SUMMARY REPORT OF PRIVATE PROPERTY AND RESIDENT FLOOD IMPACT SURVEY AND ANALYSIS SEPTEMBER 2013 FLOOD DISASTER CITY OF BOULDER–UTILITIES DIVISION

November 4, 2014

The report summarizes the results of the City of Boulder "Flood Impact Survey" regarding the September 2013 flood disaster and the extrapolation of these results to a FEMA dataset about individual applications for assistance and associated damage claims paid.

1.0 BACKGROUND AND INTRODUCTION

September 2013 brought unprecedented rainfall to the region, causing significant flooding and extensive damage to both private property and public infrastructure.

In response to this event, the city initiated a review of its flood management program and mitigation priorities and requested assistance identifying neighborhoods and areas in Boulder that were impacted by the recent flooding. As part of these efforts, an online public survey (**Attachment A**) was developed requesting information from property owners and residents about the cause, location and magnitude of flood impacts they experienced. All information and data in this report is based on City of Boulder property owners and residents only.

A letter (**Attachment B**) was sent to a list of approximately 8,500 property owners that were determined to have likely been affected by the flood disaster based on the methodology described in **Attachment C**. A total of 1,297 unique property owners and residents responded to the flood impact survey.

The Federal Emergency Management Agency (FEMA) has provided the city with data about individual applications for assistance and associated damage claims paid. This data set provides information about FEMA insurance and disaster recovery payouts, but does not include property owner and resident out-of pocket costs. For this reason, its usefulness for purposes of assessing flood damages was limited.

The FEMA dataset includes an account of verified losses (eligible losses for reimbursement), damage locations, claims and money awarded. The information presented in this memo is based on extrapolation of the 2013 flood survey results to the number of Individual Assistance (IA) and National Flood Insurance Program (NFIP) claim points in the FEMA data set in order to create an approximation of property damage and damage cost throughout the city. The FEMA extrapolated data should be used for reference purposes only.

The City of Boulder contracted with National Research Center, Inc. (NRC) to assist with the evaluation of the data and this work is summarized in **Attachment D**. An important aspect of their evaluation was to statistically adjust the flood impact survey results so that the profile of the survey properties mirrored that of the all properties affected by the floods (in the survey mailing list). This process is known as "weighting" the data. This was done by reviewing the characteristics of the properties from the survey results and comparing them to the characteristics of the survey mailing list. It was observed that certain recipients were more likely to respond to the survey than were others. For example, a greater proportion of respondents were in the South Boulder Creek basin (28%) than were recipients (21%); respondents were more likely to be have a basement (76%) than were recipients (64%); and respondents were more likely to have flood insurance (17%) than were recipients (10%, see Table *10* on the next page). Many of these variables were associated with the amount of reported damage.

2.0 SUMMARY OF FLOOD IMPACT SURVEY RESULTS

A total of 1,297 unique property owners and residents responded to the flood impact survey. Table 1 summarizes responses regarding how flooding affected property:

Table 1: Summary of Impact Type

Impact Type	Percent
Flooding Impact	92%
Dwelling Impact	86%
Other Property Impact	25%
Business Impact	4%
Other Impacts	3%

Total may exceed 100% as respondents could select more than one option.

Duplicate responses and responses with addresses outside of city limits were removed. Addresses that were not able to be geo-coded (or associated with a geographic coordinate) were repaired in order to create a viable geo-coded location. For more information on this methodology please see **Attachment C and D**.

A. Multiple Causes of Flooding Impacts

Multiple causes of flooding impact were indicated by survey respondents as summarized in Table 2:

Table 2: Cause of Flooding Impacts

What was the source of your flooding?	Percent
Major drainageway flooding	22%
Groundwater infiltration	56%
Flooding from local drainage	43%
Floor drain damage	19%
Sanitary sewer backup	17%
Other	8%

Total may exceed 100% as respondents could select more than one option.

B. Out of Pocket Costs Reported in 2013 Flood Survey

The survey asked responders to indicate out of pocket costs that were attributable to the flood disaster. Where respondents indicated impacts from multiple causes, the reported costs were apportioned to the damage categories. For example, where people reported both groundwater infiltration and local drainageway flooding, 50% of the total estimated out of pocket cost was assigned to each of these categories.

Some respondents may not have been able to fully discern whether the reported damage cost was caused by local drainage flooding or major drainageway flooding. The cause was apparent in some cases, but in other cases where flooding from a major drainageway also spilled into local streets and neighborhoods it may not be clear.

Over half of the responses that indicated the cause of damage was either groundwater, floor drain or sanitary sewer backup were in the South Boulder Creek, Bear Canyon Creek and Viele Channel Basins. The remaining responses were spread throughout the system.

Total out of pocket damage costs exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M. With the outliers included, the total estimated damage cost from the survey extrapolated to FEMA claims is $194,868,964. The outlier values are associated with the following more specific areas:

$10 million – South Boulder Creek 100-year Floodplain area
$6 million – Wonderland Creek 100-year Floodplain area

$1 million – Boulder Creek Basin area (not 100-year Floodplain area)
$1.5 million – Twomile Canyon Creek Basin area (not 100-year Floodplain area)

Table 3 summarizes the out of pocket damage costs reported for each damage cause:

Table 3: Out of Pocket Damage Costs organized by Damage Cause

	Total Cost	Percentage of Total
Major drainageway flooding	$3,475,727	18%
Groundwater infiltration	$4,440,964	23%
Flooding from local drainage	$4,951,446	25%
Floor drain damage	$1,728,650	9%
Sanitary sewer backup	$2,961,794	15%
Other	$1,944,002	10%
Total estimated damages	**$19,502,583**	**100%**

Note: these estimates exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M.

