Operational Considerations Technical Brief Resulting from a Review of the Response and Recovery to the "Great Vermont Flood of 2023"

Results of Winooski Watershed Flood Hazard Empaneled Focus Groups #2 and #3

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Winooski Watershed Flood Hazard Empaneled Focus Group Background

On September 22, 2023, and February 2, 2024, a group of professional emergency managers, regional planners, watershed and river managers, and town officials who worked in and/or supported the Winooski watershed of Vermont were convened for the second and third of four empaneled focus groups designed to study the governance, communications, and actions of emergency management, river management, regional planning, and local governments in response to major flooding events.

The first focus group was held on March 22, 2023, during which we collected data describing how stakeholders would respond to a "potential" crisis as well as their experiences with previous flood events. A separate technical brief focusing on these data was developed. It occurred months before the historic "Great Vermont Flood of 2023" that hit the state in July. This allowed for the collection of pre- and post-crisis data, which provided a unique temporal assessment of how preparation, response, and recovery, including risk and crisis communication, unfolded.

This report summarizes the outcomes of the second and third focus groups, which reviewed the content and takeaways from the first session, with specific emphasis on the July 2023 floods and the more minor but still substantial flooding that occurred in December 2023, which also had a significant impact on the region. This report also considers new perspectives from those who missed the first session, as well as inputs collected during a post-crisis debrief meeting held on July 25 and interviews with other safety and emergency professionals. These unique experiences provide invaluable insights for researchers and practitioners involved in flood risk communication.

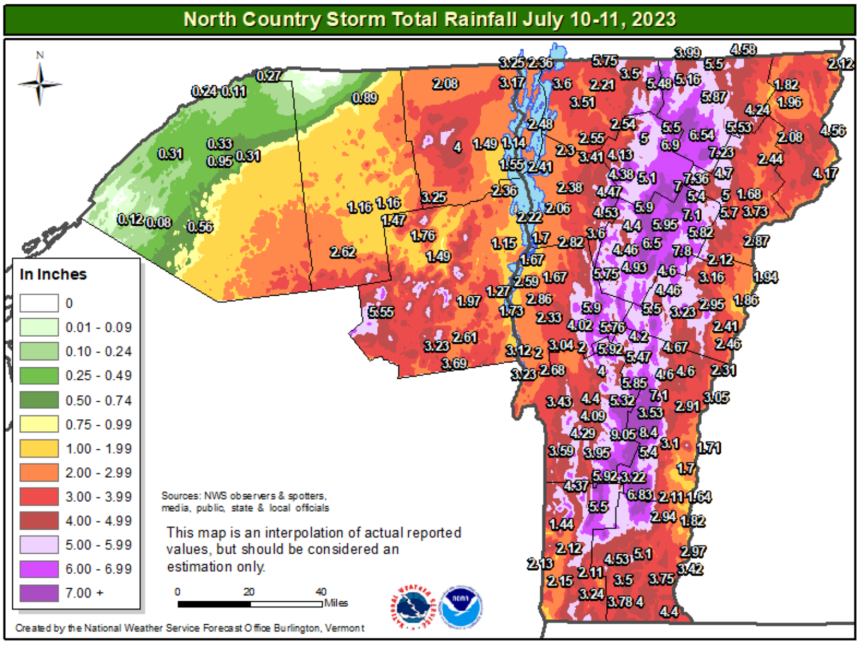
This report offers the "long version" of a policy brief summarizing the major findings and recommendations stemming from this work. These recommendations are found at the end of this report.

I. Context – The Great Vermont Flood of July 2023

In July of 2023, the state experienced a powerful storm that rapidly unleashed as much as nine inches of rain over the course of approximately 48 hours, causing flash flooding and river flooding across the state, with some of the greatest impacts occurring in the Winooski watershed region of Vermont. The most critical flood damage occurred because of sustained heavy rainfall between the July 10-11 period. According to the National Weather Service, the July 2023 rainfall in Montpelier, for example, sets an all-time monthly record of 12.06 inches.

Vermont's Governor, Phil Scott, described the event as "historic and catastrophic." Considering its magnitude and the damage it caused, this event was compared with Tropical Storm Irene, which devastated the state in 2011. According to the National Weather Service (NWS), rivers reached major flood stage in Jeffersonville and Johnson (also indicating flooding in Hardwick and Morrisville), Montpelier (also indicating flooding in Waterbury), Rutland, Essex Junction (indicating flooding in downtown Richmond, the Intervale in Burlington, and other local areas), Rockingham and Northfield Falls. Figure 1 shows the total rainfall across the state.

Figure 1: Storm total precipitation
Source: National Weather Service: https://www.weather.gov/btv/The-Great-Vermont-Flood-of-10-11-July-2023-Preliminary-Meteorological-Summary



The National Weather Service first raised concerns about the storm to Vermont Emergency Management (VEM) on the evening of Friday, July 7, 2023. Comparisons with Irene immediately started to be made, and residents began to take the storm seriously. A disaster declaration was issued for the entire state of Vermont following the event, which had not occurred since Irene in 2011.

According to the National Weather Service (NWS), high-latitude blocks of high pressure over Greenland maintained a shortwave trough, leading to unseasonably strong upper tropospheric winds to the west of Vermont, channeling significant moisture from the Atlantic Ocean. When combined with moisture-rich soils from heavy June rainfall, the right conditions for a major flood event that dropped up to nine inches of rain over the spine of the Green Mountains were created. The uniqueness of the setup of this weather system gave forecasters and responders little time to prepare. One focus group participant from Vermont Emergency Management noted the difference between the July 2023 and Irene 2011 flood events:

> "Irene, we saw coming. All eyes were on it. In this latest storm, the NWS called Friday night—two days out–was when the alarms were starting to sound. Early on people shifted gears when the comparisons to Irene started kicking in. People started taking it more seriously."

The storm generated flash flooding, extensive riverine flooding, and streambank erosion. Flood inundation was most critical in the main stems of the Lamoille and Winooski Rivers. The July 2023 flood event led to several small, privately owned dam failures, many instances of major stream bank erosion, culvert failures, and flooding of downtowns and residential areas in Montpelier, Barre, Moretown, Waitsfield, and Waterbury, all of which are located in the floodplain of the Winooski watershed. In addition, concerns about the breach of the Wrightsville Dam, upstream of Montpelier, were a point of significant apprehension, as it was during the 2011 tropical storm Irene flood event. However, the Wrightsville Dam was not near breaching; it was near activating the auxiliary spillway, which could have led to non-failure downstream consequences. There also appeared to be some concern among the public about the existence of woody debris in rivers, a point of concern that was, according to some participants in the focus group, unwarranted. The State estimated that repairs to government buildings would cost at least US $100 million. The floods impacted 20 state buildings in Montpelier (*Vermont Public* data). Two people were said to have died as a result of the flood, and some 4000 homes and 800 businesses were damaged according to self-reported data from July 25, 2023.

Our focus group included a few local officials from Waterbury, providing access to more information on the impact of the flood on this town. The town was close to losing its water treatment center. The waters did not retract as quickly as they had during Irene in 2011; however, the extent of the flood damage was not as bad as that of Irene in 2011.

Our focus group also included several residents of Montpelier. One Montpelier resident noted,

> "My spouse and I walked downtown and saw the river rising at the confluence of the rivers, and then the next day the entire downtown is under water. My neighbors are anxiously looking at the water rising. If we had to get out, we were isolated. When the water receded Montpelier ALIVE [non-profit organization] and the city mobilized quickly. There was a huge amount of work mucking out, and immense emotions."

