Overview of the Preliminary Healthy Watersheds Assessments Project: Evaluating Relative Health and Vulnerability of Conterminous U.S. Watersheds

EPA Office of Water Healthy Watersheds Program, May 2025

1.0 Introduction

In 2009, the U.S. Environmental Protection Agency's Office of Water created the Healthy Watersheds Program to bring more emphasis to maintaining the chemical, physical and biological integrity of watersheds under the Clean Water Act. This program supports the EPA's state, Tribal and local partners by taking non-regulatory, collaborative approaches to maintaining higher quality waters through assessing and protecting watershed health. A major part of this approach is providing technical analysis, tools and data to help identify healthy watersheds that may represent good prospects for protection.

This document provides an overview of the EPA Preliminary Healthy Watersheds Assessments (PHWA) project, which was initially carried out during 2016 to 2017 and updated in 2021 and 2025, to improve the availability of comprehensive, national information about watershed health and vulnerability. The goal of this project was to help EPA partners better target watershed protection efforts by systematically identifying where healthier and more vulnerable watersheds occur. This project was designed to:

- Ensure that states and other users have basic, statewide and ecoregionally based information on watershed condition that can help them identify and prioritize opportunities for healthy waters protection, communicate with protection partners and support protection approaches;
- Provide a foundation of nationally available watershed condition data that can be built on and enhanced as better data become available;
- Support state efforts to implement the protection goal of the 303(d) Program Vision[1] and include healthy watersheds protection as part of their Integrated Reporting and nonpoint source pollution control strategies; and
- Support the Clean Water Act goal of *maintaining* as well as restoring the integrity of waters across the nation so that future generations can continue to enjoy these resources and the social and economic benefits that they provide.

2.0 The Healthy Watersheds Assessment Framework

The PHWA's approach was based on the Healthy Watersheds Assessment Framework,[2] an analytical approach influenced by the EPA Science Advisory Board[3] writings that identified essential ecological attributes that support healthy ecosystems. The Healthy Watersheds Assessment Framework focuses on six key attributes of watershed health: Landscape Condition, Geomorphology, Habitat, Water Quality, Hydrology and Biological Condition (Figure 1). This assessment approach was refined over several years through the completion of projects in 12 states, including in-depth statewide catchment-scale[4] assessments of California, Wisconsin, Alabama and Tennessee. Whereas specific assessment objectives varied, each was generally aimed at developing a screening tool to evaluate *relative* watershed condition (i.e., in comparison to watersheds across the whole state) to help resource managers plan and target

[1] USEPA (2022). 2022 – 2032 Vision for the Clean Water Act 303(d) Program. https://www.epa.gov/tmdl/Vision. Accessed 21 March 2025.

[2] USEPA (2012). Identifying and Protecting Healthy Watersheds: Concepts, Assessments, and Management Approaches. https://www.epa.gov/sites/default/files/2015-10/documents/hwi-watersheds-complete.pdf Accessed 29 September 2021. See also www.epa.gov/hwp generally.

[3] USEPA Science Advisory Board (2002). A Framework for Assessing and Reporting on Ecological Condition. https://www.epa.gov/system/files/documents/2022-03/a-framework-for-assessing-and-reporting-on-ecological-condition.pdf.

[4] A *catchment* represents the area that drains directly to an individual stream segment, lake segment or other waterbody segment. Catchments are 1 to 2 square miles in area on average.

future watershed protection efforts. Because the Healthy Watersheds Assessment Framework is not designed to make a statement on the *absolute* condition of any watershed or water body, these assessments do not define a *healthy watershed* threshold. In addition to characterizing watershed health, some included estimates of relative watershed vulnerability, defined as the potential for future degradation of watershed processes and aquatic system health.

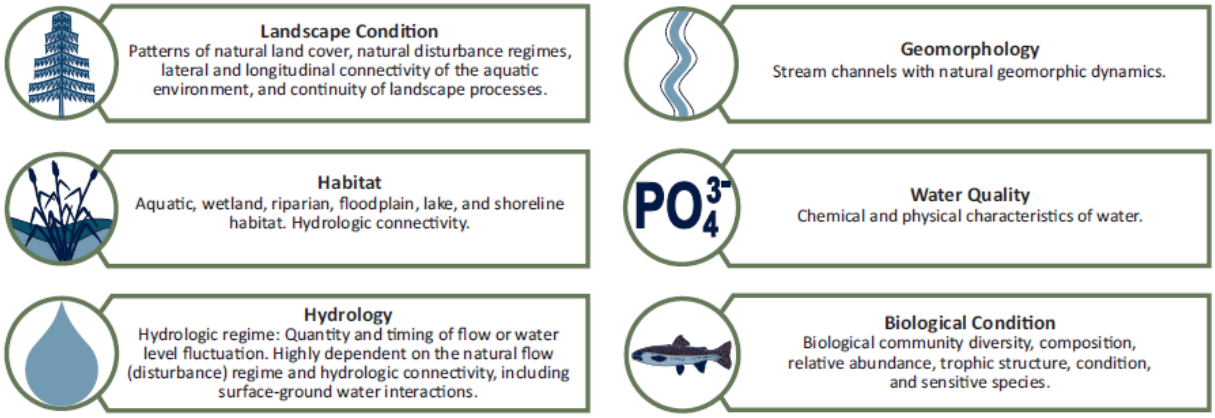

Figure 1. Six attributes of watershed health described in *Identifying and Protecting Healthy Watersheds: Concepts, Assessments, and Management Approaches* (USEPA 2012). Measurement of watershed indicators related to each attribute (i.e., *sub-index*) provides the basis for the Watershed Health Index score.