There were four survey responses which were considered outliers. These responses claimed damages of approximately $18.5M which, when extrapolated to FEMA claims totals, substantially skewed the resulting totals. For simplification purposes, the outlier survey responses have been removed from all tables in this summary report.

3.0 FLOOD IMPACT SURVEY RESULTS EXTRAPOLATED TO FEMA DATASET

FEMA provided the City of Boulder complete data set included claims from a total of 8,492 unique properties within the city's jurisdictional limits in July of 2014.

The flood impact survey results were extrapolated to the FEMA data set utilizing a weighting scheme that is discussed in greater detail in **Appendix C and D**. The weighted and extrapolated data set was analyzed and is discussed in the remaining sections of this memo.

A. Total Out of Pocket Damage Costs

Table 4 summarizes the estimated out of pocket damage costs to private property owners and residents affected by various disaster related causes based on flood impact survey responses extrapolated to the FEMA data set.

Table 4: Total Out of Pocket Damage Costs

	Total	Percentage of Total
Major drainageway flooding	$31,267,343	18%
Groundwater infiltration	$40,333,002	23%
Flooding from local drainage	$44,957,530	25%
Floor drain damage	$15,740,096	9%
Sanitary sewer backup	$26,815,555	15%
Other	$17,255,438	10%
Total estimated damages	$176,368,964	100%

Note: these estimates exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M. With the outliers included, the total estimated total cost from the survey extrapolated to FEMA claims is $194,868,964.

B. Damage Cost Breakdowns

The following tables present the estimated damage costs to private property owners and residents organized in various ways based on flood impact survey responses and extrapolated to the FEMA data set.

Table 5: Total Damage Costs organized by Major Drainageway Basin Location and Cause of Damage

	Major drainageway flooding	Groundwater infiltration	Flooding from local drainage	Floor drain damage	Sanitary sewer backup	Other	Total estimated cost from survey
Bear Canyon Creek	$1,368,535	$4,533,276	$3,535,470	$1,639,325	$6,512,547	$794,619	$18,383,772
Bluebell Canyon / King's Gulch	$473,242	$400,769	$1,019,486	$255,097	$342,121	$281,740	$2,772,455
Boulder Creek	$13,948,133	$4,846,155	$4,763,474	$2,176,750	$3,225,915	$12,315,657	$41,276,084
Dry Creek	$0	$168,460	$55,721	$41,790	$0	$55,721	$321,691
Elmer's Twomile Creek	$527,215	$2,827,839	$1,118,419	$397,432	$2,484,257	$751,083	$8,106,244
Fourmile Canyon Creek	$2,303,445	$893,281	$1,259,409	$377,744	$61,486	$21,358	$4,916,722
Gregory Canyon Creek	$1,249,111	$2,511,053	$3,626,084	$12,185	$0	$54,785	$7,453,217
Skunk Creek	$417,024	$260,026	$697,457	$128,533	$199,580	$214,613	$1,917,233
South Boulder Creek	$1,061,443	$8,786,922	$4,005,768	$5,342,396	$7,528,828	$1,090,498	$27,815,855
Sunshine Canyon Creek	$234,194	$0	$0	$0	$0	$0	$234,194
Twomile Canyon / Goose Creek	$7,328,875	$6,629,786	$17,184,929	$3,026,091	$3,884,578	$1,046,810	$39,101,067
Viele Channel	$0	$5,842,987	$4,097,852	$1,081,066	$960,638	$236,103	$12,218,646
Wonderland Creek	$2,356,128	$2,632,450	$3,593,462	$1,261,687	$1,615,604	$392,452	$11,851,784
Total	**$31,267,343**	**$40,333,002**	**$44,957,530**	**$15,740,096**	**$26,815,555**	**$17,255,438**	**$176,368,964**

Note: these exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M. With the outliers included, the total estimated damage cost from the survey extrapolated to FEMA claims is $194,868,964. The outlier values are associated with the following more specific areas:

$10 million – South Boulder Creek 100-year Floodplain area
$6 million – Wonderland Creek 100-year Floodplain area
$1 million – Boulder Creek Basin area (not 100-year Floodplain area)
$1.5 million – Twomile Canyon Creek Basin area (not 100-year Floodplain area)

