Implementation Recommendations for Phase 1 of the FY22 CIROH[1] study: "Analysis and Demonstration of the National Water Models Applicability to Resilience Planning"

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Objective: To inspire and guide communities across the United States to embrace the National Water Model to guide resilience planning in the face of water-related hazards exacerbated by climate change.

Challenge:

Local, state, and federal officials are increasingly embracing the need for resilience planning to better predict, mitigate, and adapt to shocks and hazards associated with extreme weather fueled by climate change. However, few of them are leveraging the National Water Model (NWM) to guide their decisions on how best to mitigate the risks associated with flooding and other water-based natural disasters as they continue to grow in severity, frequency, and intensity.

Study:

In 2022 and 2023, resilience planning stakeholders were engaged from Burlington, VT; Cincinnati, OH; Portland, OR; Charlotte, NC; Boulder, CO; and Minneapolis; MN to better understand 1) how resilience planning operates in practice, 2) if and how the NWM could be applied to this work, and 3) how the National Water Center and NOAA could facilitate this use. The engagement with each community included a complementary a set of interviews with NOAA/NWC staff, and concluded with a collaborative session where the community stakeholders and NOAA/NWC staff a co-generated set of recommendations for how the NWM could be used in resilience planning and how the National Water Center (NWC) could help facilitate this use. The project demonstrated that community engagement can play an invaluable role in improving climate services such as the NWM by allowing end-users to directly engage with a tool and offer feedback to improve its accessibility.

Study Key Findings:

1. **The NWM can play an important role in community resilience planning.**
   While 65% of resilience planning stakeholders interviewed had never heard of the NWM, once they had, they recognized its potential for supporting their community resilience planning.
2. **The NWM can support both near-term and long-term aspects of resilience planning.**
   During the interviews with stakeholders, it was found that a focus on resilience was being incorporated into a variety of plans created to define, prioritize, and seek funding for projects/actions that will help the communities plan for their response to disasters in the near-term and to guide effort achieving their long-term resilience goals.
3. **It is critical to acknowledge the diverse backgrounds of the professionals who are involved in resilience planning at the community level.**
   While the team expected to engage with floodplain managers and emergency managers, they found an additional cohort of stakeholders who self-identified as being involved in resilience planning to include dam safety operators, water quality specialists, academics, and watershed planners. Additionally, all these stakeholders held a broad range of areas of expertise and only 31% reported having experience running hydrologic models themselves. Most of the resilience stakeholders were users of water data, but they themselves were not hydrologists or water scientists.

Recommendations for Implementation:

The key output from this study was a set of recommendations that can help NOAA improve the service delivery of the NWM to reach a wide range of new stakeholders engaged in resilience planning. These recommendations fall into four categories which are detailed in four tables:

1. **Potential Future Use Cases (Table 1):**
   Recommendations for how communities can use the NWM in their resilience-related planning efforts.
2. **Building Awareness of the NWM (Table 2):**
   Recommendations from the communities on how NOAA can increase awareness of the NWM as a tool for resilience planning.
3. **Enhancing Accessibility of the NWM (Table 3):**
   Recommendations for how the NWC can make the NWM more accessible to a wider group of stakeholders, many of whom are not hydrologists.
4. **Requested NWM Capabilities (Table 4):**
   Recommendations for additional features or capabilities to guide future enhancements to the NWM that communities identified as being potentially helpful in supporting their resilience planning efforts.

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Table 1: Potential Future Use Cases

This table summarizes the major use case categories identified through discussions with stakeholders and NOAA. Although some of these use cases may lie outside the original intended scope of the National Water Model, they reflect instances where the NWM meets a data need identified by potential users, and indicate possible uses and features of the NWM that may not have been considered during development.

