Making the Right Choices for Your Utility:

Using Community Priorities and Sustainability Criteria for Water Infrastructure Decision-Making

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So, you're facing a large capital investment…

All across America, water utilities act as anchor institutions safeguarding public health, protecting the environment, and sustaining critical water infrastructure investments for their communities. To provide sustainable, cost-effective services, water utilities are regularly faced with the need to make large capital investments to increase levels of treatment, replace aging infrastructure, build major facility upgrades, or transform traditional treatment plants into more cost-effective "water resource recovery facilities" — all while keeping rates affordable for their customers.

These challenges translate into necessary, often costly capital program investments funded largely by the utility's customers. Many of these major capital investments have service lives exceeding 50 years, making sustainable and cost-effective project decisions critical to long-term health of both the community and the utility. Today's capital project decisions are the foundation for decades of commitment to funding both the operating and capital costs over decades of service.

How can this process help you?

In a conventional alternatives analysis, decision-making criteria is often based on technical performance (e.g., whether the alternative supports meeting a regulatory endpoint such as a technology or water quality based permit limit) and the cost of doing so (e.g., the present value of the full life-cycle costs of the alternative), along with other important technical and operational criteria such as reliability, maintainability, and accessibility.

In today's rapidly evolving and challenging project decision-making environment, traditional project alternative analysis does not fully encompass the diverse set of challenges facing utilities and may fall short in these areas:

- Proactively engaging the community to understand their priorities and elevate their awareness of utility needs.
- Addressing and quantifying some environmental, economic, and social benefits and costs associated with these long-term infrastructure investments.
- Selecting the most cost-effective project alternative when there are multiple drivers or sources of water pollution, which make project decision-making more complex.

EPA's capital project decision-making method, referred to as Augmented Alternatives Analysis, was developed to address these challenges in modern-day project decision-making.

The Augmented Alternatives Analysis (AAA) method incorporates past utility experiences and lessons learned to provide you with a simple, sound, easily explainable and transparent way to incorporate community values and best meet utility needs as you evaluate and select infrastructure investments. Utilities and municipalities using EPA's Integrated Stormwater and Wastewater Planning Framework to maximize their capital investments and meet Clean Water Act (CWA) requirements are encouraged to use the AAA method as key component in developing a meaningful Integrated Plan.

The augmented approach adds to the core tenets of conventional alternatives analysis benefitting your utility in a few key ways.

Meaningful Community Engagement

AAA provides your utility with a community engagement process to customers, partners, and other key utility stakeholders. This engagement helps your utility develop a deeper understanding of the community's long-term priorities and needs that will inform future programs and initiatives at your utility. In particular, this guide brings a focus to criteria that enable utilities to make decisions that reflect other community and utility sustainability goals and objectives related to economic, social, and environmental performance. One such initiative, for example, could be developing an integrated plan in accordance with EPA's Integrated Planning Framework. This will result in long-term infrastructure investment decisions that have broader public support. The community's support for public health/environmental protection projects are essential for utilities, as they typically entail rate increases for their customers. When customers understand the necessity for the projects and also understand that their community priorities are "baked into" project goals and outcomes, utilities can have greater support to successfully implement infrastructure that supports the long-term environmental, economic, and social health of the community.

Quantify and Compare Sustainability Criteria

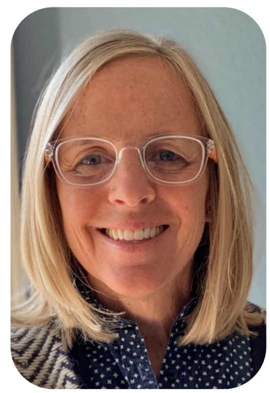
There is growing awareness that utility investments provide multiple benefits to the community, but utilities have struggled with a method to quantify and incorporate benefits that are more qualitative in nature, such as some environmental or social benefits. For example, a method to quantify these benefits can be especially helpful when utilities want a quantitative method for prioritizing investments across stormwater and wastewater assets as a part of their integrated planning process. The AAA method scales economic, environmental, and social benefits to help your utility quantify and effectively compare investments on an "apples to apples" basis to determine the alternative with the highest benefit to cost ratio.

Address Financial Constraints of Utilities

There are a variety of reasons that a utility may need to plan significant capital investments. A few of the most common drivers for utility capital investments include actual (or anticipated) environmental and/or safety regulations, aging infrastructure, operational optimization, or increased resiliency/reliability in the event of weather-related events or other natural disasters (e.g., earthquakes, flooding, drought, etc.). More often than not, capital investments may have multiple drivers, which can make the project decision-making more complex, with numerous objectives and decision-making criteria. The AAA method allows your utility to prioritize and weigh different decision-making criteria to ensure the best use of often limited financial resources.

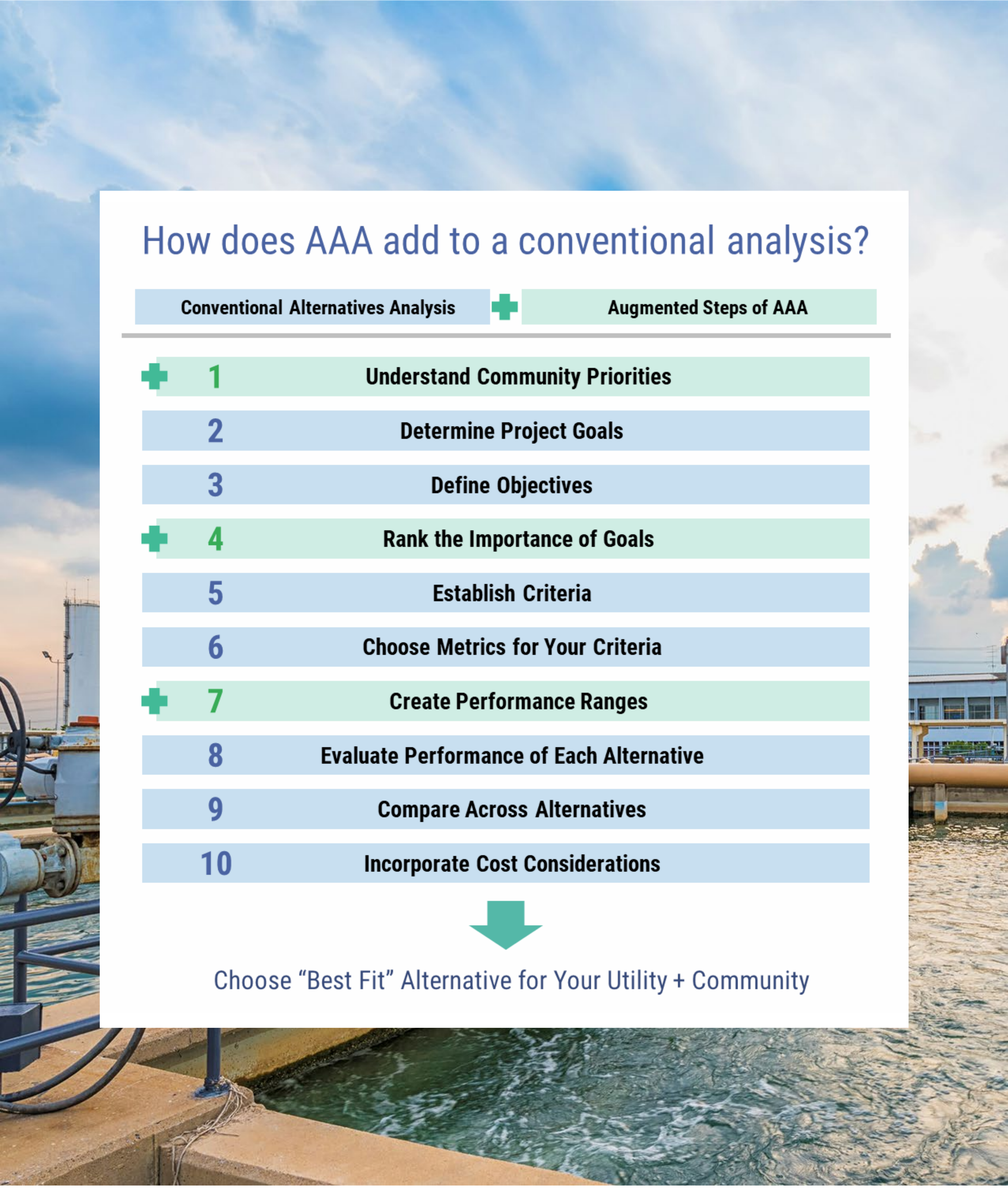
Testimonials from Real World Users

"The EPA's AAA tool was extremely helpful to me and my team while I was at the Camden County (NJ) Municipal Utilities Authority. It enabled us to identify the best alternative, from a triple bottom line basis, for a combined sewer overflow abatement project that we were evaluating. As the clean water utilities of the future strive to be environmental champions and anchor institutions in the communities that they serve, EPA's AAA roadmap will be an invaluable tool to optimize triple bottom line benefits for any new project they undertake." *– Andy Kricun, oversaw the use of the AAA method for the Camden County Municipal Utilities Authority Combined Sewer Long-Term Control Plan (LTCP) as Executive Director and Chief Engineer. To read more visit the case study.*



"The EPA's AAA process has provided the High Line Canal Conservancy the opportunity, along with our partners, to really think about and understand the true potential for the High Line Canal as it transitions from an irrigation delivery system to green stormwater infrastructure. Each step of the AAA process systematically built upon the previous one and allowed for important input from a wide base of stakeholders including the Stormwater Transformation and Enhancement Program leadership team, community members and local leaders, which then ensured a robust alternatives analysis. Guided by the expertise of EPA and grounded in a sustainable approach, the Conservancy and our partners are now able to seamlessly adapt the AAA process to respond to and meet varying needs and conditions. We're so excited to implement this impactful tool and to showcase the benefits of green infrastructure." *– Cathy McCague, Program Manager, oversaw the use of the AAA method for the High Line Canal Conservancy's the Stormwater Transformation and Enhancement Program (STEP). To read more about STEP, visit the case study.*

"The EPA's Augmented Alternative Analysis process provided our community with an organized framework on which to build priorities and goals with measurable metrics. The EPA team partnered with us to align our city goals and community priorities with our project needs to inform our future utility investment decisions. This evaluation was a critical planning step toward a more resilient and sustainable water resource recovery future here in Saco." *– Howard Carter, oversaw the use of the AAA method for the Long Term Resiliency Plan as Director of the Water Resource Recovery Department at City of Saco, Maine. To learn more, visit the case study.*



How does AAA add to a conventional analysis?

