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Energy Profiles Limited

Normalized Water Use Intensity (NWUI) Methodology

Commercial Office Buildings

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The REALPAC Normalized Water Use Intensity (NWUI) Methodology: Commercial Office Buildings ("REALPAC NWUI Methodology") provides users with a way to calculate the water use intensity of an office building, while taking into consideration a number of factors, such as weather and occupancy. It is intended that the REALPAC NWUI Methodology will provide building owners and managers with a reliable way to calculate the water use intensity of their building portfolios based on current conditions, and that it will be adopted by the commercial real estate industry. As more building owners and managers adopt the REALPAC NWUI Methodology, the water intensity of their buildings can be compared and benchmarked.

Scope & Future Updates

The REALPAC NWUI Methodology will be updated over time through feedback and review from industry to ensure that it remains current and valuable to users. Computation of resulting emissions from water usage are not within the scope of the REALPAC NWUI Methodology and Tool at this time. The REALPAC NWUI Methodology is designed as an internal tool that building owners and managers can use to calculate and report a building's water use intensity and does not involve voluntary industry reporting and benchmarking, as was the case with REALPAC's previous 20 by '15 program. The REALPAC NWUI Methodology is currently only designed for commercial office buildings but may be expanded to other asset classes in the future.

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REALPAC also thanks the REALPAC Normalized Energy and Water Use Intensity Subcommittee for reviewing the REALPAC NWUI Methodology and associated documents and tools.

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1. Introduction

In 2012, REALPAC initiated a water benchmarking pilot study to lay the groundwork for water normalization in commercial office buildings. A draft methodology was prepared between 2013 and 2015. In 2019, Energy Profiles Limited updated the methodology following a comprehensive review of water use at hundreds of buildings. The intent was to develop a means of assessing water use intensity vis-à-vis that of other office properties, regardless of geographical location, local weather variations, occupant density and operating hours, exceptional use, irrigation, and mechanical cooling configuration. This formed the basis for the REALPAC Normalized Water Use Intensity (NWUI) Methodology: Commercial Office Buildings (the "REALPAC NWUI Methodology").

For any water use target or whole building water performance evaluation to be used as a powerful management tool, it must be based on a foundation of accurate and robust data, credible and equitable assumptions, and a replicable methodology. The REALPAC NWUI Methodology discusses the technical details and processes by which the total water use of an office building is calculated. The explanation of the assumptions and procedures behind the REALPAC NWUI Methodology are geared towards helping all users (owners, operators, and energy professionals) understand how their building water use intensity metric is calculated and to provide a transparent approach. The REALPAC NWUI Methodology incorporates industry expertise as well as international best practices and can be used as a tool for calculating and reporting a building's water use intensity.

2. Background

The original model building water use breakdown was developed from 2013-2015 based on data from the 2012 water benchmarking pilot. This was updated in 2019 based on data collected over the past decade together with end-use estimates, and the updated model building best practice (32.3 L/1000 ft^2). Figure 1, below, displays the new model building water use breakdown.

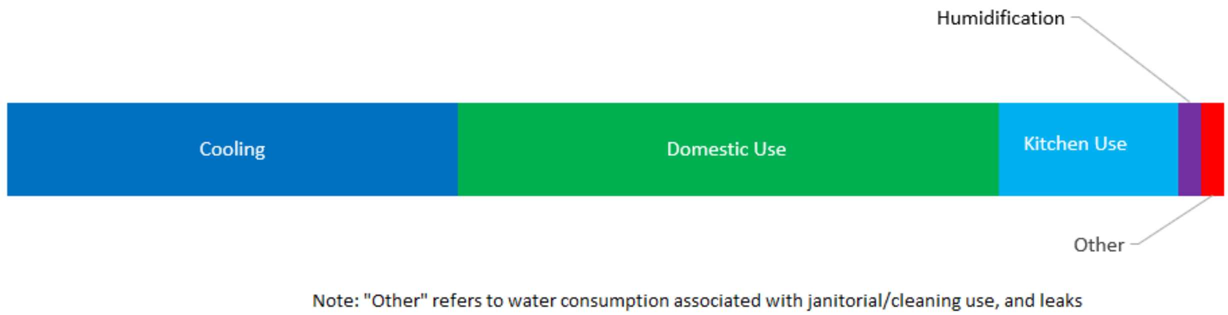

Figure 1: New Model Building Water Breakdown (2021)

This new model building water use breakdown provides a basis for the various assumptions and types of calculations chosen.

2.1. Purpose and Principles

The development of the REALPAC NWUI Methodology followed the basic principles of transparency, simplicity, credibility, verifiability, inclusivity, and relevance. These guiding principles are outlined below:

1) **Transparency** – to disclose sufficient and appropriate information regarding issues addressed, references used, and decisions made during the development process, as well as providing clear explanations of calculations to allow users to have confidence in the development and use of the REALPAC NWUI Methodology and related documents/tools.
2) **Simplicity** – to keep the REALPAC NWUI Methodology and integrated procedures easy to understand and manageable for building owners, managers, engineers, and water professionals who may have a wide range of background experience and knowledge in building water computation.
3) **Credibility** – to include both international and national standards as well as industry best practices within the REALPAC NWUI Methodology to increase its integrity and to promote widespread adoption and use.
4) **Verifiability** – to allow for third-party assurance regarding data collection and input, thus increasing the reliability of the resulting metric and the meaningfulness of comparisons between buildings.
5) **Inclusivity** – to encourage participation throughout the industry by making the procedure applicable to a wide range of buildings, as well as easily understood and accessible.
6) **Relevance** – to ensure the calculated water use intensity for a building accurately reflects the total building water consumption (before and after normalization) and that the assumptions and approaches taken reflect current best practice in the industry.

Further statements and objectives that support the REALPAC NWUI Methodology and its approach are listed below:

1) The REALPAC NWUI Methodology must incent participation by a large number and wide range of office buildings across Canada to encourage significant, country-wide reductions in water use.
2) Many landlords have concerns regarding their office buildings being "special" or "different" and thus not being eligible to participate due to factors such as tenant water consumption; therefore, the REALPAC NWUI Methodology must be broadly applicable and inclusive of most, if not all, types of office buildings and tenant-mixes.
3) Where property management has jurisdiction/control over water consumption (e.g., irrigation), the REALPAC NWUI Methodology is designed to preferentially give a 'best practices credit' as opposed to allowing a given load in question to be simply removed by submetering it. This is seen as a technique to promote/reward sites pursuing best practices.
4) Where property management does not have jurisdiction/control (e.g., where tenant water consumption varies significantly and unavoidably due to space functionality, such as with high intensity water use in fitness centres, restaurants, and retail space), the REALPAC NWUI Methodology must allow for the adjustment/removal of such excess tenant water consumption.
5) Assumptions used throughout the calculation procedures within the REALPAC NWUI Methodology have been updated based on data collected over the past decade and industry best practices.
6) Further adjustments could be made to the REALPAC NWUI Methodology which could increase the accuracy of the measurements, but this could also increase the complexity and difficulty of the REALPAC NWUI Methodology; therefore, the REALPAC NWUI Methodology aims to address only material variables in order to maintain simplicity.

Following the above guiding principles, a REALPAC NWUI Tool (the "Tool," which is an Excel spreadsheet) was created based on the REALPAC NWUI Methodology and the agreed upon assumptions contained within it. The intent of the REALPAC NWUI Tool is to readily enable calculations for a single building and allow independently prepared calculations to be tested for accuracy. Images from the Tool are used throughout to illustrate key concepts of the approach.

