

# 2016 ONPHA Conference and Trade Show

## 603

Lining up the Ducks: Energy, occupant satisfaction and environmental performance in affordable multi-unit buildings

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ONPHA



# 2016

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# Part 1: Post Occupancy Evaluation (POE) Design Guide for MURBs

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# POST-OCCUPANCY EVALUATION (POE)

## A Guide for Multi-Unit Residential Buildings

- Key concepts to perform a Post-Occupancy Evaluation (POE)
- New or existing multi-unit residential building (MURB)
- Buildings with recently completed or planned renovations



# WHAT IS A POE?

- A post-occupancy evaluation (POE) is the systematic assessment of building performance during service to assess the various design and construction strategies employed in the building.
- It can also be used to assess the extent to which the performance of a building meets objectives and how it compares to relevant baselines.



# WHAT IS THE PURPOSE OF A POE?

- To assess the performance of newly constructed buildings or buildings having undergone a major retrofit or rehabilitation, from energy consumption to air quality and noise levels.
- To assess an existing building where there are concerns about thermal comfort, energy consumption or other aspects of the building's performance.



# WHAT ARE THE PRIMARY OBJECTIVES OF A POE?

- 1.To determine the extent to which a building meets the occupants' and building management team's needs and expectations
- 2.To assess the overall performance of a building relative to benchmarks
- 3.To provide feedback on the building design, construction and commissioning process
- 4.To evaluate the success of specific innovative building features, measures and systems compared to conventional technologies
- 5.To assess the building's ability to meet the design and operational performance targets





# WHAT ARE THE BENEFITS OF A POE?

- Early identification and resolution of building problems
- Ability to respond to occupant/user needs
- Confirmation of performance objectives
- Identification of potential energy, water, and cost savings;
- Informed decision-making for building operations and management practices
- Increased industry knowledge of practices that can improve building performance



