DEPARTMENT OF NATURAL RESOURCES

WHAF Process Guide

Applying the Framework

July 2020

Contents

Introduction

The Watershed Health Assessment Framework (WHAF) is a structured, science-based approach to grow our common understanding of Minnesota's complex natural resource systems and help resource professionals and citizens work together and apply science to resource management decisions.

The WHAF brings together current data and scientific analysis to deliver information and understanding about Minnesota's watersheds. This information is delivered in a transparent and repeatable framework based on scalable watershed boundaries and ecological health scores. The WHAF is designed to foster robust conversations and innovative approaches for improving the health of Minnesota's watersheds and communities.

To achieve these objectives, the Watershed Health Assessment Framework provides a suite of products that include:

- interactive map application
- ecological health scores
- watershed reports
- key concepts for managing systems

Purpose

Follow the steps in this guide to learn how the WHAF tools and products build on one another to progress from basic explorations of location and watershed scales, to comparing health at multiple locations.

The body of this document is broken into two sections. The first section, **Set the Stage**, describes the framework and role of each tool in exploring and evaluating watershed health.

The second section, **Process Steps**, provides an example of the Watershed Assessment Process. For each step, there is a description of the purpose, an example of using the tools and information, and some observations related to understanding the natural systems.

Set the Stage

The WHAF website and interactive map are designed to help users apply systems science to watershed management decisions. These 'Why' statements introduce the foundation of the framework.

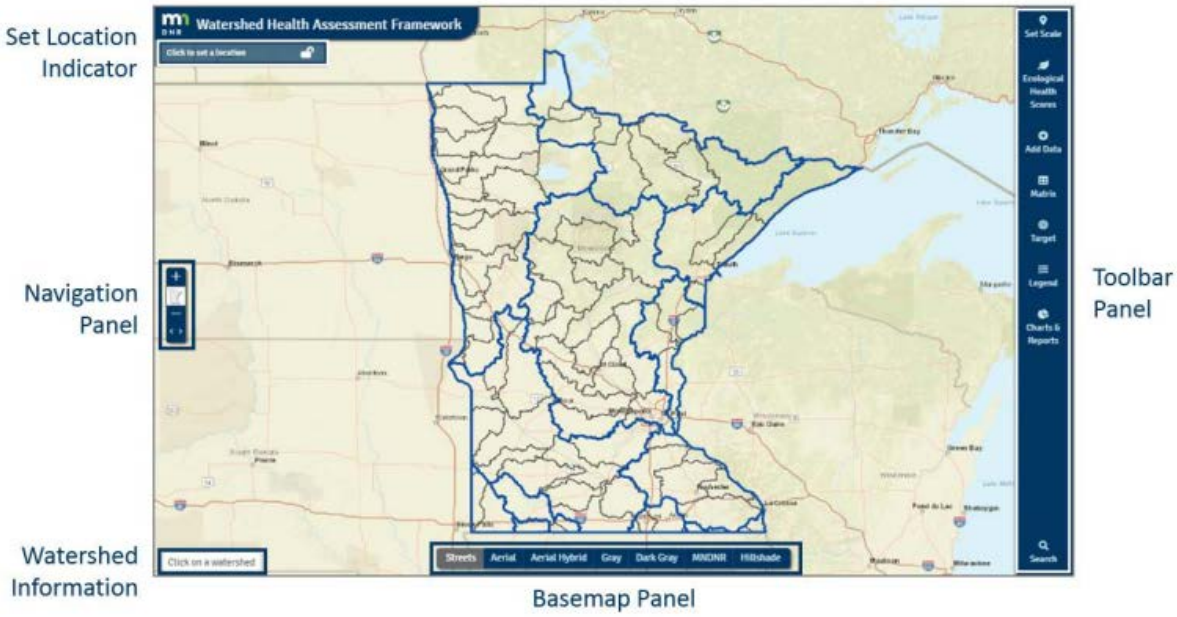
Why Watersheds?

The WHAF uses watershed boundaries as the structural foundation to organize and deliver our products. A watershed is defined as the land area that drains surface water to a point on the landscape. Because watershed boundaries are defined by natural resource features and influenced by the flow of water, they are an appropriate way to organize our work. The watershed boundaries are identified in the WHAF after a location is set. These boundaries include:

- catchment (local watershed, refined HUC12 boundary)
- catchments upstream of location
- catchments downstream of location
- major watershed
- major river basin

The WHAF uses these boundaries to navigate in the map, calculate health scores and summarize information about natural processes and human activity. A range of nested watershed sizes from local catchment to major river basin are used to evaluate conditions at different scales.

The WHAF Mapping Tools



Each of the tools in the WHAF application brings additional information about the watershed landscape. The *why* questions below provide a connection between each tool and the underlying question that it helps to address.

Why Set Location?

To display information about a specific watershed of interest, the application needs to know your area of interest. By clicking on the map, the location will be set and the location-based tools will become active.

Each location generates a watershed 'address' (lower left). Like your own street, city, state address, watersheds are nested in size from small to large: catchment, major watershed, river basin. Each watershed size should be used to help you frame your exploration of watershed health at different spatial scales.

Why Set Scale?

The first step for addressing any issue is to define the boundaries for your project or discussion. What is inside and what is outside? Boundaries define the extent of the system that you are interested in. Too small and you ignore processes that actively influence or impact the system. Too large and you consider more than is necessary or relevant, and may further complicate an issue.

With your location set, the map automatically delineates the related watershed scales. Use the Set Scale panel to view the different boundaries in the map. Note the area of each watershed extent as you consider the proper scale for your next steps.

Why View Health Scores?

Watershed Health Scores show patterns of health within each of the five ecological components that comprise the natural system. Scores are scaled 0 (least healthy) to 100 (best health), using a red to green color ramp for low to high health scores. This consistent range of values creates a way to view scores across watershed scales, looking for patterns, connections and relationships.

Why Add Data?

Adding related GIS data to the WHAF Map can help you investigate the context and conditions that are driving watershed health and the Health Score values. The wide range of available data makes information about related factors accessible for consideration, and to further evaluate and understand underlying system patterns and responses. Filter the data list by keyword to find the relevant layers to add to the map.

Why View Charts and Reports?

Charts and reports provide essential context for understanding natural and human systems that are impacting watershed function. Several important resources are available in this tool panel:

1. **Land Cover and Cropland Charts** dynamically update to reveal trends in land cover that influence watershed processes. For example, you can view land cover upstream to understand the context for land and water interactions influencing a local catchment.
2. **Watershed Reports** are downloadable documents available for every major watershed in Minnesota. Each report provides essential context for understanding health scores, resource conditions and historic climate trends.
3. Each **Google Earth Flyover** downloads a virtual flyover that follows the main steam river in your watershed. This bird's eye perspective reveals vital connections between the broader landscape and the river channel.
4. The **Water Use Charts** dynamically update to show a modeled relationship between permitted water use and estimated runoff for a selected catchment.

Why Use the Matrix Tool?

The Matrix Tool provides complex results (all the health scores across all scales) in one table, signaling potential problem spots at a glance. It summarizes complexity in an approachable way without losing/masking information. The Matrix combines the key concepts of 5 component health scores and spatial scale by creating in interactive table of health scores across scales. The table can be re-ordered to show high or low scores at each watershed scale. The highlighted scores of 40 or below can signal a health challenge or risk, and comparing that score across scales will indicate whether that condition occurs locally or more broadly across the landscape.

The Watershed Health Assessment Process

Explore Scales

Purpose

Every landscape exhibits unique patterns. These patterns are driven by such things as topography, land use, soil type, and vegetation. These landscape features interact with water as it falls or transpires or evaporates or flows through streams, lakes, wetlands and groundwater. These interactions create continuous movement that occurs at different spatial and temporal scales.