2.2. REALPAC NWUI Methodology Development

The approach taken to develop the REALPAC NWUI Methodology, including the guiding principles discussed above, aim to allow water use intensity reporting that accounts fairly for buildings with different physical and operational characteristics. These variables or building characteristics are adjusted/normalized to allow a fair comparison of water use in different buildings across the country. The variables that have been deemed material and are adjusted/normalized in the REALPAC NWUI Methodology can be categorized into five general areas:

- Building area
- High intensity or exceptional water use (e.g., space type adjustments for restaurants, retail tenants, and fitness centres, etc.)
- Normalization for weather variations (between locations and over time)
- Normalization for dwell time density (occupant density and operating hours)

- Normalization for cooling features (e.g., no cooling tower, use of cooling tower in winter)

The REALPAC NWUI Methodology is based on an example model building with the following characteristics:

- Rejects heat with a cooling tower during the summer months
- Humidifies outdoor air to maintain a minimum 30% relative humidity (RH)
- Has an occupant density of 2.3 people/1,000 ft^2 when fully occupied
- Is occupied by its tenants for 65 hours/week
- Is subject to 568.1 cooling degree days and 3034.7 heating degree days
- Is fully leased

The water breakdown associated with the model building by water use category is depicted in Figure 2, below.

Component of Model WUI	Totals (L/ft^2)
Cooling	**12.00**
Domestic Use	**14.40**
Kitchen Use	**4.80**
Humidification	**0.50**
Other	**0.60**
Totals	**32.30**

Figure 2: Model Building WUI Breakdown

This table forms the backbone of the REALPAC NWUI Methodology and the origination of the various assumptions that affect the input data and calculations. The way by which each component of the model building is adjusted is laid out in the following sections of this document.

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3. Building Eligibility Requirements

3.1. Building Designation

REALPAC has chosen to use the ENERGY STAR definition of office space to describe the types of commercial buildings that are eligible to use the REALPAC NWUI Methodology. As defined by ENERGY STAR, the term office space "applies to facility spaces used for general office, professional and administrative purposes" and encompasses all areas of the building that house functions or activities supporting office, professional and administrative work such as kitchens, lobbies, atria, storage, conference rooms, fitness facilities, elevator shafts, and stairways.[1]

3.2. Physical and Operational Characteristics

The REALPAC NWUI Methodology is applicable to those buildings that meet the physical and operational parameters outlined as follows:

- The exterior gross area of each individual building (excluding parking lots and garages) must be over 20,000 ft^2, as measured using the BOMA International publication, *BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3-2018)*, described in detail in Section 4.1.
- More than 50% of the building's exterior gross area (excluding parking lots and garages) must regularly function as "office space", as defined in Section 3.1, above.[2]
- If a parking structure is attached to the building and would be included in the calculation of exterior gross area, and/or the parking structure is on the same utility meter as the main building, it must be included in the measurement of gross floor area and water consumption.[3]
    - In addition, the combined floor area of all parking structures is not to exceed the total gross floor area of the building (the exterior gross area of the building minus the total parking area of the building).[4]
    - If the combined floor area of all parking structures exceeds the total gross floor area of the building, the building may meet the parameters of the REALPAC NWUI Methodology, but only if the water use of that entire parking area is submetered (as per submetering specifications outlined in Section 5.1).
- For multi-tower office parks, each tower or building is to be treated as an individual, freestanding building, with water use calculated separately for each tower or building.
    - Exceptions to this rule include office parks or tower complexes whose owners or managers can demonstrate that the water use of the complex is consistently captured on only one utility account (one for each fuel type or water source).

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[1] U.S. Environmental Protection Agency, *Property Types in Portfolio Manager* (ENERGY STAR: n.d.). https://www.energystar.gov/buildings/benchmark/understand_metrics/property_types.

[2] U.S. Environmental Protection Agency, 2009 Professional Engineer's Guide to the ENERGY STAR® Label for Commercial Buildings (ENERGY STAR: 2009), 4.

[3] Ibid., 2.

[4] Ibid., 2.

- If this requirement can be fulfilled and validated, then the complex may be considered as a single whole.
- This exception also applies to buildings that are supplying water (e.g., hot water, power, steam) to adjacent buildings.

4. Area[5]

4.1. Building Area Definition

The BOMA International publication entitled *BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3 - 2018)* defines *exterior gross area* as "the total *floor* area contained within the *measure line* (generally, the outside surface of the *exterior enclosure* of a *building*), including structured *parking*." It is this method of measurement which should be followed when calculating *exterior gross area* and, subsequently, *gross floor area* (defined as the *exterior gross area* minus the structured *parking* area). ***Gross floor area (GFA)*** is used as the denominator in calculating the L/year metric for each individual *building.*

If accurate building area measurements are not available, the *gross building area*, as defined by BOMA in *BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3 - 2018),* may be used as an approximation of the GFA described in the REALPAC NWUI Methodology. The *gross building area*, not including unenclosed spaces, is only a close approximation of GFA and thus is recommended to be used only for internal (within individual organizations) benchmarking purposes, but does not replace the GFA (as defined here) as the correct measure to be used within the REALPAC NWUI Methodology.

4.2. Areas of High Intensity or Exceptional Water Use

Tenant or building areas with high intensity or exceptional water use should be submetered. As described in detail in Section 5.1, submetered water use should be recorded on meters that have been approved as billing-grade/revenue-grade, or on meters that have documentation supporting their performance within specified limits.

The high intensity or exceptional water use space types addressed in the REALPAC NWUI Methodology include restaurants, retail tenants, fitness centres, and "other" space types. If the building has not submetered any of these space types, the spaces are not to be adjusted for. If the building has submetered some or all of these space types, the total areas (either individual areas entered separately or the sum of all of the individual areas throughout the building that fall into each space type category entered as a total) are to be accounted for.

High intensity or 'exceptional' water use does not include water use associated with straight-to-drain cooling, measured irrigation, or measured cooling tower use, as this would remove incentive for the landlord to implement conservation measures for these end uses.

[5] Italicized terms contained in Section 4: Area, are the same as those used in the BOMA standard and/or are defined in Appendix A.

5. Water

5.1. Water Data Collection and Input Requirements

Guidelines for collecting water consumption data for all water sources are as follows:

- Utility bills, or readings from utility meters, whole facility meters, or submeters are acceptable sources of water use data.[6]
  - Types of water meters (including submeters) that are acceptable include billing-grade or revenue-grade meters, check meters, and meters of a comparable type to those utilized by the utility supplier.
  - Metered data can be recorded hourly, daily, or monthly, and/or shorter periods can be combined into longer periods (e.g., hourly combined into daily periods).[7]
- A minimum of 12 consecutive months of water data (one calendar year) from all active meters, and water sources is required. An entire year's worth of water use data is needed to capture the effects of weather patterns on water use within a full operating cycle.[8]
- The Tool requires water consumption for the period January 1–December 31 to be entered for each selected year. Not all utility bills are aligned with the exact calendar year, thus the user is to enter the data that best corresponds to the full 12-month year under review. Any utility bill reading or metering period (not billing period) that begins after the 15th of the month should be entered as consumption for the following month.
  - For example, the value of water use recorded on a utility bill that reports consumption from December 18th to January 16th would be entered into the cell in the row labelled "Jan" with the "From" and "To" dates being Jan 1 and Jan 31 respectively.
- The Tool requires a water consumption amount to be entered in both the first and last row of each table.
  - For example, a building with water use billed each quarter would enter the first quarter's use into the row labelled "Jan," the second and third quarters' use into the rows that best approximate the period of use, and the fourth quarter's use into the row labelled "Dec."

Once the appropriate data have been collected for the period under review, they are entered into the Tool, as illustrated in Figure 3, below.

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[6] Efficiency Valuation Organization, *Core Concepts: IPMVP* (EVO: 2016), 29.
[7] Ibid., 29.
[8] Ibid., 29.