Table 6: Damage Costs organized by Major Drainageway Floodplains

	Major drainageway flooding	Groundwater infiltration	Flooding from local drainage	Floor drain damage	Sanitary sewer backup	Other	Total estimated cost from survey
Bear Creek 100YR	$957,716	$0	$442,446	$0	$126,071	$0	$1,526,232
Bear Creek 500YR	$1,006,959	$191,828	$655,462	$521,834	$542,872	$626,528	$3,545,482
Bluebell Canyon Creek 100YR	$191,323	$255,097	$191,323	$255,097	$0	$0	$892,839
Bluebell Canyon Creek 500YR	$191,323	$255,097	$191,323	$255,097	$0	$0	$892,839
Boulder Creek 100YR	$10,384,591	$336,976	$307,462	$224,434	$224,434	$131,653	$11,609,551
Boulder Creek 500YR	$10,384,591	$336,976	$9,472,851	$224,434	$224,434	$131,653	$20,774,939
Elmer's Twomile Creek 500YR	$63,084	$63,084	$63,084	$63,084	$441,591	$0	$693,929
Fourmile Canyon Creek 100YR	$1,531,248	$383,821	$948,785	$211,550	$0	$0	$3,075,404
Fourmile Canyon Creek 500YR	$1,798,688	$478,121	$1,148,387	$238,013	$26,462	$8,747	$3,698,418
Goose Creek 100YR	$0	$98,245	$90,228	$0	$0	$0	$188,473
Goose Creek 500YR	$0	$98,245	$90,228	$0	$0	$0	$188,473
Gregory Canyon Creek 100YR	$970,826	$33,532	$882,463	$0	$0	$54,785	$1,941,607
Gregory Canyon Creek 500YR	$1,236,926	$33,532	$1,148,563	$0	$0	$54,785	$2,473,806
King's Gulch 100YR	$32,753	$0	$180,916	$0	$0	$0	$213,669
King's Gulch 500YR	$32,753	$0	$180,916	$0	$0	$0	$213,669
Skunk Creek 100YR	$392,304	$108,931	$377,800	$0	$108,931	$214,613	$1,202,579
Skunk Creek 500YR	$402,392	$112,397	$377,800	$0	$108,931	$214,613	$1,216,133
South Boulder Creek 100YR	$955,733	$1,933,340	$1,809,179	$770,350	$2,566,638	$922,736	$8,957,975
South Boulder Creek 500YR	$1,005,061	$4,682,647	$2,424,308	$2,610,560	$4,196,167	$922,736	$15,841,479
Sunshine Canyon Creek 100YR	$152,754	$0	$0	$0	$0	$0	$152,754
Sunshine Canyon Creek 500YR	$152,754	$0	$0	$0	$0	$0	$152,754
Twomile Canyon Creek 100YR	$2,563,033	$5,123	$1,038,404	$0	$1,236,959	$39,584	$4,883,103
Twomile Canyon Creek 500YR	$2,829,942	$51,757	$1,360,708	$12,007	$1,236,959	$39,584	$5,530,958
Wonderland Creek 100YR	$1,064,919	$135,060	$1,216,716	$77,741	$1,131,375	$0	$3,625,811
Wonderland Creek 500YR	$1,064,919	$163,540	$1,216,716	$105,712	$1,131,375	$0	$3,682,262

Note: these estimates exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M. 500-year floodplain area includes 100-year floodplain area.

Table 7: Damage Costs organized by Geographic Areas and Causes

	Major drainageway flooding	Groundwater infiltration	Flooding from local drainage	Floor drain damage	Sanitary sewer backup	Other	Total estimated cost from survey
Basin	$31,267,343	$40,333,002	$44,957,530	$15,740,096	$26,815,555	$17,255,438	$176,368,964
500YR	$20,169,392	$6,467,224	$18,330,346	$4,030,742	$7,908,792	$1,998,647	$58,905,142
100YR	$19,197,199	$3,290,126	$7,485,722	$1,539,172	$5,394,407	$1,363,372	$38,269,998

Note: these exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M. With the outliers included, the total estimated damage cost from the survey extrapolated to FEMA claims is $194,868,964. The outlier values are associated with the following more specific areas:

$10 million – South Boulder Creek 100-year Floodplain area
$6 million – Wonderland Creek 100-year Floodplain area
$1 million – Boulder Creek Basin area (not 100-year Floodplain area)
$1.5 million – Twomile Canyon Creek Basin area (not 100-year Floodplain area)

Table 8: Damage Costs organized by Major Drainageway Basins and Floodplain Areas

Basin/Floodplain	Estimated cost from survey			Percent of total estimated cost from survey		
	Overall	500-Year Floodplain	100-Year Floodplain	Overall	500-Year Floodplain	100-Year Floodplain
Bear Canyon Creek	$18,383,772	$3,545,482	$1,526,232	10%	2%	1%
Bluebell/Kings/Skunk	$4,689,688	$2,322,641	$2,309,087	3%	1%	1%
Boulder Creek/Slough	$41,276,084	$20,774,939	$11,609,551	23%	12%	7%
Dry Creek/Gunbarrel	$321,691	NA	NA	0%	--	--
Elmer's Twomile	$8,106,244	$693,929	NA	5%	0%	--
Fourmile Canyon Creek	$4,916,722	$3,698,418	$3,075,404	3%	2%	2%
Gregory Canyon Creek	$7,453,217	$2,473,806	$1,941,607	4%	1%	1%
South Boulder/ Viele Channel	$40,034,501	$15,841,479	$8,957,975	23%	9%	5%
Sunshine Canyon Creek	$234,194	$152,754	$152,754	0%	0%	0%
Twomile Canyon/Goose Creek	$39,101,067	$5,719,431	$5,071,576	22%	3%	3%
Wonderland Creek	$11,851,784	$3,682,262	$3,625,811	7%	2%	2%
TOTALS	$176,368,964	$58,905,141	$38,269,997	100%	33%	22%

Note: these exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M. With the outliers included, the total estimated damage cost from the survey extrapolated to FEMA claims is $194,868,964. The outlier values are associated with the following more specific areas:

$10 million – South Boulder Creek 100-year Floodplain area
$6 million – Wonderland Creek 100-year Floodplain area
$1 million – Boulder Creek Basin area (not 100-year Floodplain area)
$1.5 million – Twomile Canyon Creek Basin area (not 100-year Floodplain area)

Most citizens experienced damage to their property from groundwater infiltration and local drainage concentrated in the South Boulder Creek and Twomile Canyon Creek Drainage Basins. Much of the private property damage occurred outside the 100-year floodplain limits.

