Resilient Bath Monitoring Plan

Introduction

The City of Bath seeks to track metrics related to sustainability in a meaningful way in order to track progress toward the City's climate goals. This memo outlines recommendations for the City to track progress toward the completion of the goals, strategies, and actions included in the *Resilient Bath Climate Action & Resiliency Plan*. Two types of metrics may be tracked to evaluate progress for plan implementation, including:

- **Performance Metrics**: Measure progress toward goals
- **Implementation Status**: Measure successful completion of actions

In addition to metrics specifically related to the climate action plan, continued progress monitoring on GHG reductions can be done through periodic GHG inventory updates, however these should be paired with updates to underlying data where possible and a more comprehensive collection of indicator data to illustrate overall progress.

Monitoring progress for climate change adaptation will require understanding the outputs, indicators, and impacts for adaptation related actions in Bath. In the field of local climate adaptation planning and implementation there is still a need to develop robust and consistent climate adaptation indicators and metrics. However, while there may not be shared metrics guides the field at large, there is still a critical need for the City of Bath to be explicate about what metrics are being monitored and how these outcomes are being evaluated for public awareness and confidence in the implementation of this plan.

Performance Metrics

Performance metrics are essential tools for assessing and managing progress toward the *Resilient Bath* goals. In the context of our objectives, the evaluation process involves measuring advancements against long-term and interim targets, specifically targeting key milestones in 2030, 2040, and 2050. As such, at least one performance metric has been identified for each of the *Resilient Bath* goals.

Some of the outcomes of *Resilient Bath* have clear and objective end-states that define goal achievement, such as the elimination of fossil fuel use for building heating. Other performance metrics dealing with preparedness or social outcomes will likely continuously evolve in response to factors outside the control of the community. Similarly, the maximum amount of renewable energy capacity within city limits. These types of metrics are nonetheless useful to track as trends in them may inform

continuous improvement in *how* the City of Bath and its partners implement actions and practice adaptive management. In these cases, targets are expressed in terms of "increasing" or "decreasing" values for the metric to express the intent of the goal. It will be up to relevant City of Bath staff to interpret when trends indicate changes to the plan or its implementation are warranted.

The responsibility for tracking these metrics lies with the designated department assigned with collecting and reporting the data to the Bath Climate Action Committee and Sustainability Office. To maintain transparency and accountability, the results should be reported annually.

Goal EB 1: Buildings in Bath are energy efficient and minimize greenhouse gas emissions.

Metric	Unit	Narrative Support
Share of Residential Buildings Electrified	% of homes	May be used in the interim to track progress towards high-efficiency, electric buildings.
Share of Commercial Buildings Electrified	% of commercial building area	

Goal EB 2: Bath achieves enhanced renewable energy capacity and energy resilience.

Metric	Unit	Narrative Support
Installed Rooftop Solar Capacity	MW	Will enable the City to track progress toward increasing local solar capacity.
Households Enrolled in Maine Green Power Program	% of households	Will enable City to track renewable energy purchases to be able make claims for carbon neutrality.

Goal TM 1: Bath is a model for clean transportation options.

Metric	Unit	Narrative Support
Share of Light-Duty Vehicles Electrified	% of vehicles	Will enable the City to track progress toward residential and commercial vehicle electrification.
Share of Heavy-Duty Vehicles Electrified	% of vehicles	
Public EV Charging Ports	# of ports	Aligns with City's priorities to expand public charging network.

Goal TM 2: Bath community members have more options for sustainable and safe travel.

Metric	Unit	Narrative Support
Average Daily Vehicle Miles Traveled per Household	VMT / household	Aligns with City's priorities to reduce vehicle trips. Mobility uses this metric often.

Annual Bath CityBus and Bath Trolley Ridership	# of annual riders	Will enable the City to track public transit demand. Aligns with the City's priorities to reduce single occupancy vehicle trips and encourage multimodal transportation options.

Goal CO 1: The City leverages climate data and hazard mitigation best practices for infrastructure and neighborhood planning.

