New Hampshire House Bill 648

Chapter 179 Laws of 2007

Comprehensive Flood Management Study Commission

Final Report

September 2008

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List of Acronyms

AHPC - Advanced Hydrologic Prediction Center

AoT – Alteration of Terrain

BEM – New Hampshire Bureau of Emergency Management

CRREL - Cold Regions Research and Engineering Laboratory

DES – New Hampshire Department of Environmental Services

DFIRMS – Digital Flood Insurance Rate Maps

DOS – New Hampshire Department of Safety

DOT – New Hampshire Department of Transportation

GIS – Geographical Information System

GRANIT - Geographically Referenced Analysis and Information Transfer System.

HB – House Bill

HEC-RAS - Hydrologic Engineering Center's River Analysis System

FEMA – Federal Emergency Management Agency

F&G – New Hampshire Fish and Game Department

FIRMS – Flood Insurance Rate Maps

LiDAR – Light Detection and Ranging

NERFC – Northeast River Forecasting Center

NFIP – National Flood Insurance Program

NOAA – National Oceanic and Atmospheric Administration

NWS – National Weather Service

OEP – New Hampshire Office of Energy and Planning

RMAC – Rivers Management Advisory Committee

USACE – United States Army Corps of Engineers

USGS – United States Geological Survey

Report Authorization

New Hampshire House Bill 648, Chapter 179.1, Laws of 2007, established this commission to develop a comprehensive flood management plan for the state of New Hampshire that considers possible measure for minimizing flood impacts on communities and individual properties and to consider issues associated with flood abatement. This report looks at New Hampshire's historical and predicted floods, current and expected dam inventory, the trends and regulation of development, as well as the current state and needs for both short- and long-term weather forecasts. It presents current thinking on actual and future risks to guide the wise investment of taxpayer funds to efficiently reach a more reasonable level of protection

For a complete list of all commission members please see HB 648 Interim Report (Appendix A).

Executive Summary

New Hampshire's recent experience with floods has underlined their potential danger and costly devastation. Due to the nature of the conditions that affect flooding the means to reduce the risk of flood losses are not simple or easy. To reduce the impact of flooding there must be sustained investment and cooperation from individuals, businesses, private organizations, municipalities, the state and the federal government.

New Hampshire has averaged about one major and destructive flood per decade since the early 20th century, and three major flood events in 2005, 2006 and 2007. A common theme amongst all of the data collected by this commission was that floods and flood damage can be mitigated, though not fully avoided, through a variety of land use and development regulations, proactive conservation and restoration activities, real-time data and accurate floodplain mapping availability, and infrastructure maintenance and design. However, all of these mitigation tools must be implemented with the consideration that landscape change (i.e. development) and climate change continue to alter flood regimes and floodplains. Current floodplain maps are based on historical data, and many maps may no longer be accurate given existing and/or future changes to the landscape. That is, the 100-year flood events are the current planning standard, but climate change and increased development will change the size and frequency of 100-year flood events making currently mapped 100-year floodplains inaccurate. Without accurate, updated floodplain mapping and information it is impossible to identify areas that may have an increased risk of flooding and erosion due to these changes.

The settlement pattern in New Hampshire has taken place largely around rivers and lakes with these floodplain areas often being the easiest areas to develop. Floodplains, however, are where the most flood losses occur. Development in these areas puts people, buildings and infrastructure in harms way, and increases the rate and amount of floodwaters forced downstream causing more damage. Land use and development regulations must be implemented in order to minimize damage to existing structures and to protect undeveloped floodplains to maintain their flood storage capacity. As the state continues to grow and climate change impacts become more pronounced protecting floodplains and the flood abatement services, along with other ecosystem services they provide will become harder and more costly.

Historically, thoughts have turned to dams to abate flooding. However, while New Hampshire's aging dams contribute to stream management, they themselves can pose a threat if not properly maintained. There is minimal potential for using existing dams or new dams for flood abatement due to capacity, construction costs and environmental impacts. Fewer than 2 percent of dams in New Hampshire were built to minimize flooding, the bulk of the state's dams are privately owned, and many are in need of maintenance or upgrades. There is a general shortage of funds to do this work; yet, there are 10,000 homes in the state put at risk by dam failure, and new development downstream from dams is raising those stakes.

The rapid development also means New Hampshire must prepare for the next era of watershed management, which will include flood abatement while assuring adequate water flow for downstream users and the environment. Meanwhile, flood planning needs to be improved, both to guide development and to better respond to flood emergencies. Efforts must be undertaken to correct outdated river models, and to collect, share and analyze additional storm, flow and flood data. While the state can make some of efforts on its own, others are dependent upon federal agencies such as the Federal Emergency Management Agency (FEMA). Communication among all flood related agencies must flow easier and faster. New partnerships must be formed to add to the existing inventory of stream gages. Better use must be made of data already being collected. There is a major need to

collectively fund the transition to modern mapping and Geographic Information System (GIS) tools. Risks to state and critical infrastructure must be minimized.

Flooding and flood losses cannot be fully avoided, however, sound land management practices, better forecasting and data availability, and proper dam management and operations can help to mitigate the impact of flooding in New Hampshire. An approach must be adopted that fosters long-term sustainability and improves our ability to withstand such natural events as floods without experiencing them as devastating losses for our citizens and the built environment.

For a summary of the needs and recommendations made by this commission please see Appendix B.

Landscape Management

1. **Subcommittee Members & Participants:** Michael Pillsbury, DOT; Steve Couture, DES; Mark Zankel, The Nature Conservancy; Jennifer Gilbert, OEP; Joanne Cassulo, OEP; Michael Andosca, shorefront landowner; Carl Paulsen, New Hampshire Rivers Council; John Magee ,RMAC representative to HB 648; and Jennifer Rowden ,DES..

2. **Findings**

In recent years New Hampshire has experienced three major flood events in October 2005, May 2006 and April 2007, and precipitation and rainfall totals have been higher than normal in Concord and the Merrimack Valley.[i] The total FEMA expense for just the 2006 and 2007 flood events totaled $75.6 million.[ii] The total amount FEMA has paid for flood losses though the National Flood Insurance Program (NFIP) in New Hampshire is as follows:

County	NFIP Policies	Insurance In Force	Total Paid Losses*	Total Paid Amount*	Total Repetitive Loss Properties**
Belknap	331	$62,819,300	91	$754,070	13
Carroll	542	$103,710,800	205	$917,674	11
Cheshire	552	$104,428,400	175	$4,418,672	0
Coos	196	$26,653,200	64	$358,739	4
Grafton	895	$136,516,500	192	$1,296,235	19
Hillsborough	1,317	$277,353,200	530	$9,120,271	64
Merrimack	610	$120,398,600	258	$5,128,165	49
Rockingham	3,790	$638,515,800	1,552	$15,002,917	132
Strafford	450	$92,592,800	111	$1,853,638	10
Sullivan	172	$31,745,700	33	$260,776	2
Total	**8855**	**$1,594,734,300**	**3211**	**$39,111,157**	**304**

Source: FEMA Community Information System (September 23, 2008)
* Cumulative totals since 1978
**"Repetitive Loss" means flood-related damage sustained by a structure on two separate occasions during a 10-year period for which the cost of repairs at the time of each such flood event, on the average, equals or exceeds 25 percent of the market value of the structure before the damage occurred.

Land cover conversion toward greater degrees of impermeability (e.g., roads, buildings, parking lots, etc.) and toward reduced stormwater retention will substantially affect the watershed runoff characteristics during rainfall events. When a watershed approaches ten percent impervious surface coverage, watershed characteristics begin to decline, including stream channel morphology, flood storage capacity and water quality.[iii] For example, in the New Hampshire coastal watershed, the impervious surface coverage has increased from 4.7 percent in 1990 to 8 percent in 2005, with a documented impact on aquatic life in the Exeter River Watershed.[iv] As the amount of impervious surface increases in a floodplain the location and severity of flooding and erosion can change over time and may not be accurately represented on floodplain maps.

An independent FEMA evaluation of the 2006 and 2007 flood events in New Hampshire found that land use change affects the impacts of smaller flood events to a greater extent than events the size of the 2006 and 2007 events. The 2006 and 2007 flood events were the result of a long period of precipitation on top of already saturated soils; development had minimal impact on flooding itself. The landscape in the affected areas responded as if it were impervious and completely developed.[v]

Addressing the issue of land management in relation to flooding is a key aspect in preventing or reducing flood losses. It should also be noted that improved floodplain protection and management will have many co-benefits for river health and fish and wildlife populations. Below are key findings, suggested needs and/or deficiencies several individuals from flood related programs presented to this subcommittee in relation to land management.

3. Needs and Solutions

3.1. State and Critical Facilities

3.1.1. Need: Prohibit the construction of new critical facilities or state facilities in fluvial hazard zones (mapped 100- and 500-year floodplains or identified fluvial erosion zones). As of 2003, six other states require critical facilities be kept out of the 500-year floodplain.[vi]

Recommendations

- Prohibit construction of new state facilities or state-funded facilities in fluvial hazard zones. This prohibition would not apply to water dependent facilities.

- Relocate existing state facilities out of fluvial hazard zones, if feasible. If not feasible, mitigation measures should be used to protect existing state structures up to the 500-year flood level. Relocating existing state facilities out of fluvial hazard zones is the preferred option when considering expansion or improvements to a facility within a flood hazard zone.

    - Substantial improvements of existing facilities in the fluvial hazard zones must be avoided and minimized to the maximum extent practicable.

- Avoid and minimize expansion of existing state facilities in fluvial hazard zones to the maximum extent practicable.

- Protect new critical facilities from and be accessible during the 500-year flood. If a new or existing critical facility must be located in a floodplain it should be provided a higher level of protection so that it can continue to function and provide services after a 500 year flood. When new critical facilities are constructed, at least the primary access road should also be at the 500-year flood elevation.

- Increase state facilities stormwater requirements

    - The sponsor of any development or redevelopment project involving a state facilities project with a footprint that exceeds 5,000 square feet shall use site planning, design, construction and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the

predevelopment hydrology of the property with regard to the temperature, rate, volume and duration of flow.

3.2. Land Protection

3.2.1. Need: Increase the preservation of land in floodplains to help retain natural flood storage capacity while also providing significant ecological benefits for fish and wildlife.

Recommendations

- Create a mechanism within existing land protection grants, such as the Land and Community Heritage Investment Program, to identify floodplains and fluvial erosion areas protection as a priority.

- Increase use of Natural Resource Conservation Service watershed and land conservation programs for floodplain and fluvial erosion areas.

- Create a new land protection grant program focused solely on floodplains and fluvial erosion areas. For example DES Source Water Protection Land Grants have been very effective. Floodplains, like documented source water areas, are mapped resources with documented public values; it makes sense to consider a similar incentive program for their protection.

    - US Army Corps of Engineers (USACE) and the Charles River Natural Valley Storage Initiative resulted in federal appropriations to purchase over 8,000 acres of wetland areas to maintain flood storage in Massachusetts. New Hampshire should make a similar effort in Coastal Watershed due to its development pressures and existing flooding issues.

3.3. Floodplain Management

3.3.1. Need: Establish a state-level regulatory approach for floodplain management.

Recommendations

- Incorporate floodplain management into existing state regulatory programs, specifically the DES Alteration of Terrain Program and Wetlands Bureau.

    - Incorporate floodplains into RSA 485-A:17 Alteration of Terrain Program .

        - Similar to Comprehensive Shoreline Protection Act for floodplain developments. Portion of development falls within a mapped floodplain, AoT review criteria drops to 50,000 square feet.

        - Require build-out analysis for developments that encroach on floodplains to establish a uniform method for using future conditions within a watershed. Note: According to the Association of State Floodplain Managers, flood heights in an urbanizing watershed can increase from 2

to 9 feet, putting existing houses and new development under water even though they were built to be protected from today's flood.