C. IA and NFIP Claims, Verified Losses and Payouts

The Federal Emergency Management Agency (FEMA) was able to assist members of the public through Individual Assistance Claims and the National Flood Insurance Program. Reported damage costs from the flood impact survey extrapolated to the FEMA dataset were compared with NFIP and IA claims, verified losses and payouts as presented in the following tables.

Table 9: Total NFIP and IA Payouts compared to Estimated Damage Costs

	Overall	With flood insurance	Without flood insurance	Don't know
Damage costs	$176,368,964	$59,764,868	$101,129,317	$15,474,778
Verified loss	$21,532,902	$10,788,658	$10,744,243	--
Payout	$22,735,663	$8,371,206	$14,364,458	--
Payout to damage cost	13%	14%	14%	--

Note: these estimates exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M. With the outliers included, the total estimated total cost from the survey extrapolated to FEMA claims is $194,868,964.

The data analysis indicates that the payout percentage by FEMA was approximately 13%-14% of the estimated damage costs. This percentage remains relatively consistent whether the property owner had flood insurance or not.

However, when the payout is compared to damage cost based on actual claims there is a substantial increase in the payout to damage cost percentage.

Table 10: Approved Payouts compared to Estimated out of Pocket Costs for Property Owners who made NFIP claims Extrapolated to FEMA Dataset

	Total
Damage costs	$28,713,529
Verified loss	$8,338,204
Payout	$7,922,639
Payout to damage cost	**28%**

Note: these estimates exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M.

Table 11: Approved Payouts compared to Estimated out of Pocket Costs for Property Owners who made IA claims Extrapolated to FEMA Dataset

	Overall	With flood insurance	Without flood insurance
Damage costs	$144,609,069	$43,479,752	$101,129,317
Verified loss	$13,194,697	$2,450,454	$10,744,243
Payout	$14,813,024	$448,566	$14,364,458
Payout to damage cost	**10%**	**1%**	**14%**

Note: these estimates exclude 4 outlier values ranging from $1M to $10M and a total of $18.5M.

There are a number of reasons that could explain this difference in approved dollars versus what residents have claimed as damage amounts for the IA claims data:

- The survey requested estimated damage costs to the property owner but did not request the amount of insurable damage (e.g. landscaping, basement damage, etc.). The estimated costs from the survey most likely contain damages not covered by IA or NFIP claims.
- The IA and NFIP data provided by FEMA does not include personal or homeowners insurance claims that may have been made and paid out to property owners.
- The maximum payout for IA assistance is $34k regardless if the damage is greater than the cap amount.

- Some property owners carry private flood insurance instead of insurance subsidized by FEMA.

The September 2013 flood event was unique because 1) sewer backups and groundwater infiltration caused extensive basement flooding that is not covered by NFIP flood insurance and 2) localized flooding (i.e. street runoff) occurred outside of the 100-year floodplain where property owners are less likely to carry flood insurance. The primary goal of flood insurance is to insure property located within the floodplain and at a higher risk of damage caused by major drainageway flooding in the 100-year and 500-year floodplains.

This does not mean that city residents should not carry flood insurance. If a property is located within the 100 year, or even 500 year floodplain, flood insurance is strongly recommended because it provides post-disaster assistance to properties which are at a higher risk of damage caused by flooding from a major drainage way. In the future, it may be beneficial to provide public outreach and education about the availability of NFIP insurance for properties in the 100 year or 500 year floodplains as well as other property insurance options to protect against the types of damage experienced in the September 2013 flood.

There are a few other footnotes worth mentioning regarding the above tables:

- The approved amount is often higher than the verified loss because assistance was often provided for displaced residents and the cost in returning to their homes (this is not considered property damage)
- The total approved amount is often less than the property owners estimation of damages because the verified loss and approved dollar amount is based on the replacement value of the property (what it actually costs in labor and building materials to rebuild) and is not indicative of property or home market value. There may have been discrepancy from the survey with respondents indicating the market value of their damage as opposed to the cost of rebuilding.

D. Recovery of Damage Summary

Most responders indicated they received partial damage recovery.

Table 12: Damage Recovery Status from 2013 Flood Survey

Were you able to recover the costs of damage?	Percent
Yes	9%
Partial	53%
No	38%
Total	100%

Survey responders also indicated that a Government Grant (IA Program) was the most frequent source of damage recovery.

Table 13: Sources of Damage Recovery

How were damage costs recovered?	Percent
Flood insurance	25%
Governmental grants	60%
Standard homeowner's insurance	31%
Governmental loans	9%
Private loans or grants	8%

Total may exceed 100% as respondents could select more than one option.

