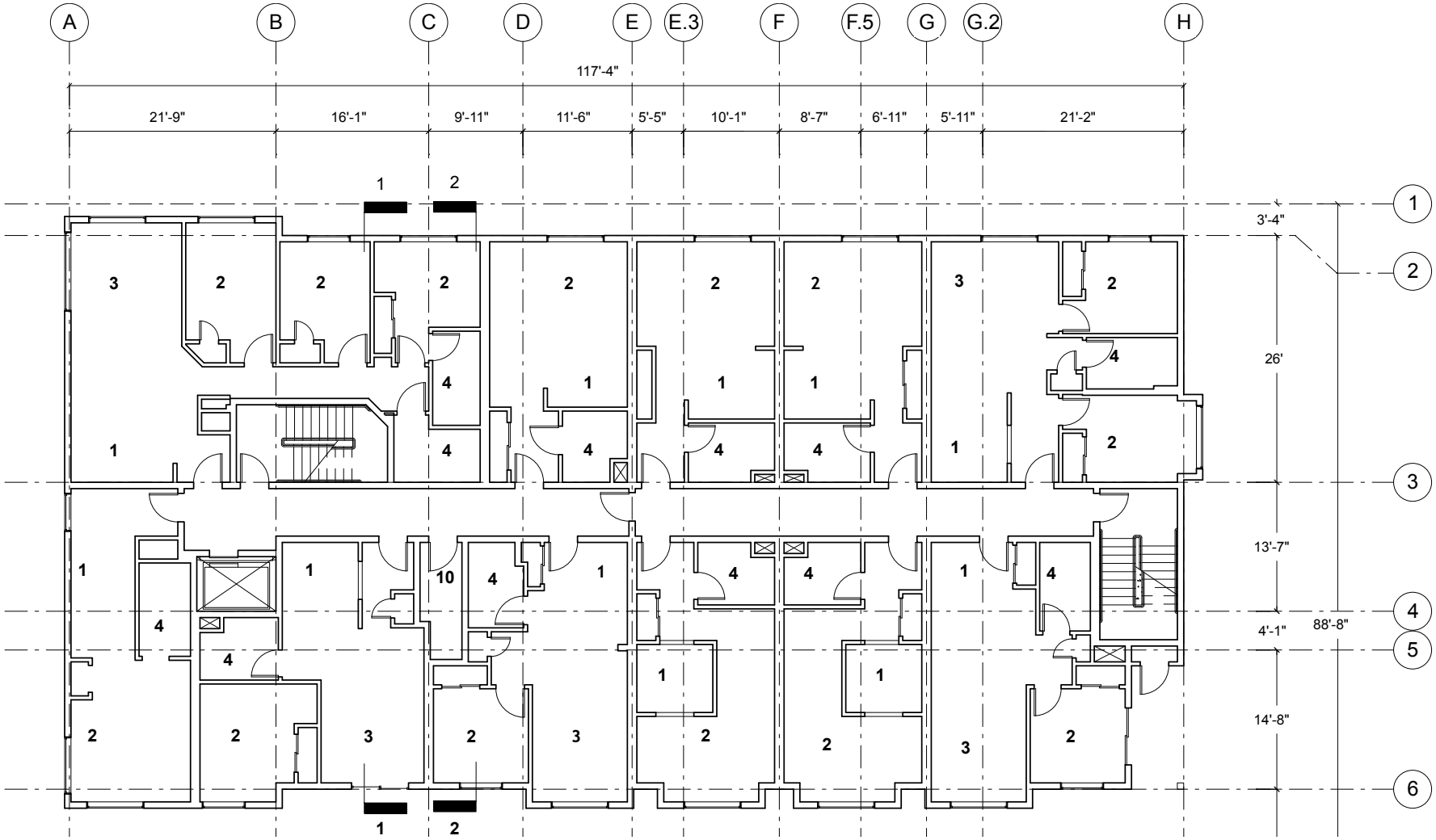
LEVEL 2 FLOOR PLAN

1 Kitchen
2 Bedroom
3 Living Room
4 Bathroom
5 Office
6 Storage
7 Common Room
8 Conference



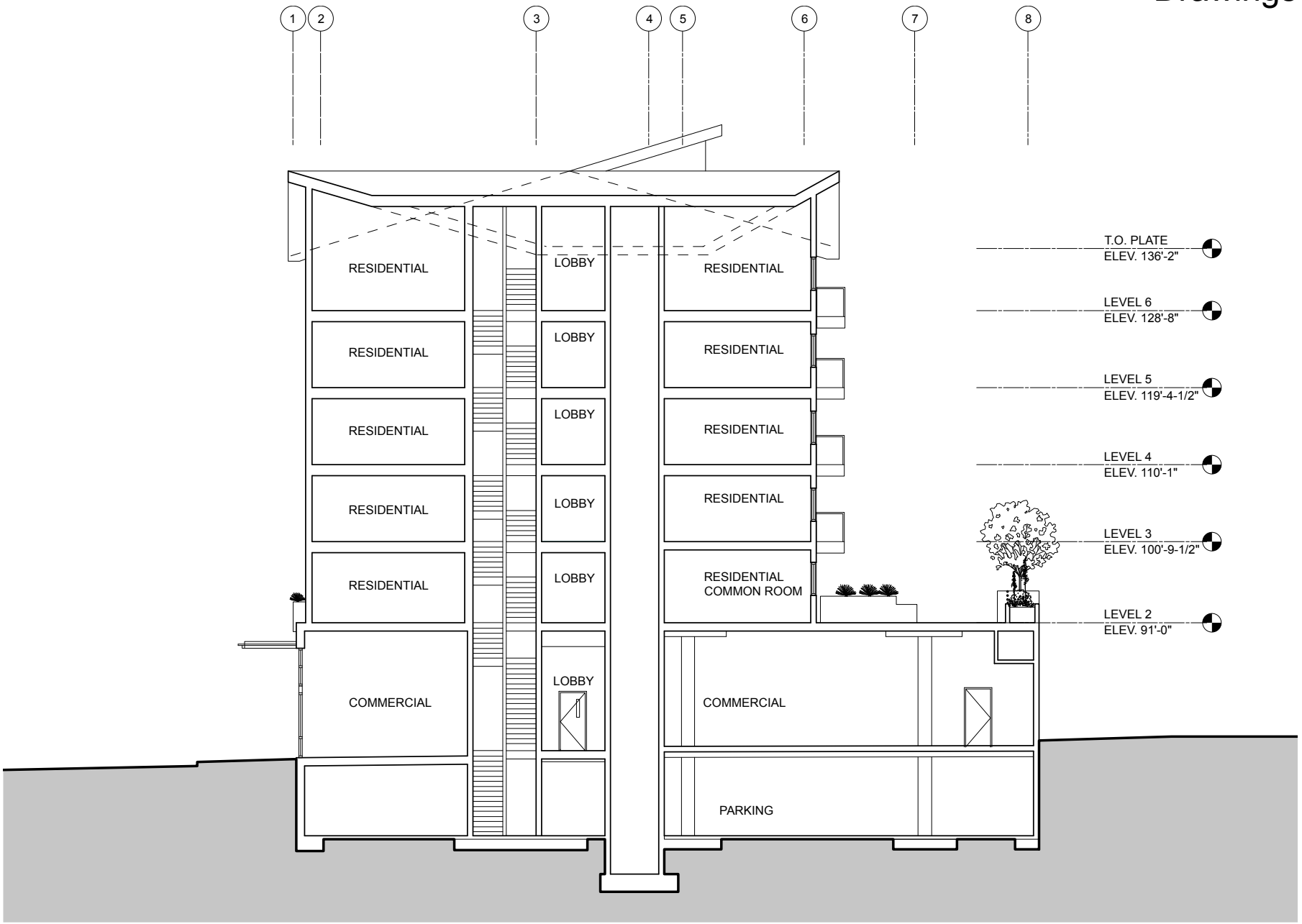
LEVEL 3-5 FLOOR PLANS

1 Kitchen
2 Bedroom
3 Living Room
4 Bathroom
5 Office
6 Storage
7 Common Room
8 Conference
9 Laundry
10 Electrical Storage
11 Public Balcony
12 Private Balcony



