

The Basin Threshold Tool Version 0.1: Framework and implementation plan

Version control for development milestones of the Basin Threshold Tool

Version	Date	Authors	Purpose/Change
<i>alpha</i>	August 01, 2024	Mathis L. Messenger, Chris W.S. Dickens, Nishadi Eriyagama, Rebecca E. Tharme	Excel-based global e-flows database consisting of 1,346 local e-flows assessments for 1,194 unique sites across 25 countries.
0.1	August 18, 2025	<i>In alphabetical order:</i> Angela L. Bowman, Chris W.S. Dickens, David W. Dilks, Michael E. McClain, Mathis L. Messenger, Samuel Sandoval-Solis, Ben Stewart-Koster, Rebecca E. Tharme, Michele Thieme, Dave Tickner, and Allen Townsend.	Excel-based global e-flows database consisting of 1,346 local e-flows assessments for 1,194 unique sites across 25 countries. Revision justification: Framework developed for relational database composed of target validation pilot data and Upper Mississippi Basin.

Basin Threshold Tool Technical Advisory Group

Members of the Basin Threshold Tool (BTT) Technical Advisory Group (TAG) were instrumental in the technical development process. TAG members have provided ongoing efforts to ensure the tool is fit for purpose scientifically, as well as readily implementable by users at a basin scale.

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We also greatly appreciate additional reviews and other contributions provided by: Alexis Morgan (WWF, Canada); Jeff Opperman (WWF-US, USA); Enrique Prunes (WWF-US, USA); and Brian Richter (Sustainable Waters, USA).

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Report summary

Purpose and scope of the Basin Threshold Tool V0.1

- The Basin Threshold Tool Version 0.1 (BTT V0.1), aligned with SBTN technical guidance, is a relational database of data, methods, and other supporting information at varying scales designed to ease the burden for companies as they set science-based freshwater targets.
- While information in the BTT V0.1 will be available at varying scales, for the purposes of this framework and the goal for freshwater target setting using the SBTN methodology, the term “basin” refers to the HydroSHEDS Level 6 or equivalent.
- The current database version focuses on freshwater quantity (surface waters), with future expansion planned for groundwater and water quality.

Guiding principles

Five core principles guide the development and evolution of the BTT framework:

- Be consistent with the purpose of the Science Based Targets Network and the water stewardship approach.
- Apply basin-scale understanding of how natural and social-cultural systems interact and influence water flows and levels.
- Establish thresholds that aim to protect, maintain, and restore the desired state of nature.
- Apply international best practices and a precautionary approach as the starting point in identification of e-flows thresholds.
- Adhere to the data principles of Findability, Accessibility, Interoperability, and Reusability (FAIR).

Framework

- Included in the BTT framework is a multi-level decision tree with three pathways to support target setting in basins of different priority levels:
 - Local path (priority), for high-priority basins that require local data.
 - Local path (non-priority), for non-priority basins with available local data.
 - Global path, the last option when local data is unavailable.
- The V0.1 design includes one master meta database, and each component has a distinct Excel table with a relational key linking each table within the master meta database.

Background and objectives

Background

In 2023 the Science Based Targets Network (SBTN) released Version 1.0 of Freshwater technical methods, including guidance for companies to set targets for freshwater quantity (surface waters) and quality (nitrogen and phosphorus; SBTN, 2023a). In 2024, SBTN published Version 1.1, which included revisions of the technical methods based on learnings from companies involved in initial target validation pilots (SBTN, 2024a).

The first version of the SBTN technical guidance included language for a Basin Threshold Tool (BTT) that would support target setting, though it had not yet been produced. At about the same time, a target

validation pilot occurred, and while companies were able to set targets, they did so without the support of the BTT. These pilot companies acknowledged that data, methods, and other supporting information were difficult to obtain and a tool such as the BTT would provide valuable support throughout the process.

Here we present the framework and data structure of the BTT Version 0.1 (V0.1) as well as an implementation plan to populate the BTT based on priority geographies for corporate target setting globally. Future versions of the BTT (beyond V0.1) will depend on a technical design that includes a web graphical user interface and a cloud-based relational database infrastructure, scientific advances in environmental flows (e-flows) and best practices, and continued alignment with future versions of SBTN technical guidance. Efforts to populate the BTT V0.1 with basin information is ongoing even as companies begin to use the BTT for target setting; with increased feedback and information, the expectation is that the BTT will continue to improve company engagement in the target-setting process.

Objectives

The overarching aim of this work is to present the framework of the current state of the BTT V0.1. This version of the database is technically sound, flexible, and sufficiently robust, containing data, methods, and other supporting information for the implementation of e-flows in science-based targets. The primary use case for this database is companies seeking to set science-based targets for freshwater in accordance with existing SBTN Step 3 guidance (SBTN, 2024b; SBTN, 2023a). Other anticipated use cases include better understanding and utilizing e-flow thresholds and system limits for non-corporate water users (e.g., academic or other applied research) and interested stakeholders (e.g., local water management authorities).

This report is comprised of three sections. The first section provides the evolution of the global e-flows database and its role in the current BTT V0.1. The second section presents the guiding principles in the BTT development. The third section presents details of the BTT framework, including the multi-level decision trees for users to determine the appropriate target-setting path, and the BTT architecture, which collectively represents the current data repository for freshwater quantity (surface waters) and quality (nitrogen and phosphorous).

The global e-flows database: Core of the BTT V0.1

Environmental flows

The Brisbane Declaration and Global Action Agenda on Environmental Flows (e-flows) in 2018 defined e-flows as *“the quantity, timing, and quality of freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being”* (Arthington et al., 2018). While e-flows have mostly been applied to river systems including rivers, floodplains, wetlands, estuaries, and inner and coastal deltas, e-flows are also applicable for other types of aquatic ecosystems, such as lakes and groundwater-dependent wetlands (Poff et al., 2017; Arthington, 2015). The definition of e-flows is intentionally inclusive in this regard, referring to both water flows and water levels.

E-flows can be a powerful tool for successfully achieving sustainability in integrated water resources planning and management (Horne et al., 2017). E-flows are also recognized as an essential element of policy and action agendas for the protection and recovery of freshwater biodiversity for rivers, lakes, and other types of wetlands. They are well established as a high potential intervention within integrated

strategies to mitigate threats to freshwater biodiversity, support efforts to conserve and restore the ecological integrity of aquatic ecosystems (Arthington et al., 2018; IUCN, 2020), and more sustainably manage nature's contributions to people (NCPs; Díaz et al., 2018).

Purpose and content of the global e-flows database

A global-scale effort to develop an e-flows database for research and decision support began several years ago with the International Water Management Institute (IWMI). Collaborating on this effort were a group of e-flows practitioners and others working in sustainable water management, including Riverfutures; IWMI; IHE Delft Institute for Water Education; the Food and Agriculture Organization of the United Nations (FAO); the National Research Institute for Agriculture, Food and Environment (INRAE), France; McGill University, Canada; WWF-UK; and Melbourne and Griffith universities, Australia. A comprehensive first-version global e-flows database was created by this group in 2024 (Messenger et al., 2024). This database was itself an adaptation of an early 2000-era look-up database of e-flows studies on which IWMI created Version 1.0 of the Global Environmental Flow Information System (GEFIS Version 1.0; Eriyagama et al., 2024).

The global e-flows database, now the foundation of the BTT V0.1, is an Excel-based spreadsheet database of technical e-flows assessments focused on the reach to basin-scale and consists of approximately 1,346 formatted records that represent 1,194 unique sites distributed across 25 countries (Messenger et al., 2024). Scripts and other code used to generate consistency in e-flows thresholds as part of the development of the global e-flows database are freely available for all purposes and can be copied, modified, and distributed with citation at https://github.com/messamat/globalEF_testPy (for data-preformatting and global e-flows calculations) and https://github.com/messamat/globalEF_testR (for comparing global and local mean annual flow [MAF] and e-flows estimates [Messenger et al., 2024 *Supplementary Information*]).

Evolution of the global e-flows database to the Basin Threshold Tool V0.1

In its current state, data available in the global e-flows database is the result of e-flows practitioners submitting information from their respective geographies (Messenger et al., 2024). As a result, the current database exhibits geographical disparity, where basins in countries like France and South Africa have many entries, while basins in other countries have few or no entries due to lack of response from practitioners. The United States is one example of a country with no entries in the global e-flows database. However, a focused pilot effort to populate the BTT V0.1 for the Upper Mississippi River Basin (UMRB) in the north-central United States resulted in data for that basin as well as a consistent, science-based process to populate other basins in the United States and globally.