Conventional Alternatives Analysis	+	Augmented Steps of AAA

	Step	
+	1	Understand Community Priorities
	2	Determine Project Goals
	3	Define Objectives
+	4	Rank the Importance of Goals
	5	Establish Criteria
	6	Choose Metrics for Your Criteria
+	7	Create Performance Ranges
	8	Evaluate Performance of Each Alternative
	9	Compare Across Alternatives
	10	Incorporate Cost Considerations

Choose "Best Fit" Alternative for Your Utility + Community

Before AAA Launch: Identifying Project Alternatives

At the launch of this process, your utility should have a clear sense of the scope of a project and a general sense of the multiple needs it is intended to address. For example, when both stormwater and wastewater projects are key components of a utility's scope, a utility could use EPA's Integrated Planning Framework, because it applies the triple bottom line AAA method. You may already be aware of one or more project alternatives by the time you begin this process. This general awareness will help you determine and refine goals and build out to the metric level. However, to ensure a meaningful process, your utility should postpone the evaluation of alternatives until you reach Steps 8-10 in the process.

CAPITAL PROGRAM DEVELOPMENT

Effective water utilities have a systematic process for determining their long-term capital program needs, which they typically incorporate into a "5 Year" or even "10 Year" capital program. Many utilities update these long-term capital programs on an annual or bi-annual basis as organizational priorities and needs change.

The capital program development process typically includes the gathering of information from internal stakeholders, such as the utility's leadership team, planning, engineering, operations and maintenance, and information systems as well as external stakeholders, such as customers, community groups, and other partners, to define and prioritize the issue(s) or problem(s) requiring resolution. Proposed capital projects must successfully address these issues and help highlight the prioritization of the utility's financial resources.

Once a capital project is appropriated (funds authorized) by the Board/Council (typically as part of an overall capital program composed of multiple capital projects), the project planning can proceed. Some capital projects are narrow in scope and targeted to address a specific need, without the need for customer input. Often these projects have a brief planning period and move fairly quickly into the design stage. Many capital projects, however, require much larger, longer-term investments and are broader in scope and complexity, as they are intended to address more significant or multiple needs.

This second type of project is conducive to using EPA's Integrated Planning Framework and applying a Triple Bottom Line AAA method because they engage with the community up front. These approaches help a utility to gain customer support in selecting the most beneficial and cost-effective project alternative(s) for implementation. These projects typically have a variety of possible project alternatives that may be significantly different in nature, and policy decisions are often required to select the best project alternative. These alternatives typically have varying degrees of potential benefits to and impacts on the community. They help a utility proactively engage the community, including residents of neighborhoods with environmental justice concerns, in the planning process.

Appendix B provides an in-depth example, based on a hypothetical water utility capital project, of how a utility might go about identifying and describing project alternatives.

Step 1: Engage Your Community

A central component of the AAA process is to establish a clear and transparent way for a utility to solicit and incorporate community input into major capital projects. AAA provides an effective way for utilities to convey the decision-making process to their community, which can garner public support on infrastructure projects that may be often costly but necessary. This also provides a robust process for meeting Element Three of EPA's Integrated Planning Framework.

Community engagement at the outset of your planning process will help set your utility up for success. There are two important reasons to engage your community. First, you are able to more accurately understand and consider the priorities and needs of residents, organizational partners, and other key stakeholders. Second, by engaging the community during the planning process, you can increase public awareness of the project's context as well as the utility's priorities and needs. Proactive community engagement enables utilities to present their community with an investment package that addresses their needs while gathering the support needed to finalize the investment plan.

To begin, consider who you would like to engage in this process (e.g., board/council members, community leaders, neighborhood associations, community-based organizations, local NGO's, chamber of commerce, watershed partners and other key stakeholders) and what form of engagement you will use (e.g., informal interviews, a workgroup, citizen advisory group, and/or public meetings). Below are a few suggestions for ways to engage your community prior to and/or during a AAA process.

Establish a Workgroup

You may choose to convene a workgroup with key constituents to encourage continuity, build trust, and ensure constituents are meaningfully involved throughout the process. Establishing a citizen workgroup is a great approach to identify long term **community priorities** to help inform utility major capital investment decisions and to provide a process to establish project goals through the AAA process. An established workgroup provides the additional benefit of creating future local utility "ambassadors" who often play a very helpful role in supporting utility decisions that benefit the environmental, economic, and social health of the community that the utility serves. At this stage in establishing a working group, your utility should seek to:

- Identify important and representative individuals in the community.
- Explain to them that you are establishing a framework for evaluating future utility infrastructure investments.
- Determine how the engagement can be mutually beneficial and align with other community planning initiatives.

- Ask them to provide a snapshot of the Community Priorities that are most important to them. For example, community partners that have experienced combined sewer overflows may provide feedback that public health is a top priority.

Once your utility has collected and analyzed the input received on community priorities, communicate back to the group the set list of key priorities (e.g., 4-5 priorities) that emerged from your engagement. These community priorities will be a reference for your team and will be used to inform the content you generate in Steps 2-6 in the process. Convening a workgroup can build help build support for your effort along the way so that by the time you are ready to build the project, you have buy-in and support for the alternative from key members in your community who understand and support the goals of the project.

Get Informal Input on Community Priorities

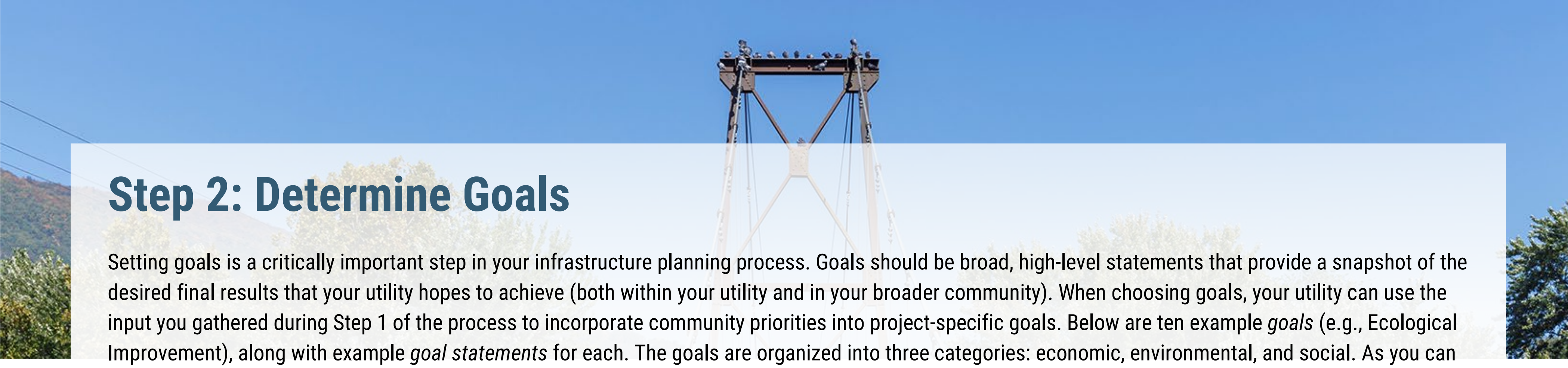
In lieu of, or in addition to establishing a workgroup to develop Community Priorities, your utility may choose to talk with community members, customers, decision-makers, and other key stakeholders in a more informal manner to find out what is important to them. This input can then be used to guide decisions and the selection of goals and objectives (Steps 1-2).

Invite the Community to Weigh In

When ranking the importance of goals (Step 4), you may choose to ask key stakeholders which project goals are most pressing to them and their community. If you've convened a workgroup, you may consider taking a formal vote to help determine the weights of each goal. By considering community priorities, your utility will be well-positioned to identify the right solutions while clearly demonstrating how community input influenced your process.

Communicate the Results

Steps 4-10 primarily deal with translating long-term goals into defined, measurable metrics to evaluate project alternatives. This prepares your utility to discuss why decisions were made with a high level of specificity. The scoring and scaling exercises provide a clear structure to demonstrate the impact of community values on evaluating and scoring the alternatives. Keep in mind that the exercises included in this workbook are specifically designed to bridge the gap between technical and non-technical audiences. Consider circulating your work (e.g., results from Steps 4 or 8) with stakeholders to increase community understanding and support of your final results. When a Project Alternative is selected by the utility, it is a great idea to “close the communication loop” with the key stakeholders by convening a meeting to discuss how the decision was made, to thank them for their help in identifying community needs for the project and enabling the development of improved alternatives, and to explain if and how engagement processes will continue as the project is implemented.



Step 2: Determine Goals

Setting goals is a critically important step in your infrastructure planning process. Goals should be broad, high-level statements that provide a snapshot of the desired final results that your utility hopes to achieve (both within your utility and in your broader community). When choosing goals, your utility can use the input you gathered during Step 1 of the process to incorporate community priorities into project-specific goals. Below are ten example *goals* (e.g., Ecological Improvement), along with example *goal statements* for each. The goals are organized into three categories: economic, environmental, and social. As you can see, different goals and goal statements often overlap.

Example Goals and Goal Statements

Goal	Goal Statement	Economic	Social	Environmental
Public Health	Protect and improve human health and safety	●	●	●
Value of Water and Water Services Promotion	Demonstrate water service benefits to community	●	●	●
Community Livability	Bolster quality of life by adding to the character and features of the community and local environment	●	●	●
Environmental Justice	Ensure infrastructure benefits and costs are equitably distributed, with special consideration of communities bearing disproportionate environmental burdens	●	●	●
Economic Development	Support economic development opportunities for the community	●		
Workforce Enhancement	Support a workforce that is competent and safe-working	●		
Stewardship of Public Resources	Attain lowest feasible full lifecycle cost	●		
System Resiliency and Asset Protection	Minimize infrastructure rehabilitation and replacement cost and prevent/protect against damage to public infrastructure and private property	●		
Ecological Improvement	Improve environmental conditions in the community (e.g., improve aquatic habitats, or reduce stormwater pollutant runoff)	●	●	●

Goal	Goal Statement	Economic	Social	Environmental
Regulatory Performance	Meet or surpass required environmental performance (e.g., NPDES permit requirements, air regulations, biosolids regulations, and other performance requirements)	●	●	●
Water Resource Reliability	Ensure that water availability is consistent with current and future customer and aquatic life needs	●	●	●

GOAL PLANNING IS NOT ONE SIZE FITS ALL!