			Account Number:	123456789
			Units:	m3
Month	From (ddmmmyy)	To (ddmmmyy)	Billing Days	Consumption
Jan	21-Dec-18	21-Jan-19	32	1,400
Feb	22-Jan-19	22-Feb-19	32	1,612
Mar	23-Feb-19	25-Mar-19	31	1,817
Apr	26-Mar-19	25-Apr-19	31	1,497
May	26-Apr-19	24-May-19	29	1,117
Jun	25-May-19	25-Jun-19	32	1,296
Jul	26-Jun-19	26-Jul-19	31	1,406
Aug	27-Jul-19	26-Aug-19	31	1,490
Sep	26-Aug-19	25-Sep-19	31	1,490
Oct	26-Sep-19	25-Oct-19	30	1,433
Nov	26-Oct-19	25-Nov-19	31	1,754
Dec	26-Nov-19	24-Dec-19	29	1,599
			369	17,910.0
365 day normalization			365	**17,689.4**
Conversion to L				**17,689,448.3**

Figure 3: Example of Entries for Water Use Data

Figure 3, above, is an example of water consumption data entries in the Tool. There are up to four (4) tables that can be populated for all water types to facilitate individual meter tracking, if desired. The reading dates (not the billing dates) as recorded on the building's utility bills must be entered into the appropriate columns, as well as the water use corresponding to each period. The water source and units used to measure that water use are also to be chosen from drop-down menus in the appropriate cells.

6. Actual Building Water Use

This section describes the calculations performed on water data entered into the Tool, which result in an actual building water intensity measure for a specific year.

6.1. Prorating Billing Days and Water Use

Once all of the building's water use data have been entered into the Tool, the number of billing days may not sum to 365, and therefore the summed building water use may not be accurately capturing an entire year period. The Tool will automatically prorate the water consumption totals for each water source to normalize for these potential irregularities in billing periods and reading dates.

		Account Number:	123456789	
			Units:	m3
Month	From (ddmmmyy)	To (ddmmmyy)	Billing Days	Consumption
Jan	21-Dec-18	21-Jan-19	32	1,400
Feb	22-Jan-19	22-Feb-19	32	1,612
Mar	23-Feb-19	25-Mar-19	31	1,817
Apr	26-Mar-19	25-Apr-19	31	1,497
May	26-Apr-19	24-May-19	29	1,117
Jun	25-May-19	25-Jun-19	32	1,296
Jul	26-Jun-19	26-Jul-19	31	1,406
Aug	27-Jul-19	26-Aug-19	31	1,490
Sep	26-Aug-19	25-Sep-19	31	1,490
Oct	26-Sep-19	25-Oct-19	30	1,433
Nov	26-Oct-19	25-Nov-19	31	1,754
Dec	26-Nov-19	24-Dec-19	29	1,599
			[illegible]	17,910.0
365 day normalization			365	**17,689.4**
Conversion to L				17,689,448.3

Figure 4: Example Building Water Use Table with Prorated Electricity Use

For example, total water consumption of 17,910 m^3 is prorated in Figure 4, above, by a formula that adjusts the total m^3 by the average amount of water used per day in the last period multiplied by the difference between the total number of billing days and 365.

6.2. Converting Water Consumption into L

After prorating the water consumption, the summed annual water consumption is converted from the respective water units into L. The conversion factors used in the calculations are listed in

Figure 5, below.

Multiply the number of:	by:	To obtain:
Cubic meters (m^3)	1000	L
US gallons (USgal)	3.78541	L
Cubic feet (ft^3)	28.31685	L
Hundred cubic feet (ccf)	2831.685	L

Figure 5: Water Conversion Factors

There exists an option for the user to enter a system-specific conversion factor into the Tool if the unit to measure water consumption does not exist in the drop-down menu.

7. Normalized Water Use Intensity

A building's water use is normalized for a specific year through a six-step process:

1. Calculate the **Actual Water Use Intensity (Actual WUI)** as the gross water use divided by the gross floor area (Section 7.1).
2. Calculate the **Adjusted Water Use Intensity (Adjusted WUI)** by accounting for any irrigation and/or exceptional water use (Section 7.2).
3. Calculate the **Adjusted Model WUI** to account for weather and location, weekly hours of operation and occupant density (Section 7.3).
4. Calculate the **Water Normalization Factor, n_f**. The Water Normalization Factor, n_f, is calculated as Model WUI / Adjusted Model WUI (Section 7.4).
5. Calculate the **Cooling tower adjustments (as required)** to account for different cooling system configurations (Section 7.5).
6. Calculate the **<u>Normalized Water Use Intensity (NWUI)</u>** by multiplying the Adjusted WUI by the normalization factor, n_f, and adjusting for cooling tower operation as required (Section 7.6).

7.1. Step 1: Calculate Actual Water Use Intensity (Actual WUI)

At this point, all water sources have been entered into the Tool and the totals have been converted to L.

The Actual Water Use Intensity is calculated by taking the sum of all prorated water use and dividing that total by its gross floor area (GFA), measured in ft^2.

$$\text{Actual WUI} = \frac{\sum \text{annual water use}}{\text{GFA}}$$

7.1.1. Example Calculation of Actual WUI

For a 243,997 ft^2 building with a total prorated water use of 17,698,448 L, the actual water use intensity is calculated as follows:

$$\text{Actual WUI} = \frac{17{,}698{,}448}{243{,}997} = 72.50\ \text{L/ft}^2$$

7.2. Step 2: Calculate Adjusted Water Use Intensity (Adjusted WUI)

In some cases, tenants have special functions or operations that require the use of excessive amounts of water. It would be unfair to penalize a building for such water use, which is an unavoidable function of their tenant's specific business operations. Accordingly, the REALPAC NWUI Methodology and Tool include adjustments for a variety of high intensity or exceptional water use. These adjustments help normalize building water consumption regardless of the tenant mix.

High intensity or exceptional water use is grouped into one of three categories:

- Irrigation
- Exceptional use affiliated with office space (e.g., tenant cooling tower)
- Exceptional use affiliated with retail activities (e.g., restaurants, retail tenants, fitness centres)

Inputs in the Tool for high intensity or exceptional water use are entered at the bottom of the Data Input tab. This table is illustrated in Figure 6, below.

Space	Area (ft^2)	Annual Water Consumption		
		Water	Units	Consumption (L)
Exceptional Use - Office				
Data centre cooling	4,000	2,115	m3	2,115,000
Other: (please specify)			(Drop-down)	
Other: (please specify)			(Drop-down)	
Totals, office	4,000	--	--	2,115,000
Exceptional Use - Retail				
The Resturant	8,890	1,811	m3	1,811,000
Retail space #2			(Drop-down)	
Retail space #3			(Drop-down)	
Other: (please specify)			(Drop-down)	
Other: (please specify)			(Drop-down)	
Totals, non-office	8,890	--	--	1,811,000

Figure 6: Input Table for High Intensity and Exceptional Water Use Data

7.2.1. Irrigation

Normalization is performed such that all buildings are compared on the basis that they do not have irrigation. An adjustment is used to deduct best-practices irrigation water use from sites with irrigation. The adjustment is calculated based on total irrigated area, location, and weather year. Evapotranspiration and effective precipitation data are used to determine how much irrigation is required in a given city and year in line with current best practices. For simplicity, all irrigated area is assumed to be 100% turf grass, and the irrigation system is assumed to operate between the months of May and September inclusive.