In 2024, several organizations collaborated to develop a collective action strategy in water stewardship (Various Organizations, 2024) and this work formed the basis for the United Nations Global Compact Water Resilience Coalition (WRC) list of *100 Priority Basins*, which includes basins around the world with the highest level of opportunity for corporate collective action. The ideal basin scale for implementation of collective action—and in turn, e-flows and SBTN target-setting—is HydroBASIN Level 6, and while the priority basins today are presented at a coarser scale (HydroBASIN Level 3-4), the focus of company action will be HydroBASINS Level 6 and this will serve as guidance to populate the BTT.

A crosswalk analysis was also completed by SBTN Freshwater Hub partners (WWF, TNC, WRI, CDP, PI/CEO Water Mandate) and their respective corporate engagement programs to identify basins for addition to the BTT V0.1 (Figure 1). While some basins already have data in BTT V0.1, known gaps exist (e.g., China, New Zealand, parts of Europe, the United States, and South America). This list is dynamic and will continue to evolve.

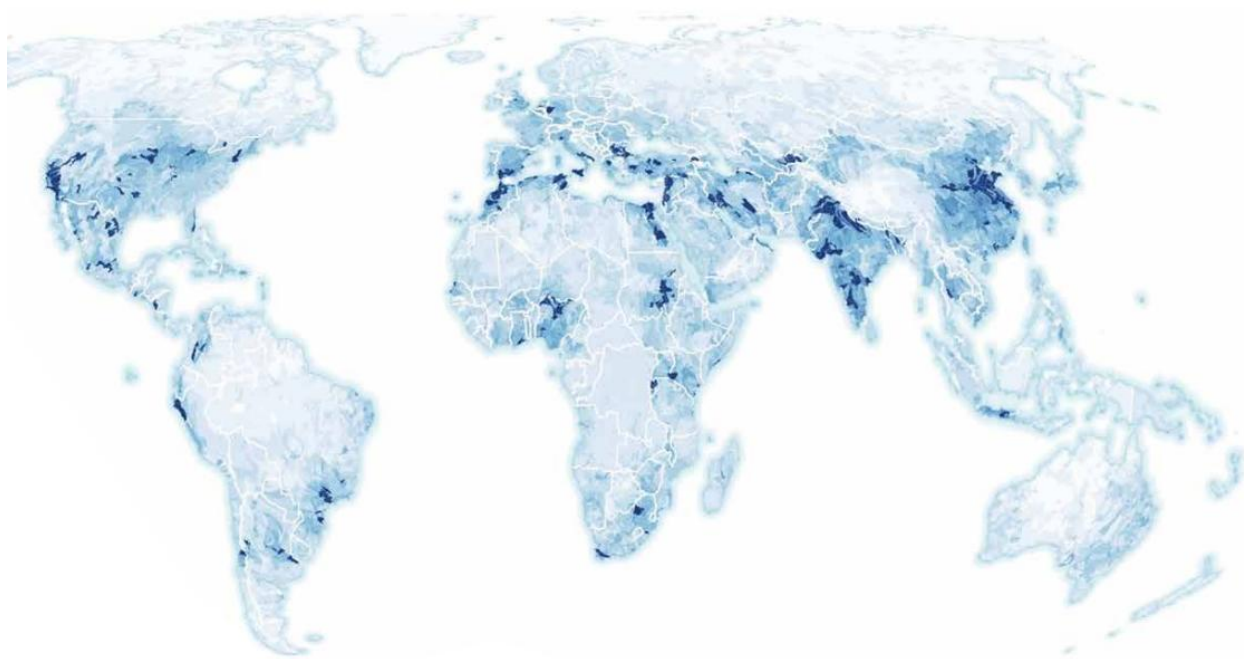


Figure 1. Graphic depicting the United Nations Global Compact Water Resilience Coalition (WRC) *100 Priority Basins* list. Those highlighted blue represent the priority basins selected to populate the Basin Threshold Tool V0.1 for completion by the release of SBTN technical methods Version 2.

Guiding principles of the Basin Threshold Tool development

Through the process of developing the framework of the BTT, we aligned on five overarching principles to support decision-making. The principles presented here—in no preferential order—serve to guide the developers of the framework in its current form as well as future versions.

Principle 1. Be consistent with the purpose of the Science Based Targets Network and the water stewardship approach.

As part of the Global Commons Alliance, SBTN works with the Earth Commission, a global team of leading natural and social scientists and expert working groups, pioneering a scientific framework combining Earth system science with social science. This alliance has defined safe and just boundaries to avoid crossing irreversible tipping points and attaining a stable and resilient planet for humanity to thrive. At the same time, this evolving science is helping to inform the SBTN guidance that companies and cities can adopt and to guide the understanding of biophysical and social thresholds relevant to target setting and the interconnections between targets and subsequent response options.

Water stewardship is central to the BTT application. Among other approaches that align with SBTN are the Alliance for Water Stewardship standard (AWS, 2019) and the Net Positive Water Impact (NPWI) from the UN Global Compact CEO Water Mandate. SBTN, AWS, and the CEO Water Mandate each support sustainable water management, ecosystem protection, and stakeholder engagement.

Principle 2. Apply basin-scale understanding of how natural and social-cultural systems interact and influence water flows and levels.

Rivers and the basins that contain them can be thought of as “spatially nested,” in which smaller-scale processes (e.g., microhabitats, stream reaches) are contained within and are influenced by larger-scale processes (e.g., land use change). While the typical scale for science-based targets will be HUC 6 (US) or HydroBASIN Level 6 (globally), a spatially nested approach to target setting and appropriate response options is fundamental to connecting hydrological and social-ecological systems. This approach includes integrating water and environmental management, applying a systems approach, engaging relevant stakeholders and incorporating where possible social-cultural dimensions of basins with water flows/water levels.

Principle 3. Establish thresholds that aim to protect, maintain, and restore the desired state of nature.

Under SBTN Freshwater Step 3, the state of nature (SoN) is defined as *the quality of the environment in relation to the functions that it fulfills* (SBTN 2023b). For science-based targets, state of nature typically refers to three key categories: species (abundance and extinction risk), ecosystems (extent, integrity, and connectivity), and nature’s contributions to people.

The Freshwater methods include a consultation process with relevant stakeholders (e.g., water management agencies, local communities, and indigenous groups) to identify appropriate hydrological models and thresholds for setting targets in basins. Stakeholder consultation is facilitated by a decision tree that provides companies with recommendations for how to proceed when local models are not immediately found. SBTN’s Stakeholder Consultation for Model Selection Recommendations (2024b) is companion guidance for the Freshwater methods.

Principle 4. Apply international best practices and a precautionary approach as the starting point in identification of e-flows estimates.

The science of e-flows continues to evolve through international best practices, from determination of e-flows using various methods in the different stages of implementation to setting the decision context for an e-flows assessment and to adaptively monitoring and managing the recommended e-flows (Arthington et al., 2018). In e-flows determination, a precautionary approach—managing water resources in such a way that prioritizes preventing harm to aquatic ecosystems and human health—addresses the reality that not all e-flows assessments can be undertaken with the same level of resources, technical rigor, or confidence in the results (Opperman et al., 2018; Richter et al., 2012; Richter et al., 2011; Richter, 2010).

A precautionary approach guides BTT development, from the global e-flows database to the current V0.1, when establishing thresholds based on global-level e-flows assessments. We also applied this approach in assessments that were conducted with limited ecological knowledge, as opposed to those e-flows established with robust local data and in close consultation with relevant stakeholders.

Principle 5. Adhere to the data principles of Findability, Accessibility, Interoperability, and Reusability (FAIR).

FAIR principles for data management and stewardship—Findability, Accessibility, Interoperability, and Reusability—should be adhered to in both the evolution and use of the BTT and supporting metadata, including the global e-flows database and the thresholds generated for target setting. A focused principle on good data management ensures open access to data and methods in BTT development and

leads to further knowledge discovery and innovation in the field of e-flows for freshwater ecosystems (Wilkinson et al., 2016).

The data, metadata, methods, and tools available in the BTT as well as any publications pertaining to the BTT and its applications should be open access, further promoting product accessibility and usability.

