

Boulder Office of Emergency Management

THIRA

Threat, Hazard Identification & Risk Assessment

Boulder County 2016 Spring Run-off Event & Severe Weather Season

April 10, 2016

THIRA Report Completed by:
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Overview

On September 11, 2013 the Front Range Flood event resulted in wide spread damage to infrastructure, property, the environment, and caused the death of 10 individuals. Boulder County was the center point of this storm and received severe damage in almost every canyon from north to south and every community from the continental divide to the eastern county line boundary. The damage in each region of the county has caused unique challenges for home, land and business owners in the canyons and the plains. Today, hazards and challenges exist that are different from those encountered during or directly following the flood. While they are different they are directly linked to the impacts of September 11, 2013.

In 2014 significant effort identified high hazard locations along all creeks and rivers in Boulder County. FEMA adjusted their Federal guidance and created the High Hazard Debris Removal Program under Category B Public Assistance. The program reimbursed debris clearing activities prior to spring run-off in the identified drainages. This program provided high hazard debris removal in rivers and creeks of Boulder County resulting in only minor incidents during the 2014 spring run-off event.

Since the completion of the 2014 high hazard debris removal program thunderstorms and monsoon rains has caused the Boulder Office of Emergency Management to activate the Severe Weather Protocol for Boulder County 13 times from May to September in 2014 and 2015. These events were significant enough to cause a National Weather Service flash flood watch or warning. These storms produced high flow events that caused only localized flooding in some areas but moved debris from the mountain drainages into the creeks and rivers of the foothills and plains of Boulder County. The excellent work to clear the rivers and creeks of high hazard debris in 2014 has unfortunately been diminished by the thunderstorms and monsoon rains of 2014 and 2015. The spring runoff of 2015 was above average in character and has also contributed to moving debris further downstream. This was most noted in Longmont during the June 2015 Tornado when flood waters carried vast quantities of woody debris into the City. The USGS reported following the 2013 flood that significant cubic yards of debris remain in the mountain drainages of Boulder County and the USGS report appears to be accurate.



On June 4, 2015 a severe storm produced a tornado, 1" hail and 8 inches of rainfall in the Lyons area, damaging 25 homes in Northern Boulder and Southern Larimer County. This storm moved from east to west and then south into the City of Boulder before moving out of the south eastern boundary of the county.

The establishment of the St. Vrain River, Four Mile and Lefthand Creek Watershed Coalitions provides excellent work in the development of long term solutions to address public safety, preserve habitat, support recreation and preserve natural river and stream ecosystems. However, there is uncertainty and worry amongst residents that spring run-off, thunderstorms or monsoon rains will bring additional flooding due to the apparent woody debris populating the river and creek channel ways. In addition, there are still areas with significant deposition of sediment reducing conveyance of bridges and the creek. The presence of woody debris in the creeks and rivers of mountain communities, suburban and urban corridors present a special hazard compared to more expansive natural lands such as national and state forest lands.

This uncertainty has turned into concern and in some cases conflict between local residents and the coalitions. Residents are worried especially after the 2015 tornado caused a high water event activating memories of the 2013 flood. As more information is becoming available about above average spring-runoff and precipitation so rises their public safety concerns pushing issues to the forefront. Boulder OEM was sought out by local residents to address public safety concerns that they felt were not being addressed in the work of the coalitions. After meeting with residents and the watershed coalition coordinators and two field assessments it is apparent that hazardous woody debris exists in the rivers and creeks in Boulder County. Some areas are in defined project areas created by the watershed coalitions but the timing is post spring runoff, severe thunderstorm and monsoon season. This is one of the factors driving community insecurity and conflict with watershed coalition leaders. The second factor causing great frustration is the presence of regulations specifically with the conditions of grant funding as defined in NRCS and specifically DOLA- CDBG-DR (HUD) regulations in these project areas. As explained by watershed coalition and community leaders if any activity performed in the rivers or creeks is classified as ground disturbance, choice limiting activities or does not have an environmental review grant funding may be subject to forfeiture thus preventing the long term recovery of the rivers and creeks.

Currently the problems of woody debris and unstable rivers or creek banks are addressed in the long term recovery projects of the watershed coalitions and the County's Emergency High Hazard River and Creek program. The Emergency High Hazard program is designed to act once a report is made into the Boulder Sheriff's Communications Center by a resident or business owner. Deputies and road crews are dispatched to evaluate the problem and if required act to stabilize the incident. The problem with this program is that is reactionary in nature and in some cases actions cannot be made until flows recede due to safety reasons.


The problem of woody debris and deposition of sediment are still problems in the rivers and creeks involved in the 2013 flood. The expectation that this problem would not arise again has never been an expected outcome or included in local planning efforts. The existing watershed coalition projects cover the long range issues and the emergency high hazards program deals with the incident when it happens. What is missing is a mitigation program that fills the space between long term work and emergency response. In order to successfully achieve the strategic intent of the watershed coalitions the establishment of a local mitigation program supported by local residents, the county and watershed coalitions cannot be overstated. In 2005, the MMC conducted a widely cited study, [*Natural Hazard Mitigation Saves: An Independent Study to Assess the Future Savings from Mitigation Activities*](#), which documented how every \$1 spent on mitigation saves society an average of \$4 in response and recovery. The cost benefit of mitigating high hazard debris in non-emergency situations will be less expensive, build community trust and most importantly reduce life safety risks. But in order to create such a program a change in attitude, strategies and effort must be achieved. It has been expressed by residents that if a mitigation program is not developed and quickly it will be too late to influence spring runoff and possible interrupt collaboration and disrupt efforts of the watershed coalitions moving forward with the community.

This report addresses the existing or potential hazards found in river and creek drainages that are near or go through communities in Boulder County. The specific hazards addressed in this report are (1) woody debris deposited as a high hazard along rivers and creeks potentially causing debris dams and subsequent flash flooding (2) reduced capacity of creeks and rivers due to deposition of sediment (3) the risk to life, structures and infrastructure, for example homes, roadways, culverts and bridges, at risk for damage or destruction.