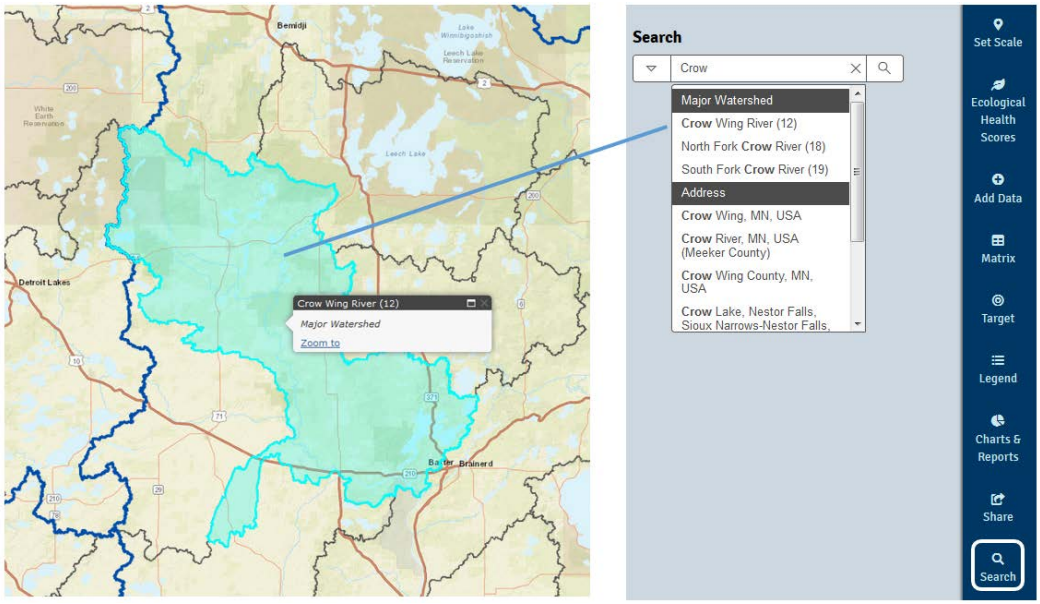
Using the Set Scale tools will help you explore the land and water relationships. When you click on the map to set your location, the watershed scale boundaries draw to reflect the watersheds associated with your location. Click a new location and the boundaries will redraw to help you quickly explore various sized watersheds, connecting the land area to related lakes and streams.

The display of watershed boundaries at multiple scales is unique and delivers a powerful way to explore and understand watershed processes and their connection to the landscape.

Process Example

Search

- Click the **Search Button** to open the search panel.
- Type **"Crow Wing"** in search box and Select Crow Wing River Watershed from the list of options
- **Filter the search** using the dropdown arrow to limit the search by category: **Major Watershed**



Set Location

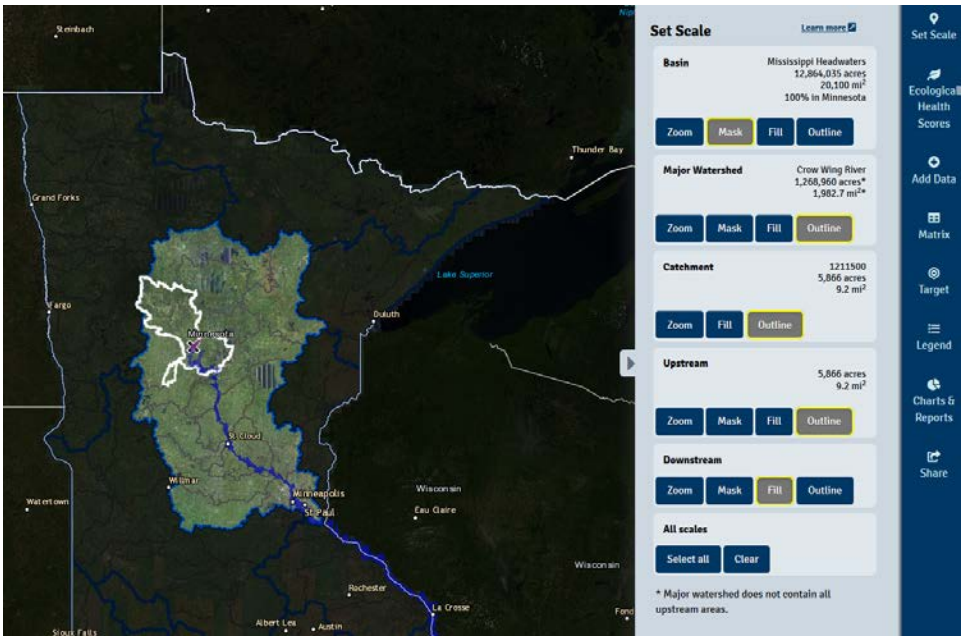
Click on the map to **Set Location** within the Crow Wing River Watershed. A black **X** will appear and the watershed information panel will display the river basin name, the major watershed name and catchment ID number.

Each time you change locations, the information in this box will update automatically.

Set Scale

Open the **Set Scale** panel. Click the 'outline' and 'fill' buttons to see each different watershed boundary displayed in the map, and use 'zoom' to change between the watershed scales.

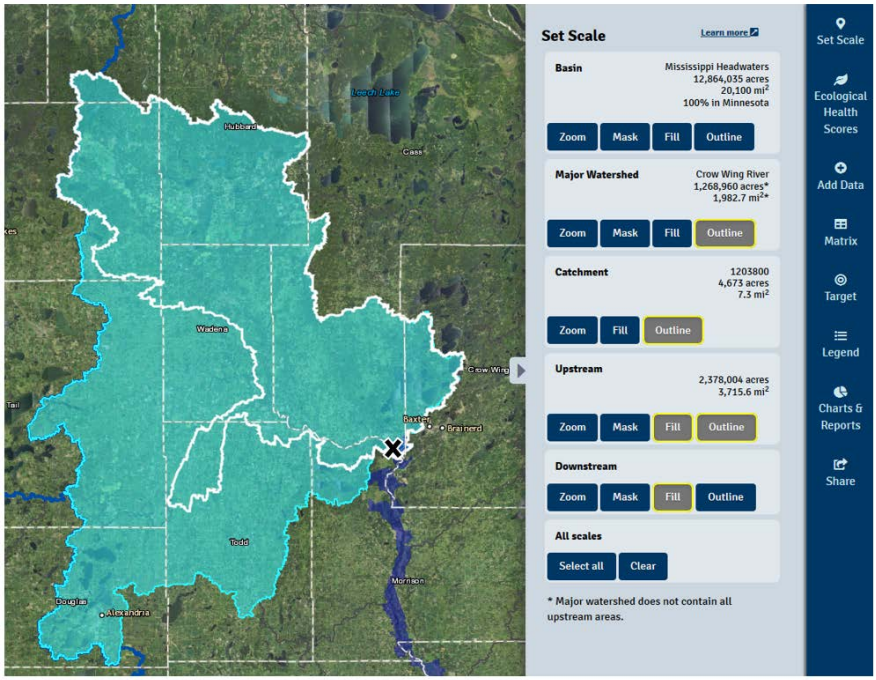
Use the '**Select all'** at the bottom of the Set Scale panel to display the nested watershed boundaries for the Crow Wing River Watershed together in one map. Change the **Basemap** to Aerial Hybrid and **zoom to the Basin.**



This map shows the location of the Crow Wing River Watershed within the Upper Mississippi River Basin

Upstream Area / True Watershed

Next, use the Major Watershed 'Zoom' button to return to the Crow Wing River Watershed scale. Find the location where the **dark blue fill crosses the white major watershed boundary.** This location is the 'mouth' of the river, where the Crow Wing River ends as it joins the Mississippi River.



- Click to reset your location within this catchment.
- From the Set Scale panel, change the upstream symbology to fill.
- Zoom to the upstream scale.
- Note statement at bottom of the panel:

  *** Major watershed does not contain all upstream areas.**

Lessons Learned

By using the Set Scale map tools you have determined that the Crow Wing River Major Watershed is not a 'true watershed'. The Major Watershed is an administrative boundary that divides a larger upstream watershed. ***The light blue fill indicates the extent of the true watershed***; i.e. the land area that contributes surface water to the mouth of the Crow Wing River.

The concept of 'true watershed' or upstream contributing area is vital for managing watersheds. There are many conditions and connections that are influenced by the extent of the upstream area for a watershed. Whether you are addressing water quality and quantity, or enhancing connections between patches of habitat, your outcome will be influenced by watershed boundaries and the landscape conditions within that boundary. Understanding the hydrologic context for your watershed sets the stage for better management results.

Explore Context

The ‘context’ for a watershed encompasses the landscape, water features and human communities. Each watershed’s unique setting influences how the ecological system has responded and shifted over time in response to driving forces like climate and land use.

The Major Watershed Context Reports provide a consistent overview with a selected series of maps and charts. This content summarizes key historic and current conditions that influence ecological health and function. The related data layers are delivered in the WHAF map for further interactive exploration.

Purpose

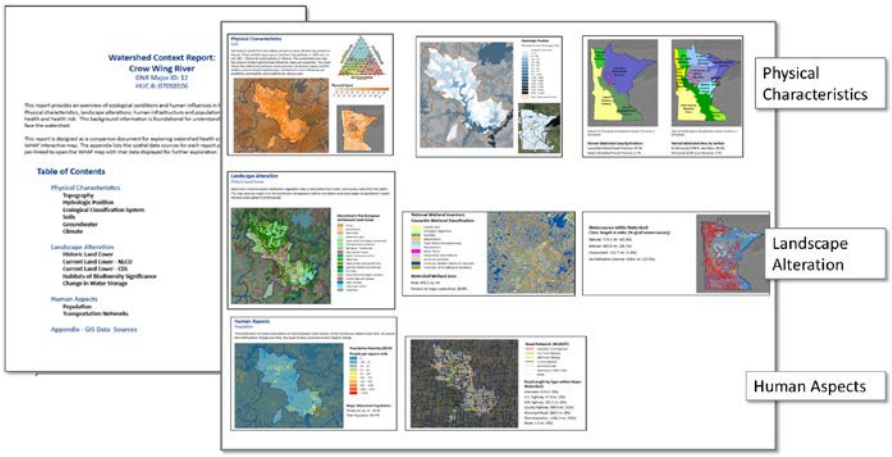
The ***Watershed Context Reports*** can be accessed from the WHAF webpage or from the Charts and Reports panel in the map. The Context Reports summarize information in a way that informs patterns of health. They are a key resource to consult throughout your watershed exploration.