Within the framework, key ecological and stressor attributes are combined to estimate overall watershed health and watershed vulnerability. *Watershed health* is characterized by the presence of natural land cover that supports hydrologic and geomorphic processes within their natural range of variation, good water quality and habitats of sufficient size and connectivity to support healthy, native aquatic and riparian biological communities. An overall Watershed Health Index is calculated by first identifying measurable indicators closely associated with each of the six key attributes that appear in Figure 1, compiling sub-indices for each attribute then developing the index from all sub-indices. *Watershed vulnerability* is scored by a similar process of indicator selection followed by sub-index and index calculation. Key terms are described in Table 1.

Table 1. Key Terms Used in Healthy Watersheds Assessments

METRIC – a general term for any watershed raw data, indicator, sub-index or index value.

INDICATOR – a measurable attribute of a watershed that is relevant to a component of watershed health or vulnerability.

SUB-INDEX – a watershed score obtained by considering several indicators relevant to one primary component of watershed health or vulnerability.

INDEX – a major, overall score per watershed obtained by combining several sub-index scores. The Preliminary Healthy Watersheds Assessment calculates a *Watershed Health Index* score for each HUC12 watershed.

> **WATERSHED HEALTH INDEX –** an integrated measure of the current condition of an aquatic ecosystem and its surrounding watershed. The PHWA *Health Index* is comprised of landscape condition, habitat, hydrology, geomorphology, water quality and biological condition sub-indices.

3.0 PHWA Methods Overview

3.1 Adapting the Healthy Watersheds Assessment Framework to the PHWA

The healthy watersheds assessment supported by the EPA were originally designed and carried out as intensive, state-specific or basin-specific projects. This approach was too expensive, labor intensive and data limited for all but a few states. Tradeoffs would be necessary for the EPA to assist all states with basic watershed health and vulnerability information at a still useful watershed scale. The substantial number and variety of datasets and indicators covering the lower 48 states presented an opportunity to advance the availability of healthy watersheds information for most states in one project. Toward these ends, the PHWA was designed and carried out to help all conterminous states obtain, use and build on at least a basic level of healthy watersheds assessment data. The PHWA's design remained consistent with the Healthy Watersheds Assessment Framework while adapting the watershed scale, data sources and products to provide more widespread state assistance .

Watershed Scale

Healthy watersheds assessments address a specific watershed scale. The PHWA used the 12-digit hydrologic unit code[5] (HUC12) scale (36 square miles on average). This scale was selected for three primary reasons: (1) most watershed planning efforts occur at the HUC12 level, as the area represents a geographic scope that is small enough to manage but large enough to address water quality problems and the concerns of stakeholders;[6] (2) this choice of scale made it possible to use already available data across the conterminous U.S.; and (3) healthy watersheds data at this scale would be compatible with the wide variety of other data already at the same scale.

Data Sources

As a national project, the use of nationally available datasets for the PHWA was not only efficient but also enabled the assessment of HUC12s in a consistent manner across states and ecoregions. Watershed health indicator data for the PHWA was retrieved from the EPA Restoration and Protection Screening (RPS) Indicator Database[7], which is a compilation of several hundred HUC12 environmental indicators for the contiguous United States. Details on the specific datasets used to calculate indicators retrieved from the RPS Indicator Database are available in the Excel metadata file on the EPA PHWA webpage.

To complement the watershed health sub-index and index scores generated by the PHWA, resources that could support assessments of watershed vulnerability were inventoried through online searches and reviews of relevant literature. These resources are described on the EPA Healthy Watersheds Program website on the Developing a Watershed Vulnerability Index page and are listed on the Protection Projects in your State and Region page. Section 5.0 of this document also discusses how these resources could be used with watershed health data to inform watershed protection efforts.

3.2 Statewide and Ecoregional Watershed Assessment

The PHWA is a national project but is actually comprised of 48 statewide and 85 ecoregional assessments at the HUC12 watershed[8] scale. The PHWA scored each watershed in comparison to the gradients of

[5] Hydrologic Unit Codes (HUCs) in a hierarchical series of scales make up the national Watershed Boundary Dataset. Although the Watershed Boundary Dataset undergoes continuous updates, the exact version used for the PHWA HUC12 boundaries is accessible at https://www.epa.gov/enviroatlas/data-download-step-2

[6] USEPA (2008). Handbook for Developing Watershed Plans to Restore and Protect Our Waters. https://www.epa.gov/sites/default/files/2015-09/documents/2008_04_18_nps_watershed_handbook_handbook-2.pdf. Accessed 29 September 2021.

[7] USEPA (2025). RPS Indicator Database. https://www.epa.gov/rps/data-downloads. Accessed 16 April 2025.

[8] For brevity, the PHWA uses the terms watershed and HUC12 interchangeably. Although HUCs are delineated based on breaks between overland drainage patterns, many HUCs are not true, full watersheds.

scores in both the entire Omernik Level III Ecoregion and the entire state in which it occurs (Figure 2). Whereas the healthier watersheds often score well both statewide and ecoregionally, the two scoring approaches occasionally contrast in useful ways.