- Incorporate floodplains into RSA 482 –A Jurisdiction (DES Wetlands Bureau)
    - ♦ Expand jurisdiction to include floodplains.
    - ♦ Avoidance and minimization would be applied.
    - ♦ Higher standards for development.
    - ♦ Restore and protect flood hazard areas with wetlands mitigation funds.
- Develop watershed-specific HEC-RAS models across the State to assist in understanding flood flow characteristics and how land use and climate changes are affecting flood prone areas. Such modeling could also determine critical flood storage areas needed for protection from development. State could use as basis for buildout analysis to be used by AoT.
    - ♦ Possible funding mechanism: Federal Emergency Management Agency.
- State adopts a higher National Flood Insurance Program standard.
    - ♦ The Association of State Floodplain Managers recommends several higher standards in their document, *No Adverse Impact - A Toolkit for Common Sense Floodplain Management* (www.floods.org/NoAdverseImpact/NAI_Toolkit_2003.pdf).

3.3.2. Need: Increased funds for flood management activities.

Recommendations

- Create a state funding source for "Floodplain Management Initiative".
    - ♦ Identify existing funding mechanisms that are linked or can contribute to Floodplain Management Initiative (restrictions for existing funding sources would have to be considered), or establish criteria within existing funding sources to provide an advantage to floodplain management projects.
        - DES (State Aid Grants, State Revolving Fund, Watershed Restoration, Drinking Water Supply Planning Grants).
        - NH Fish & Game (F&G) Fisheries Habitat Account and Wildlife Habitat Account.
        - Wetlands mitigation projects or funding.

3.3.3. Need: Locating structures within the 100-year floodplain and determining flood insurance status.

Recommendation

- Encourage local floodplain managers to research maps and building addresses in the 100-year floodplain.

3.3.4. Need: Increase knowledge of flood building codes at the local level.

Recommendation

- Establish a formal training program for local building officials relevant to flood related building codes.

3.3.5. Need: Establish a state-level fluvial erosion hazard program similar to Vermont's Fluvial Erosion Hazard Program[vii]

Recommendations

- Work with Federal Emergency Management Agency to incorporate fluvial erosion into National Flood Insurance Program and to provide technical and financial support for local implementation in accordance with FEMA's Riverine Erosion Mapping Feasibility recommendations.[viii]

- Provide a state funding mechanism to support staffing for the program.

- Amend state law, if necessary, to allow the establishment of fluvial erosion hazard ordinances.[ix]

    - ♦ This will allow for a comprehensive model "flood hazard ordinance" that considers inundation and fluvial erosion. See Vermont Fluvial Erosion Hazard Program at www.anr.state.vt.us/dec/waterq/rivers/htm/rv_floodhazard.htm

3.3.6. Need: Increase ability for the state and municipalities to manage stormwater.

Recommendations

- Local fee on impervious surfaces could be used to address/upgrade stormwater management to minimize hydrologic changes.

    - ♦ House Bill 1581 Chapter 295, Laws of 2008 allows the formation of stormwater utilities.

- DES and OEP should actively support the creation of stormwater utilities.

    - ♦ DES and OEP should provide technical assistance program for communities.

- House Bill 1295 Chapter 71, Laws of 2008 establishes a commission to study issues relating to stormwater. The following issues should be further investigated by the Stormwater Study Commission in relation to floodplain management.
    - ♦ Basic stormwater issues and their relevance to floodplain management.
    - ♦ Impervious surfaces and effect on peak flows and runoff volume. New Hampshire should strive to minimize to the extent technically feasible development impacts to hydrology (volume and peak flows).
    - ♦ Climate change impacts on stormwater.
- Continue support for DES and Regional Planning Commissions Innovative Land Use Controls stormwater ordinance.
- Encourage municipalities to submit stormwater infrastructure needs to DES as part of the *2008 Clean Water Needs Survey*.
    - ♦ Fund stormwater infrastructure improvements through the State Revolving Fund and State Aid Grant programs.

3.3.7. Need: Ensure that bridges and culverts are adequately sized.

Recommendations

- Improve connection between hazard mitigation plans and master plan.
    - ♦ Capital Improvements Program should provide the foundation for future local funding of hazard mitigation projects/areas of concern identified in master plan e.g., culvert replacements.
- Develop an in-lieu mitigation option (DES) for projects that impact floodplains and stream channels.
- Adopt wetland rules that incorporate the following design guidance:
    - ♦ To allow for passage of the 100-year frequency storm.
    - ♦ To ensure to the maximum extent possible that there is no increase in flood stages on abutting properties.
    - ♦ Flow and sediment transport characteristics will not be affected in a manner which could adversely affect channel stability as described in the *NH Fish and Game Stream Crossing Guidance(September 2008)* [x].
- Department of Transportation should address climate change and impervious surface effects when updating its *Manual on Drainage Design for Highways*.

- State agencies should work with the University of New Hampshire Technology Transfer Center to educate communities on culvert sizing criteria and potential funding sources to address floodplain issues and culvert upgrades.

- DOT, DES and F&G, with input by The Nature Conservatory, should be tasked to develop the procedure and database for a standard culvert assessment data collection.

3.3.8. Need: Establish protocol for mitigation procedures for removal of woody material that may pose an imminent threat to infrastructure.

Recommendation

- Develop a program for regular inspection and removal of only those fallen trees along river banks that pose an imminent threat to infrastructure.

3.3.9. Need: Local Floodplain ordinances should prohibit future development within a 100-year floodplain.

Recommendations

- Encourage New Hampshire municipalities to adopt floodplain ordinances that prohibit fill, new construction or substantial improvement within the 100-year floodplain, specifically the Regional Environmental Planning Program Innovative Land Use Controls model Flood Hazard Area Zoning ordinance authorized by RSA 674:21.

    - ♦ OEP should develop a model ordinance that prohibits development within the 100-year floodplain.

3.4. Flood Insurance

3.4.1. Need: Increase education and outreach to communities regarding floodplain management and insurance options.

Recommendations

- Develop a multidisciplinary approach to assist communities who request help to improve floodplain management. This could be based on the Natural Resources Outreach Coalition model.

- OEP and GRANIT web based education module on floodplain management for local officials www.nhflooded.org should contain guidance for more restrictive NFIP standards and Community Rating System.

- OEP *Flood Lines* newsletter is available quarterly and should continue to focus on communities who exceed NFIP standards.

- Promote community “flood audits” as an outreach tool.

3.4.2. Need: Encourage all New Hampshire communities participate in NFIP and its Community Rating System.

Recommendations

- Adopt legislation to encourage participation in the NFIP. The legislation would include the following:
  - ♦ Non-participating communities will not be eligible for matching state funds for state or federally declared flood disasters.
  - ♦ CRS communities pay less in local match requirements for state or federally declared disasters; the state would make up the difference.
    - BEM should work with DES and OEP to develop criteria for this incentive.

3.5. Floodplain buyouts

3.5.1. Need: A dedicated state-funding source for floodplain buyouts.

Recommendation

- Develop a state funding dedicated to buyouts. This is a significant deficiency considering the potential to match federal dollars and eliminate long term costs.

Flood Forecasting and Data

4. **Subcommittee Members and Participants:** Fay Rubin, University of New Hampshire – GRANIT; Frederick Chormann, New Hampshire Geological Survey; R. Stewart Yeaton, Town of Epsom; Jennifer Gilbert, New Hampshire Office of Energy and Planning; Michael Poirier ,Department of Safety; Katja Fox, Office of the Governor; Ken Toppin, US Geological Survey; and Keith Robinson, US Geological Survey.

5. Findings

The findings, and subsequent needs and solutions, reported here are grouped into two main focus areas: data and forecasting of floods from a planning perspective, and data and forecasting of floods from a real-time and emergency response perspective. The planning perspective is related to having proper data and forecasting of floods so that appropriate land use planning and development can occur that minimizes flood damage and the propagation of floods. This includes having reliable and up-to-date Flood Insurance Studies and associated Flood Insurance Rate Maps (FIRMs), delineation of floodways and flood plains, and tools that would allow resource managers and planners to assess the incremental impact of land-use changes and structures on flood magnitude and occurrence both locally and downstream. Real-time or flood event data and forecasting refers to having the data and forecasting tools in place so that the public and emergency management agencies can best know and estimate the extent of flooding that may and that is occurring due to a specific rainfall/snowmelt/ice jam event. These data and forecasting tools need to be available prior to and as the flooding event occurs, and includes active stream-gages, National Weather Service flood forecasting, and watershed models. These tools are needed to predict stream-flows so that dam operations can be modified as needed, and allow public notifications on the potential extent of flooding and evacuations.

Data and Flood Forecasting for Planning Purposes

Presentations by Dean Savramis of FEMA and Jennifer Gilbert of the New Hampshire Office of Energy and Planning were made to the Flood Commission that provided material for the following description of data and flood forecasting for planning purposes. For a complete list of all presentations made to the commission, please see Appendix C.

The most common planning tools for floods are FEMA's FIRMs that show the locations of the 100-year floodplains (and sometimes the 500-year floodplains) for communities across the nation, and Flood Insurance Studies that provide a summary by community of hydrologic data and studies, floodway data and profiles, and estimated peak stream-flow or discharges. The FIRMs, typically produced in the 1970s and 1980s, are based on a combination of field data collection and stream-flow modeling so that the floodways can be estimated in relation to roads and community boundaries (Figure 1). These maps are designed to help communities regulate development in floodways and floodplains. It should be noted that the FIRM maps are only flood inundation areas, and do not address potential flood erosion areas, called "fluvial erosion areas".

FEMA is currently undertaking a nationwide effort to update flood hazard data and mapping through the Map Modernization program. The Map Modernization effort produces digital county-wide maps called digital FIRMs (known as DFIRMs) that utilize aerial photography for the base layer (Figure 1). This photographic base layer provides a better reference of where the floodplain boundaries are for local officials and the public who use the maps. The benefit of a digital map is that it allows communities to merge the floodplain delineations with the community's other digital data for landscape characterization and planning.

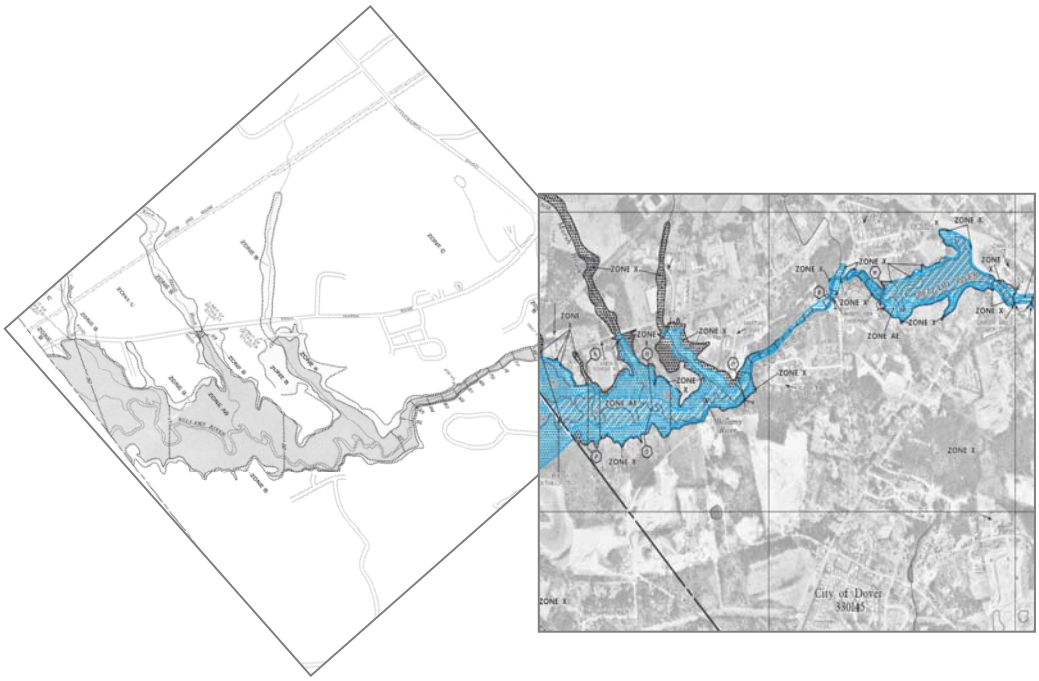

Figure 1. The map on the left is the former Flood Insurance Rate Map for the city of Dover and the map on the right is Dover's current Digital Flood Insurance Rate Map.

Presently in New Hampshire Rockingham, Strafford, Cheshire, Sullivan and Grafton counties have effective DFIRMs in place. Hillsborough and Merrimack counties have received preliminary DFIRMs, which are expected to become final in 2009. Currently, no preliminary or final DFIRM updates have been proposed for Coos, Carroll and Belknap counties.

