Ensuring One Water Delivers for Healthy Waterways:

A Framework for Incorporating Healthy Waterways into One Water Plans and Projects

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About the Organizations:

The National Wildlife Federation is a partner in the **Texas Living Waters Project**, a collaboration of conservation organizations working to ensure fresh water will be available to support both the people of Texas and the wildlife and habitats that constitute the state's natural heritage. Our project partners are the Lone Star Chapter of the Sierra Club, Galveston Bay Foundation, and Hill Country Alliance. Learn more about the Texas Living Waters Project at ***texaslivingwaters.org***.

The Meadows Center for Water and the Environment at **Texas State University** is dedicated to inspiring research, innovation and leadership that ensures clean, abundant water for the environment and all humanity. We collaborate to engage in scholarly inquiry and provide practical, science-based solutions to complex water-related challenges across Texas and around the world. Learn more at ***meadowswater.org***.

The Pacific Institute envisions a world in which society, the economy, and the environment have the water they need to thrive now and in the future. In pursuit of this vision, the Institute creates and advances solutions to the world's most pressing water challenges. More information about the Institute and our staff, directors, and funders can be found at ***pacinst.org***.

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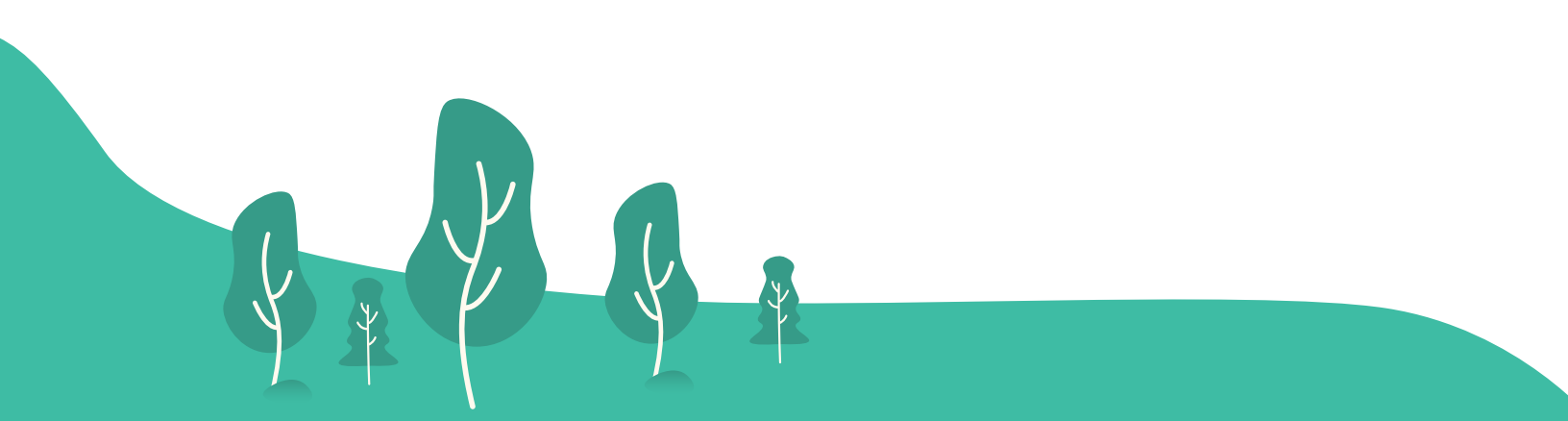

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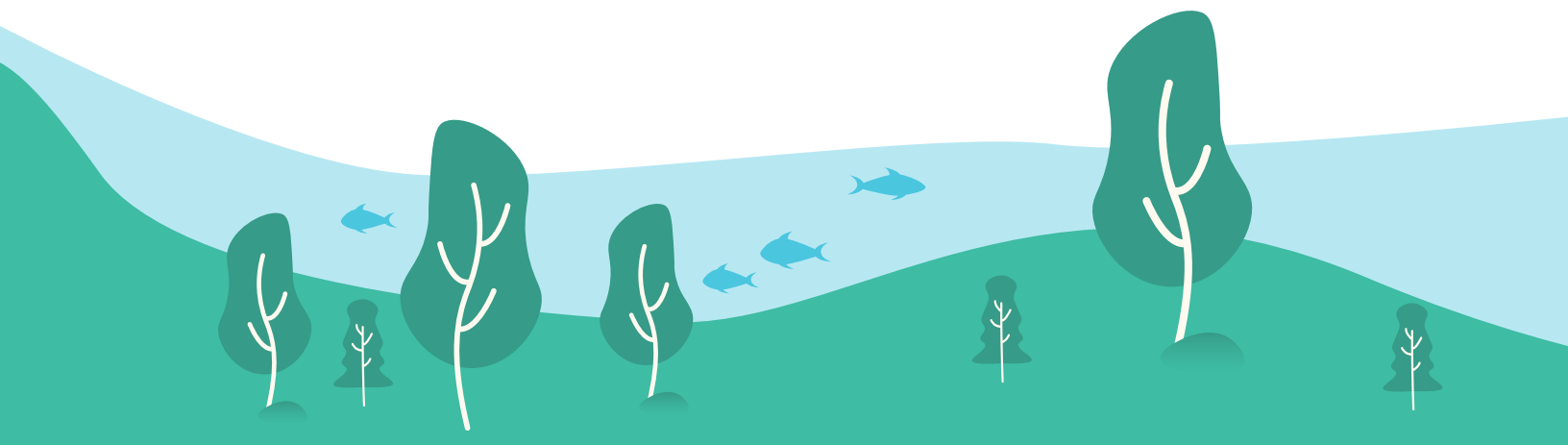


Healthy Waterways, an Essential Component of One Water

The One Water approach offers tremendous opportunities for improving how water is managed within communities. Using water efficiently and taking advantage of diverse, locally available water supplies are important goals. It is also important that the approach support communities in assessing how their water use affects the health of waterways, both upstream, where water is sourced, and downstream, where other communities and aquatic resources may be impacted.

Local water capture and reuse technologies are some of the most successful innovations featured in One Water plans and projects. However, they may also pose an inadvertent threat to river flows as maximum use of these sources can starve natural systems of needed flows and potentially reduce water available to communities downstream. To realize the full potential of the One Water approach, planners should explicitly acknowledge and quantitatively assess potential threats to healthy waterways, and incorporate actions to protect (and where possible, enhance) river flows downstream for the benefit of people and the environment.

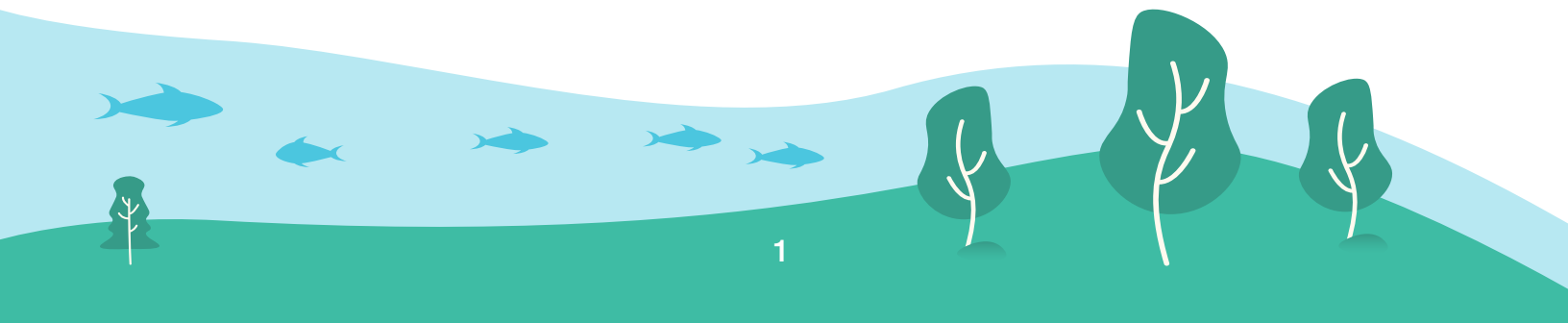
> **One Water is an integrated planning and implementation approach to managing finite water resources for long-term resilience and reliability, meeting both community and ecosystem needs.**
>
> Blueprint for One Water
> Water Research Foundation, 2017

We present the following framework to assist communities in implementing the One Water approach in a way that optimizes water supplies to cities and keeps water flowing for the creeks, rivers, and bays that support healthy fish, wildlife, and their habitats.

A Framework for Incorporating Healthy Waterways

The One Water approach is intended to facilitate comprehensive water management by enhancing coordination between the different entities or departments that manage water within a community. Early applications of the One Water approach have successfully focused on breaking down these organizational divisions, or silos, and improving the way different programs or branches within a city or private water supplier communicate and cooperate in managing water. However, in many water planning and implementation efforts, geographical silos persist, with individual water utilities focusing primarily on what happens within their specific jurisdictional boundaries. While a narrow geographic focus is understandable, it represents a missed opportunity for considering water management on a larger watershed scale that would benefit communities and ecosystems throughout the watershed. Working towards managing water resources on a watershed scale, as is promoted by the One Water approach, will increase the predictability and reliability of water supplies over the long-term.