Metric	Unit	Narrative Support
Miles of roadway inundated with flooding during prepare to manage 2050 SLR scenario	2.8 current miles	Provides some level of understanding of the resiliency of City infrastructure.

Goal CO 2: The Bath community understands climate change and has tools and resources to stay safe during climate events.

Metric	Unit	Narrative Support
Heat-related ER Visits in Sagadahoc County	# of annual visits	Extreme heat events are having an increasing impact on human health and illustrating the trends can be an important communication tool for the urgency of GHG reductions as well as crafting and supporting targeted policy responses.

Goal CO 3: Housing in Bath is affordable and climate-ready.

Metric	Unit	Narrative Support
New Accessory Dwelling Units Developed	# of ADUs	Aligns with the City's priorities to enhance housing affordability.
Energy Cost Burden of Low-Income Households	% of income spent on energy costs	Will enable the City to assess community resiliency as increasing energy affordability is a high priority to reduce vulnerability.
Households with Central AC	% of households	Provides some level of understanding of access to cooling in the home; however, many households

		that rely on window units are not captured here.

Goal WW 1: The Bath community reduces its carbon footprint by minimizing waste; reducing the consumption of disposal goods, sharing, fixing, and upcycling materials; and recycling and composting.

Metric	Unit	Narrative Support
Residential Waste Diversion Rate	% of waste diverted from landfill	Aligns with City's priorities to achieve zero waste (or 90% diversion).
Share of Residential Food Waste Composted	% of food waste	Will enable the City to track residential composting practices.
Share of Households Enrolled in Garbage to Garden Composting Program	% of households	
Businesses Enrolled in Garbage to Garden Composting Program	% of businesses	Will enable the City to track commercial composting practices.

Goal WW 2: The City efficiently and sustainably manages wastewater, stormwater, and the combined sewage overflow (CSO) system.

Metric	Unit	Narrative Support
Combined Sewer Overflows	million gallons	Provides some level of understanding of overflow risks and will inform stormwater management.

Goal NR 1: Bath's existing and future natural resources are healthy and sustainable.

Metric	Unit	Narrative Support
Tree Canopy Coverage	% of land area	Aligns with City's priorities to increase the urban tree canopy by 15%.
Residents Living Within a 10-Minute Walk of a Park	% of residents	Provides some level of understanding of community access to green spaces.

City Owned Trees	# of trees	Will enable the City to track tree plantings and monitor the implementation of design standards for street trees.

Goal NR 2: Bath's coastal resources are resilient to climate change.

Metric	Unit	Narrative Support
Miles of Unstable Coastal Bluffs	# of miles	Will enable the City to track the protection and enhancement of coastal natural resources.

Goal NR 3: The City understands and promotes the potential of Bath's natural resources to sequester carbon from the atmosphere.

Metric	Unit	Narrative Support
Acres of Conservation Land	# of acres	Aligns with City's priorities to conserve land with high carbon sequestration potential.

Implementation Status

If the performance metrics are used to track progress toward goals, the implementation status are used to track progress toward implementation of actions, enabling Bath to demonstrate follow through on actions with regular reporting on the City's website or other means.

The high-level implementation steps that Bath should track across all actions, of which the action champions will report on, include the following:

- Not started
- In-progress
- Facing roadblock
- Complete
- Complete and using performance metrics to evaluate effectiveness

While some actions may stop at "Complete" (e.g., coordination with utilities), other actions may require continued tracking through performance metrics to evaluate the effectiveness of the policy or program (e.g., tracking high efficiency, all-electric households to measure effectiveness of the energy coaching program).

Monitoring Outcomes – GHG Inventory Improvements

Greenhouse gas inventories have a variety of purposes. Inventories serve to provide the basis for prioritizing the development of actions based on the relative contributions of sources in the community.

Inventory baselines provide the basis for target setting and periodic inventory updates provide the means for monitoring whether the City of Bath is on the trajectory needed to reach its reduction targets.

The unfortunate reality of community scale GHG inventories is that there are very few instances where all data about a community is known in the original baseline, and it may be multiple re-inventories until perfectly repeatable data has been established to illustrate measured progress from the baseline.