Level 6 Floor Plan

1	Bedroom	6	Deck
2	Bathroom	7	Common Room
3	Kitchen	8	Conference
4	Living Room	9	Laundry
5	Laundry	10	Electric Storage



Section Looking East

Looking Southwest

View of Garage Entry

Addidtional Photographs - Exterior

Looking East along North Facade

Commercial and Residential Entries

Addidtional Photographs - Resident's Court

Looking East

Double Rain Garden along Court

Addidtional Photographs - Resident's Court

Rain Garden Detail

Note Apartment Ventilation Exhaust at Top Center of Photograph

Addidtional Photographs - Common Spaces

Common Room Looking Southwest

Hallway looking West with Elevator and Window

Note Drop Ceiling at West End for Ventilation Fan

Upper Floor Laundry Room

Addidtional Photographs - Apartments

Studio Apartment - View toward Living Space

Studio Apartment - View toward Kitchen

Studio Apartment Alternate - View toward Living Space

Studio Apartment Alternate - View toward Kitchen

Sleeping Nook behand Kitchen

Studio Apartment Alternate - Living Space

Level 1 Case Study - Project Information

LIHI Denny Park Apartments	
Runberg Architecture Group	2006
Seattle	Washington
Building Type	Multi-family Housing
Number of Housing Units	50 Units
Ownership Type	Non-profit

Design & Construction Cost	
Design Costs	$ -
Construction Costs	$ 10,835,029
LEED Costs	$ -
Furnishing & Relocation	$ -
Total Costs	$ 10,835,029

Building Floor Areas		Distinct Building Areas		
		Main Area	SubArea 1	SubArea 2
Area Name	Total Building	Residential	Commercial	Parking Garage
			Connected, Conditioned	Connected, Unconditioned
Gross Floor Area	55,290 SF	35,088 SF	4,317 SF	15,885 SF
Gross Measured Area	52,961 SF	33,543 SF	4,078 SF	15,340 SF
Major Vertical Penetrations	2,834 SF	1,975 SF	301 SF	558 SF
Building Common Area	2,525 SF	1,589 SF	198 SF	738 SF
Floor Common Area	2,914 SF	2,914 SF	0 SF	0 SF
Usable (Assignable) Area	44,688 SF	27,065 SF	3,579 SF	14,044 SF
Total Occupied Area	50,127 SF	31,568 SF	3,777 SF	14,782 SF
Mechanically Heated Area	30,644 SF	27,065 SF	3,579 SF	0 SF
Mechanically Cooled Area	0 SF	0 SF	0 SF	0 SF
Mechanically Ventilated Area	45,426 SF	27,065 SF	3,579 SF	14,782 SF
Parking Garage	14,044 SF	0 SF	0 SF	14,044 SF
Daylit Area	15,660 SF	12,740 SF	2,920 SF	0 SF
Metric Analysis Area	38,917 SF	33,543 SF	4,078 SF	1,296 SF
Area per Housing Unit		541 SF		

OCCUPANCY			
Staff	Number of People	Time in Building	F.T.E
Full Time Staff	1	100%	1.0 FTE
Part Time Staff	2	25%	0.5 FTE
Total Staff			1.5 FTE
Residents	Number		F.T.E
Residents	120	40	120.0 FTE
	0	0	0.0 FTE
			120.0 FTE
Total Occupants	Residents	120 People	121.5 FTE

Building Area Used in Metrics Calculations	Gross Measured Area
Is Parking Garage included in Calculations?	No

Level 1 Case Study - Measured Resource Consumption

LIHI Denny Park Apartments		Solar PV Capacity	0.00 kW DC peak
Runberg Architecture Group		Solar Thermal Area	0 SF
Seattle	Washington	Wind System Capacity	0.00 kW DC peak

Scope 1 Energy & Emissions: Site Combustion

Fossil Fuels	Natural Gas			
Comments	Date	Days	Fuel Purchased	Cost of Fuel
Natural Gas Consumption	27-Dec-06			
	26-Jan-07	30	1,478 Therm	$ 1,889.16
	27-Feb-07	32	1,375 Therm	$ 1,796.80
	28-Mar-07	29	1,051 Therm	$ 1,381.91
	26-Apr-07	29	722 Therm	$ 1,015.57
	29-May-07	33	754 Therm	$ 992.15
	27-Jun-07	29	464 Therm	$ 624.92
	27-Jul-07	30	347 Therm	$ 476.59
	27-Aug-07	31	370 Therm	$ 506.48
	26-Sep-07	30	409 Therm	$ 554.93
	25-Oct-07	29	743 Therm	$ 865.24
	27-Nov-07	33	1,151 Therm	$ 1,291.34
	27-Dec-07	30	1,385 Therm	$ 1,550.75
Annual Total		365	10,248 Therm	$ 12,945.84
Natural Gas in kBtu & CO2 Emissions			1,024,810 kBtu	67.78 Ton CO2

Fossil Fuels	LPG (Propane)			
Comments	Date	Days	Fuel Purchased	Cost of Fuel
Propane Consumption	1-Jan-09			
	1-Feb-09	31	0 gal	$ -
	1-Mar-09	28	0 gal	$ -
	1-Apr-09	31	0 gal	$ -
	1-May-09	30	0 gal	$ -
	1-Jun-09	31	0 gal	$ -
	1-Jul-09	30	0 gal	$ -
	1-Aug-09	31	0 gal	$ -
	1-Sep-09	31	0 gal	$ -
	1-Oct-09	30	0 gal	$ -
	1-Nov-09	31	0 gal	$ -
	1-Dec-09	30	0 gal	$ -
	1-Jan-10	31	0 gal	$ -
Annual Total		365	0 gal	$ -
Propane in kBtu & CO2 Emissions			0 kBtu	0.00 Ton CO2

Fossil Fuels	Heating Oil			
Comments	Date	Days	Fuel Purchased	Cost of Fuel
Heating Oil Consumption	*1-Jan-09*			
	1-Feb-09	31	*0 gal*	$ -
	1-Mar-09	28	*0 gal*	$ -
	1-Apr-09	31	*0 gal*	$ -
	1-May-09	30	*0 gal*	$ -
	1-Jun-09	31	*0 gal*	$ -
	1-Jul-09	30	*0 gal*	$ -
	1-Aug-09	31	*0 gal*	$ -
	1-Sep-09	31	*0 gal*	$ -
	1-Oct-09	30	*0 gal*	$ -
	1-Nov-09	31	*0 gal*	$ -
	1-Dec-09	30	*0 gal*	$ -
	1-Jan-10	31	*0 gal*	$ -
Annual Total		**365**	**0 gal**	**$ -**
Heating Oil in kBtu & CO2 Emissions			**0 kBtu**	**0.00 Ton CO2**

Fossil Fuel Summary	Energy	CO2	Cost of Fuel
	1,024,810 kBtu	**67.78 Ton CO2**	$ 12,945.84

Biofuels	Wood		Wood Species	*Oak - White*
Comments	Fuel	Quantity	Energy Equivelent	Cost of Biofuel
		0.00 Cords	0 kBtu	$ -
			0 kBtu	$ -
			0 kBtu	$ -
			0 kBtu	$ -
Annual Total			**0 kBtu**	**$ -**
			Biofuels CO2 Emissions	**0.00 Ton CO2**