Participants shared specific examples of the impacts of the storm. The Wrightsville Dam, upstream of the major population centers in central Vermont, reached 10 inches below the overflow stage. There were concerns of a "tsunami" headed down the river if the dam was breached (a specific section covering dam safety issues is included later in this report). Hubbard Park, in Montpelier, saw significant erosion in park roads. Debris floating in rivers was a concern for some residents. Parts of downtown Montpelier lost power for weeks and recovery of downtown businesses has been slow and arduous.

II. Response

Vermont Emergency Management (VEM) is responsible for coordinating state responses to natural disasters. Vermont lacks county governments, leaving the VEM responsible for directly supporting the local town governments. The VEM also serves as a conduit for federal support, particularly that from the Federal Emergency Management Agency (FEMA). The VEM is a key actor in the recovery process, receiving federal funds from FEMA and working closely with Regional Planning Commissions (RPCs) and local towns on resource allocation, permitting, and educational activities. The VEM operates a Vermont Flood Resiliency Fund and Hazard Mitigation Grant Program.

Local Emergency Operations Plans (LEOP) are a "forcing function" for the emergency "incident command" contacts for each town to provide information to VEM regional directors. These plans, which are to be updated regularly, include information that needs to be included for local emergency operations plan approval. This approved plan is required for a town to be eligible to receive aid following disaster declaration. At a bare minimum, local incident commanders need to file a "short form" LEOP, which includes phone numbers of key local contacts, and sections for how to communicate with individuals in times of crisis, where information is posted, and recognition of who is vulnerable, etc. Towns generally do not have the bandwidth to put together the "long form" LEOP. VEM has three regional coordinators whose job is to support local officials in responding to and planning for disasters, but it is difficult to cover 260+ towns with this limited number of regional coordinators. As one focus group participant noted, "there's a bottleneck there."

During and after the storm, the VEM looked at trends, answered information requests, developed maps and reports, and deployed assets to assist with life-saving measures. Over 200 swift water rescues occurred during the event. Just prior to and during the event, the National Weather Service provided multiple briefs per day, informing the deployment and acquisition of resources. The coordination of resources was prolonged as the weather continually changed. The VEM team that included regional and statewide personnel was understaffed at the time (25% vacancy), which made the work more challenging. Temporary support staff were called on to fulfill important roles, including support from RPCs, partnering states, and other state agencies. The temporary staff was brought up to speed, the existing staff still had to work longer shifts. As one EM professional put it, there is a need to "build up our bench depth" to double or even triple the size of EM staff during crisis events.

RPCs play a vital role in planning in terms of hazards and mitigation planning, town planning, and zoning bylaws. During flood events, RPCs collect information from towns and convert them into Situational Reports (SitRpts). During the 2023 floods, as notifications were queuing up, RPCs were helpful resources for people without Internet access to get the word out. When storms approach, the RPC teams are mobilized by the VEM to help with response and information to the VEM's Situational Awareness Unit. Moreover, depending on the magnitude

of the disaster, RPCs are tasked with working in the State Emergency Operation Center. These tasks are usually performed during the first 1-2 weeks after the disaster. During the 2023 flood, after the immediate post-crisis period, RPCs were also involved in the coordination of webinars and training, but their main role was in the substantial damage estimation process. RPCs also play a central role in recovery efforts, providing towns with added capacities for damage assessment, application for funding, and related logistical support. Much like other responders to flood events, RPCs have limited resources and are constrained by different levels of capacity. When a disaster strikes an RPC, these resources are spread thin and likely concentrated in the larger population centers and hardest hit areas.

The technical teams of the River Management Program (RMP) of the Department of Environmental Conservation (DEC) of the Agency of Natural Resources (ANR) were also part of the response and recovery processes. During and immediately after the storm, they worked on triaging and addressing calls from towns, the VT Agency of Transportation (VTrans), and individuals, while providing technical assistance to areas most directly impacted. They focused on transportation infrastructure to provide emergency management services to those in need. "Strike teams" were mobilized to meet municipalities, assess public infrastructure damage, and ensure continuity of services. Some of these teams involved professionals from private industry and higher education. During the recovery phases, the RMP technical staff responded to requests for woody debris removal and dealt with code violations, such as the dredging of waterways and unpermitted berms.

There is an emergency statute in the state of Vermont that clearly states that for emergencies affecting towns, the responsible party (including issuing evacuation orders) is the local Incident Commander. State and federal governments cannot take responsibility from them. Incident Commanders are designated locally. For example, in small towns, the Incident Commander is commonly the Select Board Chair. Communication is, therefore, very decentralized and surfaces disparities in capacities between towns. Some well-funded and well-organized communities have an Incident Commander who is proactive and on top of the processes for planning and preparation, while other towns may have a designated Incident Commanders who have no such commitment. However, turnover is a significant challenge.

Local town responses to the Great Vermont Flood of 2023 were varied. Waterbury pre-arranged for dumpsters to be delivered to the town in anticipation of debris removal from flooded structures. Volunteer coordination was streamlined and was more efficient in Waterbury than in 2011. The 2023 flood has led to renewed attention from local officials to focus on flood mitigation measures, a point that we return to later in this report. Barre was overwhelmed by 10 outside volunteer groups that came in to help. Local organizations (e.g. Barre Up and Rainbow Bridge) got involved in the response to coordinate outside and local volunteers. Volunteer coordination is handled at the local level.

Risk Communication During July 2023 Event

It is widely recognized that the communication during the 2023 floods lacked coordination in some important places. Positive examples of effective coordination between government agencies included VT River Management receiving quality information from various local sources on the ground, ensuring that the VEM received correct information about river flood stages. Technical staff responsible for dam safety were also responsible for crisis communication. Landowners who were unsure who to contact were calling organizations such as Friends of the Winooski River, asking for help with flood damage, including culvert issues and stream bank erosion.

A key communication issue identified by the focus group participants was the volume of information shared only with those who provided prior consent or actively sought it. One participant in the focus group stated:

> "It's really whether or not people are tied into things like Front Porch Forum; they're either looking for it or they've consented to get in and asked for it…"

There is a significant challenge in ensuring that information reaches people who do not give permission to receive such messages. In many cases, members of the public can only access information that they actively look for or what they see posted on platforms they signed up for, such as the Front Porch Forum and Facebook. During the 2023 flood, the VEM sent push notifications based on observed trends collected through the information requests they received via phone calls. However, there is still a clear communication gap between people who are not keyed into these information channels. A "digital divide" was observed, as official information (e.g. City of Montpelier, State Police, VTrans) was being shared via Facebook and Twitter. Those who did not follow these channels or sought these sources were out of the loop.

The Agency of Natural Resources (ANR) has identified the need to centralize flood resources and information. ANR made some efforts during the first 5-10 days of the crisis to provide more centralized access to flood resources through their River Management Program. Public inquiries were channeled to its website, which proved to be effective. This single point of contact provides an easier way to obtain triage information.

Reverse 911 (a service that allows the county/city/state to call residents in the event of a disaster or other emergency) was used by VEM to address issues related to identified anomalies and flash flood occurrences. Participants shared their concerns with the effectiveness of this communication tool, mainly related to how people recollect the calls they receive and how invasive this communication strategy might be perceived by residents. The VEM's goal is to avoid inundating people with information; therefore, there is prudence in using this tool. At the local level, towns follow local guidance and handle the bulk of the messages that go out, which are sent more frequently than by the state.

Dedicated phone numbers that are part of the North American Numbering Plan, designated by the Federal Communications Commission (FCCO), were used during the response process. *511* (a phone number focused on traffic and road information) and the VTrans website were used to

track road closures; however, these covered only state and interstate highways. The participants shared that there was no master list of road closures that included municipal roads. There are rules, though, about who can report road closures, while delayed road closures reporting. These rules must be streamlined to provide timely information.