Evapotranspiration and Precipitation Data

Figure 7, below, summarizes historical evapotranspiration and effective precipitation data (May to September, inclusive) used in the irrigation credit calculation.[9]

City	Description	2015	2016	2017	2018	2019	2020
Kelowna, BC	Evapotranspiration (mm)	764.8	709	761.1	722.7	698	653.4
	Effective Precipitation (mm)	166.2	33.9	17.1	23.3	13.1	35.6
Victoria, BC	Evapotranspiration (mm)	628	586.9	579.2	564.6	542.6	538.2
	Effective Precipitation (mm)	39.7	11.3	23.5	13.8	47.6	48.9
Halifax, NS	Evapotranspiration (mm)	526.4	497.5	490.4	524.5	487.6	475
	Effective Precipitation (mm)	233.7	150.6	310.6	222	226.4	231.8
Charlottetown, PEI	Evapotranspiration (mm)	493.9	464.4	493.3	500.5	468.5	468.4
	Effective Precipitation (mm)	204.6	144.4	256.1	208.7	229.7	90.9
Fredericton, NB	Evapotranspiration (mm)	594.8	583.1	603.2	616.4	578.1	284.16
	Effective Precipitation (mm)	268.9	154.3	128.8	113.4	228.8	27.65
St Johns, NL	Evapotranspiration (mm)	431.1	421.8	431.9	428.6	383.2	403.5
	Effective Precipitation (mm)	236.9	234.3	311.8	260.6	210.6	339.7
Calgary, AB	Evapotranspiration (mm)	608.5	577.9	643.7	596.1	551	538.9
	Effective Precipitation (mm)	136.1	156.6	78.6	56.7	132.7	178.6
Edmonton, AB	Evapotranspiration (mm)	632	606.8	631.4	614.3	560.6	543.4
	Effective Precipitation (mm)	88.7	164	121.4	100.3	94.2	124.8
Winnipeg, MB	Evapotranspiration (mm)	608.9	590.8	581.5	630.6	598.3	567.8
	Effective Precipitation (mm)	231.1	136.9	82.6	125.7	170	73.2
Montreal, QC	Evapotranspiration (mm)	559.9	551.6	540.1	591.3	554.1	545.3
	Effective Precipitation (mm)	310.8	205.7	136.5	193.3	217.3	227.8
Ottawa, ON	Evapotranspiration (mm)	627.6	648.6	571.2	635.3	607.1	571.5
	Effective Precipitation (mm)	157.2	123.3	344.1	208.1	108.7	149.8
Quebec City, QC	Evapotranspiration (mm)	559.9	551.6	540.1	591.3	554.1	545.3
	Effective Precipitation (mm)	310.8	205.7	136.5	193.3	217.3	227.8
Regina, SK	Evapotranspiration (mm)	648.6	636.7	666.8	687.6	635.5	622.1
	Effective Precipitation (mm)	129.6	87.8	49.4	62.2	124.8	8
Toronto, ON	Evapotranspiration (mm)	591.2	645.4	564	595	567.6	576
	Effective Precipitation (mm)	158.1	73.2	148.9	196.9	151.6	91.2
Vancouver, BC	Evapotranspiration (mm)	507.2	484.5	509	509.1	512.2	455.1
	Effective Precipitation (mm)	46.2	87.7	71.5	62.5	82.8	59

Figure 7: Historical Evapotranspiration and Precipitation Data

[9] Farmwest, "Evapotranspiration" (The Pacific Field Corn Association: 2021), https://farmwest.com/climate/calculators/evapotranspiration.

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Irrigated Area

In the absence of a formal or standardized methodology for calculating irrigated area, irrigated area shall be calculated from site specific architectural and landscape drawings as accurately as possible.

It is recognized that these drawings may not exist in all cases, and as an alternative, measurements can be taken from overhead views of the property, clearly marking the irrigated areas.

7.2.1.1. Irrigation Credit Calculations and Examples

Best-practices water use is calculated using the following formula:

$$\mathrm{LWR} = \left(\frac{E_T \cdot K_L - P_E}{\mathrm{DU}}\right) \cdot C_D \cdot C_M \cdot \frac{A}{10.76}$$

where:

LWR is the annual landscape water requirement, in L

E_T is the measured evapotranspiration over the growing season, in mm

K_L is the vegetation species factor (0.7 for turf grass)

P_E is the effective precipitation in mm, which also accounts for soil saturation and runoff

DU is the irrigation system efficiency (generally assumed to be 0.65 for fixed spray systems)

C_D is the vegetation density factor (assumed to be 1 for turf grass)

C_M is the microclimate factor (assumed to be 1)

A is total irrigated area, in ft^2. 10.76 is a conversion factor to convert the units from ft^2 to m^2

The irrigation credit is calculated as:

$$\text{Irrigation credit} = \frac{\mathrm{LWR}}{\mathrm{GFA}}$$

For example, for a 243,997 ft^2 building located in Halifax NS, the annual landscape water requirement (LWR) in 2019 for an irrigated area of 10,000 ft^2 is:

$$LWR = \left(\frac{643.7 \cdot 0.7 - 78.6}{0.65}\right) \cdot 1 \cdot 1 \cdot \frac{10{,}000}{10.76} = 164{,}312 \text{ L}$$

The irrigation credit is calculated as:

$$\text{Irrigation credit} = \frac{164{,}312}{243{,}997} = 0.67 \text{ L/ft}^2$$

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7.2.2. Exceptional Use - Office

The Tool allows an adjustment for any space in the building typically classified as office having exceptional water use associated with it. An example would be tenant cooling tower use associated with a call centre or data centre. The Tool requires consumption to be submetered for water.

Loads **not** considered to be exceptional use include:

- water associated with straight-to-drain cooling
- metered or submetered irrigation (already adjusted for within the Tool)
- submetered base building cooling tower use (already adjusted for within the Tool)

For an Exceptional Use – Office space to qualify as "**Other**" and be adjusted for high intensity or exceptional water use, the tenant space must require additional water for its optimal operation.

The area associated with eligible exceptional water use is generally the space served by the equipment using the water, and not the total space occupied by the tenant space. For example, if a tenant with an occupied space of 20,000 ft^2 has a data centre of 1,000 ft^2 serving its operations, the area of 1,000 ft^2 would be entered into the Tool.

To 'convert' any space identified as Exceptional Use – Office back to normal office space, people-dependent water use is added back to the space. This is based on the people-dependent component of the Model WUI, namely 19.20 L/ft^2.

7.2.2.1. Calculation of Exceptional Use – Office Credit

An Exceptional Use – Office credit, EC_O, is calculated with the following equation:

$$EC_O = \frac{\sum_{\text{Water}} (\text{Exceptional Use - Office}) - PDC_{OH} \cdot \sum_{\text{Area}} (\text{Exceptional Use - Office})}{GFA_{\text{building}}}$$

where:

PDC_{OH} is the people-dependent Model WUI component measured in L/ft^2.

For a building with:

- a GFA of 243,997 ft^2, and,
- a data centre of 4,000 ft^2 with annual water consumption of 2,115,000 L,

the Exceptional Use – Office credit is calculated as shown in Figure 8, below:

Total Exceptional Use - Office		People-dependent water to be added back (L)	Net Exceptional Use - Office (L)	GFA (ft^2)	Exceptional Use - Office adjustment (L/ft^2) (+ve = credit)
L	ft^2				
2,115,000	4,000	76,800	2,038,200	243,997	**8.35**

Figure 8: Calculation of Exceptional Use - Office Credit

7.2.3. Exceptional Use - Retail

Restaurants, Retail Spaces, and Fitness Centres are classified by ENERGY STAR as retail space, being "facility space used to conduct the retail sale of consumer product goods."[10]

The Tool allows an adjustment for any space in the in the building typically classified as Retail. Examples include restaurants, retail, and fitness centres. The Tool requires these spaces to be submetered for water.

Exceptional use associated with retail is only removed if the bundle of spaces has a water use intensity greater than the building's WUI, after adjusting for any Enclosed Parking and/or Exceptional Use – Office credits. Space identified as Exceptional Use – Retail is not adjusted with people-dependent loads. Rather the space is removed from the building's total.

7.2.3.1. Calculation of Exceptional Use - Retail Credit

An Exceptional Use – Retail credit, EC_R, is calculated with the following equation:

$$EC_R = WUI_{building} - \frac{WUI_{building} \cdot GFA_{building} - \sum_{Water} (\text{Exceptional Use - Retail})}{GFA_{building} - \sum_{Area} (\text{Exceptional Use - Retail})}$$

where:

$WUI_{building}$ is building's WUI, adjusted for Irrigation and Exceptional Use - Office

For a building with:

- a GFA of 243,997 ft^2,
- a WUI of 63.48 L/ft^2, after adjusting for Irrigation and Exceptional Use – Office, and,
- a retail space of 8,890 ft^2 and total annual water consumption of 1,811,000 L,

the Exceptional Use – Retail credit is calculated as shown in Figure 9, below:

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[10] U.S. Environmental Protection Agency, *Property Types in Portfolio Manager (ENERGY STAR: n.d.).* https://www.energystar.gov/buildings/benchmark/understand_metrics/property_types.