Scope 2 Energy & Emissions: Electricity				
Grid Electricity	**Purchases**			
Comments	Date	Days	Electricity Purchased	Cost of Service
	22-Nov-06			$ -
	26-Jan-07	65	*23,760 kWh*	$ *1,398.83*
	29-Mar-07	62	*22,440 kWh*	$ *1,267.33*
	24-May-07	56	*20,720 kWh*	$ *1,170.86*
	25-Jul-07	62	*21,600 kWh*	$ *1,221.56*
	25-Sep-07	62	*20,840 kWh*	$ *1,179.00*
	26-Nov-07	62	*19,800 kWh*	$ *1,120.45*
	26-Nov-07	0	*0 kWh*	$ -
	26-Nov-07	0	*0 kWh*	$ -
	26-Nov-07	0	*0 kWh*	$ -
	26-Nov-07	0	*0 kWh*	$ -
	26-Nov-07	0	*0 kWh*	$ -
	26-Nov-07	0	*0 kWh*	$ -
Annual Total		**369**	**127,760 kWh**	**$ 7,278.27**
Electricity in Heat Units			**436,045 kBtu**	

Solar Electricity	Total Solar Electricity Generated or Purchased		
Comments	Date	Days	Electricity Produced
	1-May-08		
	1-Jun-08	31	*0 kWh*
	1-Jul-08	30	*0 kWh*
	1-Aug-08	31	*0 kWh*
	1-Sep-08	31	*0 kWh*
	1-Oct-08	30	*0 kWh*
	1-Nov-08	31	*0 kWh*
	1-Dec-08	30	*0 kWh*
	1-Jan-09	31	*0 kWh*
	1-Feb-09	31	*0 kWh*
	1-Mar-09	28	*0 kWh*
	1-Apr-09	31	*0 kWh*
	1-May-09	30	*0 kWh*
Annual Total		**365**	**0 kWh** **$ -**
Electricity in Heat Units			**0 kBtu**

Level 1 Case Study - Measured Resource Consumption

Wind Electricity	Wind Electricity Sold to Grid			
Comments	Date	Days	Electricity sold	
Enter Wind electricity sold to grid here here.	*1-Jan-09*			
	1-Feb-09	31	*0 kWh*	$ -
	1-Mar-09	28	*0 kWh*	$ -
	1-Apr-09	31	*0 kWh*	$ -
	1-May-09	30	*0 kWh*	$ -
	1-Jun-09	31	*0 kWh*	$ -
	1-Jul-09	30	*0 kWh*	$ -
	1-Aug-09	31	*0 kWh*	$ -
	1-Sep-09	31	*0 kWh*	$ -
	1-Oct-09	30	*0 kWh*	$ -
	1-Nov-09	31	*0 kWh*	$ -
	1-Dec-09	30	*0 kWh*	$ -
	1-Jan-10	31	*0 kWh*	$ -
Annual Total		**365**	**0 kWh**	**$ -**
Electricity in Heat Units			**0 kBtu**	

Electricity Use Summary		
Electricity Consumed in Building	**436,045 kBtu**	
Net Grid Electricity Purchased and Cost	**436,045 kBtu**	**$ 7,278.27**
Net Solar & Wind Electricity Sold and Value	**0 kBtu**	**$ -**

Scope 2 Carbon Dioxide Emissions due to Electricity Consumption & Sales			
Electricity Region & Grid Emissions	*Western*	0.357 Lb CO2/kBtu	**77.93 Ton CO2**
Solar & Wind Electricity Sold			**0.00 Ton CO2**
Net Carbon Dioxide Emissions			**77.93 Ton CO2**

Building Energy Use Summary	
Annual Fuel Cost	**$ 20,224**
Building Consumption	**1,460,854 kBtu**
Net Fuel Imports	**1,460,854 kBtu**
Renewable Energy Fraction	**0%**

Building Submetered Energy Use	Main Area	Subarea 1	Subarea 2
	Residential	**Commercial**	**Parking Garage**
Annual Electricity Use by Area	*0 kBtu*	*0 kBtu*	*0 kBtu*
Renewable Electricity	*0 kBtu*	*0 kBtu*	*0 kBtu*
Grid Purchased Electricity	0 kBtu	0 kBtu	0 kBtu
Annual Fossil Fuel Use by Area	**Residential**	**Commercial**	**Parking Garage**
Natural Gas	*0 kBtu*	*0 kBtu*	*0 kBtu*
Fuel Oil	*0 kBtu*	*0 kBtu*	*0 kBtu*
Propane	*0 kBtu*	*0 kBtu*	*0 kBtu*
Annual Biofuel Use by Area	**Residential**	**Commercial**	**Parking Garage**
	0 kBtu	*0 kBtu*	*0 kBtu*
Annual Electricity Use by Function	**Residential**	**Commercial**	**Parking Garage**
Lighting	*0 kBtu*		
Plug Loads	*0 kBtu*		
Pumps			
Fans			
Heating			
Cooling			

Level 1 Case Study - Measured Resource Consumption

Water Consumption				
Comments	Date	Days	Water Purchased	Cost of Service
	3-Jan-07			
	27-Feb-07	55	*235 ccf*	*$2,353.55*
	1-May-07	63	*361 ccf*	*$3,560.24*
	28-Jun-07	58	*621 ccf*	*$6,588.51*
	31-Aug-07	64	*622 ccf*	*$6,772.40*
	30-Oct-07	60	*472 ccf*	*$4,764.36*
	2-Jan-08	64	*396 ccf*	*$3,813.78*
	2-Jan-08	0		
	2-Jan-08	0		
	2-Jan-08	0		
	2-Jan-08	0		
	2-Jan-08	0		
	2-Jan-08	0		
Annual Water Total		**364**	**2,700 ccf**	**$ 27,776.53**

Level 1 Case Study - Building Resource Use Metrics

LIHI Denny Park Apartments		Building Type and Ownership		
Runberg Architecture Group		Building Type	Multi-family Housing	Year Completed
Seattle	**Washington**	Ownership Type	Non-profit	2006

Costs per Gross Measured Area	IP Units	Metric Units	per Residence
Unit Construction Cost	278.41 $/sf	2996.82 $/m^2	216,701 $/unit
Unit Energy Cost per year	0.52 $/sf-yr	5.59 $/m^2-yr	404.48 $/unit-yr
Unit Water Costs per year	0.71 $/sf-yr	7.68 $/m^2-yr	555.53 $/unit-yr

Energy Use per Gross Measured Area	IP Heat Units	IP Electrical Units	Metric Electrical Unit	per Residence
Energy Utilization Intensity	37.5 kBtu/SF-yr	11.0 kWh/SF-yr	118.4 kWh/m^2-yr	8,561 kWh/yr/unit
Site Renewable Energy Generation Intensity	0.0 kBtu/SF-yr	0.0 kWh/SF-yr	0.0 kWh/m^2-yr	0 kWh/yr/unit
Net Imported Energy Intensity	37.5 kBtu/SF-yr	11.0 kWh/SF-yr	118.4 kWh/m^2-yr	8,561 kWh/yr/unit