The THIRA report also provides planning assumptions and target capabilities that mitigate, reduce or manage the hazardous conditions within this document. Each target capability is aligned with the following planning assumptions:

- Planning assumption #1: Assessments will be completed and existing data collected for each watershed coalition drainage, assess analytics and based on hazard rating assessment criteria focus on risk reduction activities: Complete assessments of hazardous areas using hazard criteria. Develop non-natural land specific high hazard woody debris polygons where the criteria will be applied. Boulder County Parks and Open Space is responsible for the criteria and assessment of woody debris in natural lands. Special consideration should be applied to reaches that are upstream of residences and towns. Deploy county resources and develop community guidance for private property land owners to mitigate the hazardous conditions to significantly reduce the severity of high

hazard woody debris locations before the spring run-off, severe weather and monsoon season. An oversight / planning committee will be formed to evaluate operations, required modifications to criteria and to provide recommendations for policy adjustment.

- Planning assumption #2: The risk cannot be completely removed or significantly reduced therefore a “Whole community planning and engagement program” must be implemented: Based upon the effectiveness of risk reduction through hazard mitigation the following activities are required (1) community preparedness education based on risks for the community, (2) First responder operational planning to flash flooding caused by woody debris dams and unexpected erosion or access problems, (3) public works and road department planning to address damming of rivers and creeks and road damage due to flooding caused by woody debris dams (4) public warning planning with the local communication centers, senior policy group officials, the National Weather Service and public information officers due to complexities of spring run-off flooding and (5) Emergency evacuation site, sheltering and temporary housing planning by ESF 6 & 8 agencies to ensure displaced residents can be served in an already stressed available housing inventory. 
- Planning assumption #3: This is a multi-year program and must remain in place until the recovery of the rivers and creeks is determined by the watershed coalitions: This will continue to remain a problem until creek and river stabilization projects are completed. With each year the risk is expected to decline as recovery projects are completed. Each year in October an assessment shall be completed to identify woody debris locations that meet the high hazard criteria. These sites should be logged into the Crisis Track Damage Assessment software and translated to a GIS layer for display. An operational mitigation plan should be developed to address high hazard locations well before the next spring run-off. Private property owners should notify their river or creek coalition coordinator or the Boulder Office of Emergency Management if they have a high hazard site and work to resolve the debris problem.

The final section of the THIRA includes the requirements for application of target capabilities to achieve results. An estimate of resources required to achieve the target capabilities through the use of community assets, mutual aid, county, state and Federal resources is also provided. In addition, a timeline for execution is also included to show the activities that must be coordinated and implemented over the next 30 days before spring run-off occurs. Due to this time critical period, long term river and creek planning is not emphasized in this report. Certain current efforts that address any risk or hazard of the THIRA will be coordinated with actions under taken as emergency protective measures.

Types of threats and hazards:

The significant threats identified in the assessment of Boulder County are as follows;

1. Flash Flooding during spring run-off due to the movement of debris and the subsequent collection and damming holding back the river flow.
2. Flooding during spring-run off due to deposition of sand and gravel
3. Thunderstorm activity that generates run-off flow exceeding river or creek capacity causing flash flooding or localized flooding of homes and roadways.
4. Monsoon weather patterns that can cause ground saturation increasing surface runoff swelling rivers and creeks increasing flow and causing aerial flood situations.
5. Snow pack currently is at slightly above normal levels. With the risk of more storm activity this spring the risk of a rain on snow melt increases. This is significant because it can suddenly increase run –off rates and create high water events that move woody debris or flooding.
6. Reservoirs will reach capacity in the region during run-off and will spill normally usual causing additional flow during the runoff and thunderstorm season.

Sources of threat and hazard information:

Woody Debris:

Generally low gradient rivers and creeks have debris collection issues different from Canyon Rivers that have steep gradients. The impacts of Large Wood Debris (LWD) with the presence of life safety and infrastructure in the flood plain changes the management approach to situ (original location) debris and allochthonous (originated at distance from where it is found) debris. Lower gradient and slower speed channels have more orthogonal tree fall of LWD than steeper gradient and faster velocity creeks and rivers which tend to place fallen trees from erosion in more parallel aspects with the channel flow. The likelihood of debris collection is proportional to the span of the tree covering the cross section of the channel. The presence of debris dams that span the river or creek channel increases further erosion by displacing the flow around the previous flow channel. The erosion may cause further collection of other woody debris and trees increasing size of the debris dam and collection of water until hydrologic conditions collapse and move the debris or a high flow event disrupts the debris dam downstream. The St Vrain River has sustained higher flows during spring run-off in comparison to Lefthand Creek. The foothill canyons are susceptible to drainage fed woody debris from mountain thunderstorms pushing the debris into the canyon's waterways. Lyons being positioned so close along with residences on Lefthand to the alluvial influences of rivers experiences allochthonous type debris and moderate situ debris from erosion of banks falling trees. Lefthand has a heavy density of cottonwood trees lining the creek from Highway 36 and continuing eastward. This high density of trees and the presence of a high flow event cause meandering debris to become entangled and form debris collection points which may lead to debris dams. Also in high flow events and with post flood channel changes erosion causes treefall thus creating potential debris collection points.

Summary Sources

Patterns and processes of wood debris accumulation in the Queets river basin, Washington

*Tim B. Abbe¹, David R. Montgomery**

Department of Earth and Space Sciences, University of Washington, Seattle, WA 98195, USA

Received 31 August 2001; received in revised form 8 February 2002; accepted 18 October 2002

Schuett-Hames, D., A.E. Pleus, J.Ward, M.Fox, and J.Light. 1999. TFW Monitoring Program method manual for the large woody debris survey.



Tree fall on Boulder County Open Space from erosion spanning $\frac{3}{4}$ to full channel width on Lefthand Creek West of Longmont



Tree fall on private property causing debris collection east of Airport Road and the Diagonal Hwy with BNSF railroad trestle approximately 2 tenths of a mile downstream

Snow Pack and Run-Off:

The Boulder Office of the National Weather Service (NWS) is monitoring the current snow pack levels for all drainages and will constantly provide threat analysis and recommendations as conditions get closer to the actual spring run-off date to the Boulder Office of Emergency Management. In addition, Boulder OEM partners with organizations that have responsibilities in the field of water management and flood control to gather data and advice for hazard analysis. This analysis is helpful analysis of risk and probability and assessing hazard sites for mitigation.