The One Water Roadmap acknowledges the need to escape these geographical silos by including healthy waterways (recently updated by the U.S. Water Alliance to “healthy watersheds”) among the six interconnected arenas for action: reliable and resilient water utilities, thriving cities, sustainable agriculture, competitive business and industry, social and economic inclusion, and healthy waterways.[1]



In 2019, the Texas Living Waters Project surveyed One Water practitioners across the nation about how they approach healthy waterways considerations in their One Water planning.[2] We learned that the utilities leading the way in incorporating environmental considerations (e.g., Los Angeles and San Francisco) prioritized public engagement to guide their planning. In doing so, the utilities consistently found that their customers care about both the health of their local waterways and the impact of utility actions on those waterways. The 2019 survey resulted in several other significant insights:

- Project goals, such as environmental flow protection, must be identified and incorporated very early and transparently in the One Water planning process, using an approach that engages a broad set of stakeholders.
- Even for processes affirmatively seeking to advance healthy waterways, practitioners need guidance on how to be effective, including on how to evaluate environmental flow needs and how to engage the public.
- Practitioners are seeking examples of successful efforts to incorporate healthy waterways considerations into One Water projects.
- Regulatory compliance requirements (e.g., water quality regulation) may override other One Water considerations and objectives, particularly if not adequately factored into the process early on.

The framework presented here builds on the insights of the 2019 study by providing an approach for proactively incorporating healthy waterway goals into One Water planning and implementation. We outline practical guidance on how to both engage with stakeholders and incorporate consideration of healthy waterways into the One Water planning process.

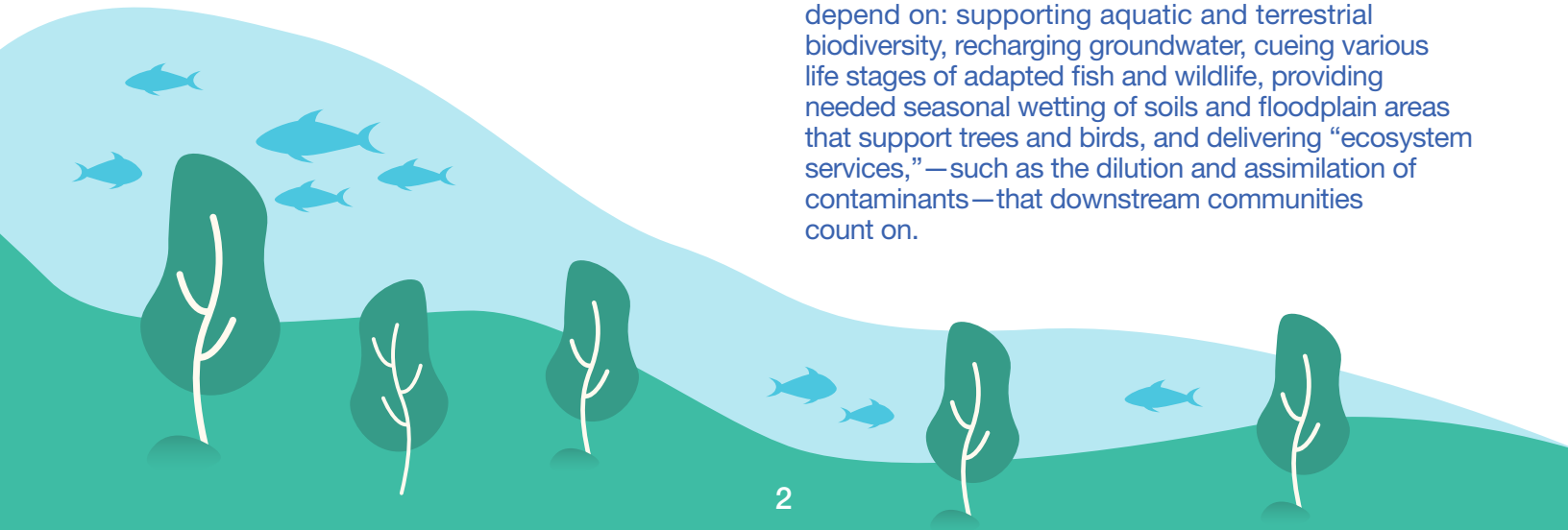
Why Use a Healthy Waterways Planning Framework?

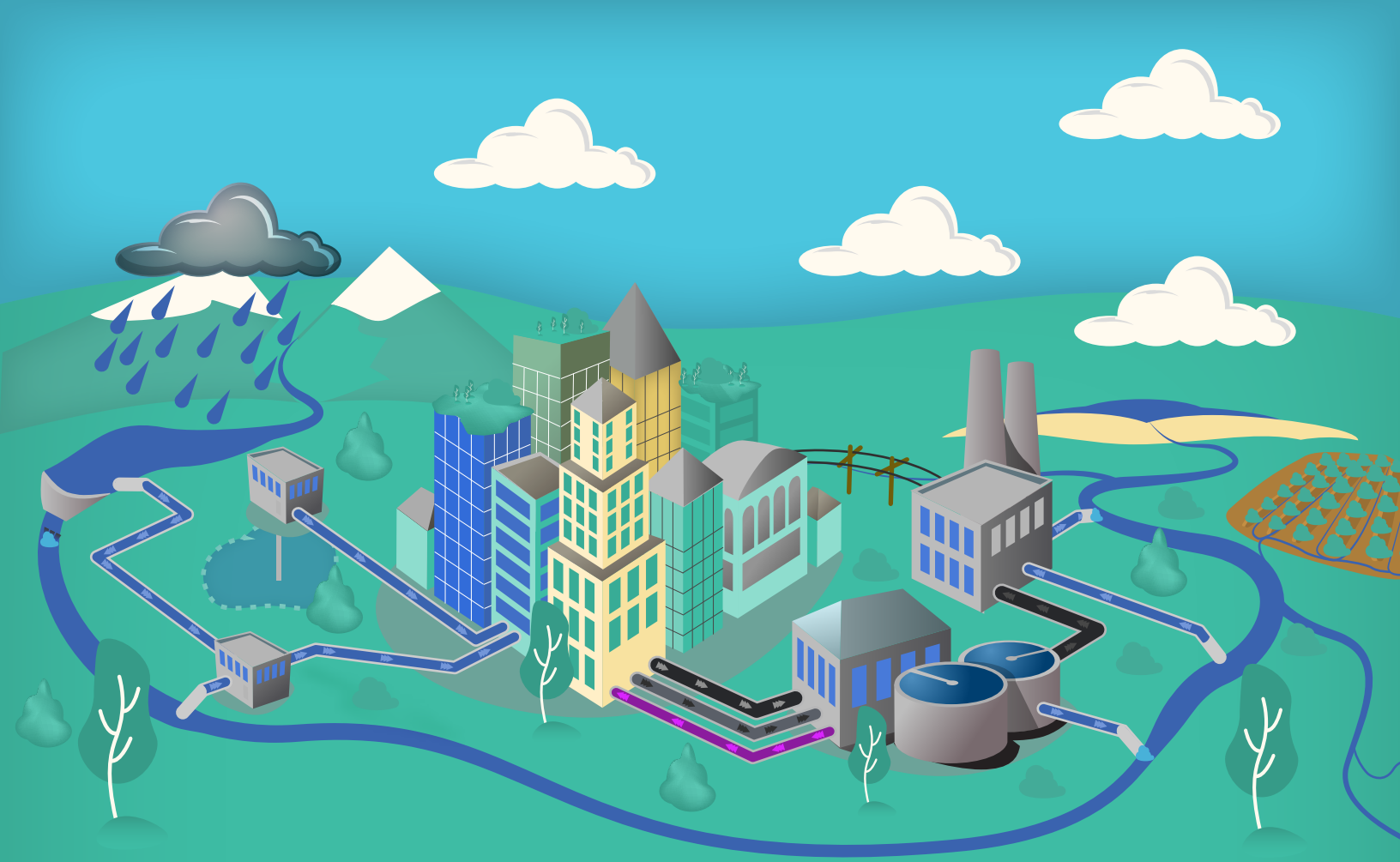
The quantity and quality of our nation's waters have been dramatically affected by human activities. In a 2013 national assessment, the U.S. Geological Survey noted that flow magnitude has been altered, either through an increase in high flows or a decrease in low flows (or a combination of both), in 86% of streams assessed across the country.[3] Changes in flows, including magnitude of flow, seasonality of flow, and rate of change in flow magnitude, can have implications for the ecological health of streams and riparian areas adjacent to streams.[4] Flow changes also can increase flood risk and diminish both recreational and amenity values of urban streams.

With increasing focus on water availability and supply, cities have prioritized innovative technologies to create "new" water by capturing and reusing water that historically would have had a single pass through a city's system before reentering the waterway. While these runoff-capture and reuse practices have the promise of decreasing other water diversions, particularly if coupled with more efficient water use, achieving the One Water goal of maintaining healthy waterways is only possible with a comprehensive consideration of the impact of capture and reuse on the overall watershed. This should include an assessment of the resulting flow-regime changes from water management decisions.

Unfortunately, due to the lack of guidance available to support planners who do want to include environmental concerns in their planning efforts, an emphasis on maximizing use of local water sources takes center stage as the primary environmental consideration, with potential impacts to the ecology of the contributing and receiving waters in their systems left for consideration during later stages of project implementation.

