Chesapeake Healthy Watersheds Assessment (CHWA) 2.0

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U.S. Geological Survey: Lower Mississippi Gulf Water Science Center

Healthy Watersheds GIT Meeting
August 14, 2023

What are the Goals of the CHWA 2.0?

- Support the Chesapeake Bay Program and its jurisdiction partners in detecting signals of change in the state-identified healthy watersheds, providing information useful to support strategies to protect and maintain watershed health.
- Provide vulnerability metrics that may help to provide an “early warning” to identify factors that could cause future degradation, allowing managers to take actions to head off these potential negative effects.
- Support cross-connections to other CBP efforts, including stream health, fish habitat assessment, water quality, climate change, and local engagement.
- Provide web-based visualization tools that make CHWA data available to a broad group of data users with an application and code that makes it easy to update based on new data.

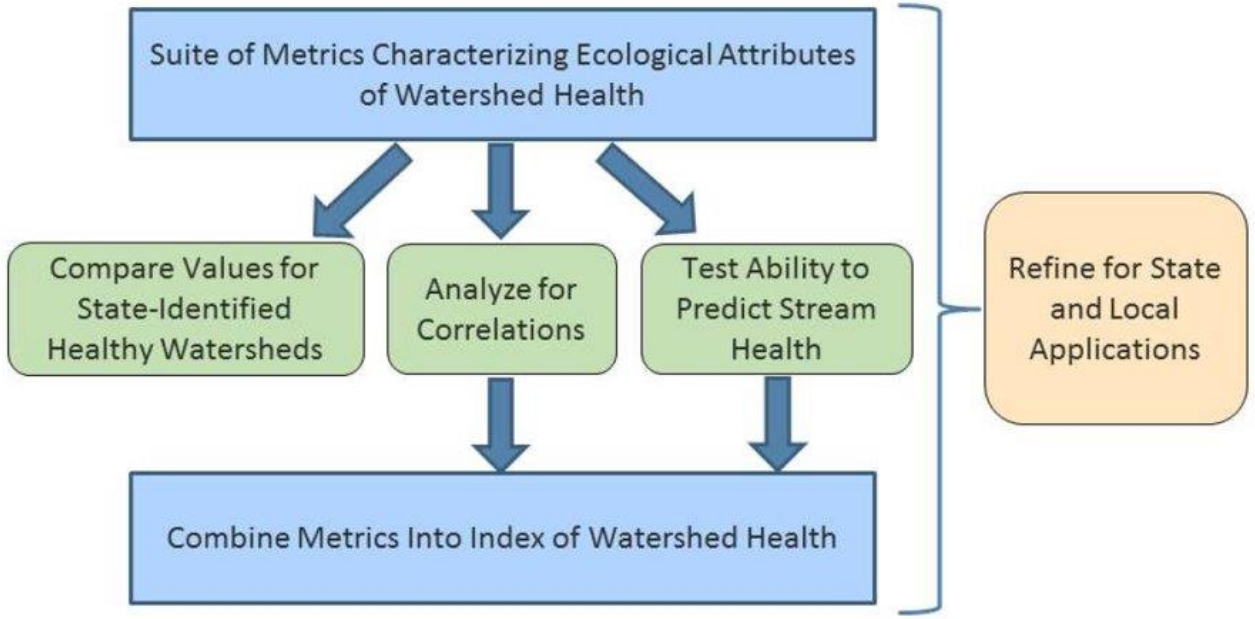
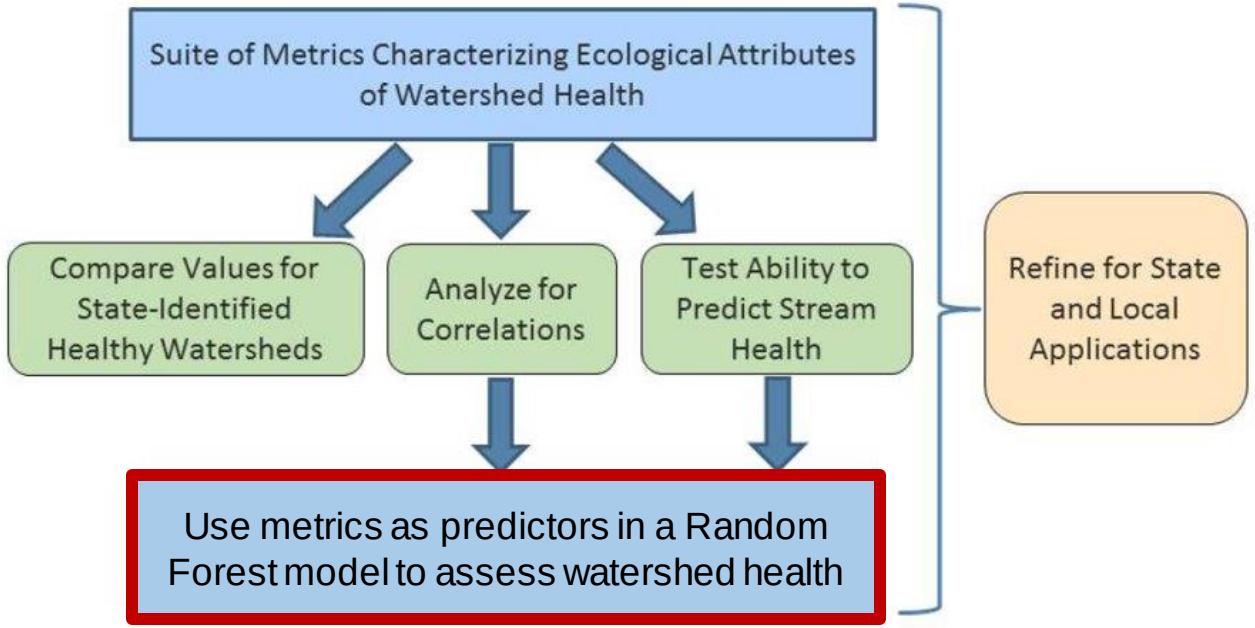


Figure 10: Exploration and refinement of metrics of watershed health. While initial analyses have been completed, additional investigations and refinement are proposed as future steps for the CHWA.

Source: Chesapeake Healthy Watersheds Assessment, May 2020, P. 20

How is CHWA 2.0 Different than the Original Assessment?



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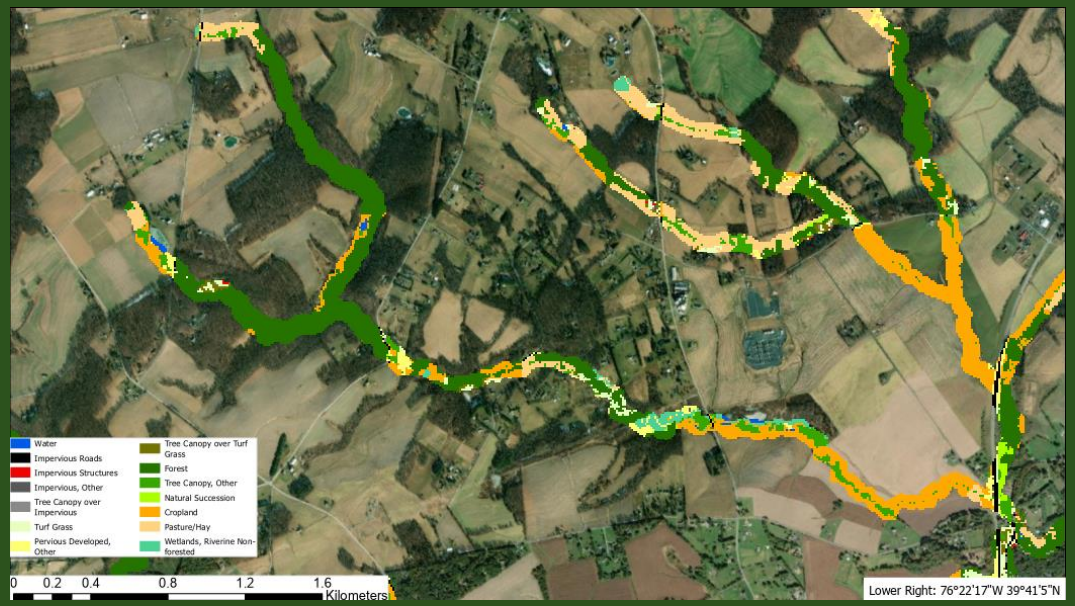
How is CHWA 2.0 Different than the Original Assessment?

Predictive Metrics

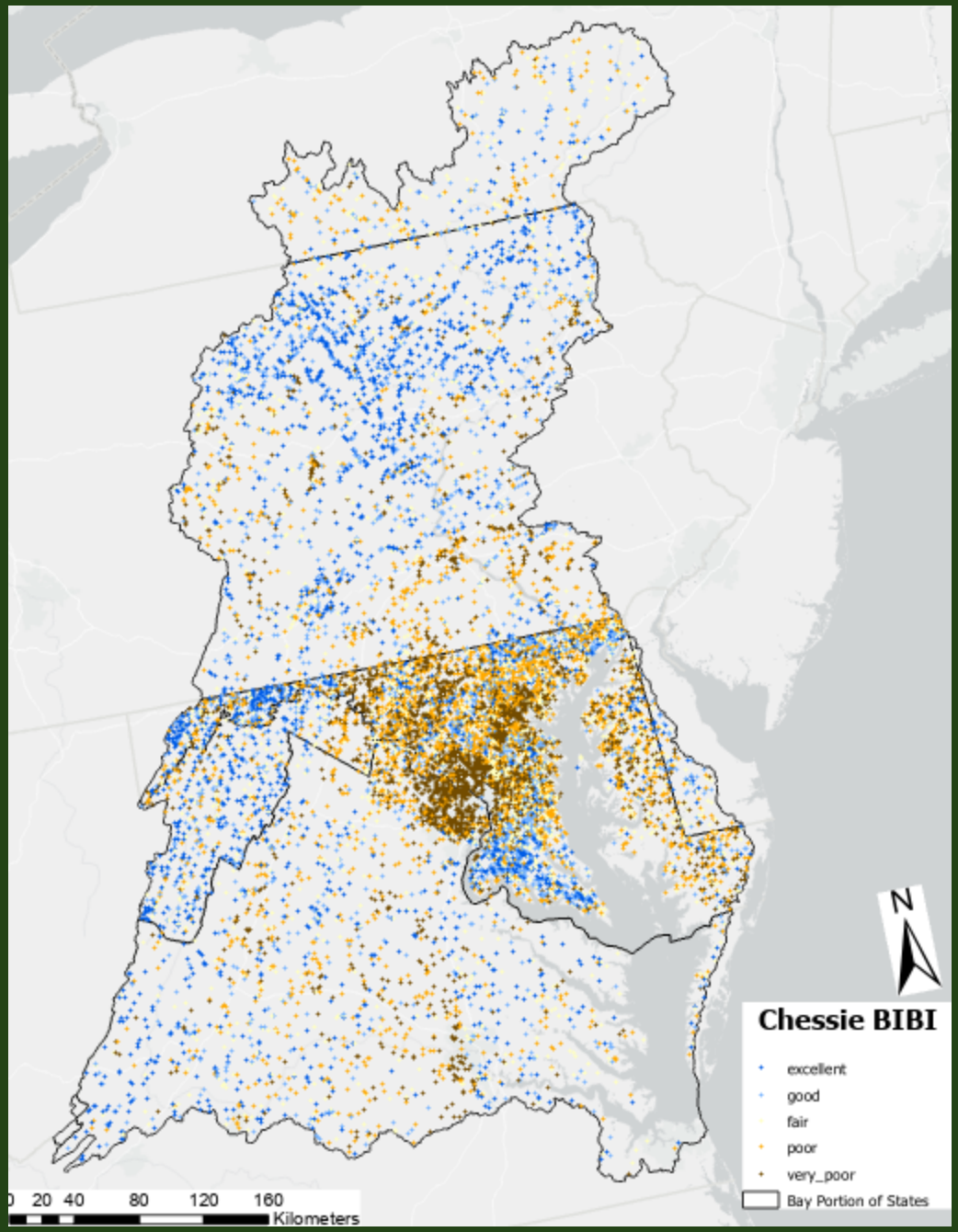
- CHWA 1.0 : An index was produced for each category, which were then used to create an overall index of watershed health.
- CHWA 2:0: The unique metrics within each category are used as predictors in the random forest model to assess watershed health.
  - New metrics were calculated for 2.0, including 1:24k landscape and landscape change riparian metrics.



- Landscape Condition
- Hydrology
- Geomorphology
- Habitat
- Biological Condition
- Water Quality

Chessie BIBI

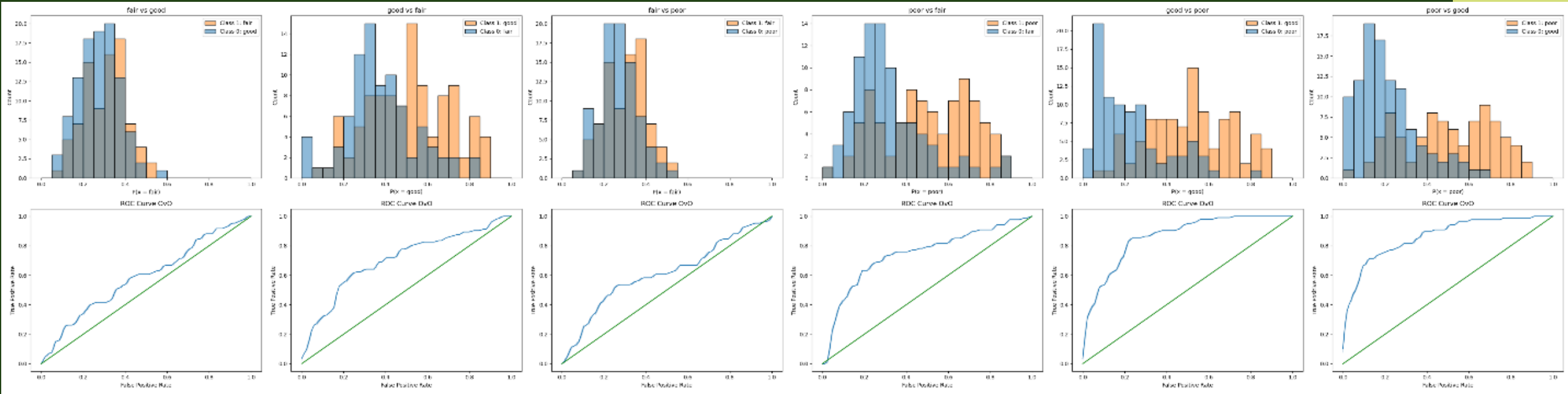
- Developed by Smith et al. (2017)
- Standardized, continuous biological index score from 0 to 100 and a categorical score, ranging from very poor to excellent
- Based on resampled diversity and species richness metrics driven by the sampled data for 1st-4th order streams at the 1:100k scale
- CHWA 2.0 Assessment uses the median categorical score



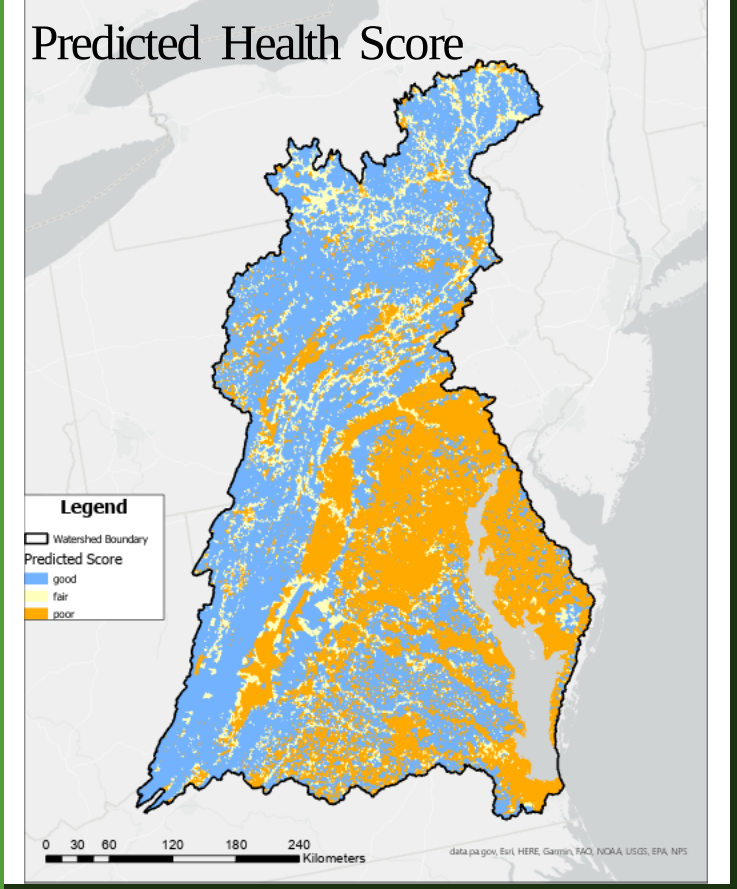
Model Accuracy

BIBI / predicted	good	fair	poor
good	**79**	10	14
fair	36	**22**	26
poor	18	8	**61**