Email from Sean Cronin Executive Director of the St.Vrain / Lefthand Water Conservatory District addressing spring run-off potential.

From: Sean Cronin

Sent: Saturday, April 9, 2016 8:35 AM

To: 'Cecily Mui'; Thompson, James (Bennet); Betts, Dan (Gardner); Danielle Henry

Cc: Jessica Olson; Chris Wiorek; Molly Urbina - GovOffice (molly.urbina@state.co.us); kevin.houck@state.co.us

Subject: RE: Brief highlighting key points of CDBG-DR funding concerns

Greetings,

On Monday, I expect a question regarding runoff potential. Below please find graphic that best illustrates the potential. The Boulder-St. Vrain basin is projected to have one of the top three runoffs in the state. As stated in the draft document, this year's runoff is a concern for many of the coalitions. To support this concern, the forecasts show many of the September 2013 flood impacted basins projected to have higher than average runoff.

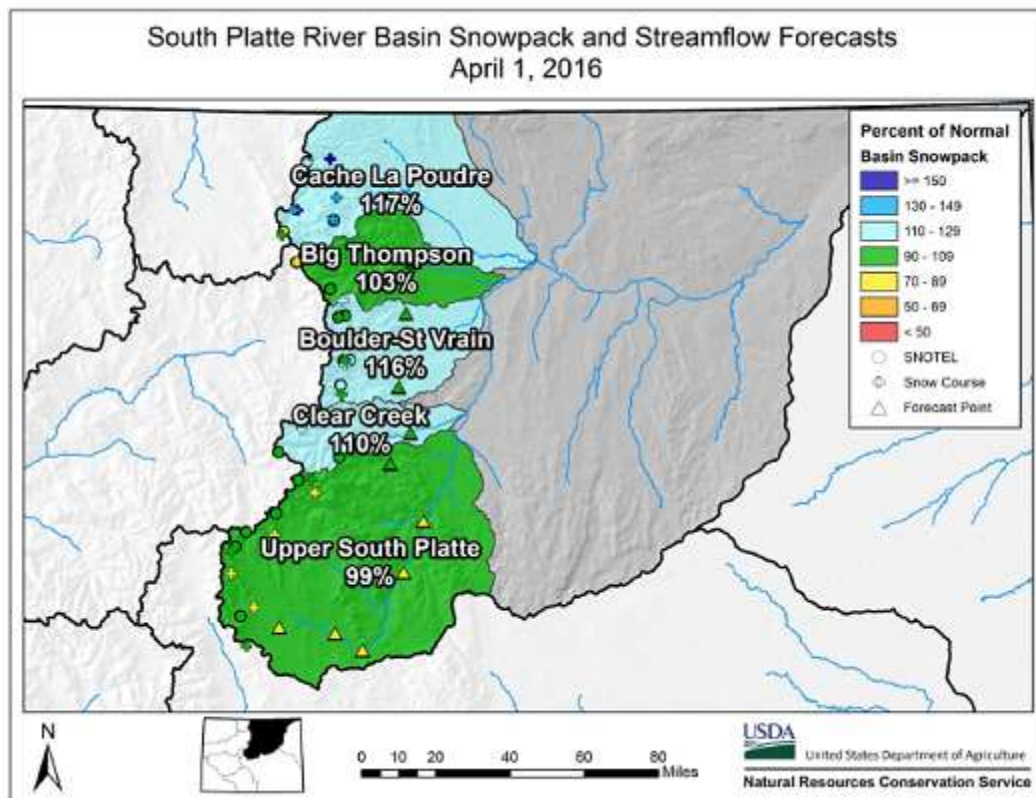
As many of you know, above average runoff is not an anomaly and in Colorado we have a long successful history of "managing" runoff with little to no incidents. What makes the last three years more prone to incidents is the flood impacted river systems are still very unstable as they continue to move large amounts of woody debris and sediment. Over the years, the debris and sediment has stacked up in natural resting places that for most of the year is relatively harmless. As the rivers swell they can dislodge this debris and sediment, create debris dams, and re-route the river out of the channel and into infrastructure with un-behaved and destructive behavior. We saw this occur during runoff in 2015 on Left Hand Creek, and as a result an additional federal disaster was declared. Please note this second federal disaster was exacerbated by significant late spring snow and rains, but does demonstrate the fragile nature of waterways (and who knows what April, May, June is going to bring to our basin).

I look forward to our conversation on Monday.

Sean

Sean T. Cronin | Executive Director

www.svlhwcd.org



The Boulder Office of the National Weather Service (NWS) is monitoring the current snow pack levels for all drainages and will constantly provide threat analysis and recommendations as conditions get closer to the actual spring run-off date to the Boulder Office of Emergency Management. This analysis will determine the appropriate triggers for public warnings.

Urban Drainage Flood Control District ("UDFCD")- awaiting analysis at the time of this report's issuance.

1. Thunderstorm Related Flooding.

UDFCD and the NWS Boulder Office have a long standing relationship with the City of Boulder and Boulder County in providing flood prevention, monitoring and hydrological and meteorological services. Threat analysis and recommendations shall be provided as data and models can be utilized for risk & vulnerability assessments. Current probability and predictability recommendations are being utilized from these agencies in preparing flood thresholds, public warning thresholds, flood prediction and river and creek capacity conditions. Recently the NWS was asked to provide a 90 outlook for the potential of severe weather and spring run-off. The following is the email providing assessment from Robert Glancy, Meteorologist, NWS.

Mike,

I won't duplicate what you are getting from NRCS, but can give you an idea of upcoming weather. Right now the rest of April looks wet, especially for the mountains and foothills. The city of Boulder has its best chance of rain later Sunday and Monday, again on Tuesday, then there are indications on at least one of the computer models of a cutoff low the following weekend along the Colorado- New Mexico border with deep upslope southeasterly flow along the Front Range, if this comes to pass there could be significant rain in Boulder and significant snow in the mountains and foothills.