The examples above may not include all the goals that are important for your utility. Goals should be broad, big-picture statements that define what your utility hopes to achieve. Try to keep increased sustainability and improved performance in mind. Here are a few key questions to consider when setting your utility's goals:

- What opportunities do our infrastructure and operations provide for increased community sustainability and improved utility performance?
- Are there existing community plans or "vision" documents that include sustainability priorities? (e.g., urban planning, brownfields redevelopment, economic development, housing, public health, education transportation, hazard mitigation plans, climate adaptation plans, reductions in greenhouse gas emissions and others)
- Are other community departments, stakeholders, or community groups pursuing sustainability goals and open for cooperation? (e.g., EPA's Integrated Planning Framework)
- Are your proposed goals consistent with your organization's Mission, Vision, Core Values, and Strategic Plan?

Maplebrook Service Authority Step 2

For this workbook we will use Maplebrook Service Authority (MSA) as a hypothetical example to illustrate how a utility can work through and implement each of the ten steps to incorporate triple bottom line Augmented Alternatives Analysis into planning processes.

MSA Needs at a Glance

The economy of the MSA region is heavily reliant on agriculture, both the farming/food production and food processing industries. The numerous farms and food processing facilities are located primarily upstream of the MSA water intake in Maplebrook. Nitrogen Loading from the MSA Water Resource Recovery Facility (WRRF) and agricultural runoff has increased nitrogen in local waterways to high enough levels that may trigger new regulatory permit requirements at MSA.

MSA's wastewater rates are relatively high due to their significant energy consumption coupled with the high cost of energy in the region. They do not recover energy from the wastewater treatment process. More than half of the industry in MSA's service area is food production and processing, which are highly dependent upon reliable, affordable energy for irrigation and industrial processing, respectively.

Another key component of Maplebrook's future economy is the revitalization of its downtown brookfront area. There is a broad interest in adding green space to the town's landscape, in particular along the brook, which has been largely inaccessible since the 1940s. Maplebrook has identified tourism as a key component of the area's future. MSA currently has twenty acres of land dedicated to wastewater solids disposal. There is community interest in some or all of that land being instead used for a community park, consistent with the revitalization vision.

The Maplebrook Municipal Golf Course, located adjacent to the MSA WRRF, has experienced a significant decline over the past decade in their irrigation water quality from their groundwater wells. This has caused major maintenance issues that have endangered the financial viability of the golf course. The green space provided at the golf course contributes to Community Livability. There is a potential for using treated secondary effluent from MSA to preclude the need to use drinking water to irrigate the golf course.

Clearly, Maplebrook's future success is dependent upon cost-effective nutrient removal, maintaining affordable wastewater rates, and creating an attractive, green downtown/waterfront area. Using EPA's Integrated Planning Framework and applying the triple bottom line AAA method would be a great choice to get a clear picture of these multiple goals that address the most pressing problems first and provide the greatest value to the utility and community.

The residential, business, community, other local departments, and industrial community has been very active in providing input into MSA's Master Planning effort as MSA established a process for a series of informal meetings followed by the formal engagement and establishment of a working group. This engagement significantly influenced the establishment of MSA's goals and after internal talks and the discussions with decision-makers, neighboring utilities, and key community stakeholders, MSA identified four goals as part of their long-term Master Planning process: Public Health, Stewardship of Public Resources; Ecological Improvement; and Community Livability. Once these were established, MSA posted the following on their webpage and newsletter to help keep their community informed on the process.

At MSA, our goals for this Master Plan are:

- **Public Health** – Protect and Improve Human Health and Safety
- **Stewardship of Public Resources** – Attain Lowest Feasible Full Lifecycle Cost
- **Ecological Improvement** – Improve Environmental Conditions in The Community
- **Community Livability** – Bolster Quality of Life by Adding to The Features and Character of the Community

Step 3: Define Objectives

Once you have determined the goals that are most important for your community and utility, you will need to define the objective(s) for each goal. Objectives provide you with specific ways to evaluate how each infrastructure alternative will perform when measured against a specific goal. Each objective is a specific, measurable outcome that contributes to the achievement of a goal. Often, an objective is targeted at achieving one aspect of a goal. If you decide to list more than one objective for a goal, take care to make sure that each objective is distinct, rather than stating the same objective in different ways.

When deciding which objectives to use, it's important to think about the real and measurable impact each of your alternatives can have relative to the objective. When setting objectives, take current resources, conditions, and constraints into account. The most effective objectives follow the **SMART**™ principles[1]:

- **S**pecific – What exactly will be achieved?
- **M**easurable – Can you measure whether you are achieving the Objective?
- **A**ssignable – Can you specify who will be responsible for each segment of the Objective?
- **R**ealistic – Do you have the capacity, funding, and other resources available?
- **T**ime-based – What is the timeframe for achieving the Objective?

Check out Appendix A for a list of example objectives for each of the goals identified in Step 1. For an example of how goals can be further refined into objectives, read Maplebrook Service Authority's text below.

[1] Doran, G. T. (1981). "There's a S.M.A.R.T. way to write management's goals and objectives". Management Review. 70 (11): 35–36.

TAKE CARE TO AVOID DOUBLE COUNTING PERFORMANCE ATTRIBUTES

You may choose to use more one or more objectives or one or more criteria to understand how a project alternative will perform relative to an important goal. For example:

- Objective: Reduce Pollutant Loads in Effluent
  - Criteria 1: Nitrogen Loading
  - Criteria 2: Phosphorus Loading

In the above example, it may be appropriate and necessary to include both as criteria. However, take care to avoid using multiple objectives or multiple criteria that measure the same performance attribute as this will result in a "double count." For example:

- Objective: Achieve Least Cost Performance Outcomes
  - Criteria 1: Cost in $ per Million Gallons of Wastewater Treated
  - Criteria 2: Sewer rate cost in $ per year per household

Maplebrook Service Authority Step 3

In Step 3, Maplebrook chose the following objectives and in doing so, provided a more concrete description of what it would look like to achieve relative to each goal.

Goal	Objective
Public Health – protect and improve human health and safety	• Reduce toxins and bacterial growth from receiving water algal blooms
Stewardship of Public Resources – attain lowest feasible full lifecycle cost	• Cost-effectively optimize resource use (energy demand reduction and renewable energy creation) • Achieve least cost performance outcomes
Ecological Improvement – enhance environmental conditions in the community	• Increase natural green space
Community Livability – bolster quality of life by adding to positive features and character of the community	• Improve aesthetics • Improve access to green space and recreational opportunities for low-income residents

Step 4: Rank the Importance of Goals

Now that you have clearly defined goals and objectives, this knowledge can help you consider which of your goals has a higher importance and thus carries more "weight" than others in your unique context and community.

For example, if your utility and community identify Public Health, Stewardship of Public Resources, Ecological Improvement, and Community Livability as your goals, Public Health might be a more pressing goal and therefore ranked "higher" relative to Stewardship of Public Resources and Community Livability. Establishing a rank *("weighting")* can prove to be among the most challenging aspects of working with a community during alternatives analysis, because preferences (and therefore the rank of each goal) are often very dependent on the perspectives of individual stakeholders. To make sure that your analysis takes these preferences into account, you can use the following basic "weighting" framework. This process can also feed directly into an Integrated Plan development if a utility decides to use EPA's Integrated Planning Framework.

Maplebrook Service Authority Step 4

To start, you will determine which of your goals is most important for your utility and community. Instead of ranking goals #1, #2, and #3, this exercise will weight goals a bit differently, on a 1–10 scale (10 being the highest rank and 1 the lowest) to ensure that the goals accurately represent the priorities of your community. The heavier the weight (i.e., 10) the more important the goal. To give you a more concrete idea of this ranking step, follow Maplebrook Service Authority as they rank the importance of their goals below.

Step 1: Maplebrook Service Authority held meetings with the community and selected four goals: Public Health; Stewardship of Public Resources; Ecological Improvement; and Community Livability. Following receipt of input at community meetings, MSA has decided that Public Health is the most important goal for their utility and community. This top priority goal will receive the maximum weight of 10.

Goals for Maplebrook Service Authority	Weight
Public Health – protect and improve human health and safety	**10**
Stewardship of Public Resources - attain lowest feasible full lifecycle cost	
Ecological Improvement - Improve environmental conditions in the community	
Community Livability - bolster quality of life by adding to the features and character of the community	

Step 2: MSA has decided that Stewardship of Public Resources is the second most important goal. Instead of assigning Stewardship of Public Resources a weight of 9 MSA must also determine how important Stewardship of Public Resources is *in relation* to Public Health. They decide that Stewardship of Public Resources is 80 percent as important as Public Health. Stewardship of Public Resources then receives a weight of 8 (10 x 0.8 = 8). MSA found it helpful to refer to the specific language of its Mission, Core Values, and Strategic Plan to help "qualitatively" evaluate the relative level of importance of Stewardship of Public Resources to Public Health in "quantifying" their agreed-to ranking/weighting.

Goals for Maplebrook Service Authority	Weight
Public Health – protect and improve human health and safety	10
Stewardship of Public Resources – attain lowest feasible full lifecycle cost	**8**

Step 3: MSA has decided that Ecological Improvement is the third most important goal. For MSA's community, Ecological Improvement is about 60 percent as important as Public Health. Ecological Improvement therefore will receive a weight of 6 (10 x 0.6 = 6).

Goals for Maplebrook Service Authority	Weight
Public Health – protect and improve human health and safety	10
Stewardship of Public Resources – attain lowest feasible full lifecycle cost	8
Ecological Improvement – augment environmental conditions in the community	**6**

Step 4: MSA has decided that their final goal, Community Livability, is 50 percent as important as Public Health and it receives a weight of 5 (10 x 0.5 = 5).