The maps and studies represent important components of state and municipal planning tools for estimating where flooding is possible. Yet, these products have a number of deficiencies; they include:

- Flood zone boundaries are estimates and can be significantly inaccurate in some areas.
- The topographic data that provides the map base for delineating modeled flood inundation areas is of relatively poor resolution i.e., topographic contours at 10-foot and in some instances 20-foot elevation intervals.
- The floodplain boundaries do not reflect watershed changes, such as development that have occurred since the maps were first completed. In some locations, the maps and/or the map data are 30+ years old and do not reflect the extensive land use changes that have occurred in some watersheds since that time.
- Improved or updated flood frequency and other data are now available to make more accurate floodway delineations or show areas of inundation, but there are no funds to perform the updates/improvements.

Another source of information for local planning of floods has been the National Weather Service's Rainfall Atlas, which characterizes the 2-, 5-, 10-, 20-, 50-, 100- and 500- year runoff events for the state. This atlas is 40 years old and based on data from the first half of the 20th century. The information in the atlas has provided useful data/information to design engineers and planners, but is now currently out of date[xi]. Updated rainfall atlas data for the northeast are also available through the Northeast Regional Climate Center at Cornell University (www.nrcc.cornell.edu).

Data and Flood Forecasting for Flood Event Awareness and Emergency Management

Presentations to the Flood Commission by Jim Gallagher of DES Dam Bureau, Keith Robinson of USGS, and Chris Pope of NH Department of Safety were used in the preparation of this section. For a complete list of all presentations made to the commission, please see Appendix C.

Currently there are a number of data collection and display, and forecasting efforts in place to warn the public, water users and managers, and emergency management officials about impending flooding. Most of these programs were described to the Flood Commission during the fact-finding phase. They include:

- National Weather Service (NWS) flood forecasts
- US Geological Survey (USGS) stream-flow gages
- Dam break analysis
- DES Dam Bureau monitoring and watershed modeling
- Coordination of emergency management activities by the NH Department of Safety (DOS).

NWS Flood Forecasting is the primary source of flood watches and warnings. These are coordinated through the NWS Advanced Hydrologic Prediction Center (AHPC) in Taunton, Massachusetts, but involve input from NWS service hydrologists in the Grey, Maine and Taunton, Massachusetts river forecast offices. These offices issue the flood watches and warnings that are displayed through the internet, television and radio.

The AHPC uses rainfall-runoff models to predict the potential for flooding. These models incorporate a variety of data that are collected by the NWS and many other agencies/organizations. Results of these models are displayed on AHPC web pages for the Grey, Maine and Taunton Massachusetts, servicing offices. They show model results (tabular forecast data, statistics, and river forecast hydrographs) for specific river locations that generally correspond to where USGS stream gages are operating. Figure 2 shows what these forecasts look like.

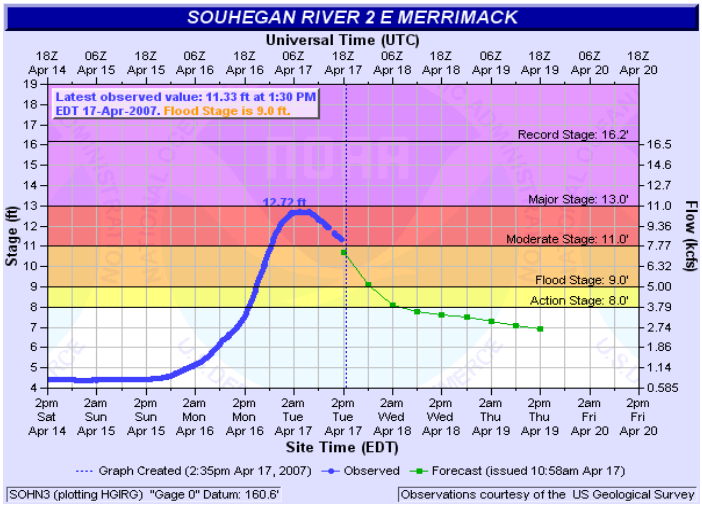

Figure 2. NWS flood forecast model.

In New Hampshire the river forecasts are available at the website: http://newweb.erh.noaa.gov/ and are made for the following rivers:

Ammonoosuc River
Androscoggin River
Baker River
Connecticut River
Contoocook River
Merrimack River
Nashua River
Pemigewasset River
Piscataquog River
Saco River
Smith River
Soucook River
Souhegan River
Spicket River
Sugar River
Warner River

The NWS will soon be adding two new rivers in New Hampshire to the flood prediction page: the Lamprey and Suncook rivers. The NWS has indicated that improved flood forecasting capabilities will be possible with enhanced data on current hydrologic and soil moisture conditions in the state.

The NWS has also been working with other agencies in other portions of the United States to produce real-time flood inundation maps. These maps are produced prior to the actual flooding to show in detail what land would be inundated if certain river stages (water height) occur during a flood.

The USGS currently operates nearly 50 stream-flow gages throughout New Hampshire for flood warning, dam operation, water quality and numerous other purposes. The stream-flow data from the gages are displayed in near real time (one to four hour delay) on the USGS web page (http://waterdata.usgs.gov/nh/nwis/current/?type=flow). These gages are supported with funds from the state of New Hampshire, US Army Corps of Engineers (USACE), the USGS Cooperative Water and National Stream-flow Information Programs and a variety of communities across the state. The USGS will be adding 15 new gages in the state over the next two years as part of the cooperative NH-USGS stream-flow gaging network. These new gage locations correspond to watersheds in the state identified by the Stream Gage Task Force in 2006-07 that are lacking stream-flow information.

The long-term sustainability of the stream-flow gaging network in the state is often in a state of flux due to the uncertainty in funding from year to year. While numerous agencies contribute funding to the network, there is currently no long-term funding program in place to support the gages indefinitely into the future. In addition to the addition of gages in the state network, increases in recent funding of the USGS National Stream-flow Information Program (NSIP) have supported several gages in the state during the past few years.

In addition to stream-flow gages, USGS operates water level stage monitors at selected streams and dams in the region; these water level monitors are less expensive to operate than full stream-flow gages, but provide real-time information on the height of the water body. These water level monitors may be an appropriate and less costly alternative to a stream-flow gage in areas of rapid flooding or ice jams.

USGS works with local, state and other federal agencies to characterize flooding and develop new stream-flow and flood statistics for rivers. USGS is currently working with FEMA to estimate the magnitude and frequency of flooding in 2007 and produce flood recovery maps of the Suncook River. It recently published reports on the October 2005 and May 2006 floods. USGS is also developing new flood flow characteristics and estimated recurrence intervals for the flows for natural rivers in the state as part of a cooperative study with DOT. This study will display results in the interactive web-

based application called “Streamstats” (described at www.streamstats.usgs.gov/). Like the NWS, USGS has developed interactive web applications that produce flood inundation maps. These applications have been developed in other areas of the nation, but show the potential of similar applications to the state of New Hampshire. Also, USGS in conjunction with other agencies and the private sector is developing new technologies to make flood monitoring safer and cheaper by using radar, acoustics, laser and other means.

In New Hampshire, all dams that are classified as either “High” or “Significant Hazard” are required to have Emergency Action Plans. A High Hazard Dam is a dam where loss of life is probable downstream if the dam were to fail. A Significant Hazard Dam is a dam where significant property damage would occur downstream if the dam were to fail. Emergency Action Plans include the results of computer modeling to determine the downstream flooding that would occur if the dam were to fail. The extent of the flooding determined by this modeling is plotted on maps showing the areas that would be inundated, the depth of flooding and the time required for the flood wave to arrive. These inundation maps are included in the Emergency Action Plans, and are to be used in an emergency in the event of a dam failure.

There are 296 High and Significant Hazard Dams in New Hampshire, all of which have available Emergency Action Plans.

The DES Dam Bureau operates 15 snow pack monitoring sites, plus lake levels and seven stream-flow gages in numerous watersheds in central New Hampshire. These data collection efforts are designed to help manage the storage of water in the lakes and impoundments and further downstream. These data are also used by the USACE in the operation of its flood abatement structures, as well as numerous small dam owners and operators. In addition, the NWS uses the snow pack and river data for making flood forecasts. Information on the Dam Bureau’s data collection efforts is available at www.des.nh.gov.

The DES Dam Bureau has developed and operates a rainfall-runoff model for the Lake Winnipesaukee basin to help in the maintenance of lake levels and protection of lakeside and downstream properties. This model incorporates data from their stream flow, lake level, and snow pack data collection efforts among other parameters.

If a flood event or the potential of a flood event exists, then the Homeland Security and Emergency Management Division of DOS will begin to coordinate information gathering and analysis with the DES Dam Bureau. If warranted, the Emergency Operation Center) may open and staffed with appropriate personnel from the DES Dam Bureau to monitor and respond to the event.

Other Considerations for Data and Flood Forecasting

The potential effects of climate change and development on flooding and river flows in general were presented by a variety of presentations made to the Flood Commission; these are summarized here.

New Hampshire is dealing with a changing landscape with regard to flooding. First, residential, commercial, and transportation development activities have resulted in more areas of the state being consider urbanized and suburbanized. Studies show that increased urbanization and impervious surfaces in a watershed results in increased flood flows and often, decreased low flows. The effects of development on the hydrology of New Hampshire streams is lacking and predictive tools are needed to help explain how future development will influence the hydrology of the state’s rivers and streams.

Secondly, broad-scale climate change studies suggest that there may potentially be significant changes in the amount and timing of precipitation in the state. This may include more intensive storms, less snow, more frequent short-term droughts, and warmer mean annual temperatures. Climate change may also mean that the long-term data that has been collected on precipitation, stream-flow and snow cover, and how this data is interpreted, may not be indicative of future conditions. Current research points to the need for re-establishing the normal and extreme hydrologic conditions in the state, and what that means for flood abatement and protection.

Finally, increasing population and changing lifestyles will lead to greater demand on water supplies. Managing water resources for flood control purposes and at the same time, ensuring adequate supplies during low-flow or drought periods will take on greater importance in the years ahead.

6. Needs and Recommendations

6.1. Forecasting Expand flood forecast capabilities. Areas for expansion would be:

6.1.1. Need: More monitoring of known areas where ice jamming is an issue.

:

Recommendation

- Ensure the National Weather Service (NWS) is aware of what its monitoring areas are; make recommendation if monitoring of other areas is warranted. In other areas that do come up, possibly use web-cams to monitor situation. NWS, USACE and USGS continue to share information; better communication.

6.1.2. Need: Through the Northeast River Forecasting Center there is a need for additional precipitation, temperature and snow-water equivalent observers and/or observation equipment appropriately distributed throughout the state and reporting on at least a daily basis.

Recommendation

- Resumed reports of at least daily precipitation and temperature measurements from the discontinued rainfall/snowfall/stream-flow site locations would improve the NERFC model simulations.

6.1.3 Need: NERFC needs additional total outflow data from select dam operations and/or impoundments and significant tributary inflows. The NERFC still has a deficiency of real-time pool elevation and release information. Data the NERFC is able to access is often not in a standardized format and requires considerable manipulation internally to either obtain or prepare the data for acceptance into the models.

Recommendation

- There are control points that are suspected to have considerable impact at times on river flows and levels at forecast points nearby downstream. Improvements include:

  - On the stretch of the Contoocook River between Peterborough to Henniker are the Powder Mill Pond and Dam in Bennington. The NERFC has little or no information as to the structure and operation of this dam. Total outflow from this dam and pool level at least at each change in release settings would be recommended for improving stage/flow forecasts downstream at Henniker.

- ♦ Franklin Pierce Lake, another dam and impoundment in the Contoocook valley for which the NERFC has little to no information. Recommended total outflow from this dam on the North Branch Contoocook along with lake level data to improve river forecasts at Henniker.

- ♦ The Suncook River is a significant tributary to the Merrimack and total outflows from the dam at Suncook, at least during high flow periods, would improve our forecast on the Merrimack at Goffs Falls, Nashua and points further downstream. The new USGS gage on the Suncook is below all of DES's dams with storage capacity in the basin. A river forecast point should be established at this location by the NERFC to provide flood warnings to the flood prone communities of Allenstown and Pembroke on the lower Suncook River.

- ♦ A real-time traditional stream-flow gaging station for Concord, New Hampshire on the Merrimack River: the current gage at Concord only is used to measure stage but not flows.