Carbon Dioxide Emissions	IP Units	Metric Units
Scope 1 - Fossil Fuels	67.78 Ton CO2	61.54 metric T CO2
Scope 1 - Biofuels	0.00 Ton CO2	0.00 metric T CO2
Scope 2 - Grid Electricity	77.93 Ton CO2	70.76 metric T CO2
Scope 2 - Solar PV Electricity	0.00 Ton CO2	0.00 metric T CO2
Total Emissions	**145.71 Ton CO2**	**132.31 metric T CO2**
Net Fossil Fuel Emissions	**145.71 Ton CO2**	**132.31 metric T CO2**
CO2 Emissions per Gross Measured Area	**7.49 Lb CO2/SF-yr**	**36.6 kg CO2/m^2-yr**
CO2 Emissions per unit	**2.91 Ton CO2**	**2.65 metric T CO2**

Water Usage	IP Units	Metric Units	per Residence
Water Usage per Gross Measured Area	51.9 gal/sf-yr	2,114.6 l/m^2-yr	110.7 gal/unit/day
Site Recycled Water	0%		
Site Rainfall Harvested	0%		

Resource Use per Occupant	IP Units	Metric Units
Occupant Utilization Intensity	320 sf/FTE	30 m^2/FTE
Occupant Energy Intensity	12,023 kBtu/FTE-yr	3,523 kWh/FTE-yr
Occupant Imported Energy Intensity	12,023 kBtu/FTE-yr	3,523 kWh/FTE-yr
Occupant Net CO2 Emissions Intensity	1.20 T CO2/FTE-yr	1.09 mT CO2/FTE-yr
Occupant Water Intensity	16,624 gal/FTE-yr	62,924 l/FTE-yr

Daylighting	per Gross Measured Area
Percent Daylit Spaces	40.2%

Floor Area Efficiencies	per Gross Area
Measured Area/Gross Area Ratio	95.8%
Usable (Assignable) Area/Gross Area Ratio	80.8%
Occupied Area/Gross Area Ratio	90.7%
Mechanically Heated to Occupied Area Ratio	61.1%
Mechanically Cooled to Occupied Area Ratio	0.0%
Mechanically Ventilated to Occupied Area Ra	90.6%

Level 2 Case Study - Building Enclosure Heat Transfer

LIHI Denny Park Apartments	
Runberg Architecture Group	
Seattle	Washington

Building Enclosure Heat Transfer Rate		
Residential	UA	2,666 Btu/hr-F
Commercial	UA	1,729 Btu/hr-F
Parking Garage	UA	5,792 Btu/hr-F
Building	UA Building	4,438 Btu/hr-F

Main Building Area Exterior Enclosure Surface Takeoffs, Infiltration Rates and Heat Transfer Calculations

Area Name:	Residential	Gross Measured Area	33,543 SF

Main Area ENCLOSURE HEAT LOSS RATE TROUGH THE GROUND PER UNIT LENGTH OF PERIMETER

Condition		Length	Transfer Rate	UA_perimeter
1	Slab-on-Grade w/ext. Slab	0.0 Ft	0.00 Btu/hr-ft-F	0 Btu/hr-F
2	Slab-on-Grade	0.0 Ft	0.00 Btu/hr-ft-F	0 Btu/hr-F
3	Basement	0.0 Ft	0.00 Btu/hr-ft-F	0 Btu/hr-F
4	Crawl Space	0.0 Ft	0.00 Btu/hr-ft-F	0 Btu/hr-F
Total		0.0 Ft		0 Btu/hr-F

CONDITIONED ENCLOSURE SURFACES (Walls & Roof) / Opaque Enclosure Calculations

Orientation	Gross Surface Area	Window Area	Percent Operable Windows	Door Area	Net Enclosure Surface Area	Enclosure Surface R-Value	UA enclosure Surface
South	5,627 SF	1,178 SF	32%	240 SF	4,209 SF	22.28 hr-SF-F/Btu	189 Btu/hr-F
South	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
South	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
South	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
East	3,226 SF	376 SF	43%	0 SF	2,850 SF	22.28 hr-SF-F/Btu	128 Btu/hr-F
East	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
East	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
East	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
East	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
West	3,021 SF	834 SF	27%	0 SF	2,187 SF	22.28 hr-SF-F/Btu	98 Btu/hr-F
West	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
West	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
West	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
West	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
North	5,857 SF	1,399 SF	25%	0 SF	4,458 SF	22.28 hr-SF-F/Btu	200 Btu/hr-F
North	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
North	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
North	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
North	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
North	0 SF	0 SF	0%	0 SF	0 SF	22.28 hr-SF-F/Btu	0 Btu/hr-F
Horizontal	1,082 SF	0 SF	0%	0 SF	1,082 SF	38.64 hr-SF-F/Btu	28 Btu/hr-F
Horizontal	2,690 SF	0 SF	0%	0 SF	2,690 SF	38.64 hr-SF-F/Btu	70 Btu/hr-F
Horizontal	2,640 SF	0 SF	0%	0 SF	2,640 SF	38.64 hr-SF-F/Btu	68 Btu/hr-F
Horizontal	380 SF	0 SF	0%	0 SF	380 SF	38.64 hr-SF-F/Btu	10 Btu/hr-F
Horizontal	220 SF	0 SF	0%	0 SF	220 SF	38.64 hr-SF-F/Btu	6 Btu/hr-F
Horizontal	1,456 SF	0 SF	0%	0 SF	1,456 SF	38.64 hr-SF-F/Btu	38 Btu/hr-F
TOTAL	26,199 SF	3,787 SF		240 SF	22,172 SF		834 Btu/hr-F

Door Calculations / Window Calculations / Window Area for Each Orientation

Orientation	Door R Value	UA Door	Window R Value	UA Window	Operable Window Area	South	West	North	East	Horizontal
South	1.00 hr-SF-F/Btu	240 Btu/hr-F	3.33 hr-SF-F/Btu	354 Btu/hr-F	377 SF	1,178 SF	0 SF	0 SF	0 SF	0 SF
South	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
South	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
South	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
East	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	113 Btu/hr-F	162 SF	0 SF	0 SF	0 SF	376 SF	0 SF
East	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
East	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
East	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
East	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
West	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	250 Btu/hr-F	225 SF	0 SF	834 SF	0 SF	0 SF	0 SF
West	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
West	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
West	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
West	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
North	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	420 Btu/hr-F	350 SF	0 SF	0 SF	1,399 SF	0 SF	0 SF
North	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
North	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
North	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
North	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
North	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
Horizontal	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
Horizontal	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
Horizontal	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
Horizontal	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
Horizontal	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
Horizontal	1.00 hr-SF-F/Btu	0 Btu/hr-F	3.33 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
TOTAL		240 Btu/hr-F		1,137 Btu/hr-F	1,114 SF	1,178 SF	834 SF	1,399 SF	376 SF	0 SF

MAIN AREA AIR VOLUME & INFILTRATION

Average Ceiling Height	8.0 ft
Conditioned Air Volume	252,544 CF
Infiltration Rate	0.10 A.C.H
UA_infiltration	454.6 Btu/hr-F

SubArea 1	Relation to Main Area		Commercial	UA_subArea_1	1,729 Btu/hr-F
	Connected, Conditioned	Floor Area	4,078 SF	UA_Common_1	136 Btu/hr-F

SubArea 1 HEAT LOSS RATE TO THE GROUND PER UNIT LENGTH OF PERIMETER

Condition		Length	Transfer Rate	UA_perimeter
1	Basement (uninsulated)	257.0 Ft	1.07 Btu/hr-ft-F	275 Btu/hr-F
2		0.0 Ft	0.00 Btu/hr-ft-F	0 Btu/hr-F
Total		257.0 Ft		275 Btu/hr-F