NWM Use Cases	Component Strategies	Suggested Enhancements
1. NWM use as a convening and community education tool.	Community education	As a hydrologic and visualization tool to: • Provide a more data-driven, day-to-day understanding of how water sources impact the community; • Educate community on relative flooding risk; • Diminish the effect of "flood amnesia."
	Youth/student Education	Education tool to guide discussion of what resilience planning is, what steps it requires, and how every community member can participate and contribute: • Provide NWM materials based on grade-appropriate standards that build student familiarity with water cycles and riverine systems; • Develop interactive exercises for high schoolers illustrating: seasonal water cycles, flow rates, and river height.
	Climate education	• Facilitate a climate conversation at national scale using the NWMs ability to show change at broader scales and help visualize risk
2. NWM use for emergency management related decisions.	Forecast timing of impending flooding	• Build "locally-calibrated" EM decision tree based on NWM river forecasts (particularly for slow moving, rainfall events); • Inform when municipalities should run pump stations to prevent flooding; • Use to help predict large scale events and needed decision-making for longer lead-time events such as tropical storms and hurricanes; • Assist local hydrologists in optimum time for monitoring and deployment
	Increase "what if" and "where" capacity to help with evacuation and positioning of response resources	• Use to assess risk/who will be most at risk, under varying rainfall and flow conditions, ahead of emergency situations; • By integrating the volume of water upstream and routing downstream, NWM can help predict where water will be to improve evac. decisions; • Assess flood risk and water quality concerns in post-fire areas;
	Help public and private decision-makers understand structure and infrastructure risks	• Road operations during flooding: NWM can help determine opportunities for water detention to protect roads and emergency vehicles in event of road overtopping; • Protection of pump and treatment stations: The NWM can help with decisions to barricade pump stations and wastewater treatment center vulnerable to river location or lower elevations; • Structure risk: Combine NWM with structure information and assess building vulnerability to flood events; • Dam operations: Use the NWM as part of the information to determine release increases or decreases needed for flood management; • Catchments most at risk (particularly those with recent flood or fire debris): The NWM could be used to determine problem areas and where to deploy crews; • Use the NWM to advise on the best areas of investment in future purchases of green space and buffer zones
3. NWM to help communities understand historical data and information, thereby improving understanding of current climate changes and evolving flood risk over time.	Reconstruct historical records or flow conditions to better understand present likelihoods and future possibilities.	• Better understand how present conditions compare to the historical picture, for use in guiding development in high-risk areas, to calibrate confidence in the NWM, or to make adjustments in decision thresholds; • Have historical record as an overlay with specific storms available for different types of planning, including identification of hot spots or areas with extreme impacts, outlier events, hardest hits.
	Calibrate NWM to help better understand local scale events	• Use multi-decade historical datasets to better refine local scale and enable better prediction of future trends (better support community adaptation to changing climate); • Develop proxies for local models by looking at patterns of historic storms and the bigger picture of rivers.

Table 1 Continued...

NWM Use Cases	Component Strategies	Suggested Enhancements
4. NWM use for large basin/regional planning.	Support understanding of local impacts of water decision making across large watersheds	• Help assess and quantify how decisions around headwater communities (e.g., Boulder CO) affect water flow in downstream communities; • Use visualizations and mapping to better support large basin planning by water and community decision makers (e.g., Willamette River basin serving ¼ to 1/3 of Oregon); • Provide guidance on where to target mitigation and planning decisions by projecting and mapping vulnerabilities at a broad scale;
	Help build better understanding of national watershed management and services	• Provide a comparative view across nation, including watersheds in different states and how interstate water systems interact; • Provide understanding of how water and flood management services could be delivered on national scale.
5. NWM capacity for scenario planning.	Support land use planning and local development codes	• Use flood inundation modeling to inform decisions regarding community development or community relocation; • Use future trend capability to identify flood prone areas to consider for restoration and local investment; • Use predictive modeling to inform flood-related community regulations, codes, and ordinances: e.g., flood-protective setback minimums • Combine NWM retrospective data such as soil moisture (available as NetCDF files), local condition proxy data, and GIS spatial reference data to support communities' ability to anticipate landslides.
	Prioritization of water management and resilience-building solutions	• Use capacity to predict future trends for siting of critical community infrastructure (e.g., pump stations, treatment plants, housing, etc.) or how flooding will impact a business; • Leverage NWC's GIS visualization service to provide visualizations around any forecast point (gauge) at minor-, moderate-, and major-flooding.
	Climate adaptation and migration choices	• Help communities have information supporting climate migration plans, identifying future areas to which people might expect to move; • Couple NWM with General Circulation Model to inform 50-100 years planning horizon for climate change impacts
6. NWM to provide information where no maps or information exist.	• Rural communities and areas with less effective mapping and few resources (for expensive consultants, H&H modeling, or constructing local models) could benefit from NWM, particularly if "ground truthed" to local or regional models • Communities that are hydrologically blind on ungauged streams/creeks could benefit from the information available through NWM	
7. NWM use as an additional data point to validate or provide additional information.	• Use the NWM in coordination with multiple scales of models to validate, calibrate, and cross-check existing local model outputs; • Use in combination with other tools in vulnerability assessments, risk assessments, prioritization, and potentially implementation action design to strengthen decision-making	

Table 2: Building Awareness of the NWM

This table includes actions and strategies which could increase user uptake of and engagement with the National Water Model, as identified through discussions with community stakeholders. Potential users and groups have been selected from suggestions made by stakeholders, and component strategies are synthesized from observations and concerns raised by participants during the collaborative engagement process.