Basin Threshold Tool V0.1 framework

The BTT V0.1 framework currently includes two parts: a multi-level decision tree (Figures 2, 3, 4) and architecture that contains the data repository (Figure 5). This design represents a unique opportunity to facilitate global consistency in locally relevant e-flows information that can be used by myriad end users, from corporate to academia and governmental as well as non-governmental organizations. Each part of the framework is described in detail in the following sections.

Multi-level decision tree

In the original SBTN Freshwater Technical Guidance, a decision tree illustrates the process of selecting a modeling approach through a series of database and stakeholder consultations and guides the user to the appropriate path through a series of stepwise decisions (SBTN 2023a, b). The framework of the BTT V0.1 is aligned with this approach and generally follows the original guidance for both local and global paths, with updates presented below. It is important to note that this framework will continue to be tested and will evolve in future versions to ensure continued alignment with SBTN technical methods.

The updated decision trees focus on three paths, one of which should be followed to achieve target setting. These paths include:

1. **Local path (priority):** The prescribed route for priority basins, shown in **purple** (Figure 2).
2. **Local path (non-priority):** The prescribed route non-priority basins, shown in **green** (Figure 3).
3. **Global path:** For cases where the local path is infeasible or no local e-flows estimate exists, shown in **orange** (Figure 4).

All paths commence in the same way through stakeholder consultation, followed by selection of the appropriate path to determine where to begin in the BTT. While the global path is currently maintained and updates to the global model are in process, the ideal is that eventually local data are available everywhere such that all users will use the local path. The reliance on global data should continue to diminish as the availability of data, methods, models, and other information at the local level increases.

In a future version, an end-user guidance document will be available to assist users of the updated decision tree and BTT. While this will continue to support ease of use, the BTT V0.1 may be used today without this document.

Local path (priority)

Consistent with the SBTN Freshwater Step 3 Technical Guidance, priority sites will follow the local decision tree path (Figure 2). The level of rigor in the priority path is the highest, including the quality of e-flows assessments, stakeholder engagement, and requirements to compile and/or develop data where they do not yet exist. This differentiates the priority basins from basins not identified as priority in Steps 1 and 2 but where companies still wish to set targets.

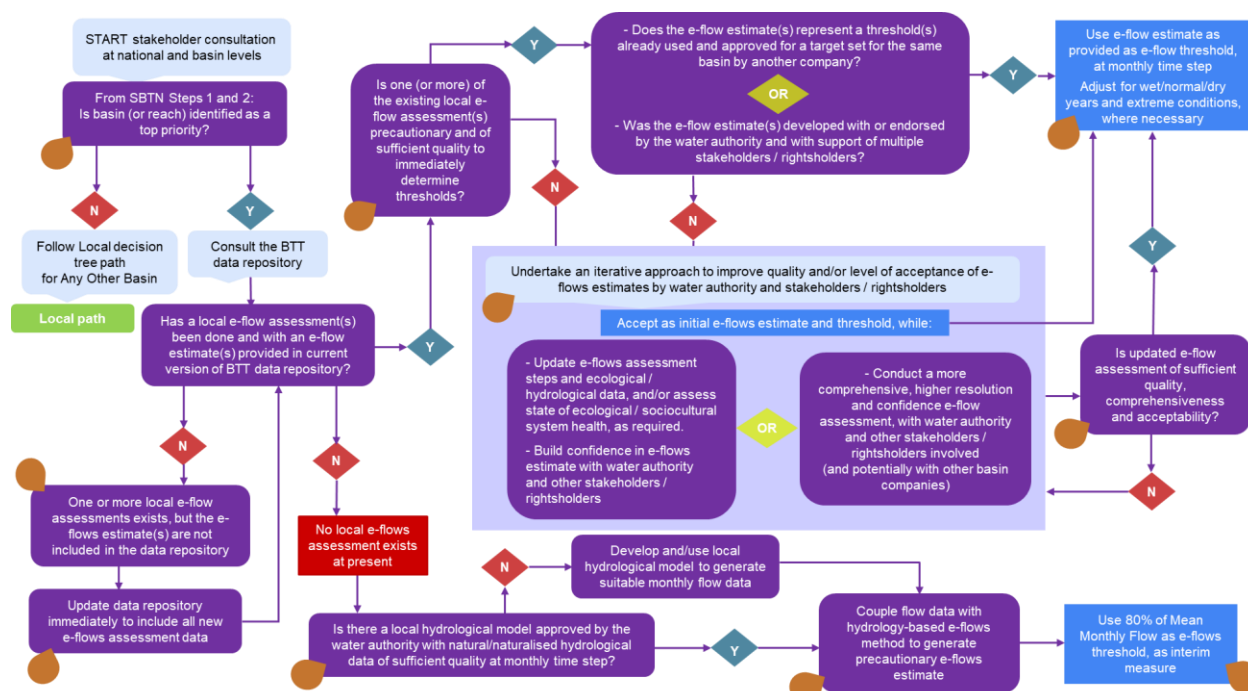


Figure 2. Decision tree of the **local path (priority basin)** to guide application of the Basin Threshold Tool V0.1. Brown teardrops indicate steps where guidance criteria will be developed.

For BTT V0.1, a few e-flow estimates may be included that do not meet the precautionary approach (Principle 4). Users will consult with local basin authorities to determine whether these e-flows data are sufficient for use, and once companies have vetted these e-flows estimates in stakeholder consultations, updated information will be added to the BTT. A data reporting form is in development for the next version to facilitate consistent addition of information to the BTT. Streamlining data acquisition will make the use of the BTT and data acquisition easier for users.

In instances where local basin authorities consider the e-flows estimates inadequate, an iterative process is recommended to strengthen the e-flows estimate or to conduct a new e-flows assessment. In the latter case, the new assessment supersedes other e-flows assessments for the same location. This situation may provide opportunity for collaboration between companies with similar sourcing regions within a defined period. For example, two years is considered a reasonable timeframe to generate high-resolution, high-confidence e-flows estimates (Opperman et al., 2018). In some cases, a company may identify a high-priority site, but either e-flow estimates of insufficient quality exist or no e-flows assessments have been completed. Here, a company may find that working together collaboratively with another company to co-resource a new assessment will be more cost- and time-effective to enable setting a target and responding than acting alone. A pilot is currently in development to explore this collaborative target setting in the US Mississippi basin, a key sourcing region for many companies.

Local path (non-priority)

As companies complete Steps 1 and 2, they may identify locations that fall outside their highest priorities but for which they would still need to set a target. When this happens, and where local e-flows assessments of sufficient quality are available, then the local path (non-priority) decision tree will be followed, and the available e-flows threshold may be selected (Figure 3).