- ♦ A real-time water level gage or index-velocity stream-flow gage at Nashua below the confluence of the Nashua River at least during medium to high flow periods would be an asset for improving high flow and flood forecasts on the Merrimack at Nashua. NERFC realizes there is a limitation with respect to the rating in this vicinity due to backwater from the Pawtuxet Falls Dam.

- ♦ In order to improve the NERFC forecasts for the Spicket River at Salem, New Hampshire / Methuen, Massachusetts real-time total outflow and pool level data is recommended from Arlington Mill Reservoir (Wheeler Dam), in Salem, NH.

- ♦ Forecasts for high flows on the Merrimack River at Nashua may be improved at times with real-time total outflow information from Massabesic Lake (Cohas Brook) below Manchester, New Hampshire.

6.1.4. Need: Improved communications between NERFC, NWS and state emergency management personnel and "spotters" regarding the locations of the most flood-prone river reaches, in order to make better use of reports from local police, fire and emergency managers.

Recommendation

- During floods and severe weather, NWS relies heavily on reports from state and local emergency officials and the public. Areas for development and improvement are:

  - ♦ Develop standardized forms communities can utilize in reporting weather conditions within their jurisdictions.

  - ♦ Develop plans and procedures in forwarding weather information to the National Weather Service in Gray, Maine and/or Taunton, Massachusetts.

- Develop and better utilize a "spotter" cadre program statewide to provide information as to river conditions, snow melt and severe weather events.

- Provide additional sensors reporting water temperatures, ice stress and visual observation (e.g., webcams) along specifically identified reaches notorious for ice jams and flash flooding where impact would be sufficient.

6.1.5. Need: Additional NWS flood modeling needed at more locations and watersheds through the state.

Recommendation

- NERFC prediction sites should be added across the state where there are currently gages.

- Coastal: While the NERFC forecasts flows at many rivers in central and southern New Hampshire, none of the coastal basins are modeled. However, flows at some coastal rivers are monitored by USGS gages. These locations could serve as additional forecast points with flow observations being used to verify simulated flows. Specifically, forecast points might be added at the following locations, where USGS gages are already operated in cooperation with the DES:

    - Cocheco River Near Rochester, N.H. (USGS gage 01072800, drainage area: 85.7 square miles)

    - Exeter River at Haigh Road, near Brentwood, N.H. (USGS gage 01073587, drainage area: 63.5 square miles)

    - Isinglass River at Rochester Neck Road, near Dover, N.H. (USGS gage 01072870, drainage area: 73.6 square miles)

    - Lamprey River near Newmarket, N.H.(USGS gage 01073500, drainage area: 183 square miles)

  NOTE: DES has developed a flood forecasting computer model of its own. Of the basins listed, all but the Cocheco and Isinglass rivers are currently modeled in the DES forecast system. However, the DES flood forecasting system has not been used effectively because of unreliable access to real-time data observations, generally low confidence in the modeling results, and the lack of resources to dedicate staff to the rigorous operation of the system. To address this last obstacle, a minimum of 20 person-hours per week of staff time would need to be dedicated to regularly operate the system. Currently, DES is reorganizing its Dam Bureau so as to dedicate the necessary staff resources to this effort.

- Another way of increasing the effectiveness of the DES flood forecasting system would be through increased cooperation between the NERFC and the DES, since both groups operate the same hydrologic models using data that can be utilized by either system. It is therefore possible to directly exchange information from one forecast system to another. The NERFC could support the DES forecast system by providing temperature forecasts (precipitation forecasts are already provided) and soil moisture information ("model states") for those rivers that are modeled in both forecast systems. This would allow DES to take advantage of the expert knowledge of NERFC river forecasters who

keep the soil moisture in their models updated and use this information as guide to adjust its own model states.

- For purposes of verifying and making improvements to estimation techniques for flash flood guidance, such local reports of flooding on streams generally with drainage areas less than 100 square miles are very valuable. A key parameter in small stream flash flood guidance computations is threshold runoff. However, threshold runoff volume measurements of stream channels (cross-sectional data, roughness, slope, hydraulic depth, bank full discharge) for small watersheds are needed for the Merrimack Valley and the entire region.

6.1.6. Need: Inundation mapping to show where flooding would occur.

Recommendation

- Enhanced statewide topographic data, based on high resolution airborne Light Detection and Ranging (LiDAR) technology, to improve the accuracy of floodplain delineations and hydrologic models used for flood forecasting. The most accurate flood inundation mapping relies on LiDAR data. This is currently lacking for most of the state. LiDAR data should be collected and made available for the entire state to facilitate detailed landscape analysis of areas prone to flood inundation. Because of the significant economy of scale to be realized when acquiring LiDAR data, large contiguous blocks of the state should be targeted for each mission. Statewide LiDAR data collected could possibly be coupled with a statewide Vermont effort. Statewide LIDAR imagery for approximately 250 communities potentially would average $10,000 per community. The cost of photogrammetric or LiDAR data for a single community can be as much as $100,000 - $200,000 or 10 to 20 times what each community would pay by participating in a statewide effort.

- Repeat high-resolution aerial orthophotography provides a means to monitor changes in the landscape at the scale of whole river basins or individual watersheds. The resulting detailed imagery provides the means to identify and map changing land use/land cover characteristics over time so that their effects can be taken into account in updating hydrologic models for flood inundation mapping and flood forecasting. The potential to accurately define the extent and location of impervious surfaces is particularly critical in this regard.

- Develop the inundation maps based on variously sized storms/flows. A library of flood inundation maps for various river discharges and associated return periods, such as the 10-, 25-, 50-, 100- and 500-year events, should be developed based on the high resolution topographic (imagery) data noted above. Inundation products for the communities most often and severely impacted by flooding such as Goffstown, Salem, Keene, Peterborough and others should be completed initially.

6.1.7 Need: Enhanced/improved digital flood insurance rate maps (DFIRMS).

Recommendation

- More efficient/quicker adoption of map work completed by FEMA. The need for FEMA to streamline the process from preliminary to final maps.

- Identify areas where more detailed studies are needed (county scoping studies).
- Encourage more detailed flood insurance studies funded by FEMA where scoping studies, state and local communities indicate that the maps are inaccurate or outdated.
- Work with communities to identify errors in digital mapping products and report deficiencies to FEMA.
- Encourage FEMA to digitize FIRMs for Coos, Belknap and Carroll counties by governor, congressional and state legislative staff lobbying to FEMA and Congress for more map modernization funding.

6.1.8 Need: Achieve better coordination among data acquisition and development initiatives in the state (specifically as they relate to topographical, land use, and parcel data) to insure that investments of limited resources are optimized to support effective flood data and forecasting programs.

Recommendation

For improved digital data products critical for use in flood forecasting and data, designate a state GIS clearinghouse and promote the New Hampshire GIS Strategic Plan, October 10, 2007 by:

- Recommend legislation to designate a clearinghouse. Currently the GRANIT, at the University of New Hampshire, is unofficially the statewide clearinghouse.
- Promote the state-wide GIS strategic plan; this includes a GIS officer, state-wide LiDAR coverage, repeat high-resolution aerial orthography imagery and derivative products ([specifically impervious surface mapping).
- Increase outreach to regional and local government to foster municipal GIS development and use especially in flood data and forecasting programs.
- Address largest geospatial data gaps. There should be targeted investments in improving key, broadly used data sets that are either currently unavailable or are inadequate for important uses. Such uses may include digital inventories of specific costs associated with past, present and future flood events. Identified priorities include: accelerating the statewide aerial photography program overseen by DOT, improving the accuracy of the town boundary data set, and developing high resolution elevation data that is suitable for flood planning and response.

6.1.9 Need: Identify high risk areas for catastrophic flooding due to culvert failure or river channel avulsions.

Recommendation

- Promote high level GIS screening analysis based on enhanced topographic data.
- Encourage continued culvert mapping by groups currently engaged in it.

- Link culvert data to the New Hampshire hydrography data set to enable virtual navigation of the stream network so that each stream crossing can be viewed in the context of its upstream watershed and the potentially impacted infrastructure downstream from it.

6.1.10 Need: Fill out stream gaging network to cover range of hydrologic and topographic areas, with a focus on urban areas.

Recommendation

- Add more gages in urban and small watershed areas to better predict and warn of potential flooding as identified by the Stream Gage Task Force.
- Identify additional partners for funding of existing and additional gages.
- Install flood warning stage gages put in critical areas as identified by the Stream Gage Task Force.
- Identify sustainable funding sources for annual operation and maintenance of gages.

6.1.11 Need: Holistic watershed-wide water management in order to better manage high- and low-flow periods.

Recommendation

- Promote the Fluvial Erosion Statewide Hazard Assessment Program currently in the pilot stage on the Exeter River watershed area.
- Develop water management plans that identify by watershed/basin flood hazard areas, where current flood storage exists and should be enhanced/protected, where and how much additional flood storage is needed, and how flood/high flow storage can be used to maintain minimum flows during low-flow periods The plan would be based on hydrologic models for the watershed/basin and should link to the current the State Water Plan currently being developed.

6.2 Data collection

6.2.1 Need: Revise real-time data collection and sharing in order to better distribute and preserve information.

Recommendation

- Plan and develop a 24/7 New Hampshire Fusion Center to collect and analyze data caused by manmade or natural events.
- Identify/develop and/or expand reasonable GIS-backed reporting system.

6.2.2 Need: Identify critical facilities built in floodplain in order to notify and evacuate, etc.

Recommendation

- Inventory with GIS locations.
- Request information from E911 (information may already be gathered).
- Obtain ground floor elevation data for critical facilities.

Dams

7. Subcommittee Members and Participants: Gary Kerr, Hydropower Representative, Vice Chairman of Flood Management Plan Commission;, Robert Beaurivage, Manchester Water Works; and James Gallagher, DES Dam Bureau.

8. Findings

Dams and dam management have the ability to help reduce flood losses in New Hampshire; however, there are key limitations that must be kept in mind for any discussion in using dams to reduce flood damage:

- Only 45 of the 3,070 dams in the state have available storage for flood abatement.
- State's flood abatement dams, built by the US Army Corps of Engineers (USACE) in the '40s and '50s and the U. S. Department of Agriculture in the '70s and '80s, have reduced flood stages for communities located on or along the main stem of the river downstream of the flood abatement sites. However, they have not eliminated damage in low-lying, flood prone areas.
- While isolated opportunities exist, the feasibility of significantly achieving a cost-effective reduction in flood damages through the construction of additional flood abatement impoundments is quite low.
    - Cost of design and constructing projects is vastly greater now than in the past, so projects may not be economically justified at this time.
    - Environmental impacts are significant and could prohibit construction.
    - Projects require large-scale property acquisition, possible eminent domain action, and possible population relocation.

<u>Brief Perspective of Flooding in New Hampshire</u>

Over the past century, there have been numerous occurrences of extremes in weather conditions in New Hampshire. The flooding events over the last one hundred years have a central theme; floods continue to happen and humans continue to be adversely impacted because of their encroachments in low-lying areas. Due to the severity of the floods in the early 20th century, studies were conducted and solutions sought. In other words, history does repeat itself.

In 1935, the Water Resources Board issued a report and map of *Proposed Storage Reservoirs for River Regulation for the Improvement of Power Output, Flood Control, and Sanitation*. A copy of the map is attached. The total storage of all the New Hampshire reservoirs proposed in the report was over 40 billion cubic feet. In later studies, two more storage reservoirs were added to the list. These were the High Errol and the Indian Stream reservoirs, neither of which was constructed. Of those original 25 major volume sites, only eight dam/storage sites were constructed in the state. Another five sites, which are owned and operated by USACE in Vermont, were constructed, but these were not part of the originally listed New Hampshire sites. In addition to the major storage reservoirs, 28 small watershed dam sites were constructed. These were designed by the former Soil Conservation Service and were primarily located in the Baker and Souhegan River drainage areas.

The total storage of actually constructed flood abatement projects that affect flood waters in New Hampshire is 35.5 billion cubic feet. Other USACE dams were constructed in Vermont, but those do not affect flows in the Connecticut River and hence New Hampshire. Other very large storage reservoirs do exist in Maine within the Androscoggin River watershed, which contribute to river flow management. However, these are owned by a private corporation and likely not available for flood

abatement practices as it may affect communities in New Hampshire.