Even best intentioned water uses can alter the pattern of flow pulses and seasonal flows that freshwater ecosystems need to reliably provide the services we depend on: supporting aquatic and terrestrial biodiversity, recharging groundwater, cueing various life stages of adapted fish and wildlife, providing needed seasonal wetting of soils and floodplain areas that support trees and birds, and delivering "ecosystem services,"—such as the dilution and assimilation of contaminants—that downstream communities count on.





The One Water approach offers tremendous opportunities for improving water management within communities. One Water is driving innovations that create "new" water supplies for cities, for example, by capturing and reusing water that historically would have had a single pass through a city's system.

To achieve the full benefits of these innovations, water managers should consider both the opportunities and the potential, unintentional impacts on river flows. As a result, One Water can create sustainable water supplies while supporting natural ecosystems and downstream communities.

The One Water framework recognizes the need to manage water in a holistic way, acknowledging that human-centric water needs must be considered in a larger context. We propose a decision framework that intentionally considers healthy waterways and prioritizes diverse perspectives to produce better-informed and more lasting decisions.

Difficult tradeoffs will still be required. However, failing to apply a healthy waterways lens to water planning will mean that uncertainty in long-term water management will continue. Failing to proactively plan for healthy waterways in One Water planning can result in impaired waterways and increase the likelihood that more species will be listed as threatened or endangered; more water bodies will fail to meet applicable water-quality standards; and more streamside recreational value and amenities will be degraded. Such loss in streamside value is often concentrated in historically disadvantaged communities where water management decisions have an established track record of adopting low-cost, utilitarian approaches—such as concrete-lined canals—that foreclose existing and potential recreational uses. Each of those outcomes increases the likelihood that water management decisions will have to be revisited, resulting in increased costs, additional unpredictability, and loss of public trust.

The Call for Implementation Guidance: Applying the Multi-Benefit Framework to Healthy Waterways

Although the steps for considering healthy waterways are not yet hard-wired into the guidance for integrated water planning, innovative cities using enhanced public engagement processes have discovered that the public is supportive of plans and projects that provide protections—or even enhancements—to the natural environment and to dependent fish and wildlife species.[5] The resulting water planning vision statements not only recognize healthy waterways as a consideration, but place robust, resilient water flows at the center of their planning vision:

Los Angeles: "Improve health of local watersheds by reducing impervious cover, restoring ecosystems, decreasing pollutants in our waterways, and mitigating local flood impacts." (One Water LA, Guiding Principles, 2015)

San Francisco: "With our OneWaterSF approach, San Francisco will optimize the use of our finite water and energy resources to balance community and ecosystem needs, creating a more resilient and reliable future." (OneWater SF Vision, 2016)

Santa Fe: "The City will provide water to maintain a living Santa Fe River, except under drought or emergency conditions." (Long-Range Water Supply Plan, City of Santa Fe, 2008)

Oregon Water Resources Department [in guidance to cities pursuing One Water plans]: "An Integrated Water Resources Strategy to meet current and future water needs...considers instream needs (where water remains in the environment) along with out-of-stream needs (where water is diverted for use), including water quality, water quantity, and ecosystem needs." (Oregon's Integrated Water Resources Strategy, 2012)

Leaders in these planning efforts credit community engagement and proactive vision-setting as keys to prioritizing environment-positive outcomes from their water plans. When a broad spectrum of community voices, including neighborhood and environmental advocates, are sought and included, the vision for the plan can broaden beyond water supply to be inclusive of other goals such as healthy waterways. While many community residents may not explicitly use the language of flow regimes and healthy waterways, their interest in maintaining both the quality-of-life benefits and historical-cultural heritage tied to neighborhood waterscapes can result in a shared concern for prioritizing healthy flows. If the planning process is expanded to include area environmental scientists, this implicit support of healthy waterways is likely to be further reinforced with informed, site-specific knowledge of the critical roles of resilient flow regimes.

While moving from broad vision to effective implementation often remains a challenge, having a proactive healthy waterways vision is a necessary first step to achieving positive environmental outcomes. Without community vision, any goals beyond basic water supply needs will prove difficult to implement.

Drawing on this same conclusion, the Pacific Institute's Multi-Benefit Framework identified engaged community visioning as a first and essential component of effective and equitable water management.[6] With an inclusive vision established, the framework then suggested a series of steps to guide planners in proactively considering the multiple benefits and trade-offs of water management decisions. With that work serving as our foundation, we present the following Healthy Waterways Framework to support One Water planners in rising to the challenge of delivering for healthy waterways, with a particular focus on flow impacts.

Four Steps to a Healthy Waterway

Step 1: Create a Community Vision for Healthy Waterways

Step 2: Identify Benefits and Trade-offs of Advancing Healthy Waterways Locally

Step 3: Evaluate Key Benefits and Trade-offs of Healthy Waterways

Step 4: Using the Healthy Waterways Framework to Inform Decision-Making

A Framework for Healthy Waterways

This framework is an adaptation of a recently-developed Pacific Institute framework for considering the multitude of benefits that can be derived from a comprehensive One Water planning process. With that work as our foundation, we present our framework as a guide for recognizing the critical need to plan for maintaining or restoring balanced flow regimes in order to achieve healthy waterways.

The Healthy Waterways Framework

Step 1: Create a Community Vision for Healthy Waterways

The creation of a community vision is the first step to safeguarding waterways. Water planners often come to the table with an established set of needs and challenges to be addressed, but with the effective engagement of impacted communities, planners can establish a more complete scope of issues, benefits, and possible solutions. If both community advocates and environmental scientists are invited to the table, the resultant vision 1) increases the likelihood for healthy waterway concerns to be incorporated, 2) enhances the prospects for community acceptance of the product and 3) maximizes intersecting benefits to impacted populations. For these reasons, to the extent possible for any project, especially for any larger-scale planning efforts or programs, we recommend the creation of a community vision based on an authentically collaborative stakeholder engagement process that incorporates four keystones:

Designate a facilitator or process "host"

A facilitator provides a consistent, neutral, and accountable figurehead. While this person may be funded by one or all of the involved agencies, they are there to manage input and responsiveness from the agencies as well as to advocate for a process that best serves all of the stakeholders. Having clear responsibilities for the independent facilitator, set apart from those of agency staff, allows the agencies to be more responsive to the public without compromising their decision-making authority. This clear separation is also crucial for process continuity and for cultivating trust from all parties. If resources do not allow for procuring a third-party facilitator, the involved agencies can designate a staff member to serve in this role, as long as that facilitator will have no other duties related to the project, program, or plan. A neutral facilitator ensures all stakeholders can approach the individual in confidence when necessary.

Create a process for comprehensive and representative stakeholder identification

The more representative the stakeholders are, the more likely the project or plan will address the true complexities of the water system. Representation needs to be ensured horizontally (for everyone who has a stake in the outcome inside and outside of the local community) and vertically (for everyone who will have to buy in to the plan to move forward; i.e., regulators, city/regional officials, etc.).

Expertise is also a critical consideration for healthy waterways. For example, to ensure that ecosystems, native fish, and wildlife species are represented as "stakeholders," experts unaffiliated with the convening agencies, who can speak to the potential impacts and benefits to these natural communities, should be identified. Depending on the complexity and controversy associated with the plan, a diverse array of experts reflecting differing points of view on the

science may be needed for the public to view the process as legitimate and not biased toward a predetermined outcome. The range of expertise may need to be procured by the convening agencies after vetting by the stakeholders.

Meet stakeholders where they are, both physically and informationally

This is the most important difference between true engagement and traditional public involvement. Thinking about the root of the term collaboration as "co-labor" can guide planners in what is needed for successful engagement. If parties are going to co-labor, they need equal access to the process and information needed to make decisions.

Planning agencies should ensure that impacted communities have not only the technical ability to contribute, by providing data and information in formats that are understandable to all participants, but also the resources to meaningfully participate and co-create the outcome, by providing accessible venues and meeting conditions that allow full participation. (See Appendix A for some practical tips.) Addressing the group's needs for trust, data, and clear process rules can be as important to gaining their support for the outcome as the substance of the outcome itself.

Craft a vision that includes stakeholder interests

Even though stakeholders are showing up to participate in a water resource planning process, they each have their own reasons for being at the table. Some of those reasons will be obvious—people want clean water, access to recreation, affordable and reliable supplies—but some of the reasons driving stakeholders will be hidden, sometimes even to the stakeholders themselves! For example, calls for clean water and affordability may be rooted in historic inequities and may actually be calls for justice; calls for recreation may be linked to a sense of heritage and lifestyles that are threatened by urbanization.

A true engagement process will work to uncover those commingled drivers and identify opportunities to address them while also solving for the water resource management questions posed by the convening agencies. When we orient the process to "interests," we uncover solutions that speak to the broader values and needs of the community.

Meaningful stakeholder engagement requires early, frequent, and continuing public involvement throughout the decision-making process, starting with creating the vision for the project or plan. Agencies are often limited in their time, funding and/or ability to conduct true public engagement, which may result in opting to instead merely notify stakeholders of plans, or, at best, vet already developed plans with stakeholders. While lower levels of public participation may be acceptable for aspects of plan implementation, collaboration with the public on the vision of a One Water plan is crucial to ensuring that the interests that could impact the plan's effectiveness and longevity have been fully considered and balanced.[7]

For smaller, more localized projects, or even for lesser planning efforts, if the resources for public engagement are not available, the simple act of including within a vision statement an explicit healthy waterways commitment, such as to "do no harm"[8] to upstream or downstream human and ecological communities, or to improve impaired ecosystems, will help set important sidebars and encourage outcomes that further the sustainability of natural systems.