4.0 FLOOD INSURANCE COMPARISON FOR COLORADO COMMUNITIES

Table 14 presents a comparison of flood insurance information for selected Colorado municipalities:

Table 14: Flood Insurance Comparison for Colorado Municipalities

Community	Estimated 2013 Population	Number of Policies	Annual Insurance Premiums	Total Insured Value (thousands $)
Boulder	103,000	3830	$ 2,909,611	$ 857,163
Colorado Springs	440,000	2727	$ 1,715,597	$ 615,724
Denver	650,000	1381	$ 1,553,231	$ 331,491
Arvada	112,000	506	$ 634,467	$ 111,951
Fort Collins	152,000	439	$ 271,142	$ 116,049
Lakewood	147,000	467	$ 484,764	$ 115,335
Longmont	90,000	376	$ 348,693	$ 89,795
Centennial	106,000	130	$ 64,467	$ 31,831
Loveland	71,000	127	$ 103,533	$ 33,286
Westminster	111,000	118	$ 82,425	$ 30,187
Pueblo	108,000	99	$ 62,855	$ 20,960
Thornton	127,000	97	$ 52,153	$ 21,983
Greeley	97,000	66	$ 76,238	$ 14,794

Source: Insurance Service Office, April 2014

Boulder has the largest number of flood insurance policies (required on all federally backed mortgages) and largest insured value of any municipality in Colorado. City of Boulder residents and businesses pay nearly $3M in total annual flood insurance premiums.

ATTACHMENTS:

Attachment A - Online Survey Form
Attachment B - Letter to Property Owners
Attachment C – Flood Impact Survey Mailing List and FEMA Claim Data Methodology
Attachment D – NRC Flood Impact Survey Data Analysis Methods

ATTACHMENT A: ONLINE SURVEY FORM

Boulder Flood Impact Survey

September 2013 brought unprecedented rainfall to the region, causing significant flooding and extensive damage to both private property and public infrastructure.

In response to this event, the city is reviewing its flood management program and mitigation priorities and needs your help in identifying neighborhoods and areas in Boulder that were severely impacted by the recent flooding.

Please fill out the short survey below.

Property Address or Street Block

Is your property in a designated floodplain?

- ◉ Yes
- ○ No
- ○ Don't know

Were you affected by September flooding?

- ○ Yes
- ○ No

Did flooding impact/damage your?

- ☐ Dwelling/House
- ☐ Property
- ☐ Business
- ☐ Other

What was the source of your flooding?

- ☐ Surface flooding from known creek
- ☐ Surface flooding from local area rainfall and drainage
- ☐ Groundwater seepage flooding

- ☐ Floor drain or sump pump backup
- ☐ Sanitary sewer backup or surcharge
- ☐ Other

Other source specified

What building floors were affected?

- ☐ First floor or main level
- ☐ Below grade basement or garden level
- ☐ Garage or ground level

If you suffered flood damage, please answer the following

How deep was the flooding you experienced?

What types of damage did you experience?

How much damage did you incur?

Do you have an estimate or value of damage incurred?

Were you able to recover the costs of damage?

- ☐ Yes
- ☐ No
- ☐ Partial

How were damage costs recovered?

- ☐ Flood insurance
- ☐ Standard homeowner's insurance
- ☐ Governmental grants
- ☐ Governmental loans
- ☐ Private loans or grants

Other Concerns

Did you observe notable flooding in other areas of the city that are a community concern?

ATTACHMENT B: LETTER TO PROPERTY OWNERS

Department of Public Works
Utilities Division
P.O. Box 791
Boulder, CO 80306-0791

Dear Resident or Property Owner,

September 2013 brought unprecedented rainfall to the region, causing significant flooding and extensive damage to both private property and public infrastructure.

In response to this event, the city is reviewing its flood management program and mitigation priorities and needs your help.

Over the past few months, the City of Boulder Utilities Division has been collecting flood damage information from site visits, community meetings, data provided by the Federal Emergency Management Agency (FEMA) and stories submitted via the Community Flood Assessment Map.

In an effort to learn more from the community, we're now asking for your assistance in identifying neighborhoods and areas in Boulder that were severely impacted by the recent flooding.

To do this, we've put together a short survey that is available at www.BoulderFloodInfo.net.

Please share your experience about the cause, location and magnitude of flood impacts to you and your property. Providing this information will help the city make the best use of limited funding and reduce the risk of future flood damages.

For more information about flood recovery, visit **www.BoulderFloodInfo.net**.

Thank you for your help.

Sincerely,

Robert J. Harberg, P.E.

Principal Engineer
City of Boulder
303-441-3266 or harbergb@bouldercolorado.gov

ATTACHMENT C: FLOOD IMPACT SURVEY MAILING LIST AND FEMA CLAIM DATA METHODOLOGY

Flood Impact Survey Mailing List (01-14-2014)

- Source Data
  - FEMA individual Assistance (IA)
  - Flood Recovery Permit (FLR) case tag properties
  - Public Works Call Log Database
  - Urban Flooding Extents
  - City of Boulder Parcel Dataset
  - City of Boulder Licensed Rental Properties
- How was the data used?
  - Lattitude/Longitude information was extracted from the FEMA IA data to preserve personal information.
  - All data used for the initial selection was converted to points on the map
  - Said points were used to select City of Boulder (COB) parcel polygons. Those polygons were reselected to only include properties inside the city limits.
  - A static copy of parcel information was created and "pared" down to only include situs address, assessor account number and owner information.
  - Licensed rental properties were noted in final dataset
  - Licensed rentals with three or more dwelling units were noted in final dataset to facilitate mailing to entire complex if desired.
- How was the data changed?
  - Final parcel selection does not include COB or BOCO properties.
  - Final data does not include "dummy" accounts (e.g. account numbers 9999999, 7777777, etc.).
  - Final spreadsheet has had duplicates removed. Duplicates are defined as records with the same owner name and situs address. 79 such duplicates were removed.