Primary Recommendations	Component Strategies	Suggested Enhancements
1. Increase NOAA outreach to build initial awareness.	Component Strategies	• Integrate the NWM into existing community outreach for Weather-Ready Nation/Climate-Ready Nation Initiatives • Prioritize face-to-face interactions, such as NWC staff participation in conferences and offering training to state and local stakeholders. • Link with the National Weather Service (NWS) Zoom calls held ahead of storms • Distribute online courses/handouts on the NWM around the timing of flooding. For example, the NWC should incorporate the NWM into the messaging and forecasts from NWS. The NWS makes their advisories digestible for flood warnings and watches, so if you tuck in NWM for someone who is interested in stormwater, they could learn more about it and access it when needed. • Launch an awareness campaign targeting small communities and consultants
	Potential Users and Groups	• Association of State Floodplain Managers • Planning consultants
2. Build state and regional partnerships to increase practical community/ watershed utilization.	Component Strategies	• NWM geospatial services could be mapped into existing community efforts, such as the VT Functioning Floodplain Initiative (FFI). • Vermont Emergency Management holds virtual weather/pre-event briefings when a big storm is predicted and they provide daily 1-page briefings - the NWM could be included in these. Use NWM in regular and pre-event weather briefings for state and local emergency managers
	Potential Users and Groups	• Minnesota Emergency Preparedness Committee (MN EPC) • Northern New England Chapter of the APA (NECAPA) • Ohio River Basin Alliance (ORBA); Ohio River Valley Water Sanitation Commission (ORSANCO); The Kentucky Association of Mitigation Managers (KAMM); Ohio Floodplain Management Association (OFMA) • Vermont Department of Environmental Conservation River Management Program • Colorado's Water Availability Task Force
3. Grow water-related and community facing partnerships to expand horizontally and deepen vertically.	Component Strategies	• The NWC should identify and support local champions–trusted individuals who understand local context, and can help others apply the NWM locally. • Leverage peer learning and cultivate a trust-based network of NWM users. Communities are willing to listen to their neighbors, and if one community is "out in front" using the NWM, others may join. • Work with regional authorities to inform and support planning with NWM • Leverage existing networks through roll out by FEMA, USGS, APA • Develop future flood risk understanding by partnering with communities to address water issues in K-12 education.
	Potential Users and Groups	• Emergency Management Centers or Emergency Operations Centers (EOCs) • Regional authorities, including conservancy districts, sewer districts, and interstate commissions
4. Invest in future use and innovation by building ties with higher education research and scholarship.	Component Strategies	• Do a "roadshow" to state Sea Grant and local university programs. • Target regional conferences, as they are big enough to attract a large audience but small enough that the message will not get lost in the crowd • Tag the NWM to a funding source. e.g., the NOAA Coastal Resilience Grants (just list it, not require it).
	Users and Groups	• American Institute of Hydrology (AIH) • The Society of Freshwater Science • Lake Champlain Sea Grant, UVM EPSCoR
5. Invest in professional development of water and community professions.	Users and Groups	• International Association of Emergency Managers annual conference, • National Emergency Management Association • Planning Information Exchange Webinars between ASFPM and APA • Urban Sustainability Directors Network • Army Corps of Engineers SilverJackets

Table 3: Enhancing Accessibility of the NWM

This table summarizes the ways in which the National Water Model can be made more accessible for a broad range of users. Recommendations have been synthesized from points raised in collaborative sessions.

Primary Recommendations	Component Strategies	Suggested Enhancements

1. Adapt NWM support materials for broad understanding and reach, particularly for critical community users from non water-focused planning and management backgrounds.	Revise for user-friendly, non-expert readability.	• Review and revise NWM use and interpretation materials for understanding and use by non-experts, non-hydrologists, non-scientists who lack advanced technical training.
		• Provide a clear description of the limitations of using the NWM:
		  ○ What the model can and can't do;
		  ○ Its ease of use for those without knowledge of expert jargon of the types of data/parameters used in the model.
		• Build outreach and community education materials around relatable lenses, e.g.:
		  ○ Remember when that road was washed away?
		  ○ Remember when you could not find a swimming hole because it was polluted, etc.?
		• Develop a DEI group to review NWM tool for how it works for different abilities (e.g., colorblind, or visually impaired stakeholders).
		• Be aware of challenges of the term "resilience," a term with broad temporal and physical applications that may be poorly understood by non-expert audiences, leading to difficulties in valuation and interpretation of output scenarios or projects/plans under consideration.

