



U.S. ARMY CORPS OF ENGINEERS LEVEE PORTFOLIO REPORT



EXECUTIVE SUMMARY

A Summary of Risks and
Benefits Associated With
the USACE Levee Portfolio

PREPARED BY
U.S. ARMY CORPS OF ENGINEERS
LEVEE SAFETY PROGRAM | MARCH 2018

*As a nation,
we know
little about
the condition
or risk
associated
with levees
outside those
inspected and
assessed as
part of the
USACE levee
portfolio.*

Cover Photos

Top Left: Sandbags placed on top of a levee near Forest, Missouri, due to overtopping concerns from a rising Missouri river in June 2011 (Source: USACE).

Bottom Left: USACE staff and the non-federal sponsor conducting a levee inspection in St. Peters, Missouri (Source: USACE).

Right: View of the Sacramento River near Sacramento, California, March 2010 (Source: USACE).

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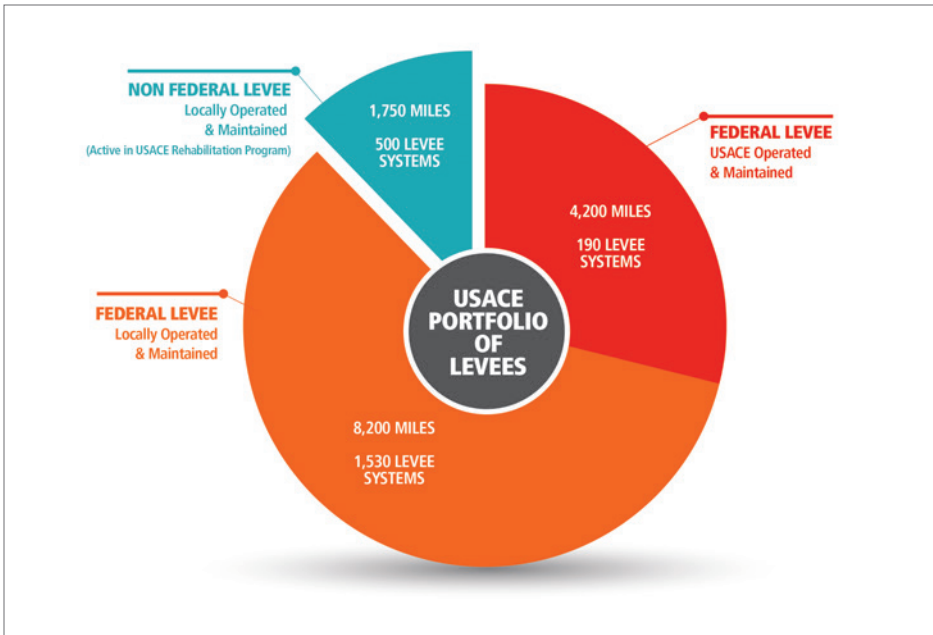


17TH STREET CANAL LEVEE BREACH IN NEW ORLEANS, LOUISIANA, SEPTEMBER 3, 2005 (SOURCE: BRETT DUKE, THE TIMES-PICAYUNE ARCHIVE).

The U.S. Army Corps of Engineers (USACE) Levee Portfolio Report shares our current understanding of the flood risks and benefits associated with the portfolio of levee systems within the USACE Levee Safety Program. The USACE Levee Portfolio Report is organized around risk (e.g., the flood risk associated with levees) to describe the magnitude of risk, key drivers of risk, sources of uncertainty in the understanding of risk, and distinct factors of risk within the USACE levee portfolio. Assessing, managing, and communicating levee-related flood risk to people, property, and the environment is the mission of the USACE Levee Safety Program. Managing this portfolio of levees requires an understanding of the levee-related flood risk within the portfolio, the risk management approaches USACE uses to

manage these risks, and the roles of USACE, other federal agencies, states, tribes, regional districts, and local communities in assessing, managing, and communicating risk.

