Panel Decision & Report

SRP ORWB080414 - Beaverton, Washington County, OR

November 2, 2015

National Institute of BUILDING SCIENCES

Table of Contents

Summary

Based on the submitted scientific and technical information, and within the limitations of the Scientific Resolution Panel (SRP), the SRP has determined that the Community's data does not satisfy NFIP standards, thus FEMA's data is not corrected, contradicted, or negated.

Introduction

This report serves as the recommendation to the Federal Emergency Management Agency (FEMA) administrator from the National Institute of Building Sciences (the Institute) Beaverton, OR Scientific Resolution Panel (SRP). SRP's are independent panels of experts organized, administered and managed by the Institute for the purpose of reviewing and resolving conflicting scientific and technical data submitted by a community challenging FEMA's proposed flood elevations used to develop proposed flood hazard data for the National Flood Insurance Program's (NFIP) Flood Insurance Rate Maps (FIRM).

Panel

Panel ID: ORWB080414
Panel Name: Beaverton, Washington County, OR
FEMA Region: X
Panel members:

- **Dr. Lee Azimi, PE,** Land Development Engineering, Division Manager, DeKalb County, GA.

  Dr. Azimi brings thirty years of experience in academic research, as consultant and educator in the areas of civil infrastructure management, design, construction, and water resources engineering. He has served on numerous committees and regional councils and as a technical advisor for water resources protection and conservation and development of technical, regulatory, and policy standards. He currently works in the north Georgia metro area and his activities have included management and administration of regional flood hazard mitigation and mapping program.

- **Mr. Jonathan Fuller, PE, RG, PH, D.WRE, CFM,** Founder, JE Fuller Hydrology & Geomorphology, Inc., Tempe, AZ.

  Mr. Fuller is the Founder of JE Fuller Hydrology & Geomorphology, Inc., a consulting firm with offices in Tempe, Tucson, Phoenix, Flagstaff, and Prescott, Arizona and Silver City, New Mexico. Over the past 30 years he has worked on projects and studies in Arizona, Nevada, Utah, California, Colorado, Montana, and Alaska. His specialties include applied fluvial geomorphology, sediment transport, erosion hazard analysis, alluvial fan flooding, and arid land hydrology. Jon has a B.S. (Geology) from Calvin College in Grand Rapids, Michigan and a M.S. (Geomorphology) from the University of Arizona, and is a registered civil engineer in Arizona, Utah, Nevada, Colorado, Texas and Oregon, a registered Professional Hydrologist (American Institute of Hydrology), a Registered Geologist, a Diplomat Water Resource Engineer, and a Certified Floodplain Manager. Jon is active in the Association of State Floodplain Managers, the Floodplain Management Association, the

Arizona Geological Society, and ASCE, and served on the Board of the Arizona Floodplain Management Association from 1988 to 1998.

- **Ms. Carolyn Gilligan, PE,** Senior Technical Consultant, LJA Engineering, Inc., Huston, TX.

  Ms. Gilligan has more than 25 years of managerial and technical experience in hydrology and hydraulics, including watershed studies, drainage studies of major waterways, design of storm water detention systems, drainage channels, and storm water collection systems. She has previously been involved in the implementation plans for the establishment of impact fees, watershed ordinance reports, levee improvement districts, municipal utility district creation reports, criteria manuals for public agencies, and FEMA studies. Ms. Gilligan is proficient in the use of XP-SWMM, HEC-1, HEC-2, HEC-RAS, adICPR, and Flood Frequency Analysis, as well as extensive use of application programs for hydrology and hydraulics. Ms. Gilligan received a Bachelor of Science degree in Civil Engineering and a Bachelor of Arts degree in Urban Planning from Michigan State University. She is a Licensed Professional Engineer in Texas and Michigan.

- **Dr. David Williams, PE, CFM, PH, D.WRE, CPESC, F.ASCE,** President, DTW & Associates, Fort Collins, CO.