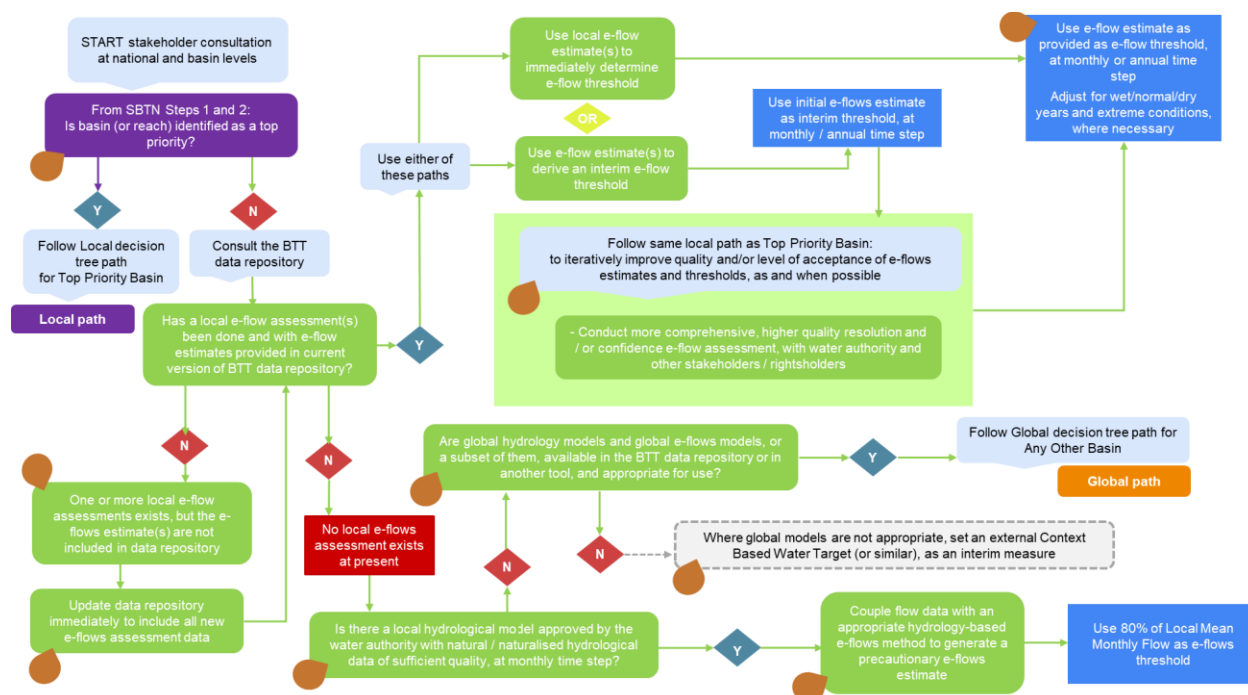


Figure 3. Decision tree of the **local path (any other basin)** to guide application of the Basin Threshold Tool V0.1. Brown teardrops indicate steps where guidance criteria will be developed.

Where a local e-flows assessment has been made, but the corresponding data has not yet been added to the BTT, an additional step is proposed that includes the user extracting the data for the relevant components and data fields in the BTT. In development for the next version is a data reporting form to facilitate consistent addition of information to the BTT. Streamlining data acquisition on multiple fronts will make the use of the BTT and data acquisition easier for users.

Like the priority path, in instances where local basin authorities consider the e-flows estimates inadequate, an iterative process is recommended to strengthen the e-flows estimate or to conduct a new e-flows assessment. In cases where a local hydrological model or dataset is available but not an e-flows assessment, then a precautionary approach may be used, where an e-flows estimate equal to 80% of Mean Monthly Flow (MMF) is computed based on local hydrology and is approved through local stakeholder consultation. In cases where no local hydrological models or data are readily available, the global path may be followed.

Global path

The global path is prescribed only for non-priority locations when no hydrologic model or dataset or local e-flows data are readily available, and is time-bound while new e-flows assessments are conducted (Figure 4). In this update to the original SBTN Freshwater Step 3 decision tree, the global path is no longer the dominant route; instead, this path becomes the path of last resort.

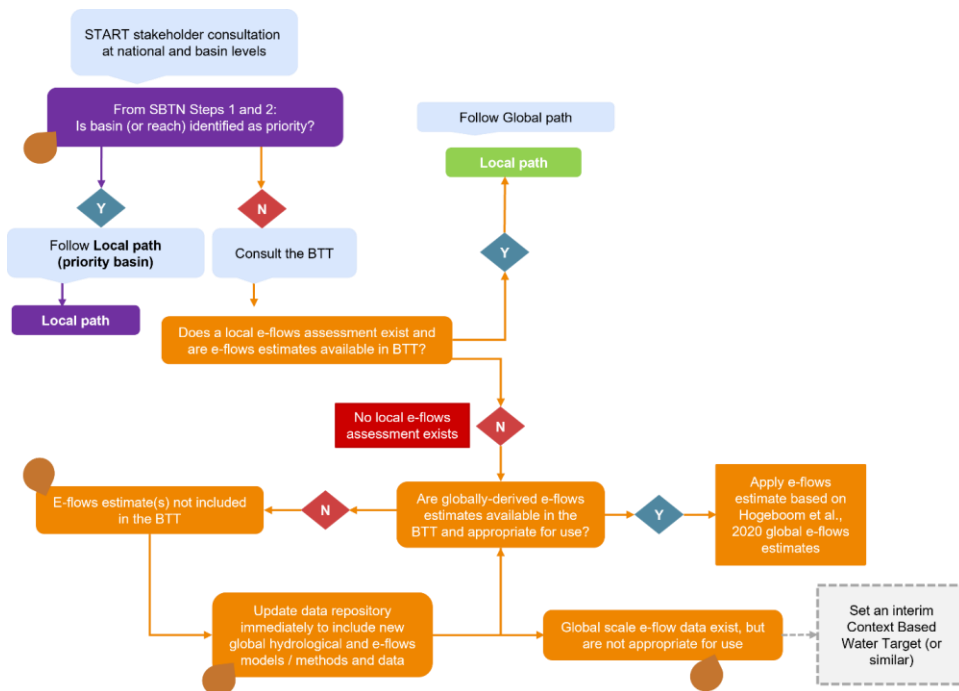


Figure 4. Decision tree of the **global path for any basin in which the local path is not feasible** to guide application of the Basin Threshold Tool V0.1. Brown teardrops indicate steps where guidance criteria will be developed.

For the BTT V0.1, the original approach from Hogeboom et al. (2020) is the continued path for target setting when only the global option is available. Updates to the global model are currently in development and are expected for future SBTN technical guidance releases.

Rarely will there be an occurrence when neither suitable data exists at the local level nor global models are appropriate. Should this scenario occur, interim context-based targets may be set. These targets, not validated by SBTN, may provide a starting point for response options until e-flows assessments can be completed. Alternatively, foregoing context-based targets and initiating e-flows assessments may be the more direct option to avoid further delays in action.

Architecture and data repository

The BTT V0.1 architecture reflects the current compilation of data and methods required across global to local scales for freshwater target setting (Figure 5). Under each architecture component are core datasets needed for identifying and setting freshwater targets. Currently, the data are in one master meta database, and each component is a distinct Excel-based relational table that links together through key values, such as basin scale, name, or other identifier.

The BTT architecture begins at the component *Scope Freshwater Target Setting* to indicate the starting point for the global or local path and priority or non-priority location. The next component is the *Basin and System Location and Character*, which contains the name, scale, and general information of the basin of interest, followed by the BTT's core data. Core data include *Climate and Hydrological Data and Models*, *Ecological Assets and Ecosystem Health*, *Social-Cultural Assets and System Health*, *Freshwater Quantity Surface Waters*, *Groundwater* (developing), and *Freshwater Quality* (developing). *Environmental Flows* includes the series of information relevant to *E-flow Assessments*, *Cultural Flow*

Assessments (developing), *Global Estimates*, and *Local Estimates*. Each of these are described in more detail below.