# POE METHODOLOGY: AN OVERVIEW

## STEP 1: OBJECTIVE SETTING





# POE METHODOLOGY: AN OVERVIEW

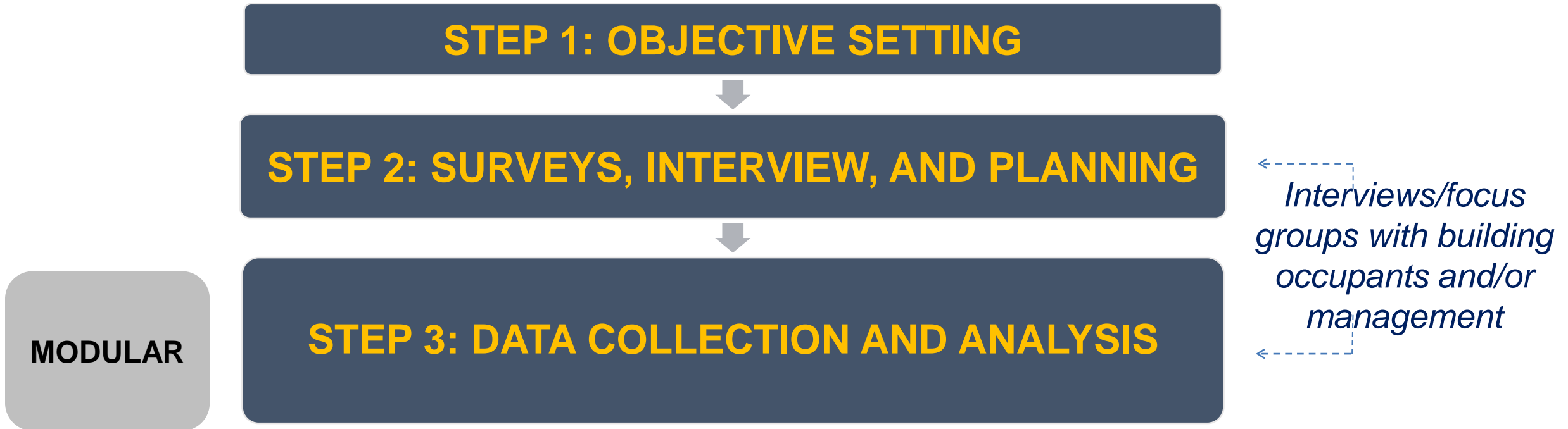
**STEP 1: OBJECTIVE SETTING**



**STEP 2: SURVEYS, INTERVIEW, AND PLANNING**



# POE METHODOLOGY: AN OVERVIEW



# KEY PERFORMANCE INDICATORS, BENCHMARKS, AND TARGETS

## STEP 3: DATA COLLECTION AND ANALYSIS

Area 1: Energy consumption

Area 2: Water consumption

Area 3: Indoor air quality and thermal comfort

Area 4: Lighting and the visual environment

Area 5: Acoustics

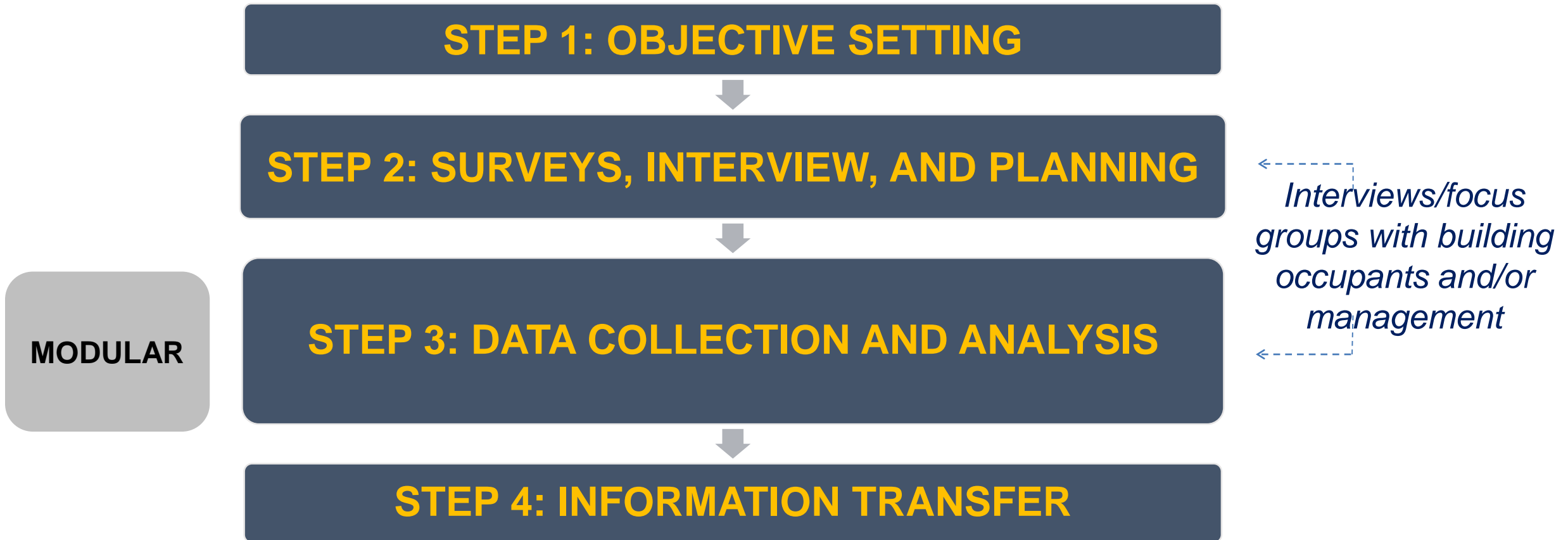
Area 6: Building envelope

+ Preliminary Reporting

1. DETERMINE THE ASSESSMENT LEVEL
2. IDENTIFY KPIs AND BENCHMARKS
3. IDENTIFY TARGETS



# POE METHODOLOGY: AN OVERVIEW



# POE ASSESSMENT LEVEL DECISION GUIDE

- **For performance areas** where significant issues have not been identified prior to the POE
- **For performance areas** where budgets are absolutely limited

**LEVEL 1**

**INDICATIVE**

- **For performance areas** central to a research or demonstration project POE
- **For performance areas** where significant issues have been identified
- **For performance areas** where Level 1 assessment outcomes are not sufficient to identify the source of the identified issues

**LEVEL 2**

**DIAGNOSTIC**



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## Part 2: Beaver Barracks Affordable Housing project

Ray Sullivan

ONPhA



# CCOC's Beaver Barracks Project

254 homes, 5 buildings

Mixed income: AMR, BMR, RGI

10% supported housing

Phase One: completed 2010

Phase Two: completed 2012



**Centretown Citizens  
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[www.ccochousing.org](http://www.ccochousing.org)



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# CCOC's Beaver Barracks Project

Designed LEED Silver <> Gold

Low VOC

Energy Star, low flow

No garbage chutes, HHW + e-waste

Isokorb thermal barriers



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# CCOC's Beaver Barracks Project

## Geothermal heating & cooling

CEP owned & operated by Corix utilities

CCOC pays input energy

Tenants pay apt. hydro + geo fee

Masking factors: construction fire  
plumbing errors



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# CCOC's Beaver Barracks Project

## First five years

- High hydro costs for CCOC
- High hydro costs for tenants
- Heat pumps repair & replacement
- Higher Corix operating costs
- Noise transference
- Hot water problems