I have attached the CPC forecasts going out to 3 months which are all showing a tilt toward wet conditions. We definitely need to be looking at the potential of runoff issues this spring. I hope this gives you the information you need in the Thira.

Bob

Probability Maps for rainfall and moisture over the next three months and increasing as later spring months occur. Predication charts are included below:

Figure 1. Shows that precipitation is slightly above normal in the next 8 to 14 days. (April 9 to April 23, 2016)

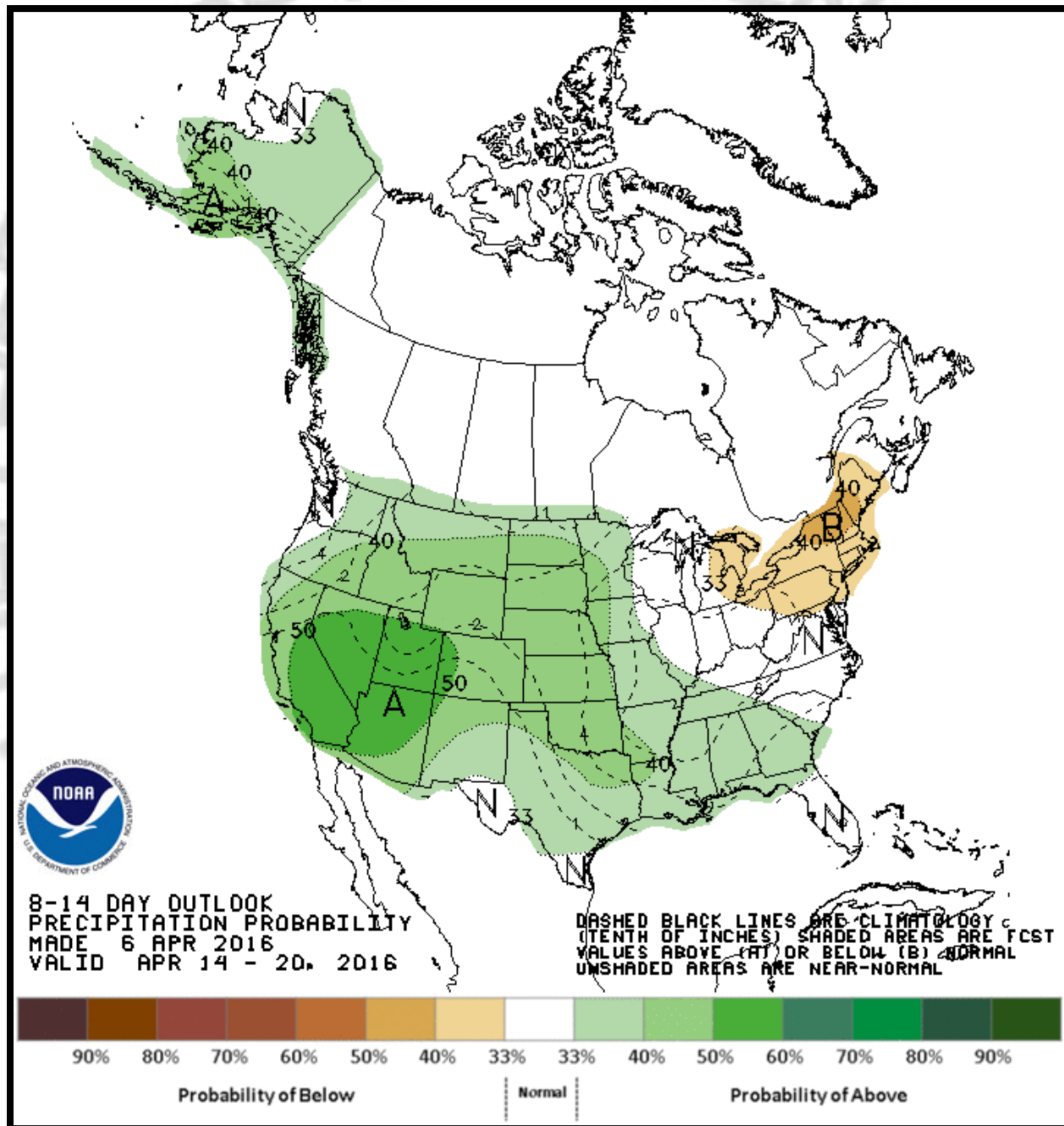


Figure 2. Shows the 1 month forecast above normal at a 50% probability (April 1 to May 1, 2016) (spring runoff begins usually in the first 10 days of May).