The 211 system is a community service and an information phone number that was also used during the response. This number differs from 911, which is aimed at reaching emergency services (police, fire departments, and ambulances). Participants reported that 211 was effective in reporting damage, but not as efficient in coordinating responses. Some residents complained that they called 211 but did not get any response. Towns (e.g. Waterbury) were not given 211 data or told how they would be getting information on affected residents.

Evacuation orders were issued in hard hit areas across the state. The decision to issue evacuation orders is determined at the town level by the designated Incident Commander. Evacuation orders usually result from consultations between local Incident Commanders and VEM. These checks and balances are employed before issuing evacuation orders. Town officials will call the VEM and share the context, and there is an agreement to distribute the message. Evacuation orders are sent via VT Alert (a system used by the state and local responders to notify the public of emergency situations) through door-to-door communication from local fire and police departments and conveyed through local volunteers.

Outreach to Vulnerable Populations

During Tropical Storm Irene in 2011, the last major flood to hit this area, there was no state office explicitly focused on supporting vulnerable populations during disasters of this magnitude. During the response to the 2023 flood, the state's Agency of Human Services had a designated role. Although more awareness about the impacts of flooding on vulnerable populations was recognized by the participants, there was a common agreement that gaps in support persisted.

One instance that highlights the issue of vulnerable populations was shared by a VEM official:

> "There was an instance of an 80-year-old woman who has been living in her house with all of the windows and doors shut with a fuel oil spill in her basement, really sticks with you. Like an 80-year-old woman with no mobility who is breathing in these fumes for days, that really does stick with you."

During the COVID-19 outbreak, the vulnerable populations were disproportionately affected. These same vulnerable populations also disproportionately experienced the impacts of this historic flood, specifically those living in manufactured home parks that tend to be adjacent to rivers. COVID-19 has also exposed the need to raise awareness of language barriers in some communities. However, participants shared that during the July 2023 flood response, the needs of people who spoke English as a second language were not effectively addressed.

One initiative considered successful by participants was the establishment of a consolidated state government location for resources in just a few days. One VEM official noted:

> "I think one of the best things that we had in terms of addressing the needs of vulnerable populations is that a few days into the event there was a consolidated single state government location for resources "… "having like that single authoritative source where each grassroots group can go through and get all the information…"

Grassroot groups that support vulnerable populations can access information and resources from a single place. It was noted that there was a lag in setting up the consolidated government site, with communications lagging, particularly during the height of the crisis.

Regarding the support provided by volunteers, mutual aid from local communities appeared to have worked, although there was some variation in the levels of participation. The role of local nonprofits is deemed critical. There were designated downtown associations that helped recruit volunteers during times of crises. For example, Montpelier ALIVE played an important role in the response and recovery processes in the state capital. These associations play an important role in bringing social capital to response. However, it remains difficult for some towns to coordinate with volunteers. Towns can learn through direct experiences. For example, during Irene, Waterbury was one of the regions with the greatest impacts, and Waterbury was able to recruit more than 1,000 volunteers. This experience served as a lesson on how to effectively deploy volunteers to help support the response to the 2023 flooding.

The flood remediation industry follows disasters around the country and helps people with debris removal, demolition, and mold remediation. Focus group participants shared concerns with cross-cultural and, at times, racist encounters between local people and some of these workers of color, some of whom accessed the same support provided to those impacted by the floods and to volunteers (e.g., free food distribution). As these workers receive low wages as a payment for their work, they may also need support, but people questioned their legitimacy to access resources meant for those who volunteered for their time or experienced flood damage.

III. Dam Management Considerations

The Great Vermont Flood of 2023 highlights the importance of focused attention on dam management and safety. Vermont has more than 1,000 dams, approximately 60% of which are privately owned and operated. Several small, private dam breaches have been reported in the Winooski Watershed. The presence of some of these smaller dams can exacerbate flood damage.

The Vermont Dam Safety Program is housed in the Department of Environmental Conservation of the Agency of Natural Resources. The program currently comprises five staff members including four engineers and one program administrator/analyst. These are the State's regulators for non-power and non-federal dams. There are roughly 1,000 dams under their regulatory purview, and they are directly responsible for 14 state-owned dams, including the

Winooski River Flood Control dams Waterbury, Wrightsville, and East Barre. Some of their responsibilities include periodic inspection and permitting programs. Two other entities have regulatory responsibilities for dams in the state: the Public Utility Commission and Federal Energy Regulatory Commission (FERC). The US Army Corps of Engineers serves as a technical resource[1] to the Dam Safety Program for the three Winooski River flood control dams, although their availability is subject to competing demands, especially during large regional crises. During the July 2023 flood, technical help was also provided by external consultants, who were rapidly hired and paid by the Department of Environmental Conservation (DEC). The consulting community in Vermont with specialized dam engineering experience is fairly limited, and in times of crisis, many of these consultants work with VTrans and other entities that support emergency responses. Therefore, the availability of technical support for dam operations during times of crisis must be considered.

Historically, dams in the state's purview have been regulated through statute (10 V.S.A. Chap.43) and federal technical standards. Compliance with inspection findings and recommendations has largely been voluntary, except in rare cases where the dam was considered to be in a condition necessitating the use of the Unsafe Dams provision of the statute. Rule-making efforts were initiated and partially adopted in August 2020 for the administrative sections of the rules. Technical standards, representing the other half of the rules, are currently under development and are anticipated to become effective in 2025, bringing a paradigm shift towards more enforceable regulations. Currently, many state dam safety regulations are voluntary for owners. These changes in rules bring them into compliance.

One point raised by the focus group participants concerned the potential for key governance misalignments between water quality regulations and flood hazard mitigation immediately before expected flood events. According to the water quality regulations, dams are not allowed to release water. Even when flood emergencies are imminent, dam managers have a reduced capacity to store flood water by releasing back waters in anticipation of extreme precipitation events. This misalignment between potentially federally mandated TMDL (total maximum daily loads) levels and the reduction in catastrophic flood risk needs to be considered.

The "Big Three" Winooski flood control dams (e.g. Waterbury, Wrightsville, and East Barre) are state-owned and operated and follow a reservoir regulation manual that dictates how to operate the dams during floods. The dams were designed and built by the Army Corps of Engineers in the 1930s. Wrightsville and East Barre are two self-regulating facilities. East Barre, for example, is a dry pool, so there is no pond behind it under normal conditions. The concrete tunnel extends through the foundation of the dam. The river flows through the tunnel and passes beneath the dam to the downstream channel. When there is a flood and the capacity of the tunnel meets the flow, the dam starts holding back water. If the flood is large enough, the water level will continue to rise until it reaches a second "auxiliary" spillway, which is designed

[1] The federally owned dams are self-regulated, which include the Army Corps of Engineer's five flood control dams located on the Connecticut basin of Vermont/New Hampshire. These are major flood control dams built in the 1950s and 1960s, similar in scale to the Waterbury and Wrightsville dams.

to release additional water to limit the possibility of the dam being overtopped. There is no way to make it go faster, slower, or different from how the system works. Wrightsville operates similarly, except that it always has a pool of water behind the dam.