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# Part 3: Beaver Barracks Post Occupancy Evaluation Case Study

Thomas Green

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# POE TEAM AND ROLES

## Dunsky Team

- **Alex Hill** (Project Lead)
- **Michel Parent** (Analysis, Retro-Commissioning and Modelling)
- **Jerome Bilodeau** and **Marina Malkova** (Support)
- **Patrick Lambert** (*Geo-Energie inc.* – Commissioning History)

## CCOC Team

- **Leanna Falkenhagen / David Boushey** (CCOC Lead)
- **Jim Gleason** (Building Operator)
- **Blake Lepard** (On-site meter reading)
- **Technicians:** Lar-mex Controls, Plumber, Electrician
- **Corix Utilities:** **Morrigan McGregor / Aida Ahmadi** (Data and reviews)
- **CMHC Team:** **Woytek Kujawski / Silvio Plescia / Thomas Green**



# BEAVER BARRACKS POE OBJECTIVES

## Overarching Goals

- Access and benchmark performance relative to recognized standards
- Assess overall occupant/owner satisfaction
- Identify improvement opportunities

## Performance Areas

1. Energy Efficiency
2. Water Consumption
3. Air-Quality and Comfort
4. Acoustic Transmission
5. Building Envelope



# POE METHODOLOGY

**Step 1: Initial Assessment and POE Plan Development**

**Step 2: Identify Data Sources and Establish Access**

- Utility Billing and Interval data
- On-site meters and measurements
- In-apartment testing of IAQ and Thermal Comfort
- Building Automation System (BAS) trend-logs

**Step 3: Occupant Survey**

**Step 4: eQuest Modelling to determine energy end uses**

**Step 5: Report on findings**





# POE ASSESSMENT LEVEL

	Level 1	Level 2
<b>Energy Efficiency</b>	Walk through energy audit and benchmarking of energy billing data.	A detailed energy audit and monitoring of major end-uses, including a calibrated simulation model and identification of improvement opportunities.
<b>Water Efficiency</b>	Walk through assessment of water using equipment.	Detailed inventory of water using equipment, including quantification of major end-uses.
<b>Indoor Air Quality and Thermal Comfort</b>	Inspection of air-handling equipment and spot checks of IAQ and thermal comfort.	Tracking of IAQ and thermal comfort indicators over multiple days and seasons. A detailed review of fresh air-supply throughout selected buildings spaces.
<b>Acoustics</b>	On site observation and occupant survey results.	Noise transmission measurements between apartments, from mechanical services and from exterior.
<b>Building Envelope</b>	Visual inspection and pressurization test using air handling units.	A review of the envelope design and construction including non-destructive tests and blower-door testing of selected units or building zones.



# POE STUDY TIMELINE

December 2014

**Kick-off meeting, discussion of metrics**

January 2015

**Develop POE Plan and eQuest Model**

January 2015 –  
March 2016

**POE Measurements and Monitoring**

- Two in-apartment intensive monitoring periods
- 15 months of meter data and interval data
- 12+ months of trend log and on-site data