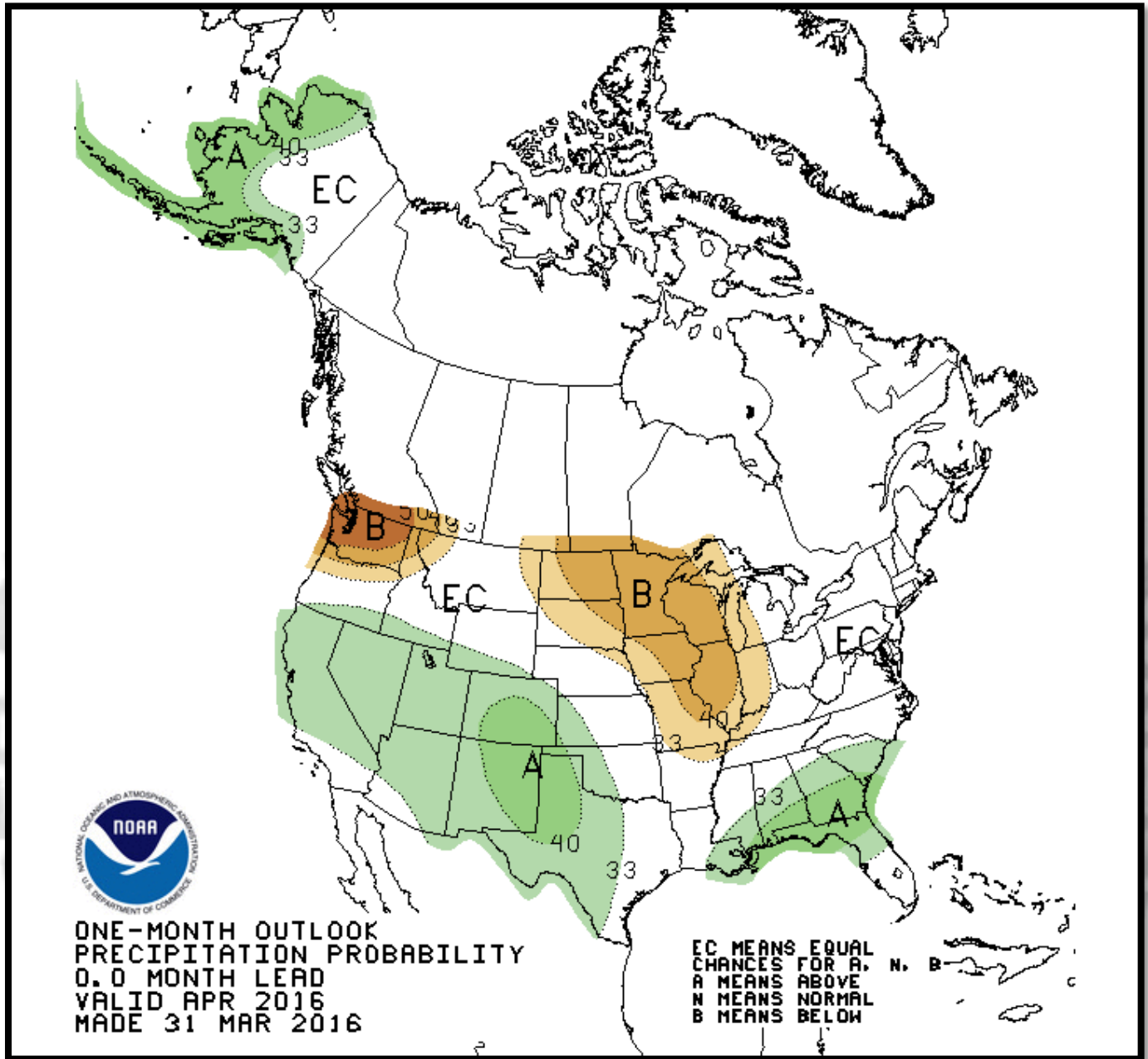
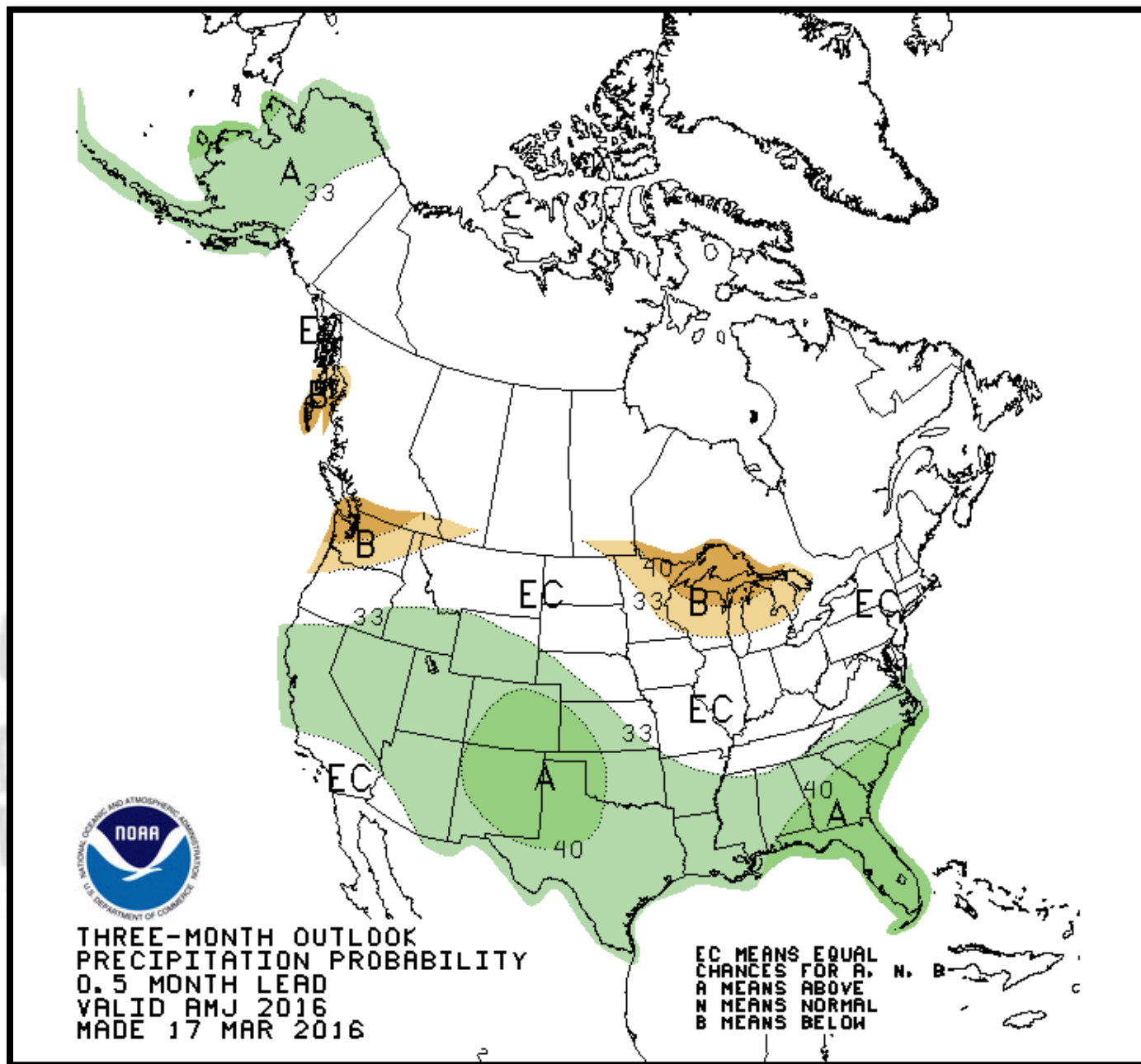