FEMA Claim Data Methodology

- **Compiling and Organizing the IA and NFIP Claims Data**

The first step in compiling and organizing the data provided by FEMA was to create a methodology that would combine the two different types of claims data: Individual Assistance (IA) and National Flood Insurance Program (NFIP) claims.

IA and NFIP are two very different types of insurance claims and drawing a correlation between the two isn't straightforward. However, there are attributes in each data set that could be considered a Verified Loss (or a loss that was investigated by FEMA or an insurance agent) and the Approved Dollar Amount.

- In the FEMA IA data (Full_IA_Inspections_No_Edits_02_13_2014_PII) these attributes are called Total_FVL (Fema Verified Loss) and Apprvd_dol (dollars approved by FEMA). The FVL includes damage to the structure and its contents and the approved amount is what FEMA paid to the property owner.

- In the NFIP data, the attributes are set up a little differently and a summarization had to be performed to create a total similar filed of verified loss and approved funds.

    - The total verified loss as determined by an insurance agent is in the attribute field T_Dmg_Bldg (damage to the building or structure) plus T_Dmg_Cont (damage to the contents or items within the structure.

    - The total approved funds was the summation of DMBGLDG_RCV (dollars received for damage to the structure or building) and DMGCONT_RCV (dollars received for damage to the contents of the structure.

All of the IA and NFIP data was left in its original point form as it was geographically located to coincide with the building structure itself and could be considered an estimation the structure's approximate location within the 100 or 500 year floodplains or drainage basin.

To create the master dataset, the following operations were performed to each of FEMA's individual claims datasets (called NFIP, IA_all and IA_ data):

1. FEMA datasets were copied into a new geodatabase
2. All claims not in City Limits were removed
3. Datasets were consolidated to only include Address, Total_VL (total verified loss), Total_APP (total approved dollar amount), Flood_Ins (1 = flood insurance per IA Assistance Data attribute or NFIP Claim, 0= no flood insurance)
4. Datasets were combined into one shapefile called FEMA_Data_Final
5. New attributes were created for drainage basins, 500year and 100year. The FEMA_Data_Final points were selected by location and the attributes filled in.

ATTACHMENT D: NATIONAL RESEARCH CENTER FLOOD IMPACT SURVEY DATA ANALYSIS METHODS

Background

The City of Boulder contracted with National Research Center, Inc. (NRC) to assist in assessing the impact of the September 2013 flood on the community. The primary goal of the analysis was to extrapolate the damages reported from the sample of respondents to the Flood Impact Survey to all homes impacted by the floods.

Data Sources

The City provided the following data sources to NRC as part of this study:

- Flood Impact Survey mailing list
- Flood Impact Survey results
- FEMA Individual Assistance (IA) claims
- FEMA National Flood Insurance Program (NFIP) claims
- County Assessor parcel data for all parcels located within the city limits of Boulder

The survey mailing list

The Flood Impact Survey mailing list contained 8,476 addresses. According to the City, these addresses were compiled from the following sources: FEMA individual Assistance (IA), Flood Recovery Permit (FLR) case tag properties and the Public Works Call Log Database. These data were matched to the Urban Flooding Extents, City of Boulder Parcel Dataset and City of Boulder Licensed Rental Properties.

The person who compiled the mailing list described their steps as follows: In adding the FEMA IA addresses to the mailing list, latitude/longitude information was extracted from those data to preserve personal information. All data used for the initial selection to the mailing list were converted to points on the map. These points were used to select City of Boulder (COB) parcel polygons. Those polygons were reselected to only include properties inside the city limits. From this list, a static copy of parcel information was created and “pared” down to only include situs address, assessor account number and owner information. Licensed rentals with three or more dwelling units were noted in final dataset to facilitate mailing to entire complex if desired. Properties belonging to the City of Boulder or Boulder County governments were removed from the list. Duplicates, defined as records with the same owner name and situs address, were removed from the list.

While some duplicates were removed from the list, when NRC examined the list, a few additional duplicates were found. There were a total of 8,427 unique mailing list addresses, matched to county assessor parcel data.

FEMA claims datasets

The FEMA IA claims dataset had a total of 7,968 records. However, there were duplicate addresses and claimants in this dataset. A “rolled up” dataset was created in which the dollar amounts for claims and losses were summed for each unique address. The final dataset had 7,175 records. Of these, 5,639 addresses could be matched to addresses in the survey mailing list. The FEMA NFIP claims dataset had a total of 525 records. Again, though, there were duplicate addresses and claimants in this dataset. As with the IA dataset, a “rolled up” dataset was created in which the dollar amounts for claims and losses were summed for each unique address. The final dataset had 490 unique addresses, of which 300 could be matched to the survey mailing list. There were 107 addresses that were in both the IA and the NFIP claims datasets.

It may be that some of the “rolled up” addresses should have had unit addresses associated with them. However, there was not a way to know this for sure, so in some cases, claims for an individual unit at an address (where the unit address was included) are separated from other claims for the same street address with no unit numbers. This may not be an entirely correct way of examining the data, but there was no way to assign a unit number. This may also have affected the ability to make matches between the survey responses, survey mailing list and FEMA datasets.

Survey responses

A dataset of 1,307 survey responses was provided by the City to NRC. As this dataset was examined, a few duplicate addresses were found, or records with unusable data. The final set of survey responses was 1,297. However, of these, only 1,126 could be matched to the survey mailing list, and thus to FEMA claims and county assessor parcel data. The survey data in this memo are based on these 1,126 survey responses. Of these 1,126 survey responses, 951 could be matched to the FEMA IA claims data, 56 could be matched to the NFIP claims, and an additional 119 could not be matched. These are likely survey responses from those included in the survey mailing list from the other non-FEMA sources such as the Flood Recovery Permit (FLR) case tag properties and the Public Works Call Log Database.