Utilizing the best available information on the USACE levee portfolio, including information gathered from inspections and risk assessments performed within the USACE Levee Safety Program, this report provides valuable information including key findings that allow for improved decision making and management of the portfolio. USACE intends for this report to promote a broader understanding of benefits and risks associated with levees. The summary of risk factors associated with the USACE levee portfolio will help USACE and others with levee risk management responsibilities inform decisions on levee safety



BREAKDOWN OF USACE PORTFOLIO OF LEVEES (SOURCE: NATIONAL LEVEE DATABASE).

related investments, including policy and technical guidance, training, and research and methods development. Finally, this report establishes a baseline set of information that allows for future analysis of USACE levee portfolio trends in inventory and risks.

THE USACE PORTFOLIO

The USACE Levee Safety Program has conducted a comprehensive inventory, inspection, and risk assessment effort for the entire USACE levee portfolio. This provides a more comprehensive understanding of the portfolio than previously known: where the levees are (inventory); their condition (inspection); and the flood risk associated with each levee (risk assessment). The USACE levee portfolio includes about 2,220 levee systems totaling approximately 14,150 miles in length. Over

70% of the portfolio (by mile) is operated and maintained by a local sponsor.

15% of the portfolio (by mile) are systems with multiple operators.

1,200 levee sponsors operate and maintain roughly 2,000 of these levee systems, spanning roughly 70% of the length of the entire portfolio. The remaining almost 200 levee systems are operated and maintained by USACE.

USACE manages its portfolio of levees by systems, but sometimes one levee system can have multiple levee sponsors, each managing one or more levee segment. Levee

systems may have multiple levee sponsors responsible for operation and maintenance of segments and other features that are integral to excluding flood water from the leveed area. Nearly 15% of the portfolio has multiple segments that make up a levee system. Performance of the levee is only as good as its “weakest link,” therefore engagement with all parties responsible for segments of the levee system is critical. This represents a relatively new way of interacting with those responsible for all the elements of the levee—elements that may not have been designed or authorized as part of a system—and is a priority for the USACE Levee Safety Program.

No levee is flood-proof. Levees reduce the risk of flooding, but no levee system can eliminate all flood risk. A levee is generally designed to exclude floodwater from the leveed area over a limited range of flood events. If a larger flood occurs, floodwaters will flow over the levee.

Risk assessments within the Levee Safety Program provide a systematic, evidence-based approach for estimating and describing the likelihood and consequences of existing and future risk associated with levee systems. Risk assessments consider what can go wrong, how it can happen, the consequences if it happens, and how likely it is to happen. To support decisions in the management of the portfolio, a Levee Safety Action Classification (LSAC) is assigned as a final step in



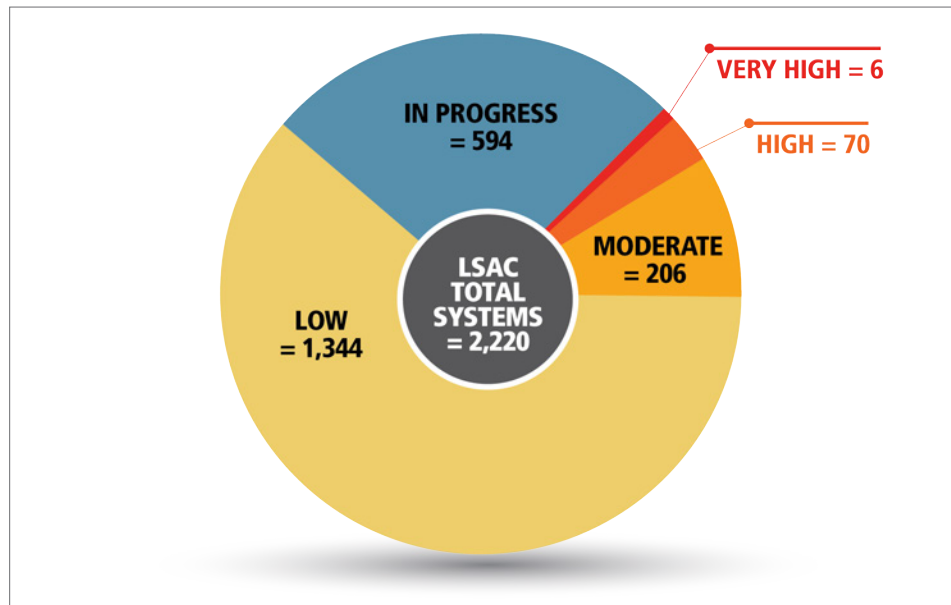
OVERTOPPING OF THE L-550 LEVEE IN ATCHISON COUNTY, MISSOURI DURING A MISSOURI RIVER FLOOD, JUNE 2011 (SOURCE: USACE).