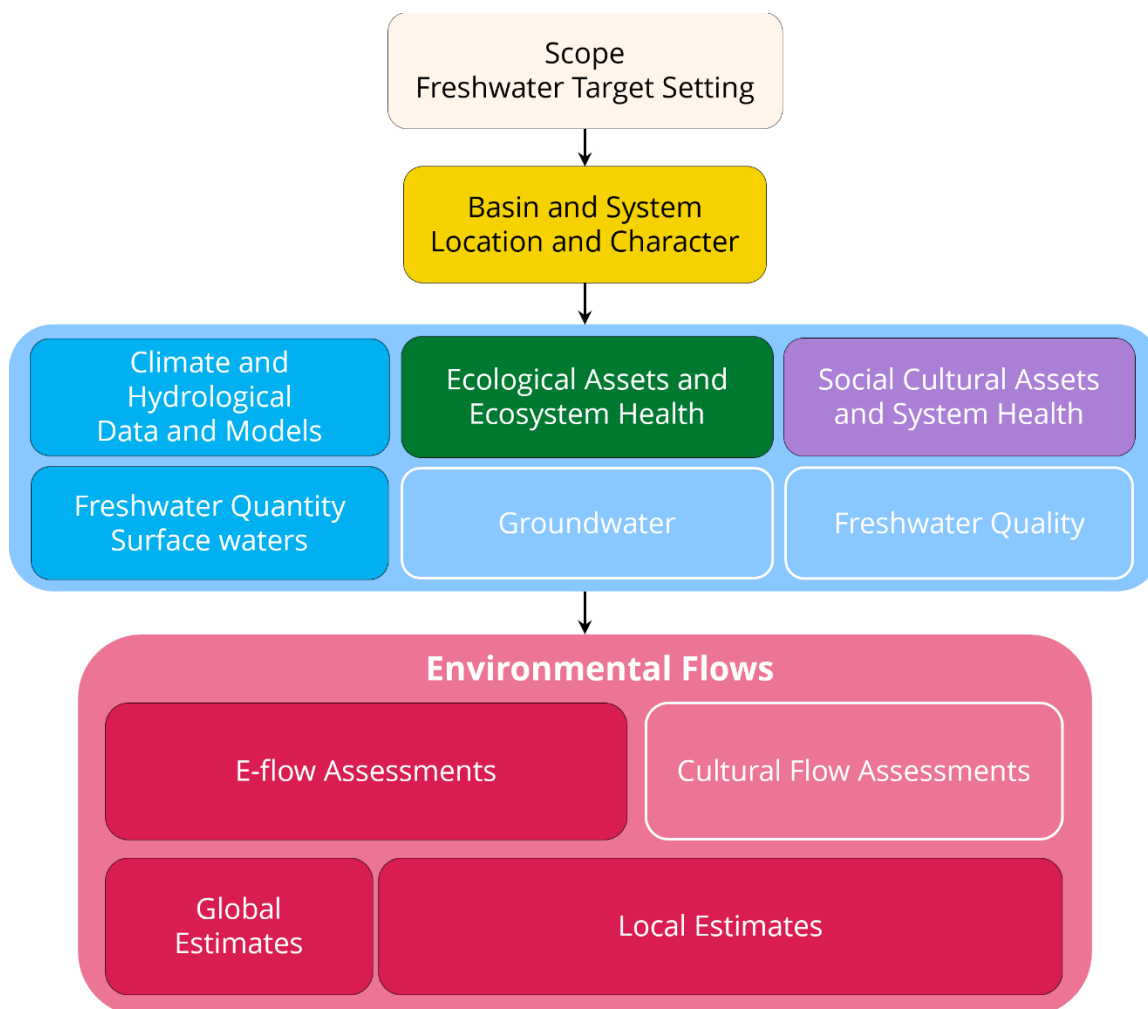


Figure 5. Architecture of the Basin Threshold Tool (BTT) V0.1. Each rounded box is a data component of the BTT and contains its own Excel-based relational table. The white rounded component boxes (Groundwater, Freshwater Quality, and Cultural Flow Assessments) reflect tool components under early development and do not yet have existing database structures.

Tool components & methods for building BTT V0.1: Local path

To simplify the evolution of the BTT V0.1 from the global e-flows database, we developed a crosswalk to reflect how the data connects between the BTT V0.1 architecture and the data fields of the global e-flows database (Table 1).

Table 1. Crosswalk of the BTT V0.1 components and global e-flows database data fields with a description of each data field.

Basin Threshold Tool V0.1 data field	Global e-flows database data field	Description of global e-flows database data field
Scope	Country	Name of country.

Basin system location and character	Basin and river system	Name and scale of basin. Scale of target setting with major basin name listed.
	Geographic coordinates of e-flows sites	Coordinates of all individual e-flows sites for which e-flows were determined as part of the e-flows assessment. Co-registered to each river reach represented by the site, in the digital representation of the global river network with corresponding HydroSHEDS ID number for basin level.
Climate and hydrological data and models	Long-term natural mean annual flow (MAF)	Derived from observed natural or modelled naturalized hydrological timeseries.
Environmental flow and/or cultural flow assessments	Type and name of e-flows assessment method used to determine recommended e-flows	Assigned to one of the main categories of methods, viz.: hydrological: single indices; hydrological: time series analysis; hydraulic rating; habitat simulation; and holistic/ecosystem function.
Thresholds	Established e-flows requirements	As annual volume, the percentage of Mean Annual Flow, discharge per month or season, and in some cases as specific flow events throughout the hydrological year and among years.
Ecological assets and situation assessment of ecosystem health Social-cultural assets and system health Environmental flow and/or cultural flows assessments Baselines and monitoring	Extent of use of ecological, geomorphological, and/or social-cultural knowledge as part of the assessment	Based on a simple qualitative rating. The actual knowledge used in determining e-flow needs, including the reasons for the specific flows recommended, is detailed in the e-flows assessment report and/or in one or more supplemental technical reports (e.g., baseline assessment of river morphology, river health monitoring survey).
Environmental flow and/or cultural flows assessments	Strength of the evidence provided for the recommended e-flows and confidence rating	Where provided in some form for the specific e-flows assessment. Based on qualitative ratings, as assigned by the e-flows experts during the e-flows assessment.
Ecological assets and situation assessment of ecosystem health	Ecological management class (EMC) or other indicator of ecological state or health of the socio-ecological system	For present and/or future state of health of the system, where this information was provided for the specific e-flows assessment or as part of the basin situation assessment supporting basin characterization.
Social-cultural assets and system health Environmental flow and/or cultural flow assessment Baselines and monitoring		
Water governance and management system	Whether or not e-flows are included in the present national legislation and any associated regulations	Yes or no, with any specific regulations, provided in the main e-flow assessment or supplemental materials or based directly on the knowledge of the local e-flow practitioners or other stakeholders.

Environmental flows and/or cultural flows assessments	Source of data	Link to source technical report, published journal paper or website (with other information, e.g., specific ecological reasons for recommended flows, results of participatory surveys with local communities).
Stakeholders and rightsholders	Point of contact	Name of key person(s) who can be contacted for any follow-up needed on the specific e-flow or cultural assessment.

The core datasets populated in the BTT are outlined under each of the components and are described in more detail below.

Scope of freshwater target setting

The data available in “Scope” includes the scale, objectives for basin target setting, and any cross-cutting data and represents the location metadata (Figure 6). Other factors include which decision path to follow. We expect future information to include anonymized company target-setting objectives and level of resolution expected with the given targets.

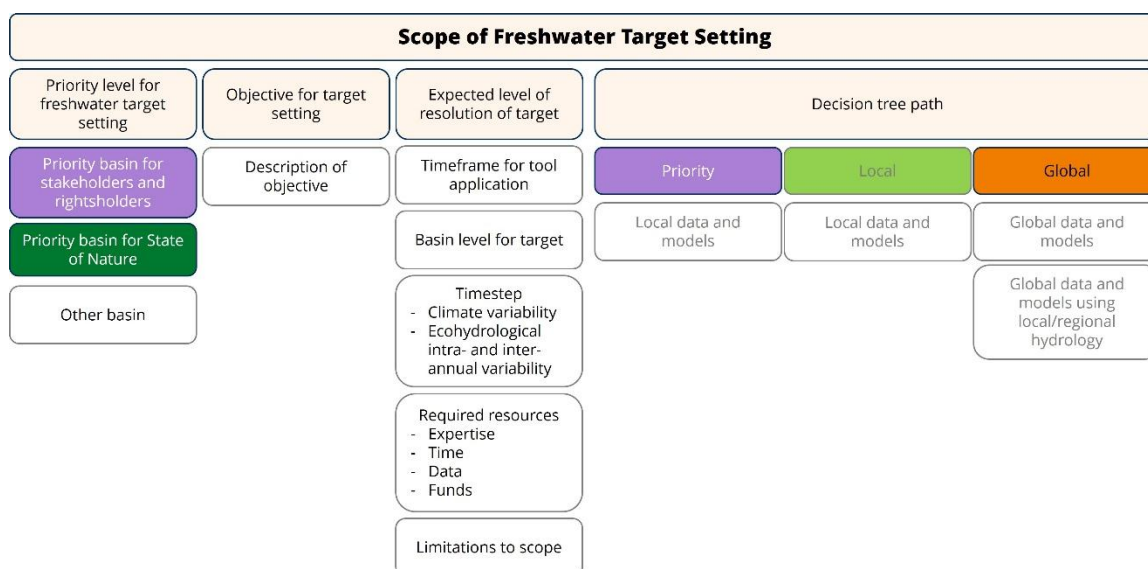


Figure 6. The data structure of the BTT vV0.1 component **Scope of Freshwater Target Setting**.

Basin system location and character

The component “Basin and System Location and Character” contains the georeferenced boundary and the hydrological unit, the basin name and its drainage network, river system of interest, and main hydrological and socio-ecological system characteristics (Figure 7). This information is key to understand how rivers and the basins that contain them are “spatially nested” (Principle 2) and when and how to apply this information during the target-setting process and potentially subsequently in acting through selected response options.