  Spanning over 40 years, Dr. Williams has a variety of work experience which includes National Technical Director for Water Resources for PBS&J and HDR, co-founder and President of WEST Consultants (a nationally recognized water resources engineering firm), the U.S. Army Corps of Engineers (USACE), and adjunct professor at San Diego State University. His work experience includes being an airborne Combat Engineer with the 7th Special Forces Group (Green Berets), over 18 years as a hydraulic engineer with the USACE at the Waterways Experiment Station (WES) in Vicksburg, MS, both the Nashville and Baltimore Districts, and the Hydrologic Engineering Center (HEC) in Davis, CA. He has presented short courses throughout the U.S. for the American Society of Civil Engineers (ASCE) and other professional and public organizations such as ASFPM and FMA on computer training using HEC-2, HEC-RAS, HEC-HMS, Bridge Scour and HEC-6 in addition to courses on channel toe protection design, sediment transport, stream restoration, fluvial geomorphology and streambank protection. His national society activities have included past chairs of the ASCE/EWRI Committees on Sedimentation, Computational Hydraulics, Probabilistic Approaches and Stream Restoration as well as past President of the International Erosion Control Association (IECA).

- **Mr. Tom Wright, PE, CFM,** Senior Water Resources Engineer, AECOM, Salt Lake City, UT.

  Mr. Wright is a Senior Water Resources Engineer and team leader for AECOM's Salt Lake City Office. He has 17 years of experience focused on hydrologic and hydraulic analysis, hydraulic design for roadways, culverts and bridges, scour countermeasure design, and stream stabilization design. Mr. Wright has updated FEMA mapping and models for many flooding throughout North America through nationally held FEMA contracts in Oklahoma, Texas, North Dakota and South Caroline. He is a Study contractor for the Utah CTP where he performs countywide mapping updates on behalf of the State for FEMA Region VIII, and is currently involved in Risk MAP watershed studies throughout the states of Utah and Colorado. Mr. Wright has a Bachelor of Science degree in Civil Engineering from the University of Wyoming, is a Registered Civil Engineer in California and Utah, and is a board member for the Utah Floodplain and Stormwater Management Association. Mr. Wright is well versed in many of the industry hydrologic and hydraulic software used in FEMA studies.

Basis for the Community's Challenge

By letter dated February 4, 2013, Lewis G. Scholl, P.E. (the Community), submitted technical information challenging the proposed Base (1-percent annual chance) Flood Elevations (BFEs) for Beaverton Creek and Hall Creek's North Fork, as presented on the Preliminary Flood Insurance Rate Map (FIRM) and in the Preliminary Flood Insurance Study (FIS) report for Washington County, Oregon and Incorporated Areas, dated December 4, 2009. The challenge primarily focused on BFEs for Beaverton Creek, Cross Section CO to Cross Section CW and North Fork Hall Creek, Cross Section A to Cross Section F.

Data Submitted by the Community and FEMA

The following data used to generate the challenged flood elevations and the correspondence submitted as part of the Beaverton, Washington County, OR challenge was provided to the Panel:

Community

1. Appeal letter, January 28, 2013.
2. Letter of response, August 5, 2013, in response to FEMA's appeal resolution letter of July 11, 2013.
3. SRP request form cover letter, August 9, 2013.
4. SRP request form, August 9, 2013.

FEMA

1. AMEC letter of response to appeal, March 1, 2013.
2. Appeal resolution letter, July 11, 2013.
3. Hydrologic Modeling for the Watershed 2000 Project report prepared by Pacific Water Resources, Inc., October 31, 2001.
4. Effective FIRM & FIS, February 18, 2005.
5. Preliminary FIRM & FIS, December 4, 2009.
6. WSW hydraulic model data.
7. Email Summary WSW.
8. Index to WSW Contents.
9. HEC-RAS hydraulic model data for Beaverton and North Fork Hall Creek.