Key Considerations for a Healthy Waterways Vision Statement

Define the "waterway" as a group. Planners enter the engagement process with their own ideas of the boundaries of the physical system (rivers, creeks, groundwater, tributaries) and the parameters that are being managed for (water quantity, quality), but it is important to engage the group to investigate whether important values are being overlooked or important potential gains are being missed.

The following are some questions and prompts that can help planners and engaged stakeholders identify possible blind spots in their understanding of a waterway:

- Where do the boundaries of authority and responsibility overlap with physical boundaries of the target waterway? How should communities within those boundaries be engaged in the plan?
- What are the social, human and biological communities within these boundaries? Are they all represented, considered? How can/will they be considered?
- Which components of the watershed need to be assessed to consider the full impact and reach of this project or plan? Do water supplies and water-treatment expenditures depend on the quantity and quality of water coming from an upstream area that might need protection? Do stakeholders understand and value the fish and wildlife downstream of the planning area?
- Identify the sites or environmental assets that are to be protected or restored.
- Describe the desired range, size, and connection of habitats needed to support the ecosystems and set target conditions for them and the biota that they support.
- Assess the volume of water and the patterns of water delivery that are required to support the different habitats and the diversity of dependent biota.
- Decide how climate change and extreme weather events will be considered.
- Consider ecological community interests. Consider including targets for species health, population, status; flow targets to sustain ecological function; and metrics that include the variety of habitats affected by river function.

Stay open to grander visions! Work with stakeholders to identify interests that can and cannot be addressed by this project/program/plan, remembering that in some cases, additional social and environmental benefits can be realized from investments in water security. Don't be too quick to throw out an idea because the linkage isn't immediately obvious. For example, a stakeholder's interest in fresh, affordable school lunches might have a nexus to greywater use on school gardens—a possible technology associated with a One Water plan.

Integrate relevant interests into the overall vision statement. The conveners of the process will have to decide whether they are going to get consensus from the stakeholders (and meet the goal of full collaborative co-creation), or if stakeholder input will receive another level of consideration. If a process is able to achieve consensus that stakeholder interests are x, y, z, and q, a vision statement might be as simple as: Implement a One Water Plan that accomplishes x, y, z, and q.

Refine the initial vision statement as necessary to stay within legal requirements, planning horizons, resources, information limits etc. In line with adaptive management practices, regularly evaluate whether you are achieving your community's healthy waterways goals. Ask if the vision needs to be modified to better ensure the plan proactively benefits dependent ecosystems.

Step 2: Identify Benefits and Trade-offs of Advancing Healthy Waterways Locally

Once a clear vision statement has been created with input from stakeholders, the benefits and tradeoffs of advancing healthy waterways must be identified. It is important that the desired benefits to healthy waterways be considered within the context of real external constraints, especially regulatory requirements. Marrying these drivers and desired benefits will require understanding healthy waterway goals as well as the potential trade-offs of implementing particular strategies.

Benefits of a Broadened Healthy Waterways Scope

Addressing a broad spectrum of regulatory and non-regulatory drivers can provide added, far-reaching benefits. If actively planned for, advances toward healthy waterways can benefit riparian and aquatic ecosystems, groundwater levels, local drinking water availability and treatment, energy generation and use, recreation and more. Balancing these outcomes requires proactively considering how One Water projects can contribute to or impair achieving the potential benefits.

Examples of how expanded benefits can accrue from planning for healthy waterways include:

- Water conservation measures that include benefits for stream flows can increase opportunities for water recreation.
- Flow-protection strategies can also impact and benefit downstream water users.
- Proactive protection of at-risk ecosystems, even those that do not yet have regulatory protection, minimizes the potential for future regulatory impediments that may undermine water-supply project yield and/or longevity.
- Shaded footpaths and informative signage adjacent to streams can provide both recreational and educational benefits to a community. They can also improve community support for water projects, particularly if incorporated during the design process.

Expanding the scope of potential benefits beyond immediate, direct impacts, can also highlight the long-term benefits of supporting healthy waterways. For example, changes in the use and management of water can have a major impact on energy use, with implications for costs, air quality, and greenhouse gas emissions. Conversely, utilities may end up adopting more energy-intensive treatment options like UV purification, ozonation, and reverse osmosis in response to declining water quality and new contaminants.

Regulatory Drivers for Healthy Waterways

Regulatory programs may drive key aspects of prioritization among competing considerations and should be identified and raised as early as possible in developing a One Water plan. This allows for design flexibility, including the potential for achieving coinciding benefits (as indicated above). Key drivers that may arise include water quality issues, threatened and endangered species issues, and, although not strictly regulatory in nature, issues related to rare ecosystems and prized recreational resources. Whether those drivers arise because of impacts within the planning community or downstream, they need to be anticipated, considered, and addressed.

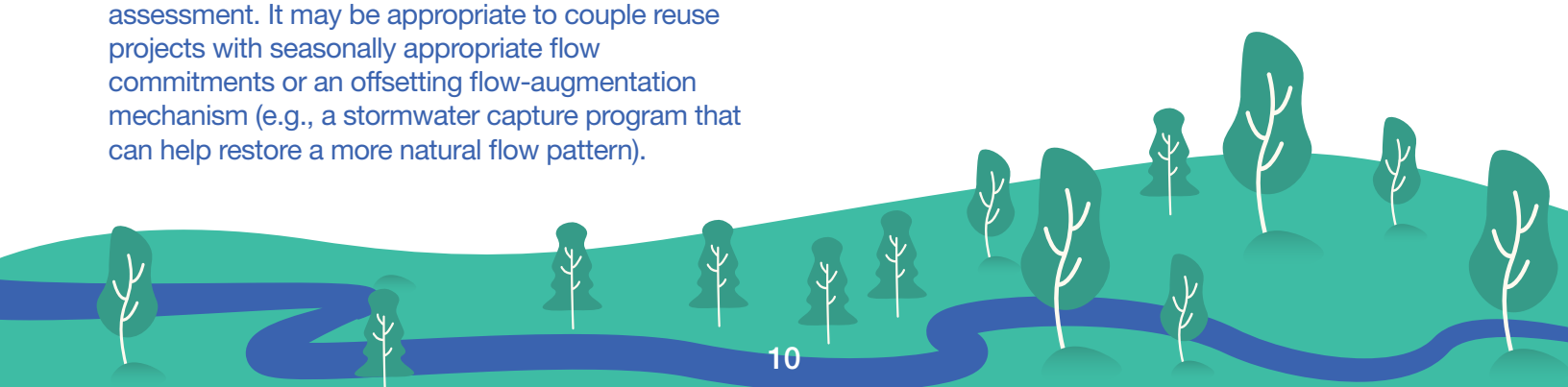
Water Quality: Planning a water-supply project that might worsen a water quality condition is not likely to be a good long-term investment. In the 2017 Water Quality Inventory Report to Congress, the U.S. Environmental Protection Agency (EPA) noted that more than 55% of assessed river and stream miles were rated as impaired.[9] Water quality impairments recognized under state or federal law must be considered, but earlier indications of declining water quality also should be factored in at the beginning of any planning process. Being proactive about water quality before a formal impairment determination can maximize predictability and return on investment in projects.

Water quality problems often reflect some combination of high levels of pollutant loading and reduced assimilative capacity caused by flow-regime disruption, so both aspects should be assessed in One Water planning. A water reuse project may reduce the loading of pollutants being discharged, which may improve water quality, but also reduce assimilative capacity because of lessened flow, which may worsen water quality. Those effects should be balanced while also addressing other healthy watershed considerations, particularly the status of the overall flow regime. For streams adversely affected by inadequate flow in addition to pollutant issues, reuse programs should undergo careful assessment. It may be appropriate to couple reuse projects with seasonally appropriate flow commitments or an offsetting flow-augmentation mechanism (e.g., a stormwater capture program that can help restore a more natural flow pattern).

Especially in a highly urbanized setting, stormwater capture may have the potential to reduce loadings of multiple pollutants by intercepting water before it enters waterways. Stormwater capture may also improve an altered flow regime by reducing artificially elevated peak flows and, if designed proactively, may be able to help restore reduced subsistence- and dry-period base flows, thereby improving the assimilative capacity of streams. Using stormwater capture to reduce elevated flows from storm events could also help limit scouring effects, which degrade habitat structure in and along streams. In some jurisdictions, water quality standards specifically address protection of aquatic habitat separately from levels of pollutants. In these instances, helping to restore flow patterns could help avoid water-quality impairments unrelated to pollutant levels.