The gradient of watershed health scores across a state allows for watershed comparisons across the political unit within which many watershed protection decisions take place. Statewide scores provide useful input to statewide planning processes that protect or avoid impacts to the state's healthier watersheds. These can include Clean Water Act Section 319 Nonpoint Source Management Plans[10] and, under the Section 303(d) Vision, Prioritization Frameworks.[11] However, top scoring watersheds at the statewide scale are sometimes clustered in one small region of the state due to exceptional conditions. Although it is certainly useful to identify and act on such areas, they can outshine the healthier watersheds in other areas when there is a need for a state program to recognize and act on healthier watersheds in other parts of the state as well. Further, statewide scoring misses the opportunity to compare in-state watersheds with similar watersheds in adjacent states when prioritizing limited resources and actions.

The PHWA dual scoring approach also assesses relative watershed health by ecoregion. There are multiple ecoregions in nearly all states, and examining top watersheds within each in-state ecoregion can reveal a more geographically distributed group of high scorers. Because most ecoregions cross multiple state lines, the ecoregion-based scores may reveal whether the in-state portion of one ecoregion is exceptional. For example, in Figure 2, many of Ecoregion 70's top scoring HUC12s (darkest blue) occur within West Virginia despite that state containing less than a quarter of the ecoregion's total area. Yet, statewide scoring alone in this West Virginia example (Figure 2, left side) failed to detect Ecoregion 70's top scorers due to better relative scores from Ecoregion 67. Further, the ecoregional scoring alternative can help users explore partnering approaches with neighboring states, such as protecting large interstate high scoring patches or restoring healthy watershed corridors across state lines.

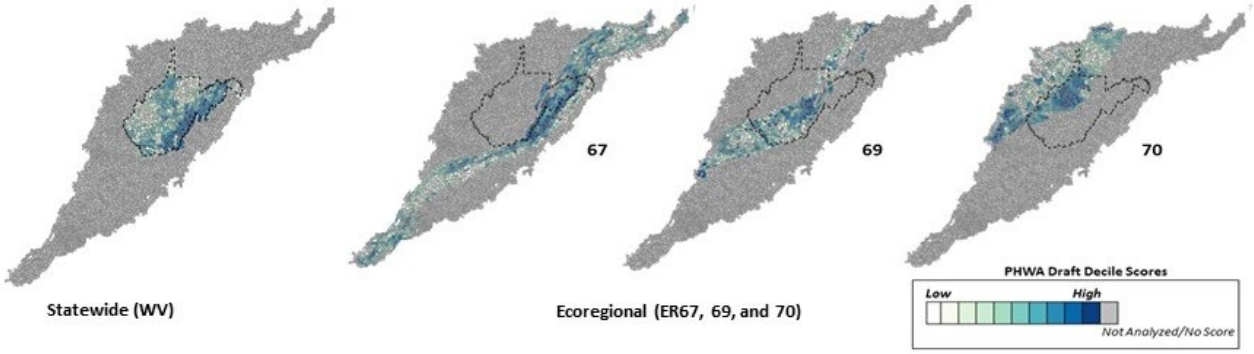

Figure 2. Watershed Health Index measured on West Virginia HUC12s statewide (left) and individually across whole, multi-state ecoregions (three maps at right). Each individual HUC12 has two watershed health scores: one relative to all HUC12s in its state and the other relative to all HUC12s in its ecoregion. Statewide and ecoregional scores are often similar but sometimes differ markedly (e.g., when a HUC12 scores high statewide but low ecoregionally, or vice versa). Both are provided to offer different perspectives on identifying the healthier watersheds for protection. (Draft data for demonstration purposes only)

[9] USEPA (2013). Level III and IV ecoregions of the continental United States. U.S. EPA, National Health and Environmental Effects Research Laboratory, Corvallis, Oregon, Map scale 1:3,000,000. Available online at: https://catalog.data.gov/dataset/omerniks-level-iii-ecoregions-of-the-conterminous-united-states

[10] The Nonpoint Source Program and Grants Guidelines, released in 2024, places a renewed emphasis on protection actions for State, territorial, and Tribal water quality programs to protection healthy waters.

[11] See also USEPA's Protection FAQs were developed to help clarify key concepts underlying the CWA Section 303(d) Vision's Protection Goal for states, territories and Tribes.

3.3 Index Calculation Methods Overview

The following processing steps were repeated for each statewide and ecoregional assessment.

Step 1: Select watershed indicators for assessment area (single state or ecoregion)

A core set of watershed health indicators served as the starting point for all ecoregional assessments. Indicator sets were sometimes modified at the ecoregional scale depending on ecological setting and the relevance of core indicators in the ecoregion. Statewide indicator selection included all indicators used in any of its component ecoregions. When a HUC12 watershed straddled more than one state or ecoregion, it was scored only in the state/ecoregion in which its majority by area resided.

Step 2: Calculate and normalize watershed indicator values

Directionality of indicator measurement was first configured to ensure that all health indicators have *higher is healthier* values. Watershed indicator values were calculated for each HUC12 watershed, then scores for each indicator were unity normalized within a range of 0 to 1. Indicator values were normalized separately within each ecoregion or state to correct for differences among the indicators in unit of measurement and to ensure that each indicator received equal weighting later when calculating sub-index scores. Because scoring is relative to the geographic area being assessed, ecoregional and statewide scores for the same indicator in the same watershed can differ.