Total Exceptional Use - Retail			Actual WUI, adjusted for Irrigation, office (L/ft^2)	Exceptional Use WUI > Actual WUI? (Y/N)	Resultant Building Energy Use (L)	Resultant GFA (ft^2)	Resultant WUI (ekWh/ft2)	Exceptional Use - Retail adjustment (L/ft^2) (+ve = credit)
L	ft^2	EUI (L/ft^2)						
1,811,000	8,890	203.7	63.48	Y	13,675,936	235,107	58.17	**5.31**

Figure 9: Calculation of Exceptional Use - Retail Credit

7.2.3.2. Calculation of Adjusted WUI Calculation Credit

The Adjusted WUI is calculated by taking the Actual WUI and applying any high intensity/exceptional use adjustments and/or enclosed parking credits.

$$\text{Adjusted WUI} = \text{Actual WUI - Irrigation credit - Exceptional Use - Office credit - Exceptional Use - Retail credit}$$

For a building with an Actual WUI of 72.50 L/ft^2 (Section 7.1), an Irrigation credit of 0.67 L/ft^2 (Section 7.2.1.1), an Exceptional Use – Office credit of 8.35 L/ft^2 (Section 7.2.2.1), and an Exceptional Use – Retail credit of 5.31 L/ft^2 (Section 7.2.3.1), the Adjusted WUI is calculated as:

$$\text{Adjusted WUI} = 72.50 - 0.67 - 8.35 - 5.31 = 58.17 L/ft^2$$

7.3. Step 3: Calculate the Adjusted Model Water Use Intensity (Adjusted Model WUI)

The Adjusted Model Water Use Intensity (Adjusted Model WUI) is calculated by adjusting the components of the model building for:

- cooling,
- people (occupant density and operating hours), and
- lease condition (leased vs. vacant).

The breakdown of how each component of the model building is affected by the above is summarized in Figure 10, below:

Component of Model WUI	Not affected by External Factors	Dependent on HDDs	Dependent on CDDs	Dependent on People	Totals (L/ft^2)
Cooling	3.00		9.00		**12.00**
Domestic Use				14.40	**14.40**
Kitchen Use				4.80	**4.80**
Humidification		0.50			**0.50**
Other	0.60				**0.60**
Totals	**3.60**	**0.50**	**9.00**	**19.20**	**32.30**

Figure 10: Model Building End-Use Breakdown

For vacant space (i.e., where there is no occupancy, and where the space is no longer leased) the Model Building End-Use Breakdown is shown in Figure 11, below:

Component of Model WUI	Not affected by External Factors	Dependent on HDDs	Dependent on CDDs	Dependent on People	Totals (L/ft^2)
Cooling	3.00		6.00		**9.00**
Domestic Use					**0.00**
Kitchen Use					**0.00**
Humidification		0.50			**0.50**
Other	0.60				**0.60**
Totals	**3.60**	**0.50**	**6.00**	**0.00**	**10.10**

Figure 11: Model Building End-Use Breakdown by Adjustment Parameter – Vacant

A few important notes on the vacant model WUI:

- *Vacant* space is different than *leased but unoccupied* space. Property managers are obligated to condition leased space. They are not, however, obligated to condition vacant space.
- Water use associated with cooling a vacant space has been reduced to account for this.

7.3.1. Weather Adjustments

In theory, location/weather normalization, or weather "correction," is a mathematical adjustment of the data which factors out variations in outside air temperature, thus enabling a like-for-like comparison of water consumption in buildings over ***time*** (year-over-year) and ***location***, where different climate conditions may exist.

To accommodate and encourage all commercial office buildings in Canada to measure and calculate their normalized water use intensity, the REALPAC NWUI Methodology incorporates a simple normalization of the L/ft^2/year value for weather variations between year periods but within geographical areas. This approach is verifiable, replicable, and is based on best practices within the industry.

7.3.1.1. Weather Data and Requirements

As with the required water use data, weather data for the normalization procedure encompasses one full year (January 1 to December 31). Weather data is collected from 15 major city centres across Canada, collectively representing the largest markets in commercial real estate. These cities include:

Calgary, AB	Kelowna, BC	St Johns, NL
Charlottetown, PEI	Montreal, QC	Toronto, ON
Edmonton, AB	Ottawa, ON	Vancouver, BC
Fredericton, NB	Quebec City, QC	Victoria, BC
Halifax, NS	Regina, SK	Winnipeg, MB

For the REALPAC NWUI Methodology, the weather data for each building site are sourced from Environment Canada weather stations situated at the international airports (or largest domestic airports) of the 15 city centres listed above. These historical weather data are stored on the National Climate Data and Information Archive website (www.climate.weather.gc.ca) and can be easily reviewed, searched for, and downloaded. The data collected and reviewed by Environment Canada at the individual weather stations are recorded as outdoor dry-bulb temperatures in degrees Celsius and are updated daily on Environment Canada's National Climate Data and Information Archive website. Heating degree days (HDDs) and cooling degree days (CDDs) are based on a balance point temperature of 15ºC.

A "Standard Weather Year," consisting of 568.1 cooling degree days and 3034.7 heating degree days has been chosen as the reference year to which all weather in all locations for each new reporting year will be normalized.

The Tool contains lists of the HDDS and CDDs for each year and at each of the city centre locations, as per the example shown in Figure 12, below.

City	CDD						HDD					
	2015	2016	2017	2018	2019	2020	2015	2016	2017	2018	2019	2020
Kelowna, BC	754.1	619.3	705.4	626.4	610.7	572.3	2623.9	2642.0	3217.7	2917.7	3117.0	2917.6
Victoria, BC	377.1	334.4	335.5	309.7	287.7	287.6	1729.9	1732.6	2125.5	1890.2	2027.6	1970.7
Halifax, NS	398.9	393.9	381.9	451.6	375.6	386.6	3194.5	2769.1	2882.1	3042.4	3177.9	2839.4
Charlottetown, PEI	403.1	420.5	421.0	485.2	368.0	493.2	3710.7	3415.8	3428.1	3673.3	3706.0	3368.3
Fredericton, NB	536.1	518.5	530.2	588.9	435.2	581.2	3839.1	3541.1	3647.5	3792.3	3874.2	3525.7
St Johns, NL	150.9	217.8	196.8	248.4	142.9	242.7	3970.3	3686.3	3766.3	3806.0	3938.1	3613.6
Calgary, AB	412.3	328.1	454.7	417.8	263.5	346.9	3563.6	3494.3	3998.6	4246.7	4310.5	3956.9
Edmonton, AB	373.4	334.5	351.2	360.4	217.5	273.0	4393.3	4179.0	4714.4	5011.0	5019.5	4906.2
Winnipeg, MB	610.5	552.3	508.9	659.3	544.9	206.4	4385.3	4203.7	4543.2	4976.7	5115.1	3718.5
Montreal, QC	773.6	844.8	698.0	883.4	684.1	810.6	3521.8	3276.5	3325.8	3572.1	3647.2	3191.4
Ottawa, ON	692.8	789.1	596.7	787.9	592.6	712.9	3719.2	3540.1	3585.8	3770.5	3920.6	3445.1
Quebec City, QC	479.3	476.8	419.1	550.9	406.1	521.8	4145.4	3921.5	4036.7	4263.7	4362.6	3940.6
Regina, SK	519.3	487.2	561.8	557.6	430.6	159.1	4351.6	4076.5	4592.6	5095.0	5139.8	3677.0
Toronto, ON	783.6	999.3	760.5	940.7	721.1	884.5	3031.5	2743.7	2805.1	3047.9	3149.2	2740.5
Vancouver, BC	400.3	317.3	361.8	356.3	359.5	307.5	1655.4	1685.8	2095.7	1866.4	1988.6	1889.5

Figure 12: Example Table of HDD and CDD

7.3.1.2. Weather Dependent Normalization Calculations and Examples

The breakdown of the benchmark model building water use identifies which components of the building are affected by variations in weather (namely, cooling). Only this specific component is adjusted for weather according to year and geographic location relative to the Standard Weather Year.