March-May  
2016

**Compile results, calibrate model**

June 2016

**Final Report and client presentation**



# **PERFORMANCE AREA 1: ENERGY EFFICIENCY**

# 1: ENERGY: EFFICIENCY ANALYSIS

## Benchmark

- Energy Use
- Energy Costs

## End-use Breakdown

- Bill analysis
- eQuest model

## Systems analysis

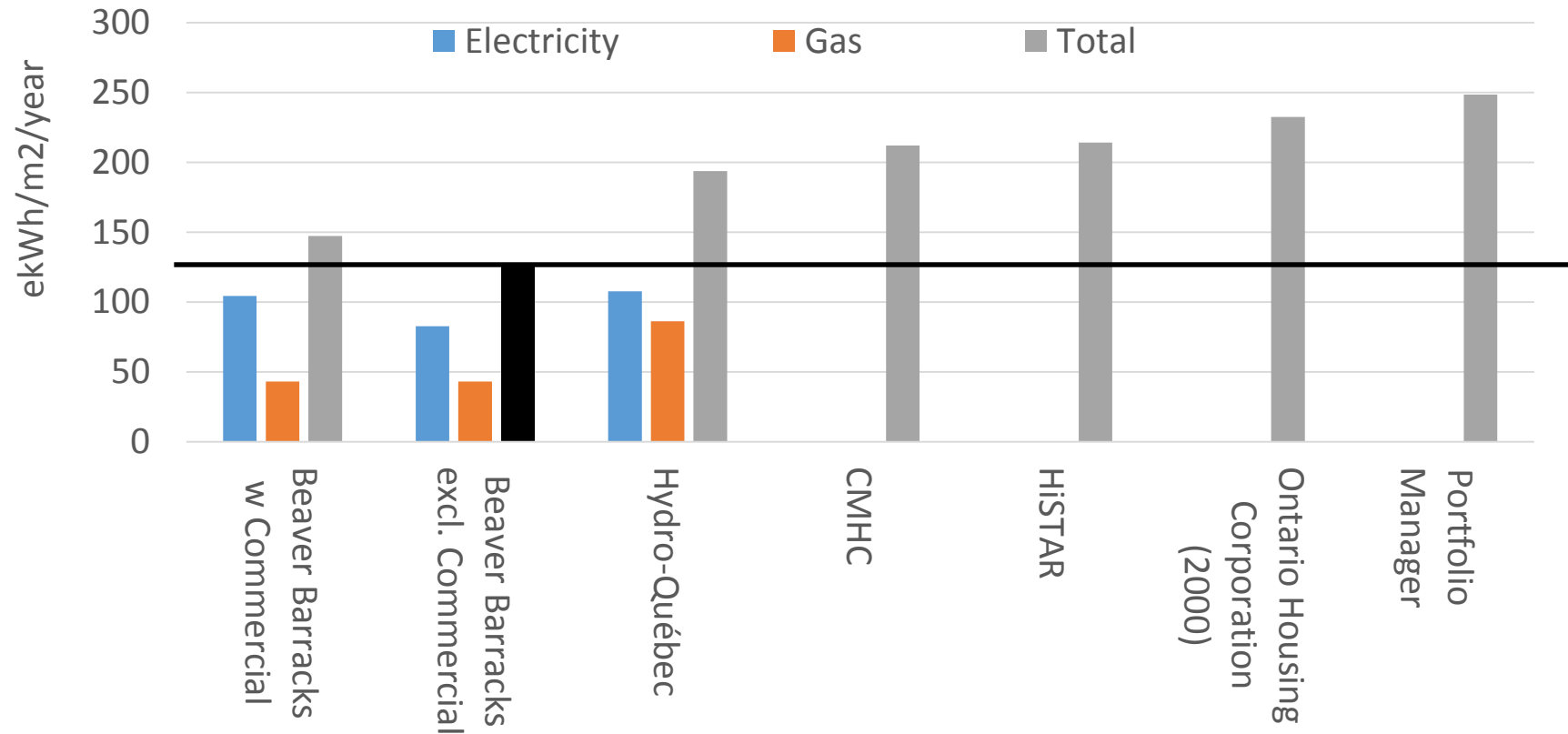
- Geothermal Plant
- Domestic hot water

## Key Data Sources

- 36+ months of 15-minute interval consumption data (Ottawa Hydro)
- 36+ months of monthly electricity and gas bills (CCOC)
- 15 months of apartment electricity billing data (hourly, daily, monthly - Enercare)
- On-site electricity and gas meter data (visual readings)
- 3 x apartment sub-meter data (Dunsky)
- Geothermal plant trend-log data (Corix)
- Laundry hot water sub-meter data



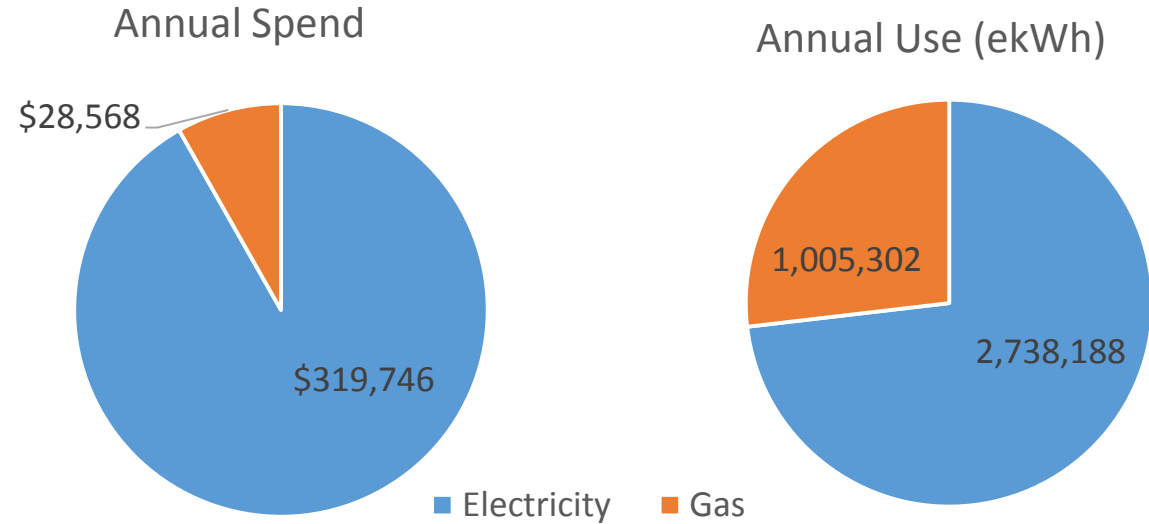
# 1. ENERGY: BENCHMARKING CONSUMPTION



- Total energy use intensity is 50%-65% lower than relevant Canadian and US data base averages for existing multi-family buildings (DHW energy use: 10% less than benchmark)