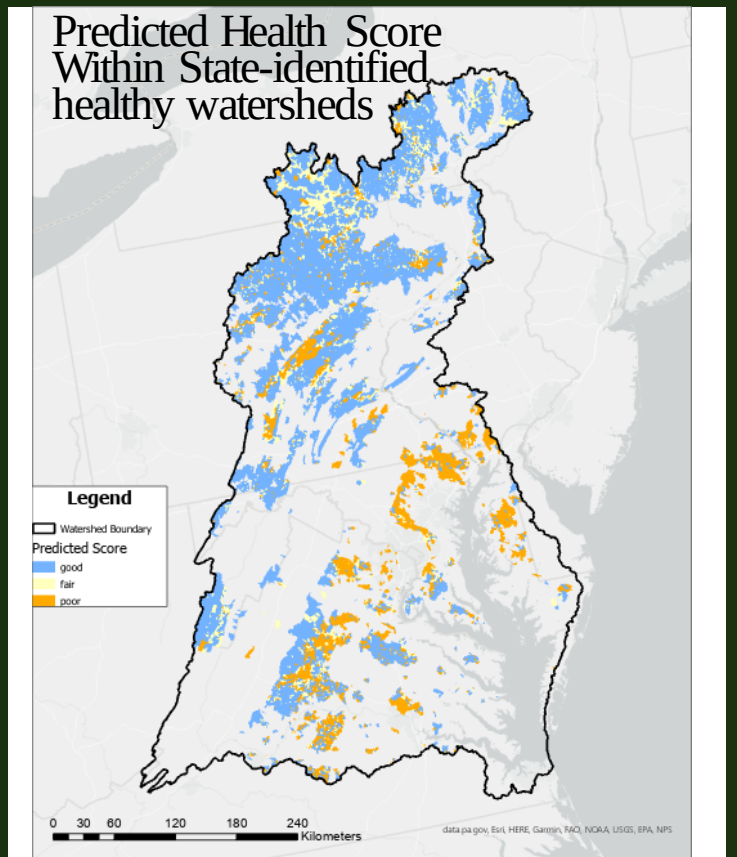
- Overall model accuracy is 0.59 with a Cohen's Kappa of 0.38 (fair agreement).
- Confusion matrix and ROC curves to assess which classes are confused with one another.
  - The largest confusion is the fair class being predicted as good. Followed by fair being predicted as poor.



Results: Predicting Watershed Health



Predicted Score (watershed)	% Area
good	52%
fair	13%
poor	35%



Predicted Score (within State Identified Healthy watersheds)	% Area
good	67%
fair	13%
poor	19%

- The watershed is predicted to be 65% good and fair.
- Within state-identified healthy watersheds, the model predicted 80% good and fair.

Metric Importance

- The random forest model measures metric importance by calculating how effective the metric has at reducing uncertainty when creating decision trees within the random forest.
- Over 100 metrics have been compiled into CHWA 2.0, 60 of which were included in the model as predictors.
- The top 7 metrics represent conditions in the upstream watershed.

Top 5 Most Important Metrics

% Tree Cover with Unmanaged Understory 2017/18 Watershed (% forest in the upstream watershed)

% Natural Land in Riparian 2017/18 Watershed (% forest, wetlands, and succession in the upstream watershed)

% Impervious Cover 2017/18 Watershed (% roads, structures, parking lots, etc. in the upstream watershed)

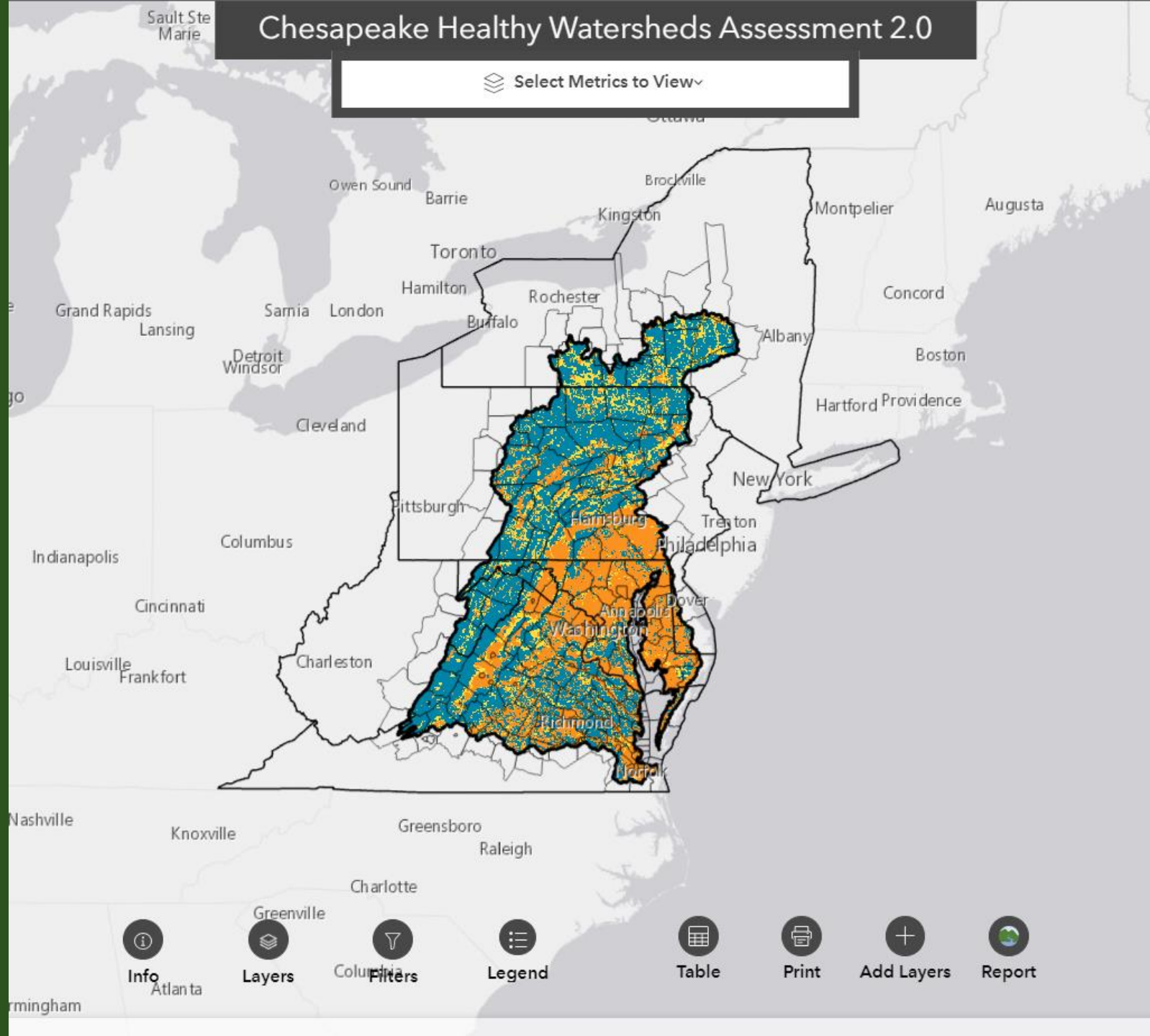
Housing Unit Density 2020 Watershed (housing units per area in the upstream watershed)

Road Density Watershed (road area per total area in the upstream watershed)

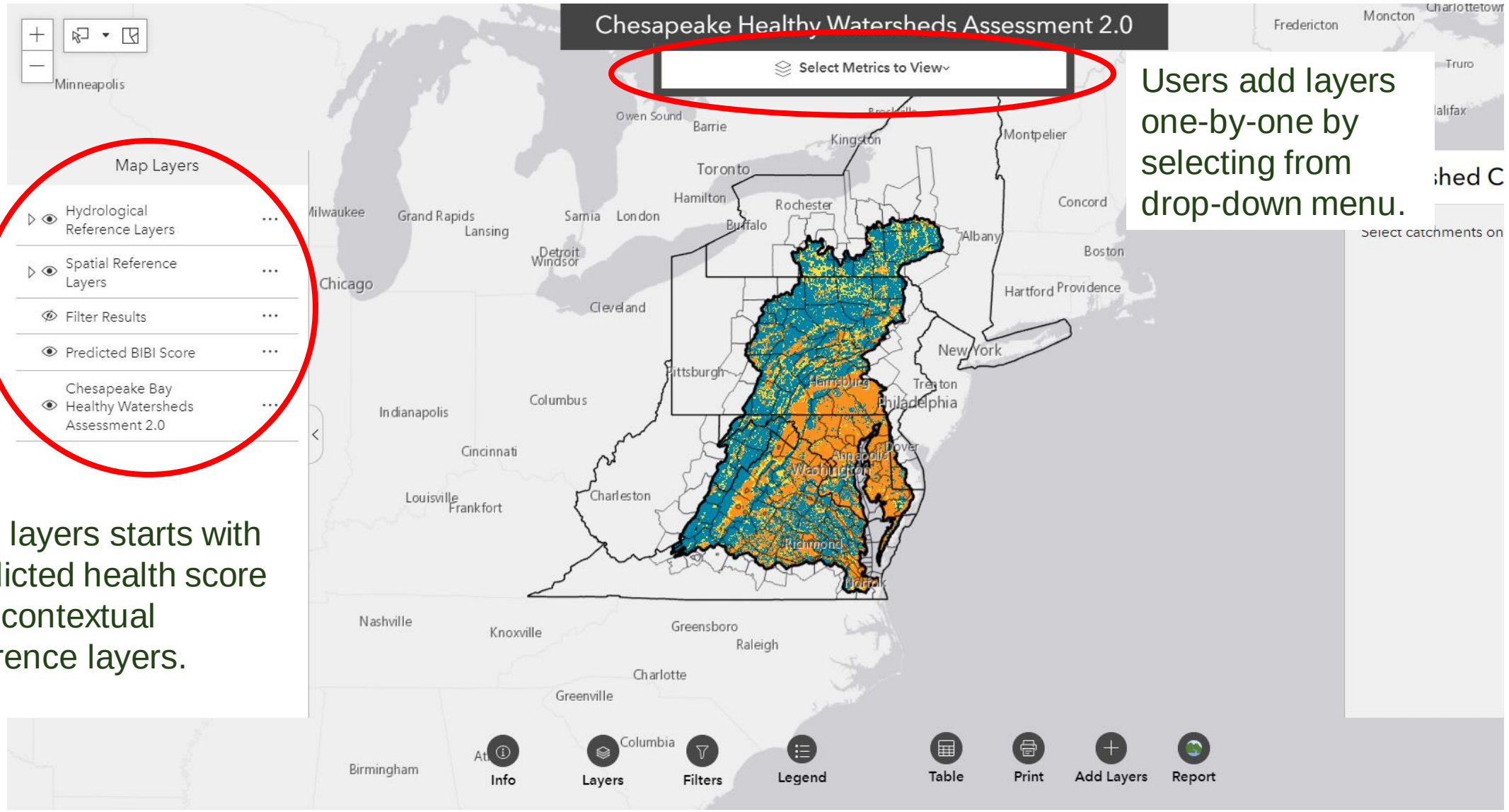
Visualization Tool

https://gis.chesapeakebay.net/chwa2.0

- A web-based visualization tool is to be complete this summer!
- This tool allows users and stakeholders to visualize and interact with over 100 metrics, predicted health scores, and numerous contextual overlay layers.



How to: Add metrics to the map



Users add layers one-by-one by selecting from drop-down menu.

Map layers starts with predicted health score and contextual reference layers.

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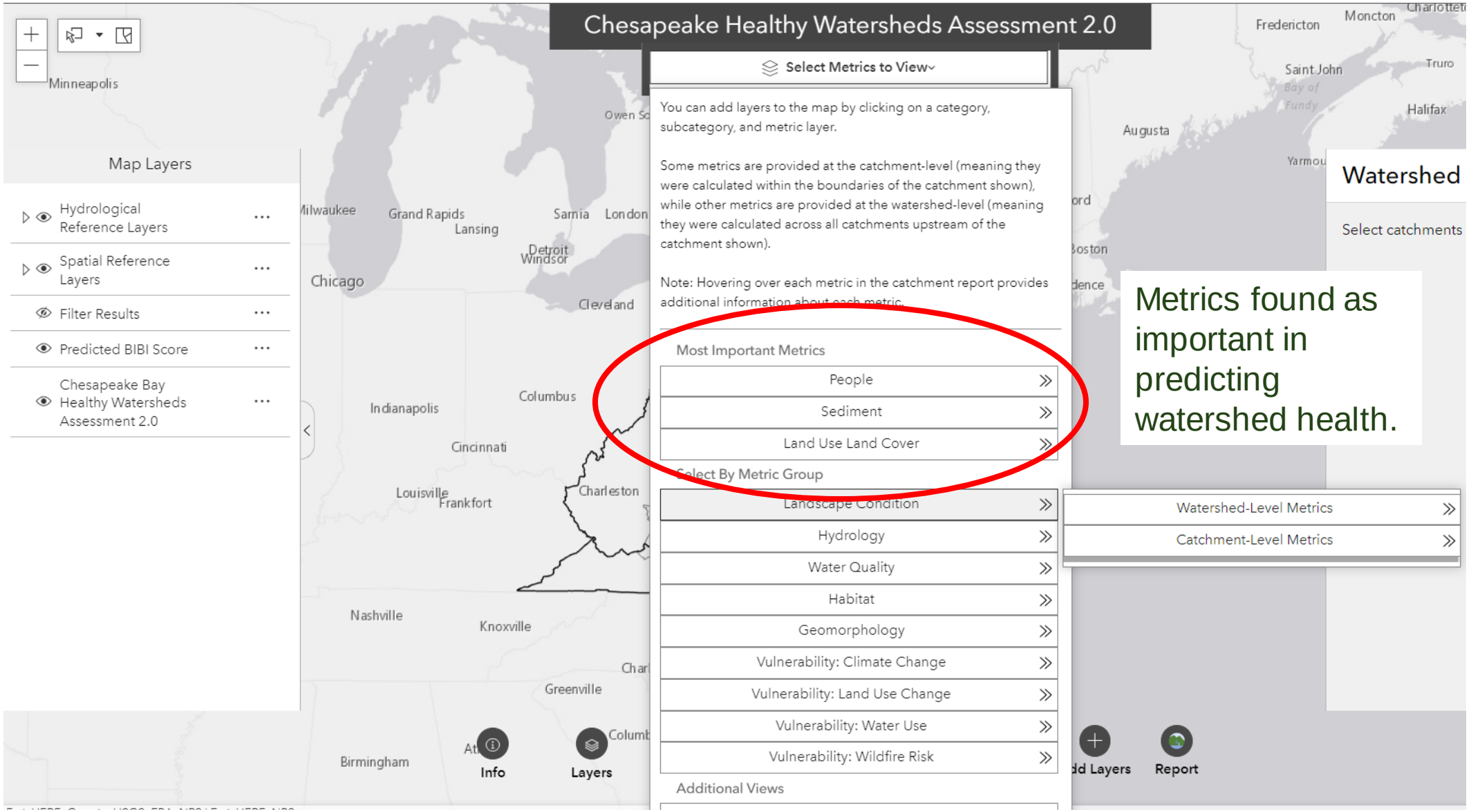