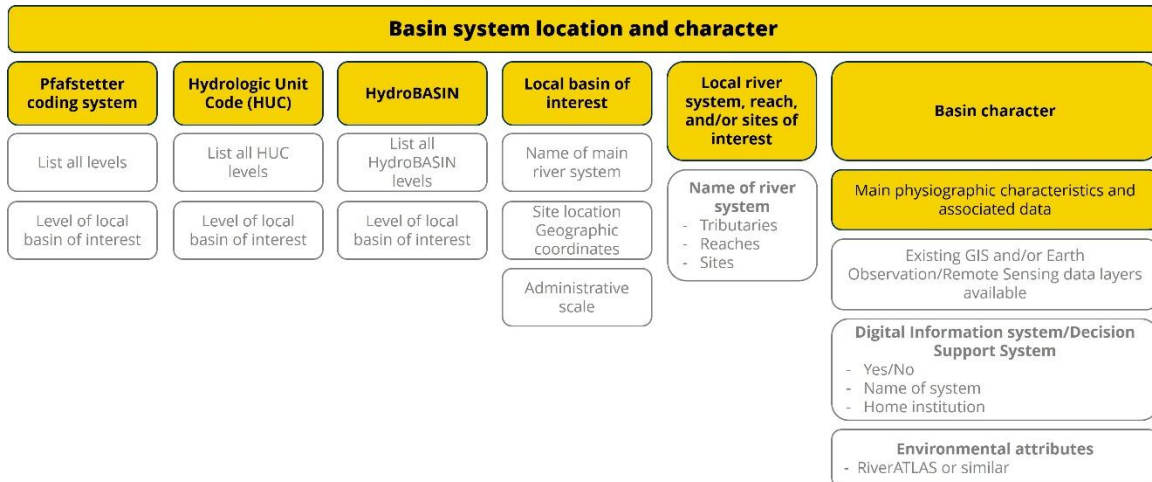


Figure 7. The data structure of the BTT V0.1 component **Basin System Location and Character**.

An important part of the BTT is the notion of information that is “spatially nested” through a hierarchy structure that includes rivers and basins at different scales. Users may identify and track relevant basins and information by scaling up or down depending on the needs of the basin and scale of action (Figure 8).

Spatially nested basin scales			
Pfafstetter Coding System HydroBASINS Level Hydrologic Unit Code (HUC)			
Pfafstetter HUC HydroSHEDS Basin Level (level determined by scale adopted in local approach)	HydroBASIN varies globally	HUC2 (Upper Mississippi)	
Pfafstetter 5 - Freshwater Quantity Surface Water and Groundwater (global approach)	HydroBASIN 5	HUC2-4 (Iowa-Skunk-Wapsipinicon)	
Pfafstetter 6 - Freshwater Quality (global approach)	HydroBASIN 6	HUC6 (Iowa)	
(local approach)	HydroBASIN 7	HUC8 (Middle Cedar)	

Figure 8. Basin scale hierarchy that correlates spatially nested basins to appropriate scale and connects information via a relational database in the Basin Threshold Tool (BTT) V0.1.

Climate and hydrological data and models

At the local level, specific data and model needs differ among basin scales, though a common set of information is required that includes data such as climate forcing or precipitation, climate scenarios, observed and/or simulated hydrologic discharge, and basin total water availability and use (Figure 9). Freshwater quantity for surface waters is a key data resource for local hydrological model development. System data includes location of gauging stations, observed and/or simulated hydrological discharge, as well as the name of local hydrological models and institutions responsible for specific model development.

While groundwater and water quality components are currently beyond the scope of this version of the BTT, they are planned for future development alongside technical methods in progress for 2026 release. As shown in Figure 5, “Groundwater” and “Water Quality” are in development, represented as white rounded boxes, and are grouped with surface water components with which they are most interconnected including hydrology, ecology and ecosystem health, and social-cultural system health.

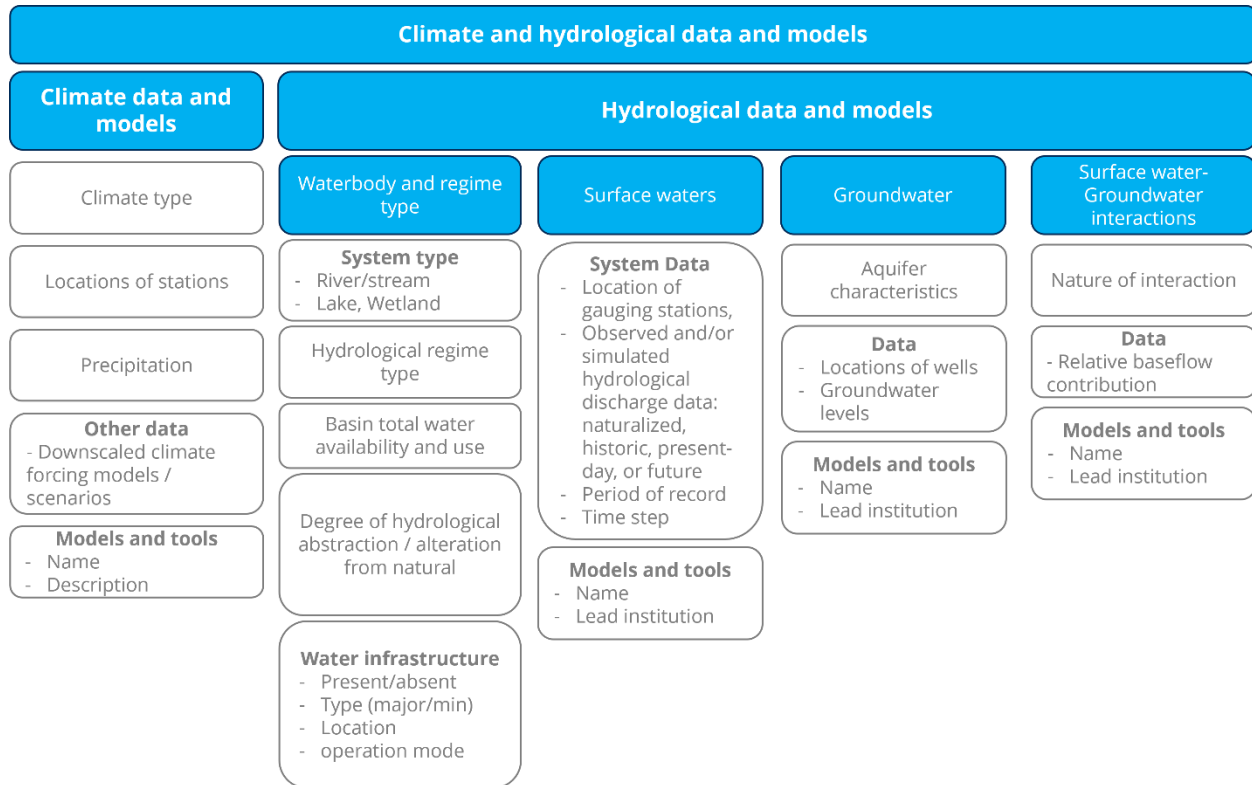


Figure 9. The data structure of the BTT V0.1 component **Climate and Hydrological Data and Models**.

Ecological assets and ecosystem health

The component “Ecological Assets and Ecosystem Health” addresses the state of knowledge on the priority ecological assets known to occur within the basin and provides a situational assessment of the health of these assets, the ecosystems with which they are affiliated, and the state of biodiversity (Figure 10). This is a synopsis of the natural and present-day state of nature (SoN) that reflects the degree of departure from natural or other baseline conditions.