13% of the portfolio (by mile) is categorized as Moderate, High, or Very High risk.

developing a risk characterization for each levee system. LSACs range from Very High risk (immediate action recommended) to Very Low risk (maintain routine activities). LSAC assignments are used by USACE to prioritize resources across the portfolio and to organize widespread levee-related risk information into reasonably commensurate groupings for action.

PORTFOLIO RISK HIGHLIGHTS

USACE currently has completed levee risk characterizations and assigned an LSAC to nearly 73% of the portfolio. For the remaining

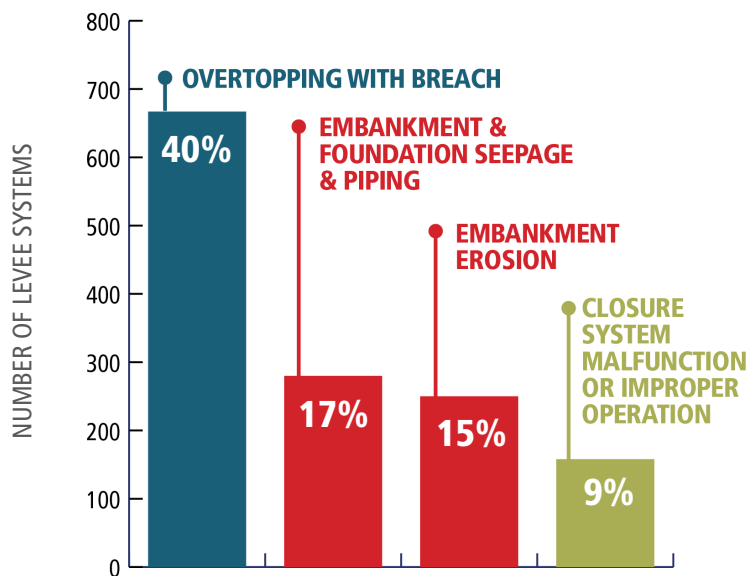


LEVEE SAFETY ACTION CLASSIFICATIONS OF THE USACE PORTFOLIO, BASED ON COMPLETED RISK ASSESSMENTS AS OF MARCH 2017.

27% of the portfolio, USACE expects to complete levee risk characterizations and LSAC assignments in the next few years. Thus far, 13% of the portfolio consist of levee systems that are Very High, High, or Moderate risk that require interim actions to reduce risk while

more long-term and comprehensive risk reduction and risk management solutions are being pursued. These Very High, High, and Moderate risk levees have over 8 million people that live and/or work behind them. USACE has begun sharing information from risk assessments

LEEVE PERFORMANCE RISK DRIVERS



TOP FOUR LEEVE PERFORMANCE RISK DRIVERS IN THE USACE PORTFOLIO, BASED ON OVER 1,600 LEEVE SYSTEMS WITH COMPLETED RISK ASSESSMENTS.

with sponsors and other community risk managers. USACE will continue to develop approaches and tools to share results of risk assessments with all kinds of risk managers, with a particular focus on training its staff to translate complicated risk information into understandable and actionable information.

USACE considers the full range of flood hazards for a levee, from when water first starts loading the levee to when water starts to flow over the top of a levee. An important flood loading that often impacts risk and indicates when flooding behind the levee starts to occur is the flood loading where water starts to overtop a levee. The likelihood of when water starts flowing over the

The most common risk driver in levee performance is when the levee is overtopped and breaches.

