Level of Protection Case Studies

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Introduction

Over the last ten years the United States has experienced many severe storms which have caused much devastation to communities across the nation. In response to these experiences, federal, state and local governments have begun to approach disaster mitigation with higher standards to protect lives, property, and economies of the American people. For floodplain management, these impacts have resulted in a variety of approaches to flood mitigation.

The Federal Emergency Management Agency (FEMA) accredits levee systems for recognition on Federal Insurance Rate Maps (FIRM) as part of the National Flood Insurance Program (NFIP). FEMA accreditation standards have been debated in regards to whether or not the standards provide a community with an appropriate level of protection. The US Army Corps of Engineers (USACE) provides federal funding assistance to levee systems which they have authorized, with the design level of protection varying from system to system. Design levels for USACE may be higher or lower than FEMA's accreditation standards.

This paper will discuss case studies from across the nation where entities have either proposed or required a level of protection differing from FEMA accreditation standards.

Project Background

In Portland, Oregon, two urban levee systems, Peninsula Drainage District #1 and Peninsula Drainage District #2 (PEN 1 and 2), have lost certification for FEMA accreditation. In efforts to re-certify the systems before FEMA requests accreditation documentation, local sponsors of the systems have begun work to re-certify the systems through a collaborative approach called Oregon Solutions. Oregon Solutions brings stakeholders together from across the state to collaborate towards solutions for complex projects and issues. A Technical Advisory Committee (TAC) was created by the Oregon Solutions team to provide recommendations and guidance to the team when making technical decisions. The TAC, which has representation from key entities impacted by the project, requested this case study paper to help guide them in their recommendations for the Oregon Solutions team. The levee systems' local sponsor staff has taken on research and publication of this paper.

The research for this paper was completed through newspaper articles, association publications, government entity publications and policies, interviews with government staff, and use of government entity website resources. The scope was to research any approach using a higher level of flood protection, for floodplain development regulations or for flood protection system standards.

FEMA currently accredits levee systems that have been certified by a professional engineer as providing protection against the 1-percent-annual-chance flood. The 1-percent-annual-chance flood has a 1-percent chance in any given year of occurring and is often referred to as the “100-year” flood. The 100-year flood may also be referred to as the “national standard” because of its role in the NFIP.

There are other common levels of protection used for modeling floods or making policy decisions. Besides the 100-year flood, the “200-year” and “500-year” floods are also common levels of protection used in policy development and consideration. The 200-year flood has the possibility of occurring once every 200 years, or it has a 0.5-percent chance to occur in any given year. The 200-year flood is technically referred to as the 0.5-percent-annual-chance flood. The 500-year flood has the possibility of occurring once every

500 years, or it has a 0.2-percent chance of occurring in any given year. The 500-year flood is technically referred to as the 0.2-percent-annual-chance flood. There are many more levels of protection communities can consider, as case studies in this paper will demonstrate.

In 1894 Portland experienced a 500-year flood, now known as the flood of record. The PEN 1 and 2 levee systems were not in place during the flood of record, but since 1894, the Columbia River has surpassed the 500-year flood elevation once more during the Vanport Flood in 1948. A portion of PEN 1 levee breached and subsequent flooding demolished the City of Vanport and killed 15 people.

The Columbia River has swelled to surpass the 100-year flood elevation four times between 1933 and 1996 (see Figure 1). The 100-year flood can be a misleading term, as flooding history shows. Statistically, a 100-year flood has a 26-percent chance of occurring during a 30-year mortgage, or a 45-percent chance of occurring during a 60-year life of a power substation.