Figure 3. Indicates over the next three months will be above normal in precipitation (April 1 to June 1, 2016)



Factors to consider

- Likelihood of incident-
 - Spring- Run-off likelihood is 100% occurring approximately from **May 1 through June 15.**
 - Thunderstorm- Likelihood of Thunderstorm occurrence in drainages affected by the flood is 100%, but the severity of storms is as follows:
 - Awaiting UDFCD Data and Analysis
 - Anecdotal information- ½-1 inches per hour rainfall is common in the mountains, 1-2 inches per hour is routinely seen in the mountains and 3-4 inch plus per hour rainfall events occur 3-6 times per year in the mountains.
 - Debris related Problems- due to the amount and location of debris in and around the streams, the likelihood of debris impacting stream conveyance is 100%.
 - Flooding causing road damage
 - Debris jams in culverts and bridges
 - Diversion of creek and river flow causing bank erosion and possible structural flooding.
- Significance of threat /hazard effects
 - The most severe effect of these hazards is the risk to life. Unlike a thunderstorm where the early warning system is initially launched with detection of a storm on radar and resources can be directed to monitor the conditions and initiate public warnings. In the current state of affairs, flash flooding is likely to occur because of debris dams forming in the creek or river basin. Detection will not occur until someone notices the presence of the dam or it releases and a surge of water is smashing through homes and washing away roads. This gives very little reflex time to assess the situation notify proper authorities of the hazardous condition and little time to warn the public to take action.
 - **A Threat Priority Rating is established to rate potential hazard sites and their need for Emergency Mitigation Measures and preparations for spring runoff.**

Threats and Hazards Context

Timing of an incident

- Spring run-off is predictable and seasonal. It generally starts in late April to early May and may last from 3-6 weeks depending on snow pack and late season storms.
- Flash flooding due to thunderstorms are detectable with radar and have about a 40 minute to 1 hour cycle from peak flow to flash flooding allowing for some warning time and risk vulnerability assessment time. Severe thunderstorm activity is generally from April 15 to October 1.
- Flooding due to debris dams and landslides are not predictable events and the time cycle from forming to impact conditions is also equally unpredictable.
- Monsoon rain season begins in late July to early August and is characterized as frequent rain events of lower intensity. The flood risk in monsoon season is multiple days of rainfall saturating the ground and then a sustained moderate intensity rain event can cause flooding.

Location of an incident

- Spring Run-Off – Boulder Creek, Four mile Creek, James Creek, Lefthand Creek, South Boulder Creek, and St. Vrain River, all experience runoff conditions. Bear Canyon Creek, Bluebell Canyon Creek, Boulder Slough, Coal Creek, Dry Creek No.2 Ditch, Four mile Canyon Creek, Goose Creek, Gregory Canyon Creek, Kings Gulch, Six Mile Creek, Skunk Creek, Sunshine Canyon Creek, Two Mile Canyon Creek, Viele Channel and Wonderland Creek are less susceptible to spring run-off but are exposed when thunderstorm activity occurs.
- Severe Weather and Monsoonal Rains- These events occur throughout the county and are not specific to an area in the county. But what should be considered is that severe storm and monsoon events can and frequently do involve a large percentage of county area during a single event.
- Debris – Debris is located in all drainages but most frequently in Boulder Creek, Lefthand Canyon Creek, St Vrain, James Creek, and Four mile Creek. With the certainty of spring run-off these areas are of high concern. This does not mean to minimize the level 1 debris locations of other drainages identified in the assessments that also require attention during thunderstorm activity.
- Deposition of sediment – Is present in all drainages and especially noticed in areas where velocities slowed and deposits formed such as before and after culverts and bridges, infrastructure features and in areas where debris slowed water movement or in areas where the flood waters receded.
- Debris Flows and Landslides – Steep canyons, under cut areas with an Eastern and southern facing slope.

Vulnerabilities

- Life Safety: Many regions along the rivers and creeks are developed and place lives at risk. Warning times are longer in debris dam situations because there is no early warning other than visualization of creek flows, the debris dam or flow drops on gauges. Vigilance in monitoring and actions that maintain the creeks and rivers are necessary to address life safety concerns.
- Damage to Property is the next significant effect these hazards create. Many homes are located along river and creek banks in Boulder Creek, Four Mile, Four Mile Canyon Creek, Gregory Creek, James Creek, Lefthand Creek, Boulder and St. Vrain Creek, as well as the City of Longmont are exposed to consequences of events on these drainages. Many homes and private roads and bridges are now protected by temporary measures to prevent further bank erosion, flash flooding or debris impacts. They are built to rudimentary design standard and only to contain normal flows and normal run-off levels. They could be compromised under high water events.

- Potential damage to Infrastructure, especially roads and bridges because many of the roads are temporary roadways and susceptible to high flows in rivers and creeks and easily impacted if flooding conditions are present. Many of the bridges and culverts high deposition of sediment on the upstream and downstream sides reducing the flow capacity through these structures. Higher creek and river flows will cause erosion and exacerbate sediment conditions possibly resulting in side scouring, overtopping and eventual damage or failure.



Deposition of Sediment at 41st Street Bridge deposited in 2013 flood.

Other conditions or circumstances that make the threat or hazard of particular concern

- **Timing** of Spring Run-off is now at the 60-90 day mark creating urgency for securing funding, prioritizing work and executing the work before spring run-off.
- **Unpredictability** in how the rivers and creeks will behave once the spring run-off starts to occur thus requiring adjustment in operational plans, community preparedness and the adjustments needed in establishing thresholds for initiating public warnings.
- **Funding** all of the mitigation projects of hazards is undetermined and future needs as critical infrastructure is impacted.
- **Presentation of Hazards** is difficult to target exactly when and where hazards conditions will occur. Also the relationship of hazardous situations upstream has potential impacts downstream and throughout the entire river or creek system. Reflex time from identification to notification of first responders and the community will be short.