A creatively designed stormwater capture program could provide both water-supply and flow-restoration benefits: reducing artificially elevated peak flows, releasing some of the captured water back to the stream during drier periods (via direct release or recharge of shallow groundwater), and making the remaining captured water available for water supply use. The Rain Catcher Pilot Program on Waller Creek in Austin, Texas is an example of an ongoing effort to study and achieve improved flows through such a program.[10]

Threatened or endangered species: The presence of species listed as threatened or endangered species (or proposed for listing) under state or federal law is an important consideration for any project. The presence of listed species can create a potential legal impediment for project authorization. As discussed further in Appendix B, we recommend that planners factor in consideration of impacts on species and ecosystems that are recognized as being at risk even if they are not currently receiving specific legal protection. In addition to making sense from a healthy waterways perspective, on a very practical level, taking a more proactive approach can provide greater long-term predictability in water supply planning and implementation, minimizing regulatory complications down the road.



Step 3: Evaluate Key Benefits and Trade-offs to Healthy Waterways

Once the benefits and constraints are identified and understood, the next step for considering healthy waterways involves a characterization of the impacts of planned projects on waterways. A quantitative assessment is preferred, but if sufficient data are lacking then a qualitative assessment should be done. (See Appendix B for discussion of potential sources and approaches for assessment or characterization of flow components.)

Due to the complexity and variability of aquatic systems, readily available environmental flow criteria, especially for individual streams, are in short supply. But, as discussed in the Pacific Institute's Multi-Benefits Framework Guidebook, difficulty in assigning precise values should not result in ignoring a particular benefit or trade-off. A wide variety of key benefits and trade-offs likely will have been identified and each will lend itself to a different level of quantification for comparison. The report, "Scaling Green Stormwater Infrastructure Through Multiple Benefits in Austin, Texas" provides an example of using differing levels of quantification for a variety of benefits in the evaluation step of the process.[11]

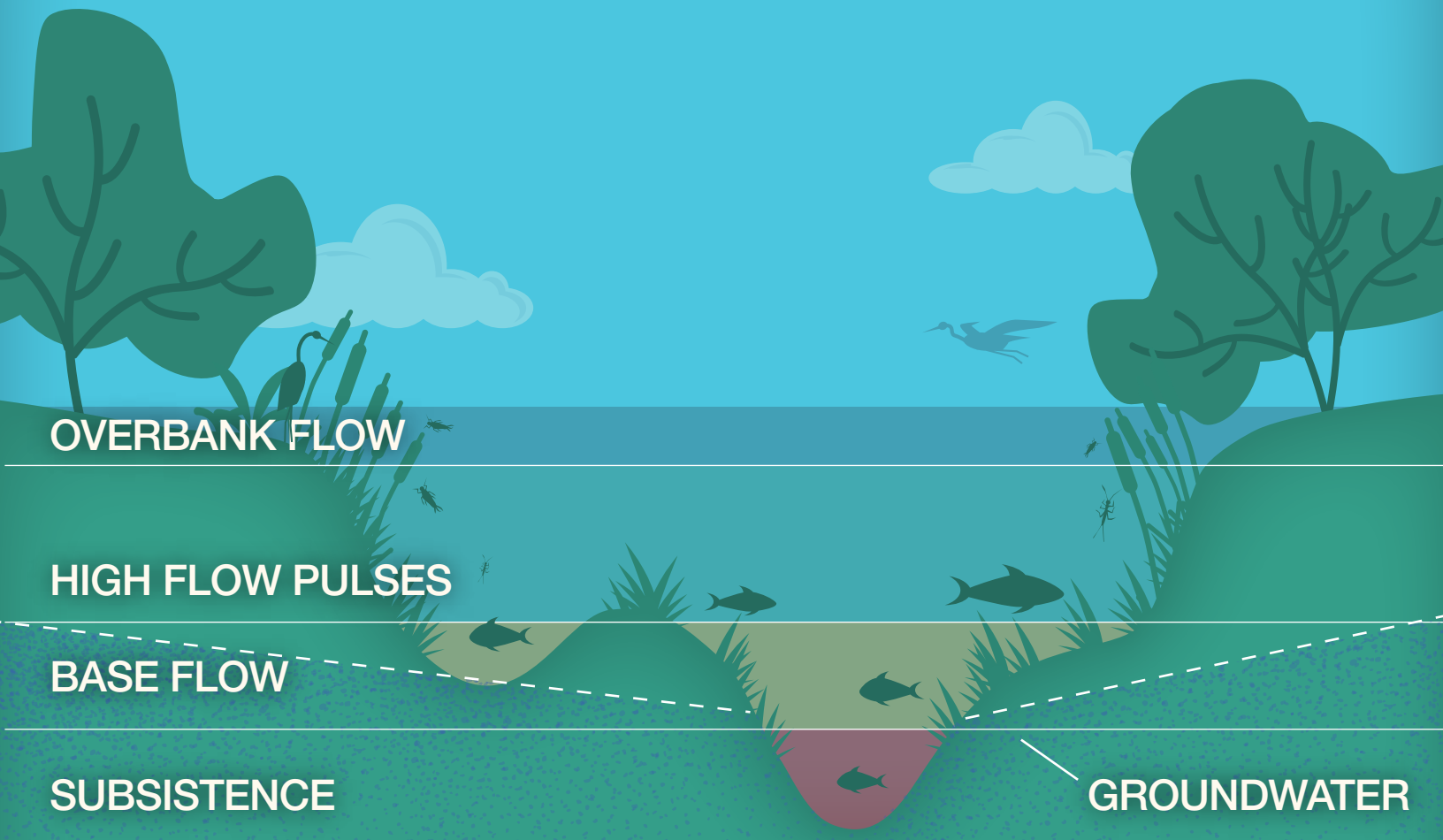
Prioritize Relevant Analyses for Healthy Waterways

Depending on the nature of the project or plan under consideration, it may not be necessary to evaluate a full environmental-flow regime, which generally would consist of: subsistence or drought-period flow; one or more levels of base flows, representing dry to wet flow conditions, and; one or more tiers of pulse flows associated with rainfall events. For example, a relatively small wastewater-reuse project may have the potential to significantly impact subsistence flows but result in only minimal change in base and pulse flows during average-to-wet conditions, allowing a focus on just dry-condition flows. In contrast, a broad planning process would be best informed by evaluating a more comprehensive flow regime.

If the healthy waterways goal is to contribute to restoring a flow regime that has been adversely affected, it will be important to first identify a less-impacted flow regime for the affected streams in order to provide a baseline for defining specific project goals. If the goal is simply to minimize adverse impacts to the current flow regime, the scope of information to be considered will be less expansive. However, it should still enable planners to understand aspects of the flow regime most important for maintaining existing uses and aquatic life forms. This can apply to an individual project as well as to a comprehensive planning effort.

In evaluating water-reuse projects through the lens of healthy waterways, it is important to understand the role that return flows play in the individual waterway. Return flows may play a critical role in maintaining a river's flow—especially where upstream diversions and impoundments, or loss of groundwater contributions, have reduced subsistence and base flows below natural levels. In those situations, careful analysis is needed to assess how proposed reuse, regardless of the source, will affect the potential for achieving healthy waterways. An informed balancing of water-quality and quantity impacts, including consideration of management approaches to reduce adverse effects, can maximize the long-term project viability. In evaluating stormwater-capture projects through that same lens, the evaluation of flow impacts may be more complex. These projects have the potential to benefit waterway health by reducing artificially elevated, and harmful, large pulse flows, but they can also harm waterway health by reducing smaller, beneficial pulse-flow events. Creative project design may allow for achieving multiple benefits across a range of flow levels.

Each Flow Level Serves an Important Ecological Function



Adapted from The Cooperative Research Centre for Water Sensitive Cities (CRCWSC) *https://watersensitivecities.org.au*

Subsistence flows represent extreme low flows that are experienced for short periods during drought conditions. These flows often depend on groundwater and allow fish and wildlife to survive dry periods.

Base flows are normal condition flows. The levels vary by season and between wet and dry years. Base flows support healthy populations of fish and wildlife when supplemented with pulse flows. Base flows both recharge and rely on groundwater at different times.

High flow pulses are short duration flows that occur in response to heavy rains. They connect streams to wetlands and secondary channels, maintain channel structure and riparian vegetation, carry nutrients to streams, and help recharge groundwater.

Overbank flows represent very large pulse flows that overtop the bank and connect the waterway to the floodplain. Overbank flows serve the same functions as other flow pulses but to a greater degree. Some fish species only spawn in the floodplain, relying on water from overbank flows to support that important life stage.

Groundwater is water below the ground that interacts with surface water in streams and rivers to varying degrees. Water moves back and forth between groundwater and surface water under different flow conditions. Groundwater levels can be impacted by groundwater pumping from wells, reduced flows in the river, and increased impervious cover.