Step 3: Calculate Sub-Index scores

Watershed indicators were grouped into sub-indices according to the six attributes of watershed health. A watershed's sub-index score was calculated as the mean of its normalized indicator values. If a watershed had no data for a given indicator, that indicator was not calculated as part of the sub-index scoring and the sub-index value reflected the mean of the remaining indicators. Watershed Health sub-indices included Landscape Condition, Hydrology, Geomorphology, Habitat, Water Quality and Biological Condition. As with their component indicators, all sub-index scores potentially range from 0 to 1. Sub-indices were not normalized so that raw sub-index scores more clearly show the actual range and distribution of scores among watersheds in the ecoregion or state.

Step 4: Calculate Index scores

An overall Watershed Health Index score was calculated for each HUC12 as the mean of the sub-index values for that watershed. All sub-indices were equally weighted within each index. Index scores were presented within a potential maximum range from 0 to 1 where higher scores denote healthier watersheds. Like the sub-indices, indices were not normalized so that raw scores could more clearly show the actual range and distribution of scores among watersheds in the ecoregion or state.

3.4 Watershed Indicators

In total, the PHWA utilized 20 indicators representing 6 sub-indices of watershed health. Indicator usage involved a core, national set as well as limited removal of specific indicators when necessary to address ecoregional differences. For example, for landscape condition indicators, ecoregion-specific determinations were made regarding the classification of *Barren Land* as natural or human use land cover.

The PHWA utilized watershed indicators measured in three different spatial zones of HUC12s: (1) the *watershed* (used to identify properties measured throughout the entire HUC12); (2) the *riparian zone* (delineated by placing a 100-meter buffer around the surface water feature layer from the National Land Cover Dataset and flowline and waterbody features from the National Hydrography Dataset Plus Version 2); and (3) the *hydrologically active zone* (defined by the riparian corridor adjacent to surface waters conflated with areas of high topographic wetness potential that are contiguous to surface waters).

3.4.1 Watershed Health Indicators

Watershed health indicators selected for the PHWA (Figure 3) reflected the six sub-indices of watershed health previously discussed. Indicators that comprise each sub-index are described briefly below. Indicator choices included those with positive as well as negative effects on watershed health; metrics associated with negative effects were inverted to be directionally consistent with positive (i.e., higher score is healthier) metrics. Detailed descriptions and source metadata are available in the PHWA data table spreadsheets compiled for each of the lower 48 states.

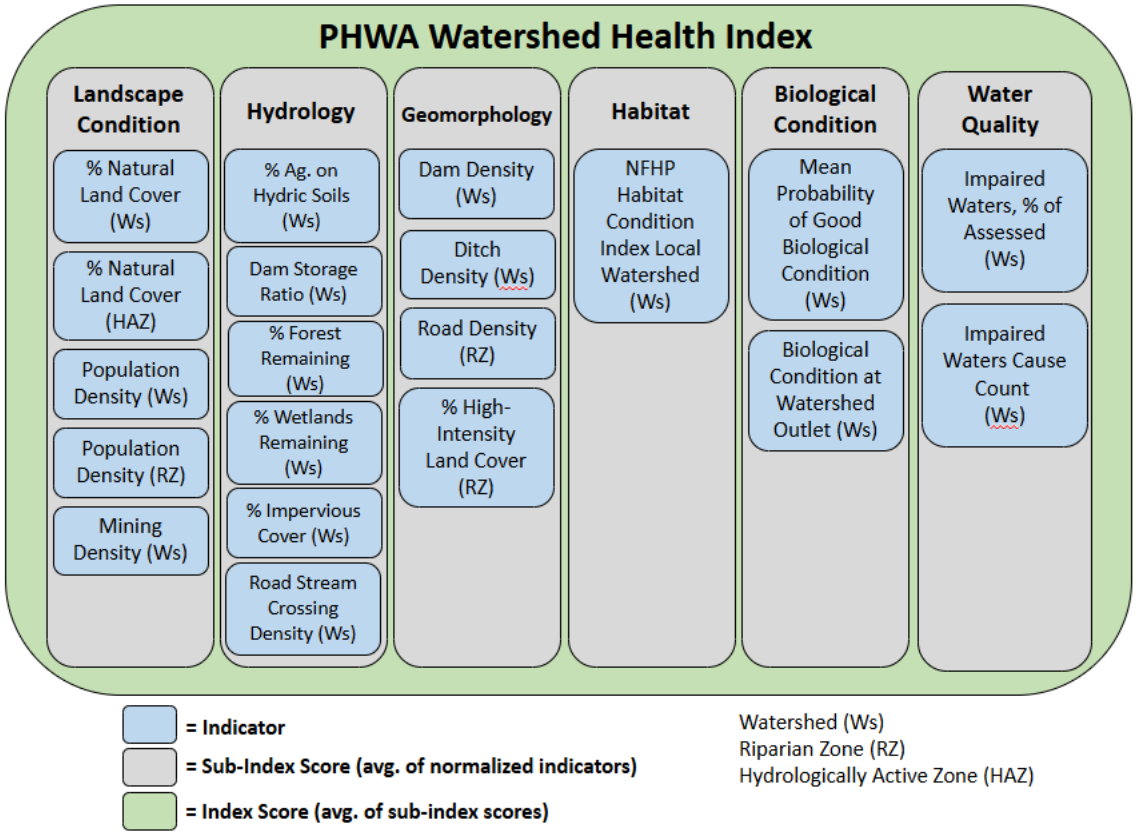

Figure 3. PHWA Watershed Health Index and Sub-Index structure with component indicators (blue boxes). Indicators measure watershed-wide (Ws), riparian zone (RZ) or hydrologically active zone (HAZ) attributes as marked.