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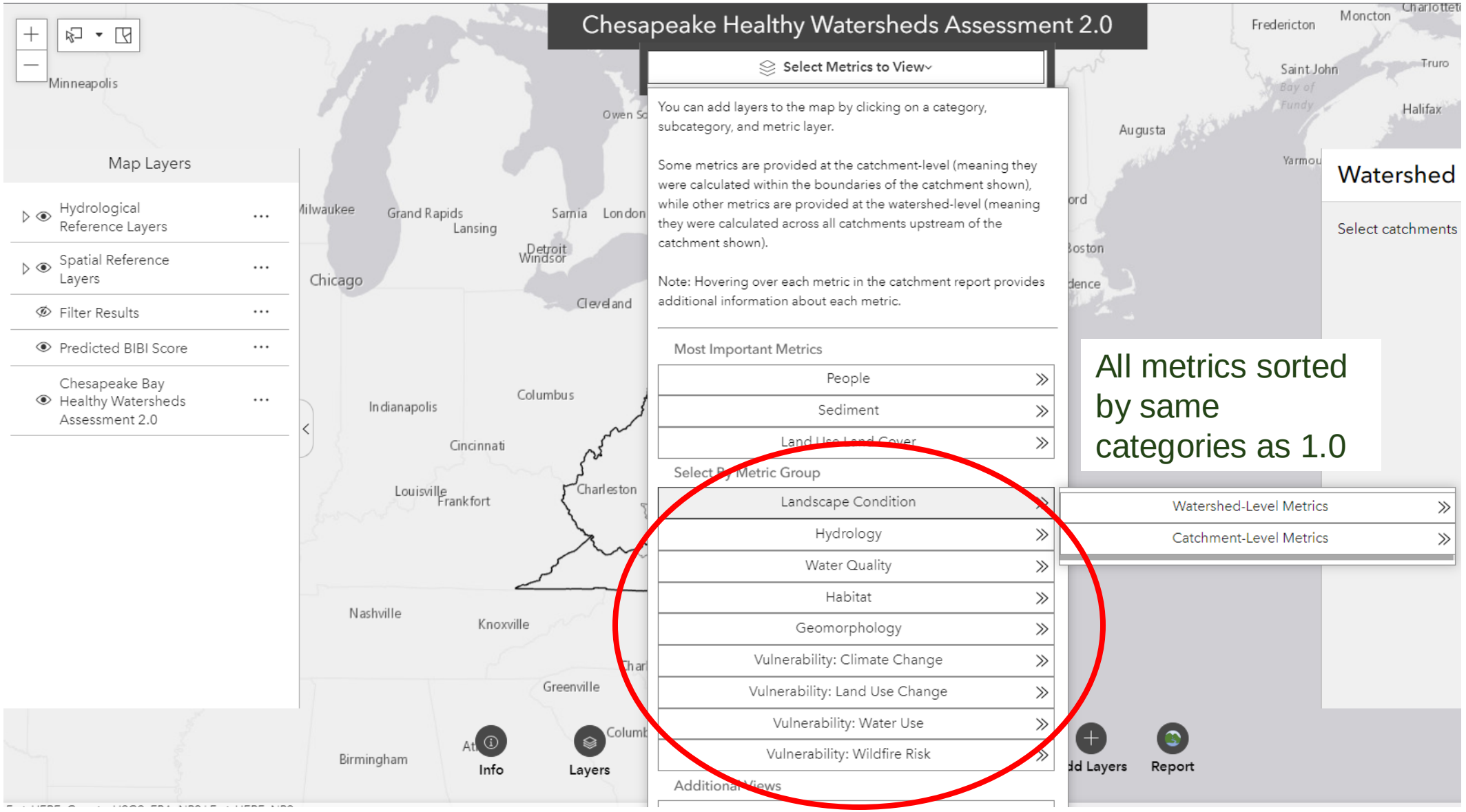

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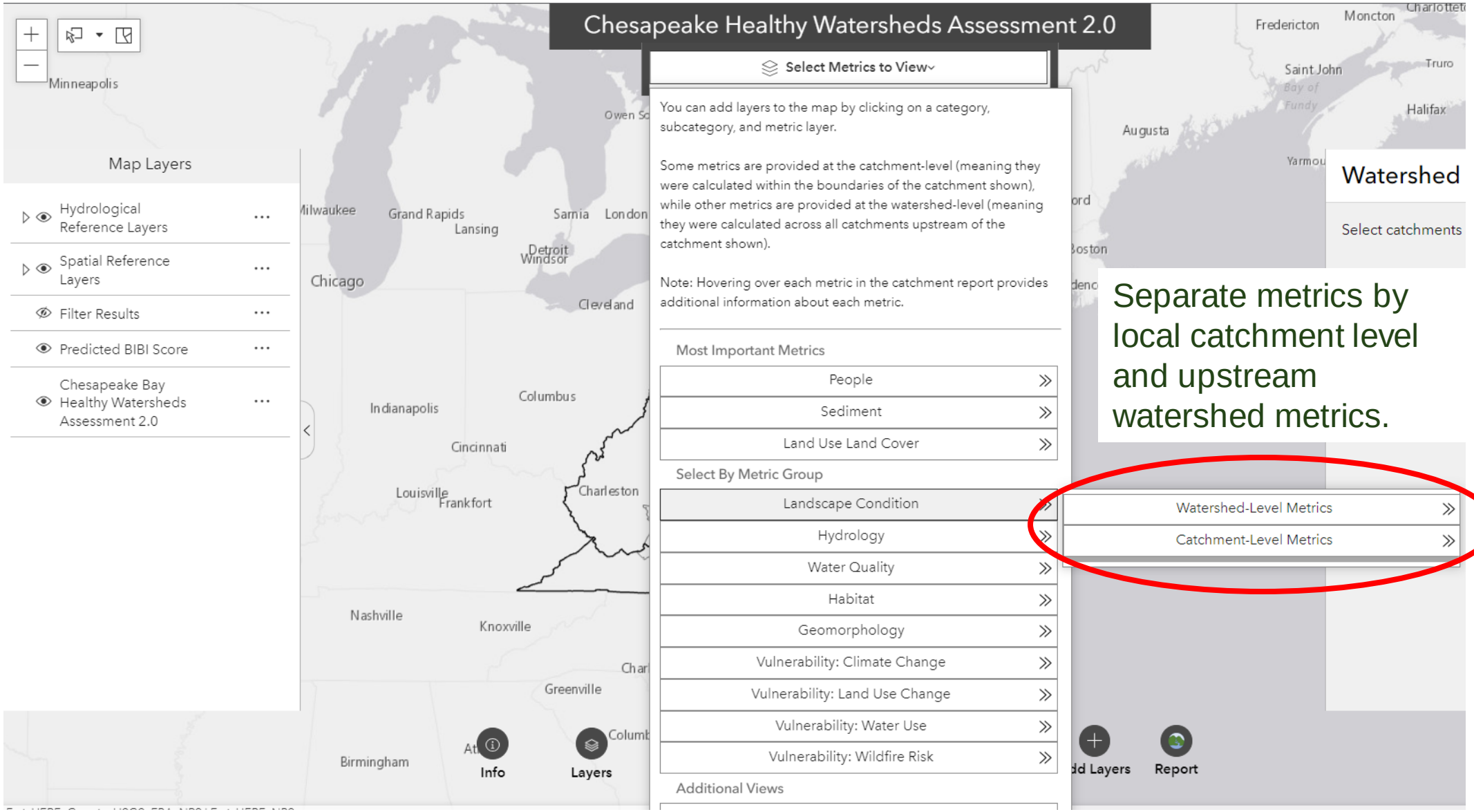

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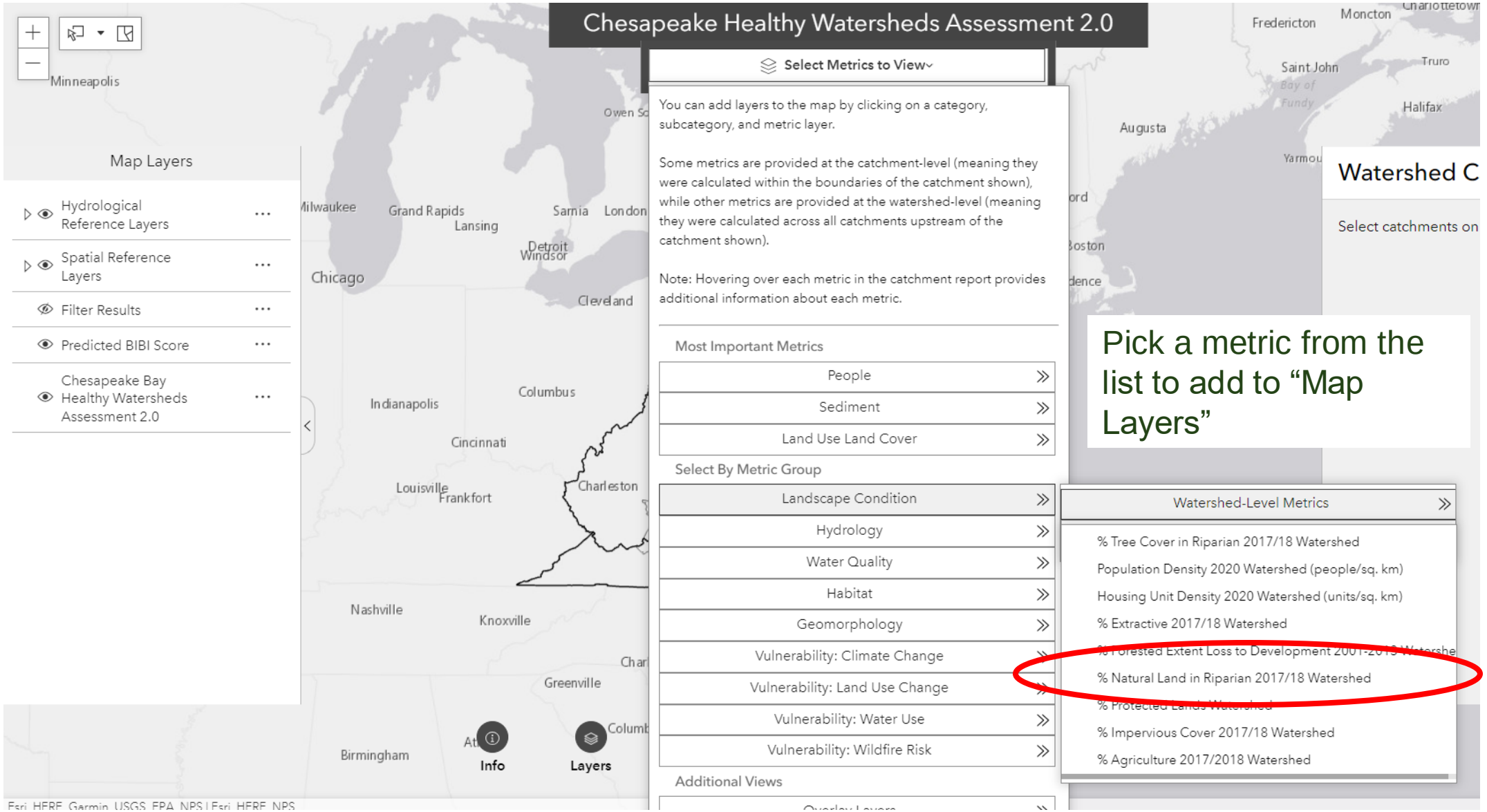

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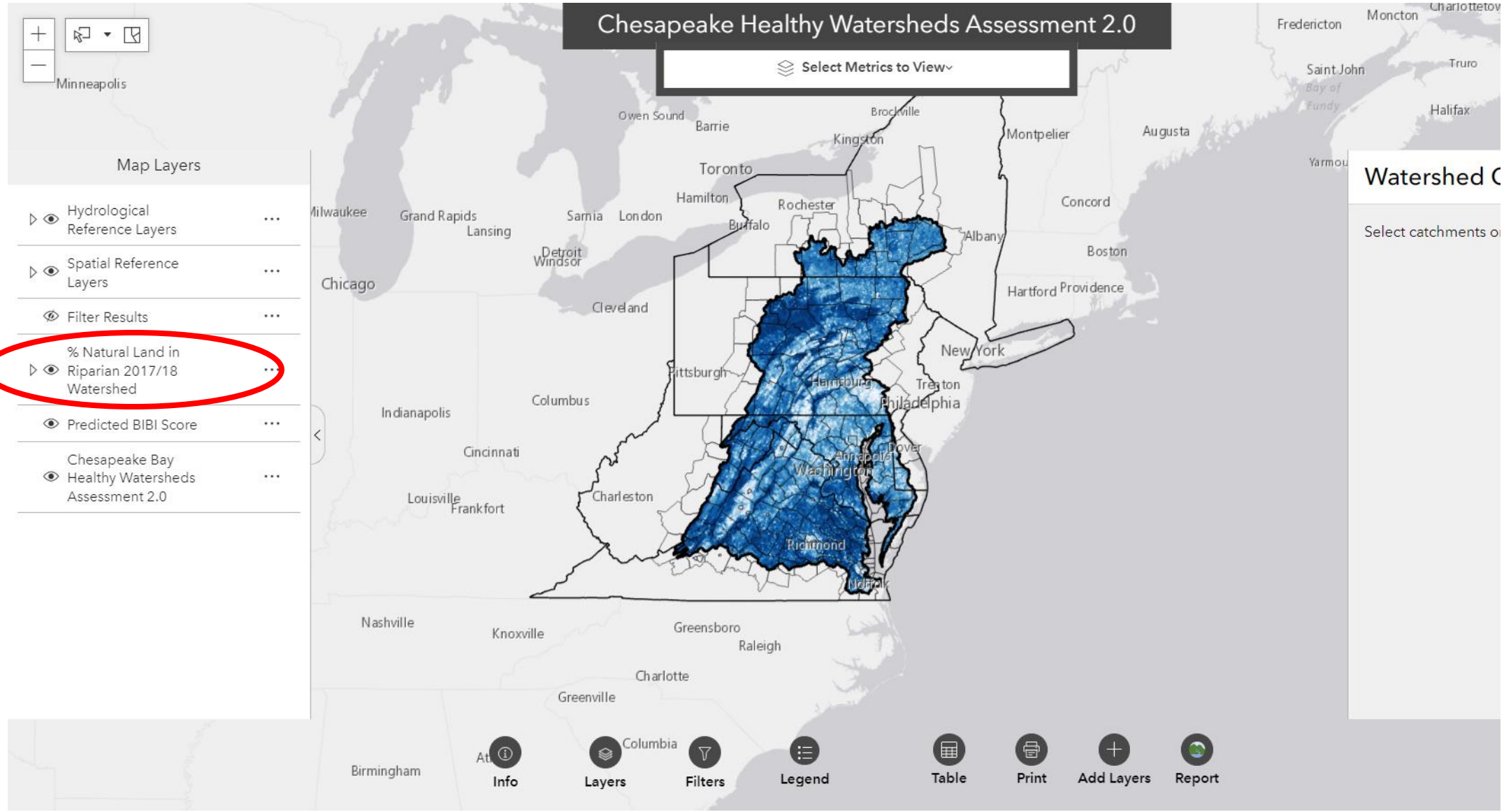
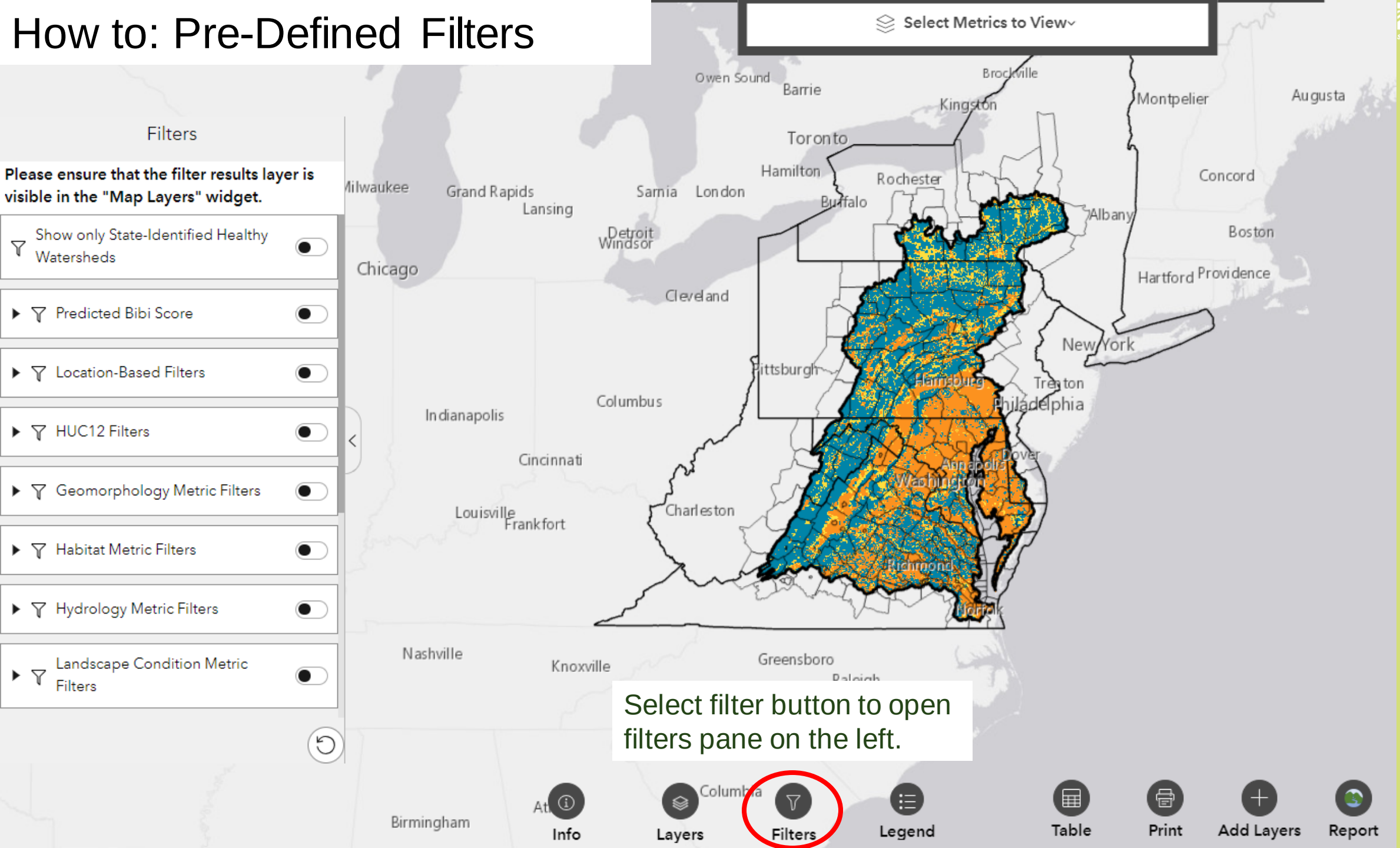