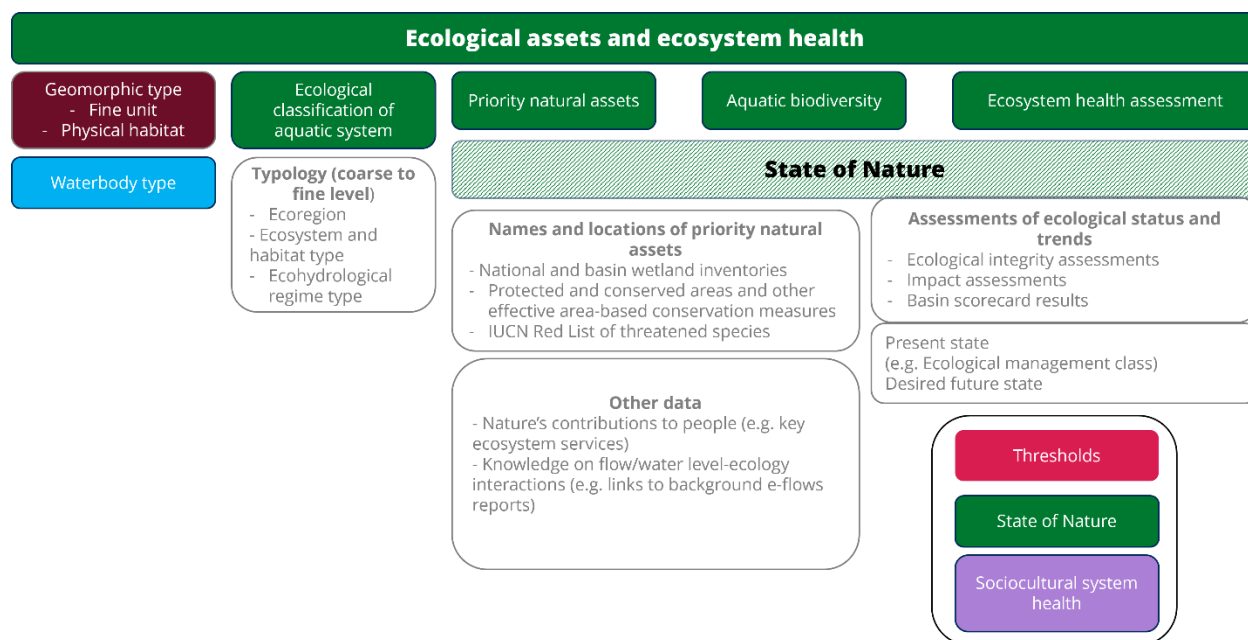


Figure 10. The data structure of the BTT V0.1 component, **Ecological Assets and Ecosystem Health**.

The information on the SoN and corresponding risks to nature under SBTN Steps 1 and 2 are linked to this component, and the ecological data from those steps will help inform the deeper ecological input required in SBTN Freshwater Step 3. The component “Thresholds” connects this table to “Environmental Flows” (Figure 12) and much of the data needed to inform the process of freshwater threshold selection is available in the supporting documentation of these components. This is particularly the case for the holistic e-flows assessments currently in BTT V0.1 that are a legacy of the global e-flows database, and which align most strongly with international best practice (Principle 4). These e-flows assessments include ecological data and specialist expertise in the specific rationale provided for individual flow recommendations and thresholds.

Social-cultural assets and system health

The component “Social-Cultural Assets and System Health” is critical for freshwater target setting in basins where there are stakeholders and rightsholders with cultural requirements for water (Figure 11). While this may not be true for all basins globally, for those basins in which cultural requirements for water are needed, this information is a critical component to current and future versions of the BTT (Jackson, 2017).

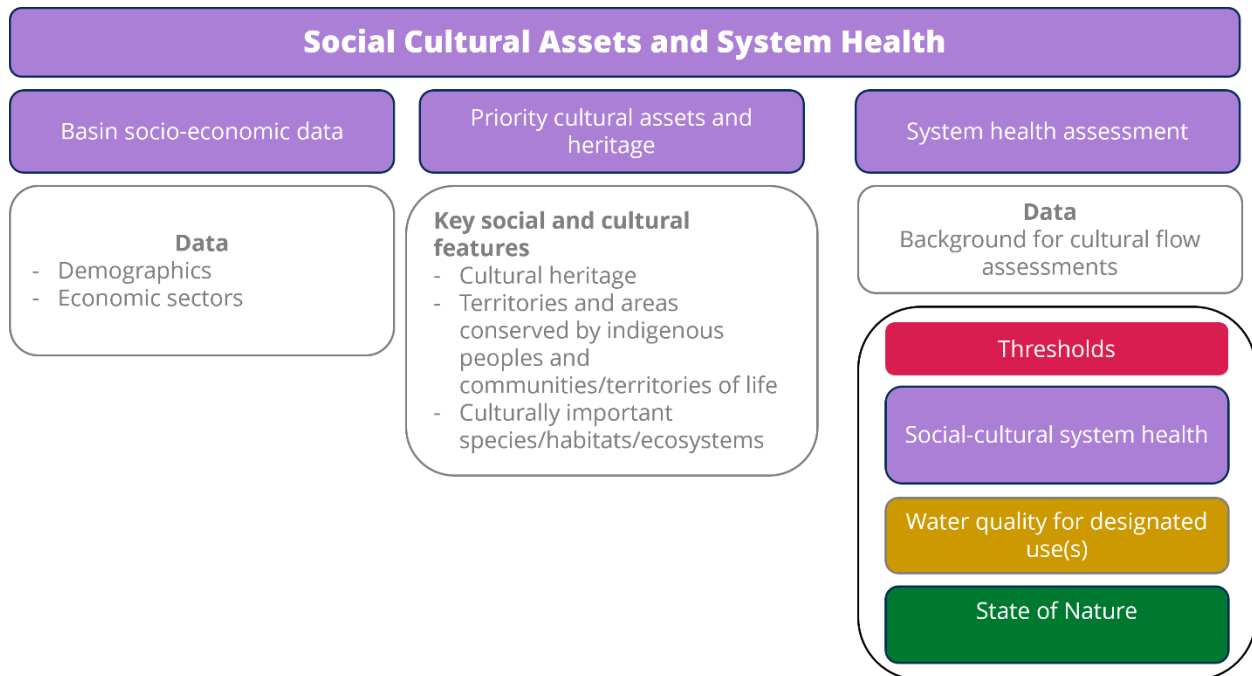


Figure 11. The data structure of the BTT V0.1 component **Social-Cultural Assets and System Health**.

Environmental flows

E-flows represent the core component of the BTT V0.1 and include global estimates, local e-flows studies, e-flow assessment types, and other relevant information (Figure 12). Other documentation in this component includes the types of e-flows methods applied, typically provided in e-flows assessments, background reports, or other gray literature.

While only a few cultural flows assessments exist in the BTT today, primarily from the evolution of the global e-flows database, cultural flows assessments are also a core component in many basins and are a focus of future development where appropriate.

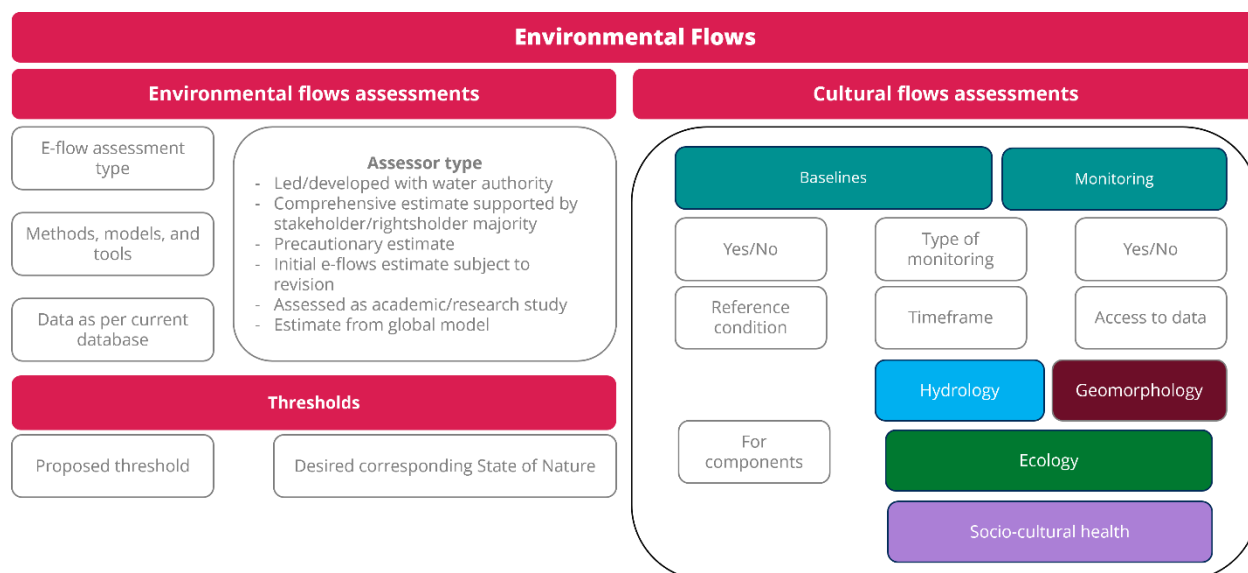


Figure 12. The data structure of the BTT V0.1 component **Environmental Flows**.