	Revise NWM language for community user roles.	• Write for use by *critical* community roles: emergency management, resilience planning, climate experts, sustainability experts, floodplain managers, national dam safety officers.
		  ○ communicate in "planning language;"
		  ○ provide examples of capabilities and value of NWM for planning;
		  ○ Use NOAA "Climate at a Glance" service as an example.
		• Write for communities with *small organizations and limited funding or capacity* who may lack personnel with technical expertise or have staff/ volunteers filling roles outside their primary professional or educational domains.

	Increase use of Case Studies to improve use of NWM AND enrich its usefulness.	• Create publicly-distributed case studies of community applications of NWM that demonstrate features and utility.
		• Provide examples of how to use the NWM at different scales, for examples:
		  ○ a multi-scale analysis to overcome the relevance that's lost at dif. Scales;
		  ○ examples of how to use the NWM both in big cities and in areas that are more rural, and
		  ○ advanced user capabilities vs. newer users.
		• Provide information on contexts in which the NWM is NOT helpful, including examples of how it should not be used or what it does not do.
		• Increase impact by describing step by step how the NWM was used and why it was used in community resilience-related planning, including:
		  ○ what scale it is suited for (e.g., is it good for a comprehensive plan update for a major city? Disaster or natural hazard planning at a county scale?).
		  ○ how to move from the NWM to a local scale with examples of the kinds of decisions that can be made and the kinds of resources available, etc.

	Develop usage guidance and helps to address levels of user expertise.	• Prepare guidance and user aids for different educational levels, including K-12 and non-technical, higher education: ○ Consider the interface in the context of the intended audience/user of the NWM: making the NWM is too "plug and play," could result in people being just knowledgeable enough to be dangerous. • Provide user manual like HEC-RAS with ample documentation to support implementation and help users understand constraints. • Build out guidance for how the NWM can be used by local communities to interact with different scenarios (e.g., blue sky vs. storm days). • Provide additional guidance and resources for the spectrum of less advanced users, not just the output files for advanced users.

2. Help professional and community users better understand NWM tools in comparison with others.	Provide easy to understand differentiation and comparison with other flood-related tools.	• Make it clear how the NWM relates to other models, reducing confusion about what to use and why.
		• Provide information on how other tools relate, how they are different, where each has authority, why each was developed, and what they are useful for (particularly, FEMA FIRM or the Natural Resource Conservation Services).
		  ○ Explain how NWM raw data are the same or different raw than other models.
		  ○ What distinguishes NWM from FEMA FIRM, Natural Resource Conservation Services and other models?
		  ○ Where appropriate, show where other models/tools come to the same conclusions (there is "value in the choir," lending more weight to conclusions and demonstrating science in action).

	Act as inter-agency repository for water/flood related tools.	• Work with other federal agencies for NWC to act as a "a library of tools," serving as repository of flood-related information (currently, no easy storefront for all flood-resilience planning info and data managed by multiple, changing, federal websites). • Pair the NWM with other up-to-date federal resources, such as LIDAR, bathymetry maps, or water quality points. ○ Provide capability for stakeholders to download data for specific areas (e.g., the Willamette River Basin) at once. • While community stakeholders understand agencies needing to stay in "correct lane," more interagency coordination is needed.

Table 3 Continued...

Primary Recommendations	Component Strategies	Suggested Enhancements

3. Develop training / education to increase new users and empower existing ones.	Provide free training and educational opportunities for communities to learn about the NWM.	• Training should include:
		  ○ Manuals for advanced and newer users that provide guidance on how to interpret and use the NWM;
		  ○ Case studies and examples to help communities relate model capabilities to their circumstances;
		  ○ Appropriate questions to ask the model;
		  ○ Helps for use of NWM in local resilience planning (such as, describing the kind of data communities need to have or acquire in order to make it more useful at a localized scale)
		  ○ Online webinars, videos, podcasts or other short tutorials which could be viewed at the desk, while eating lunch, etc.

