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SITE LOCATION

(Covarrubias, 2007)
SITE LOCATION

(City of Toronto, 2018)
SITE ANALYSIS

Site area: 1255 m²

Source: Google earth 2020
DEMOGRAPHICS_ Ward 13 (Toronto Centre)

- Ward population: 103,805
- Population growth (2011-2016):
  - Ward 13: 10.5%
  - Toronto: 4.5%
- Density (people/hectare):
  - Ward 13: 184
  - Toronto: 43
- Average rent: $1,214
- Tenure:
  - Ward 13:
    - Rent: 71%
    - Own: 29%
  - Toronto:
    - Rent: 47%
    - Own: 53%
- Unemployment rate: 8.8%

Occupied private dwellings by structure type
Source: City of Toronto, Census 2016
WEATHER CONDITION

Semi-continental climate
- warm, humid summer
- cold winter
Climate zone: 5A

Average temperature: 9.4 °C
Annual precipitation: 831.1 L/m²/yr
Elevation: 112.5 m

Average HDD (18°C): 3560
Average CDD (18°C): 380
Latitude: 43°39'36.3"N
Longitude: 79°22'35.5"W

Average annual wind speed: 14.7km/h
Extreme Global - RF1: 35 MJ/m²
OUR VISION

Introduction

Architecture

Energy

Engineering

IEQ

Operations

Innovation

Resilience

Financial feasibility

Market Potential

Embodied energy

Conclusion

The Past
(Blakey, 1907)

The Present
(2020)

The Future
(2026)
DESIGN GOALS

- Health and well-being
- Reduced construction time
- Low carbon footprint
- Low energy
EXTERIOR DESIGN

15% WWR

20% WWR

30% WWR

GEARED ENTRANCE TO SEPARATE MASSES

VERTICAL SHADING REDUCES GLARE

GLAZED AND TRANSFERRED COLUMNS LEVITATES MASS
BASEMENT AND ROOF PLAN
OFFICE SPACE DESIGN

- Architecture
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ENERGY CONSUMPTION

- Building Envelope Iterations
- Cooling and Heating Loads
- HVAC Iterations

Energy Consumption Analysis

ARCHITECTURE

- Embodied Energy

ENGINEERING

- IEQ

INTERIORS

- Innovation

OPPORTUNITIES

- Resilience

FINANCIAL FEASIBILITY

- Market Potential

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- Conclusion
ENERGY CONSUMPTION

EUI: 226 kWh/m²/yr (71.7 kBtu/ft²/yr)

EUI: 71 kWh/m²/yr (22.5 kBtu/ft²/yr)
RENEWABLE ENERGY

Office building roof area:
**Approximately 1200 m² (12916.7 ft²)**

Additional PV array potential from adjacent building:
1. Architecture building
2. Pitman Hall Residence

Office building:
- No. of PV panels: 206
- PV array size: 92.7 kW (316.3 kBTU/hr)
- Tilt angle: 32°

Additional PV array:
- No. of PV panels: 580
- PV array size: 261 kW (891 kBTU/hr)
- Tilt angle: 32°
Traditional PV panel:
Annual energy generation- 100.6 MWh (343261.4 kBTU)
Energy offset (EUI)- 18.86 kWh/m² (5978.6BTU/ft²)

BICPV:
Annual energy generation- 201.2 MWh (686522 kBTU)
Energy offset (EUI)- 37.72 kWh/m² (11957.2BTU/ft²)

Additional PV array:
Annual energy generation- 312 MWh (1064588.2 kBTU)
Energy offset- 54.23 kWh/m² EUI.
DAYLIGHTING

Maximum illuminance: **850 lux** towards the perimeter
Minimum illuminance: **170 lux** towards the interior
(at 11am during winter)

Daylight availability (without passive shading strategies) (ClimateStudio 2020)

Daylight availability and annual glare (without passive shading strategies) (ClimateStudio 2020)

Daylight availability and annual glare (with passive shading strategies) (ClimateStudio 2020)
D A Y L I G H T I N G Passive shading strategies

South facade: **External light shelves**
West facade: **Vertical shading**
South and West: **Internal blinds**
Minimize glare on South and West facade.
PLUG LOADS

AVERAGE ENERGY SAVINGS = 32%
R-Value Optimization

Optimized Wall Insulation Analysis

Optimized Roof Insulation Analysis
CONTROL LAYERS

- Air Control Layer
- Vapor Control Layer
- Bulk Water Control Layer

- 12 GA. Stainless Steel Hidden Fastener Clip (1 per panel, per support)
- Set Clip in Butyl Sealant
- 22GA Cap Flashing
- Wood Blocking Support
- Roofing Membrane
- Cover Board
- 75mm Tapered Insulation
- 250mm Insulation R-Value 55
- Blueskin VP 150 Breathable Structural Deck