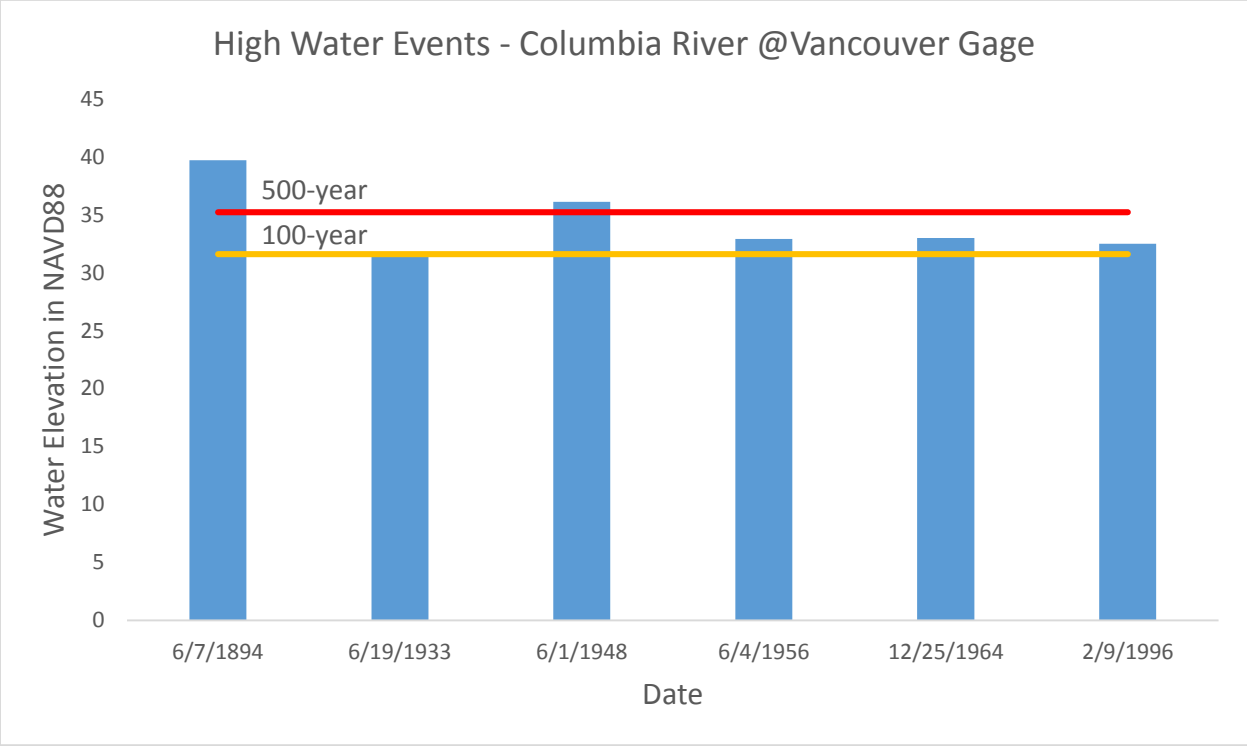

Figure 1

New York City, New York

The New York City resilience plan, titled *A Stronger, More Resilient New York* issued summer 2013, was drafted in response to the devastation experienced as a result of Hurricane Sandy. The plan came out of a work group created by Mayor Bloomberg which was focused on analyzing impacts of the storm to the area, developing designs to restore the hardest hit areas of the city, and to look at how climate change will impact floodplain management in the future. The plan continually compares the 100-year and 500-year floodplain in graphics, scenarios, and modeling while also looking at climate change. The climate change modeling for the plan comes from the New York City Panel on Climate Change, created in 2008 by Mayor Bloomberg, with representatives from leading scientific institutions, such as the NASA Goddard Institute for Space Studies and Columbia University's Earth Institute.

One of the many initiatives set forth in *A Stronger, More Resilient New York* was a feasibility study aimed at Southern Manhattan, completed in 2013. Engineers studied the feasibility of creating a 1.3 mile long multi-purpose levee system, consisting of floodwalls and earthen embankments, which would provide protection to the projected 100-year flood event of 2100. The study was identified as "Southern Manhattan Initiative 2" in the city's resilience plan. The plan asked for a multi-purpose levee system providing protection as "determined by current floodplain data, adjusted for expected sea level rise well beyond 2050" (A Stronger, More Resilient New York, 2103). The feasibility study modeled for the 2100 100-year event, which was found to be six feet higher than the current 100-year flood event. One reason the city is attracted to the multi-purpose levee system is because they are considered more practical and less intrusive to development.

http://www.nyc.gov/html/sirr/html/report/report.shtml

http://www.nycedc.com/sites/default/files/filemanager/Projects/Seaport_City/Southern_Manhattan_Coastal_Protection_Study_-_Evaluating_the_Feasibility_of_a_Multi-Purpose_Levee.pdf