Summary of Panel Procedures

An SRP kickoff meeting was held on July 2, 2015 via web-based teleconference presentation. The Institute Director, Ms. Dominique Fernandez, explained the SRP procedures, Panel members were introduced, and a Panel Chair, Dr. Lee Azimi was selected. Panel progress schedule for SRP report completion, coordination of communications with the Institute and the Panel, and the roles in completing the final report were discussed. The Chair's responsibility for leading the Panel review of the Community, and FEMA submissions was discussed. The Panel was tasked to review the technical information and data provided by FEMA and the Community. The Panel was tasked to keep their deliberations tightly focused on scientific and technical issues and correctness of the conflicting data. All subsequent Panel meetings were held via web-based teleconference calls.

A first Panel meeting was held on August 3, 2015 to review the data submitted, review Panel progress, clarify Panel questions, and discuss and divide individual Panel member's scope and responsibilities leading to the final Panel report.

The second Panel meeting was held on September 2, 2015 to discuss the Panel written submissions, review technical procedures, and discuss preliminary Panel decision.

The third Panel meeting was held on October 8, 2015 to discuss the final Panel report format, present Panel disposition, and review technical information and process time lines leading to a final report.

A draft report outlining the SRP procedures and technical data reviewed was prepared by the Panel Chair and distributed to Panel members. A vote was held within the scope of the Institute's regulations, and the Panel's final decision was based on a unanimous vote of the five Panel members. Based on the member's vote, a final report (this report) was prepared containing conclusions regarding the overall technical correctness of the information submitted to the Institute by the Community and FEMA.

Recommendation

Based on a unanimous Panel vote, the Panel recommends denial of the challenge. The Community's data does not satisfy NFIP mapping standards defined in FEMA's Guidelines and Specifications for Flood Hazard Mapping Partners (NFIP standards).

Rationale for Findings

November 19, 1996 "Cedar Hills Fire Station" rainfall data and 10-year record of "Cedar Hills" stream-gage data

The Community presented rainfall data from a "Cedar Hills Fire Station rain gage" for the November 19, 1996 as the basis for recurrence interval of infrequent storms in support of the contention that Base Flood Elevations (1% probability flood elevations) as proposed in the draft FEMA Flood Insurance Study (FIS # 41067CV000A) are significantly too high through parts of Beaverton Creek and North Fork Hall Creek. For the November 1996 flood the Cedar Hills Fire Station gage measured 4.7 inches in 24 hours while the NOAA Atlas 2 Precipitation Frequency Atlas of the Western United States, rainfall isopluvials depicts 4.5 inches in a 24-hour period as a 1-percent-annual-chance event. The Community further states with respect to antecedent soil moisture conditions that the runoff-producing effect of the November 1996 storm was likely to have been greater and more rare than the 100-year rainfall depth would suggest. The rate of runoff was most likely magnified by the large amount of soil moisture that had accumulated during a year of extremely unusual rain including the February 1996 flood. During the prior one-year period, rainfall was nearly 2 times the normal amount, and during the previous 6 weeks there had been over 12 inches of rain.

FEMA responded stating that "data from the Cedar Hills Fire Station gage are not formally published and data on the quality control procedures for the gage could not be obtained at the time of the study. Data from the gages were compared with rainfall sources from National Oceanic and Atmospheric Administration (NOAA) and the City of Portland Hydra network of gages published by the United States Geological Survey (USGS). The USGS and NOAA publications showed consistent patterns of behavior. The unpublished gage sites in Washington County, including the Cedar Hills Fire Station, did not show consistent rainfall patterns, had short record periods and frequent missing data. The recurrence interval of the rainfall depth at one single gage may have limited, or no correlation with the recurrence interval of the flow rate on the tributary for the same event". Page 9 Preliminary FIS report states, "The February 1996 flood on the Tualatin River was the largest flood flow ever recorded with an estimated 84-year return interval and an annual probability of recurrence of 1.2%. However, for almost all of the smaller urbanized Tualatin River tributaries that were studied, the November 1996 flood is thought to be the largest flood ever observed with an estimated 25-year return interval and an annual probability of recurrence of 4%."