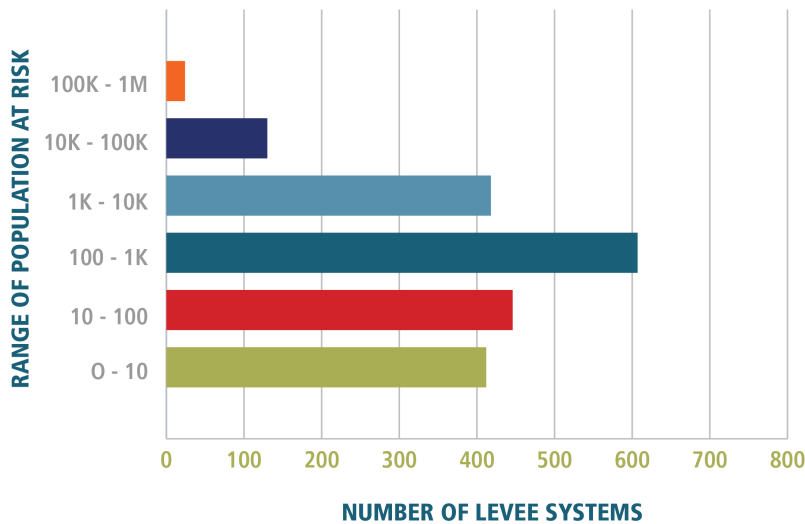
top of a levee varies considerably across the USACE levee portfolio. Within the USACE portfolio, the annual chance of exceedance (ACE) of the flood loading that reaches the top of the levee ranges from 50% to less than 0.02%—in colloquial terms, from the 1-in-2 chance to less than the 1-in-5,000 chance of occurring in any given year. The majority of the levee systems within the portfolio begin to overtop at

flood levels with an ACE of 0.5% (1-in-200 chance) or less. USACE is continuing to invest in collection and assessment of flood hazards through efforts such as the Corps Water Management System and is sharing information with other federal agencies to improve the understanding of hydrologic events.

How the levee performs when faced with flood hazards is a factor in levee-related risk. Levees in the USACE levee portfolio vary widely in age, design and construction practices, and flood regimes (e.g., coastal, river, flashy or long duration). The average age of levees in the USACE portfolio is roughly 50 years. Levees constructed by communities and accepted into the portfolio and levees designed and constructed by USACE in the 1920s–1960s may be designed and constructed to standards less stringent than current best practices.

Risk drivers in levee performance can result from many different mechanisms that can cause the levee to breach. The most common risk driver in levee performance is when the levee is overtopped and breaches. This risk driver impacts over 40% of the USACE levee portfolio. Seepage through or beneath the levee is the second most common risk driver, impacting 17% of the portfolio. Understanding the uncertainty in how a levee will perform (e.g., well or poor) during flood events is important in managing risk. Monitoring performance, regular inspections,

POPULATION AT RISK BY NUMBER OF LEVEE SYSTEMS

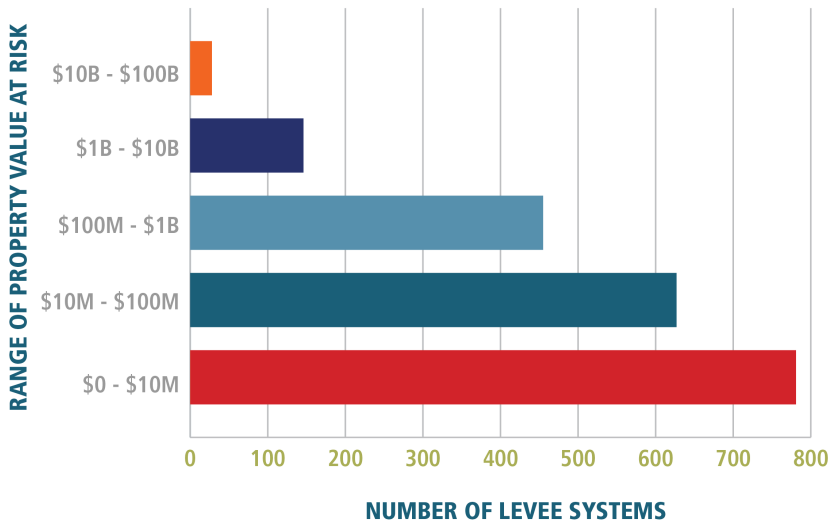


86% of the population lives behind 7% of USACE portfolio levees.

levee portfolio. Population and property value behind levees is not equally distributed behind all the levees. Over nine million people (86% of the population behind the USACE levee portfolio) are concentrated behind roughly 150 levees (7% of the USACE portfolio). These 150 levees are in urban areas with populations in excess of 10,000 behind them. While there are very large urban areas behind some levees, most of the levees (1,465 levee systems) in the USACE portfolio have relatively low populations (fewer than 1,000 people) working and living behind them.