SubArea 1 ENCLOSURE HEAT TRANSFER RATE

					Opaque Enclosure Calculations			Door Calculations		Window Calculations			Window Area for Each Orientation				
Orientation	Gross Surface Area	Window Area	Percent Operable Windows	Door Area	Net Enclosure Surface Area	Enclosure Surface R-Value	UA enclosure Surface	Door R Value	UA Door	Window R Value	UA Window	Operable Window Area	South	West	North	East	Horizontal
South	514 SF	0 SF	0%	0 SF	514 SF	13.00 hr-SF-F/Btu	40 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.79 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
West	1,851 SF	453 SF	0%	0 SF	1,398 SF	13.00 hr-SF-F/Btu	108 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.79 hr-SF-F/Btu	253 Btu/hr-F	0 SF	0 SF	453 SF	0 SF	0 SF	0 SF
North	2,526 SF	1,103 SF	0%	0 SF	1,423 SF	13.00 hr-SF-F/Btu	109 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.79 hr-SF-F/Btu	616 Btu/hr-F	0 SF	0 SF	0 SF	1,103 SF	0 SF	0 SF
East	616 SF	71 SF	0%	148 SF	397 SF	13.00 hr-SF-F/Btu	31 Btu/hr-F	1.00 hr-SF-F/Btu	148 Btu/hr-F	1.79 hr-SF-F/Btu	40 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	71 SF	0 SF
Horizontal	845 SF	0 SF	0%	0 SF	845 SF	30.00 hr-SF-F/Btu	28 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.79 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
TOTAL	6,352 SF	1,627 SF		148 SF	4,577 SF		315 Btu/hr-F		148 Btu/hr-F		909 Btu/hr-F	0 SF	0 SF	453 SF	1,103 SF	71 SF	0 SF

COMMON WALL BETWEEN SubArea 1 & Main Area

								Door Calculations		Window Calculations			Window Area for Each Orientation				
Orientation	Gross Surface Area	Window Area	Percent Operable Windows	Door Area	Net Enclosure Surface Area	Enclosure Surface R-Value	UA enclosure Surface	Door R Value	UA Door	Window R Value	UA Window	Operable Window Area	South	West	North	East	Horizontal
Horizontal	4,078 SF	0 SF	0%	0 SF	4,078 SF	30.00 hr-SF-F/Btu	136 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
West	0 SF	0 SF	0%	0 SF	0 SF	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
North	0 SF	0 SF	0%	0 SF	0 SF	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
TOTAL	4,078 SF	0 SF		0 SF	4,078 SF		136 Btu/hr-F		0 Btu/hr-F		0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF

SUB AREA 1 INFILTRATION

Average Ceiling Height	12.0 ft
Unconditioned Air Volume	45,324 CF
Infiltration Rate	0.10 A.C.H
UA_infiltration	82 Btu/hr-F

SubArea 2	Relation to Main Area		Parking Garage	UA_SubArea_2	5,720 Btu/hr-F
	Connected, Unconditioned	Floor Area	1,296 SF	UA_Common_2	130 Btu/hr-F

SubArea 2 HEAT LOSS RATE TO THE GROUND PER UNIT LENGTH OF PERIMETER

Condition		Length	Transfer Rate	UA_perimeter
1	Slab-on-Grade	0.0 Ft	0.00 Btu/hr-ft-F	0 Btu/hr-F
2	Basement (uninsulated)	155.0 Ft	1.07 Btu/hr-ft-F	166 Btu/hr-F
Total		155.0 Ft		166 Btu/hr-F

SubArea 2 ENCLOSURE HEAT TRANSFER RATE

					Opaque Enclosure Calculations			Door Calculations		Window Calculations			Window Area for Each Orientation				
Orientation	Gross Surface Area	Window Area	Percent Operable Windows	Door Area	Net Enclosure Surface Area	Enclosure Surface R-Value	UA enclosure Surface	Door R Value	UA Door	Window R Value	UA Window	Operable Window Area	South	West	North	East	Horizontal
South	1,731 SF	0 SF	0%	0 SF	1,731 SF	0.50 hr-SF-F/Btu	3,462 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
West	0 SF	0 SF	0%	0 SF	0 SF	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
North	0 SF	0 SF	0%	0 SF	0 SF	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
East	1,186 SF	0 SF	0%	280 SF	906 SF	0.50 hr-SF-F/Btu	1,812 Btu/hr-F	1.00 hr-SF-F/Btu	280 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
Horizontal	0 SF	0 SF	0%	0 SF	0 SF	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
TOTAL	2,917 SF	0 SF		280 SF	2,637 SF		5,274 Btu/hr-F		280 Btu/hr-F		0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
							0 SF										

COMMON WALL BETWEEN SubArea 2 & Main Area

								Door Calculations		Window Calculations			Window Area for Each Orientation				
Orientation	Gross Surface Area	Window Area	Percent Operable Windows	Door Area	Net Enclosure Surface Area	Enclosure Surface R-Value	UA enclosure Surface	Door R Value	UA Door	Window R Value	UA Window	Operable Window Area	South	West	North	East	Horizontal
Horizontal	1,296 SF	0 SF	0%	0 SF	1,296 SF	10.00 hr-SF-F/Btu	130 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
West	0 SF	0 SF	0%	0 SF	0 SF	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
North	0 SF	0 SF	0%	0 SF	0 SF	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	1.00 hr-SF-F/Btu	0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF
TOTAL	1,296 SF	0 SF		0 SF	1,296 SF		130 Btu/hr-F		0 Btu/hr-F		0 Btu/hr-F	0 SF	0 SF	0 SF	0 SF	0 SF	0 SF

SUB AREA 2 INFILTRATION

Average Ceiling Height	0.0 ft
Unconditioned Air Volume	0 CF
Infiltration Rate	0.00 A.C.H
UA_infiltration	0 Btu/hr-F

Level 2 Case Study - Lights

LIHI Denny Park Apartments
Runberg Architecture Group
Seattle Washington

INSTALLED LIGHTING Main Building Area	Residential				
Luminaire	Power per Lamp	Lamp/Luminaire	# Luminaires	Installed Power	Control
R	18 W	54	1	972 W	Manual
H	64 W	47	2	6,016 W	Occupant Sensor
G	62 W	10	1	620 W	Manual
F	32 W	1	1	32 W	Daylight
N	15 W	30	1	450 W	Daylight
J	62 W	28	2	3,472 W	Daylight
A	28 W	7	1	196 W	Occupant Sensor
D	18 W	74	1	1,332 W	Occupant Sensor
C	18 W	118	1	2,124 W	Manual
B	18 W	55	1	990 W	Manual
L	20 W	55	2	2,200 W	Manual
K1	18 W	50	1	900 W	Manual
E	18 W	8	1	144 W	Manual
K	60 W	2	1	120 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Occupant Sensor
	0 W	0	0	0 W	Exit always on
Total Installed Lights, Main Area				19,568 W	

INSTALLED LIGHTING SubArea 1	Commercial				
Luminaire	Power per Lamp	Lamp/Luminaire	# Luminaires	Installed Power	Control
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Manual
Total - Lights in Sub Area 1				0 W	

INSTALLED LIGHTING SubArea2	Parking Garage				
Luminaire	Power per Lamp	Lamp/Luminaire	# Luminaires	Installed Power	Control
	0 W	0	0	0 W	Manual
	0 W	0	0	0 W	Occupant Sensor
	0 W	0	0	0 W	Manual
Total - Lights in Sub Area 2				0 W	

Exterior Lights (attached to Buildings)					
Luminaire	Power per Lamp	Lamp/Luminaire	# Luminaires	Installed Power	Control
	0 W	0	0	0 W	
	0 W	0	0	0 W	
	0 W	0	0	0 W	
Total - Exterior Lights attached to Building				0 W	

INSTALLED LIGHTING - SITE					
Luminaire	Power per Lamp	Lamp/Luminaire	# Luminaires	Installed Power	Control
	0 W	0	0	0 W	
	0 W	0	0	0 W	
	0 W	0	0	0 W	
Total - Site Lighting				0 W	