The Community also presented and pointed to 10-years of "Cedar Hills" stream gage data by plotting the elevation versus flow relationship for the "February 2002 to June 2012" record showing highest recorded elevation of 174.99-ft during the record period. On the same plot the November 19, 1996 flood, the highest historic elevation, is reported at 176.67-ft. The same graph attempts to illustrate the highest historic flood elevation barely exceeds the elevation of the 2-year flood from the HEC-RAS model plotting points. On the same graph, while the arrow points to the wrong plotting point (174.5-ft as the highest recorded elevation), since the raw data was not provided for the "10-year stream flow record", the SRP could not verify credibility of plotted information, the Community's arguments presented on the graph, or the purported mismatch between HEC-RAS and flood frequency return periods from observed data.

FEMA responded stating that "the Cedar Hills gage data presented in the letter were not available at the time of the study, and it is not clear to what extent gage measurements were made to support the measurement of flows by the gage. Also, 2-year flows were not computed for the FEMA study; the lowest recurrence interval is the 10-year flow."

To provide a sound basis for floodplain management and insurance rating, the Flood Hazard Maps must present flood hazard information that is accurate and up to date. To reach that goal FEMA encourages strong Federal, State, regional, and local partnerships for the purposes of producing the most statistically unbiased flood elevation estimates with most current hydrologic measurements. In that spirit Code of Federal Regulations and G&S guidelines state the following:

"Section 67.8 of the NFIP regulations: FEMA shall "review and fully consider any technical or scientific data submitted by the community that tends to negate or contradict the information upon which the proposed determination is based."

"The Mapping Partner must analyze peak flow data in accordance with those standards as presented in Bulletin 17B and subsequent modifications. Bulletin 17B recommends a minimum of 10 years of data for frequency analysis. The Mapping Partner must provide written justification and obtain approval from the RPO to use analysis techniques other than those described in Bulletin 17B. Discharge-frequency relations derived by the USGS in accordance with Bulletin 17B for gaged sites on unregulated streams may be obtained from published USGS reports. (Section C.2.4.1)

"Note that gage record analyses are valid only for homogeneous periods of record in which the hydrologic response of the watershed is unchanged. In some cases where gage records contain short, discontinuous, or non-homogeneous periods, peak flow data may be revised within and/or added to a record using techniques described in Bulletin 17B. The Two Station Comparison method described in Bulletin 17B and the Maintenance of Variance Extension method described by Hirsch (1982) can be used to augment and extend the record of short-term gaging stations using data for nearby long-term stations. Such enhancements to stream gage record data must be fully documented in the hydrology report." (Section C.2.4.1)

FEMA is generally dismissive of the Community's comments stating insufficient or poor quality data or stating that gage measurements were not available at the time of the study. FEMA preliminary study relied on flood risk determination and development of flood hazard boundary maps based solely on heuristic hydrologic and hydraulic computations accompanied by complete disregard of actual historical measurements. Neither the Community nor FEMA completed any flood frequency analyses of the Beaverton Creek, or made any attempts to incorporate "two station comparison methods" between existing available stream flow records for augmentation or extension of Cedar Hills stream gage data of Beaverton Creek peak flow rates. Moreover, the Community did not present any information on how Beaverton Creek flood risk inundation information or Flood Insurance Rate Maps should be revised or impacted if November 19, 1996 "Cedar Hills Fire Station" rainfall data and 10-year record of "Cedar Hills" stream-gage data were to be incorporated in hydrologic and hydraulic modelling based on NFIP standards.