Land cover is a fundamental driver in the types of natural resource issues that are encountered. Dynamically generated ***land cover charts*** allow you to easily compare and contrast land cover at different scales. This is crucial for comparing landscape conditions across watershed scales.

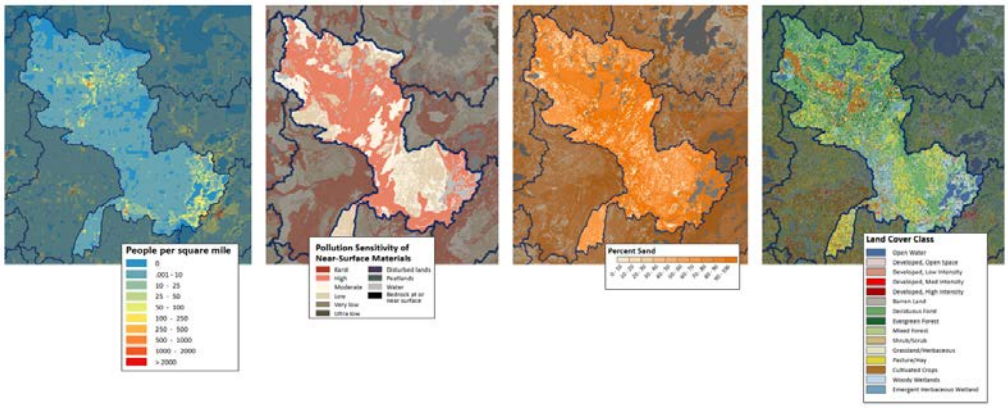
Process Example

Watershed Context Report:

Download the Crow Wing River Context Report from the Watershed Reports webpage. Review this document to consider the landscape conditions at the major watershed scale that may influence health in this watershed. You can quickly review important features.

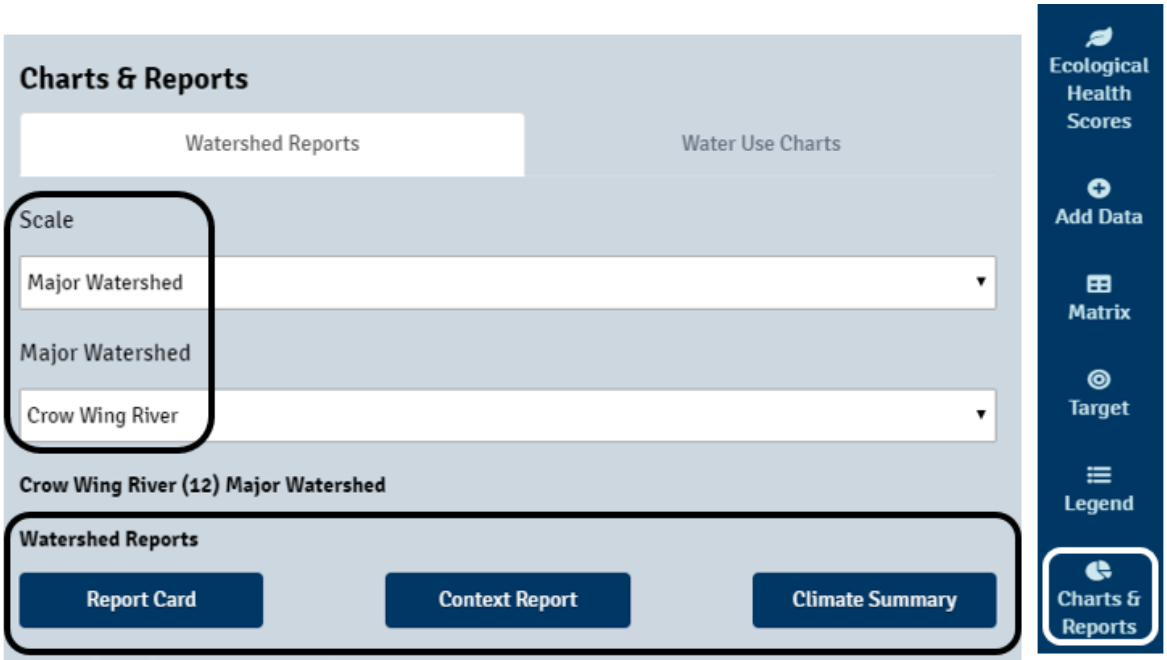


For this watershed, you should pay attention to the location of sandy soils, altered streams and areas of wetland loss. Compare those patterns to areas with increasing population, expanding impervious surfaces, pollution sensitive groundwater and intense agricultural use.



Watershed Charts and Reports

You can also access Charts and Reports directly from the WHAF map. Open the Charts and Reports panel, select the 'Major Watershed' scale. The links to the Watershed Report Card, Context Report and Climate Summary for your location will be available



Land Cover Charts

This panel also displays interactive charts of watershed land cover and cropping data related to your set location. As you select other watershed scales from the drop down menu, it will display the appropriate data in the charts.

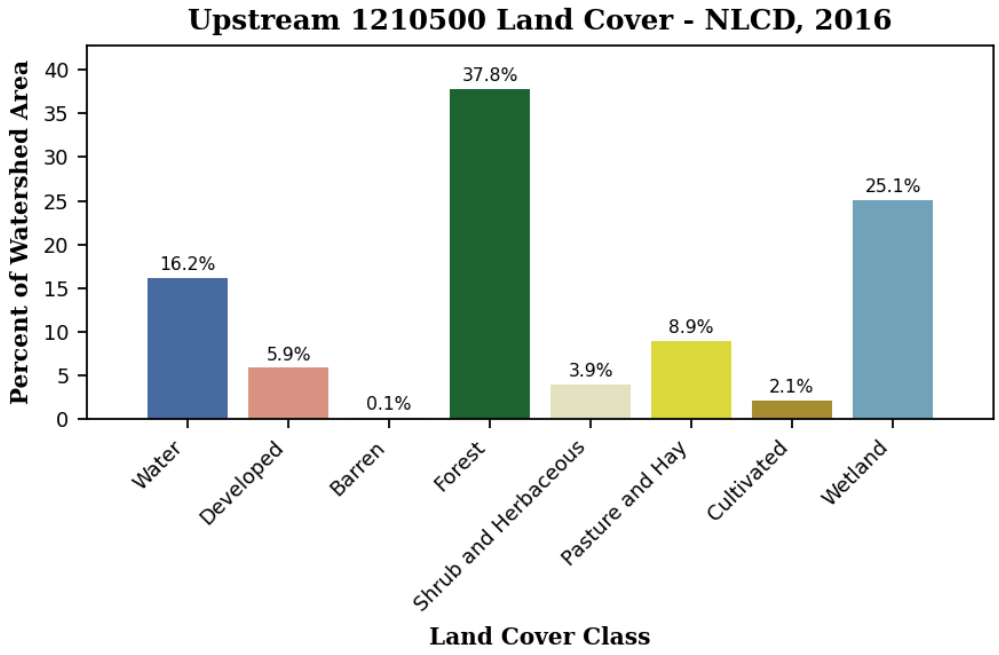
Explore Upstream Land Cover

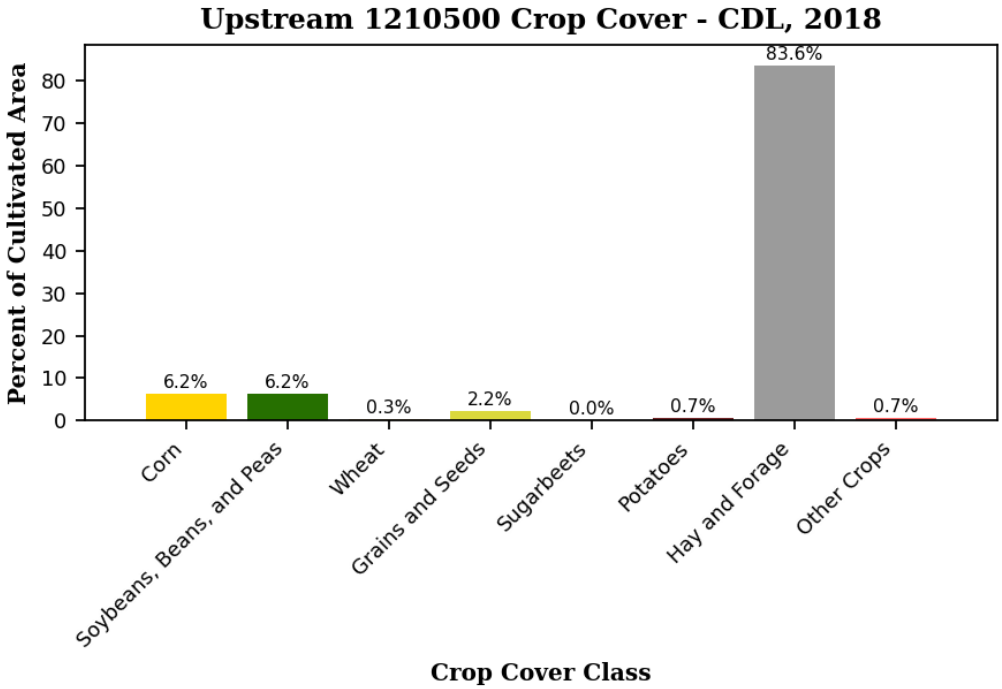
Use Search to return to Catchment 1210500;