Goals for Maplebrook Service Authority	Weight
Public Health – protect and improve human health and safety	10
Stewardship of Public Resources – attain lowest feasible full lifecycle cost	8
Ecological Improvement – improve environmental conditions in the community	6
Community Livability – bolster quality of life by adding to the features and character of the community	**5**

As demonstrated in the example above, weighting goals allows you to account for the fact that while your utility may have multiple goals, some may be more pressing or important to your community's specific Mission, Core Values, Strategic Plan, and/or specific infrastructure challenge/situation. Weighting makes sure that this reality is accounted for when evaluating possible alternatives.

CONSIDER HOW DIFFERENCES IN THE NUMBER OF OBJECTIVES, CRITERIA, OR METRICS MAY SKEW GOAL WEIGHTS

While the importance of each goal is reflected in the goal weight, a difference in the number of objectives, criteria (Step 5), or metrics (Step 6) will also change the final weighting of each goal. For example, a goal that has two metrics will result in double the "score" that a goal with only one metric will receive. For some utilities, this will not be a concern while other utilities will want to take care to ensure each goal has the same number of objectives, criteria, or metrics to ensure that the weights assigned in Step 4 do not change. As long as your utility is aware of how the variety in the number of metrics impacts the final weight of the goal, it is okay to choose the approach that works best for your unique context.

Step 5: Establish Criteria

Once you have selected your goals and objectives and weighted the importance of these goals, you will identify criteria to evaluate program, project, and investment alternatives. In the planning process, each alternative will have strengths and weaknesses in their ability to achieve aspects of various goals and objectives. You will use criteria to reveal those strengths and weaknesses clearly to provide a basis for evaluating how each alternative will perform relative to the goals and objectives you have chosen. If you choose more than one criterion for an objective, take care to ensure that criteria are not duplicative.

Below are examples of criteria you can consider. This is not a complete list, but they can provide a starting point for creating your own criteria. Similar to the goals and objectives, you may have more than one criterion under each objective. Each criterion will fall under a certain goal from Step 1.

Social Criteria

Example Social Criteria and Definitions:

Social criteria have people, their health, quality of life, and well-being front and center. Below are two examples of how criteria can help evaluate the impact a project alternative may have on the community.

Goals	Objective	Criteria	Rationale
Public Health – protect and improve human health and safety	Reduce toxins and bacterial growth from receiving water algal blooms	**Nitrogen loading**	Wastewater treatment plants not designed to remove nitrogen may discharge a high concentration of nitrogen into the receiving water, which can lead to bacterial growth and toxic algal blooms in receiving waters. Algal blooms produce “dead zones” in receiving waters, potentially impacting biotic life as well as beneficial public uses including fishing, swimming, and other recreational water sports.
Community Livability – bolster quality of life by adding to the features and character of the community	Improve aesthetics	**Design integrity and Principles**	Utility infrastructure investments can positively or adversely impact a community, for example, by upgrading or degrading the character of a neighborhood. In historically underserved communities, returning blighted areas to beneficial community reuses, including open space and parks, can improve the neighborhood’s access to green space. In another example, consideration of the design and “fit” of industrial structures ensures that the structures will not negatively affect people who live, work, and play in the community.

Other examples of social criteria that may support one or more of the goals and objectives that you have selected include:

- Equitable access to community green space and water for public use and recreation
- Safety risks
- Odor
- Noise
- Truck traffic
- Community design consistency
- Vacant property clean-up and revitalization (brownfield, superfund)
- Apprenticeship/trades programs to enhance green job opportunities for the community
- Joint use facilities (e.g., parks/underground storage, training center, environmental visitor's center)
- Educational opportunities for community
- Public engagement potential
- Business/residential access during construction
- Disaster resilience
- Environmental justice concerns

Economic Criteria

Example Economic Criteria and Definitions:

Economic criteria focus on the flow of money and the effect an alternative will have on the financial bottom line of your utility and community. The example below demonstrates how criteria can help evaluate the economic impact for each project alternative under consideration.

Goal	Objective	Criteria	Rationale
Stewardship of Public Resources – attain lowest feasible full lifecycle cost	Cost-effectively optimize resource use (energy demand reduction and renewable energy creation)	**Net energy consumption (or production)**	How much electricity a utility consumes (and/or produces) can affect the rates a utility must charge and revenue available for future infrastructure investments.

Other examples of economic criteria that may support one or more of the goals and objectives that you may select include:

- Swimmable, fishable waterways
- Flood and drought tolerance
- Energy intensity
- Disaster response and recovery
- Redeveloped properties
- Local material use
- Affordability to community and reduction of upward pressure on utility rates
- Local supplier use
- Local employment and community workforce skills and capabilities
- Cost effectiveness ("knee of curve" analysis and/or ROI analysis)

- Economic value of enhanced reliability of an internal energy source in the event of power outages
- Ability to optimize benefits to community via low-interest loan funding and/or grant-funding
- Effect on utility's bond rating
- Economic benefits of improved waterways for equitable waterfront development and revitalized neighborhoods, including for small businesses and local employmen

Environmental Criteria

Example Environmental Criteria and Definitions:

Environmental criteria address the impacts alternatives can have on local communities' environmental and ecological health, including water quality and quantity, air quality, land revitalization, and overall ecosystem functions.

Goal	Objective	Criteria	Rationale
Ecological Improvement – Augment environmental conditions in the community	Increase natural green space	**Impervious surface area**	Conversion of impervious surface area to natural green space (pervious surface) can improve animal habitats, stream flows, and infiltration.

Other examples of environmental criteria that may support one or more of the goals and objectives that you have selected include:

- Increased biodiversity
- Source water quality
- Reduced nutrient and other contaminant loading to receiving waters
- Floodplain functions
- Per capita water demand
- Water contaminant concentration
- Discharge volume to receiving waters
- Energy type (e.g., renewable)
- Reuse or recycled materials
- Decreased carbon and water footprint
- Enhanced source water protection
- Brownfield redevelopment
- Swimmable, fishable waterways
- Decrease in air quality days

When developing criteria, **don't forget that...**

✓ Criteria should address at least one or more of the three triple bottom line pillars of sustainability – environmental, social, and economic.

✓ Each utility objective with direct relevance to the alternatives under consideration should have at least one criterion set for it.

Step 6: Choose Metrics for Your Criteria

Under Step 5, you refined your goals and objectives to the criteria level. In Step 6, you will establish a “metric” for each of your criteria. Metrics provide a way for you to measure the performance of each alternative. Sometimes, metrics are direct units of measurement, which means they are easily quantified using numbers (e.g., acres, kWh, time, beach closing days, permit violations, Air Quality Index values, commuting times, greenhouse gas emission reductions, etc.). Other times, utilities will need to establish metrics for criteria that do not have clear numerical values (e.g., environmental justice goals and objectives, design integrity, etc.), using a constructed measurement, and this takes some care.

Direct Measurement

Direct measurement is possible when criteria can be easily quantified and measured. For example, the change in net energy consumption can be accurately and precisely measured as the percent reduction in kilowatt hours (kWh) per month and impervious surface areas in acres. In these cases, percent reduction in kWh would be the metric for net energy consumption and acres would be the metric for impervious surface area.

Constructed Measurement

Constructed measurement supports criteria that do not have clear numerical values (known as qualitative criteria), because they are describing the **quality** of something, not the **quantity**. To measure this, utilities will need to use a qualitative “best professional judgment” basis to measure the performance of an alternative.

Essentially, the goal of constructed measurement is to express qualitative criteria in a quantitative manner to establish the ability to compare otherwise unlike performance characteristics of an alternative (e.g., comparing net electricity consumption to design integrity). Check out the MSA example on the next page for more information on how to conduct this step.

Pause and Revisit Project Alternatives

Now is the time to pause and revisit your Project Alternatives, prior to completing the creation of Performance Ranges in upcoming Step 7. This is the last opportunity to further refine/add Project Alternatives in relationship to the goal, objective, and metric analysis above, and in advance of range development and project alternatives benefit/cost analysis. Appendix B contains the hypothetical MSA project alternatives identification and description, along with suggestions for the development of alternatives.

Maplebrook Service Authority Step 6

MSA has decided that each of the below goals, objectives, and criteria are important for their utility. To measure the performance of each alternative in meeting the selected goals, MSA has established a metric they can use to measure each of their four criteria.

Goal	Objective	Criteria	Metric
Public Health – protect and improve human health and safety	Reduce toxins and bacterial growth from receiving water algal blooms	Nitrogen loading	**Percent reduction in nitrogen loading**
Stewardship of Public Resources – attain lowest feasible full lifecycle cost	Optimize resource use (energy)	Net energy consumption	**Percent reduction in net energy consumption**
Ecological Improvement – augment environmental conditions in the community	Increase natural green space	Impervious surface area	**Acres of impervious surface area converted to natural green space (pervious surface)**
Community Livability – bolster quality of life by adding to the features and character of the community	Improve aesthetics	Design integrity	**Index of the natural harmony, cultural alignment, and visual quality of the project in relation to its environment**

Step 7: Create Performance Ranges

Once you have identified project alternatives and refined goals down to the metric level to evaluate the performance of your alternatives, you will need to assign common numerical values to the performance ranges to enable comparability between different types of measurements (e.g., acres and kWh). They are not directly comparable in their current form, such as trying to compare apples to oranges to bananas. At the same time, utilities have difficulty comparing stormwater (e.g., increasing natural green space) and wastewater performance (reducing nitrogen loading) to demonstrate their environmental and community impacts. This step will help municipalities and utilities who are developing an integrated plan to make these comparisons.

For most utilities, a minus five (-5) to plus five (+5) numeric performance range can work well for this evaluation, with a zero (0) being a neutral, “no impact” from existing conditions. A negative and positive range reflects that any alternative or investment used by water sector utilities has the potential for either positive or negative outcomes (for example, Community Livability might decrease or increase depending on the alternative selected).

The example below goes through creating a performance range process for each of the four goals, objectives, criteria, and metrics that MSA has chosen and built out in the previous steps. Creating performance ranges will help you establish a way to compare scores across different alternative analysis criteria and the process of translating metrics unique to each criterion into a performance range. This example will take you through four different metrics and their performance ranges: percent reduction in nitrogen loading; percent reduction in net energy consumption; acres of converted impervious surface area to green space; and index of the natural harmony, cultural alignment, and visual quality.