How to: Pre-Defined Filters



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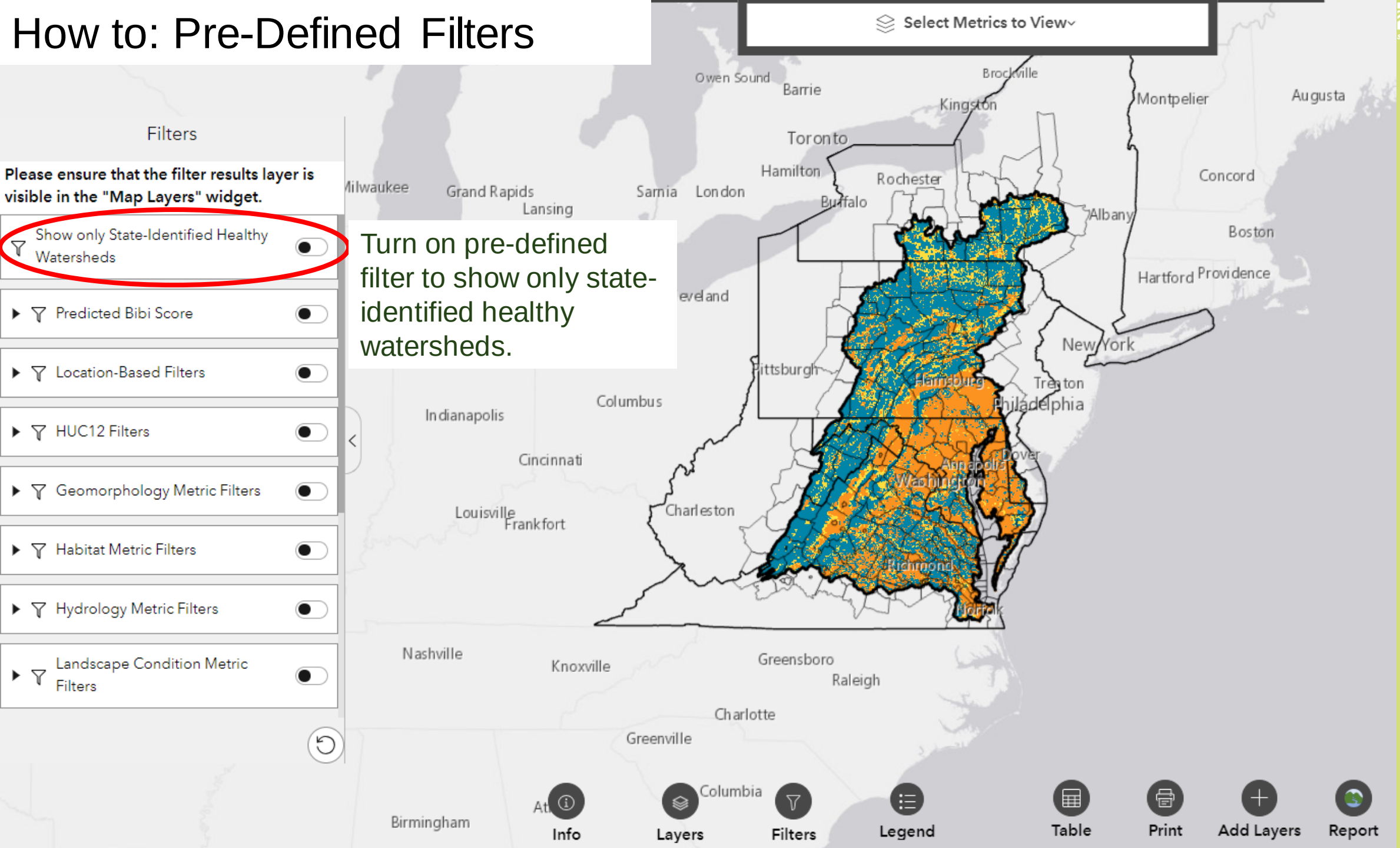

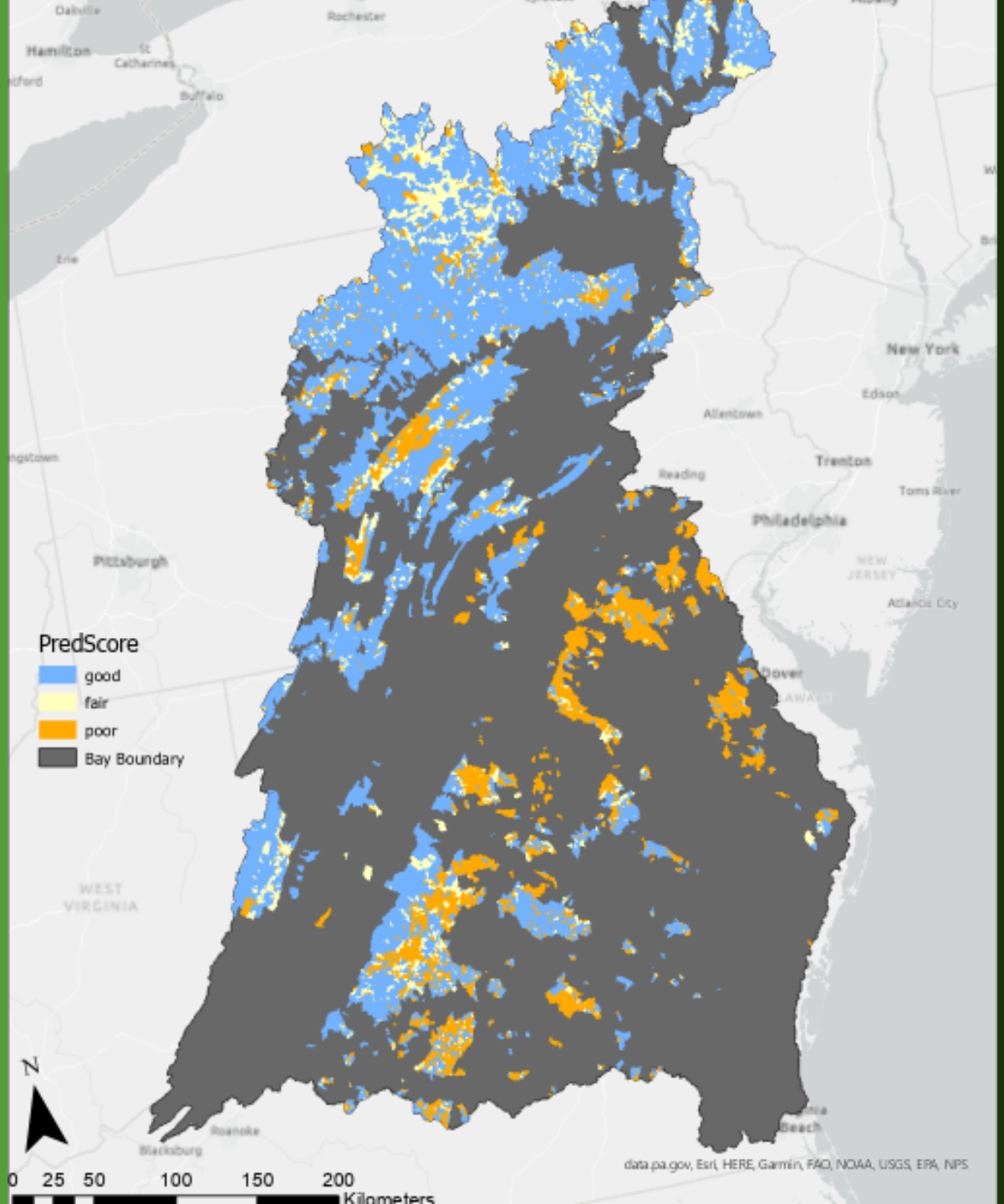

Pre-Defined Filters: Example

What is the predicted health score within state-identified healthy watersheds?

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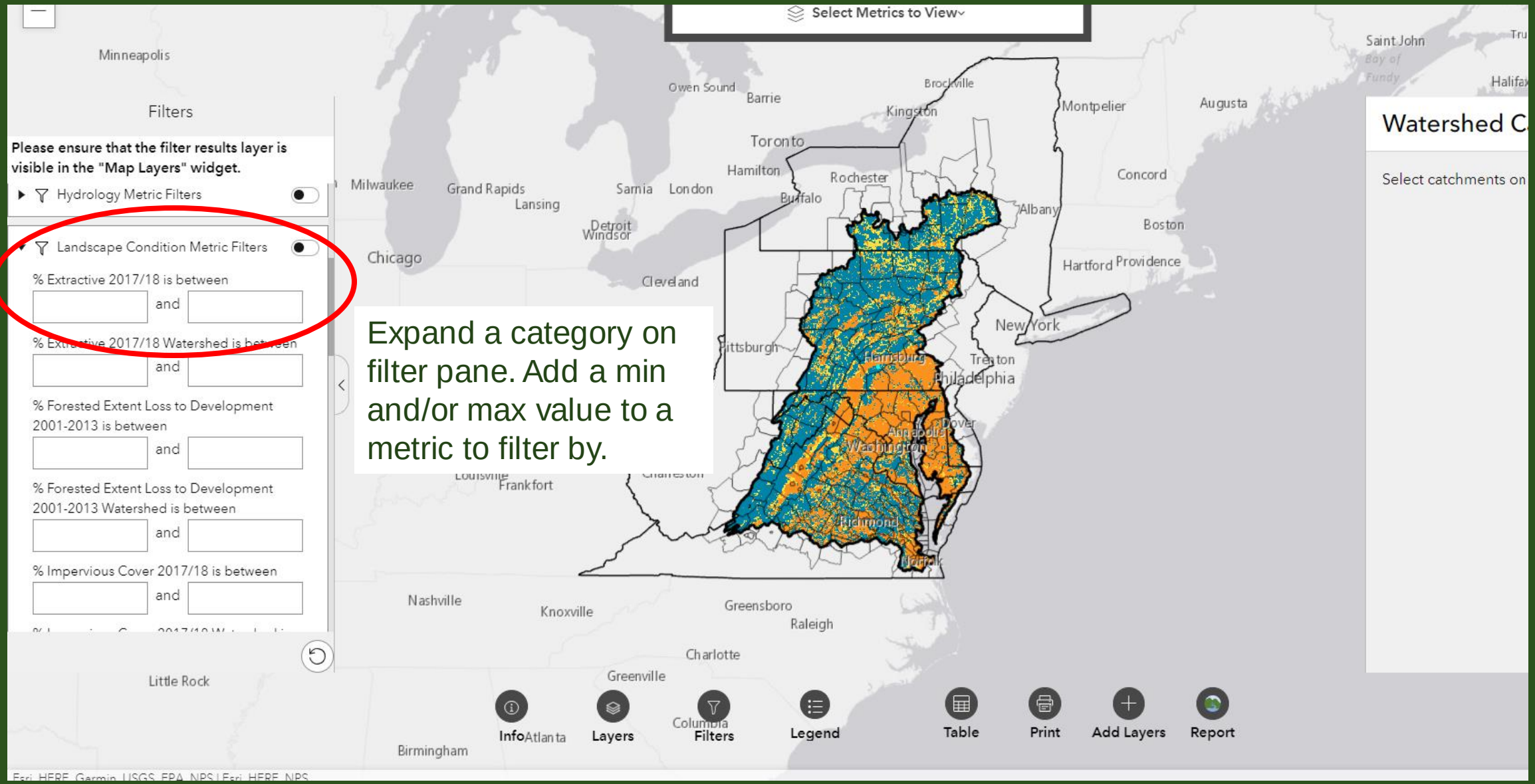
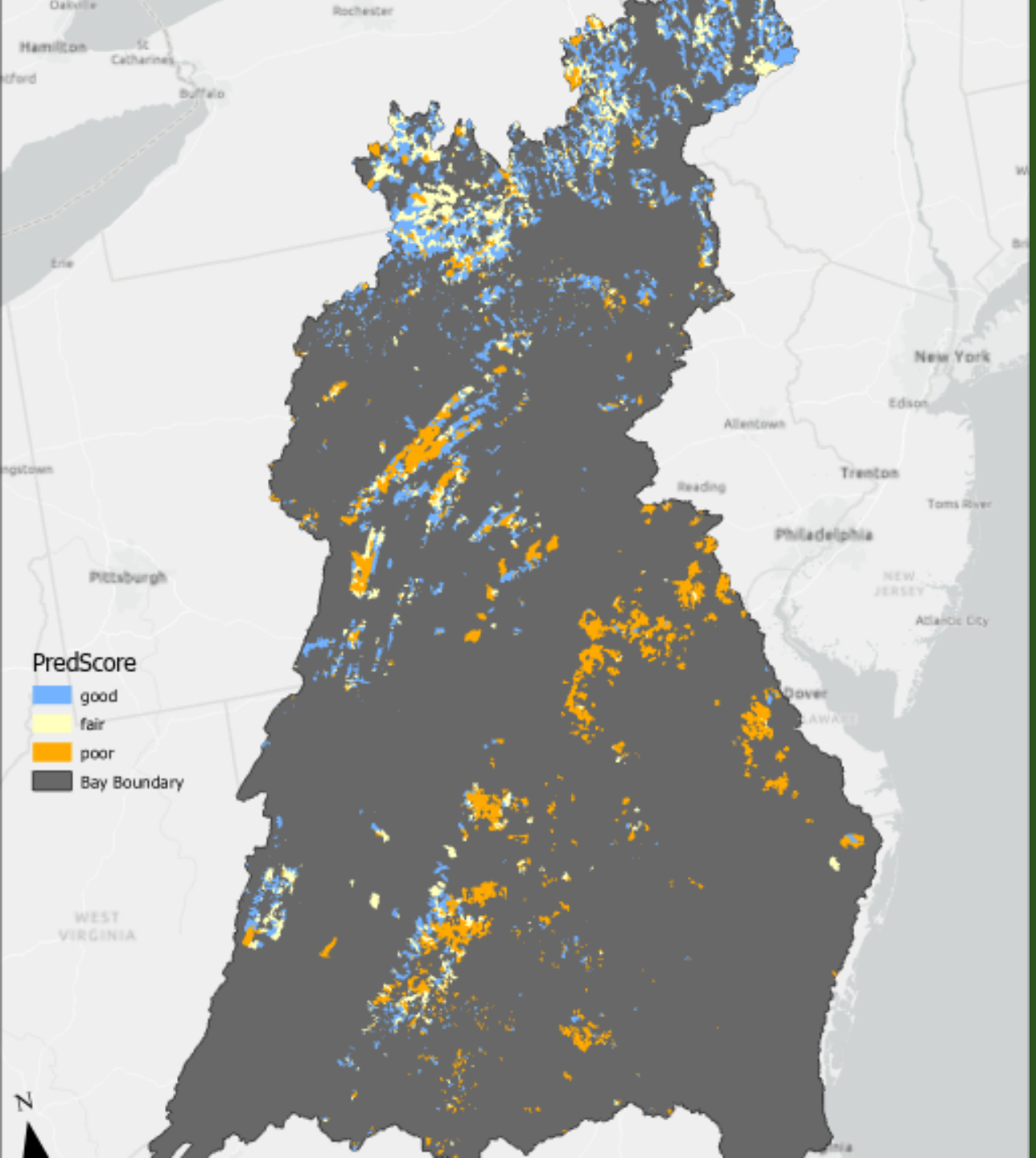
How to: User-Defined Filters





How to: Answer Science Questions with User-Defined Filters

- What is the predicted health scores in state-identified healthy watersheds that have less than 70% riparian forest buffers?