Cedar Hills Blvd, & Beaverton Transit Center, Historic High-water Marks

Guidelines and Specifications for Flood Hazard Mapping Partners Appendix C, Section C.3.3.4 states: *"The most useful data relative to historic floods are high water marks, and these data can be used to calibrate the Manning's "n" values. Whenever possible, the Mapping Partner should calibrate hydraulic models using measured profiles, reliable high-water marks, or reliable stage information at stream gages for past floods. Models should match know high-water marks within 0.5 feet."*

The Preliminary Flood Insurance Study for Washington County, Oregon and Incorporated Areas (Preliminary FIS) Section 3.2 - Hydraulic Analysis, states "Hydraulic roughness (Manning's "n" values) for the channel and overbanks were first estimated from field observations. The "n" values were then adjusted to match high-water marks where available."

According to the Preliminary FIS, for "almost all of the smaller urbanized Tualatin River tributaries", which includes Beaverton Creek, the November 1996 flood "is thought to be the largest flood ever observed with an estimated 25-year return interval and an annual probability recurrence of 4%". The original January 28, 2013 challenge of the Beaverton Creek Base Flood Elevations (BFE) shown in the

Preliminary FIS referenced historic high-water marks established after the November 1996 flood event. In addition, the Community representative states that he, personally, installed a marker next to Beaverton Creek at Cedar Hills Boulevard to document the high-water mark for the November 1996 storm event and that the marker is still in place.

FEMA's response to the challenge, however, stated "High-water marks for the Beaverton Creek were unavailable when the original work was completed and the best available data were used for hydrologic and hydraulic model calibration." Additionally, the study contractor indicates that, although other hydraulic models were calibrated to high water marks using roughness values, the Beaverton Creek hydraulic model was calibrated to photographs of "large storm events" without specifying the storm event(s) used."

Since it is evident that high-water marks are available for the flood of record for Beaverton Creek, the hydraulic model should incorporate this data in establishing the revised BFE's. However, the Community did not present any analyses to demonstrate how available high-water marks may revise Manning's "n" calibrations or subsequently revise flood risk maps.

HEC-HMS Hydrologic Modeling & Calibrations, Flow Attenuation, and Storage Effects

The Community stated that unpublished rainfall and stream flow data for Beaverton Creek were not utilized, and antecedent soil moisture conditions were not accounted properly resulting in HEC-HMS hydrologic modeling and calibrations overestimating discharges for extreme flooding conditions.

Based on the SRP's review of information provided by the Community and FEMA responses, the use of unpublished rainfall or stream flow data is not recommended, nor should it be considered the standard practice. It is further noted that the Community states, "the data from the Cedar Hills Fire Station may not be the most reliable data available for that particular storm," a statement that does not lend credibility to use of the data. If the Community wished new data to be considered, it should have demonstrated that the data met quality standards and were reliable, and should have completed an engineering analysis including a revised estimate of flood frequency. It is presumed that the City of Beaverton would have been aware of both the on-going FIS and the existence of additional rainfall and stream flow data, and should have brought it to the attention of the study contractor during the data collection phase of the study. Antecedent moisture condition generally refers to the few days prior to an event. The Community cites rainfall in February 1996 as contributing to antecedent conditions for the November 1996 event. The cited 12 inches of rain in the six weeks previous to the November 1996 event is more relevant, but would require more specific data on rainfall by date, temperature, and other data to determine soil moisture conditions. In general, the Community provides anecdotal and unpublished information of unknown accuracy that purports to cast doubts on the study results. The Community does not provide alternative engineering analyses or models to demonstrate the impact on estimated peak discharges or BFEs.

The community stated that HEC-HMS hydrologic modeling of North Fork Hall Creek should be evaluated to determine if adequate storage capacity of a large detention facility upstream on Highway 217, and flow attenuation behind culverts, including above a long culvert under Highway 217 were accounted properly. Further stating that the flow attenuation in the wetland area north of Center Street provides considerable flood storage, the terrain there is flat for over 1000 feet as evidenced by the channel bottom elevations in The HEC-RAS model.