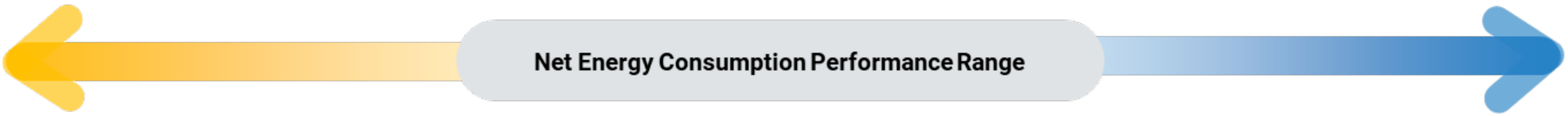
Maplebrook Service Authority Step 7

Example 1: Stewardship of Public Resources

Step 1: In the tables below, MSA has written the corresponding objective, criterion, and metric for the goal:

Stewardship of Public Resources - attain lowest feasible full lifecycle cost
Objective: Optimize resource use (energy)
Criteria: Net energy consumption
Metric: Percent reduction in net energy consumption (kwh)

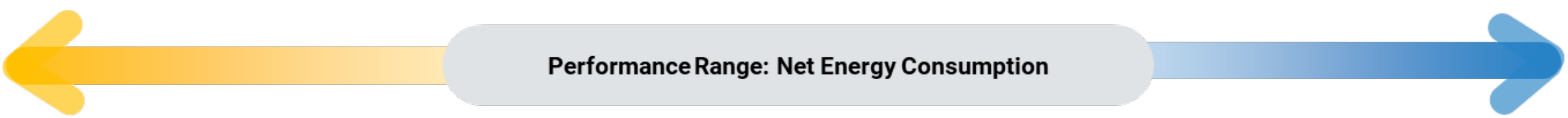
Step 2: To start the process, MSA established what it would mean if there was no change to their metric, net electricity consumption, in the 0 box.



-5	-4	-3	-2	-1	0	1	2	3	4	5
					Alternative has no effect on plant's net energy consumption					

Step 3: Next, MSA must determine if a negative outcome would be acceptable within the community. If any negative impact is unacceptable (e.g., increased human contact with sewage), then they will not consider any alternative that will produce such a result and they will not use the negative side of the range. In this example a negative outcome (i.e., an increase in electricity consumption) is undesirable but acceptable, and the -5 range will be used.

Step 4: Now MSA creates their end points for the range. At +5 they have written down the maximum possible impact they anticipate any alternative will have relative to this criterion. MSA then goes to -5 and does the same. To create a balanced range, they have used the largest possible impact and assigned this value (positive and negative respectively) to both ends of the range.



-5	-4	-3	-2	-1	0	1	2	3	4	5
Increased net energy consumption by more than 50%					Alternative has no effect on plant's net energy consumption					**Decreased net energy consumption by more than 50%**

Step 5: Now, MSA works from 0 to +5 and from 0 to -5 keeping the following points in mind:

- The measurement MSA uses matches how precisely they can characterize the alternatives' performance.
- The incremental change in performance represented by moving up or down the range is the same (or very similar) at each level of the range.

- The complete range of the range corresponds to the widest performance range possible of the alternatives under consideration.
- Each + and – end points should have an identical metric (e.g., -5 = +50%; +5 = -50%).

Performance Range: Net Energy Consumption

-5	-4	-3	-2	-1	0	1	2	3	4	5
Increased net energy consumption by more than 50%		**Increased net energy consumption by more than 30%**			Alternative has no effect on plant's net energy consumption			**Decreased net energy consumption by more than 30%**		Decreased net energy consumption by more than 50%

Example 2: Ecological Improvement

MSA is also interested in determining the impact of each alternative on greenspace in the community and will use the same steps outlined above to create a range for this metric.

Goal	Objective	Criteria	Metric
Ecological Improvement – augment environmental conditions in the community	Increase natural green space	Impervious surface area	Acres of impervious surface area converted to natural green space (pervious surface)

Performance Range: Impervious Area Converted to Pervious Area

-5	-4	-3	-2	-1	0	1	2	3	4	5
Increase in impervious area by more than 20 acres	Increase in impervious area by 15–20 acres	Increase impervious area by 10–15 acres	Increase in impervious area by 5–10 acres	Increase in impervious area by 1–5 acres	No impact on impervious area	Converts 1–5 acres of impervious area to pervious	Converts 5–10 acres of impervious area to pervious	Converts 10–15 acres of impervious area to pervious	Converts 15–20 acres of impervious area to pervious	Converts more than 20 acres of impervious area to pervious

Example 3: Public Health

For certain metrics, MSA has decided it would be more useful to score using a percentage (e.g., five percent above the current state) instead of a numerical value (e.g., 5 acres). Due to the fact that MSA does not reuse any of their wastewater effluent, there will be no negative side of the range as MSA cannot use less than zero.

Goal	Objective	Criteria	Metric
Public Health – protect and improve human health and safety	Reduce toxins and bacterial growth from receiving water algal blooms	Nitrogen loading	Percent reduction in nitrogen loading

To score this metric, MSA has used a 0 to +5 range to establish what outcomes are neutral, and positive for each criterion. Below is MSA's range of impacts and scores:

Performance Range: Nitrogen Loading

-5	-4	-3	-2	-1	0	1	2	3	4	5
					No reduction in nitrogen loading	18%–36% decrease in nitrogen loading	36%–54% decrease in nitrogen loading	54%–72% decrease in nitrogen loading	72%–90% decrease in nitrogen loading	90%+ decrease in nitrogen loading

Example 4: Community Livability

As discussed in Step 5, some metrics are qualitative and do not have numerical values. Below is an example of how MSA created a performance range for an inherently qualitative criterion. MSA still uses a -5 to +5 range to establish what outcomes are negative, neutral, and positive for these types of criteria. The example below illustrates a simplified range of impacts and scores for a qualitative criterion.

Goal	Objective	Criteria	Metric
Community Livability – bolster quality of life by adding to the features and character of the community	Improve aesthetics	Design integrity	Index of the natural harmony, cultural alignment, and visual quality of the project in relation to its environment

Performance Range: Index of the natural harmony, cultural alignment, and visual quality of the project in relation to its environment

-5	-4	-3	-2	-1	0	1	2	3	4	5
Major adverse impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment				Minor adverse impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment	Neutral impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment	Minor beneficial impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment				Major beneficial impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment

ADJUSTING FOR DIFFERENCES IN BENEFITS

Performance outcomes along the performance continuum associated with any criteria might not reflect a linear, stepwise increase in the benefits provided. For example, you might continue to derive enjoyment when moving from one to two scoops of ice cream, but by the time you've eaten ten scoops, you may not be as excited to eat an eleventh scoop. The same situation might be in play with certain of your evaluation criteria. If this is the case, the different levels of the performance range will require an adjustment to calculate a truly accurate representation of benefit. See Appendix D Refinement 1 for a review of a method for addressing such benefit situations.

Step 8: Evaluate the Performance of Each Alternative

Each project alternative that you have chosen will have relative strengths and weaknesses. This next step will help you to score those strengths and weaknesses using the common scaling outlined in Step 7 and assign numerical "scores" by looking at the effect each of your alternatives will have on each metric.

This step should be familiar to any utility that has conducted comparative analysis of alternatives using performance criteria such as reliability, maintainability, and technical performance. Essentially, you will be looking at the design and performance parameters of the alternatives to estimate the nature of the impacts that can be expected relative to the evaluation criteria.

Maplebrook Service Authority

The example below goes through the estimated impacts of an Alternative 1 under consideration by MSA. To determine the estimated impact, this example uses the ranges and metrics derived from MSA's goals and objectives. There are many ways to determine the impact of alternatives, and oftentimes computer software is used to model this impact.

For each metric, MSA must determine the effect the alternative will have on the metric (**Step 1**), then determine how that translates into points as defined by the ranges developed in Step 7 (**Step 2**).

Metric 1: Percent Reduction in Nitrogen Loading

Step 1: MSA will need to determine the effect Alternative 1 will have on nitrogen loading. In Alternative 1, the construction of conventional nitrogen removal (nitrification-denitrification) facilities will provide for 90 percent reduction in nitrogen loading.

Goal	Objective	Criteria	Metric
Public Health – protect and improve human health and safety	Reduce toxins and bacterial growth from receiving water algal blooms	Nitrogen loading	Percent reduction in nitrogen loading

Performance Range: Nitrogen Loading

-5	-4	-3	-2	-1	0	1	2	3	4	5
					No reduction in nitrogen loading	18%+ decrease in nitrogen loading	36%+ decrease in nitrogen loading	54%+ decrease in nitrogen loading	72%+ decrease in nitrogen loading	**90%+ decrease in nitrogen loading**

Step 1: For this reason, MSA will mark Alternative 1 with a +5 as the score for its impact on the reduction of nitrogen loading from MSA's WRRF.

Metric	Alternative 1 Score
Public Health metric 1: percent reduction in nitrogen loading	**+5**
Stewardship of Public Resources Metric 2: percent reduction in net energy consumption	
Ecological Improvement metric 3: acres of impervious surface area converted to natural green space (pervious surface)	
Community Livability metric 4: the natural harmony, cultural alignment, and visual quality of the project in relation to its environment	

Metric 2: Percent Reduction in Net Energy Consumption

Step 1: MSA will need to determine the effect Alternative 1 will have on net energy consumption at their utility. MSA expects this enhancement to provide enough renewable energy to offset some of the energy required for the high energy demand conventional nitrogen removal facilities. The Alternative receives a -3 for Stewardship of Public Resources, because this alternative would still increase net energy consumption by 30 percent at the WRRF.