For the dam safety team, the July 2023 flooding event began on Sunday (July 9). In response to a call from the VEM that Sunday night, two dam safety engineers visited the Curtis Pond Dam in Calais, VT, to review the condition of the already stressed dam and discuss potential actions the owner could take. Monday morning the water level of the Winooski River at the Crossett Brook USGS gauge in Waterbury rose to the point where closure of the Waterbury Dam Flood gates was required, in accordance with the regulation manual. Site visits were made to check the Wrightsville and East Barre Dams. Due to the limitations of the team (four engineers), they spent time discussing how to best allocate resources. Two engineers were stationed overnight: one in Waterbury and the other in Wrightsville. The other two monitored and responded to inquiries from VEM and other entities. On Friday, the week following the flood, a rapid inspection program was started. By the following Monday, inspection teams were on the ground to inspect the high-, significant-, and low-hazard potential dams that the program could obtain the owner's permission to review.

At the Wrightsville Dam, the water level came within 10 inches of spilling over the auxiliary spillway. The flow in the North Branch between the dam and the Winooski River was still controlled by the tunnel at the dam, which prevented the water from getting too far out of the bank and caused too much flooding. However, if the water level reached just 10 inches or more, it would have activated the auxiliary spillway and more water would have made its way downstream to areas already stressed with flooding. This would have resulted in higher levels of water in the northern section of the North Branch than has been seen since the major 2007 flood in Vermont.

The Dam Safety Program was surprised to see a WCAX news article that stated that the Wrightsville dam was at risk of breaching, because at no time did the dam safety team communicate this. This ambiguity in communication created unnecessary concerns that affected public perceptions and confused local officials.

Communication governance / protocols for dams

Risk and crisis communication in the context of dam safety management in Vermont was highlighted as a critical issue in our focus group discussion. What follows is a description of how the communication process unfolds, as well as some lessons learned.

During the 2023 event, the dam safety team called through the call list included in the Emergency Action Plans (EAPs) for Wrightsville and Waterbury. These calls were made by a dam engineer at each site during the height of the July 2023 flood event. This procedure was not performed for East Barre because the water level was still far below the spillway crest, and the engineers evaluating the situation determined that the risk of activating the auxiliary spillway was not high enough to warrant doing so. The criterion to kick off the communication process is

based on water levels. If it is within 10 feet of the auxiliary spillways, the formal communication process starts. After making these calls, the team kept close contact with Emergency Management in Montpelier and at the state level.

In relation to the ownership responsibilities of the dams, the Dam Safety Program is directly responsible for the team's role when activating the EAP is to follow the call chart, which includes the local incident commanders downstream who are then responsible for managing the emergency and communicating with the general public within their jurisdiction. The dam safety team is also responsible for communicating with the VEM; therefore, if, for some reason, the incident commander is not contacted directly by dam engineers, there is a second conduit that can initiate communication with the public. The team holds other roles beyond dam management, in which they communicate with the general public (i.e., respond to calls from dam owners and provide technical guidance). Direct communication with the public is conducted at the local level. This was what happened during the 2023 flood.

One of the recommended actions being considered by the dam safety team is the development of a Joint Information Center for Dam Safety Programs. This would address the inefficiency of having engineers in the field check water elevations and operating gates, among other tasks, while simultaneously having the additional responsibility of communicating with Incident Commanders across the state.

Pre-crisis stakeholder engagement was another opportunity to improve the dam safety communication process. Pre-existing relationships between dam safety managers/engineers and emergency managers, for example, would positively impact the agility and effectiveness of the process. For example, holding annual meetings to integrate efforts and discuss plans would help address the coordination challenges of communication during crises. This needs to be done during the pre-crisis stage, as post-crisis priorities would hinder such commitments.

Discussions were held around the tools used by the dam safety teams to inform and update the models used to anticipate the potential consequences of a breach. At the Wrightsville Dam, there have been some previously developed HEC-RAS models of the dam and watersheds. These models, which are part of the Emergency Action Plans developed in 2018 and 2019, were recently updated and used during the July floods. River gauge data and observations were also used. In addition, physical measurements of depth and bridge sizing were taken, which were not performed in the HEC-RAS models. While there are opportunities for the Dam Safety Program to leverage various technologies to perform live flood forecasting, it should be understood that modeling relies on numerous engineering assumptions, calibration based on limited data sets, and the accuracy of weather forecasts (e.g., statistics and probability) that are not well understood by the people; this information will be provided to (the local incident commander).

For emergency planning, the "keep it simple" principle should be applied as a general rule of thumb. There is something to be said about having multiple answers emanating from forecast models, which is better than having no answers in certain situations. In most cases, the best

course of action, except in rare cases where emergency managers are extremely qualified, is the development of a plan in advance based on a conservative scenario and adhering to that plan even if it ends up being an overreaction. The conservative approach (e.g., caution) to utilize flood forecast models for dams is preferred over rapid, in situ optimization of a plan based on mid-event forecasting, which has associated uncertainty that is difficult to quantify and translate to others. The Dam Safety Program (DSP) partnered with the United States Army Corps of Engineers (USACE) to obtain flood forecasting for the Wrightsville Dam, which helped inform the operations of the Dam Safety Program. This information was presented to Montpelier officials, and it did not appear to translate well based on post-event interviews.

As described previously, not every dam in the state is owned by the Dam Safety Program; some dams are owned by private dam owners who do not have the ability to forecast to local incident commanders. Dam safety regulations apply to owners of dams and not to people who manage emergencies at a local level. The DSP can require owners to maintain an EAP, which may only be a starting point for coordination between dam owners and local incident commanders. There is no regulation that requires these local incident commanders to take the next step and further develop their own plan to notify the public if certain water thresholds of the dam are exceeded, or even do anything with it other than put it on the shelf for safe storage. In engaged communities annual or biannual EAP test exercises involving the dam owner, incident commander, VEM and others can be incredibly helpful but requires people who want to be engaged.

IV. Long Term Recovery and Mitigation

Recovery from the July 2023 floods will take a long time for certain hard-hit communities. The participants evidenced that the lengthy recovery projects from Irene were just being concluded 12 years following the 2011 event.

To discuss how the 2023 event unfolded and how people perceived it, the city of Montpelier and non-profits organized discussion forums with the local communities. There were 3 major events that brought up significant considerations into how the recovery process will shape the future. Reflecting on the issues raised in these forums, one of Montpelier residents of our focus group noted,

> "Avoiding damage is not something people like to think about, particularly during and immediately after a flood. Then people get deep into the denial phase. In Montpelier, the Vermont Council on Rural Development (VCRD) pulled a forum together- with three major flood events in recent memory (1992, 2011, 2023) that brought up significant considerations into how the events unfolded and how people viewed it and are thinking of the future. I've been shocked though that people are not just looking at this as 'their' story, but a watershed story. I went to Cabot- at the headwaters—they understood that they are connected with downstream concerns in Montpelier and Barre. The big issue I'm seeing in these downtowns are these historic structures that were built a long time

> ago, without flood plain maps, and they are not built to handle the situations they are placed in, and things are not getting better. We don't have the regulatory power to do something about this. And many times, the owners of those buildings don't live in those structures. These communities need to adapt."

There have been discussions about what recovery should look like. After Irene, buyouts were the most widely circulated option. Now there are more nuanced discussions, that include buyouts, adjustment in green spaces, longer-term recovery, and how to adapt downtowns to the increasing threats of flood hazards.

After an extreme event such as this, there is a need to issue permits for flood recovery, repairs, and developing and accessing buildings if they have had substantial damage. Substantial damage is defined as the flood damage cost to repair that is 50% or more than the assessed value prior to flooding. During the post-crisis/recovery stage, other states provided support: South Carolina helped with software to assist the substantial damage estimation, and Florida with on-the-ground support, working with communities on systematic substantial damage estimations. Home visits across the region were performed as part of the substantial damage estimation process.