State of Nevada

In the State of Nevada, the cities of Reno, Sparks, and Washoe County come together for flood protection through the Truckee River Flood Management Authority. One product of this entity is the Truckee River Flood Project which has the goal "to reduce flood damages and deaths from a 1997 type flood (117-year event)" (The Living River Plan, Version 2.2, 2011). The Flood Project is supported by local entities, counties, state entities, and federal entities. The Flood Project is run by a 23-member coordinating committee that was established in 2005 with representatives from key stakeholders. The Living River Plan, approved in 2009, describes the flood protection projects under the overall Flood Project. Only certain projects identified in the Living River Plan are identified as needing 117-year protection, while others are identified as needing 100-year flood protection.

http://truckeeflood.us/uploads/files/File/Living%20River%20Plan%20Book/Living_River_Plan_Book_FINAL_April2011edition_reduced.pdf

State of Washington

The Washington Department of Ecology was asked by the Washington State Legislature to evaluate the status of certified levees across the state. As noted in a 2012 King County issue paper on levels of service, the Department of Ecology concluded: "The 100-year standard may be woefully insufficient in some areas (such as highly urbanized environments) and perhaps overly protective in others (such as agricultural lands, undeveloped lands, etc.), thus FEMA accreditation should include risk and economic analysis".

The City of Kent, located in King County, is currently moving forward to ensure their flood control system protects against a 1-percent-annual-chance flood event to acquire certification for FEMA accreditation. For the future, the City of Kent has stated their long-term goal is a 500-year level of protection (Green River Projects, 2012).

A statewide approach to floodplain management in Washington comes out of the Department of Ecology. Floodplains by Design received a total of $44 million to "Promote the reduction of flood risks and floodplain ecosystem recovery while maintaining or improving agricultural production, water quality, and open space/recreation. [And to] improve the coordination of public funding for floodplain efforts" (www.ecy.wa.gov). Seventy-one projects were proposed, and currently 30 are going through technical review and have been placed on the Floodplains by Design project list.

http://www.ecy.wa.gov/programs/sea/floods/floodplainsByDesign.html

https://kentwa.gov/WorkArea/DownloadAsset.aspx?id=21367

http://your.kingcounty.gov/dnrp/library/water-and-land/flooding/flood-hazard-mgmt-plan-update-2012/flood-plan-update-issue-paper-levee-certification-accreditation-service-levels.pdf

State of California

California 2007 Senate Bill 5 called for 200-year flood protection to be the minimum level of protection for urban and urbanizing areas in the Sacramento-San Joaquin Valley. Subsequently, in May 2012, the State of California introduced the *Urban Levee Design Criteria* (ULDC). The ULDC fulfills the need for engineering guidance to aid in compliance with the state law from Senate Bill 5. The ULDC "provides engineering criteria and guidance for the design, evaluation, operation, and maintenance of levees and floodwalls that provide an urban level of protection (i.e., 200-year level of flood protection) in California" (ULDC, 2012). Urban areas are defined as currently having 10,000 residents, and urbanizing areas are defined as areas that will have 10,000 or more residents within 10 years (ULDC, 2012). The ULDC also states that "While improving our levees to a 200-year level of flood protection provides significant reduction in flood risk, there is always the chance that a larger flood will occur and overwhelm the flood protection system. This suggests that over time we should continually seek higher and higher levels of flood protection" (ULDC, 2012). Though the ULDC was in response to the law impacting Sacramento-San Joaquin Valley, it is written as to provide guidance to all communities in California. Sources have said it is believed that the 200-year level was selected by policy makers because 200 is twice as much as 100. The level of protection was not selected through a risk or economic analysis.

http://www.water.ca.gov/floodsafe/leveedesign/

State of New Jersey

In 2007 New Jersey adopted the Flood Hazard Area (FHA) Control Act Rules N.J.A.C. 7:13. N.J.A.C. 7:13 defines "flood hazard area design flood" as "a flood equal to the 100-year flood plus an additional amount of water in fluvial areas to account for possible future increases in flows due to development or other factors. This additional amount of water also provides a factor of safety in cases when the 100-year flood is exceeded". More explicitly, the state's flood hazard area design flood elevation for fluvial areas is 125% of the 100-year flow rate reported by FEMA, while in tidal areas the state uses the standard 100-year flood elevation.