# 1. ENERGY: BENCHMARKING COSTS



Billing Item	Beaver Barracks	Average MURB
Gas	n/a	\$3.94 per m <sup>2</sup>
Electricity	\$9.99 per m <sup>2</sup>	\$12.63 per m <sup>2</sup>
Geothermal Plant Charges	\$12.77 per m <sup>2</sup>	n/a
<b>Total annual energy cost</b>	<b>\$20.76 per m<sup>2</sup></b>	<b>\$16.57 per m<sup>2</sup></b>
<b>Facility-wide aggregate energy charges to CCOC</b>	<b>\$25.34 per m<sup>2</sup></b>	



# 1. ENERGY: IMPROVEMENT OPPORTUNITIES

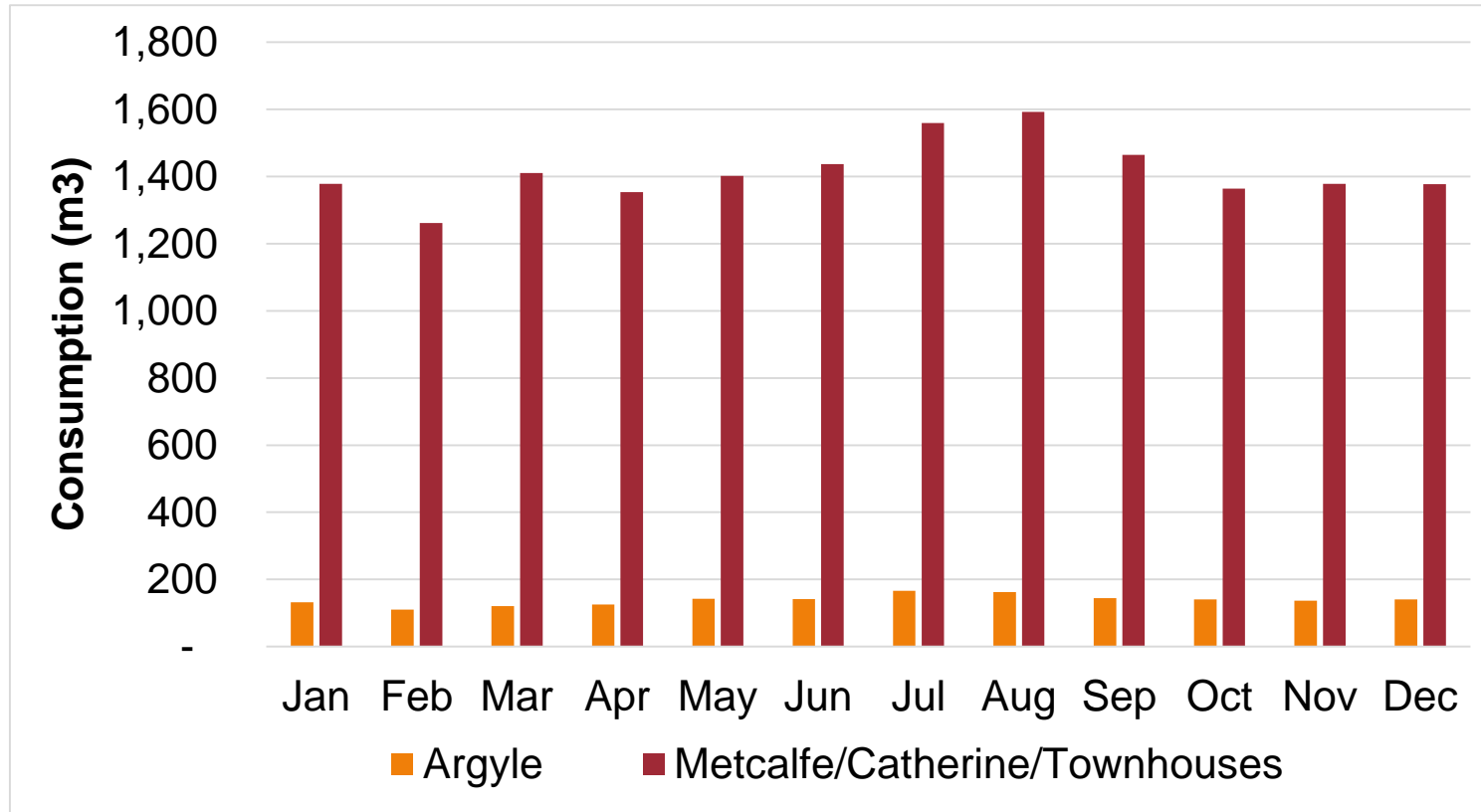
- Corix plant and heating/cooling system review
- Make-up air unit optimization
- Review occupancy sensor operation for the garages and corridors
- Correct the snow melting operation for the Metcalfe garage
- HVAC re-commissioning
- Assess garage ventilation
- Energy awareness education