There has been a post-crisis focus on the enforcement of zoning, as some recovery measures implemented in haste did not meet these standards. Two main areas that violate the state's Stream Alteration Permit and Rule have been the focus of enforcement: the dredging of waterways and berms. Following the immediate period after the crisis, River Management technical teams reviewed existing projects to ensure that they met standards regarding encroachment to streams and rivers and to minimize future public safety damages caused by improper repairs.

The VEM notes that FEMA requires more details pertaining to substantial damage estimates and follow-up certification of repairs. This work is nuanced and technical, and requires a level of expertise, something that residents and many towns do not have.

Additionally, the issue of criteria for the assessment of flood hazard mitigation investments came up. One focus group participant, with knowledge of the process, noted that the flood insurance insurability standard was insufficient.

> "We manage flood hazards through flood insurance, which is a weird fit. We consider rebuilding to standards that will make the building insurable, instead of through more nuanced ways—like how we look at wetlands restoration in which we consider functions and services. The whole idea around the original National Flood Insurance Program (NFIP) was that no one would build new in the flood plain and then we'd mitigate those buildings that do get flooded when the time comes."

An issue raised by the participants that explicitly impacts vulnerable communities is the controversy surrounding the need to build affordable housing and the recommended limitations

of building these residences in floodplains. Legislators are pushing for the development of affordable housing; however, some concerns have been expressed that these pressures can run up against the need to *not* build in floodplains. Therefore, there is still a movement that places the most vulnerable people in the highest-risk areas. One focus group participant noted these dynamics accordingly.

> "We've spent so much time concentrating on downtown development- we may need to expand that focus. Vermont has a lot of NIMBYs ("*Not in my Backyard*"). They don't want neighbors—to increase density—leading to class issues. Going from one house per acre to two house per acre is needed."

There is also a need to focus on the explicit needs of flood-impacted businesses, particularly those run by inexperienced owners. One participant told the story of a business owned by a non-native language speaker who had challenges speaking with their landlord. "They didn't know that they needed to remove everything to prevent mold. Other businesses were already ripping out dry wall. They were not able to access the volunteers—they didn't know the steps to take and were really disadvantaged. Business owners have special needs. Public health recommendations to provide details of needing to rip out wet drywall. There was misunderstanding that help needs to be requested."

This highlights the need for proactive outreach to businesses.

V. Reflections on the December, 2023 Flood Event

On December 17 and 18, 2023, a significant "rain on snow" event occurred, inundating the Winooski watershed with two to three inches of rain over a period of 12 hours. The rain fell on top of 4–10 inches of snowpack that blanketed the area. The result was a significant flooding event that hit the Mad River valley and Waterbury area. The event resulted in basement flooding in Waterbury, road closures, and significant damage to the downtown Waitsfield in the Mad River. According to one former town official from Waterbury,

> "In December was nowhere near as bad as July and Waterbury in July was nowhere near as bad as Irene. I think people are starting to put a premium factor on their forecasts. If someone is telling that predictions show that there is going to be bank-full, people should prepare for it, considering it will be eight inches over that. I don't know where people are looking for or receiving information from."

The timing of the event, early winter, caught some off guard. One focus group participant noted that some people he met after the storm told him that they ignored the forecast because they saw the rainfall totals but did not consider the snow. "For March, April, May, folks would be thinking about snow melt more… People saw reports saying the area would have floods, but 2- or 2.5-inch storm total opposed to summer, which was double that." He noted that the snow melt threat wasn't heeded.

This event triggered a much smaller response from the VEM, with no mobilized statewide incident command center. Dams in this region have never been a point of concern.

As of February 2024, Governor Phil Scott has requested a federal disaster declaration for the December floods. Link: https://vtdigger.org/2024/02/20/vermont-seeks-federal-major-disaster-declaration-for-december-floods/

VI. SUMMARY OF FINDINGS AND RECOMMENDATIONS

This process provided insightful perspectives on how to prevent, respond, and recover from flood events. Participants with first-hand experience of the July 2023 historic flood shared the best practices and issues that needed to be addressed. After Action Reviews (AAR) on the crisis response are planned and will be released by the summer of 2024. The following is a set of recommendations based on what was learned during the three focus group sessions.

A. INVESTMENT IN MUNICIPAL AND COUNTY LEVEL CAPACITY-BUILDING

By most accounts, the responses of the state, regional, and local emergency responders to the Great Vermont Flood of 2023 were commendable. Professionals and volunteers alike worked long hours over many days and weeks to ensure that the response and early recovery from the emergency conditions were carried out, potentially saving lives, personal property, and untold trauma.

The lack of county infrastructure and strong reliance on local control places a great deal of responsibility on elected, appointed, or volunteer local officials to serve as local incident commanders. While it is believed that local officials stepped up and did their best to respond to the Great Vermont Flood of 2023, the flow of information to and from local and state officials could be improved, particularly during times of major risks. Evacuation decisions are locally determined in consultation with the state and occur in high-risk situations. Assessment of risk is rendered better when situations are clear and expert judgment is considered. *However, the capacity of local communities to manage crises and mitigate risks varies drastically across Vermont.*

The lack of capacity in some towns is a critical weakness. In many communities, social capital and community involvement are limited. Pre-planning is key (e.g., having Flood Emergency Response Plans is critical). In rural areas, road integrity during an emergency to get to shelter/aid/healthcare is particularly fraught. During an emergency, the response of real people on the ground is crucial. Sometimes these can emerge from formal organizations or informal networks. However, it is important to have centralized and targeted messages and information flow regarding safe actions, available support, and coordinated responses, including shelters and safe passages.

Recommendation A.1: Document location and implications of smaller towns that may lack emergency management or "incident command" capacity across all phases of a flood crisis. It is anticipated that such a comprehensive review of local capacities will yield troubling and significant variability in local town capacities when planning for and responding to flood disasters. The focus group participants cited many examples of some of the even more well-resourced towns of the Winooski watershed, which lacked the capacity to conduct adequate flood hazard response planning. A comprehensive assessment should focus on the unmet needs of smaller towns that may lack emergency management or "incident command" capacity across all phases of a flood crisis. Such a study could be funded and contracted out to researchers.

Recommendation A.2: Provide select board members and other local officials with routine incident command/emergency management training and orientation. This recommendation is not offered in lieu of recommendation A.3 but is an important feature of the shared responsibilities of state-county-regional-local emergency management officials. Most town officials serve in volunteer capacities and turnover is likely frequent. Given the authority that these local officials have in informing residents, ordering evacuations, and communicating flooding impacts that are unfolding "on the ground," it is critical that they understand their community's vulnerabilities and the best ways to respond to disaster conditions. Such training can be coordinated between the state and educational service providers.

Recommendation A.3: Advance community-wide discussions on flood risks, trade-offs, and adaptation measures that could be undertaken to mitigate them. As the immediacy of the flood recedes, people are shifting their focus from the community and the neighborhood to their own issues and needs. Avoiding damage is not something people like to think about, particularly during and immediately after a flood. Therefore, it is important to consider ongoing awareness-raising and risk communication discussions on how to systematically address the lessons learned from previous crises in an effort to minimize future risks undertaken at the community scale. Such efforts could be facilitated by trusted facilitation and capacity-building non-governmental organizations.

Recommendation A.4: Shift accountability for disaster response from towns to counties or regions to capture the watershed scale of flood hazards. With flood recurrence intervals shortening, town wide attention to flood resilience and mitigation impacts should be planned for at *and* beyond the municipal level. It is believed that this would best work at the county level or watershed scale, as many communities are connected through riverine systems and cannot be considered in isolation. Maintaining this discussion over time requires a full-time commitment of professionals operating at the county, regional, or watershed scale, rather than being part of a mix of duties carried out by most municipal authorities. Such a shift in disaster management responsibilities aligns with enhanced capacity at the state level (see recommendations B.1-3; E.2).