The Community did not provide topographic mapping, survey data, design plans or any documentation of the storage areas that demonstrate the available storage volume. Analysis of the normal pool elevations in the alleged storage areas or any analysis of the potential for storage were not presented to demonstrate how increased storage volume could revise BFE's in a steady-state HEC-RAS hydraulic model. It is possible that the FIS modeling underestimates storage, but sufficient information and modeling was not provided to demonstrate claims.

The Community referenced a 1980 USGS study, stating that the study presented land use and land cover data showing that a long lag time, measured at 14 hours is evidence that Beaverton Creek behaves more like a natural watershed than a landscape characterized by urbanization. However, as evident there are several decades of time gap between when USGS study data was collected and the date of Preliminary FIS. The Community failed to demonstrate by presenting, comparing, and quantifying land use and land cover data between decades of time lapse and how lag-time parameterization in HEC-HMS modelling is impacted.

HEC-RAS & WSPG Hydraulic Modeling and Calibrations, & FEMA Policy of Excessive Conservatism

Calibration of Manning's "n" Values

The study contractor, in general followed FEMA procedures in determining Manning's "n" values by examining photos of major floods on Beaverton Creek during its calibration and utilized established high-water marks. The resulting "n" values compared favorably with the results from nearby Fanno Creek that was calibrated to high-water marks. During the study, the study contactor also held an open house asking for any additional information such as high-water marks but did not receive any significant additional information to aid in the hydraulic calibration. The Cedar Hills gauge stream flow data was not formally published at the time of the study and the Community cited several high-water marks that were not consistent with the hydraulic model results (and thus "n" value calibration). This information was not available during the study and since study contractors are to use only reliable information, the study contractor excluded the information and proceeded according to standard practices.

Cumulative Effects of Conservative Parameter Selection

Hydrologic and hydraulic modelers select model parameters based upon their experience in the study area, education and the information at hand. The study contractor's work was performed by personnel in the local Beaverton office who had study related experience in the area. There was no evidence of a systematic or conscious effort to select overtly conservative parameter estimates that would result in a cumulative overestimation of the results.

Hydraulic Errors and Inaccuracies Referenced in Appendix B

Appendix B, presented by the Community, pointed out perceived errors and inaccuracies related to the results of the hydraulic modeling. Much of the discussion was related to interpretation of the flood maps and the direction and amount of flow. The Community had differing opinions on these items in comparison with the study results but the SRP did not see any obvious errors or inaccuracies related to the study's interpretation of the hydraulics.

Streamflow-Elevation Relationship at Cedar Hills

As stated previously, the information at Cedar Hills was not published nor validated when the study was performed. The study contractor was correct in excluding this information from calibration of its models.

Hydraulic Modeling & Data Reduction

Water surface elevations for North Fork Hall Creek

The Community stated both that the bubble up design of the culvert under the Beaverton Transit Center MAX Station is not accounted for, and that North Fork Hall Creek geometry modeled does not reflect reality. These two items have been reviewed in detail by the Panel. Upon detailed review of the modeling efforts both in the WSPG program and the HEC-RAS representation of the floodplain hydraulics, the claims of the community are either not valid, or do not provide an alternative analysis to consider.

The HEC-RAS modeling was reviewed to establish the basis for the water surface elevations in the North Fork of Hall Creek through published sections. The boundary conditions and modeling techniques used in the HEC-RAS model provided by FEMA utilize correct practices for hydraulic modeling for all conditions reviewed with the exception that the representation of the storm drain system under the MAX station, the “bubbler” design, cannot be verified by the information provided by either the community or FEMA.

The water surface elevation are controlled specifically at two locations, first at the downstream connection to Beaverton Creek, then at the overland flow representation out of the Mobile Home Corral to MAX Station. The downstream water surface elevations for North Fork Hall Creek are controlled by Hall Creek and in turn Hall Creek elevations are controlled by a rating curve at the junction with Beaverton Creek. In the floodplain profile, the backwater influence of Beaverton Creek extends through the MAX station. Upstream of this location, water surface elevations are controlled by overland flow greater than the capacity of the bubbler system under the MAX station.