Key Considerations for Analyzing Healthy Waterways

Setting Geographic Scope

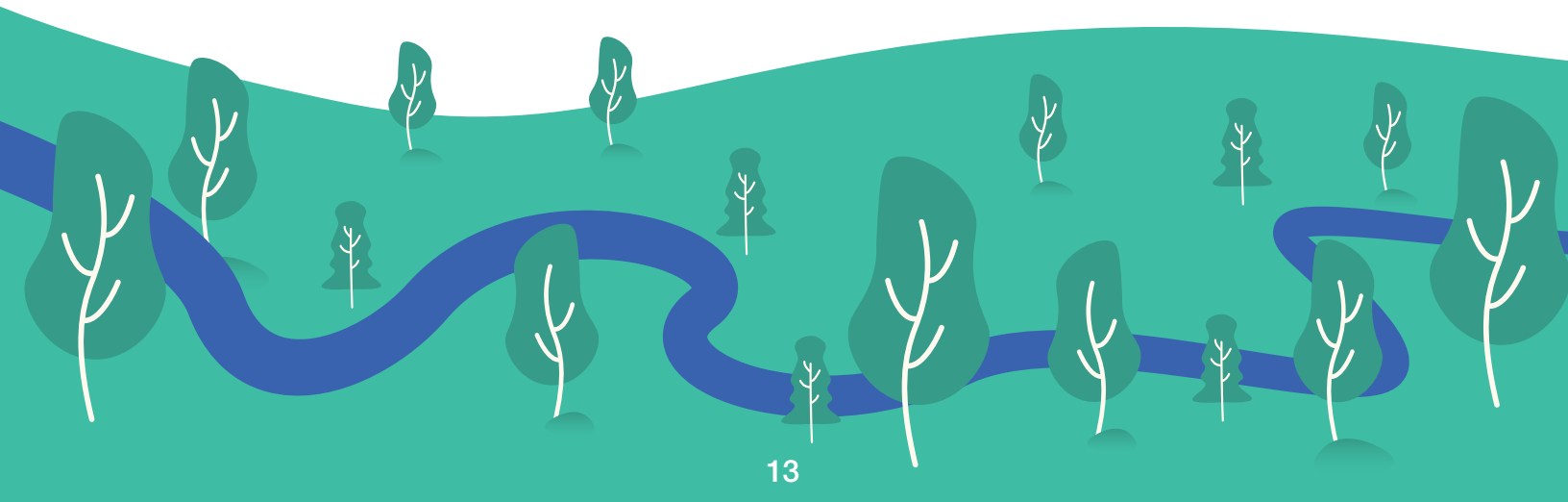
The geographic scope of an appropriate flow regime evaluation will vary with the size of the project or planning effort. For example, an integrated water-supply plan for a large metropolitan area will have implications for local streams within the city limits and may also have significant impacts on the flow regime of rivers and streams for a hundred or more miles downstream, as well as on freshwater inflows for coastal waters. By contrast, a relatively small reuse or stormwater-capture project may only noticeably affect flows in the immediate stream where the project is located. During project visioning, stakeholders can help inform the appropriate scope for analysis, including setting appropriate geographic boundaries.

Defining a Flow Baseline for Healthy Waterways

Defining the baseline for analysis *(e.g., What is a healthy waterway? How do we define success?)* is a significant challenge for analyzing project impacts to healthy waterways. Particularly in urban areas and more rural areas with extensive water infrastructure, current flow patterns may bear little resemblance to the natural flow regime. Although restoring the natural flow pattern may not be an attainable or appropriate goal in all circumstances, understanding historical context can offer important insights for selecting flow targets. Depending on the level of urban development, there may be limited opportunity, or justification, to reproduce the full suite of historical patterns of flow, but the visioning process will benefit from an informed discussion on that issue, which likely will enhance the opportunity for broad stakeholder buy-in.

There are a variety of methods for setting the baseline for analysis of a local watershed. One initial challenge will be gathering information to be used for informing such a discussion. Information may be needed about the immediate stream(s) on which a project is proposed or for which a plan is being developed, as well as downstream segments into which the stream flows. The extent of downstream area that should be included in impact analysis is normally a function of the size of the project and its potential relative impacts on downstream reaches.

Larger streams may have one or more flow gages with records that can be used to understand changes in flow over time. However, determining what aspects of the flow record to pay attention to can be challenging. How have flows changed over time as a result of water-supply development or other alterations? Should the focus be on low flows, and if so, how low—fifth percentile, tenth percentile? Or, is it more appropriate to focus on average flow conditions or periodic pulse-flow events? See Appendix B for more information for understanding and evaluating the flow regime.



Step 4: Using the Healthy Waterways Framework to Inform Decision-Making

The fourth and final step of the process is to inform decision making by communicating the results of analysis and recommending actions for funding and implementation. Ideally, key decision makers and stakeholders will have been involved throughout the planning process and will help make the case to others on why the community's plan should be supported.

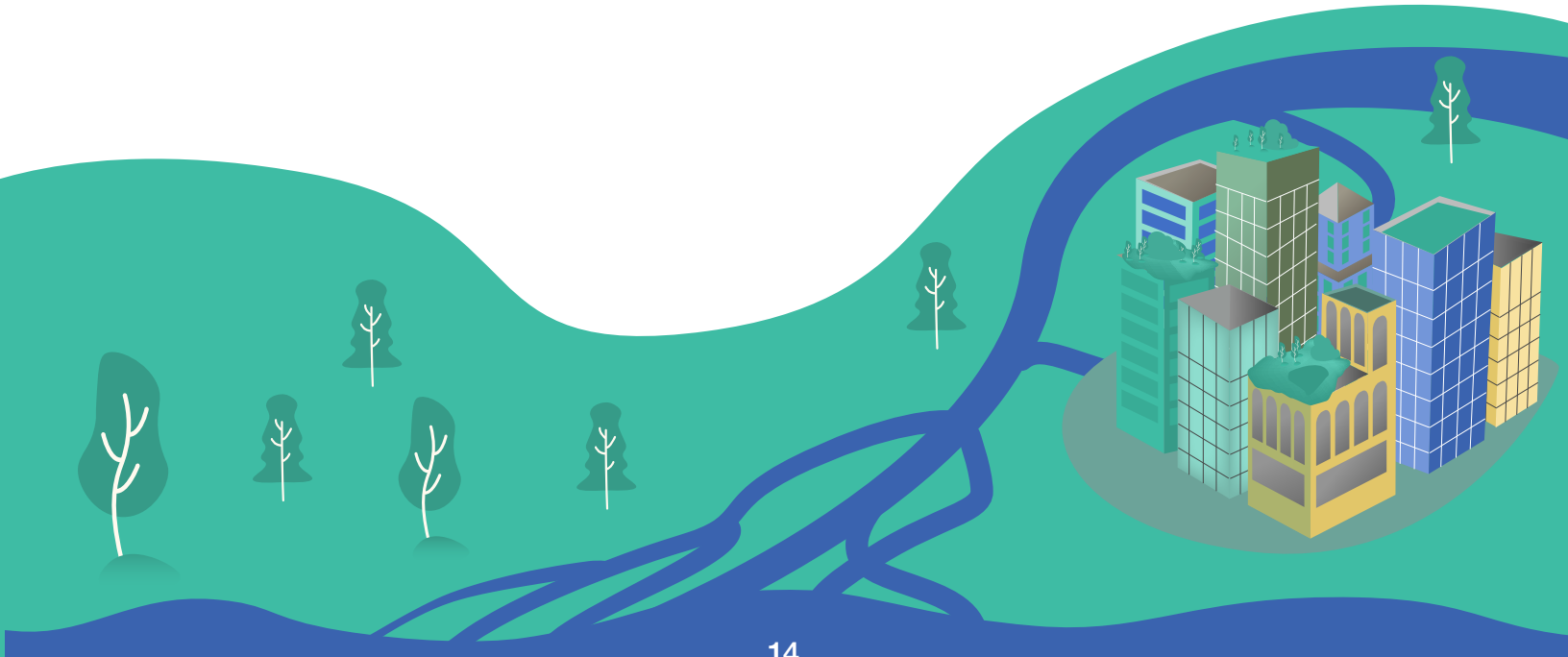
Ultimately, decision makers will need to support the plan through formal adoption, policy changes, and funding. In order to accomplish this, decision makers will need to understand and accept the community vision, be clear on how the plan achieves that vision, understand the benefits and trade-offs of the options evaluated, and appreciate the many ways the plan benefits the community. The communication of benefits should not focus solely on water supply—which may be the ultimate goal of the planning effort—it should also provide information and context on the other benefits that emerge from employing the One Water approach. Communities stand to benefit in many ways through the comprehensive application of One Water practices and many of these benefits can be quantified. Practices such as employing triple-bottom-line assessments to demonstrate a fuller accounting of a project's costs and benefits, or simply measuring decisions against the community's stated vision, can help policy makers expand their criteria for important decisions.[12]

The framework presented here can be applied at different scales: from project to program to planning. The community vision should serve as a touchstone not only for the overarching plan, but for every project implemented under its umbrella.

Once a community's One Water plan is in place, the real work begins. The community vision and goals need to be clear and ever present as the plan moves to implementation and individual plan elements are developed.

Conclusion

The principles set out here are important to apply to any city's One Water efforts, but advancing this work nationally will require developing a community of practice built on successful implementation in myriad settings and at multiple scales. With climate and population growth putting increased pressure on water supplies, we can no longer afford to address urban water-supply in a vacuum, separate from water quality, healthy rivers and springs, biodiversity, and other features of a sound environment. They are all connected, and One Water gives us a playbook to address these issues collectively.



Appendix A
Community Engagement Best Practices

Addressing stakeholders' needs for trust, data, and clear process rules can be even more important to their sense of process legitimacy than the substance of the outcome itself. Historic inequities within a community or cultural differences amongst stakeholders can necessitate customized approaches for successful engagement processes. Some of the following considerations may be useful:

Access

Hold meetings at times and locations (and in languages) that are convenient and comfortable for people in the communities affected by decisions. Consider working hours, access to childcare, public transportation, accessible parking, and safety.