Recommendation A.5: Require Flood Response Annex to the Local Hazard Mitigation Plans (LHMP). With enhanced capacity at county/regional levels, these plans would include

assessments of local vulnerabilities, local communication protocols, and redundancy or backup roles and responsibilities of local officials. The town-level government makes this challenging; however, emergency action plans should be mandatory for towns and overseen at the state level to ensure that they are up-to-date and account for town hazards. Ultimately, full-time town, regional, or county officials are needed. Most communities in Vermont have local emergency operational plans. These are updated annually but are mostly limited to lines of emergency authority in the community. *Communities really need much more*. They need additional Flood Response Plans (as annexes) for the LHMP. This would require the community to consider local vulnerabilities with roads/culverts, community members who are particularly exposed/isolated/difficult with mobility or health conditions, or other complications. Part of the plan needs to point to future community conditions with safer homes, workplaces, reliable roads, and functional community services. One focus group participant suggested that after Town Meeting Day in March all towns could review and pass their LHMP every few years, "which is a great time to review the document and walk through with the staff involved and the Select Boards, the fire chief, etc."

B. INVESTMENT IN HUMAN RESOURCES

Among Vermont's competing priorities for resources, emergency management planning and response needs developed attention, chiefly among them, increasing the capacity of VEM and building the capacity for emergency management at the county or regional scales. Several times over the course of the focus groups the observation that the state has just three regional emergency managers for 261 towns was mentioned. In times of crisis, as well as when planning, preparation, recovery, and mitigation are undertaken, this ratio is insufficient. Recommendation A.1, the assessment of a gap analysis, further underscores the need to invest in more human capital.

Recommendation B.1: Conduct a gap analysis pertaining to the roles and responsibilities of actors across the emergency response and immediate recovery network across the state of Vermont, including local officials. The focus group participants shared that the state needs a more robust assessment of who is doing what during a crisis. While all the responders to the Great Vermont Flood of 2023 should be commended, some breaks in communication channels and overburdened emergency management professionals and engineers were evident. Pre-assigned roles and access to information must be determined during the pre-crisis stage; therefore, when a crisis occurs, the process of monitoring the response can be more effective. This recommendation complements recommendation A.1 and is likely to be accomplished in one study.

Recommendation B.2: Increase investments in provisioning for emergency management personnel at the state and local levels. It is recommended that the filling of vacant positions in the VEM staff be prioritized. VEM has three regional coordinators whose job is solely supporting local Emergency Management development. When data are available, they need to decide how to apply them, and who in the community needs translation. Three EM Regional Coordinators

cannot cover 260+ risk management directors. As one participant noted, “there is a bottleneck there.” Emergency management directors should already be thinking about vulnerable populations, but it is the application of knowledge that often does not occur. Increasing the number of EM Regional Coordinators is one way to increase the capacity. Growing human resources for emergency management at county and/or regional scales is also recommended and aligned (see Recommendation A.3).

Recommendation B.3: Provide cross-training to temporary staff mobilized during flood events. The temporary mobilization of non-emergency management personnel and regional planning commission staff is essential during crises and is woven into existing state-level EM planning and mobilization. However, absorbing new staff during an active and ongoing crisis can place undue burdens on the existing EM staff. Cross-training of temporary staff mobilized during crises is recommended. It should also be noted that the current capacity of full-time EM staff is taxed, and additional resources to develop and implement such cross-training are needed. In addition, the capacity of RPCs to supply temporary staff to incident command centers varies drastically across the state. Some RPCs have emergency management professionals in place, whereas others do not. If cross-training sessions occur outside one’s professional duties, stipends for participation in the training should be offered to ensure equity. Mobilizing other content experts from the industry and academia has also been suggested.

C. REVIEW AND ENGAGE RISK COMMUNICATION PLANS

A key feature of preparation and response to flooding disasters is the communication systems in place to convey forecast and real-time, in situ information about anticipated and existing flood conditions. While the communication channels around the response to the July 2023 floods were sufficient and resulted in good outcomes, redundant and clear channels of communication, particularly between dam engineers, hydrological modelers, emergency managers, and local and state officials, are needed. *Lapses or challenges in conveying information in real time to the right people could result in misinformation or lack of information regarding risks and recommended actions.* In most cases, channels and protocols exist, but are not always well understood, and staff are limited. No system is perfect. The Joint Information Center concept was introduced to DEC management in the spring of 2023 and is yet to be implemented. This will require training and time/resource commitment, which is currently not available.

The tension between the recommended model of communication – clear, consistent, authoritative, repetitive messaging – and a complex dynamic situation with many variations among towns is noted. It was suggested that consistent, authoritative, general messages, be complimented with the ability to have differentiated local authoritative messages as needed. Communication must be centralized and targeted. There is a need to centralize clear sources of public information. If dissemination of information becomes a second hand or more rapidly deteriorating, the validity of the information becomes compromised. While it is important to maintain official messaging, a portal allowing individuals to see the breadth of emergency information may aid people looking for further information. A clear challenge with the public is

the assessment of the importance of the message. “Is it just another message?” or “Do I need to pay attention at this time?” Emergency information must be audience-centered and focused on considering how the right people know what is going on, and how unfolding events affect their safety, egress, emergency plans, family, workplaces, schools, homes, etc.

Meaningful data for towns in floodplains include knowing how to access the river forecast data, interpreting the maps of affected areas, and understanding the implications of location/building structure, egress, etc. This is best looked at in two stages: developing clear points of input from field professionals and local officials and the distribution of the information in clear, official channels. The first might benefit from input at the administration/agency level to develop uniform protocols and might necessitate an agency leading to the development, maintenance, and update of a uniform process of communication with external partners/emergency officials.

Recommendation C.1: Assess gaps and generate recommendation for risk communication “two-way” channels, plans and protocols using SMART standards for emergency responses that include meteorological, hydrological, and emergency response professionals; locally elected, appointed, and volunteer leaders; and major infrastructure providers. Consider leveraging non-flood-related networks and communication channels during a flood crisis. Review gaps in light of plans for the establishment of a Joint Information Center. This assessment should include the consideration of two-way information flows between state and local officials to improve the efficacy of providing information to the public about current or impending hazards and drawing on local officials, their comments, and understanding about the situation to inform messages to the public. This plan should include having information coming from as few sources as possible and one place the public can go for information. Categories such as dam safety, transportation and road closures, emergency shelter sites, and requests for volunteers should be included.

Recommendation C.2: Provide timely comprehensible, translated risk communication to the public and vulnerable communities during crisis situations. “Translation” here is understood both in terms of English as second language Vermonters, as well as in terms of taking technical information and distilling it down to the lay person. The needs of people who use English as a second language are not always considered during emergency responses. The response of the Vermont Agency of Health and Human Services in July 2023 is commendable in this regard. However, translation services should be fully integrated into the overall communication backbone. During the July flood response, translation services were slow. There were no real time translators on call ready to support the response process. VEM is aware of this issue and is working to do this more rapidly when responding to emergencies. Many of the translations and messages (alerts, flood warnings, closures) can be pre-packed and vetted by local community leaders and other authoritative members of the community who know the locality and demographics. Some of these communication plans must include the most vulnerable, (such as nursing homes, manufactured home parks, and schools). The questions include: Who will reach out to whom? How should these messages be designed to be understood by different audience members?