Target Capabilities

Describe impacts and desired outcomes:

Criteria to evaluate Debris:

- Decision tool that addresses the public safety and infrastructure concerns.
- Can be used to communicate risk to the public.
- Balance the importance of wood debris in streams and creeks to assist in flood control, create and preserve habitat, limit impacts on healthy river and riparian systems.

Tree Criteria

1. The fallen tree is in an identified hazard polygon.
2. The tree is $\frac{3}{4}$ or completely spanning the river channel.
3. The fall attitude is orthogonal within 70-110 degrees of creek or river flow.

Multiple Tree Removal Criteria

1. The fallen tree is in an identified hazard polygon.
2. The trees are $\frac{1}{2}$ or completely spanning the river channel.
3. The fall attitude is orthogonal within 70-110 degrees of creek or river flow.
4. There are multiple trees (2 or more additional trees) within the visual observation area of the tree site upstream or downstream.
5. There are signs of debris collection within the river or creek at the review site location.

Debris Dam Removal Criteria

1. The debris dam is spanning $\frac{1}{2}$ to 100% of the river or creek channel width.
2. The debris dam is already or going to cause a change in flow around the dam causing erosion or cause water to back up.
3. Further collection of woody debris is going to create a complete dam.
4. Is this a potential flash flood CFS release situation?

Establish hazard polygons to identify where debris and fallen tree criteria shall be used to determine hazard:

- Determine high hazard polygons along creeks and rivers to apply criteria.
- Polygons can be used also for the assessment phase to assign crews performing the work.
- Polygons will be numbered and drainage specific.

Perform risk hazard analysis with damage assessment teams

- **Collect all existing hazard site reports from watershed coalitions.**
- **Solicit community input on hazard sites.**
- Assemble damage assessment teams to perform hazard assessments.
- Use hazard polygons to coordinate assessment activities.
- Perform assessments using criteria.
- Develop analytics from the data to determine cost and also develop an execution plan.
- Hazardous sites will then be assessed using the following threat levels.

Level 1- The probability and risk is high

- If woody debris is identified it has a high risk of causing damming or blocking culverts or bridges.

- Deposition of sediment will cause flooding
- Bank erosion or avulsions will not handle creek flow and cause flooding
- If a home, it is in great danger of being impacted by spring run-off.

Level 2- Moderate probability and risk

- If woody debris is identified it has a potential if erosion or the flow is achieved to cause the debris to move and possibly causing damming or blocking culverts or bridges.
- Deposition of sediment will cause flooding if a certain flow is achieved.
- Bank erosion or avulsions could possibly not handle creek flow and cause flooding if unsuspected erosion or additional flow is achieved.
- If a home, it is in possible danger because debris dams, erosion or unanticipated flow in the creeks places the residence at risk, possibly affected by spring run-off.

Level 3- Low probability and risk

- If woody debris is identified it has a low potential to cause damming or blocking culverts or bridges under normal or expected conditions.
- Deposition of sediment not likely to cause flooding unless a certain flow is achieved due to a thunderstorm or other extreme condition.
- Bank erosion or avulsions could possibly not handle creek flow and cause flooding if extreme conditions are created from damming, if extreme spring run-off conditions are present or thunderstorm activity causes severe runoff flows.
- If a home, it is unlikely to be in possible danger from spring run-off but extreme conditions such as unanticipated debris dams, erosion or unanticipated flow in the creeks places the residence at risk.

Level 4- needs to be evaluated after the spring run-off and the risk re-evaluated.

Community preparedness & engagement program

- Community messaging and personal preparedness programs
 - Messaging is currently being updated and all public information resources updated, completed by May 1, 2016.
 - Meet with County and City /Town PIOs to develop messaging and provide updates as needed.
- Community engagement and meeting schedules
 - Schedule community meetings immediately.
 - Coordinate with City of Longmont on public messaging and public meetings.
- Intermountain alliance
 - Report activities to the IMA coordinator for immediate messaging and schedule the agenda for this topic.
- Boulder Mountain Third Arm Community Preparedness group
 - Advise the Boulder Mountain Fire Protection District Fire Chief and coordinate messaging and actions on future needs.
- Report the program and activities to the Boulder County Firefighters Association, the County Law Group, Boulder Multi Agency Coordination Group, and the County Flood Planning Group.

Risk and Hazard Assessments Completed

- Spring Run-Off: Analysis completed and monitoring situation with NWS, UDFCD and SVLHWCD.
- USGS landslide report
- Complete and update THIRA
- LIDAR data completed on all rivers and creeks
- 3 month precipitation forecast completed.

Emergency Response Plans

- Updated existing flood planning that involves multiple agencies and multiple disciplines by March 2016.
- Established Severe Weather protocols and radar technology in the EOC and utilized by emergency dispatch centers.
- Evacuation and sheltering plan in place and Medical Reserve Corps for access and functional needs populations.
- Rain gauge and stream gauge system currently in place.
- Working with Local communities to develop creek and river "Watch Programs".

Public Warning

- Outdoor warning systems
 - Tested every week silently and public testing begins April 2016.
- Everbridge emergency telephone warning systems
 - Polygons created for Four mile, Boulder Mountain, western areas of Boulder.
- NWS civilian warning protocol in place with the NWS (status: Completed)
- Emergency Alert System Protocol (Status: Completed)
- Civilian weather spotter systems (Status: Completed)
- BCARES: Mountain Emergency Response Network: 100 Ham radio operators trained, county wide system connected to the EOC ham radio operators.