To put these flood storage values into perspective, 41 billion cubic feet is the approximate equivalent of two-tenths of an inch of water spread over the entire state of New Hampshire, whose size is approximately 8,968 square miles.

Potential dam/flood water storage sites do still exist in New Hampshire as enumerated in the 1935 Water Resources Board report. However, no new fiscal and environmental have been completed. It should be noted that existing and potential flood water storage sites can only moderate the impact of a flood in an area downstream of the storage reservoir.

Flooding events can and do occur anywhere and without prior notice. They are not necessarily related to the existence or a failure of a dam. The severity, however, is definitely related to the amount of human intervention upon an area.

Inventory of Dams in New Hampshire

As shown in Figure 3, there are 3,070 active dams in the state of New Hampshire. Of these, 840 dams are classified as hazardous dams because the flooding produced by their failure would result in loss of life or property damage downstream. The hazardous classification of a dam is based on the height of the structure, the amount of water stored behind the structure, and the extent development downstream within the potentially inundated area. It is not in any way related to the condition of the dam.

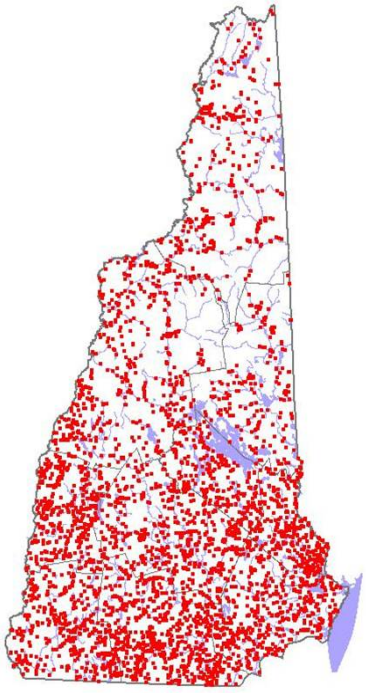

Figure 3. There are 3,070 active dams in the State of New Hampshire

Of these 840 hazardous dams, 90 are classified as High Hazard Dams because their failure would inundate houses or other occupied structures downstream and likely cause loss of life. One hundred and ninety six dams are classified as Significant Hazard Dams because their failure would cause

major property damage downstream, and 558 are classified as Low Hazard Dams because their failure would cause minor property damage downstream, such as damage to a town road. The remaining 2,230 active dams are classified as Non-Hazardous Dams.

Potential Flood Damages Associated with Failure of Dams in New Hampshire

DES estimates that there are more than 10,000 homes, 500 state road crossings and more than 4,500 town road crossings that would be destroyed or damaged if these hazardous dams were to fail. When the privately-owned Meadow Pond Dam, a Significant Hazard Dam in Alton, failed in 1996, it caused approximately $8 million worth of property damage and one fatality when the State Route 140 road crossing downstream was destroyed. Using the costs of this tragedy as a yardstick, it is clear that many thousands of lives and hundreds of millions of dollars of property are at risk downstream of state-owned dams.

Recent events in Alstead dramatically illustrate the destructive force of a sudden release of stored water. A dam failure was not the cause of that tragedy; rather, a culvert was became blocked, the roadway embankment was overtopped and failed causing the loss of life and enormous devastation downstream.

Even the loss of any of the Low Hazard Dams that the state owns, which do not have significant property at risk downstream, could cause significant economic losses to the state due to the loss of recreational opportunities and the devaluation of waterfront property associated with the dam. According to the *Report on the Economic Value of New Hampshire's Surface Waters*, New Hampshire's lakes provide up to $1.5 billion annually of economic benefit to the state, and waterfront property owners pay nearly a quarter billion dollars annually in property taxes[xii]. Since the majority of New Hampshire's surface waters are impounded by dams, the upkeep of these dams is important, not only to protect public safety and the environment, but also to maintain the large economic benefits.

Ownership of Dams in New Hampshire

Figure 4 shows the breakdown of the total dams by type of owner. Governmental organizations or utilities own about one-quarter of the dams in the state. Private utility companies own 12 dams , various municipalities own 389 dams, the federal government owns 38, and the state of New Hampshire, through its various state agencies own 273 dams. However, the majority of the dams, which number 2,358, are owned by private organizations or individuals.

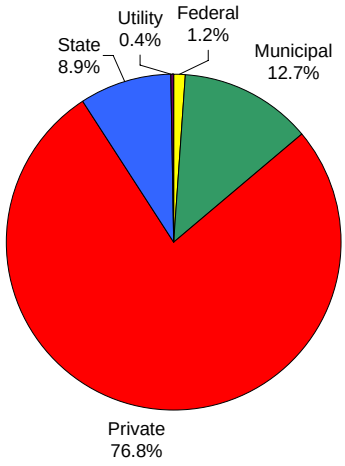

Figure 4. Breakdown of the total number of dams in New Hampshire by type of owner

Purpose of the Dams in New Hampshire

Figure 5 shows a breakdown of the dams in the state by purpose. As shown in the figure, only 1.6 percent or 45 dams in the state have flood abatement as a primary purpose. The single largest category is dams built for recreation, of which there are 1,448. Dams that impound conservation or farm ponds make up the next largest category with 759, followed by stormwater detention ponds with 295, fire ponds with 239, hydropower dams with 132, sewer lagoons with 60, water supply reservoirs with 76 and mill dams with 16.

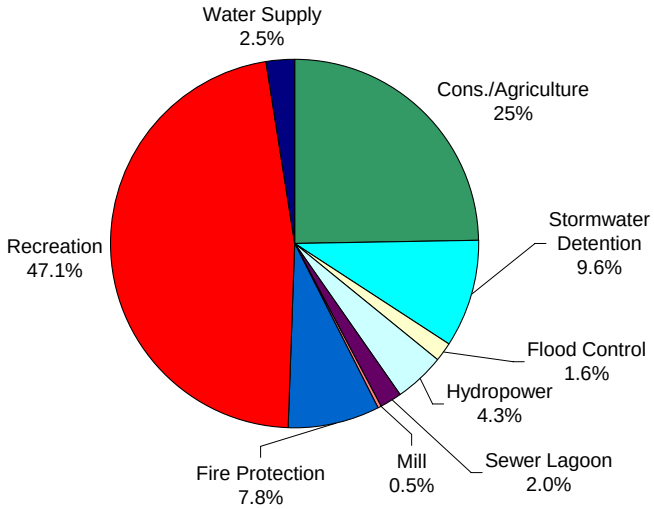

Figure 5. Breakdown of total number of dams in New Hampshire by purpose

Except for the flood abatement dams and the stormwater detention dams, all the dams must impound water to the crest of the spillways of the dams to fulfill the purposes for which they were built. In addition, these dams typically have very limited discharge capacity through the low level outlets in the dams. As a result, the impoundments behind these dams cannot be drained very quickly to provide flood storage in advance of forecasted floods. Figure 6 shows the components of a typical non-flood abatement dam in New Hampshire.

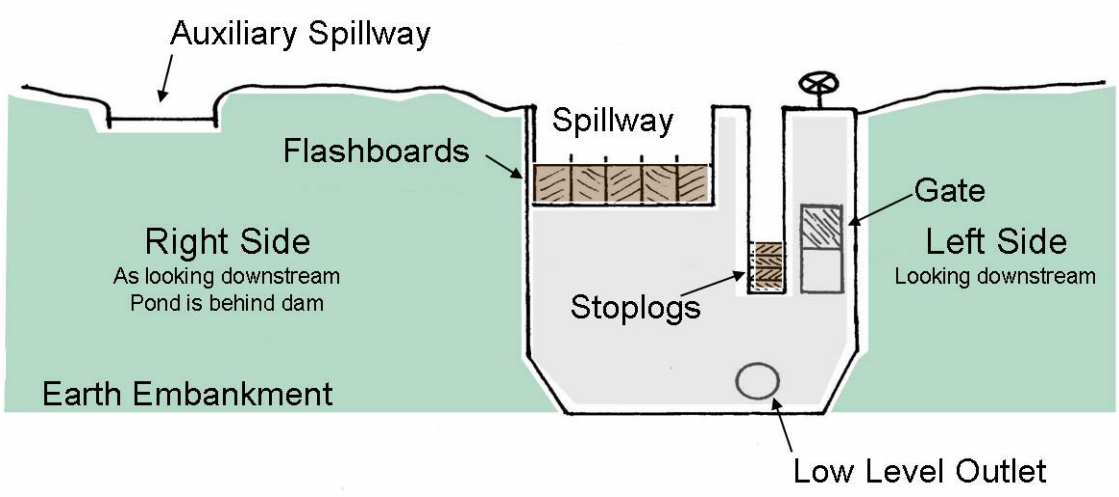

Figure 6. Schematic diagram of typical non-flood control dam in New Hampshire

The New Hampshire's dams impound the largest and most important recreational lakes in the state, including Winnipesaukee, Squam, Winnisquam, Newfound, Sunapee and Ossipee. The impoundments behind dams provide aquatic habitat for waterfowl, wildlife, fish and other aquatic species, as well as recreation opportunities for boaters, anglers, hunters and bird watchers. However, dams can also alter the quantity and quality of the water in the river downstream of the dams and create a barrier to fish passage.

DES receives approximately 30 to 50 applications each year to construct or reconstruct a dam, so the inventory of the dams in the state continues to grow. However, much of the inventory is old. Some of the state's dams were constructed in the early to mid-1800s to provide waterpower to fuel the industrialization of New Hampshire and Massachusetts. Due to their age, they require continued attention and expenditures to maintain them in a safe condition.

Risk of Failure

Driving every other issue and all activities within the subject area of dams is the risk of dam failure. Although the majority of dams in New Hampshire have responsible owners and are properly maintained, dams can and do fail, particularly when they are stressed by high flows like we have seen occur during the three major floods that we have experienced over the past two years. Dam failures are most likely to happen for one or more of the following reasons:

- Overtopping caused by water spilling over the top of a dam which is not designed for such action.
- Structural failure of materials used in the construction of the dam.
- Cracking caused by movements like the natural settling of a dam.
- Inadequate maintenance and upkeep.

- Piping—when seepage through a dam is not properly filtered and soil particles continue to progress and form sink holes in the dam.

Historically, dams that failed had some deficiency, as characterized here, which caused the failure. These dams are typically termed "deficient." Currently, approximately 120 privately and municipally owned dams in New Hampshire are characterized as deficient, and there are 35 state-owned dams in need of repair.

The Increasing Hazard

Dams are innately hazardous structures. Failure or miss-operation can result in the release of the reservoir contents, including water, sewage or agricultural refuse, causing negative impacts upstream and/or downstream or at locations remote from the dam. Negative impacts of primary concern are loss of human life, economic loss such as property damage, lifeline disruption and environmental damage.

The current issue is over the increasing number of high-hazard structures, not because more high-hazard dams are being built, but that more development is occurring downstream of dams. The state has little control over local zoning issues or developers' property rights within the area downstream of dams that could potentially be inundated from a failure of the dam.

Financing for Maintenance, Upgrade and Repair

Dams must be maintained to keep them safe. Occasional upgrade or rehabilitation is necessary due to deterioration, changing technical standards and improved techniques, better understanding of the area's precipitation conditions and increases in downstream populations and changing land use. When a dam's hazard classification is changed to reflect an increased hazard potential, the dam may need to be upgraded to meet an increased need for safety.

The lack of funding for dam upgrade has become a serious concern, especially within the private sector. Unfortunately, operation, maintenance, and rehabilitation of dams can range in cost from the low thousands to millions of dollars, and owners are responsible for these expenses. The costs of removal may also be beyond the resources of many private dam owners. In New Hampshire, more than three-quarters of the dams are privately owned, and many owners cannot afford these repair or removal costs.

Lack of Public Awareness

Many people are unaware that the beautiful lakes on which they boat, swim or fish are only there because of man-made dams. Owners of homes or commercial interests built in areas that could be inundated from a dam failure flood typically know little about the potential that an upstream dam and the devastation it can cause should it fail. Even if people are aware of dams, they still have unrealistic expectations of the ability of the dams to reduce flooding downstream.

Many dam owners do not realize their responsibility and liability toward the downstream public and environment. Adequate understanding of proper dam maintenance and upgrade techniques is a typical problem among many owners.