Recommendation C.3: Provide greater education, guidelines, and resources for volunteers and residents regarding the public health risks of living and volunteering in flood hazard zones. Focus group participants raised concerns about the health and safety of volunteers and residents (e.g., sickness due to working in contaminated areas) and the need for more training in areas such as readiness and water literacy. Participants suggested that the state should play a more proactive role in supporting towns that do not have past experiences or the capacity to recruit or coordinate volunteers. Local governments and nonprofits may benefit from additional training, but groups of volunteers should have safety briefing information before performing work. With the ad hoc nature of immediate volunteers, work pamphlet information available at municipal offices for distribution may be a time-effective means of communicating hazards associated with flood waters. The State may want to consider this as a reason for distributing strategic hospital surplus, such as masks and gloves.

D. ENHANCE DAM EMERGENCY PLANNING, PREPARATION, AND COMMUNICATION

It should be noted that the major dams in the Winooski watershed functioned properly during the July 2023 event and remained functionally sound. However, the functioning of flood-control dam structures has not eliminated the risk of downstream flooding, particularly in relation to the types of high precipitation events of 2011 and 2023 and the expectations for more such events in the future. During July 2023, at least two of the flood control dams for the Winooski watershed were filled and remained vulnerable to additional follow-up precipitation on top of a saturated landscape. Had conditions been even slightly more severe and, for instance, a major dam had been breached, the capacity of local town officials, state emergency managers, and water resource managers to effectively assess and communicate risk to those in harm's ways would be limited. *Steps can and should be taken in order to avoid catastrophic loss of life when the next flood disaster strikes.* Recommendations A1-A3; B1-B3; and C1-C3 are all designed to improve the capacity and communication of state, regional and local officials, and their messaging to the public. These communications should include status updates for dam safety and function.

Our focus group surfaced with specific considerations for dam management and safety. As noted in the full technical report, two of the major flood regulation dams of the Winooski were under constant assessment during the height of the July flooding. At the Wrightsville Dam, the water level came within 10 inches of spilling over the auxiliary spillway. The flow in the North Branch between the dam and the Winooski River was still controlled by the tunnel at the dam, which prevented the water from getting too far out of the bank and caused too much flooding. However, if the water level rose by just 10 inches or more, it would have activated the auxiliary spillway and more water would have made its way downstream to areas already stressed with flooding. *Both communication and emergency response plans were inadequate for local officials and the general public to be informed.* In addition to the major flood-regulating dams of the Winooski, the focus group also raised concerns about the regulation of smaller private dams.

Recommendation D.1: Undertaking routine tabletop exercises related to major dam failures. These tabletop exercises should include dam failure and/or unscheduled auxiliary channel

release during high-precipitation events. Such exercises will help clarify communication plans, dispel misunderstandings, and provide stakeholders with a better sense of how the major flood-regulation dams of the Winooski (and all across Vermont) function. It also highlights the vulnerabilities related to dam safety and is helpful in informing local flood response plans and EAPs.

Recommendation D.2: Provide better integration of dam failure scenarios into actionable Emergency Action Plans (EAPs). Some private dams in the state have Emergency Action Plans (EAPs), but there are no requirements to update them. Developing a standard for what these plans should look like and a process to continuously review and update them are critical for the safety of these dams. Emergency Management Directors (EMDs) should incorporate all dam EAPs into their Emergency Operations Plans. Funding, education, and resources are needed to better educate dam owners and EMDs regarding dam emergencies and proper planning. New EAP rules are emerging as part of the Dam Safety Rule Technical Standards by 2025. EAP templates already exist for SIGNIFICANT hazard dams and a general template is used for HIGH hazard dams. EAPs for privately owned dams are strongly encouraged to integrate tabletop exercises, but they are not required. Currently, safety regulations for small dam owners do not mandate tabletop exercise. EAPs for small dam owners provide a summary of information about the dam, potential risks of failure, and a few limited scenarios of what can possibly happen when a dam fails. They do not spell out what to do in case of an emergency. Communications between the owners of small dams and local town officials is not required. These issues deserve further attention.

Recommendation D.3: Fund and resource inundation mapping for all dams (publicly and privately owned). This is an initiative that is already underway, "but does not have the resources to get to the finish line." The plan is to make the maps viewable on a public site. Larger dams have their own flood inundation maps for breaching or failure scenarios, whereas most smaller dams do not. A project to develop inundation mapping of every dam in the state would be beneficial even if these were simplified versions that only included dam water levels at the top of the dam and downstream flood conditions, assuming the spillway was running full. In addition, policies around dam releases before a major flood event should be considered in light of water quality restrictions.

E. ACTIONS TO AID RECOVERY

The recovery process needs to point to a safer outcome rather than the same outcome. We need clear, consistent messages about building safely, the need to "bounce forward," not simply bounce back," and to elevate new and replaced equipment. After a flood, clear communication and expeditious processing are crucial. Much of the problem currently is a lack of seeking guidance on permits and people disregarding legal requirements to build safely. It is feared that many professionals will install equipment while not meeting community standards or even seeking permits.

Expeditious action for permitting is needed, but these actions need to be informed by considerations of flood resilience outcomes, and avoiding allowing, for instance, "towns to decide to dredge their rivers without any real understanding of how bad of a decision that actually is." Keeping the stream alteration permit still needs to be enforced.

In Vermont, towns have different permitting standards, making it difficult to get unified clear messaging out. If everybody (including the plumber, furnace installer, etc.) knew the standards, the permit process would be much easier. This challenge was noted by one participant as, "What one person hears in one town does not translate over and there's a lot of hearsay bouncing."

Recommendation E.1: Streamline permit processes for recovery and mitigation. Simplification of the permitting process in floodplains is needed. Current processes require local development review boards to approve simple actions such as replacing boiler systems. Simplifying this process makes the recovery simpler, quicker, and less costly. The processes undertaken by the Development Review Boards (DRB) involve time-intensive actions that are ill-suited to emergency demands. Specific to immediate flood recovery, having consultants on retainer to assist towns may help inform the DRB in an expedited fashion by developing complete projects for review in a timely manner.

Recommendation E.2.: The State should take responsibility for all floodplain regulations. The participants noted the need for statewide floodplain bylaws. This is important because of the vast variation in bylaws between towns. The outcomes of recommendations A.2, A.3, and B.2 complement this action and address this issue.

Recommendation E.3: Provide comprehensive support for downtown businesses located in vulnerable floodplains and their long-term recovery. The lack of direct FEMA aid for businesses impacted by flooding has created a major resource gap between support for local businesses and residents. This lack of federal aid is a significant burden, particularly for small businesses that often comprise downtowns. Many businesses in historic buildings/downtowns are located in vulnerable buildings and often put inventory in the basement, disregarding the risk. Many of these historic buildings need considerable work to make them at least somewhat more floodproofed (for smaller, more frequent flood events). There is often a contradiction between the priorities of off-site owners and on-site renters. Small businesses vulnerable to flooding often do not have control over their buildings, high expenses and levels of debt, and find it difficult to plan ahead for real-world risks. These historic buildings/downtowns require attention to identify opportunities to make these settings less vulnerable. Better assistance to small business owners, particularly those renting, to highlight the need for inventory insurance, placement of assets in flood-prone basements, and steps to take for flood recovery are needed. This assistance should come in the form of structured information campaigns prior to floods and proactive outreach to businesses impacted by floods during the recovery phases.