Hazard Vulnerability Assessment Matrix

EVENT	Probability	Severity Level			Preparedness Levels			Risk
		Human Impact	Property Impact	Infrastructure impact	Preparedness needs	Internal response	External response	Relative threat
Score	Likelihood this will occur	Probability of injury or death	Physical losses and damages	Interruption of services	Preplanning	Time effective response	Mutual aid and other resources	0-21
	0= N/a 1- low 2- moderate 3- high	0= N/a 1- low 2- moderate 3- high	0= N/a 1- low 2- moderate 3- high	0= N/a 1- low 2- moderate 3- high	0= N/a 1- high 2- moderate 3- low	0= N/a 1- high 2- moderate 3- low	0= N/a 1- high 2- moderate 3- low	
Spring run-off Flooding	3	2	2	2	2	1	2	14
Woody debris dams	2	2	2	2	2	1	1	12
Woody debris jams: culverts and bridges	3	1	1	1	2	2	1	11
Deposition of sediment due to erosion	3	1	1	2	2	2	2	13
Flash flooding from debris dams	2	3	3	3	1	1	1	14
Flash flooding from thunderstorm activity	2	1	2	2	1	1	1	10
Average score	2.5	1.67	1.67	2	1.67	1.3	1.3	12.3
							R- P x S=	30.75%

Risk = Probability x Severity

What do the numbers mean?

Probability Column- The probability value is a subjective assessment of how likely the hazard will occur based on field reviews, review of data, and anecdotal reports from field personnel. An average probability score of 2.5 shows that the probability for an event to occur is above average.

Relative threat column- Provides a means to evaluate which event carries a higher degree of threat based on severity and preparedness levels. The higher the number the worse the risk or hazardous situation. The numbers can then be used to prioritize hazards. The 30.75% represents that the relative threat is moderate based on an average score of 12.3 out of 21 possible points.

Strategic, operational and tactical plans

- Public Works and County Roads Emergency Hazardous Debris and Landslide Response Plan- in place and updated February 2016.
- Boulder County Operational Flood Response Plan- Currently in place and being updated.
- Boulder Resource Mobilization Plan- Currently in place and updated.
- Boulder Emergency Operations Plan- Currently in place and updated.
- Boulder Emergency Operations Center Operations Manual- Currently in place and being updated.
- Boulder Disaster Response Incident Plan- Base plan completed and hazard specific response plan updated.
- Boulder ESF 6 & 8 Evacuation and Sheltering Plan- Currently in place
- Boulder Damage Assessment Plan- Currently in Place

Mitigation, Preparedness plans & capabilities

- Boulder Hazard Mitigation Plan- Currently Adopted April 2016
- Flood preparedness guides and all-hazards guides currently in place.
- Community Engagement- Strategies are in place, schedule is being created and format developed.
- Community Preparedness education- Messaging is being updated and incorporates personal preparedness, hazard identification, recognition of hazard presentation, reporting actions and protective measures to employ.
- Preparedness Information & Distribution- City and county websites, media plan, social media usage, video productions and documentation updated.

Existing capability analysis

- Community Preparedness- Strong experience from previous disasters being applied, excellent strategies to accomplish goals present and implementation plan under development.
- First Responders- Excellent interagency cooperation present, joint planning efforts are strong and excellent first responder experience in handling threats identified.
- Publics Works and County Roads- Strong desire to work within mutual aid environments, exploring pre-event MOUs and desire to develop pre-event cost share understanding or agreements.
- EOC – Excellent capability to operate and support hazard environments identified in the THIRA. Strong experience in providing policy group support, developing situational awareness, resource support and ESF staffing through the Boulder Multi-agency Coordination Group.
- Resource Mobilization- Existing resource mobilization has excellent performance experience locally and integrates with all resource mobilization systems at the state and federal level.
- Incident Command and Type 3 Team- Unified command experience is strong and local Type 3 incident management team experience is strong and ready to manage complexity of hazards.
- Mass Care and Sheltering- Strong local experience in integrating with Red Cross sheltering plan, developing local capability as needed, providing transportation support and addressing access and functional needs populations.
- Public Information & Social Media- ESF 15 External Affairs / PIO experience is strong in public messaging and operating in a joint information system.

- Public Warning- Excellent familiarity with existing systems, strong experience in application of systems and procedures in place to use and activate systems.

Mutual aid resources

- Existing Mutual Aid and Auto Aid Agreements- Currently in place for first responder agencies and being developed for public works organizations.
- County and City MOUs and IGAs- Being evaluated currently and under development to address the threats and hazards identified in the THIRA.
- Contracted Resources- Currently contractors are in place, RFPs are being executed to address current projects and additional resource needs are being evaluated and contractors possibly acquired to address gaps.
- Non-profits- Red Cross, Salvation Army, COVOAD, United Way and local non-profits engaged.

Regional, State and Federal resources

The following resources could be needed to respond to the various hazards that manifest as a result of spring run-off and thunderstorm activity from April 16 to October 1, 2016.

- Colorado National Guard
- Swift Water rescue Teams
- Helicopter resources
- Urban Search and Rescue, Mountain Rescue Teams & Search Dogs
- Heavy Equipment
- EPA
- CDPHE
- State Patrol
- CDOT
- COVOAD

Conclusion

It is through community engagement, post flood experience and community / watershed coalition collaboration that the content of this THIRA has been created. There must be an immediate shift in policy and within the next 7 to 10 days in order for any content of this THIRA to be implemented in time to reduce the risk and vulnerabilities as described. The need to immediately secure a variance to HUD's policies related to ground disturbance and choice-limiting activities cannot be over emphasized. There is no time for looking backward as to how we got to this point and all effort should be focused on what are the next steps and how to surgically execute the plan.

The recommended solution advised by the Boulder Office of Emergency Management is a multi-year mitigation program that complements the watershed coalition activities moving forward. The program should be funded based on yearly assessments of hazard mitigation sites. This program if implemented addresses the gap that the longer term watershed coalition projects and emergency programs do not. More importantly it addresses the needs and concerns of the residents and business owners in Boulder County. As stated, earlier mitigation has a cost benefit of every 1 dollar you spend on mitigation you save 4 dollars in response and recovery. The real return on investment with this mitigation program is residents start to feel that there is basic level of safety in their daily lives especially when the snow melts or the rain falls. It all begins with a simple change in policy, and then together the residents, local government, watershed coalitions, State Recovery Office, NRCS, HUD, DOLA, CWCB and Colorado's Congressional Delegation can once again make a difference in Boulder County. Our residents and communities are counting on it!

Respectfully,

Michael N. Chard
Director, Boulder Office of Emergency Management