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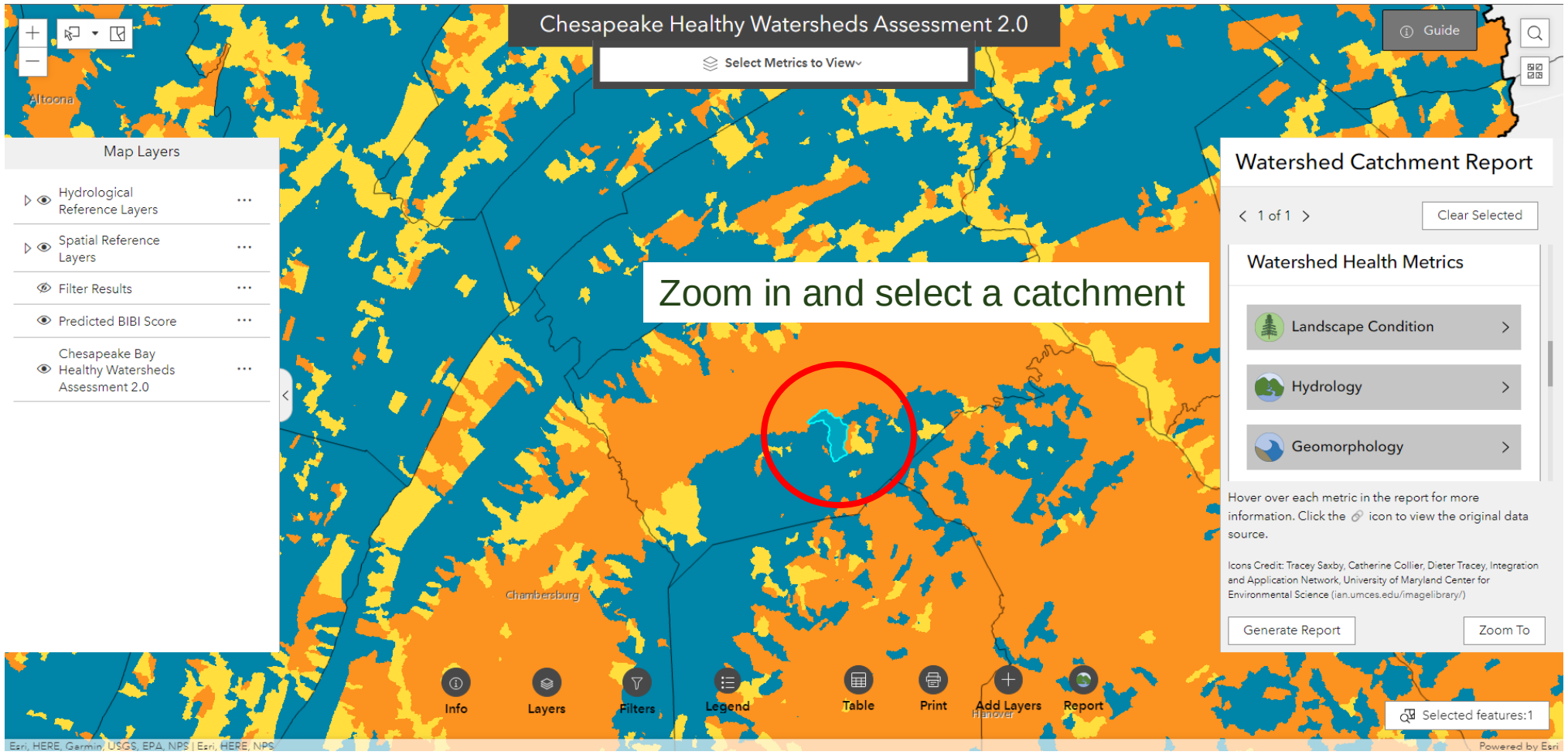
How to: Navigate the Watershed Catchment Report



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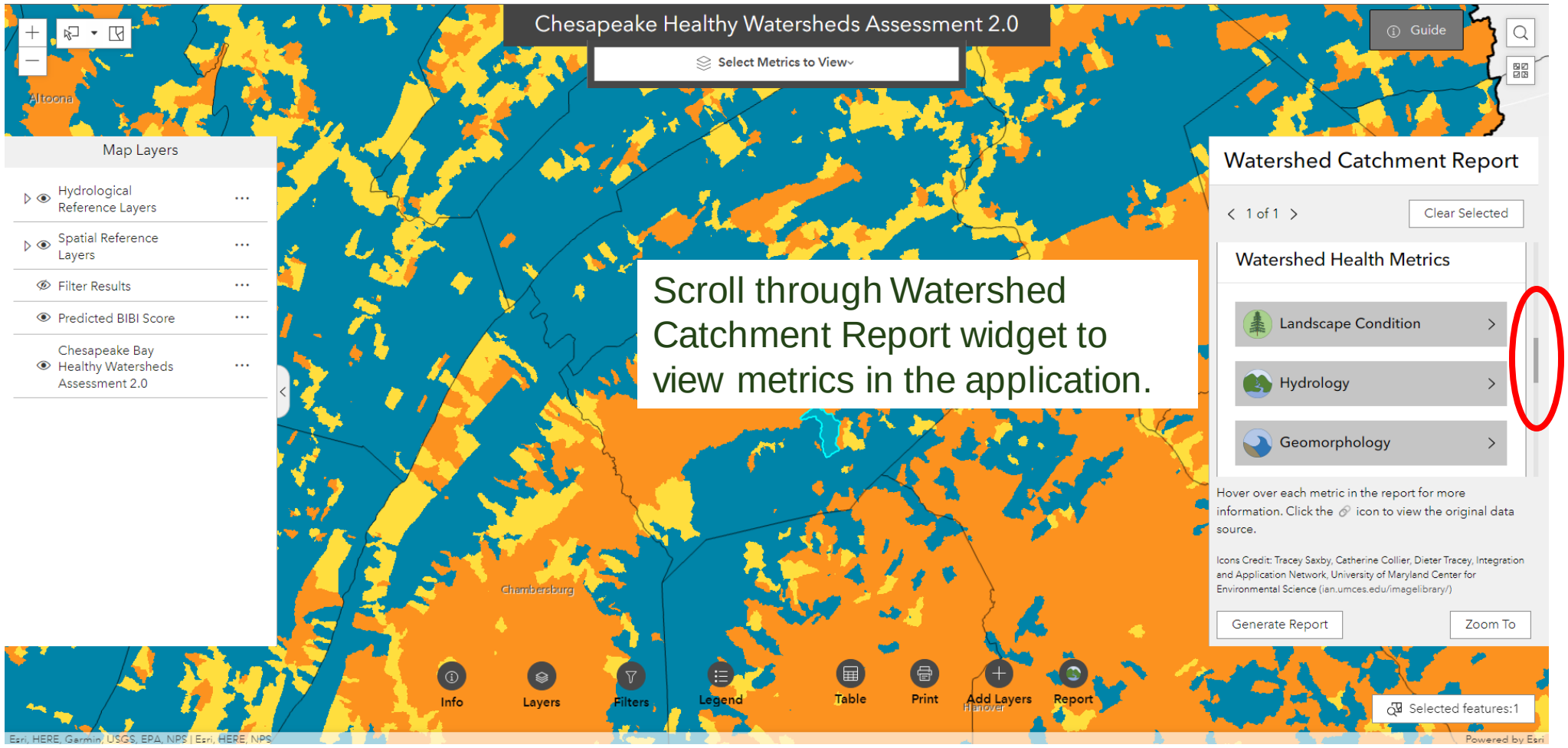

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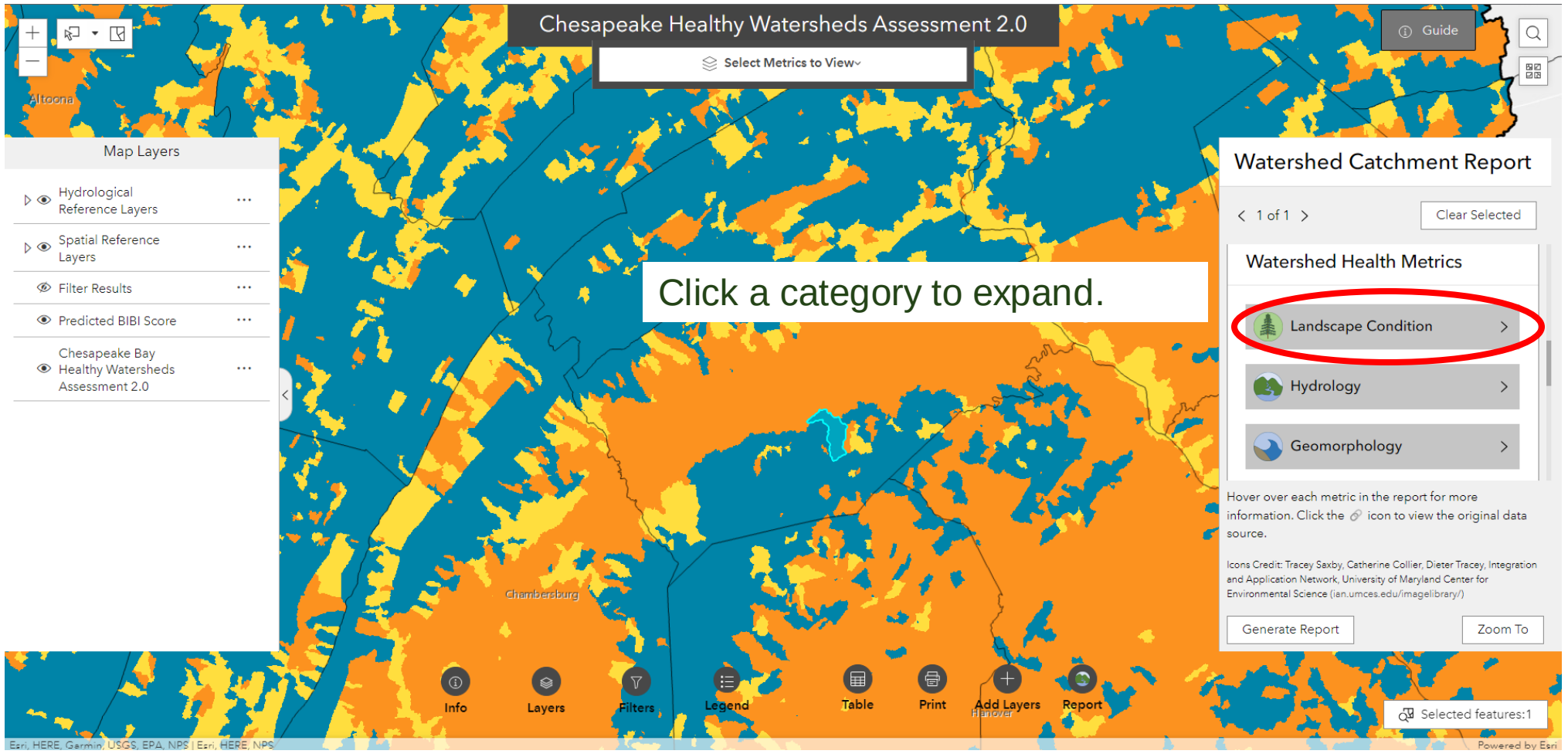

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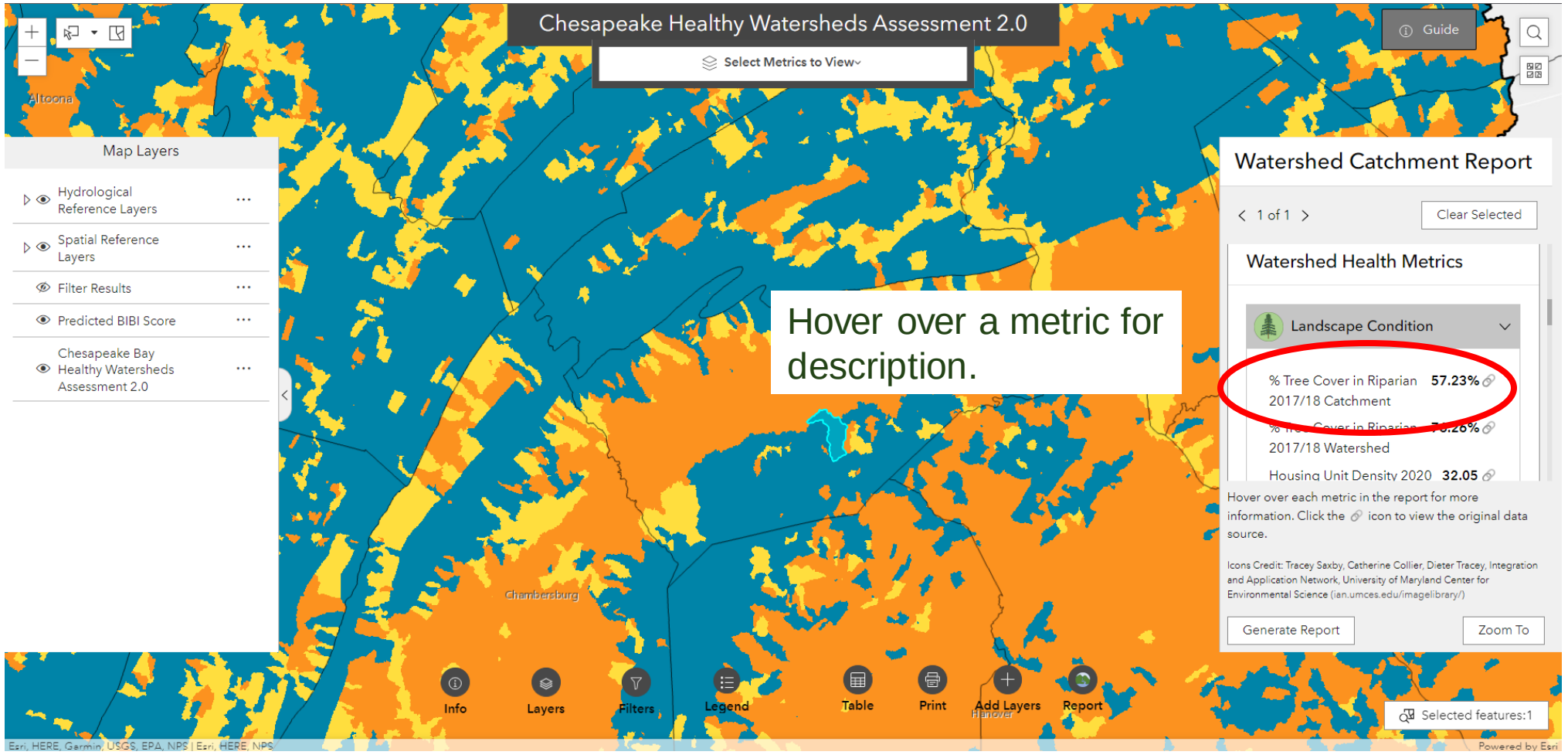