Goal	Objective	Criteria	Metric
Stewardship of Public Resources – attain lowest feasible full lifecycle cost	Optimize resource use (energy)	Net energy consumption	Percent reduction in net energy consumption (kwh's)

Performance Range: Net Energy Consumption

-5	-4	-3	-2	-1	0	1	2	3	4	5
Increased net energy consumption by more than 50%		**Increased net energy consumption by more than 30%**			Alternative has no effect on plant's net energy consumption			Decreased net energy consumption by more than 30%		Decreased net energy consumption by more than 50%

Step 2: MSA Utility will mark Alternative 1 with a -3 as the score for its impact on Net Reduction in Net Energy Consumption.

Metric	Alternative 1 Score
Public Health metric 1: percent reduction nitrogen loading	+5
Stewardship of Public Resources metric 2: percent reduction in net energy consumption	**-3**
Ecological Improvement metric 3: acres of impervious surface area converted to natural green space (pervious surface)	
Community Livability metric 4: the natural harmony, cultural alignment, and visual quality of the project in relation to its environment	

Metric 3: Reduction in Impervious Area

Step 1: MSA will need to determine the effect Alternative 1 will have on impervious area converted to pervious. Alternative 1 includes converting half of the dedicated solids disposal lagoon acreage to parkland (10 acres), plus converting part of the old treatment site into a seven-acre landscaped rain garden and recreational space made up of native plants and vegetation. This will convert a total of 17 acres of impervious surface into natural greenspace with pervious surface.

Goal	Objective	Criteria	Metric
Ecological Improvement – augment environmental conditions in the community	Increase natural green space	Impervious surface area	Acres of impervious surface area converted to natural green space (pervious surface)

Performance Range: Impervious Area Converted to Pervious Area

-5	-4	-3	-2	-1	0	1	2	3	4	5
Increase in impervious area by more than 20 acres	Increase in impervious area by 15–20 acres	Increase impervious area by 10–15 acres	Increase in impervious area by 5–10 acres	Increase in impervious area by 1–5 acres	No impact on impervious area	Converts 1–5 acres of impervious area to pervious	Converts 5–10 acres of impervious area to pervious	Converts 10–15 acres of impervious area to pervious	**Converts 15–20 acres of impervious area to pervious**	Converts more than 20 acres of impervious area to pervious

Step 2: Alternative 1 receives a +4 for Ecological Improvement, because the chart above shows that a 15–20-acre conversion from impervious to pervious will receive a +4 score.

Metric	Alternative 1 Score
Public Health metric 1: percent reduction in nitrogen loading	+5
Stewardship of Public Resources metric 2: percent reduction in net energy consumption	-3
Ecological Improvement metric 3: acres of impervious surface area converted to natural green space (pervious surface)	**+4**
Community Livability metric 4: the natural harmony, cultural alignment, and visual quality of the project in relation to its environment	

Metric 4: Design Integrity

Step 1: MSA will need to determine the effect Alternative 1 will have on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment. As mentioned above, Alternative 1 also involves the construction of new nitrogen removal and cogeneration facilities, which will bring the facility's fence line and new above-ground industrial structures within sight distance of an existing neighborhood. In discussions with its stakeholders, MSA concludes this represents a minor adverse impact on the natural harmony, cultural alignment, and visual quality in relation to its environment and the alternative receives a -1 score.

Goal	Objective	Criteria	Metric
Community livability – bolster quality of life by adding to the features and character of the community	Improve aesthetics	Design integrity	Index of the natural harmony, cultural alignment, and visual quality of the project in relation to its environment

Performance Range: Index of the natural harmony, cultural alignment, and visual quality of the project in relation to its environment

-5	-4	-3	-2	-1	0	1	2	3	4	5
Major adverse impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment				**Minor adverse impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment**	Neutral impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment	Minor beneficial impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment				Major beneficial impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment

Step 2: MSA will mark Alternative 1 with a -1 as the score for its impact on the natural harmony, cultural alignment, and visual quality of the project in relation to its environment.

Metric	Alternative 1 Score
Public Health metric 1: percent reduction in nitrogen loading	+5
Stewardship of Public Resources metric 2: percent reduction in net energy consumption	-3
Ecological Improvement metric 3: acres of impervious surface area converted to natural green space (pervious surface)	+4
Community Livability metric 4: the natural harmony, cultural alignment, and visual quality of the project in relation to its environment	**-1**

After completing the scoring process for Alternative 1, MSA completed the scoring for Alternatives 2 and 3 and has determined the full "scorecard" for all three alternatives under consideration and their full scorecard is included below.

Metric	Alt 1 Score	Alt 2 Score	Alt 3 Score
Public Health metric 1: percent reduction in nutrient loading	+5	+4	+2
Stewardship of Public Resources metric 2: percent reduction in net energy consumption	-3	+1	+3
Ecological Improvement metric 3: acres of impervious surface area converted to natural green space (pervious surface)	+4	+5	+3
Community Livability metric 4: the natural harmony, cultural alignment, and visual quality of the project in relation to its environment	-1	-1	+1

ACCOUNTING FOR UNCERTAINTY

Some uncertainty about the precise performance an alternative can deliver is common, and in the case where there is substantial (material) uncertainty, an adjustment to the process for deriving a benefit score is needed. Typically, the same experts/stakeholders best positioned to rate or establish performance for a given alternative are also best positioned to estimate the uncertainty of performance. Though many methods for addressing uncertainty exist, a relatively straightforward and common approach is to derive an "expected value" (probability-weighted outcome) for an alternative's performance. This approach is covered in Appendix D Refinement 2.

Step 9: Compare Across Alternatives

Once you have evaluated how each alternative scores against your metrics, you are almost ready to compare across alternatives to decide which alternative is the best option for your utility and community. Step 9 will take you through the process for determining the final score for each of the alternatives by incorporating the rank of each goal as explained in Step 4. If care has been taken in the previous steps to establish a consistent basis for performance evaluation of each alternative across all selected criteria, this step becomes very straightforward. The "total benefit score" of each alternative is merely the sum of each of the individual criterion benefit scores multiplied by the weight of the overall goal. Keep in mind, when using the triple bottom line AAA method under EPA's Integrated Planning framework there is a stronger emphasis in prioritizing clean water and public health protections when comparing alternatives. To demonstrate this concept, below is an example of how MSA compared alternatives.

Maplebrook Service Authority

In order to determine which alternative has the highest score, MSA must consider not only the scores of each alternative, but also the weight, or importance, of each goal. In Step 3, we detailed the process for determining the "weight" for each goal. Each metric that you score will carry the same "weight" as the overall goal itself. The table below includes the weight of each metric for MSA.

Goals for Maplebrook Service Authority	Weight
Public Health – protect and improve human health and safety	10 (most important)
Stewardship of Public Resources – attain lowest feasible full lifecycle cost	8
Ecological Improvement – improve environmental conditions in the community	6
Community Livability – bolster quality of life by adding to the features and character of the community	5

Metrics for Maplebrook Service Authority	Weight	Alt 1 Score	Alt 2 Score	Alt 3 Score
Public Health metric: percent reduction in nutrient loading	**10**	+5	+4	+2
Stewardship of Public Resources metric: percent reduction in net energy consumption	**8**	-3	+1	+3
Ecological Improvement metric: acres of impervious surface area converted to natural green space (pervious surface)	**6**	+4	+5	+3

Metrics for Maplebrook Service Authority	Weight	Alt 1 Score	Alt 2 Score	Alt 3 Score
Community Livability metric: the natural harmony, cultural alignment, and visual quality of the project in relation to its environment	**5**	-1	-1	+1

To determine the Total Score for each alternative, each score is multiplied by the weight to determine the weighted score. For example, the metric, "Percent Reduction in Nutrient Loading" received a weight of 10 and a score of +5 for Alternative 1 (5*10 = +50). This metric will receive a weighted score of 50. The total score is the sum of weighted scores across all metrics for each alternative.

Metric	Weight	Alt 1 Weighted Score	Alt 2 Weighted Score	Alt 3 Weighted Score
Public Health Metric: Percent Reduction in Nitrogen Loading	**10**	5*10 = **50**	4*10 = **40**	2*10 = **20**
Stewardship of Public Resources Metric: Percent Reduction in Net Energy Consumption (kwh)	**8**	-3*8 = **-24**	1*8 = **8**	3*8 = **24**
Ecological Improvement Metric: Reduction in impervious area converted to pervious in acres (acres)	**6**	4*6 = **24**	5*6 = **30**	3*6 = **18**
Community Livability Metric: The natural harmony, cultural alignment, and visual quality of the project in relation to its environment	**5**	-1*5 = **-5**	-1*5 = **-5**	1*5 = **5**
TOTAL SCORE		**45**	**73**	**67**

SENSITIVITY TO WEIGHTING

Once you have had a chance to review the weighted scores of your alternatives, you may want to explore how robust their results are even if the relative weightings of the goals are changed slightly. This is known as a sensitivity analysis. To conduct a sensitivity analysis, make small changes to the weights you assigned to your goals. Once you have changed the weights, determine if the results lead to a different recommendation. If the initial recommendation does not change when these adjustments are made, then that increases the confidence in the "correctness" of the outcome. On the other hand, if these adjustments would point to different recommended alternatives, the utility may then want to consider how firmly it wants to adhere to the initial weightings. More information on this concept can be found at Attachment D, Refinement 3.

Step 10: Incorporate Cost Considerations

We have not yet addressed the incorporation of costs into the alternatives analysis process. This is the point at which you can decide to stop at Step 9 with a total benefits score. However, it is the reality that cost is oftentimes one of the most important considerations for your utility, and you may choose to combine the benefit scores with the cost of the alternatives to derive a cost/non-monetized benefit calculation. By incorporating cost as a consideration in Step 10, your utility will be able to determine the amount of benefit your utility can receive for the cost of the alternative. This is referred to as the benefit-cost ratio. Check out the example below to see how MSA incorporated cost considerations into their process.

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In this example, if cost were not a factor, which is unlikely, MSA would have chosen Alternative 2 as the better choice as it received the highest Total Score of 73 in comparison to Alternative 1, which received 45, and Alternative 3, which received 67.

	Alternative 1	Alternative 2	Alternative 3
Total Score	45	**73**	67

However, cost is a key consideration, so MSA must analyze the total score while considering the cost of each alternative. Alternative 1 is estimated to cost $3 million, Alternative 2 is estimated to cost $4 million, and Alternative 3 is estimated to cost $3.9 million.