Communicate in plain language to foster true engagement from all stakeholders.

Commit to reaching the hard-to-reach. Use outreach modalities that are preferred by local communities: culturally-specific media, community representatives, email listservs, organizational newsletters, faith centers, and community centers.

Secure resources to support the process to its conclusion. In addition to funds for materials, facilitation, staff, etc., be prepared to pay for meeting space, translation services, food and beverages, parking, transportation costs, and, where possible, childcare to ensure full participation.

Ask participants to identify barriers to participation.

Create multiple ways for people to contribute and be flexible about how people participate.

Structure

Contact established community-based organizations that have existing relationships with the residents of their areas to seek participation and advice on your approach. Their buy-in will lend legitimacy to the process and help build trust.

Consider representation—after a thoughtful recruitment effort, ask attendees who is missing. Commit to not moving forward with a process until affected stakeholders are able to be present at the table with capacity to meaningfully participate.

If identifying "representatives" to speak for key interests, make sure these representatives have some authority within their interest group(s), and are relatively equal in status to one another (e.g., all officers within an organization versus staff level).

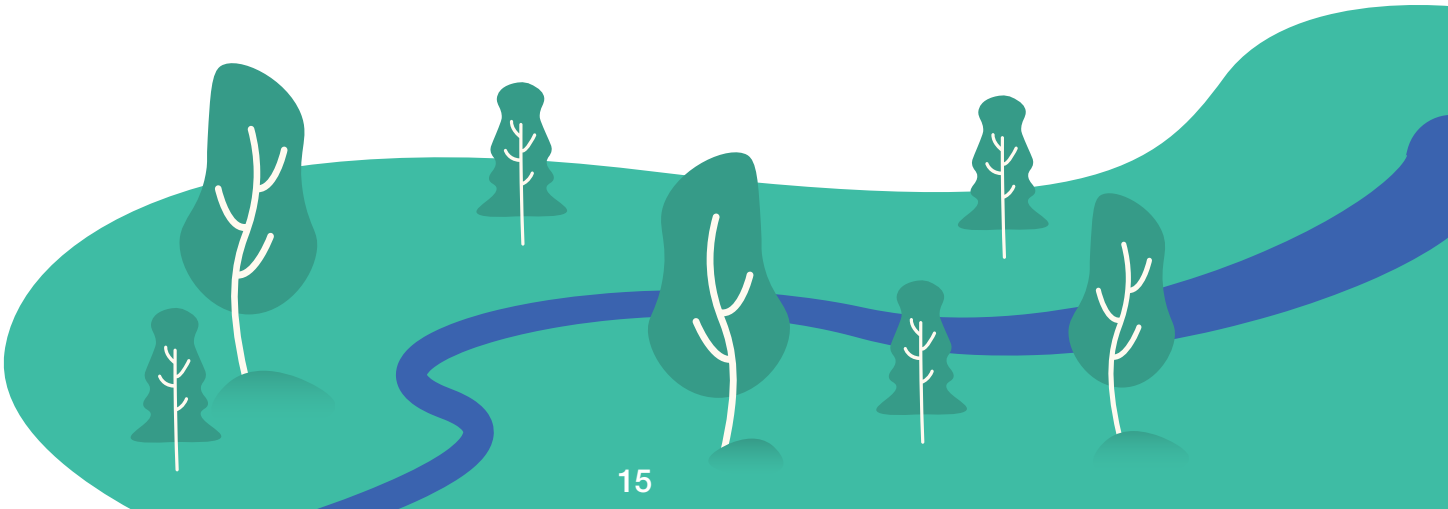
Be careful of tokenism. Ensure that diverse communities are adequately represented, so that a particular participant is never perceived as speaking on behalf of an entire demographic.

Encourage the facilitator or someone else to serve as "citizen advocate" to enable candor, facilitate problem solving, and maximize the effectiveness of the communications.

Create spaces, places, and reasons for people to come together. Make it fun and easy to participate.

Trust-building

Food! Allow for time before or during a meeting that people can share food. There is real trust-building power in breaking bread together.



Arrange seating so that all participants can make eye contact and hear each other on a level field.

Be a good host—consider lighting, room temperature.

Provide staff support to prepare agendas, meeting notices/RSVPs, materials, notes, distribution of summaries, and logistics. Allow for the extra time it might take to reach stakeholders between meetings, using multiple modalities and languages.

Establish and enforce ground rules for the group; outline the structure, shared expectations for behaviors, and procedural guidelines.

Stakeholders must believe and see that they have the ability to influence the outcome. Reflect their influence on decisions as they are being made.

Respect people's time. Make every meeting matter and conduct them as efficiently as possible.

Process

Share and track against a transparent work plan, referring back to it frequently to ensure accountability and increase understanding.

Encourage joint learning through field trips, storytelling, and other approaches that allow for real-time experience. Reports and presentations are less useful modes of learning when trying to understand "interests."

Have technical staff available to provide materials for stakeholders to use at meetings and workshops (e.g., reviews, assessments, maps, and identified tradeoffs).

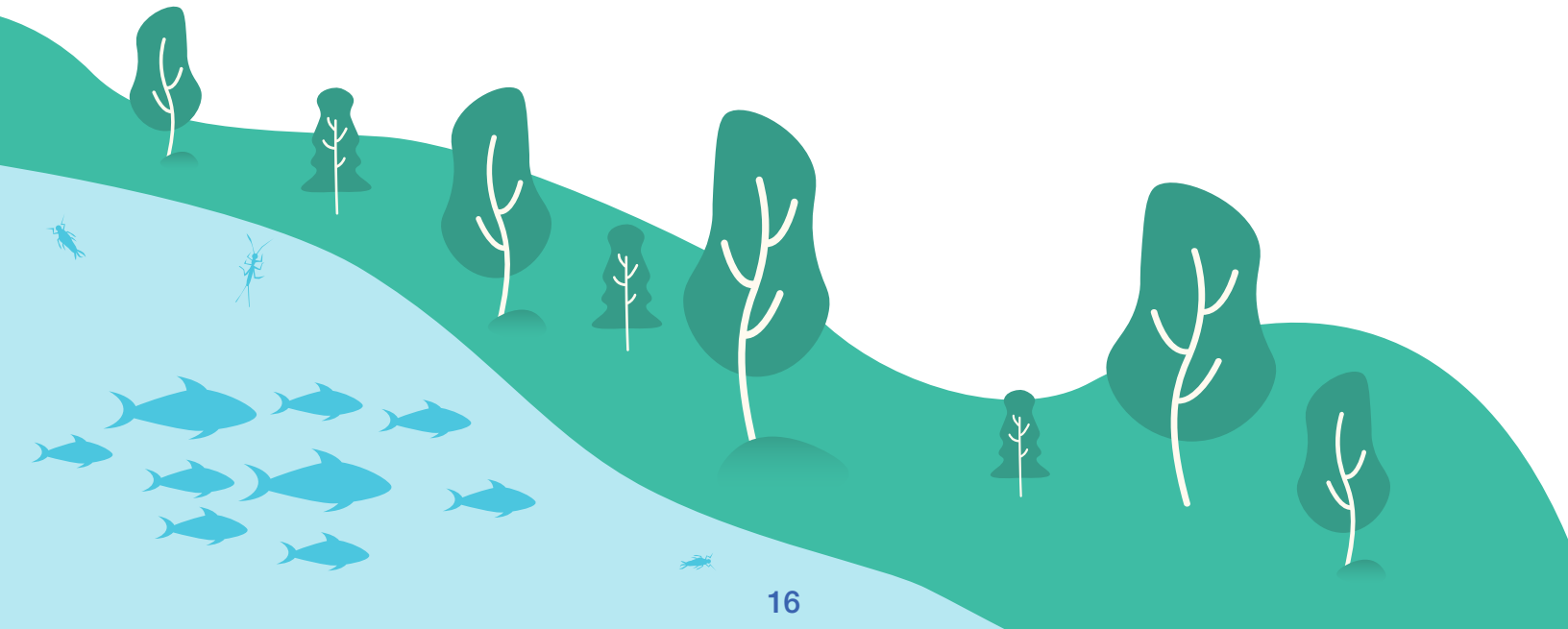
Consider any statutory framework for the discussions (e.g., open meeting laws, confidentiality, etc.). What do participants need to know?

Information

Information management is key to empowered participation. Communicate how information will be made available to all interests, including people not at the table. Deliver the information as promised.

Agencies should be thoughtful about their representation at the table (ideally selecting staff who are skilled communicators). Agency representatives can set the tone for collaboration by modeling good listening, providing participants with information about the agency interests, and bringing needed changes back to the stakeholders in a timely manner.

Technical assistance is the most important equalizer for participation. Not only does technical information need to come in an understandable format, but the participants need to be able to help identify the technical questions to be addressed. The entire group should be engaged as a learning alliance, exploring together as the process moves forward.



Appendix B
Tools for Assessing Environmental Flow Needs

Determining how much flow the environment needs can represent a key challenge in planning and project design. Admittedly, there is a lot still to be learned about the role played by differing levels of flows, particularly in a site-specific context. In the likely scenario where little or no site-specific information about flow needs is available, various tools and sources of information can provide helpful insights for assessing potential impacts and designing flow-protection goals. Site-specific studies are the preferred approach when that option is feasible.