- Click to Set Location within that catchment
- Set background map to Aerial

Open the **Charts and Reports** panel,

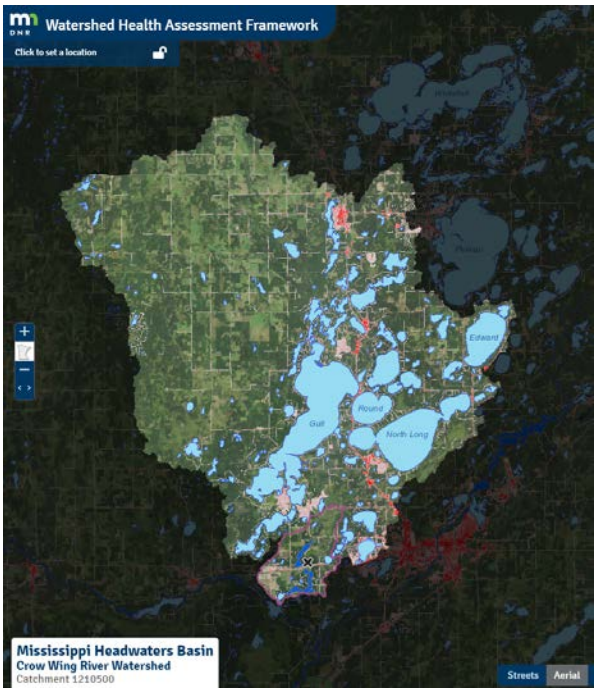
- Select **Upstream** from the scale drop down menu
- Review the Land Cover Chart; NLCD 2016
- Review the Crop Cover Chart





This sub-watershed is dominated by forest, wetland and open water. Only 2% of the land is cultivated and 84% of that is in hay and forage.

While dominated by natural land cover, there is potential concern highlighted by the 6% developed land cover. The location of development can be shown by adding **Impervious Cover 2016** data layer to the map. Intense development is occurring around well-known recreational lakes in close proximity to Brainerd and Baxter. Area lakes and streams will require careful management to protect the quality of the resource and the quality of the recreational experiences.



Lessons Learned

In a watershed, the ecological context will influence and interact with the location and intensity of human use of that landscape. A review of land cover types together with other information about watershed activities bring a basic understanding of the unique challenges and opportunities that may exist. Making note of the spatial pattern exhibited by these various conditions is an important part of the watershed exploration experience.

Evaluate Health

Purpose

In this step, you will put your understanding of the landscape together with the pattern revealed in the watershed health scores.

Health scores are calculated at both the major watershed and catchment scales. The score values can be used to compare and contrast aspects of watershed health. The health scores are particularly important for considering ecological connections and relationships. When making management decisions, the impact can be maximized by focusing limited resources on the areas where the need or opportunity is greatest. Watershed Health Scores provide a useful tool to help identify where this need or opportunity exists on the landscape. Greater variability means that the health score is identifying a range of conditions that can be used to guide management actions.

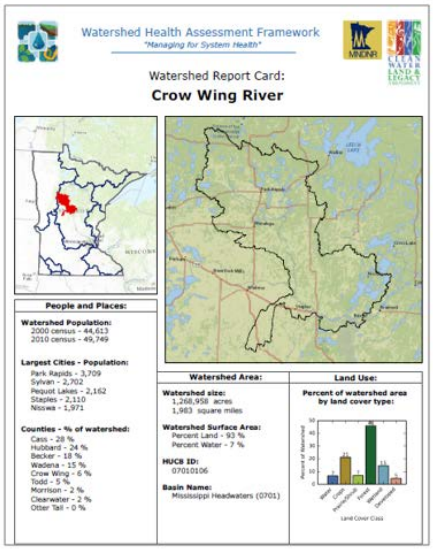
Process Example

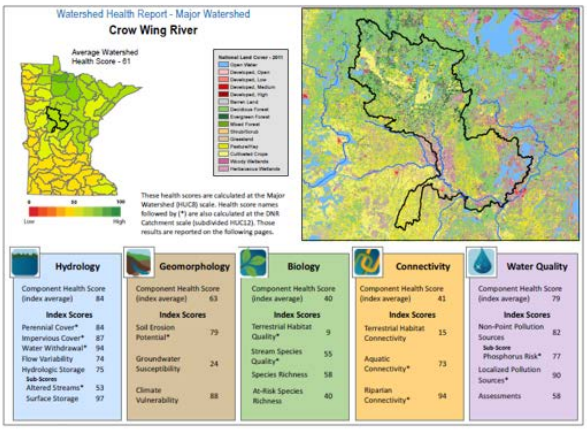
There are two ways to view the Ecological Health Scores:

- Download the Watershed Report Card from the Charts and Reports panel
  - Set 'Scale' to Major Watershed
  - Click map to set a location, or use Major Watershed dropdown list to select a watershed
  - Click blue 'Report Card' button
- Add Health Scores as a data layer in the WHAF map

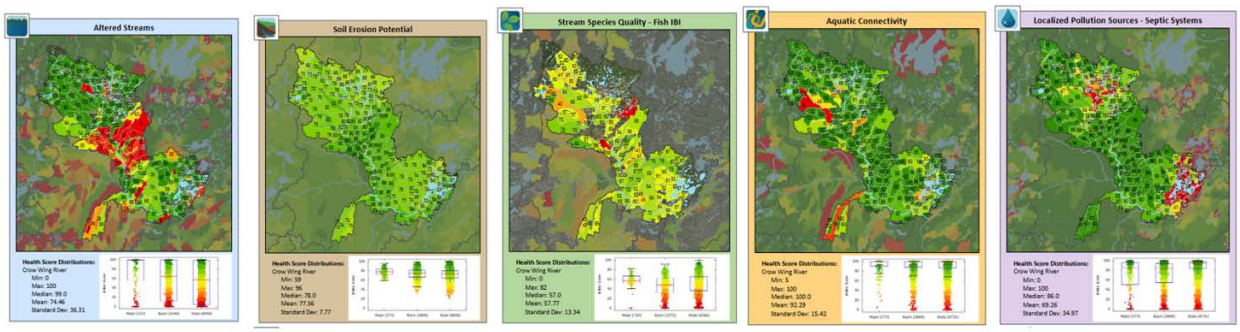
Using the Watershed Report Card

The Watershed Report Card provides quick access to a summary of health scores for each major watershed. The first page also gives an overview of population trends, watershed size and land use.

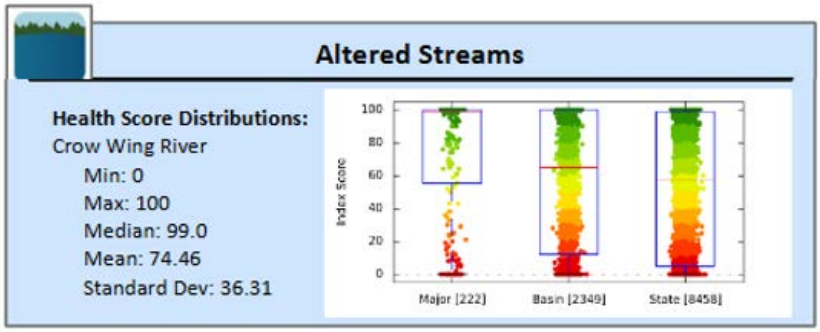




The following pages in the report card hold the catchment scale health scores. Below are some examples for the Crow Wing River watershed. These scores represent *each of the five components*, as indicated by the icon and the page color



The charts found below each health score summarize the distribution of that score across spatial scales. For example, the Altered Streams score shows a similar range of values at each scale but the median altered streams score for this major watershed is substantially higher than the median basin score. The pattern of health score values in the map shows a large cluster of low scoring catchments in the middle portion of the watershed. Examination of additional data layers will help you understand possible reasons for this pattern.



The printed report card can help you quickly see health score patterns with variability that can be evaluated further. The Watershed Report Card Overview provides guidance on interpreting the maps and charts.