	Alternative 1	Alternative 2	Alternative 3
Total Score	45	73	67
Annualized Project Capital and O&M Cost	**$3 Million**	**$4 Million**	**$3.9 Million**

To determine the benefit-cost ratio, MSA will divide the total score (or "benefit") by the cost. Alternative 1 has a total score of 45 divided by the cost of 3 million (45/3= 15). Alternative 1 has a benefit-cost ratio of 15. Alternative 2 has a benefit-cost ratio of 18.2 (73/4 = 18.3). Alternative 3 has a benefit-cost ratio of 17.2 (67/3.9=17.2).

	Alternative 1	Alternative 2	Alternative 3
Total Score	45	73	67
Cost	$3 Million	$4 Million	$3.9 Million
Benefit-Cost Ratio	**15.0**	**18.3**	**17.2**

In this example, Alternative 2 is the preferred alternative, as it is the project with the overall highest benefit-cost ratio, even though it is the highest cost project. One way to think about this result is that Alternative 3 requires an annualized expenditure of $58,209 per each benefit point, while Alternative 2 only requires $54,795 per benefit point.

TIME SENSITIVITY AND DISCOUNTING

Each alternative you consider may have very different timeframes for when costs are incurred and when the utility and community may see the benefits of the alternative. It is well known that people value receiving benefits sooner rather than later and prefer to incur costs later rather than sooner. Therefore, to improve the fairness and accuracy of comparing alternatives, the time distribution of both costs and benefits should be considered. The method of adjusting costs and benefits to account for time is called discounting, and the result of discounting identifies the "present value" of both costs and benefits that are distributed over time. Visit Attachment D, Refinement 4 for more information.

Conclusion

The 10 Steps in this workbook allow water sector utilities to conduct a robust comparison of project alternatives by incorporating and standardizing the full range of benefits associated with those projects into their evaluation process. The methods outlined throughout this workbook provide a structure by which you can make sound and transparent infrastructure investment decisions, leading to greater overall benefits and community sustainability. AAA can be useful as a stand-alone planning document, or for developing a variety of planning documents. For example, it could be used to develop an integrated plan that meets EPA's Integrated Planning Framework. It could also be used for developing resiliency plans, sustainability plans, green infrastructure master plans, or other planning processes.

Having the capacity to compare a range of infrastructure alternatives objectively is critical to a water or wastewater utility's long-term sustainability and its ability to serve the needs of its community. For additional resources and information on sustainable utility management for water and wastewater utilities, please visit EPA's website: http://water.epa.gov/infrastructure/sustain/watereum.cfm.

Appendix A: Examples of Sustainability Goals with Related Objectives

The list is not meant to be exhaustive. Rather, it is included to provide a starting point for determining the right objectives for your utility.

EXAMPLES OF SUSTAINABILITY GOALS WITH RELATED OBJECTIVES

Goals	Examples of Possible Objectives
Public Health – protect and improve human health and safety	• Limit flooding in combined sewer system areas • Reduce human contact with hazardous compounds or contaminants • Reduce solids and floatables • Improve receiving water quality* • Achieve water quality at or below allowable contaminant limits*
Value of Water & Water Services Promotion – demonstrate water service benefits to community	• Improve public understanding of water services • Increase public support for utility rates and investment needs
Community Livability – bolster quality of life by adding to the features and character of the community	• Improve aesthetics • Enhance public space • Create/enhance recreational opportunities • Ensure consistent land use
Environmental Justice – Ensure infrastructure benefits and costs are equitably distributed, with special consideration of communities bearing disproportionate environmental burdens	• Provide tangible benefits to historically underserved communities • Address systematic and institutional barriers for historically underserved communities • Address inequities of stormwater impacts
Economic Development – support economic development opportunities for the community	• Support community development plans • Encourage redevelopment • Job opportunities
Workforce Enhancement – support a workforce that is competent and safe-working	• Improve professional development opportunities • Minimize operational complexity • Meet all current safety requirements
Stewardship of Public Resources – attain lowest feasible full lifecycle cost	• Meet appropriate affordability considerations • Achieve least cost performance outcomes • Achieve predictable and adequate rates • Optimize resource use (e.g., energy, water, materials, system capacity)

Goals	Examples of Possible Objectives
Ecological Improvement – augment environmental conditions in the community	• Improve receiving water quality* • Meet drinking water standards • Protect aquatic and terrestrial habitat • Improve riparian corridor conditions • Reduce greenhouse gas emissions • Improve ambient air conditions • Increase greenspace
Regulatory Performance – comply with permit requirements and other performance requirements	• Meet/exceed capture targets (e.g., CSO) • Meet/exceed treatment targets • Meet/exceed water quality based permit limits • Achieve water quality at or below allowable contaminant limits*
Water Resource Reliability – ensure that water availability is consistent with current and future customer needs	• Enhance reuse • Encourage recharge • Improve environmental flows • Increase water use efficiency • Improve source water protections
System Resiliency and Asset Protection – minimize repair cost and prevent/protect against damage to public infrastructure and private property	• Increase flexibility to adapt to changing conditions (e.g., water resource availability) • Improve operational resilience • Improve resistance to storm surges • Reduce flooding events • Reduce basement backups

**Some objectives fit under multiple goals and have been mentioned more than once to illustrate that there is a great deal of overlap. However, to avoid duplication, do not use objectives more than once.*

Appendix B: Identifying Project Alternatives

A critical step in selecting a preferred project is the identification of several **feasible** project alternatives that address the identified "needs," which are established in Step 2 of the AAA process. Utilities may begin the project identification phase by creating/brainstorming a list of potential project alternatives, sometimes as many as five to eight alternatives. Next, they evaluate which of these are deemed to be infeasible for various reasons (e.g., an alternative that does not meet a required regulatory compliance limit or that is inconsistent with the organization's values). With closer scrutiny, several alternatives may actually be small variations to another alternative, allowing for combining into one alternative.

Typically, utilities will then establish a "short list" of three or four preferred project alternatives for detailed evaluation and selection. In some instances, establishing only two alternatives can work, particularly if utility "needs" are relatively few and the potential options to address them are limited. The cost of establishing five or more alternatives for detailed evaluation often outweighs the benefit of adding the additional alternatives, as each requires detailed capital and operating life cycle cost projections. We'll go through three example alternatives using the hypothetical Maplebrook Service Authority project example below.

Maplebrook Service Authority – Project Alternatives

In our Maplebrook Service Authority example, MSA has identified three alternatives for detailed evaluation that are considered feasible options to address the community's key issues: 1) nutrient pollution of Maplebrook; 2) the high impact of energy costs on wastewater rates; 3) the desire to increase green space; and 4) bolstering the community's quality of life while implementing a project to address the first three issues. (For a more complete review of key issues, visit Step 2: Needs at A Glance.)

The following is brief description of each of the three MSA alternatives:

Alternative 1

- **Build conventional nitrogen removal (nitrification and denitrification) and anaerobic digestion/biogas cogeneration facilities**
- **Convert old site into rain garden and recreational space**

Alternative 1 includes the construction of new conventional nitrogen removal (nitrification and denitrification) and anaerobic digestion cogeneration facilities that will successfully address any future nitrogen regulatory requirements by reducing nitrogen levels by 90 percent and free up one half (10 acres) of the 20 acres of dedicated wastewater solids disposal lagoon for community use. Alternative 1 proactively addresses the nutrient issue, even though new nitrogen regulatory requirements may not be established for some time. This alternative therefore eliminates the future nitrogen compliance risk but does increase the cost-effectiveness risk due to the high life cycle cost of conventional nitrogen removal facilities—particularly the related increased energy consumption.

The new anaerobic digestion facility will reduce the currently needed 20 acres of dedicated wastewater solids disposal by 50 percent, freeing up 10 acres for greenspace or other utility and/or community benefit. This facility will also serve to reduce odors in the downtown area, particularly during the hot summer months. A new cogeneration facility will produce enough electricity to offset a portion of the energy needed for nitrogen removal.

Alternative 1 also includes converting part of the old treatment site into a landscaped rain garden and recreational space made up of native plants and vegetation, resulting in seven acres of impervious surface converted into greenspace with pervious surface. This alternative, however, would make MSA a more significant net consumer of energy due to the high energy demand of nitrogen removal facilities.

Alternative 2

- **Build sidestream nitrogen removal, non-potable water reuse, anaerobic digestion/biogas cogeneration, and composting facilities**

Alternative 2 includes the construction of sidestream nitrogen removal, non-potable water reuse, anaerobic digestion/biogas cogeneration and composting facilities that will significantly reduce nutrient concentrations using sidestream nitrogen removal by 36 percent. The treatment required for water reuse would lead to additional nutrient removal of 25 percent and may meet future nitrogen regulations with a potential net reduction of 61 percent of nitrogen loading. The reuse of highly treated wastewater biosolids for use as fertilizer in lieu of chemical fertilizers will provide a beneficial reuse opportunity that will benefit the agricultural community. Anaerobic digestion coupled with the avoidance of high energy consumption conventional nitrogen removal would provide an opportunity for MSA to become a net producer of energy. This alternative is “greener” than Alternative 1, as existing facilities can be modified for sidestream nitrogen removal. In addition, this alternative would reduce net energy consumption, even with the added water reuse facilities and shift wastewater solids from “disposal” to “reuse.”

The golf course adjacent to the MSA WRRF would use irrigation water from the water reuse facility, allowing it to discontinue use of their groundwater wells which have caused significant maintenance issues due to the increasing salt content of water from the wells. As mentioned above, this alternative also contributes a 25 percent reduction in nitrogen loading to Maple Brook, by reducing wastewater effluent discharged into the waterway.

Alternative 2 would provide for a reduction in impervious plant area via a green roof composting facility. It would also allow for the complete transformation of the existing 20 acres of solids disposal lagoons into park/green space. It may not fully address future nutrient removal requirements if regulations ultimately require that, however it would provide for significant reductions and would not preclude a future expansion to mainstream nitrogen removal if needed in the future. More public engagement may be required with the agricultural community to educate them on the benefits of biosolids reuse rather than continuing the use of expensive chemical fertilizers.