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Market Potential
Embodied Energy
Conclusion
CONTROL LAYERS

13MM CYPUSUM
152MM HORIZONTAL
WOOD SUPPORT
150 MM INSULATED
METAL PANEL

AIR CONTROL LAYER
VAPOUR CONTROL LAYER
BULK WATER CONTROL LAYER
HVAC SYSTEM

Legend

- Heat Pump Loop
- Air Flow
- Fan
- Zone thermostat
- Discharge thermostat
- Louver
- Piping inside a system component
- Filter
- Heating / Cooling Coil
- Energy Recovery Wheel
- Exhaust Air
- Fresh Air
- Supply Air
- Return Air

ROOFTOP DOAS SYSTEM WITH A ROTARY HEAT EXCHANGER WHEEL

FRESH AIR

EXHAUST

CONDITIONED SUPPLY AIR

RETURN AIR

HEAT EXCHANGER BETWEEN GSHP AND WSHIP

GSHP BOREHOLE LOOP SYSTEM
WATER MANAGEMENT

Roof area: approximately 1200 m² (12916.7 ft²)
Storage tank capacity: 16000 L (4226.7 gallons)
Average water use intensity: 700 L/m²/yr (17.2 BTU/ft²/yr)
Annual precipitation: 831.1 L/m²/yr
### Water Management

#### Total Annual Water Usage

<table>
<thead>
<tr>
<th>Description</th>
<th>L/yr (gallons/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total annual water usage</td>
<td>3,275,138 (865,200)</td>
</tr>
<tr>
<td>Low flow water use reduction</td>
<td>447,053 (118,099)</td>
</tr>
<tr>
<td>Annual rainwater harvested</td>
<td>797,855 (210,771)</td>
</tr>
<tr>
<td>Total water use reduction</td>
<td>1,244,912 (328,871)</td>
</tr>
<tr>
<td>Annual water usage after reduction</td>
<td>2,030,226 (536,329)</td>
</tr>
</tbody>
</table>

#### Water Usage Reduction

- **% of reduction:** 38%
LIGHTING DESIGN

GROUND FLOOR:

SPACE TYPE:
- RETAIL
- ATRIUM
- BATHROOM
- CAFE
- LOADING
- GARBAGE
- CORRIDOR

AZUL LINEAR
4' CIRCADIAN LED

RAB
LED STRIP LIGHT - 10 W

LED LIGHT FIXTURE
MOTION SENSOR

LIGHT CONTROL ZONE

Page 36
LIGHTING DESIGN

TYPICAL OFFICE FLOOR:

SPACE TYPE:
- Reception
- Kitchen / Break
- Office Space
- Meeting Rooms
- Copy Room
- Washroom
- Corridor

AZUL LINEAR
4' CIRCADIAN LED - 63 W

RAB
LED STRIP LIGHT - 10 W

LIGHT CONTROL ZONE
LIGHTING CONTROL

TYPICAL OFFICE BAY LIGHTING CONTROL SOLUTION:

- **MULTI-TECH CEILING MOUNT OCCUPANCY SENSOR**
  - LEVITON OSC20-RMW

- **PHOTOCELL SENSOR**
  - LEVITON ODC0P-W

- **LIGHTING CONTROL STATION**
  - LEVITON RLVSW-4LW

- **INTEGRATED ROOM CONTROL DIMMING**
  - LEVITON MZD20-102
INNOVATIVE BUILDING TECHNOLOGIES

(Architecture & Design, 2020)

(Saleh, 2011)

(Vincent, 2020)
RESILIENCE

- **Storage batteries** to provide backup power to the office.
- **Energy gateway** to detect grid outages and response accordingly
- **Rapid Shutdown system** for emergency situation
- Control of **rainwater inflow** into the city's sewers.

![Storage tank size determination](chart)

*Increase in rainwater usage (water savings) associated with increase in tank size*
Construction Cost Breakdown

Base Cost:
$8.1 M total, $185 PSF

Designed Cost:
$11.5 M total, $258 PSF
Operational Cost

- Electricity
- Natural Gas
- Domestic Water
- Total Operational Cost

Costs:
- $120,000.00
- $100,000.00
- $80,000.00
- $60,000.00
- $40,000.00
- $20,000.00
- $0.00

Base Building vs. Designed Building
The State of Toronto’s Office Market

![Graph showing net rent and vacancy rate for different areas in Toronto.](image)

- **Downtown**: $33.92
- **Midtown**: $24.59
- **East**: $15.15
- **North**: $19.55
- **West**: $16.99
- **GTA**: $18.80

**Net Rent (PSF)**

**Vacancy Rate**

**Key:**
- Blue bars represent Net Rent
- Orange line represents Vacancy Rate
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Thank you!
References


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