Target Relevant Flow Components

It may not be necessary to evaluate a full environmental-flow regime because the potential impacts of a project or plan may be limited to only certain flow components. A conceptual representation of the various components of a flow regime supporting a healthy waterway is included on page 12 above. Each of those components plays an important role in maintaining a healthy stream environment. However, various types of One Water projects may have limited, if any, impact on many of those flow components. The level of effort needed to evaluate flow impacts generally can be commensurate with the extent of potential impacts. However, if key regulatory drivers are implicated, such as the presence of threatened or endangered species or the existence of a water-quality impairment, a more comprehensive evaluation may be required to assess how that species or water-quality parameter may be affected.

Determine "Natural" Flow Conditions

As noted in the Pacific Institute's Multi-Benefits Guidebook, a baseline must be selected to inform identification and evaluation of benefits and tradeoffs. That Guidebook recommends using conditions prior to implementation of the project or projects under consideration as the baseline. However, using the lens for healthy waterways, a robust community visioning process will also likely require an understanding of how that baseline compares to more "natural flow conditions"—that is, to conditions with limited human-caused alterations in flows. We believe that the determination of appropriate "natural conditions" for comparison should be the result of an informed exercise (ideally through a robust community visioning process), designed to explore what is desirable, possible, and achievable under the circumstances. The ultimate healthy waterways goal chosen may simply be to minimize adverse impacts compared to the pre-project condition, or it may be to restore the waterway to an improved ecological and/or recreational condition, which still may deviate greatly from what existed under undisturbed conditions. Regardless, some understanding of what natural flow conditions were will provide important information for the decision process.

Identify Qualitative Changes in Flow Patterns

If time or resources dictate a limited analysis, a good starting point would be simply identifying the qualitative changes that have occurred in stream-flow patterns based on photographs and historical documentation, with an emphasis on the flow parameters that the project may affect, either positively or negatively. A broad planning process would be best informed by evaluating a more comprehensive flow regime.

Sources for Understanding and Evaluating Flow Regimes

Valuable information for understanding and evaluating the flow regime can be obtained from a variety of sources. Some examples include:

Photographs and historical documentation

In urban and, especially, rural areas with extensive water infrastructure such as large diversions or impoundments, current flow patterns may bear little resemblance to the natural flow regime. Although restoring the natural flow pattern may not be an attainable or appropriate goal in all circumstances, understanding that historical context can offer important insights for selecting flow targets.

Historical photographs, which may be available in newspaper archives, natural or cultural history collections, or even family photo albums, can provide important insights on prior flows of a particular stream. Photographs, for example, can reveal that a stream that now fluctuates between a bare trickle and raging rapids post-rain events, may have been very different historically. Photographs can also provide important insights on changes in the structure

of the streambed and in watershed vegetation, particularly in the riparian zone adjoining the stream.

Historical accounts, such as natural history surveys and collections, may be available at local libraries, museums, and universities, and can provide valuable information about species or natural communities previously found in, and along, specific streams and rivers. That information can inform an understanding of what flow conditions must have existed to support those species or communities. Similarly, local newspaper stories or other historical accounts referencing recreational activities (e.g., swimming or fishing) or reliable sources of livestock water can provide helpful insights into historical flow conditions. Natural history collections also can provide important insights on species currently found in local streams and rivers and their life history, which can help improve the understanding of which components of the flow regime may be of particular importance. That improved understanding is important not only in designing plans and projects that minimize potential adverse impacts, but also in identifying the potential to implement projects that might provide a net benefit to the waterway.

Least-impacted stream as a surrogate to identify target flows

Depending on the level and geographical extent of urbanization, it may be possible to identify minimally impacted local streams, also commonly referred to as "least-impacted streams," that can be used as a reference to help characterize what a more natural flow regime might look like when considering a project on a highly urbanized stream. "Least-impacted stream" studies are commonly used in the water quality arena. To provide the most useful information, the least-impacted stream should be in a hydrogeological setting similar to the stream likely to be affected by the plan or project under consideration and should not have been significantly altered by land-use changes. Analyzing the flow regime of such least-impacted streams, with appropriate adjustments for factors such as watershed size, could provide important insights on what more natural flow conditions likely were in the affected stream and inform development of potential flow targets, particularly when restoration above baseline conditions is a potential goal. Depending on the urban setting at issue, identification of "less impacted" streams may have to suffice in the absence of any that have undergone only minimal impacts.

Analysis of historical flow patterns based on flow-gages

Larger streams may have one or more flow gages that, depending on how long the gage has been in operation, may illustrate changes in flow over time. Working with local sponsors, the U.S. Geological Survey maintains a system of flow gages across much of the country. With a flow gage and a long period of record, important insights can be gained. However, determining what aspects of the flow record to pay attention to can be challenging. The Nature Conservancy (TNC) has compiled useful information about developing environmental flow recommendations with varying levels of information.[13] TNC also developed specific tools including the Indicators of Hydrologic Alteration (IHA) that can be used to analyze flow data.[14] In addition, the US Geological Survey has developed the USGS EflowStats "R" package for analyzing available gaged flow data.[15] One important issue that arises when looking at an historical flow record is identifying the appropriate time-period for use in defining a target flow regime. This becomes particularly important when the flow regime has changed significantly over time as a result of the construction of large impoundments, the initiation of large diversions, or the addition of wastewater or irrigation return flows from sources outside of the contributing watershed.

Watershed modeling approaches

The degree to which benefits to instream flows can be quantified is based on data availability and the technical resources available to perform the analyses. There are numerous models available for simulating water-quality and water-quantity impacts of water management options. One example of applying such models is a study conducted for the State of Vermont and EPA Region 1 using watershed modeling to help identify target flow-duration curves for restoring impaired streams. The streams were understood to be impaired primarily as a result of stormwater runoff from urban and suburban areas. The study included a comparison of impaired and unimpaired watersheds.[16] Models by the USGS and other research organizations are freely available to predict impacts to instream flow due to a variety of water management strategies, but they require specific data inputs and technical training to use properly (Figure 3). Engaging with local land-use, water, and flood-control managers will help to elucidate the best resources for quantifying impacts to instream flows.

Figure 3

Additional Resources for Quantifying Instream Flow

SWAT (Soil & Water Assessment Tool) by Texas A&M University: A small watershed-to-river-basin scale model used to simulate the quality and quantity of surface and groundwater and predict the environmental impact of land use, land-management practices, and climate change. A 2018 article in the journal Water discusses the use of the SWAT model to simulate predevelopment flows for the purpose of identifying possible environmental flow targets.[17] *https://swat.tamu.edu/*

MODFLOW-OWHM (One Water Hydrologic Flow Model) by USGS: Allows simulation of nearly all components of human and natural water movement and its use in a physically based supply-and-demand framework. *https://ca.water.usgs.gov/modeling-software/one-water-hydrologic-model.html*

RIOS (Resource Investment Optimization System) by Natural Capital Partnership: An InVEST sub-model that supports design of investments in watershed services to optimize ecological return on investment. *https://naturalcapitalproject.stanford.edu/software*

Threatened and endangered species and species of greatest conservation need

Threatened and Endangered Species protections under state laws vary greatly, but information about those protections should be readily available. Species listed under the federal Endangered Species Act, particularly animal species, have strong levels of legal protection. Any potential for adverse impacts to such species (even to those just proposed for listing), will trigger additional procedural steps. Projects with a federal nexus, such as a requirement for a federal permit or the receipt of federal funding, that may affect a federally listed species are subject to additional review. Any project, even without a federal nexus, that could result in "harm" to a federally listed animal species, such as through adverse impacts to occupied habitat, likely will require special authorization.

Species of greatest conservation need are identified by state fish and wildlife agencies during the development of their respective State Wildlife Action Plans (required for eligibility for various types of federal funding). These species merit special consideration in assessments of One Water plans and projects. Indeed, proactive management to benefit such species could help to minimize the likelihood that they will ever need to be listed as threatened or endangered or become a regulatory impediment to project implementation.

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8. **"Do no harm"** does not mean flows cannot change. Existing flow regimes often are greatly altered—with different flow components increased or decreased—from more natural levels and patterns. In addition, land use changes may have altered what is reasonably attainable for a stream system, making restoration of a full "natural" flow regime an inapposite goal. The focus should be on restoring or maintaining key flow components.

9. ***National Water Quality Inventory: Report to Congress***, USEPA, EPA 841-R-16-011, Aug 2017, p. 8.

10. **S. Diringer, M. Shimabuku, H. Cooley, M. Gorchels, J. Walker, S.Leurig**, *Scaling Green Stormwater Infrastructure Through Multiple Benefits in Austin, Texas: Distributed Rainwater Capture on Residential Properties in the Waller Creek Watershed*, Pacific Institute, 2020. *https://pacinst.org/publication/multiple-benefits-in-austin-texas*

11. Ibid.

12. **The triple bottom line** (TBL) is an accounting framework that seeks to quantify and monetize benefits and costs to "people, planet, and profit." TBL analyses expand traditional benefit-cost analyses by measuring not only the economic impacts of investments, but the social and environmental impacts as well.

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