# **PERFORMANCE AREA 2: WATER CONSUMPTION**

## 2. WATER: CONSUMPTION ANALYSIS



### Key Data Sources

- Bulk water meters in Argyle and Metcalf
- Laundry water sub-metering
- DHW sub-meter canceled
- Corix plant trend logs

- Steady water use throughout the year
- Slight peak in summer attributed to irrigation

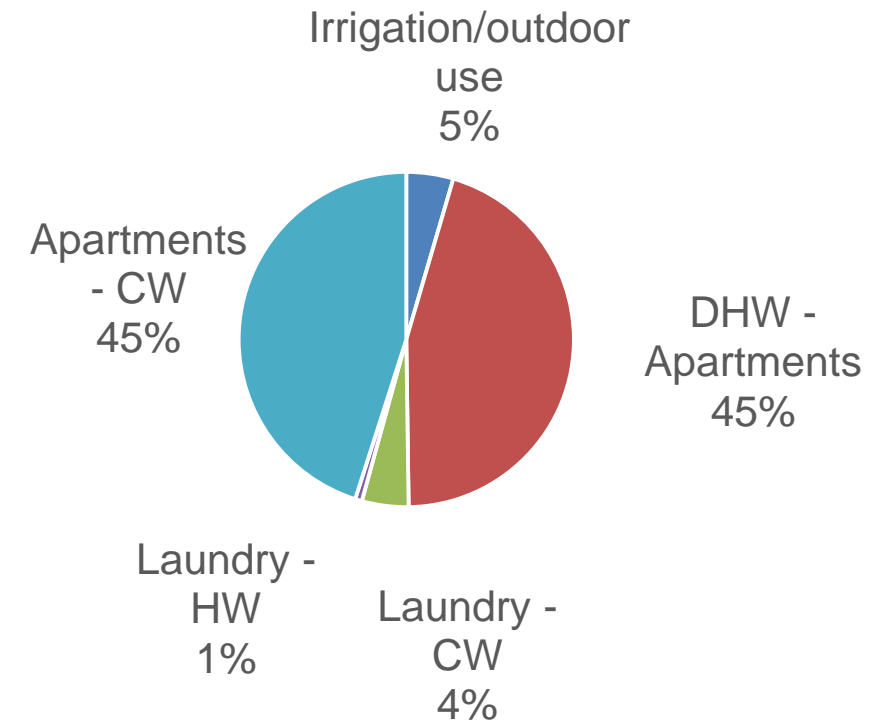


## 2. WATER: CONSUMPTION

Basis	Argyle	Metcalfe Catherine Townhouses	Total
Per m <sup>2</sup>	0.91 m <sup>3</sup>	0.99 m <sup>3</sup>	0.97 m <sup>3</sup>
Per Apartment	60.0 m <sup>3</sup>	76.9 m <sup>3</sup>	73.4 m <sup>3</sup>
Per resident	41 m <sup>3</sup>	47 m <sup>3</sup>	45 m <sup>3</sup>

### Outperforms benchmarks significantly

- CMHC benchmark for MURBS is 2.0 m<sup>3</sup>/m<sup>2</sup>/year
- Environment Canada per capita average: 66.5 m<sup>3</sup>/year



# **PERFORMANCE AREA 3: INDOOR AIR-QUALITY AND COMFORT**

### 3. IAQ AND THERMAL COMFORT: ANALYSIS

	Design flow (cfm)	Measured (cfm)	ASHRAE 62.1 (cfm)
Metcalfe	9,000	6,983	5,893
Argyle	3,000	2,741	2,629
Catherine	5,500	3,000	4,366