Conclusion

The Basin Threshold Tool (BTT) Version 0.1 (V0.1) is an Excel-based relational database of information (data, methods, and other supporting documentation) to support companies setting science-based targets as well as other research purposes. The BTT is underpinned by five guiding principles that serve to guide scientifically sound database structure and development.

The BTT framework builds on and strengthens the existing SBTN Freshwater Step 3 Technical Guidance. Included in the framework are a series of multi-level decision trees for local path (priority), local path (non-priority), and a global path for when no local information is available. The selected decision tree guides the user to identify appropriate e-flows estimates for target setting. Also included is the architecture, a series of components linked together through relational keys such as basin scale, name, or another identifier. Associated datasets collectively represent the data repository for freshwater quantity (surface waters). Future development will include groundwater and freshwater quality.

The BTT V0.1 may be used today by companies to set science-based targets for Freshwater. While not all geographies and basins are currently represented, active development plans are in place to continue to populate the BTT following the priority basins identified through corporate water stewardship teams in SBTN FW Hub organizations as well as the 100 priority basins listed by the UN Global Compact Water Resilience Coalition.

Next steps and plan for implementation

Future versions of the Basin Threshold Tool will coincide with the development and evolution of the SBTN Freshwater technical methods. Version 2 of the technical methods is in progress currently and is intended for release in 2026. The goal is that Version 1.0 of the BTT will be released at the same time. Version 1.0 will be the first fully web-based version of the database, which is expected to be a workable graphical user interface (GUI) connected to a cloud-based relational database utilizing the framework structure presented in this report. A tentative goal for the BTT V1.0 will be to house, maintain, and

update the database in conjunction with the WWF Risk Filter Suite, which supports Steps 1 and 2 of the SBTN Freshwater technical methods today.

To achieve key milestones and make iterative and meaningful progress on the BTT, next steps have been outlined in the report and are reiterated here:

- Accelerate populating the BTT with identified basins including the UN Global Compact Water Resilience Coalition *100 Priority basins* and basins identified through corporate water stewardship programs from WWF, TNC, WRI, and PI/CEO Water Mandate.
- Develop, test, and refine detailed end-user guidance criteria to assist in use of updated decision trees that support ease of use of the BTT V0.1. Note, however, that the BTT V0.1 may be used today without this document.
- Develop, test, and refine a data reporting form or structure to facilitate consistent addition of information collected by companies and other users to the BTT. Streamlining data acquisition on multiple fronts will make the use of the BTT and data acquisition easier for all users.

References

- Arthington, A. H. et al. (2024). [Accelerating environmental flow implementation to bend the curve of global freshwater biodiversity loss](#). *Environmental Reviews* 32:3, 387-413.
- Arthington, A. H. et al. (2018). The Brisbane declaration and global action agenda on environmental flows. *Frontiers in Environmental Science* 6:45.
- Arthington, A. (2015). *Environmental flows: Saving rivers in the third millennium*. University of California Press, Berkley, California.
- AWS (Alliance for Water Stewardship). (2019). *International Water Stewardship Standard Version 2.0*. AWS, North Berwick, Scotland.
- Díaz, S. et al. (2018). Assessing nature's contributions to people: Recognizing culture, and diverse sources of knowledge, can improve assessments. *Science* 359(6373), 270–272.
https://doi.org/10.1126/SCIENCE.AAP8826/SUPPL_FILE/AAP8826-DIAZ-SM.PDF
- Eriyagama, N. et al. (2024). Towards the harmonization of global environmental flow estimates: Comparing the Global Environmental Flow Information System (GEFIS) with country data. Colombo, Sri Lanka: International Water Management Institute (IWMI). IWMI Research Report 186. doi: <https://doi.org/10.5337/2024.204>
- Hogeboom, R. J. et al. (2025). <https://www.acc.waterfootprintassessmenttool.org/?b=sbtn>
- Hogeboom, R. J. et al. (2024). Dataset of Science Based Target Network's Freshwater quantity target. Version 1. 4TU. ResearchData. <https://doi.org/10.4121/089afa18-bbd5-493e-8a6c-39e1ca7b2a59.v1>
- Hogeboom, R. J. et al. (2020). Capping human water footprints in the world's river basins. *Earth's Future* 8(2).
<https://doi.org/10.1029/2019EF001363>
- Horne, A. C. et al. (eds). (2017). *Water for the environment: From policy and science to implementation and management*. Academic Press.
- Horne, A. C., E. L. O'Donnell, and R. E. Tharme. (2017). Mechanisms to allocate environmental water. Chapter 17. Pp: 361-398. Horne, A. C. et al. (eds). *Water for the environment: From policy and science to implementation and management*. Academic Press.
- Hogeboom, R. J. et al. (2020). Capping human water footprints in the world's river basins. *Earth's Future* 8, e2019EF001363. <https://doi.org/10.1029/2019EF001363>.
- IUCN (International Union for Conservation of Nature). (2023). *Global Species Action Plan: Supporting implementation of the Kunming Montreal Global Biodiversity Framework*. Gland, Switzerland: IUCN.

- IUCN. (2020). Guidance for using the IUCN Global Standard for Nature-based Solutions: A user-friendly framework for the verification, design and scaling up of Nature-based Solutions. First edition. Gland, Switzerland: IUCN.
- Jackson, S. (2017). How much water does a culture need? Environmental water management's cultural challenge and indigenous responses. Horne, A. C. et al. (eds). *Water for the environment: From policy and science to implementation and management*. Academic Press. 10.1016/B978-0-12-803907-6.00009-7
- Meren, G. et al. (2021). Integrated water resource management: Principles and applications. *The Economics of Water* (1st ed., pp. 23–121). Springer Water. https://doi.org/10.1007/978-3-030-48485-9_1
- Messenger, M. L. et al. (2024). Limited comparability of global and local estimates of environmental flow requirements to sustain river ecosystems. *Environmental Research Letters* 19 024012. <https://doi.org/10.1088/1748-9326/ad1cb5>. See also for online supplemental information.
- Opperman, J. J. et al. (2018). A three-level framework for assessing and implementing environmental flows. *Frontiers in Environmental Science* 6 (76): 1-13. <https://www.frontiersin.org/journals/environmental-science/articles/10.3389/fenvs.2018.00076>. 10.3389/fenvs.2018.00076
- Poff, N.L., R. E. Tharme, and A. H. Arthington. (2017). Evolution of environmental flows assessment science, principles, and methodologies. Horne, A. C. et al. (eds). *Water for the environment: From policy and science to implementation and management*. Academic Press. ISBN 9780128039076, <https://doi.org/10.1016/B978-0-12-803907-6.00011-5>.
- Science Based Targets Network. (2024a). Stakeholder engagement and science-based targets. Version 1.0.
- Science Based Targets Network. (2024b). Step 3: Measure, Set & Disclose: Land. Version 1.0.
- Science Based Targets Network. (2023). Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose. <https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Freshwater-v1.pdf>.
- Various organizations (2024). Unpacking collective action in water stewardship: Shared solutions for shared water challenges. <https://wwfint.awsassets.panda.org/downloads/unpacking-collective-action-in-water-stewardship.pdf>.
- SBTN. (2023a). Technical Guidance: Step 3 Freshwater: Measure, Set & Disclose. <https://sciencebasedtargetsnetwork.org/wp-content/uploads/2024/07/Technical-Guidance-2024-Step3-Freshwater-v1-1.pdf>.
- SBTN. (2023b). SBTN Glossary of terms. SBTN, Global Commons Alliance.
- SBTN. (2023c). Stakeholder Engagement Guidance. Version 0.1.
- SBTN. (2024a). Science Based Targets Network validation pilot summary report. Version 1.1.
- SBTN. (2024b). Freshwater: Step 3: Stakeholder consultation for model selection recommendations. Version 1.0.
- SBTN. (2024c). Stakeholder engagement and science-based targets for nature. Version 1.0.
- SBTN. (2024d). Corporate manual: Science Based Targets for Nature.
- Wilkinson, M. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data* 3: 160018. <https://doi.org/10.1038/sdata.2016.18>
- WWF (Worldwide Fund for Nature). (2022). Living Planet Report 2022. Almond, R. E. A., M. Grooten, D. Juffe Bignoli, and T. Petersen (eds). *Building a nature positive society*. WWF, Gland, Switzerland. <https://www.worldwildlife.org/pages/living-planet-report-2022>.