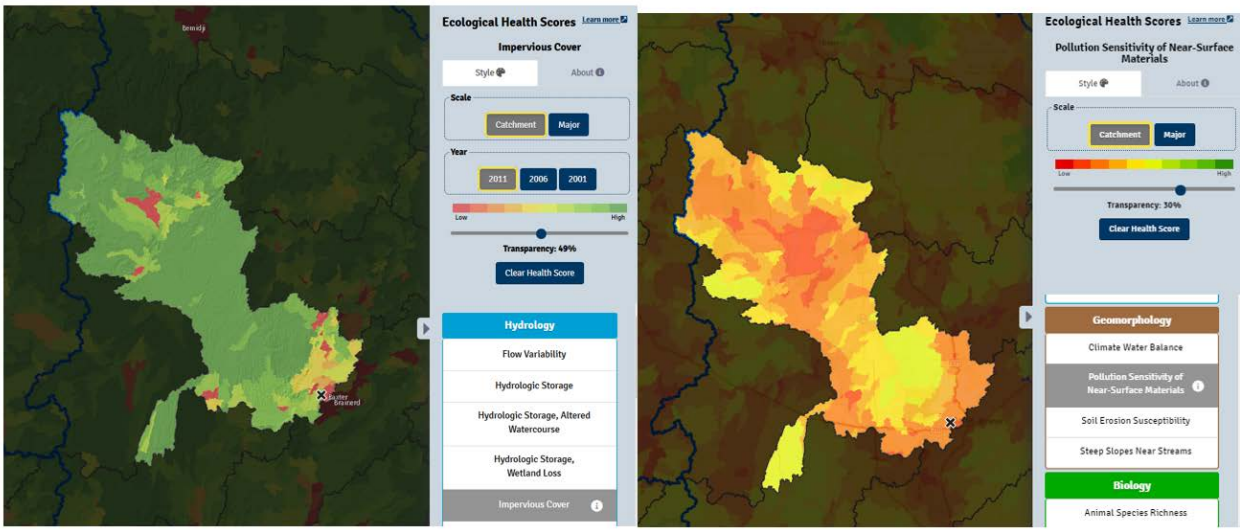
Download a report card for any major watershed with the Watershed Report Card selector map.

Adding health scores to the map:

The other way to view health scores is to open the **Ecological Health Scores** panel in the WHAF Map. For this example, click the **Impervious Cover** health score in the **Hydrology** component**.** Note the pattern of the scores and consider how impervious surfaces might interact with the land and water resources.

Continue to view other key health scores, ***including scores from each of the five components***; for example:

- **Hydrology:** Altered Watercourses, Impervious Cover
- **Biology:** Fish Stream Species Quality
- **Geomorphology**: Pollution Sensitivity-Near Surface
- **Connectivity**: Aquatic Connectivity
- **Water Quality**: Localized Pollution Sources-Septic Systems



The score on the left is **Impervious Cover,** and on the right is **Pollution Sensitivity of Near-Surface Materials.** Consider the relationship between more hard surfaces that create runoff and transport contaminants and areas that are sensitive to pollutants entering groundwater.

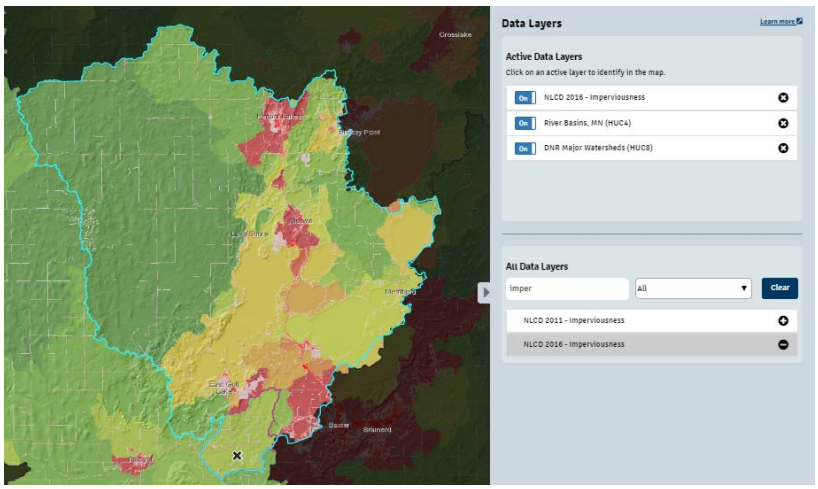
Make note of patterns in scores; look for areas that may be more or less healthy. Some scores will reveal potential risks and some may show areas that are important to protect.

Add Data

Adding related data will enhance your understanding of the health score patterns. With the Impervious Cover Health Score displayed:

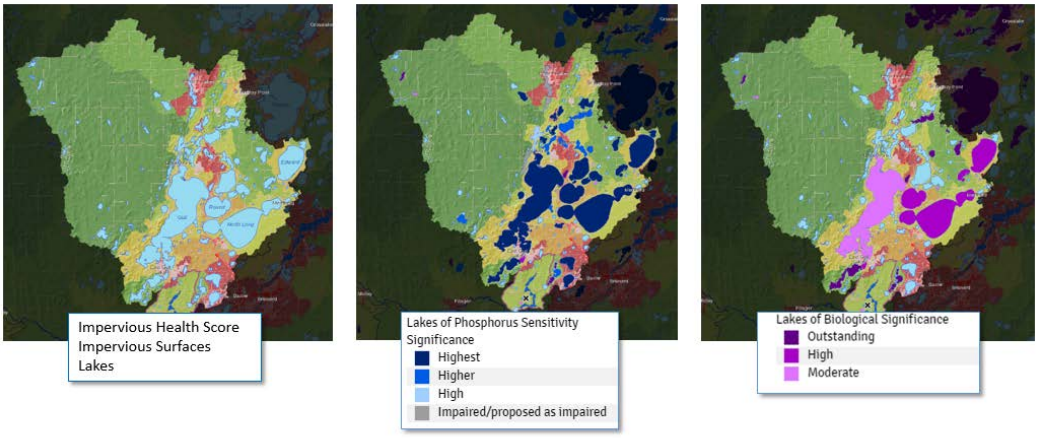
- Open the **Add Data** panel.
- Type 'impervious' in the search box
- Click to add ***NLCD 2016 - Imperviousness*** to the map.

This example is zoomed to the upstream area for catchment 1210500 in the southeast part of the watershed. **Note how the data helps explain the pattern in the catchment scale health scores.**

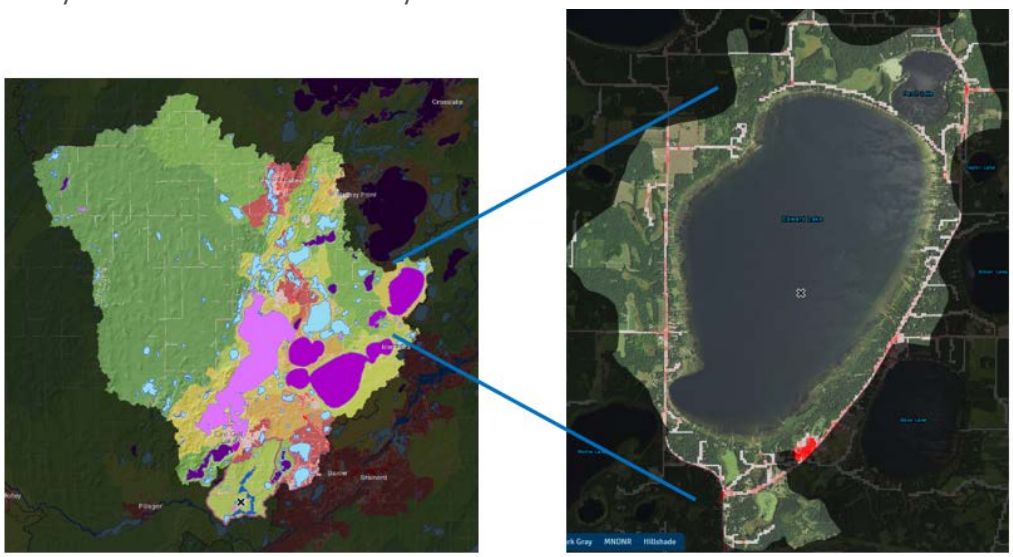


To further expand the evaluation, you might consider the relationship between impervious surfaces and lake health.