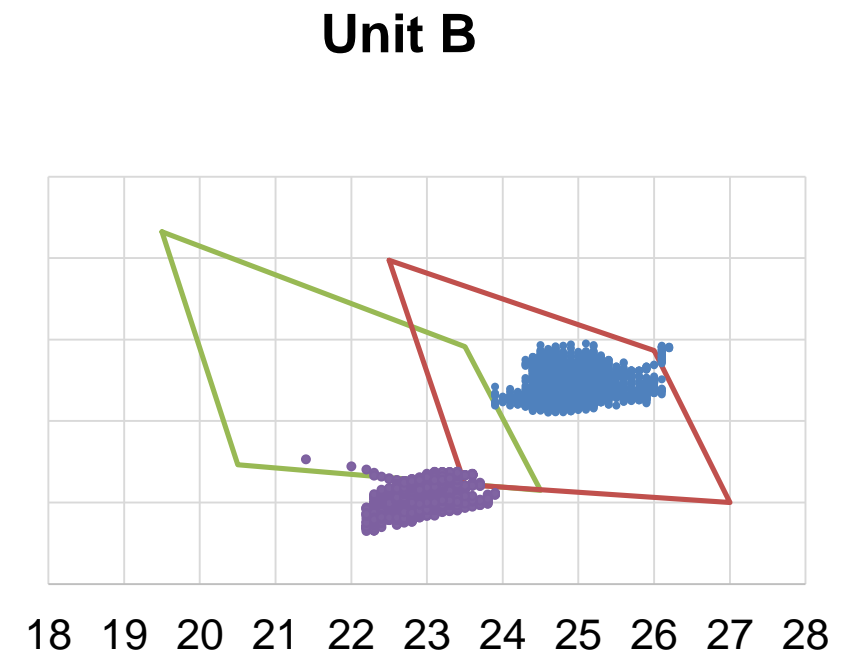
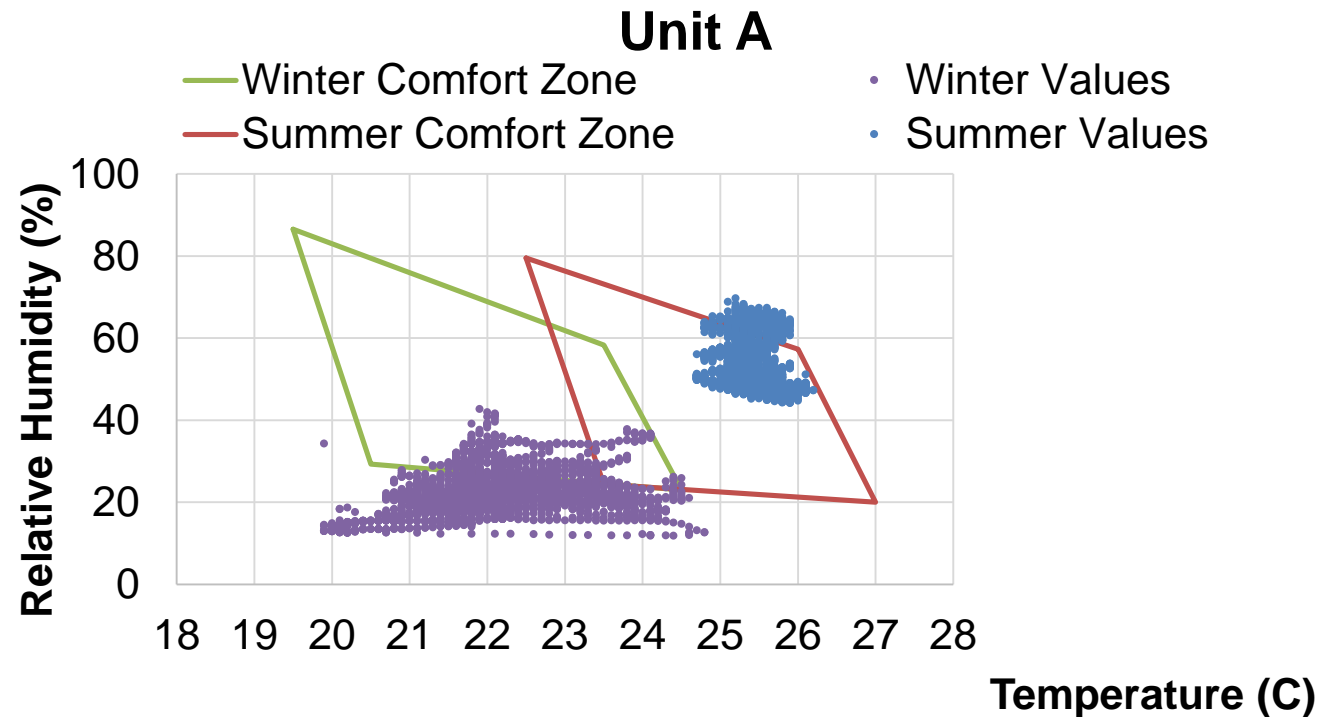
- IAQ and Thermal Comfort standard measurements less clearly established
- Benchmarking to best identifiable thresholds for IAQ