	Partner with existing state or federal programs in order to gain and train new users.	• Provide funding for targeted training of employees/volunteers of existing water quality, water resources, flooding, or river management/ stewardship programs as critical users. • Use NWM demonstrations to reach out to local officials, showing how NWM could be valuable to local decision makers and making important community information accessible to them.

4. Build end user appetite for and trust in NWM usefulness.	Cultivate involvement of community focused users to naturally build awareness; access critical end users; increase likelihood of use, usefulness, and "buy in," and reduce communities' tendency to default to what they comfortably know.	• Incorporate, inform, and involve community resilience stakeholders AND representatives of sovereign, tribal nations as critical end-users into the development process of the NWM from beginning of development through deployment:
		  ○ Account for communication styles and accommodate cultural participation.
		• Focus on building trust with communities by:
		  ○ providing financial support to hold demonstrations with the state, reducing skepticism of the NWM and increasing adoption by regional and state stakeholders;
		  ○ developing program champions that local communities already trust (for instance, at the state level where they are used to looking for technical capability).

	Create an end user committee to participate in and assist with development of NWM.	• Forming a review/advisory group of critical community users to review and provide input to usage issues as well as input to creation of guidance and support materials. • Leverage partnerships with members of the emergency management, resilience planning, flood managers, etc. organizations to develop frameworks for training that fit into existing fields of practice.
5. Use more visualizations to help the NWM be more accessible and valuable to community users.	Provide additional support materials for existing visuals.	• Construct visuals around things community members can relate to in their daily roles. • Include plain language text descriptions of what visualizations mean. • Explain accuracy of flood depth maps or compare NWM flood maps to FIRM • Provide visuals to support recommended education, outreach, and engagement activities.
	Add data layers/features to increase NWM effectiveness.	• Map future/projected severe rainstorm impacts and how this would affect stormwater/wastewater systems. • Map what past events would have looked like with increased precipitation and how this would affect stormwater/wastewater systems. • Provide maps that incorporate fluvial erosion. • Develop visualizations of street level impacts instead of only bird's eye view • Develop visualizations that show how changes, such as water withdrawal or removal of a dam, affect water up- and down-stream. • Provide layering tools that allow viewers to see multiple characteristics at once (similar to those around Geohazards for landslides, erosion, and flooding, helping communities ID dangerous areas).
	Support increased effectiveness and accessibility of FIM with additional visualizations.	• Build capability to animate maps like a radar loop. • Provide a simple online map viewer and GIS map service. • Build in ability to color code maps by flood stage or relative to flood stage. • Develop scenario display capability, such as "storm of record" or combining depth and aerial extent of flooding. • Develop capability to display an "ensemble mean," with a fuzzy band graphic to communicate uncertainty.
	Integrate GIS capabilities within model.	• Provide GIS layers similar to FEMA with similar boundaries (e.g., 100-year floodplain) to help organizations show stakeholders how NWM works. • Provide shape files and GIS layers so stakeholders can put NWM visualizations into community maps. • Ensure GIS compatibility so NWM visualizations can be overlain with natural systems boundaries to estimate ecosystem services impacts (e.g., wetlands or forests). • Bring data from groups/agencies into one place so stakeholders can add and subtract relevant layers.

Table 4: Requested NWM Capabilities

This table summarizes additional functionalities that communities would like to see added to or supported by the National Water Model. Some of these requested features may be outside the scope or capacity of the National Water Model project, but they reflect communities' evaluations of their water-related concerns and technical needs. Although overlapping and duplicate suggestions have been synthesized for brevity, they reflect the diverse needs and functionalities that communities have been unable to fill.

Primary Recommendations	Component Strategies	Suggested Enhancements
1. Improve availability and accessibility of data.	Better data availability	• Provide an annual or multi-year summary of conditions, including historic river levels, at a specific stream reach, which could be used in the identification of hot spots. Could partner with AWS and other cloud services to provide raw data in an outward facing archive. • Develop a library of maps of past inundation boundaries and corresponding rainfall data. This would allow communities to look at past thresholds to see where inundation boundaries might be and it would allow them to make decisions ahead of time. ○ It would be helpful if communities could query areas where no FEMA maps exist. • Create an interface that allows users to easily download data, such as an API to make calls to stations. • Facilitate data sharing, as in the University of Texas DesignSafe Data Depot • Curate better historical flood information/mapping (e.g., select specific events and provide retrospective run data) and provide updated riverine and flood melds for all waterways.