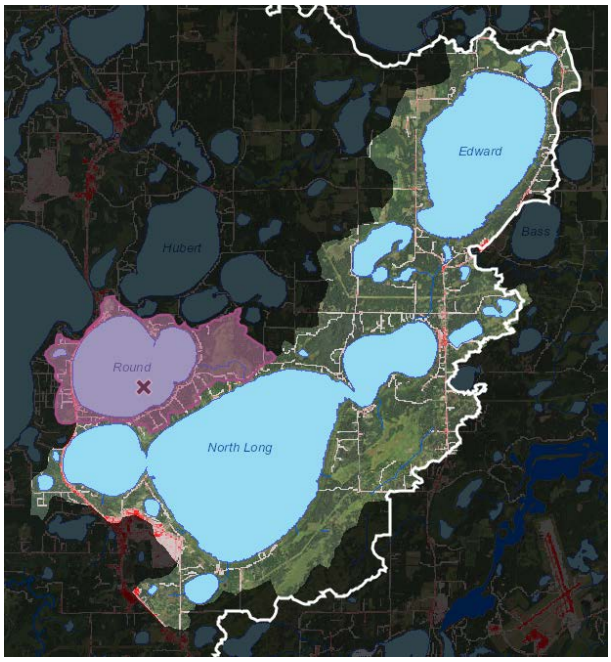
- Open the **Add Data** panel.
- Type 'lakes' in the search box
- Click to add ***Lakes, Lakes of Phosphorus Sensitivity*** and ***Lakes of Biological Significance***.



Use the **Active Data Layers** list to turn different layers on and off in the map. Open the **Legend** to display the symbols used for each data layer.



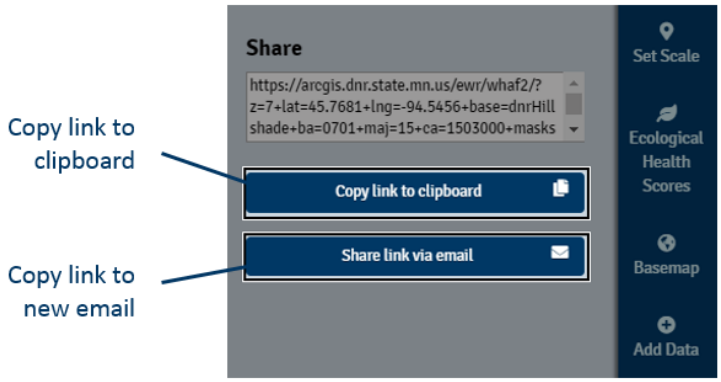
Click to set your location in Edward Lake. Use Set Scale to zoom to the catchment scale. This lake is ranked for its high biological significance. Turn on the upstream mask to highlight the contributing land area. The impervious cover data layer shows areas of intense development while the aerial image shows docks and development of the shoreline.



Continue to explore with the upstream mask and make note of those lake systems that are connected into a 'chain of lakes'. These systems allow water, nutrients, sediment, organisms and contaminants to move between the different lakes, with a range of impacts to the health of each one.

Save and Share

To save and share any of the maps you have created, open the **Share** panel to record and save the map information as a URL. Whenever the URL is re-opened, these saved map will be displayed.

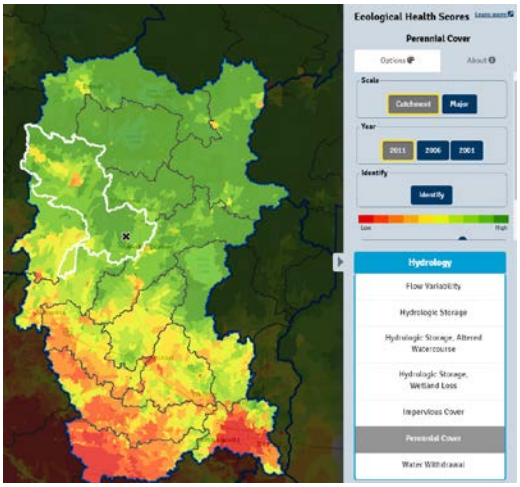


Lessons Learned

The patterns revealed in the WHAF health scores can quickly reveal information about a wide range of ecological conditions across the landscape. By looking for scores that show a range of values at a particular scale of interest, you can zero in on the concerns you may need to address.

The previous example showed how the Impervious Cover Health Score helped us zero in on areas that had a higher concentration of impervious surfaces. By adding related data, connections can be drawn between areas of concentrated impervious surfaces and lakes that are high conservation priorities.

In contrast to those scores that show ‘hot spots’ to investigate, some scores have uniform values with little variability at the major watershed scale. In this case, you should zoom out to check for patterns at a different spatial scale. Some conditions are most meaningful when compared across an entire river basin or even statewide.



Perennial Cover is an example of an index that tells an important story at many different watershed scales. While there is some variability in the Crow Wing Major Watershed, the contrast with other parts of the Upper Mississippi River Basin is striking and informative.

Compare Locations

Purpose

Comparing locations within a watershed is a vital step for expanding our understanding of watershed processes. The purpose of that comparison will vary depending on the location and management objectives. Consider these two scenarios: In one region you have large expanses of intact, high quality natural resource features. Here, you may choose to compare the potential risks to those resources and identify priorities for protection. In another region, you have a highly altered ecosystem where land use conversion has dramatically altered the quantity and quality of the natural resources. Here you may want to identify the most functional resources and focus efforts on protecting and reconnecting these intact fragments. In both of these cases a selected area of interest is used to compare and contrast conditions in order to prioritize management actions.

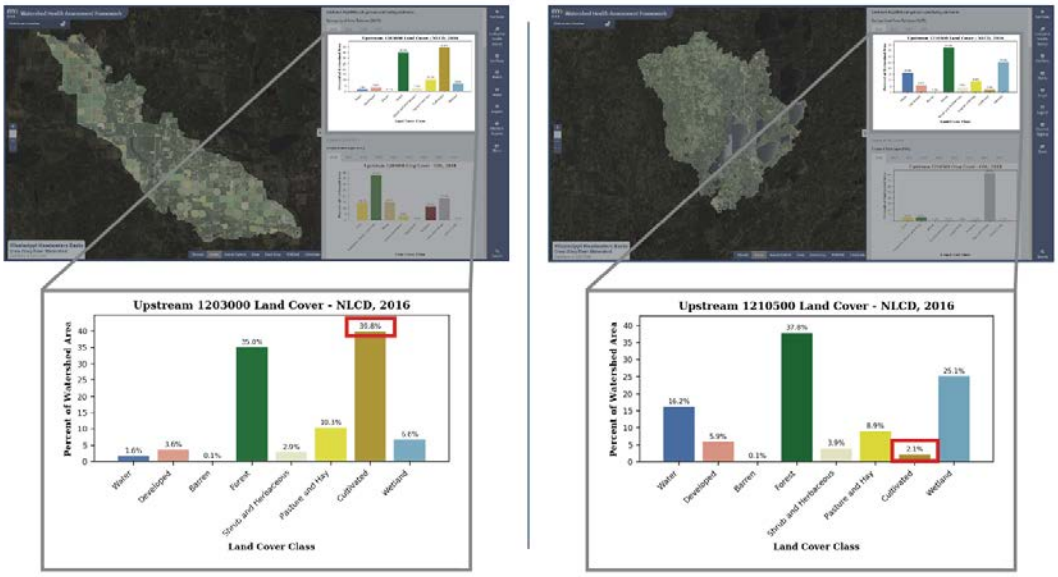
Process Example

Land Cover and Cropland Comparison

To compare land cover for another upstream area, navigate to the upstream area for Catchment 1203000, in the north central part of the watershed.

Catchment 1203000

- Use **Search** to find catchment 1203000
- Click to **Set Location** within that catchment
- **Set Scale** to the **Upstream.**
- Open the **Charts and Reports** panel
    - Select **Upstream** from the scale drop down menu
    - View the NLCD and Cropland Charts

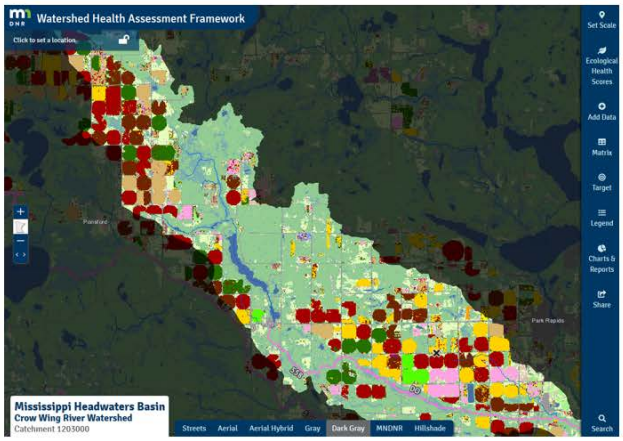


Note the difference in prevalence of agriculture between these sub-watersheds. Pivot irrigation systems create an obvious signature pattern of circular areas in the aerial image on the left.