Bubbler Design Summary

The “bubbler” consists of a culvert system that reduces capacity in the underground culverts as flow continues downstream. The open channel section of North Fork Hall Creek at the southwest corner of the Mobile Home Corral transitions to an enclosed trapezoidal concrete section at a headwall structure. The trapezoidal section then connects to a 66-inch reinforced concrete pipe with less stormwater capacity under the MAX Station. The junction structure connecting the trapezoid and the 66-inch pipe includes a large open grate that allows the flow contained in the upstream trapezoidal section to fill the 66-inch culvert and overflow excess storm water through the grate, or bubble up as overland flow. This design concept reduces backwater caused by the downstream 66-inch pipe that would otherwise result in higher water surface elevations upstream into the trapezoidal section and into the open channel section in the Mobile Home Corral.

Bubbler Model Representation

The Panel believes that the study contractor used the best available information to develop the floodplain analysis and in their response, the claim that the flows were reduced to account for the bubbler has been confirmed. For instance, the study contractor did account for the flows through the bubbler and reduced the flows in the hydraulic model accordingly by reducing the amount of overland flow in the model. The 100-year flow of 259 cfs was reduced to 50 cfs of overland flow with the remaining 209 cfs handled by the bubbler. The 50-year flow of 239 cfs was reduced to 38 cfs of overland flow, etc.

The Panel review of the hydraulic modeling revealed that while the HEC-RAS portions of the model are consistent with FEMA Guidelines and Specifications, the use of the WSPG model to represent the bubble up design at the Max Track Station does not best represent the hydraulics conditions of the culvert system under the MAX station.

The study contractor's attempts to recreate the WSPG files were not conclusive, and have been seen by neither the Community nor the Panel at this time. Additionally, while the WSPG program is accepted FEMA software as claimed by the study contractor, it is not appropriate design software for this application as flooding at the junctions and other elements are computationally handled by an imaginary extension of element height. Specifically from the program documentation:

> "*If the computed depth of flow in any open section exceeds the given section height the program will extend vertical walls; a note is provided in the output file indicating the computed water surface elevation is greater than the ground elevation.*"

The bubbler design by definition forces flow out of the model and the "vertical walls" created by the WSPG program will cause increased water surface elevations and no reduction in flow once flooding were to occur out of the bubbler grate. While this may have been accounted for in the modeling approach, the details of the analysis cannot be verified.

Overland Flow Path and Friction Losses

What is referred to by the Community as friction losses of 1.3 feet in the new study verses 0.5 feet in the effective study more accurately describe a backwater constriction caused by overland flow passing through a 10-foot wide opening between the building southwest of the Mobile Home Corral and a retaining wall for the MAX tracks. This 10-foot opening is modeled as the only escape route once the capacity of the entrance to the bubbler is exceeded. The Community provided no alternative data to refute this claim.

Considering the proposed increase in the 100-year flow from 150 cfs to 260 cfs, this additional backwater created through this constriction is appropriate if this is the only overland flow path. A closer look at the preliminary 10-year results indicates that a flow of 189 cfs results in a 0.9 foot increase in water surface elevation. This 10-year preliminary and 100-year effective comparison indicate that FEMA is using a similar modeling approach to that of the effective study, and as currently modeled, the increased preliminary flow value of 260 cfs accounts for the increase water surface elevations.

In short, the Community has provided no recourse or sufficient contrary analysis to change the proposed BFEs in the Preliminary FIS. A Letter of Map Revision would be a viable approach to adjusting the water surface elevations for North Fork Hall Creek if the Community can produce a better representative model of the MAX bubbler design and a better representation of the overland flow route.

References

FEMA, November 2009. Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix C - Guidance for Riverine Flooding Analyses and Mapping.

###