Funding Concerns Regarding Dams in New Hampshire

The trends that are driving the need to address the subject areas of dams are identified in the answers to the previous question. Trends in New Hampshire's Dam Safety Program that need to be addressed include the following.

The DES Dam Bureau regularly inspects, on a schedule based on hazard classification, the 840 dams that could cause loss of life or property damage if they were to fail. Following those inspections, DES issues reports to the dam owners identifying the deficiencies that were observed during the inspection and specifying a schedule to correct the deficiencies. However, current compliance inspections and follow-up on deficient dams lag performance goals. At this time, there are 35 state-owned dams in need of repair, and approximately 120 privately and municipally owned dams with known deficiencies, including six with major deficiencies.

Just as financing the maintenance, repair and upgrade or removal of dams is a problem for private and municipally-owned dams, so too is it a problem for state-owned dams. Of the 273 state-owned dams DES owns 113, including dams on many of the largest recreational lakes in the state (Winnipesaukee, Squam, Winnisquam, Newfound, Sunapee and Ossipee). While other state agencies also own dams, the DES Dam Bureau is charged with repairing and reconstructing all 273 of them. The operation, maintenance, repair and reconstruction costs are funded through the State Dam Maintenance Fund. The sole source of revenue to the fund is rent payments that DES receives from leasing twelve of the dams that it owns to private hydropower developers who generate electricity at the sites. Under the terms of the leases, the rent that is paid to DES is a percentage of the revenue from the sale of power at the facilities. Eleven of these lessees sell the power to Public Service Company of New Hampshire. In 2002, PSNH initiated actions to renegotiate their above-market power purchase agreements with the small power producers from whom they purchase power. The result was a 40 percent drop in revenue to the State Dam Maintenance Fund, which, combined with the continuing obligations of the fund, has caused the fund to become insolvent. Another source of funding is needed to make up this shortfall.

Initiatives to Address Identified Concerns

In the last legislative session, the New Hampshire Legislature passed HB 664, which increases the fees charged for a permit to construct or reconstruct a dam as well as the annual dam registration fees. In addition to covering the costs of inspection and permitting, the resources provided with these fee increases will allow DES to increase follow-up inspections and institute enforcement actions, where necessary, to reduce the number of non-compliant dams by up to 75 percent.

Since 2004, the New Hampshire Legislature has been working to identify a new source of funding for the operation, maintenance and repair of state-owned dams. In 2004, the Legislature formed a study committee to study funding alternatives. The committee's final report predicted that the shortfall in the Dam Maintenance Fund could be over $1 million per year in the short term and average $900,000 per year over the next nine years. The committee concluded that, since the dams could not be dismantled or turned over to others, another source of funding needed to be found to fill this gap. Two sources that were examined by the committee, but determined to be impractical, included the leasing additional dams for hydropower generation and increasing fees derived from fishing licenses, boat registrations, boat moorings, and state parks. (Since the committee completed its work there has been more interest in developing hydropower at existing dams in New Hampshire. Although, the number of feasible sites is limited and the revenue potential is small, it has increased from the time of the committee due to higher market prices for power and new credits available to hydropower generators. It may be worth reexamining this alternative). The committee then focused on those who

benefit most directly from the impoundments created by state-owned dams, namely, shorefront property owners. One possible solution would be to assess them a fee of per linear foot of shorefront property. Another recommendation by the committee was to allocate a portion of the un-refunded road toll taxes to the Dam Maintenance Fund. Bills introduced in the legislature to implement each alternative failed to pass.

On the federal side, HR 3224, the Dam Rehabilitation and Repair Act, which was introduced in Congress, would provide funding for the repair of publicly-owned dams. Under the allocation formula in the bill, New Hampshire would receive approximately $2.5 million over a five-year period for the repair of publicly-owned dams. The bill, which is co-sponsored by both Representatives from New Hampshire, has been voted out of committee and is scheduled for a full floor vote sometime this fall.

9. Needs and Recommendations

9.1. Need: Funding for the repair or removal of aged dams

Recommendations

- Establishment of a dependable funding source for the operation, maintenance, repair or removal of state-owned dams.

- Establishment of a low interest loan program in New Hampshire, similar to that developed in other states, to finance the repair, upgrade or removal of both publicly and privately-owned dams.

The funding needs for the repair of both publicly and privately-owned dams must be addressed to ensure that the state's dams continue to be operated and maintained so that they do not pose a threat to life and property downstream and continue to provide economic and recreation benefits to the state. While some initial progress is being made on the state and federal level to fund the operation and maintenance of publicly-owned dams, unsafe privately owned dams can also cause loss of life and present public safety concerns.

9.2. Need: Increased public awareness

Recommendations

- An educational program needs to be developed and distributed that helps the general public and prospective real estate purchaser to understand the advantages and disadvantages of building/living near the shoreline of a lake, pond and river. There is a misconception that floods are controllable and that structures can be built to withstand all weather conditions.

- A second educational program needs to be developed and distributed that explains the difference between reservoir storage capacity and dam and river channel discharge capacity. Dams are usually built with a primary purpose and whose operation is based on that purpose. Most run-of-the-river dams are not constructed with the purpose of flood abatement and, as such, operated at spillway crest elevation. These structures are required to be able to safely pass the storm discharge, but not required to store it. However, a flood storage dam/reservoir system is intended to abate and store flood

runoff; hence their requirement to remain drained and empty until called upon for service during a flood.

9.3. Need: Improved dam operations during floods

Recommendations

- Have dam owners submit operating rules for each dam capable of flood control operations and have the DES Dam Bureau ensure that operations at each dam will collectively result in maximum flood control benefits to the watershed as a whole.

In July 2008, the Federal Emergency Management Agency issued a final report entitled *Independent Evaluation of Recent Flooding in New Hampshire*. The evaluation was requested by Governor John Lynch following the floods that devastated Southern New Hampshire in 2007. The evaluation was performed to determine the specific causes of floods of May 2006 and April 2007 in New Hampshire and provide recommendations for improving water management procedures and dam operations to reduce the impacts from future flooding.

The evaluation found that the causes of the flooding in May 2006 and April 2007 were different for the two events. The May event was unusual because of the sheer volume of rainfall, which ranged from 6 inches inland to over 14 inches along the seacoast over a two-day period. The region normally receives only about 3.5 inches of rainfall in an average spring month. The April 2007 event was extraordinary because of the combination of heavy rainfall, which ranged from 4 to 8 inches across south central and southeastern New Hampshire, and rapidly melting snow. The runoff produced during these events overwhelmed the region's rivers and streams, and inundated the region's floodplains. The evaluation found that the high runoff also lessened the effect of operations performed at dams in the region. All but the largest lakes in the upper reaches of the rivers filled rapidly and passed all inflows downstream. Flooding occurred upstream and downstream of the dams, similar to the flooding experienced in river reaches without dams.

- The evaluation recommended several actions to mitigate future flood damages including improved floodplain management, improved flood forecasting, and a watershed approach to flood operations. These recommendations are based on the findings that:

  - ♦ Flood events as large as and larger than the May 2006 and April 2007 floods are will occur in the future. Communities and the state should plan accordingly.

  - ♦ Many of the floodplains adjacent to the rivers and streams in the region are still relatively undeveloped. Building in these floodplains will subject the structures to flood risk and will increase the flood elevations and flow rates elsewhere, and should be discouraged. Sound floodplain management, based on accurate information about the floodplains, is critical to reducing the effects of future floods.

  - ♦ Flood forecasting, while not always sufficiently accurate, should be used as a tool to help decision makers take appropriate actions during flood events.

  - ♦ Storing water in the region's lakes, ponds and reservoirs, and coordinated dam operations help reduce flooding. However, storage opportunities in south central and southeastern New Hampshire are very limited, and the effect of improved dam

operations is relatively minor. Implementing flood management recommendations can reduce local flooding, but cannot prevent widespread flooding from events like the May 2006 and the April 2007 events.

9.4. Need: Improve flood forecasting for dam operations during flood events

Recommendation

- Engage the National Weather Service to gain timely access to forecasting products at all important locations in New Hampshire.

- Revitalize the forecasting component of DES's data management, flood forecasting and reservoir operations systems to provide forecasts for locations that NWS does not serve.

Regarding flood forecasting, the FEMA report noted that two entities can currently provide independent flood forecasts in southern New Hampshire: the NWS through the Northeast River Forecast Center (NERFC) and the DES Dam Bureau through its data management and stream-flow forecasting system. The report identified deficiencies in the current flood forecasting systems, noting that some of the existing forecasting products created at the NWS were not readily available to the decision makers at the DES Dam Bureau and the New Hampshire Bureau of Emergency Management (BEM) and that forecasting products are not available for all points of interest to the Dam Bureau, in particular the Cocheco, Exeter, Isinglass, Lamprey and Suncook Rivers. In addition, longer-range forecasts of five to six days that would enable the DES Dam Bureau to enact preventive dam operations are currently not available. The report recommended that DES engage the NWS to gain timely access to forecasting products at all important locations in New Hampshire.

The report also noted that, while extensive use is made of the data management capability of the DES Dam Bureau's system, the forecasting component of the system is not utilized. The report recommended that this component of the system be revitalized to provide forecasts for locations that the NWS does not serve.

Relative to the finding on dam operations, the report noted that the DES Dam Bureau has procedures in place to collect information on dams, and recommended that the DES Dam Bureau build on that information to develop a plan, including standardized operating rules for each dam capable of flood abatement operations for each watershed. Each private dam operator should submit information to the Dam Bureau and the Dam Bureau should ensure that operations at each dam will collectively result in maximum flood abatement benefits to the watershed as a whole. This watershed approach will allow for coordinated action by dam operators designed to maximize flood abatement benefits.

Appendix A – NH House Bill 648 Interim Report

State of New Hampshire

GENERAL COURT

CONCORD

MEMORANDUM

DATE: **December 1, 2007**

TO: **Honorable John H. Lynch, Governor**
Honorable Terie Norelli, Speaker of the House
Honorable Sylvia B. Larsen, President of the Senate
Honorable Karen O. Wadsworth, House Clerk
Tammy L. Wright, Senate Clerk
Michael York, State Librarian

FROM: **Representative Gene Andersen, Chairman**

SUBJECT: **Interim Report on HB 648, Chapter 179:1, Laws of 2007**

Pursuant to Chapter 179:1, Laws of 2007, enclosed please find the Interim Report of the Commission to Develop a Flood Management Plan.

If you have any questions or comments regarding this report, please do not hesitate to contact me.

GA:dm
Enclosure

cc: Commission Members

COMMISSION TO DEVELOP A COMPREHENSIVE FLOOD MANAGEMENT PLAN
STATE OF NEW HAMPSHIRE
HB 648 CHAPTER 179:1, LAWS OF 2007

INTERIM REPORT

December 1, 2007

The Charge of the Commission is to study the following:

Committee Duties
Commission To Develop Comprehensive Flood Management Plan HB 648, Ch. 179.1, 2007
I. Establishes a commission to develop a comprehensive flood management plan II. Requires the division of safety services to institute a no wake order on Silver Lake at a certain water level
Duties: Study possible measures for controlling floods to minimize their impact on communities and individual properties throughout the state. These measures shall include but not be limited to:
(a) Land treatment to reduce flood runoff.
(b) Flood hazard assessment.
(c) Management of flood waters by means of dams and reservoirs
(d) Removal or preservation of dams as an element of flood management
(e) Possible zoning and flood plain regulations
(f) Cooperative efforts between private dam owners and New Hampshire emergency management in the event of serious flood threats
(g) Flood forecasting practices
The commission may also consider issues associated with flood control, including:
(a) Tax exemption for private dam owners to encourage dam maintenance and restoration
(b) Expansion of hydroelectric power generation.
(c) Use of flood plain lands for agriculture
(d) Wetland preservation
(e) Effects of floods on storm sewers and waste treatment plants.
(f) Recreational use of water bodies used for flood control.
(g) Availability of grants for flood control and dam improvement and restoration.
(h) Recovery of monies owed to the state for flood control dams
(i) Proper management of public water resources
(j) Other issues as the commission sees fit
Reporting Dates: (a) Progress report due 12/1/2007 (b) Final flood control plan due 6/1/2008