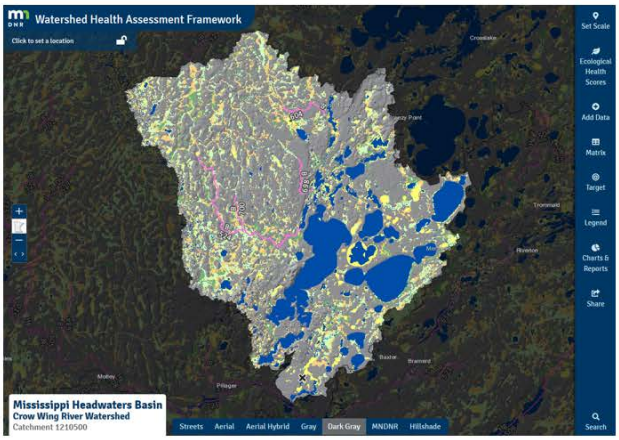
Adding Data

Adding additional data layers will show how key land cover types are distributed across the landscape.

- Mask Upstream for Catchment 1203000: Add **Crop Data Layer** to reveal the different crop types.
- Add **Impaired Streams** layer, note the stream reach that is impaired for **Dissolved Oxygen**
- Mask Upstream for Catchment 1210500: Add **National Wetland Inventory** data to show distribution of lake and wetland features.
- Add **Impaired Streams** layer, note the stream reaches impaired for **Bacteria**



Upstream of catchment 1203000



Upstream of catchment 1210500

Lessons Learned

Managing the land and water resources within these two very different upstream areas will require unique approaches. Understanding of the similarities and differences in land cover, surface water, groundwater, and economic activities will help you consider appropriate next steps for each location.

Both upstream areas hold a stream reach with impaired water quality, but the threats are different. The intense irrigation in the map on the left may be impacting groundwater and, as a result, surface water flow and dissolved oxygen levels; while the wetland dominated landscape on the right has concerns about stream bacteria levels. Comparing two areas allows you to connect health responses to conditions at an appropriate scale.

	Upstream of 1203000	Upstream of 1210500
Total Area	82.4 mi²	324.4 mi²
Land Cover - Developed	3.6%	5.9%
Land Cover - Open Water	1.6%	16.2%
Land Cover - Cultivated	39.8%	2.1%
Land Cover - Wetland	6.6%	25.1%
Water Quality Impairment	Dissolved Oxygen	Bacteria

Investigate Relationships

Purpose

The final step explores patterns of health at different watershed scales. By connecting landscape conditions to local ecological responses, you can begin to identify the ecological processes that are influencing system health.

By focusing on watershed health outcomes, the WHAF applies these key concepts for managing complex systems:

Target solutions at the appropriate scale.

Evaluate health conditions across watershed scales to gain insights into which patterns of land use and landscape risks are likely to be affecting watershed health. Management actions are more likely to lead to lasting change when they address the source of the problem at the appropriate scale.

Recognize connections across time and space.

Consider health scores as measures of context → condition → and response**.** Thinking about health scores in these conceptual categories leads to a better understanding of each score's significance.

- Ecological ***context:*** Landscape limitations should guide the suitability of a particular management action at a certain location.
- Landscape ***conditions:*** Past land management choices impact current conditions, but may also present opportunities for different future choices.
- Watershed ***responses:*** The aquatic and terrestrial community health and water quality are examples of responses that provide feedback on how the watershed is handling the context and conditions. Over time, a response can also provide feedback on whether a management action was effective.

Evaluate health from the 5 component perspective.

Evaluating health from multiple angles helps to address the needs of the whole system and identify trade-offs. Look for solutions that enhance function without harmful impacts to other components.

Process Example

This exercise will use the Matrix table and the WHAF Map together to review upstream conditions that may influence water quality and aquatic community health.

The focus is on these health scores: Groundwater Contamination Susceptibility (context), Water Withdrawal (condition) and Aquatic Life Assessments (response).

The **Matrix Table** brings the health scores and watershed scales together in a table that delivers:

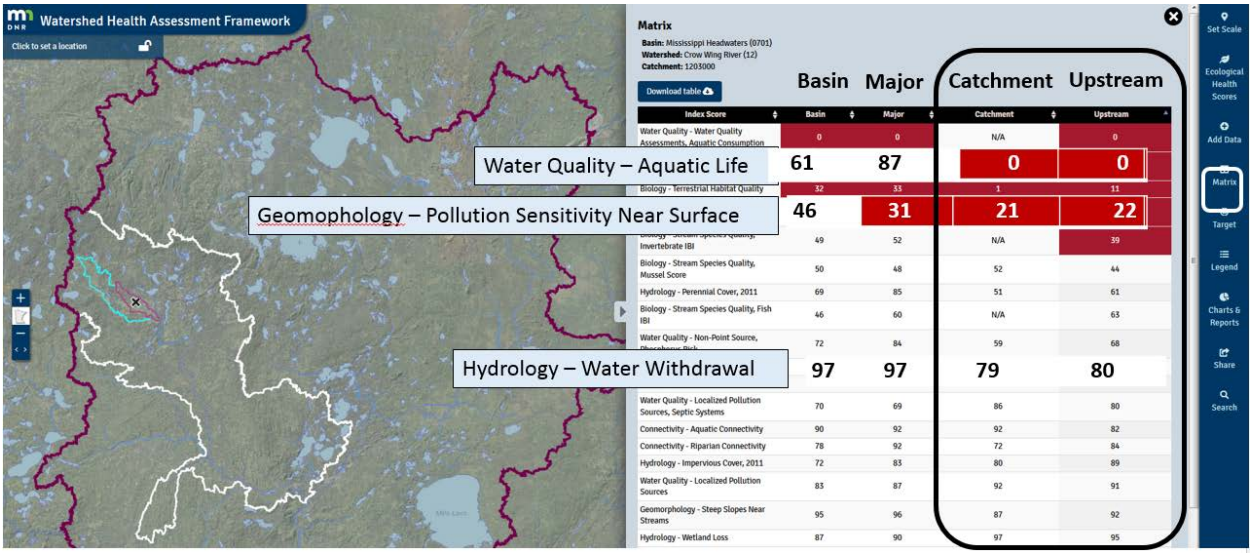
- Average WHAF health scores at 4 different watershed scales
- Score values for your set location, automatic refresh when you set a new location.
- Scores below 40 are 'flagged' with a red box.
- Option to download the matrix as an Excel table for further analysis.

For this exercise we will use the table to identify **low 'Upstream' health scores** that may be related to **a low 'Catchment' health score.**

Steps for comparing scores:

Search for **Catchment 1203000** and click to set your location.

- Use the **Set Scale** tools to Outline the Catchment and Mask the Upstream
- Open the **Matrix** panel.
- Click on the table headings to sort the records by name or value.
    - Order the Upstream scores from low to high



With the table sorted in ascending order, the lowest health scores are listed together at the top of the table. Comparing these scores across watershed scales, note that most of the lowest health scores have a significantly higher average value at the Major and Basin scales. These differences in health conditions suggest an opportunity for a targeted management action. It is less likely that conditions outside your project scale will overwhelm steps to make local improvements

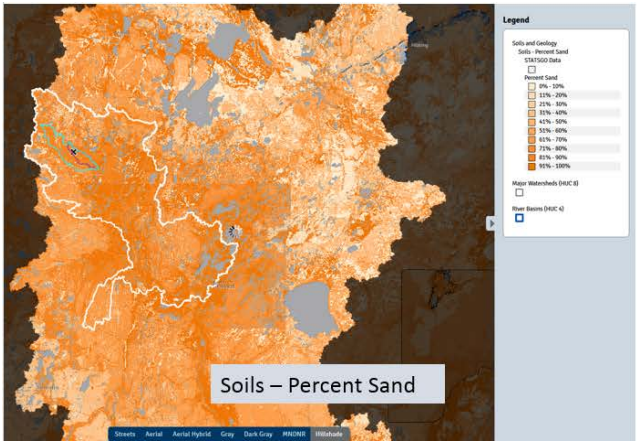
View Health Scores and Data in the Map

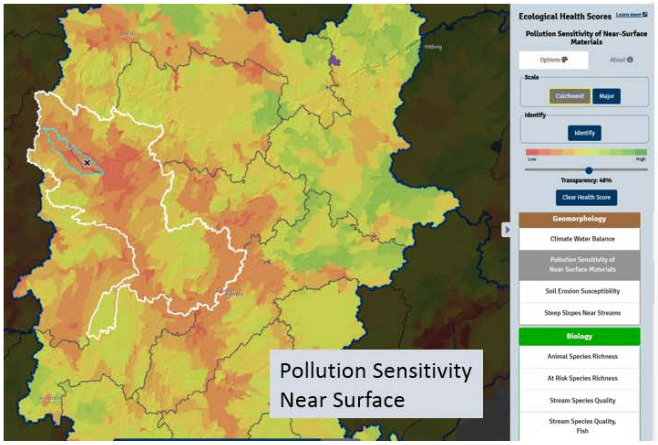
The next step is to review the low health scores and related data in the map. Consider connections between the impaired conditions and how water quality and biology are responding.

How well are the stream systems able to handle the watershed conditions?