TOTAL INSTALLED LIGHTING POWER	
Total Installed Illumination Power	19,568 W

Level 2 Case Study - HVAC and Service Hot Water Systems

LIHI Denny Park Apartments
Runberg Architecture Group
Seattle Washington

HVAC Ventilation Fans

Main Building Area — Residential

Supply Fans	Function	Max. Air Flow	Constant Volume, Variable or VFD	Motor HP	Motor Watts
FC-1	Corridor Level 2	400 cfm	Constant Volume	0.50 Hp	373 W
FC-2	Corridor Level 3	400 cfm	Constant Volume	0.50 Hp	373 W
FC-3	Corridor Level 4	400 cfm	Constant Volume	0.50 Hp	373 W
FC-4	Corridor Level 5	400 cfm	Constant Volume	0.50 Hp	373 W
FC-5	Corridor Level 6	400 cfm	Constant Volume	0.50 Hp	373 W
Total Installed Supply Fan CFM & Power		2,000 cfm		2.50 Hp	1,864 W
				Supply Fans Heat Transfer Efficiency	1.2 Btu/hr-F-W
				Supply Fans Volume Flow Efficiency	1.1 cfm/W

Exhaust Fans	Function	Max. Air Flow	Control: Constant, Variable or VFD	Motor HP	Motor Watts
EF-1	Studio & 1 Bedroom Studio Baths (37)	1,850 cfm	Constant Volume	2.73 Hp	2,036 W
EF-2	2 bedroom Baths (8)	720 cfm	Constant Volume	0.54 Hp	403 W
EF-3	3 Bedroom Baths (5)	500 cfm	Constant Volume	0.60 Hp	447 W
EF-4	Level 1 UP Garage	4,500 cfm	Variable Speed	1.50 Hp	1,119 W
EF-5	Level P1 LP Garage	9,500 cfm	Variable Speed	3.00 Hp	2,237 W
EF-6	Attic Corridor Exhaust	250 cfm	Constant Volume	1.00 Hp	746 W
EF-7	Level P1 Electrical Room Exhaust	1,100 cfm	Constant Volume	0.17 Hp	124 W
EF-8	Level P1 Elevator machine Room	750 cfm	Constant Volume	0.17 Hp	124 W
EF-9	Boiler Room Exhaust	326 cfm	Constant Volume	0.14 Hp	107 W
EPF-1	Elevator Pressurization	0 cfm	Constant Volume	0.00 Hp	0 W
HB-1	Typical Kitchen (17 HP x 50)	2,500 cfm	Variable Speed	8.33 Hp	6,212 W
Total Installed Exhaust Fan CFM & Power		21,996 cfm		18.18 Hp	13,554 W
				Exhaust Fans Heat Transfer Efficiency	1.8 Btu/hr-F-W
				Exhaust Fans Volume Flow Efficiency	1.6 cfm/W
Main Area Installed Fan CFM & Power		23,996 cfm		20.68 Hp	15,418 W
				All Fans Heat Transfer Efficiency	1.7 Btu/hr-F-W
				All Fans Volume Flow Efficiency	1.6 cfm/W
Main Area Outdoor Air Supply					
Outdoor Air Ventilation Rate		2,000 cfm			
Fraction of Supply Air that is Outdoor Air		100%			

FANS - SubArea 1 — Commercial

Supply Fans	Function	Max. Air Flow	Constant Volume, Variable or VFD	Motor HP	Motor Watts
		0 cfm	VFD	0.00 Hp	0 W
		0 cfm	Constant Volume	0.00 Hp	0 W
Total Installed Supply Fan CFM & Power		0 cfm		0.00 Hp	0 W
				Supply Fans Heat Transfer Efficiency	0.0 Btu/hr-F-W
				Supply Fans Volume Flow Efficiency	0.0 cfm/W

Exhaust Fans	Function	Max. Air Flow	Control: Constant, Variable or VFD	Motor HP	Motor Watts
		0 cfm	VFD	0.00 Hp	0 W
		0 cfm	Constant Volume	0.00 Hp	0 W
Total Installed Exhaust Fan CFM & Power		0 cfm		0.00 Hp	0 W
				Exhaust Fans Heat Transfer Efficiency	0.0 Btu/hr-F-W
				Exhaust Fans Volume Flow Efficiency	0.0 cfm/W
SubArea 1 Installed Fan CFM & Power		0 cfm		0.00 Hp	0 W
				All Fans Heat Transfer Efficiency	0.0 Btu/hr-F-W
				All Fans Volume Flow Efficiency	0.0 cfm/W
SubArea 1 Outdoor Air Supply					
Outdoor Air Ventilation Rate		0 cfm			
Fraction of Supply Air that is Outdoor Air		0%			

FANS - SubArea 2 — Parking Garage

Supply Fans	Function	Max. Air Flow	Constant Volume, Variable or VFD	Motor HP	Motor Watts
		0 cfm	VFD	0.00 Hp	0 W
		0 cfm	Constant Volume	0.00 Hp	0 W
Total Installed Supply Fan CFM & Power		0 cfm		0.00 Hp	0 W
				Supply Fans Heat Transfer Efficiency	0.0 Btu/hr-F-W
				Supply Fans Volume Flow Efficiency	0.0 cfm/W

Exhaust Fans	Function	Max. Air Flow	Constant Volume, Variable or VFD	Motor HP	Motor Watts
		0 cfm	VFD	0.00 Hp	0 W
		0 cfm	Constant Volume	0.00 Hp	0 W
Total Installed Exhaust Fan CFM & Power		0 cfm		0.00 Hp	0 W
				Exhaust Fans Heat Transfer Efficiency	0.0 Btu/hr-F-W
				Exhaust Fans Volume Flow Efficiency	0.0 cfm/W
SubArea 2 Installed Fan CFM & Power		0 cfm		0.00 Hp	0 W
				All Fans Heat Transfer Efficiency	0.0 Btu/hr-F-W
				All Fans Volume Flow Efficiency	0.0 cfm/W
SubArea 2 Outdoor Air Supply					
Outdoor Air Ventilation Rate		0 cfm			
Fraction of Supply Air that is Outdoor Air		0%			

FANS - Total Building

Supply Fans CFM	2,000 cfm	Supply Fans Power	1,864 W
		Supply Fans Heat Transfer Efficiency	1.2 Btu/hr-F-W
		Supply Fans Volume Flow Efficiency	1.1 cfm/W
Exhaust Fans CFM	21,996 cfm	Exhaust Fans Power	13,554 W
		Supply Fans Heat Transfer Efficiency	1.8 Btu/hr-F-W
		Supply Fans Volume Flow Efficiency	1.6 cfm/W
Total Building Installed Fan CFM & Power	23,996 cfm		15,418 W
		All Fans Heat Transfer Efficiency	1.7 Btu/hr-F-W
		All Fans Volume Flow Efficiency	1.6 cfm/W
Total Building Outdoor Air Supply			
Outdoor Air Ventilation Rate	2,000 cfm		
Fraction of Supply Air that is Outdoor Air	100%		

Fan Characteristics	Flow Rate	Motor Watts	Flow Efficiennncy
Constant Volume Fans	6,370 cfm	4,999 W	1.3 cfm/W
Variable Frequency Drive Fans	0 cfm	0 W	0.0 cfm/W
Variable Speed Fans	16,500 cfm	9,567 W	1.7 cfm/W
All Fans	22,870 cfm	14,566 W	1.6 cfm/W