For the 2024 Resilient Bath Plan, several updates were made to previous inventories to make some calculation corrections as well as make clear which pieces of data are well positioned for progress monitoring and which data sources are still based on estimated inputs that will need to be refined over time.

Updates to the 2022 GHG Inventory:

Corrected electricity consumption:

- Data input into the ClearPath software was checked against notes and raw data that was attached to records in the tool.
- Initial review found that data inputs matched the values provided by Central Maine Power.
- Further review of results led to a determination that the quantity of energy represented by the records was unrealistically small and 2018 data was checked for reference. This review led to the realization that data reported by Central Maine Power was low by an order of magnitude, or a single decimal point.
- To correct for this, records for electricity use in the Residential, Commercial, and Industrial sectors were increased by 10x.
- Future engagement with Central Maine Power should include checks to ensure correct units. Where possible, it may be advantageous to also seek electricity use data at monthly intervals instead of annual totals.

Updated reference for non-utility energy:

Non-utility stationary energy such as fuel oil and propane are fundamentally limited in terms of ability to track usage. While building assessor records can help track the number and size of structures using these fuels for primary heat, actual use and improved performance that may come from building weatherization or changes in heating demand from the weather will not be captured. Trends here can be measured solely in terms how many buildings are using these fuels.

Placing a value on these fuels for inventory purposes and to gauge the relative impact of focusing decarbonization on buildings using different fuel types requires a reference for energy intensity of buildings using those fuels. Both the 2018 and 2022 inventories utilized the US EIA Residential Energy Consumption Survey and Commercial Building Energy Consumption Survey. These resources are included as default values in methods such as the US Community Protocol, however new data sources with better precision have emerged in recent years the ResStock[1] and ComStock[2] models from the National

[1] https://resstock.nrel.gov/
[2] https://comstock.nrel.gov/

Renewable Energy Laboratory provide modeled estimates of these intensities with greater geographic and building type precision.

Updating these data sources provides a better estimate of relative GHG reduction potential with the added benefit of aligning with the modeled energy saving values from ResStock and ComStock models. It is recommended that Bath monitor these models and other data products from all US national labs as potential continued improvements.

Natural gas in buildings:

An unfortunate complication for tracking natural gas usage in Bath is the presence of a single large customer using fuels in a productive capacity at Bath Iron Works with the inability to distinguish that usage from consumptive usage for the heating of buildings, domestic hot water, and cooking; all of which have viable options for decarbonization with today's technology. Thankfully this situation does not impact residential usage, but it does complicate getting a clear understanding of utility gas within non-residential structures in Bath. It is recommended that the city continue to engage with Maine Natural Gas to exclude Bath Iron Works from future reports on aggregate gas consumption in order to better track progress in this area.

Alternatively, some directed survey efforts focused on downtown businesses or other voluntary disclosure could fill gaps in knowledge. While improved information would be useful to know, the current situation should not be an impediment to action as individual building owners can still make proactive decisions to decarbonize their properties. It is worth noting that the situation in Bath is not unique and the need for modernizing utility privacy rules to advance climate action are recognized in other places, particularly within the State of California[3].

On-road transportation:

Emissions from on-road transportation in Bath's GHG inventories to date have been based on measures of total VMT occurring within the city limits derived from simple traffic counts on major roads. While this is an overall good and repeatable measure of traffic activity, it does not indicate much about the transportation demands of Bath residents and workforce. Alternative data sources such as those derived from cell phone and vehicle location data can provide a clearer picture of what Bath resident's individual contributions are; however, those alternatives are currently expensive. Over time options may continue to improve and possibly studies from the State of Maine or Mid-Coast Council of Governments could refine inventory estimates in this sector.

Evolving data availability is a factor that all communities working on climate action must work with. The City of Bath should not shy away from continued improvements in data collection and shifting to improved methodologies even if they lead to inconsistencies with the baselines from which targets were set. As field of local government climate action continues to evolve, it is likely that messaging and updating targets in the future may re-orient in terms of our distance from zero emissions rather than how far we've come from an uncertain starting point.