Creating the merged dataset

Since the data sources used different formats for capturing the addresses of the properties (e.g., “street” v. “St.” or “Apt.” v. “#”), all files underwent an address standardization process. The standardized files were imported in Microsoft Access® to be matched on address. In some cases, duplicate addresses were found (most commonly when a multi-housing unit property was missing the unit number). The number of duplicate addresses varied; most addresses had two or three duplicates, while a few addresses had 10 or 15 duplicates. When duplicate addresses were found, the data were merged to one record representing a unique address and individual data points summarized. For nominal variables to determine the values when duplicate addresses were present (e.g., property type (residential, commercial or other) or flood insurance (yes or no)), the first instance of the duplicated address was used. For the dollar values of damages and payments, the sum across the duplicate addresses was used.

To create the merged dataset, the survey mailing list was first matched to the Assessor’s parcel dataset by account number. This matched mailing list file was then used as the basis for matching each of the other data files (i.e., IA claims, NFIP claims and survey results) by address; the Assessor’s parcel number was appended to each of these files. These matched files were imported into SPSS and matched by parcel number in order to arrive at the final merged and matched dataset used in the analyses.

Table *9* below shows the total number of records in each data file, the number of unique addresses identified and the number of address matches available for the final analyses.

Table 9: Unique Addresses Available for Matching and Analysis

Source file	Total records	Unique addresses	Matched to survey mailing list	Matched to survey results*
FEMA IA claims	7,968	7,175	5,639	951
FEMA NFIP claims	525	490	300	56
Flood Impact Survey mailing list	8,476	8,427	--	1,126
Flood Impact Survey results	1,307	1,297	1,126	--

** Note: this column does not include the 119 survey responses that were not matched to a FEMA claim and likely came from other non-FEMA sources such as the Flood Recovery Permit (FLR) case tag properties and the Public Works Call Log Database.*

Some of the analyses extrapolate the survey response data to the entire FEMA IA and NFIP claims data. There were a total of 7,175 unique IA claims and 490 NFIP claims, for a total of 7,665 claims. However, 107 properties had claims in both IA and NFIP datasets. When extrapolating the survey results to these FEMA claims, one set of the 107 duplicated properties were removed, thus the extrapolation was based on 7,558 unique properties.

Data Weighting

One of the first steps in the data analysis was to statistically adjust the survey results so that the profile of the survey properties mirrored that of the all properties affected by the floods (in the survey mailing list). This process is known as "weighting" the data. This was done by reviewing the characteristics of the properties from the survey results and comparing them to the characteristics of the survey mailing list. It was observed that certain recipients were more likely to respond to the survey than were others. For example, a greater proportion of respondents were in the South Boulder Creek basin (28%) than were recipients (21%); respondents were more likely to be have a basement (76%) than were recipients(64%); and respondents were more likely to have flood insurance (17%) than were recipients (10%, see Table *10* on the next page). Many of these variables were associated with the amount of reported damage.

To create the weighting standard for the type of FEMA assistance, we added back to the survey mailing list the number of IA and NFIP claims that had not been included in the original mailing list. Thus, our weighting standard assumed the survey results should mirror a total compilation of 10,153 records: 7,068 IA claims (70%), 383 NFIP claims (4%), 107 IA and NFIP claims (1%), and 2,595 non-FEMA survey recipients (such as those from the Public Works call log database, 26%). Table *10* on the next page displays the results of the weighting scheme.

The variables used for weighting were basin, total assessed value, occupancy, flood insurance, basement type, and type of FEMA assistance. The table on the next page displays the results of the weighting scheme.

Table 10: Weighting Table for the Flood Impact Survey

Characteristic		All properties	Flood impact survey	
			Unweighted	Weighted
Basin*	Bear Canyon Creek	14%	13%	14%
	Bluebell Canyon / King's Gulch	3%	3%	3%
	Boulder Creek	13%	10%	13%
	Dry Creek	1%	0%	1%
	Elmer's Twomile Creek	4%	5%	4%
	Fourmile Canyon Creek	3%	3%	3%
	Gregory Canyon Creek	2%	1%	2%
	Skunk Creek	4%	3%	3%
	South Boulder Creek	21%	28%	21%
	Sunshine Canyon Creek	0%	0%	0%
	Twomile Canyon / Goose Creek	19%	16%	19%
	Viele Channel	7%	8%	7%
	Wonderland Creek	10%	10%	10%
	Total	100%	100%	100%
Total Assessed Value*	$350,000 or less	20%	14%	20%
	$350,001-$450,000	21%	22%	21%
	$450,001-$550,000	18%	21%	18%
	$550,001-$750,000	21%	25%	21%
	More than $750,000	20%	19%	20%
	Total	100%	100%	100%
Occupancy*	Residential	96%	99%	96%
	Commercial	3%	1%	3%
	Other	1%	0%	1%
	Total	100%	100%	100%
Flood insurance*	Yes	10%	17%	10%
	No	60%	71%	59%
	Don’t know	31%	12%	31%
	Total	100%	100%	100%
FEMA funds*	None	26%	12%	28%
	IA only	70%	83%	70%
	NFIP only	4%	3%	2%
	IA and NFIP	1%	2%	1%
	Total	100%	100%	100%
Basement*	Finished	29%	35%	30%
	Unfinished	35%	41%	35%
	None	36%	24%	35%
	Total	100%	100%	100%
Homeowner's insurance	Don’t know	33%	16%	33%
	No	8%	5%	5%
	Yes	59%	79%	62%
	Total	100%	100%	100%