3.4.1.1 Landscape Condition

Landscape condition is described by the extent and connectivity of natural land cover throughout a watershed and within key functional zones such as floodplains, riparian areas and wetlands. Natural land cover supports watershed health by maintaining hydrologic and geomorphic processes and protecting aquatic ecosystems from nonpoint sources of pollution. Further, natural land cover in and around the riparian zone, floodplains and wetlands filters pollutants, serves as habitat for aquatic and semi-aquatic species and supports connectivity between habitat patches.

Landscape condition indicators for the PHWA included direct measures of natural land cover extent and measures of anthropogenic sources of landscape alteration. The extent of natural land cover was measured throughout the entire HUC12 watershed and within the hydrologically active zone. Indicators of anthropogenic sources of landscape alteration measured the size of human populations in the watershed and riparian zone, and the number of mining focus operations in the watershed. Large human

populations reduce natural vegetative cover through conversion to urban and agriculture lands, while human settlement in riparian corridors removes the buffer between waterbodies and upland development. Coal and mineral mining operations can alter the landscape through vegetation loss and excavation. Other common human influences on landscape condition such as agriculture and urbanization were reflected in the percent natural land cover metrics.

3.4.1.2 Hydrology

The flow regime refers to a stream's characteristic pattern of flow magnitude, timing, frequency, duration and rate of change. The flow regime plays a central role in shaping aquatic ecosystems and the health of biological communities. Aquatic organisms have adapted to the range of physical and chemical conditions brought about by natural flow patterns. Alteration of natural flows can reduce the quantity and quality of aquatic habitat, degrade aquatic life and result in the loss of ecosystem services. Yet, flow measurements and data are generally not consistently available across the country, or even across most states, requiring use of surrogate measurements of the factors that strongly influence flow.

Hydrology indicators in the PHWA characterized the maintenance of natural land cover types in the watershed that support natural flow regimes, and also characterized anthropogenic watershed features that have the potential to alter hydrologic processes on the landscape or within stream channels. Forest and wetland cover types help to maintain key hydrological processes such as canopy interception, soil infiltration rates, evapotranspiration, groundwater recharge and flood storage within their natural range of variability. Impervious cover in a watershed can increase the flashiness of streamflow, with high rates of stormwater runoff, reduced infiltration and reduced groundwater recharge. The presence of agriculture on hydric soils in place of wetland cover can also increase flow magnitudes through artificial drainage of wet soils. While the effects of dams on riverine hydrology vary with storage and release operations, alterations can include attenuation of high flows, augmentation of low flows or an increase in the frequency of extreme low flows. Road-stream crossings can alter stream velocity and depth above and below their culverts and interrupt upstream-downstream hydrologic connectivity.

3.4.1.3 Geomorphology

Stream channel shape, sinuosity, slope and bed substrate reflect a dynamically stable balance between the stream's sediment supply and sediment transport capacity. This balance can be destabilized under altered flow or sediment regimes, resulting in a long-term change in channel form, such as incision or widening. While periodic changes to channel form occur naturally with disturbances such as floods, human activities often instigate and accelerate geomorphic change that can reduce the quality, extent and connectivity of habitat for aquatic organisms. Like hydrology, geomorphically relevant data are not consistently available across the U.S. and geomorphic condition is inferred through surrogate metrics.

Geomorphology indicators in the PHWA described watershed features that have the potential to alter geomorphic processes and stream channel form, including dams, artificial drainage ditches, near-stream roads and high-intensity land use in the riparian zone. Dams can alter channel geomorphology by slowing water velocity and increasing sediment deposition above the dam and releasing sediment-deficient water below the dam outfall. Artificial drainage ditches increase water delivery to streams, resulting in changes to flow magnitudes and velocities that can drive geomorphic change. The presence of roads and high-intensity land use types (cropland and medium- or high-density urban) in the riparian zone can alter channel forms through changes to flow patterns or through direct channel manipulations (i.e., channel straightening, bank armoring or levee construction).

3.4.1.4 Habitat

The term aquatic habitat encompasses a host of physical, chemical and biological characteristics of aquatic ecosystems, and the optimal set of conditions for aquatic life will vary from one species to another. The PHWA characterized aquatic habitat using a national, multi-metric index of reach-scale fish habitat

condition developed by the National Fish Habitat Partnership. The National Fish Habitat Partnership's 2015 Habitat Condition Index scored fish habitat condition in stream reaches across the U.S. according to the following characteristics of the local drainage area of each stream reach: extent of urban and agricultural land cover types, human population density, road length, number of road-stream crossings, number of dams, number of mine operations, number of facilities with National Pollutant Discharge Elimination System wastewater discharge permits, number of sites in the EPA Toxic Release Inventory program and number of sites on the Superfund National Priorities List. Each of these measures were selected by the National Fish Habitat Partnership because they were determined to be meaningful for assessing fish habitat condition. Habitat Condition Index calculation inputs and methods were validated by comparison with states and regional fisheries datasets across the country. The National Fish Habitat Partnership first calculated the Habitat Condition Index nationally in 2010 and recalculated it in 2015.