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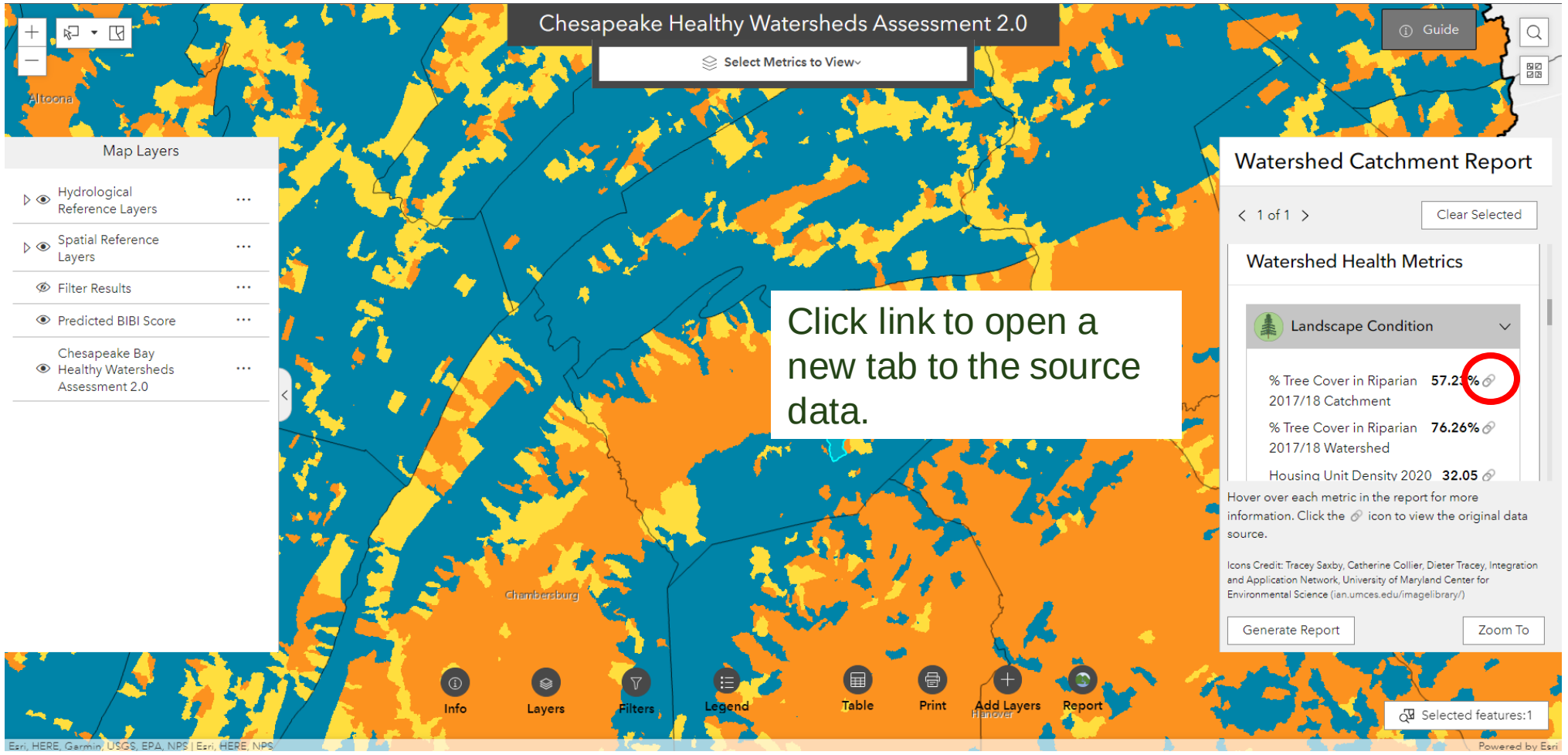

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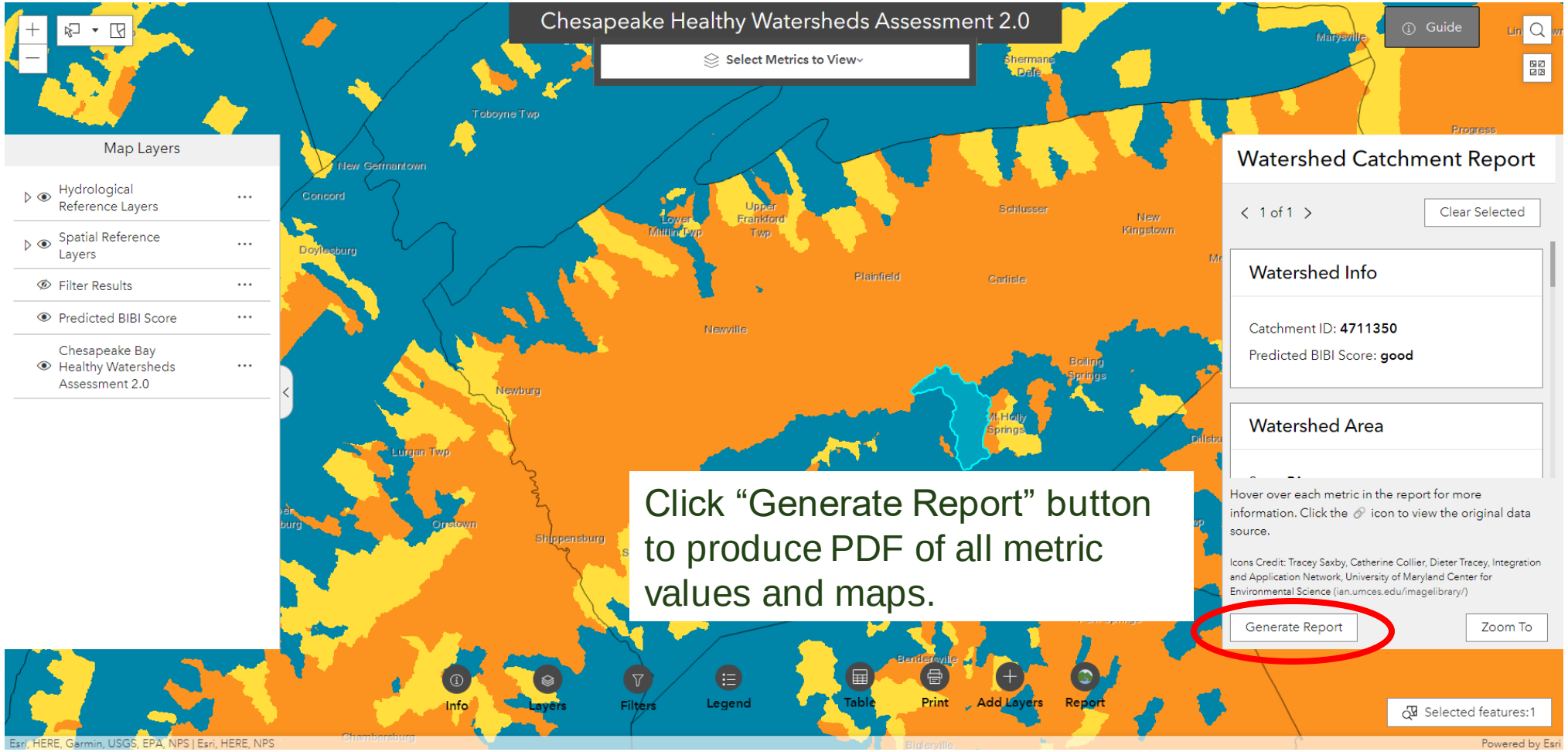


How to: Generate a Watershed Catchment Report

Chesapeake Bay Program

Chesapeake Watershe

Watershed Factsheet for (

8/11/2023

Watershed Vulnera

Land Use Change

Housing Unit Density Change Catchment*	11.98
Housing Unit Density Change Watershed*	4.61
% Non-forested Wetland Conversion to Development 2013-18 Catchment*	0.00%
% Non-forested Wetland Conversion to Development 2013-18 Watershed*	0.00%
% Forest Harvesting 2013-18 Catchment*	0.22%
% Forest Harvesting 2013-18 Watershed*	0.72%
% Change in Impervious Cover 2013-18 Catchment*	0.00%
% Change in Impervious Cover 2013-18 Watershed*	0.00%
% Change in Forested Extent 2013-18 Catchment*	-0.01%
% Change in Forested Extent 2013-18 Watershed*	-0.01%
% Impervious Projected to 2055 Catchment*	0.07%

Climate Change

Probability of Brook Trout (current)*	0.22
Probability of Brook Trout (2-degree Celsius increase)*	0.15
Probability of Brook Trout (4-degree Celsius increase)*	0.09
Probability of Brook Trout (6-degree Celsius increase)*	0.06
Climate Stress Catchment*	0.17

Chesapeake Watersheds Assessment -
Watershed Factsheet for COMID: 4711350
8/11/2023
Page 1 of 3

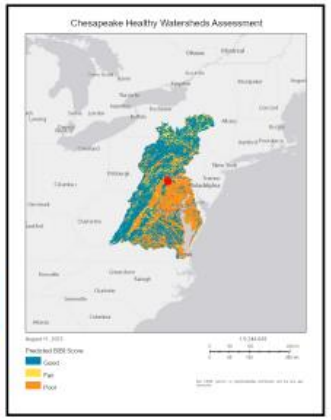
The Chesapeake Bay Program (CBP), through its Maintain Healthy Watersheds Goal Implementation Team, has a goal of maintaining the long-term health of watersheds identified as healthy by its partner jurisdictions.
Maintain Healthy Watersheds Goal Implementation Team

Watershed Info

Catchment ID	4711350
Predicted BIBI Score	good

Watershed Area

State	PA
County	Cumberland, PA
HUC12 Acres	15553
HUC12 Headwater	No
HUC12 ID	020503050502
HUC12 Name	Upper Yellow Breeches Creek



Watershed Info

Predicted BIBI Score	good

Chesapeake Watersheds Assessment -
Watershed Factsheet for COMID: 4711350
8/11/2023
Page 2 of

Watershed Health Metrics

Landscape Condition

% Tree Cover in Riparian 2017/18 Catchment	57.23%
% Tree Cover in Riparian 2017/18 Watershed	76.26%
Housing Unit Density 2020 Catchment (units/sq. km)	32.05
Housing Unit Density 2020 Watershed (units/sq. km)	15.03
Population Density 2020 Catchment (people/sq. km)	80.07
Population Density 2020 Watershed (people/sq. km)	31.94
% Extractive 2017/18 Catchment	2.36%
% Extractive 2017/18 Watershed	0.39%
% Forested Extent Loss to Development 2001-2013 Catchment*	0.01%
% Forested Extent Loss to Development 2001-2013 Watershed*	0.03%
% Impervious Cover 2017/18 Catchment*	4.55%
% Impervious Cover 2017/18 Watershed*	3.17%
% Natural Land in Riparian 2017/18 Catchment*	53.17%
% Natural Land in Riparian 2017/18 Watershed*	75.94%
% Protected Lands Catchment*	18.33%
% Protected Lands Watershed*	44.28%
% Agriculture 2017/18 Catchment*	45.21%
% Agriculture 2017/18 Watershed*	28.66%

Habitat

Nature's Network Connectivity Catchment*	0.08%
Fish Habitat Condition Index (Catchment)	4
Fish Habitat Condition Index Cumulative	3.75
Fish Habitat Condition Index Network (Watershed)	3.75
% Tree Cover with Unmanaged Understory 2017/18 Catchment	32.22%
% Tree Cover with Unmanaged Understory 2017/18 Watershed	58.46%

Hydrology

% Tree Canopy with Managed Understory 2017/18 Catchment*	4.23%
% Tree Canopy with Managed Understory 2017/18 Watershed*	2.02%
% Non-forested Wetlands 2017/18 Catchment*	0.27%
% Non-forested Wetlands 2017/18 Watershed*	0.26%
Road Stream Crossing Density Catchment (km/sq. km)	0.02
Road Stream Crossing Density Watershed (km/sq. km)	0.02
FlowAlteration	1

Geomorphology

Streambed Fine Sediment and Sand Cover Catchment	10
Streambed Particle Size D50 Catchment	7.30
Streambank Sediment Flux Catchment (kg-sed m-1 yr-1)	<0.01
Streambank Lateral Erosion Catchment	<0.01
Streambank Fine Sediment Flux Catchment (kg-finesed m-1 yr-1)	<0.01
Streambank Erosional Change Catchment	<0.01
Road Density Catchment (km/sq. km)	3.78
Road Density Riparian Catchment (km/sq. km)	4.27
Road Density Watershed (km/sq. km)	2.53

Water Quality

% Impaired Stream Catchment*	0.00%
Incremental suspended-sediment load from streambank erosion (lbs/acre/yr)*	222.03
Incremental total nitrogen load from manure applications (kg/yr)*	5977.24
Incremental total nitrogen load from fertilizer applications (kg/yr)*	5688.20
Incremental total nitrogen load from septic system effluent (kg/yr)*	1487.52
Incremental total nitrogen load from wastewater treatment facility point sources (kg/yr)*	0
Incremental total phosphorus load from manure applications (kg/yr)*	322.19

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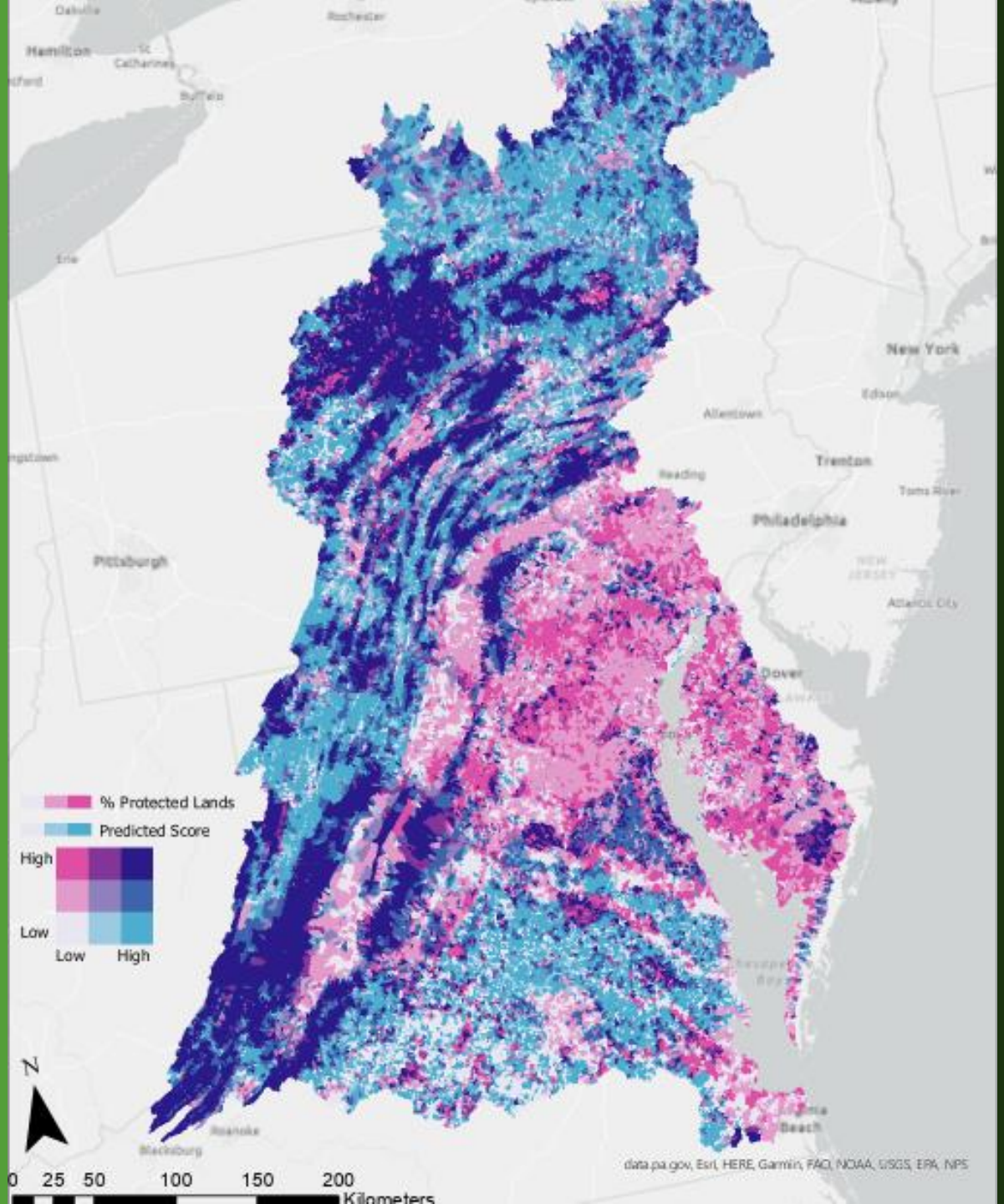

How to: Answer Science Questions using CHWA 2.0 Bivariate Maps

How protected are resilient lands?