The New Jersey Environmental Infrastructure Finance Program has required infrastructure flood protection guidance and best practices for any new projects the program funds, which are higher than the 100-year level of protection. The requirements mirror Executive Order 11988, which requires that any federal funding or projects for critical actions must happen outside of the 500-year floodplain (read more on EO 11988 below). If a location outside of the 500-year floodplain is not feasible, then the infrastructure must be built to withstand a 500-year flood event. The program describes critical infrastructure as including government facilities, schools, prisons, retirement homes, medical facilities, key transportation systems, hazardous material facilities, military installations, and also urban levees. PEN 1 and 2 levee systems have almost every single type of critical infrastructure behind its levee system, which is itself considered a critical infrastructure under this program. These requirements are also being applied to New Jersey's State Revolving Fund. The guidance and best practices are described as being needed because:

> In many cases, [the 100-year] elevation has proven inadequate based on the flooding and storm surge experienced during Sandy and other recent storms. The need for enhanced flood protection for critical infrastructure has been recognized by FEMA, which requires a higher minimum design threshold for activities involving the repair, rehabilitation, or construction of facilities for which

Federal financial assistance is provided. State-funded projects will equally require this more stringent standard. (Infrastructure Flood Protection, 2014)

http://www.nj.gov/dep/rules/rules/njac7_13.pdf

http://www.nj.gov/dep/watersupply/pdf/guidance-ifp.pdf

City of Dallas, Texas

The levee system in Dallas was originally built in the 1930s by USACE and was designed for an 800-year event. Over the years it was assumed the system had degraded to a possible 600 to 700-year level of protection. At the periodic inspection by USACE in 2009, the Dallas levee system lost certification and FEMA began remapping the area. The City of Dallas began with their own evaluation of their levee system spending more than $25 million dollars before USACE decided to begin a modern risk analysis on the Dallas system (National Research Council, 2013). The preliminary results from this USACE risk analysis proved the system to provide protection against a 1,500-year or higher flood event. The worst events to impact the Dallas levee system were in 1989 and 1990 and both were considered to have a water surface elevation below the 100-year event. The USACE risk analysis is yet to be finalized, but the analysis is expected to decrease initially projected accreditation costs.

Though initial modeling on the levee system has shown a higher level of protection, Dallas has been approaching flood mitigation with high level of protection standards since 2003. The City of Dallas' Balanced Vision Plan (2003) envisions the Dallas flood protection system as providing an 800-year level of protection, as the system was originally built to provide. The plan has multiple primary goals, but one goal focuses on flood protection: "It will provide undiminished flood protection for the full length of the corridor in a way that supports the achievement of environmental, recreational, mobility and economic goals" (Balanced Vision Plan, 2003).

Information obtained from Dhruv Pandya, Assistant Director of Operations for the Trinity Watershed Management, City of Dallas, and from the following sources:

http://www.trinityrivercorridor.com/flood-control/100-year-plan.html

http://www.trinityrivercorridor.com/about/balanced-vision-plan.html

http://www.dallascityhall.com/trinity_watershed/index.html

http://www.dallasnews.com/news/community-news/dallas/headlines/20130117-dallas-levees-deemed-safe-after-long-and-expensive-process.ece

http://www.nap.edu/openbook.php?record_id=18309&page=147

Executive Order 11988 on Critical Actions within Floodplains

Executive Order 11988 was signed in 1977 and states that critical actions should never be taken within a 500-year floodplain. It directs all federal agencies to follow this standard, which includes granting money or loans to state or local governments. The goal of the order is to "avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative" (FEMA.gov, 2014). A critical action is defined as "an action for which even a slight chance of flooding is too great" (44 CFR 9). Examples of critical actions, as described in 44 CFR 9:

> Include, but are not limited to, those which create or extend the useful life of structures or facilities:
>
> (a) Such as those which produce, use or store highly volatile, flammable, explosive, toxic or water-reactive materials;
> (b) Such as hospitals and nursing homes, and housing for the elderly, which are likely to contain occupants who may not be sufficiently mobile to avoid the loss of life or injury during flood and storm events;
> (c) Such as emergency operation centers, or data storage centers which contain records or services that may become lost or inoperative during flood and storm events; and
> (d) Such as generating plants, and other principal points of utility lines.