HVAC	Pumps				
Main Building Area	**Residential**				
Line Pumps	Function	Flow Rate	Control	Motor HP	Motor Watts
BP-1	Boiler B-1	*25.0 gpm*	*Constant*	*0.75 Hp*	559 W
BP-2	Boiler B-2	*25.0 gpm*	*Constant*	*0.75 Hp*	559 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
		0.0 gpm	*Constant*	*0.00 Hp*	0 W
Total Line Pumps		**50.0 gpm**		**1.50 Hp**	**1,119 W**
				Pump Heat Transfer Efficiency	**22.4 Btu/hr-F-W**
				Pump Volume Flow Efficiency	**0.04 gpm/W**
Redundant (lead/lag) Pumps					
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
Total - Redundant Pumps		**0.0 gpm**		**0.00 Hp**	**0 W**
Total - Main Building Area Pumps		**50.0 gpm**		**1.50 Hp**	**1,119 W**
PUMPS - SubArea 1	**Commercial**				
Line Pumps	Function	Flow Rate	Control	Motor HP	Motor Watts
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
Total Line Pumps		**0.0 gpm**		**0.00 Hp**	**0 W**
				Pump Heat Transfer Efficiency	**0.0 Btu/hr-F-W**
				Pump Volume Flow Efficiency	**0.00 gpm/W**
Redundant (lead/lag) Pumps					
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
Total - Redundant Pumps		**0.0 gpm**		**0.00 Hp**	**0 W**
Total - SubArea1 Pumps		**0.0 gpm**		**0.00 Hp**	**0 W**
PUMPS - SubArea 2	**Parking Garage**				
Line Pumps	Function	Flow Rate	Control	Motor HP	Motor Watts
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
Total Line Pumps		**0.0 gpm**		**0.00 Hp**	**0 W**
				Pump Heat Transfer Efficiency	**0.0 Btu/hr-F-W**
				Pump Volume Flow Efficiency	**0.00 gpm/W**
Redundant (lead/lag) Pumps					
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
		0.0 gpm	*VFD*	*0.00 Hp*	0 W
Total - Redundant Pumps		**0.0 gpm**		**0.00 Hp**	**0 W**
Total- SubArea2 Pumps		**0.0 gpm**		**0.00 Hp**	**0 W**
PUMPS - Total Building			**Flow Rate**	**Motor Watts**	**Flow Efficiency**
Line Pumps		**Constant Speed**	**50.0 gpm**	**1,119 W**	**0.04 gpm/W**
		Variable Frequency Drive	**0.0 gpm**	**0 W**	**0.00 gpm/W**
		Variable Speed	**0.0 gpm**	**0 W**	**0.00 gpm/W**
		Total - Line Pumps	**50.0 gpm**	**1,119 W**	**0.04 gpm/W**
Redundant Pumps			**0.0 gpm**	**0 W**	

Level 2 Case Study - HVAC and Service Hot Water Systems

HVAC	Providing Heat: Boilers, Furnaces, Radiant & Electric Heaters				
Main Building Area		**Residential**			
Boiler	Function	Fuel	Rated Output	Input	Efficiency
B-1	*Hydronic Baseboard Heat*	*Natural Gas*	*366 kBtu/hr*	*399 kBtu/hr*	*92%*
B-2	*Hydronic Baseboard Heat*	*Natural Gas*	*366 kBtu/hr*	*399 kBtu/hr*	*92%*
Total Boilers			732 kBtu/hr	798 kBtu/hr	0.917293233
Furnace	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Furnaces			0 kBtu/hr	0 kBtu/hr	
Radiant Heater	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Radiant Heaters			0 kBtu/hr	0 kBtu/hr	
Electric Heater	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Electric Heaters			0 kBtu/hr	0 kBtu/hr	
Total - Main Building Area Heat Production			**732 kBtu/hr**	**798 kBtu/hr**	**92%**
SubArea 1		**Commercial**			
Boiler	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Boilers			0 kBtu/hr	0 kBtu/hr	
Furnace	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Furnaces			0 kBtu/hr	0 kBtu/hr	
Radiant Heater	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Radiant Heaters			0 kBtu/hr	0 kBtu/hr	
Electric Heater	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Electric Heaters			0 kBtu/hr	0 kBtu/hr	
Total - SubArea 1 Heat Production			**0 kBtu/hr**	**0 kBtu/hr**	**0%**
SubArea 2		**Parking Garage**			
Boiler	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Boilers			0 kBtu/hr	0 kBtu/hr	
Furnace	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Furnaces			0 kBtu/hr	0 kBtu/hr	
Radiant Heater	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Radiant Heaters			0 kBtu/hr	0 kBtu/hr	
Electric Heater	Function	Fuel	Rated Output	Input	Efficiency
			0 kBtu/hr	*0 kBtu/hr*	*0%*
					0%
Total Electric Heaters			0 kBtu/hr	0 kBtu/hr	
Total - SubArea 2 Heat Production			**0 kBtu/hr**	**0 kBtu/hr**	**0%**
Total Building Heat Production			Rated Output	Input	Efficiency
		Boilers	**732 kBtu/hr**	**798 kBtu/hr**	**92%**
		Furnaces	**0 kBtu/hr**	**0 kBtu/hr**	**0%**
		Radiant Heaters	**0 kBtu/hr**	**0 kBtu/hr**	**0%**
		Electric Heaters	**0 kBtu/hr**	**0 kBtu/hr**	**0%**
		Total	**732 kBtu/hr**	**798 kBtu/hr**	**92%**

LIHI Denny Park Apartments	Basis of Analysis	Gross Measured Area
Runberg Architecture Group	Parking Garage Included in Analysis?	No
Seattle **Washington**		

Renewable Resource Variables per Gross Measured Area	IP Units	Metric Units
Solar PV Density	0.00 Wpeak/SF	0.0 Wpeak/m^2
Wind Electric Density	0.00 Wpeak/SF	0.0 Wpeak/m^2
Solar Thermal Density	0.000 SF/SF	0.000 m^2/m^2

Building Enclosure Variables per Gross Measured Area		IP Units	Metric Units
Enclosure Area per Gross Measured Area	**Total Building**	**0.91 SF/SF**	**0.91 m^2/m^2**
Main Area	Residential	0.78 SF/SF	0.78 m^2/m^2
SubArea 1	Commercial	1.56 SF/SF	1.56 m^2/m^2
SubArea 2	Parking Garage	2.25 SF/SF	2.25 m^2/m^2
Heat Transfer Rate per Gross Measured Area	**Total Building**	**0.12 Btu/hr-sf-°F**	**0.66 W/m^2-°C**
Main Area	Residential	0.08 Btu/hr-sf-°F	0.45 W/m^2-°C
SubArea 1	Commercial	0.42 Btu/hr-sf-°F	2.41 W/m^2-°C
SubArea 2	Parking Garage	4.41 Btu/hr-sf-°F	25.06 W/m^2-°C

Illumination Variables per Gross Measured Area		IP Units	Metric Units
Lighting Power Density	**Total**	**0.503 Watt/SF**	**5.41 Watt/m^2**
Main Area	Residential	0.583 Watt/SF	6.28 Watt/m^2
SubArea 1	Commercial	0.000 Watt/SF	0.00 Watt/m^2
SubArea 2	Parking Garage	0.000 Watt/SF	0.00 Watt/m^2

Building Glazing per Gross Measured Area	Total Building	Main Area Residential	Subarea 1 Commercial	Subarea 2 Parking Garage
South	3.0%	3.5%	0.0%	0.0%
East	1.1%	1.1%	1.7%	0.0%
North	6.4%	4.2%	27.0%	0.0%
West	3.3%	2.5%	11.1%	0.0%
Horizontal	0.0%	0.0%	0.0%	0.0%
Total Glazing	**13.9%**	**11.3%**	**39.9%**	**0.0%**