The Commission Members Are

Committee Roster		
Commission To Develop Comprehensive Flood Management Plan		
Name	Representing	Address
Rep. Vincent Greco	House: Fish and Game	P.O.Box 151 Pembroke, NH
Rep. Peter Allen	House: Environment and Agriculture	25 Seaver Rd. Harrisville, NH 03450
Rep. David Russell	House: Resources, Recreation and Development	P.O.Box 60 Gilmanton I.W., NH 03857
Rep. Gene Andersen	House: Science, Technology and Energy	4 Allen Street Lebanon, NH 03766
Sen. Margaret Hassan	Senate	107 N. Main Street Room 302 Concord, NH 03301
Sen. Harold Janeway	Senate	107 N. Main Street Room 302 Concord, NH 03301
Katja Fox	Governor's Office (Assistant for Policy)	107 N. Main Street Concord, NH 03301
John Magee	NH, Rivers Management Advisory Committee	11 Hazen Drive Concord, NH 03302
Gary Kerr	Hydroelectric Industry	224 Horse Corner Rd Chichester, NH 03258
Sue Desruisseaux, MPA	NH Municipal Association (Town of Goffstown)	16 Main Street Goffstown, NH 03045
Mark Zankel	The Nature Conservancy	22 Bridge Street (4th Floor) Concord, NH 03301
Steve Couture	NH, DES Commissioner (DES Water Division Rivers Coordinator)	6 Hazen Drive P.O. Box 95 Concord, NH 03302-0095
Robert Beaurivage, P.E.	NH Water Works Association (Manchester Water Works Assistant Director)	281 Lincoln Street Manchester, NH 03103
Joanne Cassulo	Governor's Office of Energy and Planning	58 Regional Drive Concord, NH 03301

Stewart Yeaton	Agriculture	546 Suncook Valley Hwy Epsom, NH
Michael Andosca	Shorefront Property Owner	41 Franklin Pierce Dr. Webster, NH 03303-7912
James Gallagher, P.E.	NH, DES - Hydrologist (DES Water Division) (Chief Engineer)	29 Hazen Drive P.O. Box 95 Concord, NH 03302-0095
Michael J. Poirier	NH, Department of Safety Division of Emergency Services Bureau of Emergency Management	33 Hazen Drive Concord, NH 03305
Michael P. Pillsbury, P.E.	NH, Department of Transportation Assistant Director/Division of Operations	7 Hazen Drive P.O. Box 483 Concord, NH 03302-0483
Keith W. Robinson	Director USGS, NH/VT Water Science Center	361 Commerce Way Pembroke, NH 03275

New Members Invited to Commission:

HB 648 Provided for Members from the following:

(h) One member of the Army Corps of Engineers, appointed by the Corps.

(i) The Director of Homeland Security and Emergency Management of the Department of Safety, or designee.

Members from the above listed organizations were not selected at the time of the organizational meeting.

Corps of Engineers:

No member was found available to fill the slot provided for the Corps of Engineers. In the place of this slot, Keith Robinson, Director of U.S. Geological Services NH/VT was invited to participate on the commission and accepted.

Director of Homeland Security and Emergency Management of the Dept. of Safety.

A member was requested to participate from the Flood Commission and Michael J. Poirier was appointed by the Department of Safety.

No commission member was listed in HB 648 from the NH Dept. of Transportation. Presentations provided to the committee provided that Transportation received the highest impact from floods. The commission therefore requested a member from the NH Dept of Transportation and the Acting Commissioner appointed: Michael P. Pillsbury, P.E., Assistant Director/Division of Operations to serve on the Commission.

Study

The Commission met nine times during late summer and fall to take testimony from experts and provide commission work sessions. Meetings to date include:

Date	Presenter/Presentation
Organizational Meeting 8-8-07	Organizational Meeting: 1. Rep. Gene Andersen selected Chair 2. Gary Kerr selected as Vice Chair 3. Meeting Schedule set
8-28-07	1. DES Commissioner Thomas Burack: *Connections between and among flood control, land use planning, storm water management, climate change, and other.* 2. Jennifer Gilbert, Asst State Coordinator National Flood Insurance Program in office of OEP: *NH's National Flood Insurance Program.* 3. Mike Poirier, NH Office of Emergency Management and Homeland Security: *Damages that NH has sustained from floods from most recent years.* 4. James Gallagher Jr., P.E., Chief Engineer, Dam Bureau: *a. Dams in NH* *b. Limited amount of flood control dams* *c. Flood forecasting practices* d. *NH stream gauging program.*
9-18-07	Kari Dolan, Vermont Fluvial Erosion Hazard Coordinator: *Fluvial Erosion*
9-25-07	Professor Michael Simpson, Dir. of Resource Management and Conservation Program, Antioch University of New England: *Research relevant to climate change impacts on flooding on infrastructure within a small watershed in Keene, NH.*
10-9-07	Dean Sauramis, FEMA Region 1, (Boston Office) *National Flood Insurance Program*
10-23-07	Keith Robinson, Director USGS, NH/VT Water Science Center: *Stream Gauging, Data Collection, Archival Services*
10-30-07	Committee work session and breakdown into subcommittees (a) Dams (b) Flood Forecasting (c) Land Use
11-6-07	Sub Committee Work Sessions
11-20-07	1. Colin Apse, Dep. Director of The Nature Conservancy's Eastern U.S. Freshwater Conservation Program: River Hydrology, Natural Flow Regimes and how these are affected by Dams, Development and River Management 2. Dr. Keith Nislow, Aquatic Ecology Research Scientist for the U.S. Forest Service: River Management – its influences on fish other aquatic organisms and riparian habitat.

PRELIMINARY FINDINGS

1. The definition of a "flood" and a "flood plain" is not universal to all interested parties.
2. A definition needs to include the reality that a river's, lake's, pond's, etc. flood plain is dynamic (not static) and, to maintain stable (i.e. dynamic yet still maintains it typical physical form) channels and floodplains at, upstream and downstream of a given site, the flood plain needs to be refreshed on a regular, ecological cycle.
3. Human activities upon flood plains constitute a change on a natural made system and that change will be reclaimed dramatically during a flood.
4. Changes to floodplains can have detrimental effects both upstream and downstream from any given site.
5. Costs and benefits of flooding are associated in both environmental and human terms.
6. There is a need to create a funding mechanism to address:
    a. Immediate relief for impacted humans and the environment after a flood disaster occurs.
    b. Floodplain definition and management thereof covering the entire state.
    c. Data collection for redefining floodplain, as required by the dynamics of the floodplain change.
    d. Continual data collection for:
        i. Redefining and/or updating floodplain developments from an environmental and human aspect.
        ii. Prior planning, planning during actual disasters, and planning after disasters.
7. A need exists to determine what is considered as critical data, how to collect it, and who is to use, then coordinate distribution of the same.
8. It is required that the impact of droughts be considered in combination with floods.

AREAS OF INVESTIGATION REMAINING INCLUDE:

Management and Construction of flood control (abatement) dams; flood plain mapping and data collection, and the collection and distribution of real-time (pre-, during, and post-) data regarding emergency situations. A presentation by the Army Corps of Engineers has been scheduled on these matters.

Many of the presentations to the Floods Commission are available on a DES web site:

To Access:

1) Go to this address using a web browser: ftp://199.192.6.23/DES/wmb/ . Please note that some may have to copy and paste this address into a browser for the link to work.

2) A the login window, click on the box in the lower left hand corner labeled "Login Anonymously".

3) The User name will then be automatically filled in with the word "Anonymous".

4) Type in your email address in the Email Address block.

5) Then click on the Log On button.

6) The Watershed Management Bureau directories should appear.

7) Click on the HB648 directory and download files as desired.

Note: If the site cannot be accessed, it could be due to security settings on your PC. Please check with your computer personnel to correct this issue.

Appendix B – NH House Bill 648 Recommendations Implementation Table

IMPLEMENTATION TABLE OF IDENTIFIED NEEDS

Recommended Solution	Action Required	Entity Responsible	Potential Funding Source and Predicted Amount	Report Section
Landscape Management				
State and Critical Facilities				
Need: Limit the construction of new critical facilities or state facilities in fluvial hazard zones (mapped 100- and 500-year floodplains or identified fluvial erosion hazard zones).				
Prohibit construction of new state facilities or state-funded facilities in fluvial hazard zones. This prohibition would not apply to water dependent facilities.	Legislation or Executive Order	State	Not applicable	3.1.1
Relocate existing state facilities out of fluvial hazard zones, if feasible. If not feasible, mitigation measures should be used to protect existing state structures up to the 500-year flood level. Relocating existing state facilities out of fluvial hazard zones is the preferred option when considering expansion or improvements to a facility within a flood hazard zone.	Legislation or Executive Order	State	Not applicable	3.1.1
Avoid and minimize expansion of existing state facilities in fluvial hazard zones to the maximum extent practicable.	Legislation or Executive Order	State	Not applicable	3.1.1
Protect new critical facilities from and be accessible during the 500-year flood. If a new or existing critical facility must be located in a floodplain it should be provided a higher level of protection so that it can continue to function and provide services after the flood. When new critical facilities are constructed, at least the primary access road should also be at the 500-year flood elevation.	Legislation or Executive Order	State	Not applicable	3.1.1
Increase state facilities stormwater requirements: the sponsor of any development or redevelopment project involving a state facilities project with a footprint that exceeds 5,000 square feet shall use site planning, design, construction and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume and duration of flow.	Legislation or Executive Order	State	Not applicable	3.1.1

Recommended Solution	Action Required	Entity Responsible	Potential Funding Source and Predicted Amount	Report Section
Land Protection				
Need: Increase the preservation of land in floodplains to help retain natural flood storage capacity while also providing significant ecological benefits for fish and wildlife.				
Create a mechanism within existing land protection grants, such as the Land and Community Heritage Investment Program, to identify floodplains and fluvial erosion areas protection as a priority.	Modification of grant requirement Identification of fluvial erosion area	DES DRED OEP	Existing grant programs Unknown	3.2.1.
Increase use of Natural Resource Conservation Service (NRCS) watershed and land conservation programs for floodplain and fluvial erosion areas.	Evaluate existing NRCS funding criteria	NRCS	Existing program	3.2.1
Create a new land protection grant program focused solely on floodplains (example: DES Source Water Protection Land Grants).	Funding for grant program	DES	Unknown	3.2.1
Floodplain Management				
Need: Establish a state - level regulatory approach for floodplain management.				
Incorporate floodplain management into existing state regulatory programs, specifically the DES Alteration of Terrain program (AoT) and Wetlands Bureau.	Legislation & Administrative Rule	State	Not applicable	3.3.1
Incorporate floodplains into Wetlands Bureau (DES) jurisdiction	Legislation Administrative Rules	DES	Not applicable	3.3.1
Develop a state watershed HEC-RAS model as basis for build out analysis.	Develop scope of work and requirements for model	DES OEP	FEMA	3.3.1
State adopts a higher National Flood Insurance Program standard.	Legislation	OEP	Not applicable	3.3.1
Need: Increased funds for flood management activities.				
Create a state funding source for "Floodplain Management Initiative": • Identify existing funding mechanisms to linked or contribute to Floodplain Management Initiative (restrictions for existing funding sources would have to be considered) • Establish criteria within existing funding sources to provide an advantage to floodplain management projects.	Legislation	DES F&G OEP DOT	Existing funding sources.	3.3.2