Updates to 2018

[3] Berkeley Law, et al. Data Access for a Decarbonized Grid. 2021. https://www.law.berkeley.edu/wp-content/uploads/2021/02/Data-Access-for-a-Decarbonized-Grid-February-2021.pdf

In addition to updates made to 2022, the process of comparing the two inventories prompted additional review of the 2018 baseline inventory as solid waste emissions had dropped significantly to 2022. Further exploration of input data revealed that the total tons of waste landfilled used to calculate GHGs included tons from road construction and other largely inert C&D debris. To correct the value of waste deposited was reduced to only include mixed municipal solid waste, reducing the tons from 10,073 tons to 4,562 tons. Both these values are listed in the Bath Landfill report attached to the ClearPath record.

Moving forward, as actions from the Resilient Bath Plan are implemented to eliminate organic material from the waste stream, the impact of this will show up somewhat in the reduced tons of waste deposited at the landfill. However, the full benefit of the savings would not be recognized in the calculation of subsequent inventories unless the share of organics in the waste characterization factor set are also updated to reflect that these materials are being diverted.

Simple calculations to re-allocate the waste characterization based on the tons removed could accomplish this adjustment as an estimate in lieu of a physical waste characterization study, however those should be performed periodically to understand what is truly remaining in the waste stream and how effective all diversion practices have been at eliminating sources of landfill methane.

Comprehensive Progress Monitoring

Relying on inventories alone to evaluate progress towards GHG reductions has limited ability to illustrate significant details into the drivers of change from one year to the next. As GHG inventories typically work data at annual timescales, it can be difficult to quantitatively recognize the influence of external factors working for or against target achievement. For example, changes to the carbon intensity of grid electricity may not always be progressively lower. Particularly hot or cold years may have a significant impact on building energy use that could mask achievements made or give a false impression of progress. Significant changes to the overall building stock can also skew apparent progress as will welcoming new residents and businesses into the community.

Overall, these types of factors should be considered and incorporated into any evaluation of trends and achievements and apparent progress should not be penalized when that occurs. To fully account for the driving factors behind changes in GHG performance, data that describes the community context at the time of the inventory can not only qualify the results, but also provide direction for adaptive management of the actions in the Resilient Bath plan.

While some of these datapoints are collected by default in an inventory, such as the grid electricity emissions factor, others may need to be deliberately collected in addition to the standard inventory inputs. Some examples include:

- Square feet of building area by building type and fuel type
- Vehicles registered and miles driven by vehicle type
- Total value of commercial activity
- Heating and cooling degree days