3.4.1.5 Biological Condition

A stream's biological condition can be described by the abundance, diversity and functional organization of fish, invertebrates and other aquatic fauna. A healthy biotic community demonstrates a balance of native species that are integrated across trophic and functional levels and are able to adapt to short- and long-term variation in ecosystem conditions. The EPA 2008-2009 National Rivers and Streams Assessment[13] evaluated the ecological condition of perennial rivers and streams in the conterminous United States by sampling 1,924 sites randomly selected based on a probability-based design. A multi-metric index based on measures of benthic macroinvertebrate community was used to represent overall biological condition. Biological condition at sampling sites was classified as *poor*, *fair* or *good* by comparing scores to the distribution of scores observed as least-disturbed reference sites.

Whereas nationally consistent data estimating biological condition has long been desired but unavailable, modeled estimates are now emerging. The PHWA characterized biological condition using data from a landscape based model of biological condition, developed by the EPA Office of Research and Development[14]. The EPA Office of Research and Development modeled the probability of *good* biological condition in perennial stream reaches using local (catchment surrounding stream reach) and cumulative (total upstream contributing area) watershed-scale landscape predictor metrics from the EPA Stream-Catchment (StreamCat) dataset.

The Mean Probability of Good Biological Condition per HUC12 offered an area-weighted average of all perennial stream catchments in the National Hydrography Dataset Plus that have a *probability of good condition* value calculated by the EPA Office of Research and Development model. Catchments without a score in the HUC12 do not affect this indicator, which is sensitive only to what has been modeled. The second metric, Biological Condition Score at Watershed Outlet, reflected the *probability of good condition* score for the most downstream perennial stream catchment in the National Hydrography Dataset Plus receiving flow from upstream portions of the HUC12. As the outlet or pour point integrates much of the stresses and responses from upstream, it differs from and complements the first metric. Due to the reliance on perennial streams for this sub-index, HUC12s with no perennial waters did not receive a sub-index score.

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[12] Crawford, S., Whelan, G., Infante, D.M., Blackhart, K., Daniel, W.M., Fuller, P.L., Birdsong, T., Wieferich, D.J., McClees-Funinan, R., Stedman, S.M., Herreman, K., and Ruhl, P. 2016. Through a Fish's Eye: The Status of Fish Habitats in the United States 2015. National Fish Habitat Partnership. Accessed on 09 February 2017, at http://assessment.fishhabitat.org.

[13] USEPA (2021). National Rivers and Streams Assessment. https://www.epa.gov/national-aquatic-resource-surveys/nrsa. Accessed 09 September 2021.

[14] Hill, R.A., E.W. Fox, S.G. Leibowitz, A.R. Olsen, D.J. Thornbrugh, and M.H. Weber. 2017. Predictive mapping of the biotic condition of conterminous US rivers and streams. *Ecological Applications*. 27(8): 2397-2415.

3.4.1.6 Water Quality

Under natural conditions, water chemistry in a waterbody varies within a characteristic range that is determined by geography, geology, topography and other characteristics. Aquatic biota adapted to such conditions and the presence of water quality parameters in their natural range are key features of healthy streams. The PHWA characterized water quality using assessment data from the EPA Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS) database[15], which contains nationwide data on assessed and impaired waters assembled from state-specific biennial assessment reports. Like the Biological Condition sub-index, the development of Water Quality indicators was challenging because of state-to-state differences in assessment and reporting, as well as limitations in data availability across the conterminous U.S. For this reason, the Water Quality indicators focused only on summarizing extent of assessed and impaired waters in general and the number of pollutants causing impairments rather than attempting to represent pollutant-specific conditions.

PHWA water quality indicators were developed using ATTAINS data on the area within each HUC12 watershed containing impaired waters. ATTAINS tracks and reports water quality assessment and impairments within small drainage area delineations called catchments.[4] ATTAINS reports the impairment status of waters within each catchment across the U.S. as: attaining water quality standards, impaired or not assessed. For catchments with 303(d) listed and other impaired waters, ATTAINS also reports the causes of impairment. Impairment causes are generally specific pollutants, such as excess pathogens, nutrients or metals, but can also include other physical, chemical and biological characteristics of a waterbody that are the basis of impairment designations, such as degraded biota or habitat alteration.

The first indicator measured in the Water Quality sub-index is the percent of the assessed catchment area in the HUC12 that is impaired. By representing the extent of impaired waters as a proportion of total assessed waters in the HUC12, this indicator controlled for variability in extent of assessed waters among watersheds. The second indicator in the Water Quality sub-index measured the number of unique impairment causes reported for catchments in the HUC12. Both indicators were used in every statewide assessment. As with the Biological Condition sub-index, the Water Quality sub-index may be a good candidate for refinement using state-specific data.

4.0 PHWA Products

The PHWA watershed health index and sub-index scores are accessible through the EPA's How's My Waterway[16] community level *Protect Tab*, as well as the EPA RPS Indicator Database, described below.

Restoration and Protection Screening Indicator Database

The RPS Indicator Database is a dataset of indicators for HUC12s in the contiguous U.S. that is maintained by the EPA. Included in the RPS Indicator Database are PHWA index and sub-index scores and all of the indicators used to calculate the PHWA scores. The RPS Indicator Database is distributed in a variety of formats, including Excel files and a file geodatabase. In addition, the RPS Indicator Database can be accessed as a map service for developers of interactive tools and mapping applications.

[15] USEPA (2020). Assessment and Total Maximum Daily Load Tracking and Implementation System (ATTAINS). https://www.epa.gov/waterdata/attains. Accessed 05 February 2025.