#### Key Data Sources

- In-apartment CO<sub>2</sub> Humidity and Temperature Measurements
- Environment Canada Weather Data
- Total VOC spot tests (Winter)
- Occupant Survey
- Building operator interviews



# 3. IAQ and COMFORT: BENCHMARKS



- Humidity low in winter – no humidification in building
- Summer RH/Temperatures fell outside of high range on occasion



# **PERFORMANCE AREA 4: ACOUSTIC TRANSMISSION**



# 4. ACOUSTICS: ANALYSIS

Observed Noise Level	Neighbouring Apartments	Corridor and stairwell	HVAC equipment	Plumbing	Traffic	Other
1: None	30	29	20	56	18	9
2	32	25	27	21	19	2
3: Moderate	17	22	28	13	41	9
4	17	16	16	8	15	7
5: High	16	19	19	11	17	9

- Acoustic testing not performed as not initially identified as a key issue
- Occupant survey revealed that internal sound transmission is causing discomfort for a notable number of tenants

## Key Data Sources

- Occupant Survey
- Building operator interviews



# **PERFORMANCE AREA 5: BUILDING ENVELOPE**

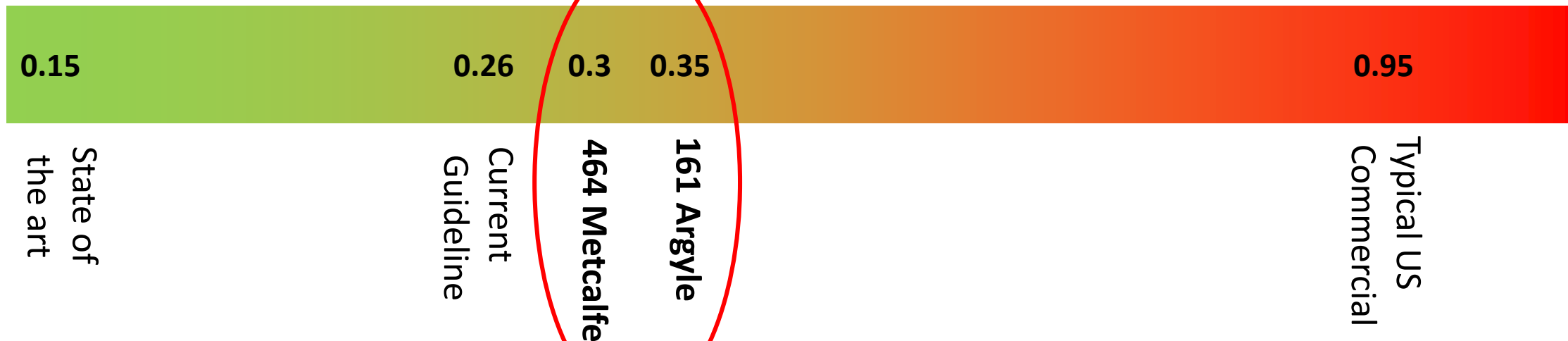
# 5. BUILDING ENVELOPE: ANALYSIS

	Ontario Building Code ASHRAE 90.1	160 Argyle	464 Metcalf	111 Catherine
Walls	2.8	4.2	3.2	3.2
Roof	3.7	4.8	4.2	4.2
Window	0.32	0.40	0.40	0.40

## Key Data Sources

- Building operator interviews
- Design documents (wall sections)
- Air-tightness testing

## Air Tightness (CFM50/ft<sup>2</sup>)



# OVERALL KEY FINDINGS

# BEAVER BARRACKS POE FINDINGS

- **ENERGY:** consumption is low (50% less than ave.) but, geothermal plant charges combined with tenant energy bills result in a 25% higher energy service cost.
- **WATER:** The water performance is exemplary, with a unitary consumption per square meter of less than 50% of the baseline.
- **IAQ and THERMAL COMFORT:** Thermal comfort conditions within apartments generally stayed within or close to the targets specified in ASHRAE guidelines, but a few IAQ issues may warrant action.
- **ENVELOPE:** The envelope is considered well insulated, air-tight and appears from visual inspection to be in good condition.



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## Part 4: Beaver Barracks Lessons Learned

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# Lessons We Learned

- Active, complex technology!
- Plans vs Reality
- Listen to the people who live there!
- No substitute for real life measurement





# What now?

- Hired consulting engineer
- Working with Corix





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