** Used in weighting scheme.*

To better understand how weighting can affect survey results, an example of how weighting works may be helpful. For example, the assessor data for the survey mailing list shows that 36% of those receiving the survey had no basement, while 64% did have a basement. However, only 24% of those completing the survey had no basement, while 76% did have a basement. This means that those with a basement were more likely to respond

than those without a basement. The weights we would need to apply to make our sample representative of those making a claim would be 0.8421 (64% ÷ 76%) for those with a basement (thereby giving each response less weight in the overall results) and 1.5000 (24% ÷ 36%) for those without a basement (giving each response more weight overall). We know that these two groups' valuation of the damages incurred during the floods differed: $30,939 for properties with a basement versus $18,752 for properties without a basement. Given that we had more responses from properties with basements, if we did NOT weight the results, we would be overestimating the total damages incurred due to the floods: The unweighted average damage per property is $28,046 ($30,939 × 76% + $18,752 × 24%), while weighting by basement status would result in an estimate of the average damage per property of $26,552 ($30,939 × 64% + $18,752 × 36%).

Table 11: Example of how weighting calculations work

Characteristic	Percent in Population	Percent in Sample	Weight	Unweighted damages incurred	Weighted damages incurred
Does not have a basement	36%	24%	1.5000	$18,752	$18,752
Has a basement	64%	76%	0.8421	$30,939	$30,939
TOTAL	100%	100%	--	$28,046	$26,552

Additional examination was made of the data after the weighting scheme was applied. It was found that even after adjustment for factors like presence of a basement and type of FEMA claim, those who responded to the survey had about 20% greater verified losses and claims than did those who did not respond to the survey (see the table below). Thus, an adjustment factor of 0.82 was applied to all dollar estimates from the survey dataset to account for this.

Table 12: Average verified losses and approved dollars, FEMA dataset compared to survey respondents with FEMA claims

	FEMA IA and NFIP claims	
	Average verified loss	Average approved dollars
FEMA survey recipients who did not respond to survey	$2,843	$3,029
FEMA survey recipients who DID respond to survey	$3,489	$3,684
Ratio	1.23	1.22
Adjustment factor	0.815	0.822

Outliers

There were four very large damage estimates in the dataset: one of $10 million, one of $6 million, one of $1.5 million and one of $1 million. In order to not let these large numbers exert an outsize influence the damage estimates, they were removed from analyses of reported damage in the report. Tables that do not include these estimates have a note indicating these four outliers were removed. The total of $18.5 million of damage from these four properties could be added back to the totals on these tables to come up with the more likely true estimate of the total damage. However, their influence was so great as to mask true differences in damages by subgroups of respondents, which is why they were removed.

Confidence Intervals

Sampling error ("margin of error" or "confidence interval") is defined as the precision of estimates made from survey results. A 95% confidence interval can be calculated for any sample size and indicates that in 95 of 100 surveys conducted like this one, for a particular item, a result would be found that is within a certain range of the result that would be found if everyone in the population of interest was surveyed. Obviously, though, there are many other potential sources of error which are harder to quantify. Some adjustment for non-response error was accomplished by weighting the results. However, there were additional issues with trying to create a "clean" list of FEMA claims, matching the addresses to assessor data, etc. There could also be reporting errors by those completing the survey – not remembering or knowing for sure how much the damage actually was, etc.

Survey results were reported as proportions and as averages. With 1,126 surveys (the number of survey responses that could be matched to the survey mailing list), the 95% confidence interval around estimated proportions is ±3%.

For averages, the width of the confidence interval is determined by the number of surveys received and the amount of variability in the responses. Three confidence intervals for the estimated cost of damages were calculated, as shown in Table *13* below; the 95% confidence interval, but also the 90% and 80% confidence intervals. These confidence intervals were calculated with the four outliers mentioned above included or excluded from the estimates.

There was wide variability in the amount of damage estimated by survey respondents, as can be seen by the large standard deviations for the estimates. (Including the four outliers makes the standard deviation especially high.) The average total cost per survey respondent of flood damage (including the four outliers described above) was $32,108, with a standard deviation of $319,316. If these four outliers are removed, then the average total cost per survey respondent is $17,378 with a standard deviation of $49,230 -- still demonstrating significant amount variability, but much reduced from the estimate that includes the outliers.

As can be seen in the table, the width of the confidence interval is reduced as the amount of "confidence" in the estimates is decreased. For example, the 95% confidence interval around the average property damage (excluding the outliers) is plus or minus about $2,900, but if the confidence is diminished to 80%, the precision of the estimate is increased and the confidence interval is narrowed to plus or minus about $1,900. So, using the 80% confidence interval, it could be colloquially said that we are 80% confident that the "real" damage value is about ±11% of the survey estimate.

Table 13: Confidence Intervals for Estimates of Costs of Damages

			Confidence Interval		
Estimate	**Mean**	**Std. Dev.**	95%	90%	80%
Outliers included	$32,108	$319,316$	±$18,651	±$15,654	±$12,180
Outliers excluded	$17,378	$49,230	±$2,876	±$2,413	±$1,878