[16] How's My Waterway was designed to provide the general public with information about the condition of their local waters based on data that states, federal, Tribal, local agencies and others have provided to the EPA. Water quality information is displayed on three scales in How's My Waterway: community, state and national. https://mywaterway.epa.gov/. The PHWA watershed health index and sub-index scores are accessible through the EPA's How's My Waterway community level *Protect Tab*, along with data from the National Wild and Scenic River System, America's Protected Areas Database and protection plans accepted/approved by the EPA.

The RPS Indicator Database with PHWA data can be accessed at https://www.epa.gov/rps/data-overview.

Restoration and Protection Screening Tool

The RPS Tool was developed by the EPA to support efforts to prioritize watersheds for restoration and protection actions. The RPS Tool allow users to explore and apply data in the RPS Indicator Database to compare and prioritize HUC12s, including PHWA index scores, sub-index scores and all indicators used to calculate the PHWA scores.

The RPS Tool can be accessed at https://www.epa.gov/rps/tools-overview.

5.0 Assessing Watershed Vulnerability

Watershed health is a dynamic property that can vary with future change. Over time, human activities or natural disturbance events such as floods, hurricanes or wildfire may alter landscape condition, hydrologic processes or other watershed health attributes. The EPA Healthy Watersheds Assessment Framework[2] therefore includes an evaluation of both watershed health and the vulnerability of healthy watersheds to future degradation. Watershed vulnerability is a combination of a system's exposure and sensitivity to changing conditions, and its adaptive capacity to cope with change.

Watershed vulnerability can be assessed alongside watershed health to help identify priority watersheds for protection. Whereas watershed health indicates current condition, watershed vulnerability indicates a watershed's risk to degradation because it is projected to face increasing stressor levels, has high sensitivity to projected changes or lacks adaptive capacity to acclimate to projected changes. The EPA Healthy Watersheds Assessment Framework[2] contains examples of how vulnerability has been assessed by states, including undertaking a build-out analysis to identify areas with potential future development and increased impervious cover based on zoning regulations; analyzing land use and aquifer characteristics affecting contaminant transport to identify areas with greater risk for groundwater contamination; and using projected water use changes to assess potential hydrologic changes and associated aquatic habitat impacts.

Vulnerability assessments could consider many different future threats and could be conducted using a wide variety of data. The data and analysis methods used ultimately depend on project specific goals for the vulnerability assessment and the geographic area of interest. For example, if the goal is to assess the vulnerability of fish communities in streams to future water withdrawals, then data describing projected future streamflow conditions, sensitive fish taxa distribution and connectivity between suitable habitat patches could be evaluated. In contrast, if the goal is to assess watershed vulnerability more generally, then a wider range of data relevant to multiple threats and watershed health attributes could be selected.

To assist PHWA users with assessing the vulnerability of healthy watersheds to future degradation, the EPA Healthy Watersheds Program has inventoried resources published by the EPA and other federal and non-government organizations which are relevant to watershed vulnerability. These resources include maps, datasets and data hubs, as well as example watershed vulnerability assessments. The maps, datasets and data hubs included in the inventory have national or regional geographic coverage, can allow for assessing vulnerability at the HUC8, HUC12 or finer scale and are relevant to one or more of the six attributes of watershed health (Figure 1). The resources are described on the EPA Healthy Watersheds Program website on the Developing a Watershed Vulnerability Index page and on the Protection Projects in your State and Region page.

The EPA RPS Tool is one example resource that can support a watershed vulnerability assessment. In addition to storing all watershed health indicator data, sub-index scores and index scores from the PHWA, the RPS Tool also contains many indicators which may be relevant to users interested in assessing

watershed vulnerability. For example, the RPS Tool includes indicators of the potential exposure of HUC12s to future threats, such as projected changes in temperature, precipitation, streamflow and sea level rise; past and projected changes in land use; and wildfire risk. Indicators that are relevant to watershed vulnerability can be added to a screening in the RPS Tool along with the PHWA Watershed Health Index, and results of the screening can be used to evaluate the gradient of vulnerability among healthier HUC12s and identify priority HUC12s for protection due to their vulnerable status.

The Wisconsin Department of Natural Resources Healthy Watersheds, High-Quality Waters project provides an example of how the PHWA and the RPS Tool can be used to assess watershed health and vulnerability. The project used the RPS Tool to calculate a customized Watershed Health Index to identify healthy watersheds and a Watershed Vulnerability Index that included indicators of past and projected land use change, projected temperature and runoff change, wetland functional loss, and historical trends in activities that may alter hydrology and habitat (e.g., wetland and waterway permit demand or shoreline alterations). Results from the RPS Tool were applied to highlight HUC12s that could be targeted for funding or protection activities by partner organizations based on their health scores. The Vulnerability Index and its individual metrics will assist organizations in taking a proactive and targeted approach to addressing threats to healthy watersheds.