Recommended Solution	Action Required	Entity Responsible	Potential Funding Source and Predicted Amount	Report Section
Need: Locating structures within the 100 year floodplain and determining flood insurance status.				
Encourage local floodplain managers to research maps and building addresses in the 100-year floodplain. (Recommendation from 2008 FEMA report on flooding in New Hampshire.)	Develop program	OEP DES RPCs Municipalities	Not applicable	3.3.3
Need: Increase knowledge of flood building codes at the local level.				
Establish a formal training program for local building officials relevant to flood related building codes.	Develop program	OEP DOT DES	Not applicable	3.3.4
Need: Establish a state-level fluvial erosion hazard program similar to Vermont's Fluvial Erosion Hazard Program.				
Work with Federal Emergency Management Agency (FEMA) to incorporate fluvial erosion into National Flood Insurance Program and to provide technical and financial support for local implementation in accordance with FEMA's Riverine Erosion Mapping Feasibility recommendations.	Legislation	DES OEP	FEMA Emergency Management Grants Hazard Mitigation Grants 319 High Quality Water Grants	3.3.5
Provide a state funding mechanism to support staffing for the program.	Legislation (Biennial Budget)	DES OEP	$150,000 annually	3.3.5
Amend state law, if necessary, to allow the establishment of fluvial erosion hazard ordinances.	Legislation	DES OEP	Not applicable	3.3.5
Need: Increase ability for the state and municipalities to manage stormwater.				
Local fee on impervious surfaces could be used to address/upgrade stormwater management to minimize hydrologic changes.	None	Municipalities	Local fee	3.3.6
DES should actively support the creation of stormwater utilities.	Outreach and Education	DES OEP	Not applicable	3.3.6
New Hampshire House Bill 1295 establishes a commission to study issues relating to stormwater. The following issues should be further investigated by the Stormwater Study Commission in relation to floodplain management.	Commission activities	Commission members	Not applicable	3.3.6
Continue support for DES and Regional Planning Commissions Innovative Land Use Controls stormwater ordinance.	Legislation (Biennial Budget)	DES Regional Planning Commissions	$224,000 annually for the Regional Environmental Planning Program (REPP).	3.3.6
Encourage municipalities to submit stormwater infrastructure needs to DES as part of the *2008 Clean Water Needs Survey*.	Outreach and Education	DES	State Revolving Fund State Aid Grant Program	3.3.6

Recommended Solution	Action Required	Entity Responsible	Potential Funding Source and Predicted Amount	Report Section
Need: Ensure that bridges and culverts are adequately sized.				
Improve connection between hazard mitigation plans and master plan.	Education and Outreach	OEP DOS	Municipal Capital Improvement Programs DOS Hazard Mitigation Funding	3.3.7
Develop an in-lieu mitigation option (DES) for projects that impact floodplains and stream channels.	Legislation	DES	Existing program	3.3.7
Adopt wetland rules that incorporate the following design guidance: • To allow for passage of the 100-year frequency storm • To ensure to the maximum extent possible that there is no increase in flood stages on abutting properties. • Flow and sediment transport characteristics will not be affected in a manner which could adversely affect channel stability	Administrative Rule changes	DES	Not applicable	3.3.7
Flow and sediment transport characteristics will not be affected in a manner which could adversely affect channel stability as described in the *NH Fish and Game Stream Crossing Guidance (September 2008)*	Administrative Rule changes	DOT DES F&G	Not applicable	3.3.7
DOT should address climate change and impervious surface effects when updating its *Manual on Drainage Design for Highways*.	Update Manual	DOT	Existing program	3.3.7
State agencies should work with the UNH Technology Transfer Center to educate communities on culvert sizing criteria and potential funding sources to address floodplain issues and culvert upgrades.	Education and Outreach	UNH State Agencies	Existing Program	3.3.7
DOT, DES and F&G, with input by The Nature Conservatory, should be tasked to develop the procedure and database for a standard culvert assessment data collection.	Funding for development	DOT DES F&G	Unknown	3.3.7
Need: Establish protocol for mitigation procedures for removal of woody material that may pose an imminent threat to infrastructure.				
Develop a program for regular inspection and removal of fallen trees along river banks that pose an imminent threat to infrastructure.	Program Development	DOS	Unknown	3.3.8
Need: Local Floodplain ordinances should prohibit development within a 100 year floodplain.				
Encourage New Hampshire municipalities to adopt floodplain ordinances that prohibit fill, new construction or substantial improvement within the 100 year floodplain, specifically the Regional Environmental Planning Program Innovative Land Use Controls model Flood Hazard Area Zoning ordinance authorized by RSA 674:21.	Outreach	OEP	Existing Program	3.3.9

Recommended Solution	Action Required	Entity Responsible	Potential Funding Source and Predicted Amount	Report Section
Flood Insurance				
Need: Increase education and outreach to communities regarding floodplain management and insurance options.				
Develop a multidisciplinary team to assist communities who request help to improve floodplain management. This could be based on the Natural Resources Outreach Coalition model.	Develop Team	OEP DES	Existing grant program	3.4.1
OEP and GRANIT web based education module on floodplain management for local officials www.nhflooded.org should contain guidance for more restrictive NFIP standards and CRS (Community Rating System).	Continue Action Already in Progress	OEP	Existing grant program	3.4.1
OEP *Flood Lines* newsletter is available quarterly and should continue to focus on communities who exceed NFIP standards.	Continue Action Already in Progress	OEP	Existing grant program	3.4.1
Promote community "flood audits" as an outreach tool.	Continue Action Already in Progress	OEP	Existing grant program	3.4.1
Need: Encourage all NH communities participate in NFIP and its Community Rating System.				
Adopt legislation to encourage participation in the NFIP. The legislation would include the following: • Non-participating communities will not be eligible for matching state funds for state or federally declared flood disasters. • CRS communities pay less in local match requirements for state or federally declared disasters; the state would make up the difference.	Legislation	DES OEP BEM	Not applicable	3.4.2
Floodplain Buyouts				
Need: A dedicated state-funding source for floodplain buyouts.				
Develop a state funding dedicated to buyouts. This is a significant deficiency considering the potential to match federal dollars and eliminate long term costs.	Legislation	State	$500,000 per biennium	3.5.1

Recommended Solution	Action Required	Entity Responsible	Potential Funding Source and Predicted Amount	Report Section
Flood Forecasting & Data Collection				
Need: Increase information collection to improve flood forecasting				
Enhance data collection and sharing on ice cover of rivers to improve ice-jam monitoring and forecasting by the National Weather Service.	Memorandum of agreement between the NWS, US ACOE, and USGS	NWS USACE USGS	$50,000/yr	6.1.1
Enhance data collection and sharing with the National Weather Service Northeast River Forecasting Center (NERFC) for daily information on precipitation, temperature and snow-water equivalent throughout the State.	Cooperative agreement between the State, NWS, USACE and USGS	DES	$300,000/yr	6.1.2
Enhance stream flow/dam outflow data at selected locations in the state.	Enhance stream flow/ dam outflow data at selected locations in the State	DES	$100,000/yr with possible USGS cooperative matching funds	6.1.3
Improved communication between the National Weather Service and emergency management personnel and other “spotters” identifying where flooding is occurring	Memorandum of agreement between NWS and OEP	BEM	$50,000/yr	6.1.4
Additional flood flow prediction modeling sites in the state by the National Weather Service NERFC.	Request additional flood predictions to the NWS	NWS	Not applicable	6.1.5
Improved geographic information system (GIS) and LIDAR data for the state to help identify potential flood inundation areas for different size flood events; initiate a flood inundation mapping program for the state	Legislation	OEP BEM	$500,000/yr for flood inundation mapping; $1.0 million for statewide LIDAR data	6.1.6
Quicker adoption of new flood insurance rate maps, better estimation of flood prone areas, and completion of flood map modernization for the entire state (DFIRMs)	Unknown	FEMA OEP	Unknown	6.1.7
Develop a data command center that collects flood forecasting data and distributes to emergency management officials statewide.	Unknown	BEM	Unknown	6.1.8
Identify high risk areas for catastrophic flooding due to culvert failure.	Legislation	DES	Unknown	6.1.9

Recommended Solution	Action Required	Entity Responsible	Potential Funding Source and Predicted Amount	Report Section
Flood Forecasting & Data Collection				
Expand stream-gage network to include more sites in urbanizing areas of the state.	Cooperative agreement between the State and USGS	DES	Unknown	6.1.10
Develop watershed models and plans that identify flood storage potential within the watershed, where land protection is needed to preserve flood storage, and how flood storage could be used to mitigate peak water demand periods/low flows	Legislation	DES	Unknown	6.1.11
Need: Improved flood insurance rate maps and watershed planning				
Quicker adoption of new flood insurance rate maps, better estimation of flood prone areas, and completion of flood map modernization for the entire state (DFIRMs)	Unknown	FEMA OEP	Unknown	6.2.1
Identify critical facilities and infrastructure in flood prone areas for assisting with emergency operations.	Unknown	BEM	Unknown	6.2.2

Recommended Solution	Action Required	Entity Responsible	Potential Funding Source and Predicted Amount	Report Section
Dams				
Need: Funding for the repair or removal of aged dams				
Establish a funding source for the operation, maintenance and repair or removal of state-owned dams.	Legislation	DES	$3 million per year	9.1
Establish a low-interest loan program, similar to that developed in other states, to finance the repair, upgrade or removal of municipally-owned and privately owned dams.	Legislation/ Administrative Rules	DES	$10 million from fines and Capital Appropriation	9.1
Need: Increase public awareness				
Develop and distribute an educational program that helps the public and prospective real estate purchaser to understand the advantages and disadvantages of building/living near the shoreline of a lake, pond, and river.	Outreach	DES	Not applicable	9.2
Develop and distribute an educational program that helps the public understand the limitations of dams in the state to reduce flooding.	Outreach	DES	Not applicable	9.2
Need: Improve flood forecasting for dam operations during flood events				
Engage the National Weather Service to gain timely access to forecasting products at all important locations in New Hampshire.	Coordination, Development of Forecast Model	DES/NWS	$1 million Federal funds for NWS to develop models	9.3
Revitalize the forecasting component of DES's data management, flood forecasting and reservoir operations systems to provide forecasts for locations that NWS does not serve.	Resource Allocation	State	$30,000 to $50,000 per year contract support for proprietary forecast model	9.3
Need: Improve dam operations during floods				
Have dam owners submit operating rules for each dam capable of flood abatement operations and have the DES Dam Bureau ensure that operations at each dam will collectively result in maximum flood abatement benefits to the watershed as a whole.	Outreach and Coordination	State/Dam Owners	Not Applicable	9.4

Appendix C - Complete List of HB 648 Presentations

Date	Presenter/Presentation
8/8/2007	1. Rep. Gene Andersen selected Chair 2. Gary Kerr selected as Vice Chair 3. Meeting Schedule set
8/28/2007	1. DES Commissioner Thomas Burack: *Connections between and among flood control, land use planning, storm water management, climate change and other* 2. Jennifer Gilbert. Asst. State coordinator National Flood Insurance Program in office of OEP: *Damages that NH has sustained from floods from most recent years* 3. Mike Poirier, NH Office of Emergency Management and Homeland Security: *Damages that NH has sustained from floods from most recent years* 4. James Gallagher Jr. P.E., Chief Engineer, Dam Bureau a. Dams in NH b. Limited amount of flood control dams c. Flood forecasting practices d. NH stream gauging program
9/18/2007	Kari Dolan, Vermont Fluvial Erosion Hazard Coordinator: *Fluvial Erosion*
9/25/2007	Professor Michael Simpson, Dir. of Resource Management and Conservation Program, Antioch University of New England: *Research relevant to climate change impacts on flooding on infrastructure within a small watershed in Keene, NH.*
10/09/2007	Dean Savramis, FEMA Region 1 (Boston Office): *National Flood Insurance Program*
10/23/2007	Keith Robinson, Director USGS, NH/VT Water Science Center: *Stream Gaging, Data Collection, Archival Services*
10/30/2007	Committee work session and breakdown into subcommittees a. Dams b. Flood Forecasting c. Land Use
11/6/2007	Sub-Committee Work Sessions
11/20/2007	1. Colin Apse Dep. Director of the Nature Conservancy's Eastern U.S. Freshwater Conservation Program. *River Hydrology, Natural Flow Regimes and how these are affected by Dams, Development and River Management.* 2. Dr. Keith Nislow, Aquatic Ecology Research Scientist for the U.S. Forest Service.
12/06/2007	1. Rick Chormann, Senior Hydrogeologist, NHGS: *Enhanced Elevation Data: The Case for LiDAR* 2. Chris Pope, Director of Homeland Security and Emergency Management of Dept. of Safety: *Information Analysis Center* 3. Paul Marinelli, Ce.E., Chief, Reservoir Control Center, USACOE New England District: *USACOE Flood Risk Management in NH*
1/7/2008	1. John Kennelly, Chief of Planning, USACOE New England District: USACOE Planning Programs: *USACOE Planning & Technical Assistance Programs* 2. Michael P. Pillsbury, PE, Assistant Director, NHDOT Division of Operations: *Highway Drainage and Crossing Structures*
1/28/2008	1. Robert Roseen, PE, PhD, Environmental Research Group, Dept. of Civil Eng., UNH: *Stormwater Management, Land Use, and Flooding Implementations*

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