Ventilation Variables per Gross Measured Area		IP Units	Metric Units
Operable Window Area	**Total**	**2.9%**	**2.9%**
Main Area	Residential	3.3%	3.3%
SubArea 1	Commercial	0.0%	0.0%
SubArea 2	Parking Garage	0.0%	0.0%
Outdoor Air Ventilation Rate	**Total**	**0.05 cfm/SF**	**0.26 l/s-m^2**
Main Area	Residential	0.06 cfm/SF	0.30 l/s-m^2
SubArea 1	Commercial	0.00 cfm/SF	0.00 l/s-m^2
SubArea 2	Parking Garage	0.00 cfm/SF	0.00 l/s-m^2
Supply Air Ventilation Capacity	**Total**	**0.05 cfm/SF**	**0.26 l/s-m^2**
Main Area	Residential	0.06 cfm/SF	0.30 l/s-m^2
SubArea 1	Commercial	0.00 cfm/SF	0.00 l/s-m^2
SubArea 2	Parking Garage	0.00 cfm/SF	0.00 l/s-m^2

Heating Capacities per Gross Measured Area		IP Units	Metric Units
Heating Capacity	**Total**	**5.51 Watt/SF**	**59.3 W/m^2**
Main Area	Residential	6.39 Watt/SF	68.8 W/m^2
SubArea 1	Commercial	0.00 Watt/SF	0.0 W/m^2
SubArea 2	Parking Garage	0.00 Watt/SF	0.0 W/m^2
Heating Installed Power	**Total**	**6.01 Watt/SF**	**64.7 W/m^2**
Main Area	Residential	6.97 Watt/SF	75.0 W/m^2
SubArea 1	Commercial	0.00 Watt/SF	0.0 W/m^2
SubArea 2	Parking Garage	0.00 Watt/SF	0.0 W/m^2

Level 2 Case Study - Building Design Variables

Cooling Capacities per Gross Measured Area		IP Units	Metric Units
Cooling Capacity	**Total**	0 SF/Ton	0.0 m^2/kW
Main Area	Residential	0 SF/Ton	0.0 m^2/kW
SubArea 1	Commercial	0 SF/Ton	0.0 m^2/kW
SubArea 2	Parking Garage	0 SF/Ton	0.0 m^2/kW
Installed Power	**Total**	0.00 Watt/SF	0.0 W/m^2
Main Area	Residential	0.00 Watt/SF	0.0 W/m^2
SubArea 1	Commercial	0.00 Watt/SF	0.0 W/m^2
SubArea 2	Parking Garage	0.00 Watt/SF	0.0 W/m^2

Fan Efficiencies per Gross Measured Area		IP Units	Metric Units
Fan Power Density (supply & exhaust)	**Total**	0.40 Watt/SF	4.26 Watt/m^2
Main Area	Residential	0.46 Watt/SF	4.95 Watt/m^2
SubArea 1	Commercial	0.00 Watt/SF	0.00 Watt/m^2
SubArea 2	Parking Garage	0.00 Watt/SF	0.00 Watt/m^2
Fan Volume Flow Efficiency	**Total**	1.6 cfm/W	0.73 Liter/s/W
Main Area	Residential	1.6 cfm/W	0.73 Liter/s/W
SubArea 1	Commercial	0.0 cfm/W	0.00 Liter/s/W
SubArea 2	Parking Garage	0.0 cfm/W	0.00 Liter/s/W
Fan Thermal Transfer Efficiency	**Total**	1.7 Btu/hr-°F-W	3.19 kJ/hr-°C-W
Main Area	Residential	1.7 Btu/hr-°F-W	3.19 kJ/hr-°C-W
SubArea 1	Commercial	0.0 Btu/hr-°F-W	0.00 kJ/hr-°C-W
SubArea 2	Parking Garage	0.0 Btu/hr-°F-W	0.00 kJ/hr-°C-W
Fan Characteristics	**Flow Rate**	**Motor Watts**	**Flow Efficiennсy**
Constant Volume Fans	6,370 cfm	4,999 W	1.3 cfm/W
Variable Frequency Drive Fans	0 cfm	0 W	0.0 cfm/W
Variable Speed Fans	16,500 cfm	9,567 W	1.7 cfm/W

Pump Efficiencies per Gross Measured Area		IP Units	Metric Units
Pump Power Density	**Total**	0.03 Watt/SF	0.31 Watt/m^2
Main Area	Residential	0.03 Watt/SF	0.36 Watt/m^2
SubArea 1	Commercial	0.00 Watt/SF	0.00 Watt/m^2
SubArea 2	Parking Garage	0.00 Watt/SF	0.00 Watt/m^2
Pump Volume Flow Efficiency	**Total**	0.04 gpm/W	0.00 Liter/s/W
Main Area	Residential	0.04 gpm/W	0.00 Liter/s/W
SubArea 1	Commercial	0.00 gpm/W	0.00 Liter/s/W
SubArea 2	Parking Garage	0.00 gpm/W	0.00 Liter/s/W
Pump Thermal Transfer Efficiency	**Total**	22.4 Btu/hr-°F-W	42.48 kJ/hr-°C-W
Main Area	Residential	22.4 Btu/hr-°F-W	42.48 kJ/hr-°C-W
SubArea 1	Commercial	0.0 Btu/hr-°F-W	0.00 kJ/hr-°C-W
SubArea 2	Parking Garage	0.0 Btu/hr-°F-W	0.00 kJ/hr-°C-W
Pump Characteristics	**Flow Rate**	**Motor Watts**	**Flow Efficiennсy**
Constant FlowPumps	50.0 gpm	1,119 W	0.04 gpm/W
Variable Frequency Drive Pumps	0.0 gpm	0 W	0.00 gpm/W
Variable Speed Pumps	0.0 gpm	0 W	0.00 gpm/W

Level 2 Case Study - Building Design Variables

Plug Load Power per Gross Measured Area		IP Units	Metric Units
	Total	0.00 Watt/SF	0.00 Watt/m^2
Main Area	Residential	0.00 Watt/SF	0.00 Watt/m^2
SubArea 1	Commercial	0.00 Watt/SF	0.00 Watt/m^2
SubArea 2	Parking Garage	0.00 Watt/SF	0.00 Watt/m^2

Elevator & Escalator Power per Gross Measured Area		IP Units	Metric Units
	Total	0.00 Watt/SF	0.00 Watt/m^2
Main Area	Residential	0.00 Watt/SF	0.00 Watt/m^2
SubArea 1	Commercial	0.00 Watt/SF	0.00 Watt/m^2
SubArea 2	Parking Garage	0.00 Watt/SF	0.00 Watt/m^2

Process Load Power per Gross Measured Area		IP Units	Metric Units
	Total	0.00 Watt/SF	0.00 Watt/m^2
Main Area	Residential	0.00 Watt/SF	0.00 Watt/m^2
SubArea 1	Commercial	0.00 Watt/SF	0.00 Watt/m^2
SubArea 2	Parking Garage	0.00 Watt/SF	0.00 Watt/m^2

Balance Point Estimates		IP Units	Metric Units
Thermostat Settings	Heating	68.0 °F	20.0 °C
	Cooling	77.0 °F	25.0 °C
Internal Heat Generation based on Total Electric Consumption		49,777 BTU/hr	14,584 W
		1.28 BTU/hr/SF	4.03 W/m^2
Building Balance Point	Heating	57.0 °F	13.9 °C
	Cooling	66.0 °F	18.9 °C

Actual Utility Data used in analysis

Websites-
High Performance Buildings Data Base

AIA COTE Top 10

acknowledgements

Student team (?)