6.0 Using PHWA Results

The PHWA was developed to help the EPA and state partners protect higher quality waters and maintain their benefits to society and the environment, by identifying healthier and more vulnerable watersheds and making this information available to others involved in watershed protection. Potential uses include:

Support state actions to prioritize, protect and maintain healthy waters.
The PHWA was supported by the EPA Clean Water Act Section 303(d) Listing and Impaired Waters Program and the Section 319 Nonpoint Source Control Program, because both programs have encouraged states to more actively protect heathy waters in recent years.[17] Under the Section 303(d) Vision initiative, states, territories and Tribes develop a holistic strategy for implementation of Vision Goals, systematically prioritize waters or watersheds for Total Maximum Daily Load and other plan development, including protection plans, and report on the progress towards development of plans for priority waters. Although healthy watersheds assessments exist in some states, the PHWA supports the Vision's protection goal by nationally improving the basic level of information about watershed health and the location of healthy watersheds in all the conterminous states. Similarly, the nonpoint source control programs in states may be able to utilize PHWA information in developing statewide protection strategies and targeting protection efforts that result in the sustained prevention of water quality degradation in healthy waters threatened by nonpoint source pollution, including pollutant stressors or watershed alterations. The PHWA may also prove useful to other protection oriented programs within and beyond the Clean Water Act. The PHWA can complement case-by-case approaches to protecting high quality waters with a more comprehensive, statewide characterization of watershed health and vulnerability.

[17] Healthy waters include, for example, unimpaired waters, at-risk waters, outstanding national resources waters or other specific category of high-quality waters, healthy aquatic resources, and source water (including groundwater) high quality, unimpaired, outstanding national resource waters, and at-risk waters that are degrading and not yet impaired.

Raise awareness of where the healthiest watersheds occur.
One of the most important objectives of the PHWA was to identify the healthier watersheds throughout the country, and it remains equally important to communicate those findings effectively. The PHWA Watershed Health Index statewide health scores are viewable within the EPA How's My Waterway mapping tool under the community scale *Protect Tab*. Maps of Watershed Health Index scores or other PHWA data can provide a foundation for raising awareness of the gradient of watershed conditions across a geographic area. However, as a national assessment, the PHWA does not capture all possible impacts on watershed health. For smaller areas such as counties or small river basins, displaying local data on watershed conditions alongside PHWA data can help further communicate watershed health patterns and pinpoint priority healthy areas for protection.

Raise awareness that healthy watersheds are sometimes highly vulnerable.
It may come as a surprise that even some of the healthiest watersheds are vulnerable to degradation and the loss of their beneficial qualities. PHWA data on watershed health can be combined with information on vulnerability to specific threats and pressures, including land use change, water use and wildfire (see Section 5.0). Better understanding these specific vulnerabilities can help identify HUC12s that are candidates for management efforts, like conservation easement programs, water conservation efforts and fuel reduction treatments. This information can also help educate watershed managers, protection partners and the general public about the importance of watershed health and resilience to disturbances, such as fires, floods and droughts. Broader understanding of vulnerability can help avoid the loss of benefits that healthy watersheds provide to communities and the environment.

Improve communication and coordination among states, the EPA and other partners by providing nationally consistent measures of watershed health.
As partners in implementing the Clean Water Act, staff from the EPA's headquarters and regional offices and states all interact and communicate about their respective geographic areas of responsibility. Having nationally consistent sources of watershed condition information can help the EPA and the states better understand others' protection options, plans and priorities.

Provide a basis for the EPA, states and others to promote waters for protection in cross-program interactions and partnering with other landscape management efforts.
Large-scale planning activities such as utilities or transportation routing often seek information on environmentally sensitive or high-quality areas to avoid or minimize impacts. A common concern is avoiding impacts to waterways. A watershed-based dataset on health may be more useful to such efforts than waterbody-based data because it addresses the whole landscape rather than just the waters themselves. Further, the PHWA's orientation toward protection of higher quality waters makes it potentially complementary to more terrestrial oriented landscape protection efforts such as federal, state and private wildlife management plans. Because all watersheds are scored in the PHWA, it provides a basis to find locations of mutual interest with other programs.

Provide an initial dataset upon which others can build better watershed condition information.
To some extent, developing the PHWA needed to sacrifice some data richness and variety to establish a nationally consistent dataset. Thus, the PHWA should be considered a limited, initial dataset on watershed health that has great potential to be improved and enhanced with more data at statewide or other scales. For example, an individual state may have extensive bioassessment data that could improve health index and sub-indices well beyond the more basic data available nationally. A state may choose to identify thresholds of health scores that are appropriate to their watersheds and priorities. Further, whereas the PHWA used impairments in general to score the Water Quality Sub-index, a single state may be better suited to use data on impairment from several specific pollutants to score this attribute in a more

informative manner. As the PHWA assigned equal weights to all indicators and sub-indices, weighting could also be changed on a statewide or ecoregional basis to match environmental conditions or program priorities. The full PHWA dataset is provided to facilitate whatever improvements might be considered over time. As resources permit, the EPA Healthy Watersheds Program may be able to help states' and others' efforts to build on and improve PHWA data.

7.0 Contact Information and Disclaimer

The Preliminary Healthy Watersheds Assessments project (PHWA) was initially carried out during 2016-2017 and updated in 2021 and 2025 by the U.S. Environmental Protection Agency Office of Water, Healthy Watersheds Program, with contractual assistance from The Cadmus Group LLC. Questions, comments and requests pertaining to the PHWA should be routed through the online *contact us* form available at https://www.epa.gov/hwp/forms/contact-us-about-healthy-watersheds-protection .

Disclaimer

The information compiled in the Preliminary Healthy Watersheds Assessments project (PHWA) and presented in this document and related data files is intended to support screening-level assessments to inform potential watershed protection priorities and is based on modeled or aggregated data that may have been collected or generated for other purposes. Results should be considered in that context and do not supplant site-specific evidence of watershed health. Scores represent relative gradients from lowest to highest with reference to watersheds statewide and ecoregion-wide, and no absolute threshold values of health are implied.

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