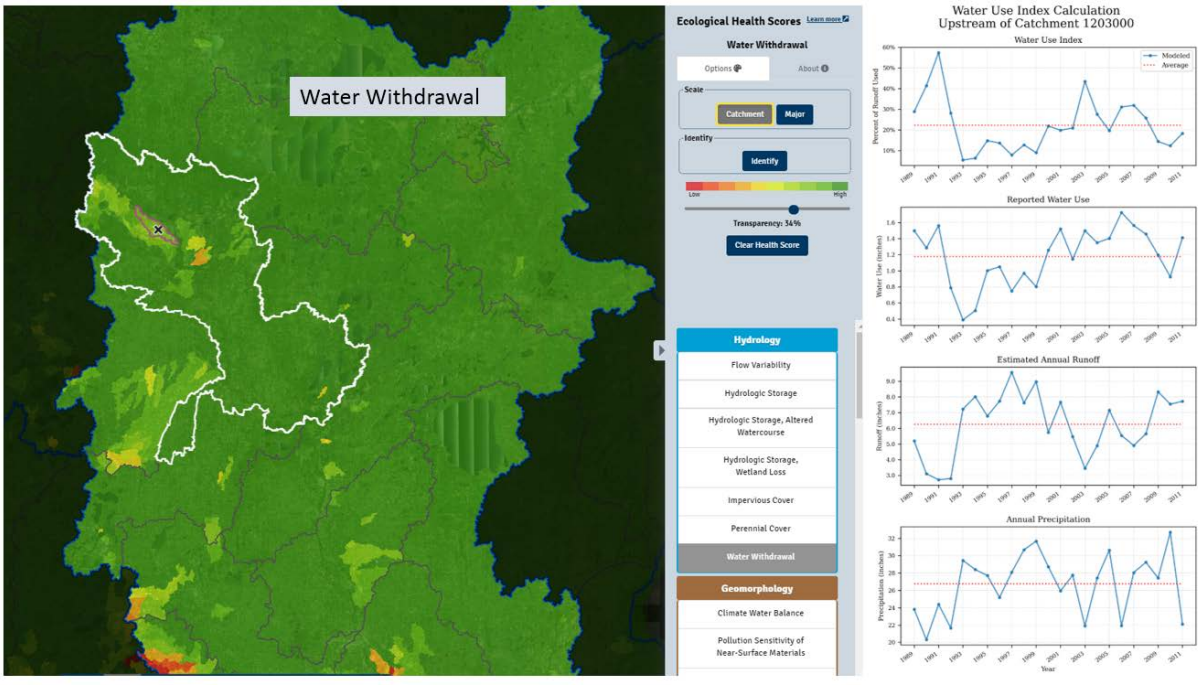
To begin to answer this question, review the selected health scores and related data layer in the map. An example for the three highlight scores are shown below.

- **Add Data**: Soils - Percent Sand
- **Health Score**: Geomorphology - Pollution Sensitivity of Near Surface Materials

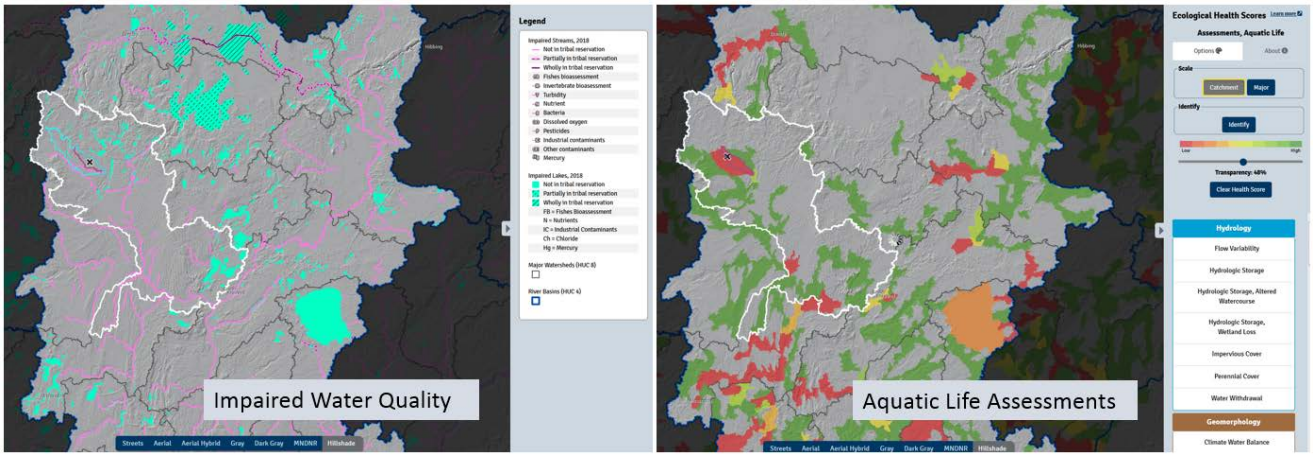




- **Health Scores**: Hydrology - Water Withdrawal
- **Charts and Reports**: Water Use Charts (tab at top of panel)



- **Add Data**: Impaired Streams, Impaired Lakes
- **Health Scores**: Water Quality - Aquatic Life Assessment Health Score



Streams and lakes with impaired water quality are found throughout the watershed. The legend helps interpret the labels and identify the type of impairment. The Aquatic Life Assessments show how aquatic communities are responding to water quality impairments and other disturbances.

Focusing on the health scores that were selected in the Matrix, look for any patterns or connections:

	Basin	Major	Catchment	Upstream
Pollution Sensitivity of Near-Surface Materials (context)	46	31	21	22
Water Withdrawal (condition)	97	97	79	80
Aquatic Life Assessments (response)	61	87	0	0

EXAMPLE OBSERVATIONS:

How well is the aquatic system handling the conditions in this subwatershed?

Aquatic life was assessed for the stream reach downstream of Straight Lake. The results scored below the water quality standard for fish and aquatic macro invertebrates. This is reflected in the '0' Health Score for Aquatic Life Assessments. This stream reach has been listed as 'impaired' for water quality with dissolved oxygen as the specific impairment parameter.

What conditions might be leading to an unhealthy response in the streams? (Consider intensity of alteration to land cover, water storage and delivery systems, introduction of contaminants.)

Land cover has been widely converted to row crop agricultural use. The water cycle has been altered by that vegetative change as well as intense irrigation required for crops in sandy soils. Water use charts

show possible over use of available water a number of times since 1989. Groundwater pumping can draw contaminants from the surface, as it draws the surface waters. The sandy soils in this area also increase the susceptibility of groundwater resources to contamination. This contamination risk is shown in the near surface pollution sensitivity index score.

At what watershed scale are those conditions present?

In most cases the response health scores in this sub-watershed have lower scores at the catchment and upstream scales. Generally the scores indicate that the major watershed and basin are in better shape than this particular sub-basin. However, the risks from sandy soils and pollution sensitivity extend throughout this major watershed and into surrounding areas. This will present a management challenge if intensive agriculture use and irrigation practices expand. A negative health response by aquatic resources in additional locations would be anticipated.

What management actions should be focused on the local conditions?

The intensity of crop production systems and irrigation appears to be impacting surface water resources. Monitoring and research should determine the connections and impacts to aquatic system health. The dissolved oxygen water quality impairment is an indicator that water use is already stressing the stream system. Alternative irrigation systems and water saving measures should be implemented. Expansions to perennial vegetation, prioritizing riparian zones and locations that connect remaining patches of quality terrestrial habitat, should be implemented.

What actions should look more broadly at the major watershed or basin conditions?

Introduce alternative crops that are more suitable to sandy soils and low moisture conditions. Explore incentives to encourage adoption at this location and other locations with similar vulnerable landscapes.

Lessons Learned

Comparing health scores across scales provides insights into the proper spatial scale for addressing ecological threats and opportunities.

Reviewing scores for all 5 components will enhance your awareness of the connections between a range of ecological conditions and responses. This awareness can inform the selection of appropriate actions that enhance system function while avoiding harm to other parts of the system and have a higher chance for creating a successful system response.

Process Guide Conclusion

The Watershed Health Assessment Framework provides a consistent science-based approach for exploring watershed health. Each interactive exploration applies principles of system science. The key concepts of health, scale, resilience and complexity are interwoven into the process steps and embedded into the design of the experience.

By applying the tools in the map in a series of steps, you can gain new insights into a wide range of watershed context, condition and response indicators. You can review health scores and data across spatial scales. You can share your observations with other watershed practitioners; and seek to implement the right actions at the right scale to improve watershed health.

Additional Resources

The **WHAF website** contain additional information about the key concepts that the application is designed around, as well as detailed descriptions of all of the Ecological Health Scores and additional data layers.

Health Scores

WHAF Health Scores: GIS Data Download

Using WHAF Health Scores

The Five Components

Watershed Science

What is a watershed?

What is a Watershed? Story Map

Major Watershed reports

Scientific Literature

References

Recommended Readings

For questions and guidance on managing for watershed health, or for information on the WHAF application, contact the WHAF team **at whaf.dnr@state.mn.us**