	Support accessibility for a variety of end users	• Collaborate with local universities to develop municipality-specific GIS tools that summarize live forecast conditions across that municipality.
		• Account for communities without reliable internet connection in the design of the NWM, and allow some features of the NWM to be available to those with low bandwidth.
		• Allow communities to sign up for alerts for specific areas on a map (alerts for high flow exceedance, etc.) which could be embedded within town websites..
		• Ensure that the NWM is equitably accessible to a variety of end-users.
		  ○ Anticipate challenges with capacity, technical expertise, accessibility, and training.
		  ○ Include users other than hydrologists who apply climate data, such as social scientists.
		• Offer a help desk/help line, including support for communities that lack access to an experienced modeler, and to explain the strengths and limitations of the model.
		• Host "open office" events for communities to visit and engage

	Information on accuracy and appropriate use	• Offer guidance on how to communicate the accuracy of the NWM and its results to decision makers • Ground-truth to ensure accuracy and defensibility. There should be no divergence between the short and long-term forecasts (as one interviewee reported seeing) • Provide guidance on use in flood warning programs to provide communities with more advance notice of flood events, especially for flash flooding
	Integrate other data sets to enable resilience planning	• Overlay/integrate information around social equity and vulnerability • Since water quality is linked to flow, provide guidance or information on how water quality impacts might be changed by different stage events • Identify locations with extremes in flow (low and high) so NWM can be used to see the biological impacts of water conditions (e.g., dissolved oxygen, solids, etc.).
2. Improve Resolution and detail.	Interaction with built environment and water supply	• Offer more information on the interaction between groundwater and surface water at levees and dams. • More 3D groundwater flow modeling and groundwater flow velocity at levees and dams. • Incorporate culverts, smaller watersheds, or changes in development. • Address urban flooding • Incorporate the connection to stormwater management so that it can predict street level flooding and flag areas of concern before communities begin a project.
	Additional information about predictions and scale	• Add the functionality to utilize FEMA depths and lake level forecasting • Provide information on flood hazards at different recurrent timeframes, not just the 100-year needed for NFIP (e.g., yearly, 5, 10, 25, 50, 100, 500, 1000-year, greatest magnitude events). This should include guidance in the context of other models that provide a range of risks as communities may approach water models like they do weather models (e.g., using different weather models to compare a range of risks related to stormwater flow). • Provide information on river systems on the watershed scale. This would be helpful in educating emergency managers and responders.

	Improved localization	• Offer street level resolution of data, information, and analysis
		• Leverage local data and sensors to increase data density of the NWM (e.g. Portland is doing local modeling with USGS).
		  ○ Integrate low cost sensors
		  ○ Utilize data from sensors and gauges other than those provided by USGS
		  ○ Move local meters around to help calibrate the model in areas without sensors.
		• Account for holistic elements in watersheds that support resilience like vegetation, maintaining surface quality, managing channels to account for sinuosity and sediment transport

Table 4 Continued...

Primary Recommendations	Component Strategies	Suggested Enhancements

3. Develop New forecast features that expand usefulness.	Climate scenarios / outlier data	• Provide climate change scenarios based on GHG emissions? (e.g., how much worse will watershed flooding get due to climate change?) Could the NWM provide more detailed mapping that addresses climate change?
		  ○ As we are seeing an uptick in events that are defying the historical record, start running the NWM for more speculative flood scenarios to inform resilience planning.
		  ○ Project beyond the 500-year flood zone or provide information about a 1000-year flood. However, how speculative should be informed by the risk tolerance of a community.
		• When doing resilience planning or designing nature-based solutions, the community may do its own modeling to design floodplain sizes (etc.) based on flood size. If the NWM were connected to downscaled future climate projections, the community could run a simulation for future scenarios, which might show extra area of inundation to plan for.
		• Provide a stream temperature map under different climate scenarios

	Erosion and soil stability	• Provide guidance on how the model can help anticipate landslides. (E.g., through proxy data like soil moisture, such as from the NWM retrospective run data.) • Incorporate fluvial erosion
	Water supply and drought	• Incorporate water withdrawal and account for the impact of surface water withdrawal. • Provide guidance on how/if the NWM can be used for low-flow events. E.g., how drought scenarios would affect drinking water supply. • The great lakes region is being featured as a receiving area for climate migration, access to fresh water is a key factor in the theories that are emerging right now. It would be helpful if the NWM could begin to help understand how access to fresh water will factor in, there are a variety of different variables that come into play.