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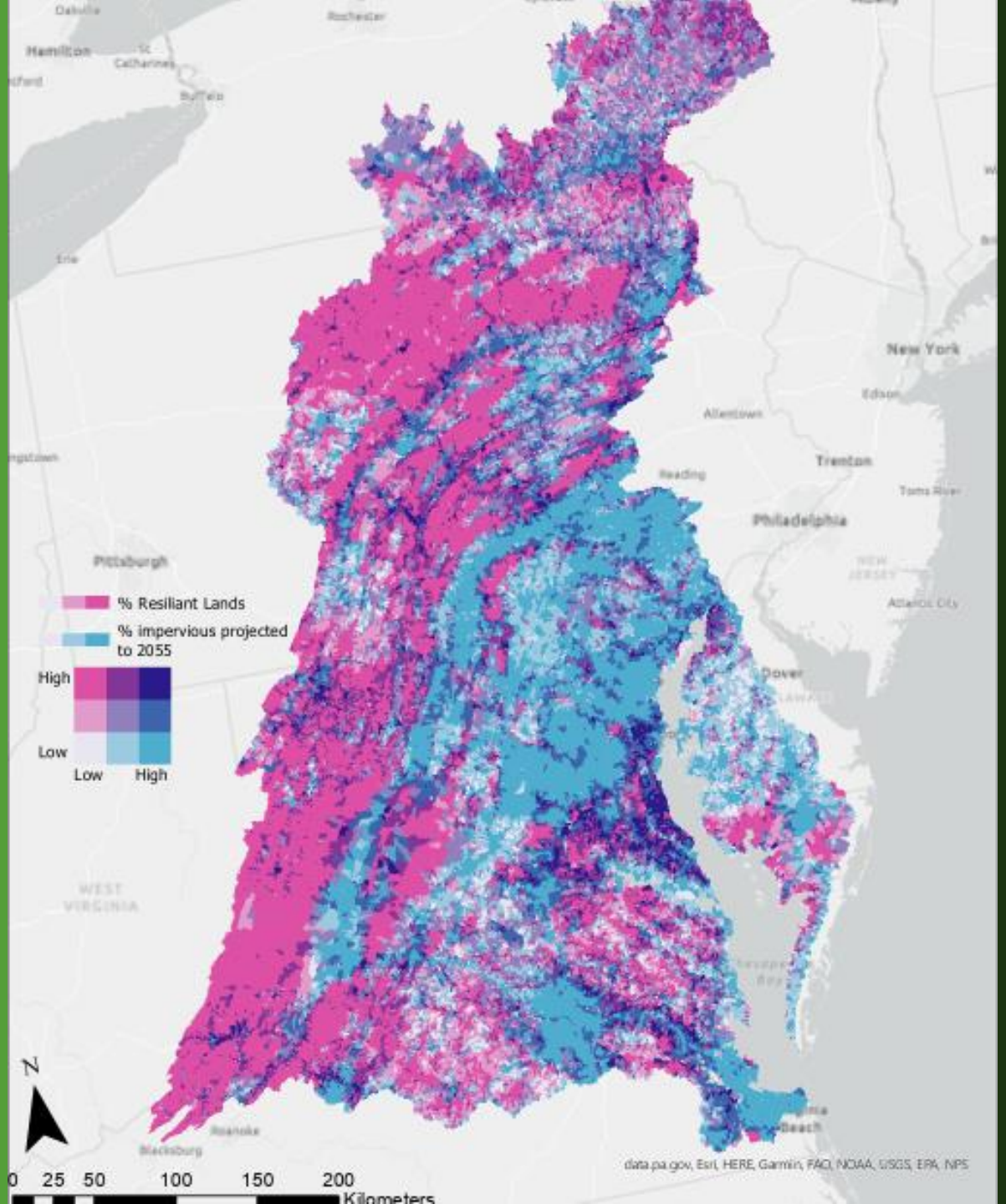
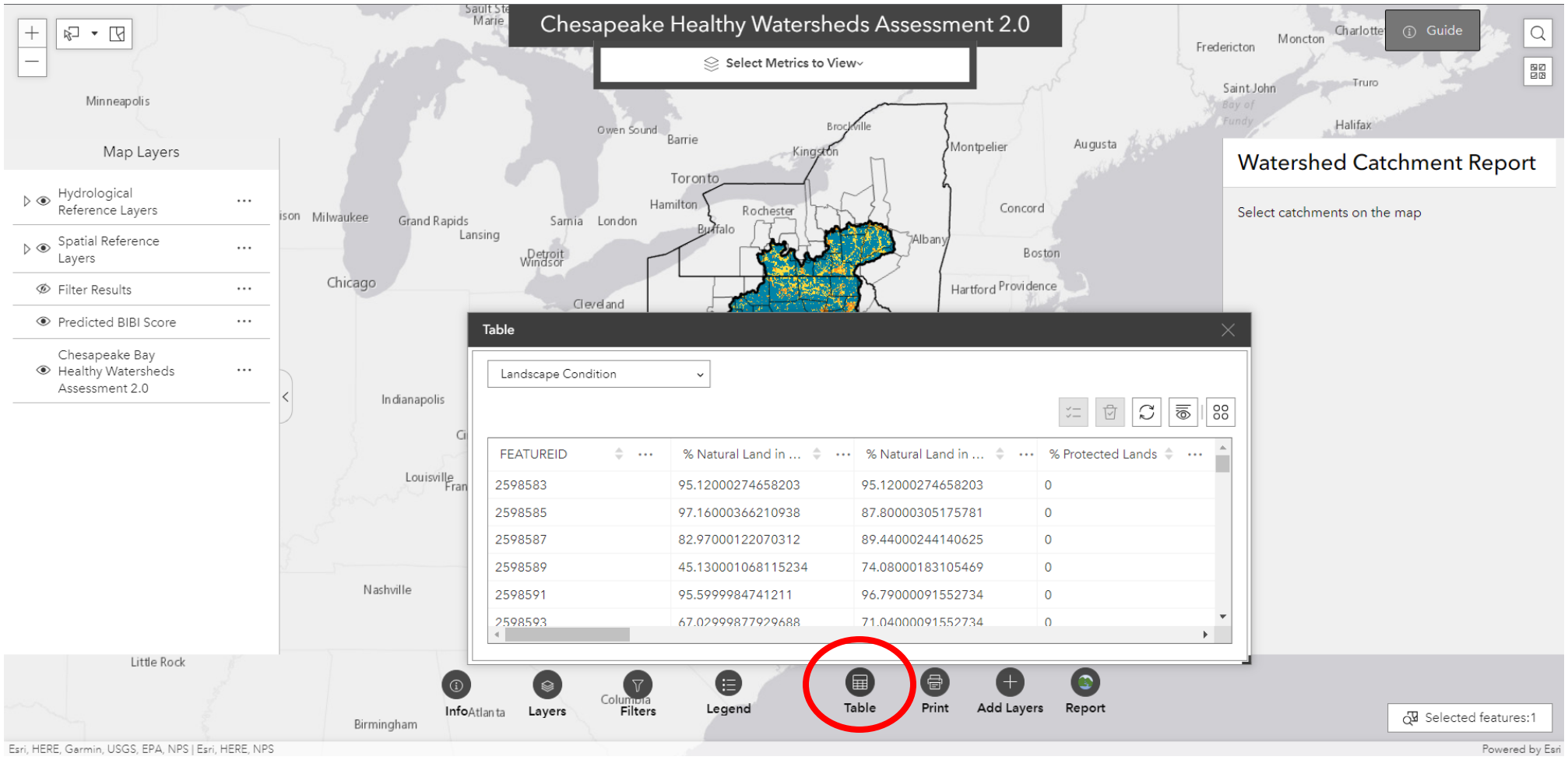


How to: Answer Science Questions using CHWA 2.0 Bivariate Maps

Where are resilient lands vulnerable to future development?

How to: Access Table of Metrics



Click “Table” button to open a tabular version of the data.

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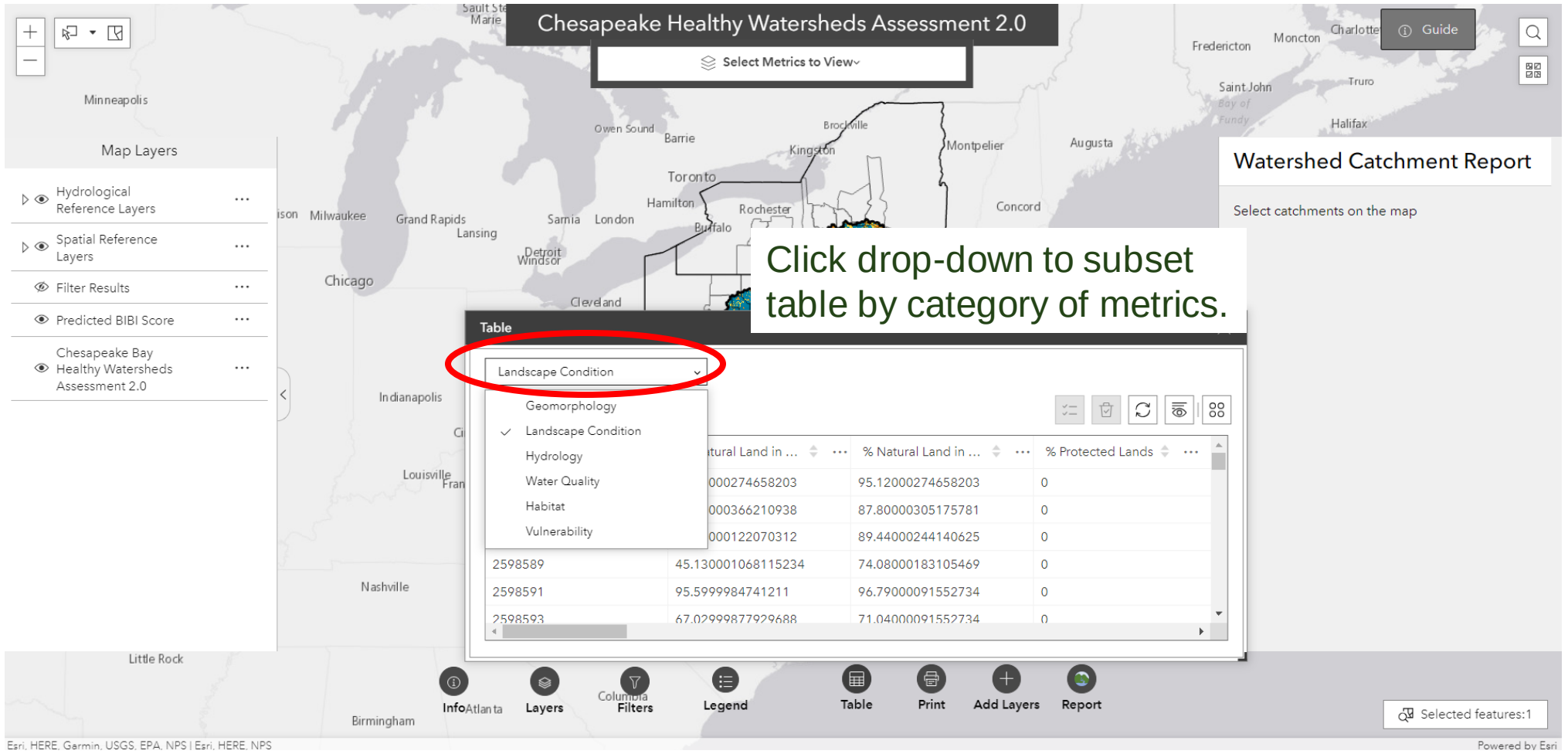

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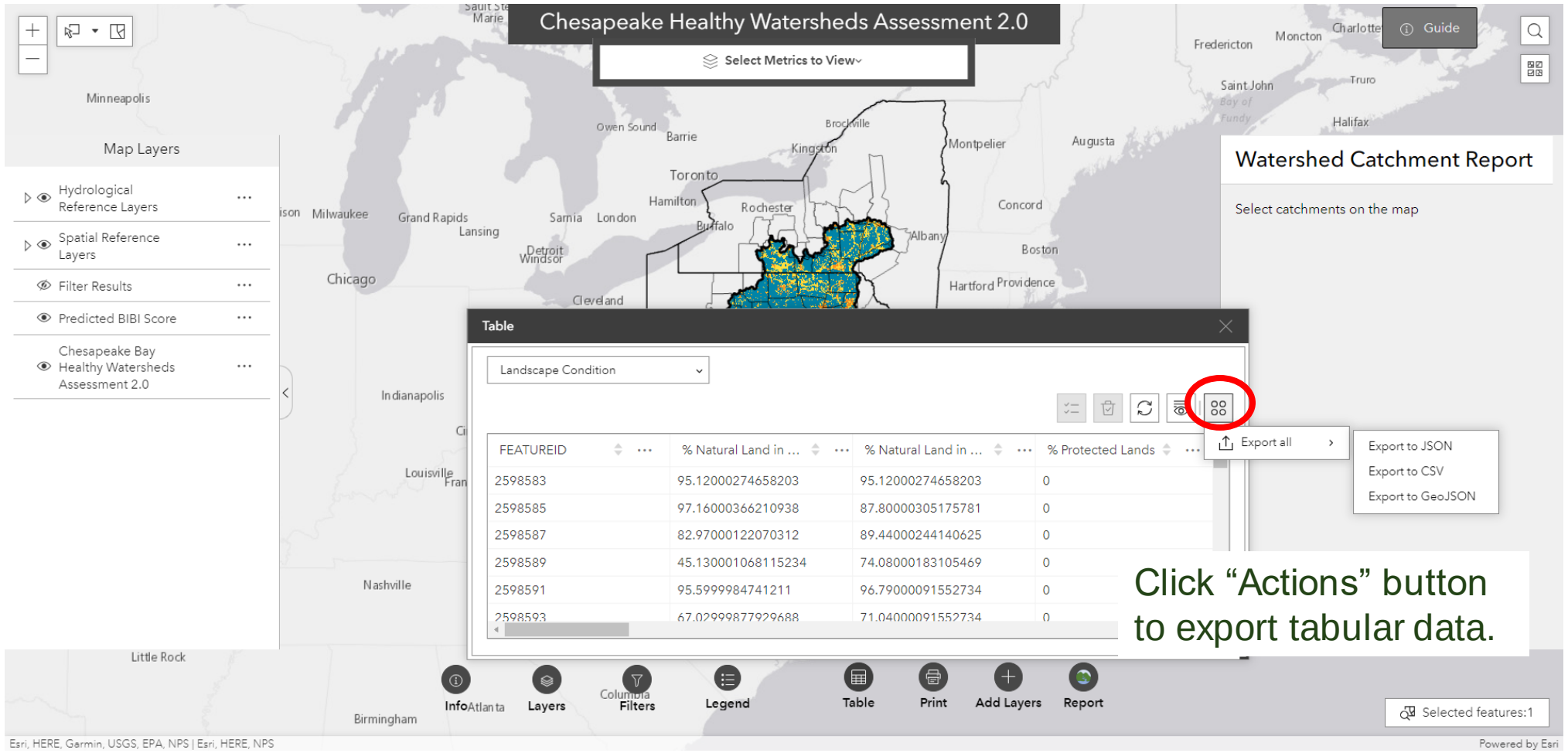
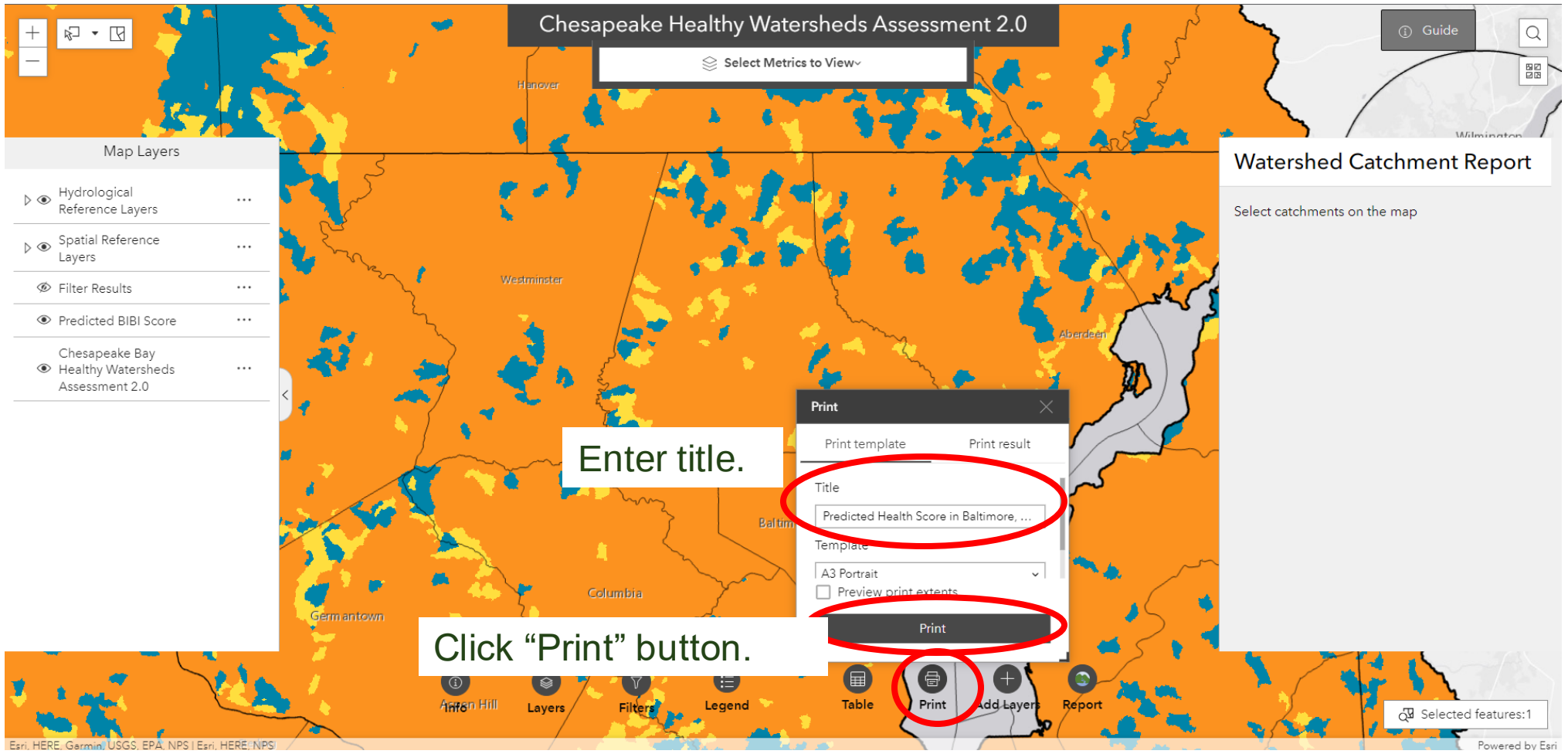