Normalization for the cooling-dependent portion of water use is calculated as follows:

$$CW_X = CW_o \left(\frac{CDD_X}{CDD_o} \right)$$

where:

CW_x is the total annual cooling-dependent water use for the model building at the given location and year

CW_o is the annual cooling-dependent water use for the model building (9.00 L/ft^2)

CDD_x is the total annual cooling degree days for the given location and year

CDD_o is the total annual cooling degree days for the model building (568.1)

Normalization for humidification is a function of HDDs, but analysis shows the balance point temperature is different than for cooling. Rather than generate HDD and CDD tables using different balance points, water use for humidification is shown to be proportional with HDDs when 1,500 HDDs are subtracted from the nominal values.

With this in mind, water use associated with humidification is calculated as follows:

$$HW_X = HW_o \left(\frac{HDD_X - 1500}{HDD_o - 1500} \right)$$

where:

HW_x is the total annual heating-dependent water use for the model building at the given location and year

HW_o is the annual heating-dependent water use for the model building (0.5 L/ft^2)

HDD_x is the total annual heating degree days for the given location and year

HDD_o is the total annual heating degree days for the model building (3034.7)

For example, total weather-dependent water use associated with the leased and vacant model buildings in Halifax, NS in 2019 is as shown in Figure 13, below.

Component of Model WUI	Building Location	Year	Occupancy Status	Model WUI weighting (L/ft^2)	Variable	Standard Weather Year	Site	Adjusted Model WUI weighting (L/ft^2)
Cooling	Halifax, NS	2019	Leased	9.00	CDD	568.1	375.6	**5.95**
			Vacant	6.00	CDD	568.1	375.6	**3.97**
Humidification			Leased	0.50	HDD	3034.7	3,177.9	**0.55**
			Vacant	0.50	HDD	3034.7	3,177.9	**0.55**

Figure 13: Model WUI: Adjusting for Weather

Note that if the site does not have a cooling tower, there is no adjustment for cooling, and the adjusted Model WUIs associated with cooling would be equivalent to the nominal values.

7.3.2. Occupant Density and Weekly Hours of Use (Affects Domestic and Kitchen use)

Water use varies with the number of people occupying a building and the number of hours they are present. Loads impacted by the building's population and hours of use include domestic and kitchen use.

The Tool incorporates a simple normalization of the L/ft^2/year value for variations in building population and weekly hours of use. The following sections describe the assumptions made and procedures used to adjust water consumption relative to variations in these factors.

7.3.2.1. Population Data and Requirements

The number of occupants is defined as the number of workers who are present during the main shift. It is **not** the same as the total number of employees and visitors to the building each day.[11]

Users are encouraged to calculate the annual average number of workers present in their building during the main shift/normal hours of use and enter this value into the Tool.

The Methodology normalizes the number of occupants based on the occupant density, defined as the number of occupants per 1,000 ft^2 *of leased space*.

7.3.2.2. Weekly Hours of Use Data and Requirements

The weekly hours of operation are defined as the number of hours per week that a building (or space within a building) is occupied by a majority of the tenant employees, averaged over the year under review.[12] The Methodology uses a default value for weekly operating hours of 65 hours of operation per week.

If the hours of use of different tenant areas are known to be greater than 65 hours/week or can be measured accurately as per the definition above, users can use a weighted average approach to calculate operating hours for the whole building. Please refer to *REALPAC Normalized Energy Use Intensity (NEUI) Methodology: Commercial Office Buildings* for additional information on calculating weekly operating hours.

7.3.2.3. Vacancy Data and Requirements

Vacancy is defined as space that is neither leased nor occupied. It is generally reported as a percentage of the total leasable space.

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[11] U.S. Environmental Protection Agency, *ENERGY STAR – Portfolio Manager – Glossary* (ENERGY STAR: n.d.).
[12] Ibid.

Users must calculate their building vacancy, averaged over the 12-month period of review. Vacancy can be calculated periodically or for the entire year under review, but the number used for the calculation must be the annual average.

7.3.2.4. Calculation of People-Dependent Adjustments

Normalization for people-dependent water is a three-step process:

1. Adjust for occupant density, then,
2. Adjust for weekly hours of operation, then,
3. Adjust for vacancy.

a) Adjustments for Occupant Density

The people-dependant loads (PDLs) of the Model WUI are adjusted for occupant density using the following equation:

$$\mathrm{PDC_O} = \mathrm{PDL} \cdot \mathrm{occ.adj}$$

where:

$\mathrm{PDC_O}$ is a people-dependent water use of the model WUI, adjusted for occupancy

$\mathrm{occ.adj}$ is the occupancy adjustment factor

The occupancy adjustment factor is calculated as the number of reported occupants per 1,000 ft^2 of leased space divided by the occupant density of the model building (namely 2.3 people per 1,000 ft^2).

Some adjustments are constrained to reflect the reality of commercial office operations.

Figure 14, below, summarizes the people-dependent loads adjusted for occupant density, assuming 4.10 people/1,000 ft^2. Adjustment limits are also indicated for each component of the model WUI. If the adjustment factor lies outside the range defined by the limits, then the appropriate limit is adhered to. Blanks in the adjustment columns indicate no limits are applied.

Component of Model WUI	People Dependent Load (L/ft^2)	Occ. Dens. (adjusted for vacancy) (ppl/1,000sqft)		Adjustment limits (% of load)		People Dependent Load, adjusted for occupants (L/ft^2)
		value	adjustment factor	min.	max.	
Domestic Use	14.40	2.28	99%	5%		14.26
Kirchen Use	4.80			5%		4.75

Figure 14: Model WUI: Adjusting for Occupant Density (with Limits)

Limits to people-dependent loads are expressed in the Tool as a percentage of the nominal people-dependent load.

b) Adjustment for Weekly Hours of Operation

The adjustment for weekly hours of operation takes the people-dependent loads adjusted for occupancy (‘$\mathrm{PDC_O}$s’) and applies an adjustment factor, calculated as the weekly hours of the site divided by the weekly hours of the Model Building (65 hours per week):

$$\mathrm{PDC_{OH}} = \mathrm{PDC_O} \cdot \mathrm{hrs.adj}$$

where:

$\mathrm{PDC_{OH}}$ is the people-dependent WUI component (adjusted for occupant density and weekly hours)

$\mathrm{hrs.adj}$ is the weekly hours adjustment factor calculated as site weekly hours of the site divided by model reference (i.e., 65 hours/week).

The adjustment factor for weekly hours of operation is always equal to or greater than 100%, as the model assumes, consistent with ENERGY STAR in Canada, that there is no material impact on water use for weekly hours of operation less than 65 hours/week.