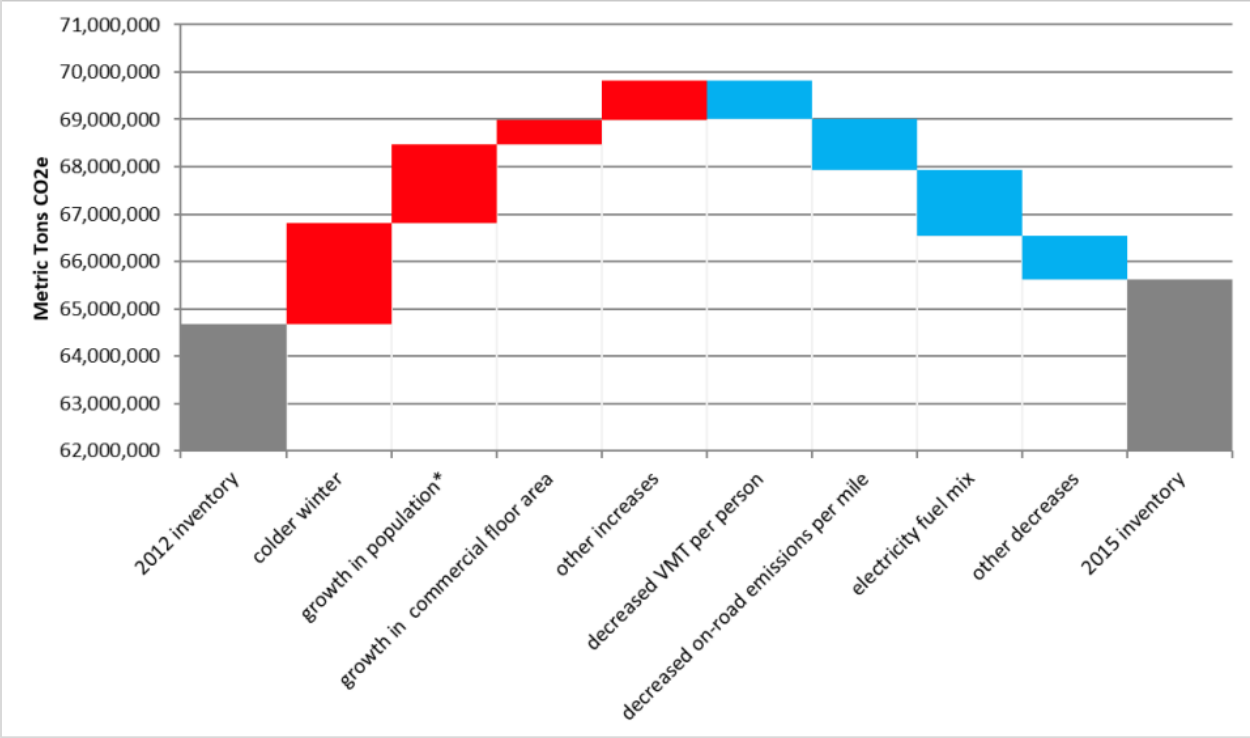
At a minimum, these types of metrics will support the City of Bath to perform simple “normalization” adjustments by expressing both absolute values in the GHG generating activities as well as in an indicator

format. Communicating per-capita or per-square foot, or other indicators can illustrate some level of progress when it is masked by growth or other external factors.

The use of indicators is one relatively low level of effort option for illustrating progress, but it has limitations for illustrating how changes across multiple variables impact. For example, illustrating the relative impact between changes to electricity usage as well as changes to the carbon intensity of that electricity. For this type of illustration, the Contribution Analysis Framework[4] from ICLEI-USA can be a powerful tool for communicating results and recalibrating level of effort applied to the actions in the Resilient Bath Plan.

One important aspect of the Contribution Analysis Framework is its ability to combine factors from both top-down and bottom-up perspectives. For example, it is possible to illustrate both the impact of cleaner grid electricity derived from high-level inventory inputs with measured or estimated impacts from implemented actions. As the City tracks the number of home electrification and or weatherization projects, all factors can be combined to illustrate comprehensive change. There are opportunities for integrating many of the Resilient Bath performance metrics into estimates of achieved reductions in this type of comprehensive framework.

Figure 1. Example Contribution Analysis Results (not Bath)



While there always remains some level of unallocated change “other” increases or decreases, this type of analysis is much more useful than simply knowing whether change is up or down. The Contribution Analysis Framework can be applied to individual sectors and does not require a full inventory to perform

[4] https://icleiusa.org/ghg-contribution-analysis/

either. It may be useful for the City of Bath to track annual building energy usage and apply the framework to just that sector alone. The scope of this type of analysis fits within a summer internship or other internal resources to accomplish, especially if Bath can also leverage training and other support from ICLEI-USA. The contribution analysis framework can be leveraged to look at individual sectors and any number of factors for which data is available. Overall, the technique could be the basis for a number of project suitable for summer internships, particularly during interim years when a full inventory is not required.

Monitoring Outcomes – Climate Adaptation

While there is not a consistently utilized framework for measuring adaptation at the sub-national, a consistent and transparent approach will enable the City of Bath to track progress overtime and adapt strategies and actions and new and better climate science becomes available. We recommend that for every adaptation action that the City begins to implement, your team identifies six core categories: *output*, output indicator, *outcome*, outcome indicator, *impact* and impact indicator. Examples of climate adaptation actions within this climate adaptation framework can be found here on the C40 Cities knowledge Hub.