How to: Print Maps



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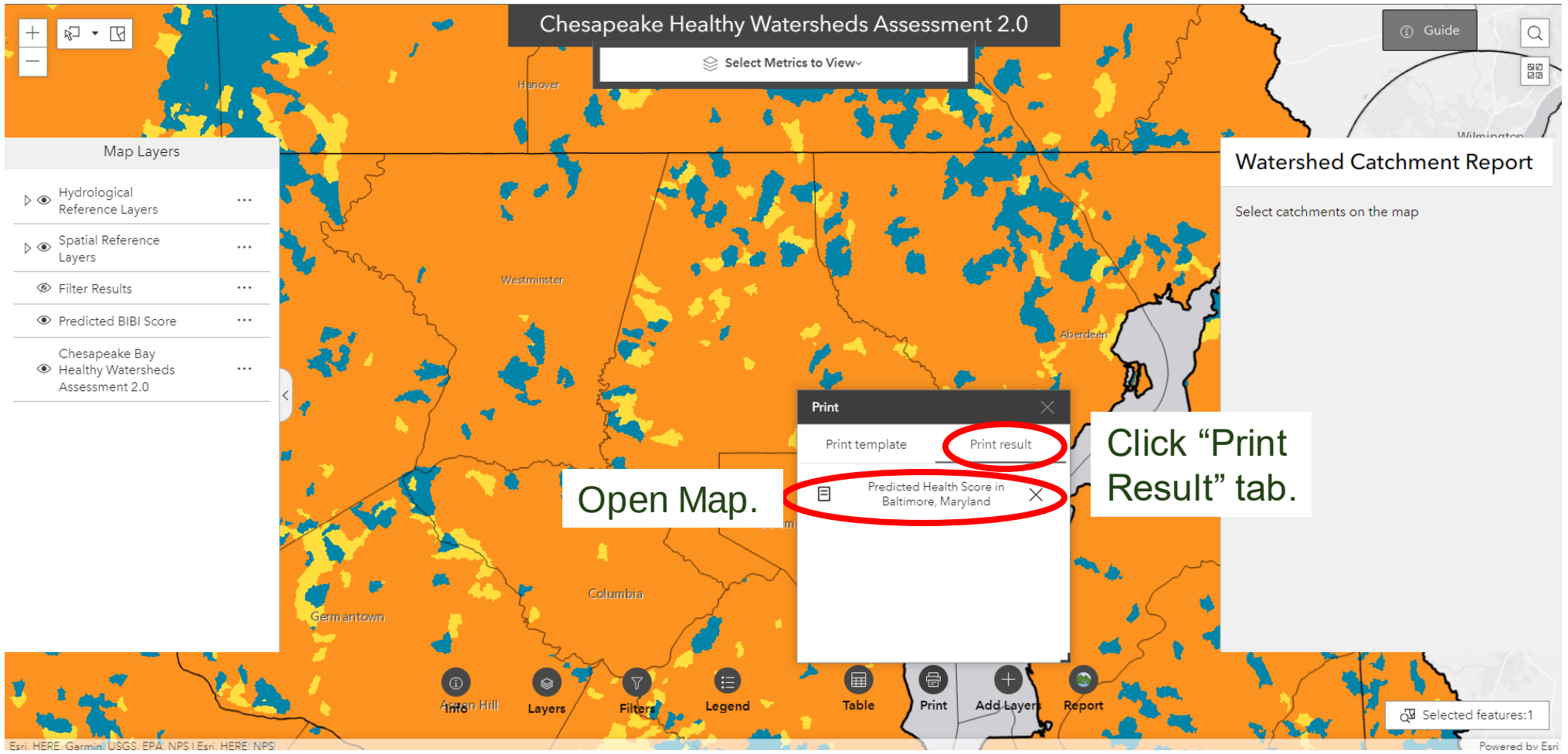

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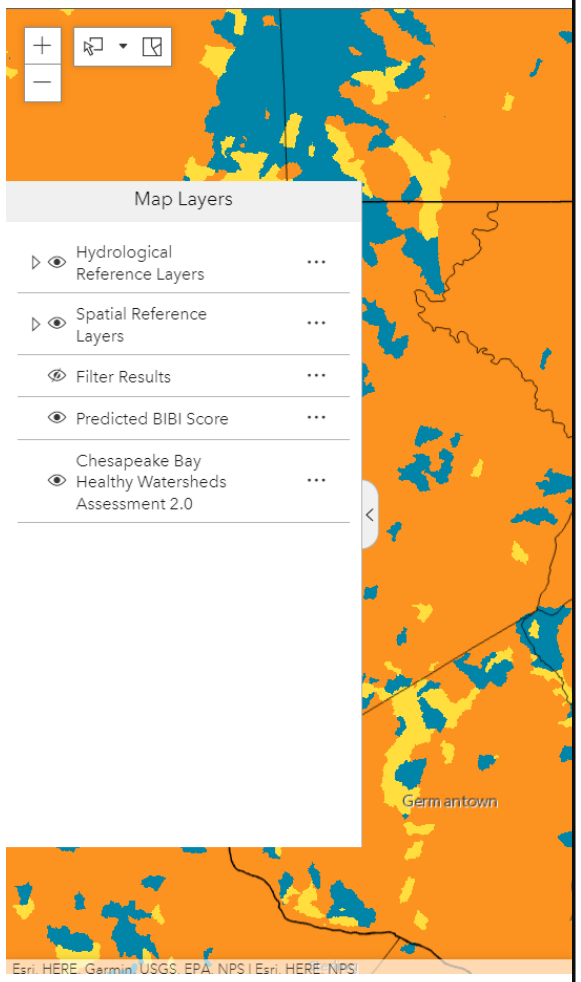
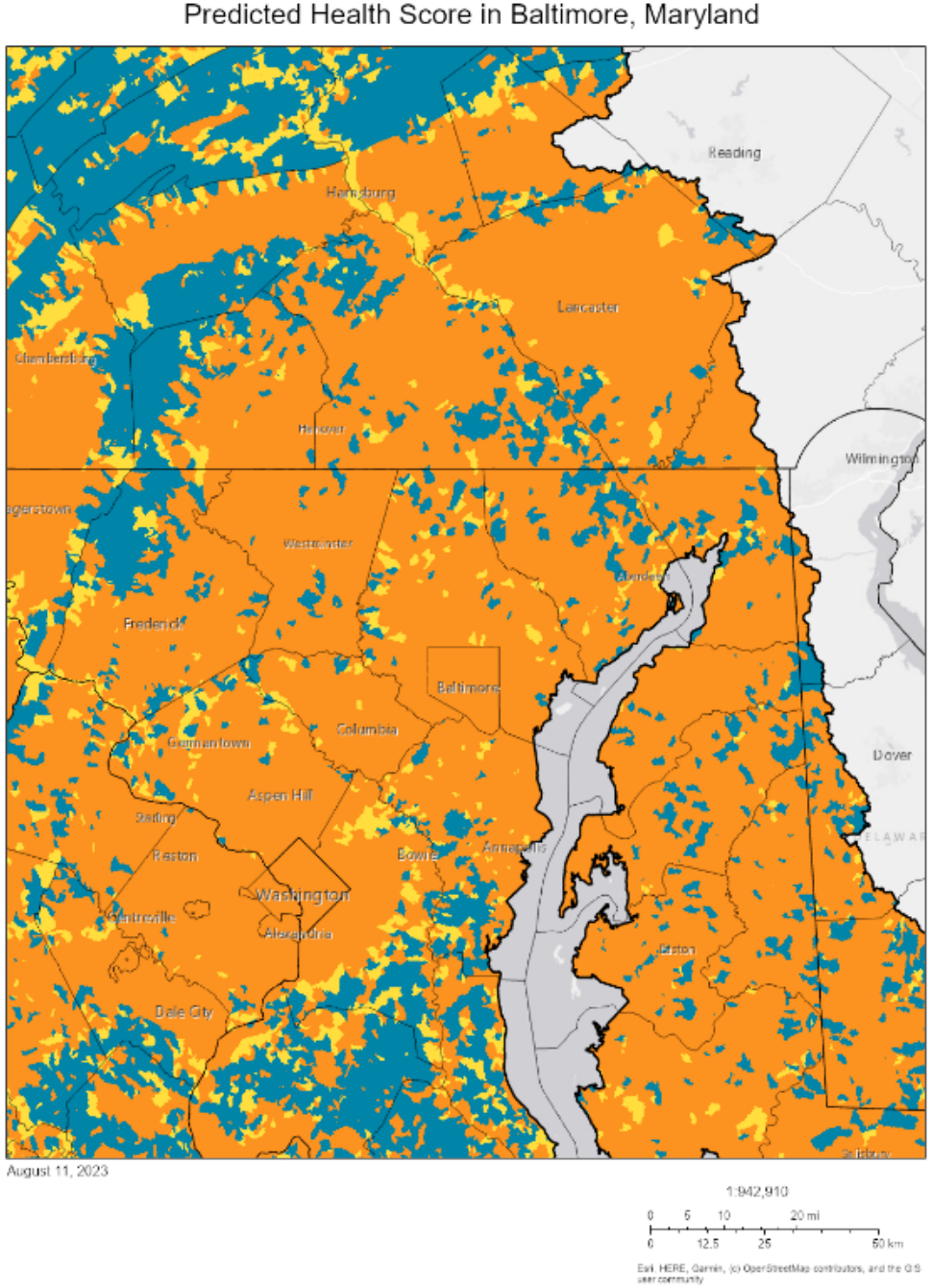
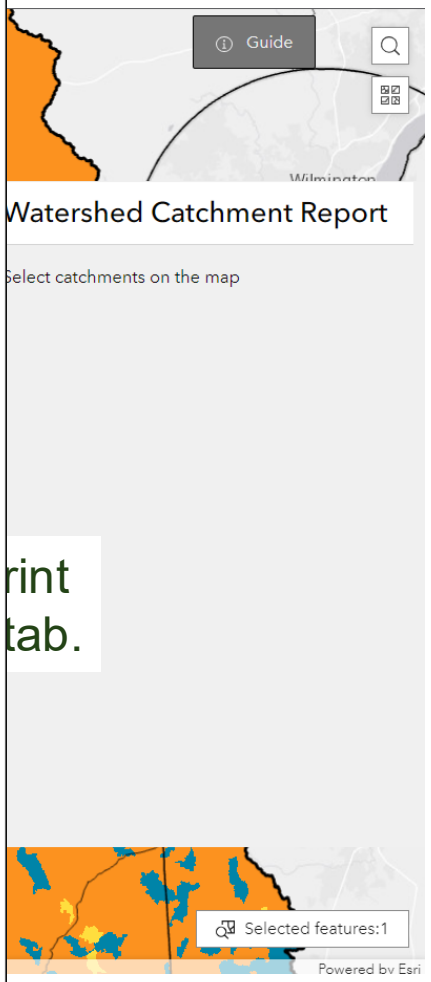
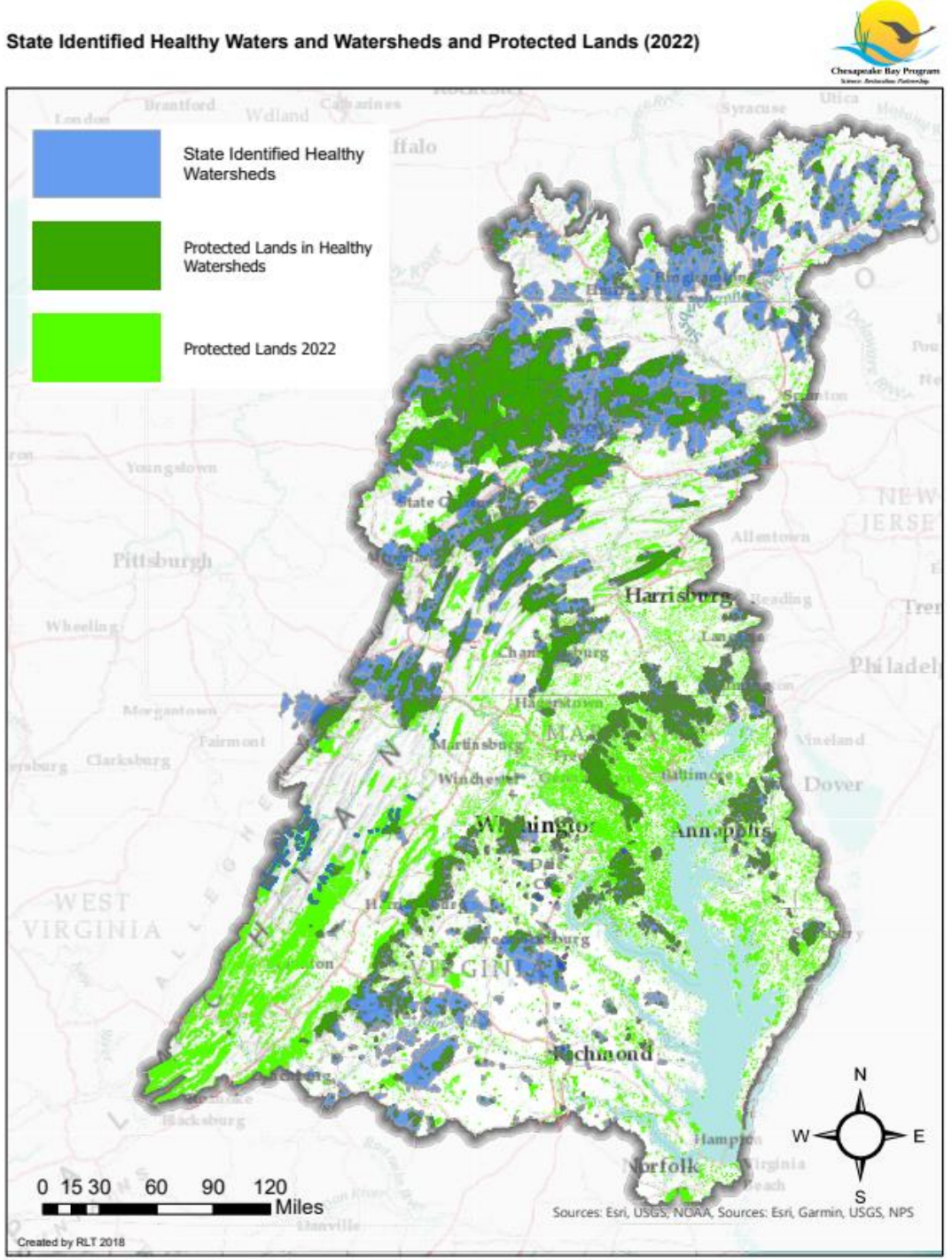






Next Steps

- FY' 23: Release visualization tool and report.
- FY' 23: Incorporate new metrics, including conductivity, "effective"/connected impervious cover.
- FY '24: Author journal article to better understand:
  - Which metrics are most important in predicting watershed health.
  - the difference in local catchment versus upstream watershed conditions in predicting watershed health.
- FY '24: Incorporate feedback on improvements on the visualization tool.



Contact

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