For a building with Model WUI components adjusted for occupant density as summarized in Figure 14, above, the people-dependent WUI components adjusted for both hours and occupant density are as follows (see Figure 15, below):

Component of Model WUI	People Dependent Load (L/ft^2)	Occ. Dens. (adjusted for vacancy) (ppl/1,000sqft)		Adjustment limits (% of load)		People Dependent Load, adjusted for occupants (L/ft^2)	Reported hours		Adjusted People Dependent Load (L/ft^2)
		value	adjustment factor	min.	max.		value	adjustment factor	
Domestic Use	14.40	2.28	99%	5%		14.26	50.00	100%	**14.26**
Kirchen Use	4.80			5%		4.75			**4.75**
							Total, People Dependent adjusted		**19.01**

Figure 15: Model WUI: Adjusting for Hours

c) Adjustment for Vacancy

The Model WUI is adjusted for vacancy by calculating the weighted average of the adjusted Model WUI loads for the leased portion of the building with those of the weather-adjusted vacant Model WUI. The weighted average WUI of a given model component $\mathrm{C_{OH,W}}$ is calculated as follows:

$$\mathrm{C_{\,OH,W}} = \mathrm{C_{OH,L}} \cdot (1 - VR(\%)) + \mathrm{C_{OH,V}} \cdot VR(\%)$$

where:

$\mathrm{C_{OH,L}}$ is the given WUI component (adjusted for occupant density and hours) associated with the leased Model WUI

$\mathrm{C_{OH,V}}$ is the given WUI component associated with the vacant Model WUI

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$VR(\%)$ is the average vacancy ratio

For a building with weather adjusted components, as summarized in Figure 13, above, people-dependent WUI components, as summarized in Figure 15, above, and an assumed average vacancy of 10%, the Adjusted Model WUI is calculated as follows:

Component	Adjusted Model WUI		
	Average vacancy:		10.0%
	Leased	Vacant	Weighted
Not affected by external factors	3.60	3.60	3.60
HDD Dependent	0.55	0.55	0.55
CDD Dependent	5.95	3.97	5.75
People Dependent	19.01	0.00	17.11
			27.01

Figure 16: Calculating Adjusted Model WUI with Vacancy

7.4. Step 4: Calculate Water Normalization Factor, n_f

The water normalization factor, n_f, is calculated by dividing the model WUI of 32.30 L/ft^2 by the Adjusted Model WUI (Section 7.3):

$$n_f = \frac{\text{Model WUI}}{\text{Adjusted Model WUI}}$$

For a building with an Adjusted Model WUI of 27.01 L/ft^2, n_f is calculated as:

$$n_f = \frac{32.30}{27.01} = 1.196$$

This is also demonstrated for the sample building used in the examples above in Figure 17, below:

Component	Adjusted Model WUI			Model WUI (for reference)
	Average vacancy:		10.0%	
	Leased	Vacant	Weighted	
Not affected by external factors	3.60	3.60	3.60	3.60
HDD Dependent	0.55	0.55	0.55	0.50
CDD Dependent	5.95	3.97	5.75	9.00
People Dependent	19.01	0.00	17.11	19.20
			27.01	**32.30**
			Normalization Factor n_f:	**1.196**

Figure 17: Calculation of Normalization Factor, n_f

7.5. Step 5: Calculate Cooling Tower Adjustments (As Required)

The existing reference model assumes a centralized chiller plant and cooling tower serves the building during the summer months only.

In some cases, tenants use their cooling towers throughout the year for waterside free cooling. Alternatively, some commercial buildings do not use cooling towers at all. In both scenarios, the amount of water use is impacted when compared to the reference model.

The REALPAC NWUI Methodology assumes that cooling is predominantly supplied by one cooling source (e.g., central plant with cooling tower, packaged rooftop units (RTUs), etc.). If more than one type of cooling system is present, please assume the primary, or predominant one for use in the Tool.

7.5.1. Cooling Tower Eligibility and Data Collection Requirements

Users are asked to answer a few simple questions in the Tool regarding cooling tower use.

There are otherwise no formal documentation requirements for these adjustments.

7.5.1.1. Does This Building Have a Cooling Tower (“Yes”/”No”)

As shown in Figure 18, below, if the building has a cooling tower associated with mechanical cooling serving the primary cooling needs of the building, select “Yes” in the Tool. If the building does not have a cooling tower associated with it, select “No” in the Tool.

Building (Name):	Centre Tower
Building Owner (Org.Name):	JBK TSL
Closest Major City:	Halifax, NS
Annual Year of Water Data:	2019
Gross Floor Area (ft^2):	243,997
Number of Occupants:	500
Occupant Density (occ/1000 ft^2 of GFA) =	2.0
Average Vacancy (%):	10.0%
Normalized Occupant Density (occ/1000 ft^2 of GFA)	2.28
Weekly Operating Hours:	50
Does this building have a cooling tower?[1]	YES
Does the cooling tower operate year-round?[2]	NO
Does this building have soft landscaping (irrigation)?	YES
Irrigated area (ft^2):	10,000

[1] Answer “YES” if primary cooling relies on an evaporative process or any other water-consuming process.

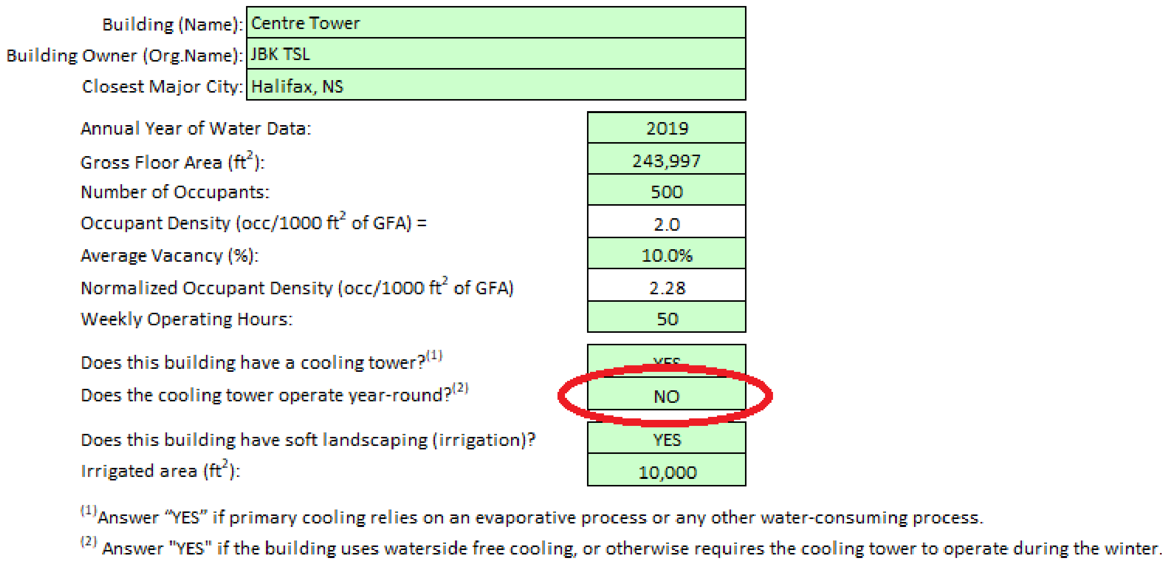
[2] Answer "YES" if the building uses waterside free cooling, or otherwise requires the cooling tower to operate during the winter.

Figure 18: Cooling Tower Input (Y/N)

For buildings without any cooling towers, an adjustment of +12 L/ft^2 is applied.

7.5.1.2. Does the Cooling Tower Operate Year-Round ("Yes"/"No")

As shown in Figure 19, below, if the building has a cooling tower associated with mechanical cooling serving the primary cooling needs of the building, select "Yes" in the Tool. If the building does not have a cooling tower associated with it, select "No" in the Tool.



Building (Name):	Centre Tower
Building Owner (Org.Name):	JBK TSL
Closest Major City:	Halifax, NS
Annual Year of Water Data:	2019
Gross Floor Area (ft²):	243,997
Number of Occupants:	500
Occupant Density (occ/1000 ft² of GFA) =	2.0
Average Vacancy (%):	10.0%
Normalized Occupant Density (occ/1000 ft² of GFA)	2.28
Weekly Operating Hours:	50
Does this building have a cooling tower?(1)	YES
Does the cooling tower operate year-round?(2)	NO
Does this building have soft landscaping (irrigation)?	YES
Irrigated area (ft²):	10,000

(1) Answer "YES" if primary cooling relies on an evaporative process or any other water-consuming process.

(2) Answer "YES" if the building uses waterside free cooling, or otherwise requires the cooling tower to operate during the winter.

Figure 19: Cooling Tower Input – Year-Round Operation

For buildings with cooling towers that operate year-round, an adjustment of -3 L/ft^2 is applied.