If there are no practical alternatives for the action's location, then the facility must be protected against the 500-year event.

https://www.fema.gov/environmental-planning-and-historic-preservation-program/executive-order-11988-floodplain-management

FEMA NFIP Evaluation, 2006

In 2006 a FEMA initiated evaluation on the NFIP was published. The "Design for the Evaluation of the National Flood Insurance Program" (January 2002) explains why the evaluation was needed:

> Despite the many changes that have occurred and the program's significance, the NFIP has not yet been evaluated comprehensively. … Given the program's size, scope, and national importance, it is imperative to know how well it is operating and to identify areas where performance may be deficient or where performance exceeds reasonable expectations. As a consequence, FEMA convened a committee in 1999 to establish a framework for conducting the first comprehensive evaluation of the NFIP.

The American Institutes for Research was awarded the multi-year contract to evaluate the NFIP. A sub-study of the overall evaluation analyzed the adequacy of the 1-percent-annual-chance national standard. The conclusion and recommendations of the sub-study state: "The 1 percent standard is too low for removal of NFIP land use and insurance requirements for population centers behind levees. A 1 percent standard does not adequately take into account the residual risk behind levees. [Recommendation] 5: FEMA should not recognize levees under the NFIP unless they provide protection to the 0.2 percent (500-year flood) level. Levees in non urban areas should protect against the 1 percent or larger flood, depending on the economic costs and benefits of the levee" (Assessing the Adequacy of the National Flood Insurance Program's 1 Percent Flood Standard, 2006).

http://www.fema.gov/media-library-data/20130726-1602-20490-6095/nfip_eval_1_percent_standard.pdf

http://www.fema.gov/media-library-data/20130726-1603-20490-1120/nfip_eval_design.pdf

The Association of State Floodplain Managers

The Association of State Floodplain Managers (ASFPM) published the *National Flood Policy Challenges, Levees: The Double-edged Sword* white paper in 2007. The white paper included many recommendations for national flood protection standards, with some touching on the 1-percent-annual-chance FEMA

minimum standard. The ASFPM makes their view on flood protection clear as being more stringent than the current outlook on flood protection:

> Because of the nature of levee failure flooding, the ASFPM believes that levees are not a wise community choice and should never be used to protect undeveloped land so development can occur in the flood risk area behind the levee. However, many levees already exist in the nation, especially in communities that were built right on the river or coast, usually at a time when the nation was convinced it could engineer its way out of flooding. (*Double-edged Sword*, 2007)

In the white paper, the ASFPM ultimately recommends that the 500-year event be the minimum standard for federal investments in levees as well as for the purpose of flood insurance. In another ASFPM paper called *Critical Facilities and Flood Risk* (2011), the ASFPM recommends considering a higher level of protection for critical infrastructure above the 500-year standard, as recognized in Executive Order 11988 currently. The ASFPM explains that "flood risk may actually increase behind a levee if more development or higher value structures are placed behind the levee where they will be damaged when the levee is overtopped or fails and the flood occurs" (*Critical Facilities*, 2011), hence the recommendation for a higher standard.

http://www.floods.org/PDF/ASFPM_Levee_Policy_Challenges_White_Paper_021907.pdf

http://www.floods.org/ace-files/documentlibrary/Whitepapers/ASFPM_Critical_Facilties_and_Flood_Risk_Final_Feb_2011.pdf

National Committee on Levee Safety

The National Committee on Levee Safety recommends that every structure within a leveed area be required to have flood insurance with risk-based premiums. The level of protection afforded by the levee would correlate to the premium, so a 500-year designed levee would provide cheaper insurance to landowners than a 100-year designed levee would. The Committee lists five positive impacts that would result from having risk-based flood insurance for all structures within leveed areas, which focus on risk awareness and ownership, emergency planning and preparation, incentivizing communities to maintain levees, speedier disaster recovery, and reducing the ultimate cost of disaster recovery.

http://www.leveesafety.org/ip_Updated_FloodInsurance_04February11.cfm

Conclusion

As the case studies show, a variety of approaches to level of protection required for levee systems have been implemented across the US. Decisions to differ from the NFIP's 1-percent-annual-chance standard are shown to be context sensitive, concerned with short and long term goals and factors, often are focused on building resiliency, and always have the ultimate goal of public safety.