F. PRIORITIZATION OF NATURE-BASED FLOOD MITIGATION EFFORTS

The CIROH research plans to continue the data collection process over the next year and focus on efforts that can be taken to reduce the harmful impacts of flood events in the region. Efforts will be made to engage with more local officials and community leaders in hard hit towns such as Montpelier, Barre, and Waterbury, to better understand how the Great Vermont Flood of 2023 and to a lesser extent the smaller flood events of December 2023 have led to more concentrated efforts to invest in longer term mitigation efforts. The extent of discussions among focus group participants around mitigation efforts centered on the uses of "nature-based solutions" related to enhancing the capture and storage of floodwaters by connecting rivers to floodplains. Efforts are underway to engage in such projects in the Waterbury region. Other towns with few opportunities for adjacent flood storage are left to consider other flood hazard mitigation needs such as modifying or moving structures. The larger flood mitigation picture to be painted here, however, is one of the considerations at watershed scales. Reducing flood risks for towns such as Montpelier will require the advancement of upstream flood mitigation measures. Just who champions and pays for such efforts should be a matter of interest to the entire state. To this extent, recommendations A.2, A.3, and E.2 should enhance the capacity of the region to think wholistically and coordinate resource flood hazard mitigation projects that reduce flood risks. However, this requires continued education. To quote one of our focus group participants:

> "The public education piece is incredibly important here – we're also talking to a lot of towns that think there is a silver bullet, i.e., remove the dam in downtown, and their flood risk magically goes away – that just isn't the case, we're talking about minor reductions in flood levels and incremental progress from each mitigation action. But with rainfall coming heavier and faster and that trend anticipated to continue… We have to have the hard conversations now before the next one."

More recommendations relative to mitigation measures are forthcoming. However, drawing on our current data, the following recommendations are offered:

Recommendation F.1: Invest in public and community education on watershed ecosystems. Educate the public on the relationship between the upstream and downstream dynamics associated with flood hazards. Introduce the concept of nature-based solutions. Consider some of the tough trade-offs that need to be made, for example, choices about rebuilding versus disinvestment, opening new tracts of land for concentrated development, etc. Educate on the impacts of woody debris on flood risk and water quality. These efforts could be undertaken by non-governmental organizations in the region.

Recommendation F.2: Prioritize investment criteria that consider the ecosystem services of flood hazard mitigation actions. More comprehensive accounting of the total ecosystem service valuation of buildings in flood plains can drive state and federal investments. Reduce reliance on standards defined by the National Flood Insurance (NFI) program and by inferring FEMA maps to drive zoning and building requirements inside floodplains.

Recommendation F.3: Increase focus on the removal of small dams and restoration of floodplains where it can be done. The US Army Corps of Engineers plans an assessment of the Wrightsville and East Barre dams (with the $500k from the governor's budget as a match for this project), and other efforts are already underway to address needs at the Waterbury Dam. The vast majority of dams are not meant for flood control; however, removing them and restoring the floodplain reduces the likelihood of failure and causes much greater flooding, since many are not in good shape. Instead, removal has a significant benefit in improving and restoring the river function.

Recommendation F.4. Prioritize the co-benefits of flood hazard mitigation and water quality for planning and resource allocation. The Tactical Basin Plan process, run by the Agency of Natural Resources, can serve as a communication channel for flood hazards. The process can provide communities with explanations about the planning processes and mitigation efforts, and why they are done, so that they understand the purposes and benefits (e.g., flood resilience). Sharing the co-benefits of water quality and flood control has been successfully used during planning and communication processes, encouraging people, for example, to have riparian buffers, which have been found to have both nutrient sequestration and flood hazard mitigation co-benefits. It is also noted that apparent trade-offs between flood hazard mitigation and water quality need to be considered, particularly in light of dam management (see recommendations D.1-D3). Watershed-scale efforts to prioritize and fund water quality projects can be leveraged, in some cases, to support mitigation projects that support nature-based solutions (e.g., water absorption and retention).

VII. Conclusion

Following the devastation of Tropical Storm Irene in 2011, the Institute for Sustainable Communities initiated a process to engage stakeholders from across the state of Vermont to enhance resilience and reduce the risks associated with flooding and other natural disasters. The "Vermont's Roadmap to Resilience" (VRR) report was written following a robust, consensus-driven process of stakeholder engagement. The report offers the following objectives that are worth reiterating:

- A resilient Vermont is better prepared for and able to more effectively manage and bounce back from natural disasters and climate-related shocks, and the risks they pose to our economy, environment, and social well-being.
- A resilient Vermont focuses on proactively reducing our vulnerabilities and improving our response and recovery to ensure that we are continually strengthening our resilience.
- Vermont must be resilient at every level – from individual residents, households, businesses, and neighborhoods–to the entire community and state. There is a shared sense of responsibility for resilience at every level and across the public, private, and nonprofit sectors (Institute for Sustainable Communities, 2013,5)

A series of twenty-three recommendations (2013, 41-42) was offered in the VRR to strengthen the capacity of the state to plan for, respond to, and recover from disasters. A series of recommendations relating to risk communication, elevated and integrated emergency management, alignment of rules and investments, and steps to enhance collaboration were offered to much fanfare. Although some of these recommendations were likely taken up, many appear to have not been pursued. We surfaced evidence to suggest that a few of these key recommendations remain unaddressed or under-addressed, including:

> Incorporate vulnerable population data and analysis into municipal, regional, and state hazard mitigation plans with the help of social service providers so that the needs of Vermont's vulnerable populations are clearly identified and represented at all levels of hazard mitigation planning (VRR recommendation 4; see C.2 of this report).
>
> Increase emergency management capacity at the local/municipal level to ensure that those who are responsible for emergency management functions before, during, and after disasters have the skills, training, and equipment they need (VRR recommendation 9; see A.1, B.1-2 of this report).
>
> Regionalize key emergency management functions to provide more efficient and effective support to communities, improve communications, and create strong regional coordination (VRR recommendation 10; see A.3 of this report).
>
> Invest in training and technical assistance programs to promote cost-effective action and preparedness and reduce future disruptions to state and municipal infrastructure systems (VRR recommendation 13; see B.3 of this report).
>
> Create a regulatory framework/approach to land use that does not create any new or additional vulnerabilities along Vermont's waterways ("No Adverse Impact" approach) (VRR recommendation 16; see E.1-2 of this report).
>
> Develop model flood resiliency bylaws for compact communities located in river corridors (VRR recommendation 17; see E.1-1 of this report).
>
> Use regional networks to support watershed-scale planning and enable municipalities to collaborate across jurisdictions to set priorities and make cost-effective investments that reduce hazards for downstream communities and development (VRR recommendation 21).

The VRR report relied heavily on the development and maintenance of regional resilience networks to enable greater collaboration and coordination. Although we commend this grassroots approach, the sustainability of such networks between times of crisis can be difficult. While we found evidence of several nonprofit, community-based organizations mobilized to play critical roles in preparation (some provided early warnings), response, and recovery, major communication gaps still persist. Greater attention to the coordination between state and local

officials, and increasing the capacity to coordinate planning, response, and mitigation measures at the regional and county scales are desperately needed. *Problems AND solutions to flooding events occur at watershed scales*. Vermont's efforts to take a watershed-scale approach to water quality serve as an excellent example to refer to and replicate for emergency management. Building regional planning capacity occurs through the resourcing and building capacity of all RPCs, or by considering a new county-level approach. *The point to be made here is that a serious approach to moving Vermont into robust regional planning and a coordinated response approach is needed.*

Solutions to enhance the resilience of Vermont's communities are present. These solutions require resources, and the political and social will to think differently about our culture of planning, communicating, and resourcing. Some of these solutions were first surfaced in the VRR report and appear to remain unaddressed.

Future flood events on the scales of 2011 and 2023 are inevitable. To think that "it can't get worse" *next* time is short-sighted and could possibility result in greater catastrophic losses of live and property. While the emergency response to the Great Vermont Flood of 2023 was adequate, further action is needed to ensure that it is capable of responding to a flood crisis of equal or greater severity when it (very likely) occurs.