7.6. Step 6: Calculate the NWUI

The Normalized Water Use Intensity (NWUI) is calculated by multiplying the normalization factor, n_f, (Section 7.4) by the Adjusted WUI (Section 7.2) and applying any cooling tower adjustments as required (Section 7.5).

$$\text{NWUI} = n_f \cdot \text{Adjusted WUI (+ year-round cooling tower adjustment)}$$

For a site with an Adjusted WUI of 58.17 L/ft^2 and a normalization factor of 1.196, a year-round cooling tower adjustment of -3 L/ft2, the NWUI is calculated as shown in Figure 20, below:

Adjusted WUI:	58.17	L/ft²/year
Normalization Factor:	1.196	
(nf x Adjusted WUI)	69.56	L/ft²/year
Absence of Cooling Tower Adjustment:	0.00	L/ft²/year
Year-Round Cooling Adjustment:	-3.00	L/ft²/year
NWUI	66.56	L/ft²/year

Figure 20: Calculation of NWUI

8. Appendix A: Abbreviations, Acronyms, and Definitions

8.1. Abbreviations and Acronyms

ASHRAE	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
BOMA Canada	Building Owners and Managers Association of Canada
BOMA BEST	BOMA Building Environmental Standards
CaGBC	Canada Green Building Council
ccf	100 cubic feet
CDD	cooling degree day
cf	cubic feet
EGA	exterior gross area
Evapotranspiration	The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants
EVO	Efficiency Valuation Organization
GFA	gross floor area
IPMVP	International Performance Measurement and Verification Protocol
L	litre
m^3	cubic metre
NRCan	Natural Resources Canada
REALPAC	Real Property Association of Canada

8.2. Definitions

Many of the definitions listed below that are related to the measurement of building area have been taken directly from the BOMA International standard, *BOMA 2018 Gross Areas: Standard Methods of Measurement (ANSI/BOMA Z65.3-2018).*

Those definitions attributable to this standard have been identified with an asterisk (*).

***Basement** – a floor of a building that has an elevation below that of the average adjacent grade plane by a distance of more than two thirds of the vertical dimension between the elevation of that floor level and the elevation of the floor immediately above it. A building may have more than one basement level; all are included in the definition of a basement.

***Building** – a contiguous and undivided shelter comprising a partially or totally enclosed space, erected by a means of a planned process of forming and combining materials.

Call centre – a department or business wholly focused on telephone inquiries. Call centres usually provide a centralized point of contact for an organization and support telephone selling, after-sales service, telephone helplines, or information services, either for a parent organization or on a contract basis for other businesses.

***Connector** – a covered or enclosed bridge, walkway, tunnel, or other similar connecting element between two separate buildings.

Data centre (computer) – "refers to buildings specifically designed and equipped to meet the needs of high density computing equipment, such as server racks, used for data storage and processing. Typically these facilities require dedicated uninterruptible power supplies and cooling systems. Data centre functions may include traditional enterprise services, on-demand enterprise services, high performance computing, internet facilities, and/or hosting facilities."[13]

***Enclose(d)** – to separate the inside of a building from the outside, affording protection from the elements appropriate to the occupancy and the local climate. All enclosed space must have a roof.

***Exterior enclosure** – the wall, roof or soffit that constitutes the envelope necessary to enclose a building. The exterior enclosure generally determines the location of the measure line.

***Exterior gross area (EGA)** – the total of all the horizontal floor areas (as viewed on a floor plan) of all floors of a building contained within their measure lines, excluding voids (with the exception of occupant voids), interstitial space, unexcavated space, and crawl space. This includes the exterior gross area of every floor in the building, including basements, mechanical floors, mezzanines, penthouses, and structured parking without the removal of column area or other structural elements within the measure line.

***External circulation** – unenclosed pedestrian circulation providing the minimum path for access to tenant suites, egress stairs, elevators, refuge areas, toilets, and building entrances, and required

[13] U.S. Environmental Protection Agency, *Property Types in Portfolio Manager* (ENERGY STAR: n.d.). https://www.energystar.gov/buildings/benchmark/understand_metrics/property_types.

by local building code to meet egress requirements, only when there are no fully enclosed pedestrian corridors serving a floor or portion (such as a wing) thereof.

Floor – a normally horizontal, load bearing structure and constituting the bottom level of each story in a building, including its associated permanent mezzanine, if any exists.

Gross floor area (GFA) – in the REALPAC NWUI Methodology, the exterior gross area of a building minus the parking area (as defined by BOMA International). Other definitions of gross floor area may exist but are not applicable in the REALPAC NWUI Methodology.

Measure line – a horizontal line on the outermost structural or architectural surface of the exterior face of the exterior enclosure, or at the exterior edge of any external circulation of a given floor of a building. In determining the measure line, do not consider overhangs, pilasters, columns, awnings, eaves, cornices, sills, ledges, casing, wainscoting, gutters, downspouts, chimneys, signs, shutters, attached electrical or mechanical systems, decorative projections and the like that protrude beyond such surface or edge.

Mezzanine – an intermediate horizontal load bearing structure that lies between a floor and the floor or roof immediately above, which contains a fraction (usually 1/3) of the area of the floor below, where there exists adequate headroom above and below the mezzanine, and which shares service areas (e.g., toilets, fan rooms) with the floor immediately below it.

There are three types of mezzanines that are measured as follows:

1. *Temporary mezzanines* – non-permanent (built with the intention of being removed or relocated), often tenant improvements, are supported upon the floor but otherwise not part of the building structure, and used most frequently (but not exclusively) in retail and industrial occupancy for storage of goods and materials or as part of manufacturing processes. Such mezzanines are not measured as part of construction gross area or exterior gross area of a floor or building.
2. *Permanent mezzanines* – not built with the intention of being removed and share building systems (e.g., HVAC, lighting, power). In a multi-story building containing elevators, the existence of an elevator stop at a mezzanine indicates that it is permanent. Such mezzanines are always measured as part of construction gross area and exterior gross area of the floor immediately below.
3. *Unclassified mezzanines* – cannot be classified as either temporary or permanent, are included in construction gross area and exterior gross area, though are always disclosed when presenting area measurements.

Occupant void – a floor opening between two or more adjacent floors created by removal of floor area by or for the occupant that would otherwise be included in the exterior gross area or construction gross area of the floor.

Parking – enclosed structured floor area used for transient storage of motor vehicles, including associated circulation and building services (such as exhaust fans and ducts that serve the parking area), but not including the loading docks, sally ports, and building service areas such as enclosed auxiliary lobbies used to enter a building from parking areas.

Penthouse – fully enclosed floor area located on the roof level of a building that occupies less than all of the roof.

***Restricted headroom** – For occupiable space: Space that does not meet the requirement of the International Building Code, section 1208.2, Minimum Ceiling Heights, including subsections thereof. For all other space: Space that has a clear ceiling height of less than 7'-0" (approximately 213 cm).

Retail store – "refers to individual stores used to conduct the retail sale of non-food consumer goods such as Department Stores, Discount Stores, Drug Stores, Dollar Stores, Hardware Stores, and Apparel/Specialty Stores (e.g., books, clothing, office products, sporting goods, toys, home goods, and electronics). Buildings containing multiple stores should be classified as enclosed mall, lifestyle centre, or strip mall."[14] In the REALPAC NWUI Methodology, the definition of retail space includes stores, restaurants, food court areas, fitness clubs and/or other businesses providing consumer goods and services.

***Vault space** – sub-grade space that is enclosed and contiguous to a basement that extends below the adjacent ground plane past the property line, often under a public right-of-way, such as a sidewalk or alley.

***Void** – absence of a floor within the exterior enclosure of a building in excess of ten square feet (1 square meter) where a floor might otherwise be expected or measured, that is typically in the plane of the upper floors adjacent to multi-story atria or lobbies, light wells, auditoria, or the area adjacent to a partial floor, permanent mezzanine, or unclassified mezzanine at a given floor level. Only the lowest floor of a multi-story space, such as an atrium, or a well, or lobby, is included in construction gross area and exterior gross area.

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[14] U.S. Environmental Protection Agency, *Property Types in Portfolio Manager* (ENERGY STAR: n.d.). https://www.energystar.gov/buildings/benchmark/understand_metrics/property_types.

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