Alternative 3

- **Build sidestream nitrogen removal, anaerobic digestion/biogas cogeneration, and composting facilities**
- **Construct solar or wind energy generation facilities**

Similar to Alternative 2, Alternative 3 includes sidestream nitrogen removal facilities that may meet future regulatory requirements and provides anaerobic digestion/biogas cogeneration and composting facilities that will increase renewable energy production and transform biosolids disposal to reuse. The alternative further increases renewable energy production through the addition of solar and/or wind energy generation.

Alternative 3 does provide additional renewable energy production via solar or wind generation in addition to recovering energy via the biogas cogeneration facility. Alternative 3 would require using half of the 20 acres of current wastewater solids disposal lagoons for siting solar panels and/or wind turbines. Finally, this alternative provides for a positive first step toward nitrogen reduction and is the most successful alternative in decreasing net energy demand.

Appendix C: Key Resources

Integrated Municipal Stormwater and Wastewater Planning Approach Framework

This framework provides guidance for EPA, states, and local governments to develop and implement effective integrated plans under the CWA. This framework was finalized after extensive public input including a series of workshops across the country. *Available online:* https://www.epa.gov/npdes/integrated-municipal-stormwater-and-wastewater-planning-approach-framework

Making the Right Choices for Your Utility & Community - Case Studies

EPA undertook three pilot projects working with different organizations and their communities and stakeholders. Using an augmented alternatives analysis approach, each project used sustainability criteria to compare infrastructure alternatives based on the triple bottom line approach of environmental, economic, and social criteria. These case studies demonstrate how organizations in very different contexts applied the AAA process to reach their goals.

- Camden County Municipal Utilities Authority: *Available online: https://www.epa.gov/sites/default/files/2018-01/documents/camden_case_study-1-16-18.pdf*
- *High Line Canal Conservancy and Saco WRRD: Available online: https://www.epa.gov/system/files/documents/2021-09/right-choices-utility-case-examples.pdf*

Water Utilities as Anchor Institutions

This report highlights how forward-thinking leaders are reaching outside the fence lines and beyond the day to day operation of their utilities to more positively impact their communities through a variety of activity areas to act as anchor institutions and impact their communities. The report includes examples of how utilities promote environmental justice, sustain critical infrastructure investments, and partner with others to advance community goals, often with a focus on utility leadership toward community equity. *Available online: https://www.epa.gov/sustainable-water-infrastructure/water-utilities-anchor-institutions*

Effective Utility Management: A Primer for Water and Wastewater Utilities

The Primer presents a framework for water and wastewater utility managers to use when assessing the effectiveness of their utilities. The framework is based on a series of 10 Attributes of Effectively Managed Utilities and Keys to Management Success. *Available online:* http://www.watereum.org

Rural and Small Systems Guidebook to Sustainable Utility Management

The Guidebook uses the same Effective Utility Management framework as the Primer but is tailored to the needs of rural and small systems. *Available online:* https://www.epa.gov/sustainable-water-infrastructure/rural-and-small-systems-guidebook-sustainable-water-and-wastewater

Moving Toward Sustainability: Sustainable and Effective Practices for Creating Your Water Utility Roadmap

Using the same Effective Utility Management framework as the two previous documents, this document identifies a series of proven and effective managerial practices to improve utility operations over time and move toward sustainability, at a pace consistent with utility needs and the needs of its community. *Available online:* https://www.epa.gov/sustainable-water-infrastructure/moving-toward-sustainability-sustainable-and-effective-practices

Appendix D: Potential Refinements

Refinement 1: Adjusting for Differences in Benefits

Performance outcomes along the continuum of any measurement range might not reflect a linear, stepwise increase (or decrease) in the benefits provided. The "Law of Diminishing Returns" is one reflection of such a situation. Diminishing returns refers to the outcome where an additional unit of performance beyond a certain level no longer provides the same rate or benefit (marginal utility) as previous performance improvement increments. For example, you might continue to derive enjoyment when moving from one to two scoops of ice cream, but by the time you've eaten ten, an eleventh probably will not be so desirable. The same outcome may be in play with some of your evaluation criteria. If this is the case, the different levels of the performance range will require an adjustment to calculate a truly accurate representation of benefit. There are sophisticated mathematical methods for deriving marginal utility; however, non-linear benefits adjustments can also be made by simply translating the linear raw score range into a Benefits Adjusted Range reflective of the interests and perspectives provided by community members or technical experts.

Example:

The table on the next page provides the raw score scaling for the permeable surface impacts of alternatives as presented in Step 7 of the main text. The initial constructed range is essentially linear, with the constructed range score reflecting equal increments of change in the amount of permeable surface affected by an alternative with a corresponding 1 benefit point increase or decrease. The benefits adjusted range indicates, however, that the community and/or utility wishes to reflect three distinct aspects of the loss or gain of permeable surface:

(1) Even low levels of permeable surface loss raise substantial concern for members of the community, and they wish to substantially penalize alternatives that lead to any amount of permeable surface loss. This is reflected by, for example, converting the -2 raw score associated with the loss of between 5 and 10 acres of permeable surface to a -3.5 benefits adjusted score. This creates additional -1.5 benefits score "penalty" for this level of permeable surface loss.

(2) Initial gains of permeable surface are valued more highly than later gains. This is reflected, for example, when converting the +2 raw score associated with the gain of between 5 and 10 acres to a +3 benefits adjusted score. This change reflects an incremental benefits adjusted score increase of 1.0 (from 2.0 to 3.0). This preference is further reflected in the incremental benefit between the raw scores of 4 and 5, while the benefits adjusted scores are 4.5 and 5.0, respectively (a 0.5 point increase in benefit).

(3) A loss of low levels of permeable surface is of greater concern than the desirability of adding low levels of additional permeable surface. This is reflected in the -2 benefits points assigned to the first increment of permeable surface loss (loss between 1 and 5 acres), and the 1.5 benefits points assigned to the first increment of permeable surface gain (gain between 1 and 5 acres).

METRIC: Acres

-5	-4	-3	-2	-1	0	1	2	3	4	5	Benefits Adjusted Score
-5	-4.75	-4.5	-3.5	-2	0	1.5	3	4	4.5	5	←
Increase in impervious area by more than 20 acres	Increase in impervious area by 15–20 acres	Increase impervious area by 10–15 acres	Increase in impervious area by 5–10 acres	Increase in impervious area by 1–5 acres	No impact on impervious area	Converts 1–5 acres of impervious area to pervious	Converts 5–10 acres of impervious area to pervious	Converts 10–15 acres of impervious area to pervious	Converts 15–20 acres of impervious area to pervious	Converts more than 20 acres of impervious area to pervious	

Once the conversion from raw scores to benefits adjusted scores has been made, the benefits adjusted score is used in the overall calculation of benefits for alternatives.

Refinement 2: Accounting for Uncertainty

Each alternative, because it will be implemented in the future, has an element of uncertainty. In the case where there is a high level of uncertainly, you will want to make sure that your analysis reflects this uncertainty. Typically, the individual with the expertise responsible for scoring a metric will have the appropriate level of knowledge to estimate the level of uncertainty as well. Though many methods for addressing uncertainty exist, many are quite complicated and require specialized software support. For this exercise, a relatively straightforward and common approach is to determine an "expected value" (probability-weighted outcome) for an alternative's performance.

Example:

If Maplebrook Service Authority is considering an alternative that has a high level of uncertainty, they can determine the expected value by identifying the different possible outcomes and determining the probability of each scenario occurring. In this example, Alternative 1 has three different levels of possible net kWh production levels. To calculate the Expected Value, MSA will use the following equation:

Production Level	Likelihood of this Outcome	kWh/Month
Low	20%	150,000
Moderate	60%	200,000
High	20%	250,000

- Expected Value = (*Likelihood of Low Production Level* x *kWh/Month*) + (*Likelihood of Medium Production Level* x *kWh/Month*) + (*Likelihood of High Production Level* x *kWh/Month*)
- Expected Value = (0.2 x 150,000) + (0.6 x 200,000) + (0.2 x 250,000)
- Expected Value = 200,000 kWh

The Expected Value (200,000 kWh) would then be used in all calculations concerning net electricity production. Note that when assigning probabilities to each potential performance outcome, the sum across all assigned probabilities must equal 1 (or 100 percent).

Refinement 3: Sensitivity to Weighting

Step 4 in this guide asks you to rank the importance of your goals and assign them a weight. This is an essential step for determining the preferred alternative. Some utilities may want to explore how robust their results are even if the relative weightings of the goals are changed slightly. This is known as a sensitivity analysis. To conduct a sensitivity analysis, make small changes to the weights you assigned to your goals. Once you have changed the weights, determine if the results of the worksheets lead to a different recommendation. If the initial recommendation does not change when these adjustments are made, then that increases the confidence in the "correctness" of the outcome. On the other hand, if these adjustments would point to *different* recommended alternatives, the utility may then want to consider how firmly it wants to adhere to the initial weightings. If the initial weightings are confidently held, the initial result can prevail. If weightings are debatable, the utility may want to be transparent about how the results could be different with slightly different weightings.

Refinement 4: Time Sensitivity and Discounting

Each alternative you consider may have very different timeframes for when costs are incurred and when the utility and community may see the benefits of the alternative. For example, if a utility decides to reduce impervious surfaces and convert the green space into a recreational space, there are a few key questions that should be answered. For example, what will the capital costs be (e.g., construction)? How long will it take for the community to enjoy the benefits? Will it take months? Years?

Typically, the flow of benefits to customers from a construction project will be spread out over many years or decades and many projects will incur costs over the life of the project (e.g., operational costs) in roughly the same proportion as the benefits that customers enjoy from the project. It is well known that people value receiving benefits sooner rather than later, and prefer to incur costs later rather than sooner. Therefore, to improve the fairness and accuracy of comparing alternatives, the time distribution of both costs and benefits should be taken into account. The method of adjusting costs and benefits to account for time is called discounting, and the result of discounting identifies the "present value" of both costs and benefits that are distributed over time.

Some utilities may want to refine their analysis by incorporating discounting, especially if the alternatives being considered have widely different time distributions of costs and benefits. Resources describing the discounting methodology are widely available, including from EPA.

Making the Right Choices for Your Utility:
Using Community Priorities and Sustainability Criteria for
Water Infrastructure Decision-Making

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