11 million people (\$1.3 trillion property value) are in areas behind USACE portfolio levees.

PROPERTY VALUE AT RISK BY NUMBER OF LEVEE SYSTEMS



THE USACE PORTFOLIO IS DIVERSE, WITH LEVEES RANGING FROM HIGHLY URBANIZED - WITH LARGE POPULATIONS AND LARGE PROPERTY VALUES IN THE LEVEEED AREAS - TO VERY RURAL.

risk assessments, and continuous operation and maintenance are essential for the effective management of risk associated with levees.

Approximately 11 million people live or work behind levees, and \$1.3 trillion of property value exists in the leveed area (e.g., the area that represents the portion of the floodplain where floodwaters are excluded by a levee) of the USACE

In addition to property, population, and economic activity, USACE portfolio levees reduce the risk of flooding to some of our most vital infrastructure. From roads and schools, police and fire stations to historical sites and national treasures, there are countless structures that provide invaluable services to our communities and nation that are located behind levees.

USACE portfolio levees reduce the risk of flooding to some of our most vital infrastructure. There are countless structures that provide invaluable services to our communities and Nation that are located behind levees including:

- roads
- schools
- police and fire stations
- historical sites
- national treasures

These structures help sustain our economy and provide venues for recreation, among other functions. For example, there are almost 4,500 schools located behind levees that collectively enroll over two million students. In addition, over 25% of the nation's oil refining capacity is located behind levees. Damage to, or failure of, these levees could significantly impact local, regional, and national resources.

Flood awareness and emergency preparedness play a key role in risk management for individuals and communities behind levees. Involved, informed individuals and communities behind levees will be better prepared to take meaningful actions to reduce risks to loss of life (e.g., practicing emergency action plans, warnings, and evacuations) or property (e.g., purchasing flood insurance, flood proofing or elevating

structures). USACE will continue to support and apply the results of research and knowledge in social science to better understand how warnings are issued and how they spread through communities that experience severe flooding. This research will advance knowledge about the public warning process, help improve how future public warnings and evacuations for any hazard are implemented, enable levee owners to better assess the existing risk posed by their assets, and investigate non structural risk reduction measures alongside levee upgrades.

COST ESTIMATION

Risk information for the USACE portfolio allows decision makers at the federal, state, and local levels to understand the impacts of risk and magnitude of investment needs to address risk. An understanding of investment needs to address levee-related risks for the USACE portfolio has not been previously attempted as risk information has not been readily available. However, now that risk assessments are nearing completion, a combined cost estimate to address risks within the portfolio was determined. A portfolio cost estimate does not try to indicate who pays (levee sponsor or federal government) nor does it address other factors that must be considered when making investments, such as environmental and community values, but rather informs investment priorities and decisions through the understanding of primary factors

Estimated cost to address risk in the USACE levee portfolio is \$21 billion.

that influence costs to address risk and risk management measures that efficiently and effectively reduce risk. USACE will use this portfolio cost information to inform research needs and guidance updates with an eye toward not only reducing risk, but lowering assessment, repair, and mitigation costs.

The cost to address risk in the USACE levee portfolio ranges from \$6.5 billion to \$38 billion, with an expected cost of about \$21 billion. The expected cost of \$21 billion is broken down into approximately \$13 billion for levee infrastructure improvements to mitigate risk drivers in levee performance before the levee overtops, approximately \$8 billion in armoring of levees to mitigate risk drivers in levee performance when the levee overtops, and about \$300 million to improve evacuation effectiveness within the leveed area. The estimated cost to improve evacuation effectiveness includes measures such as improved evacuation plans, community outreach, and warning systems. USACE will work with levee sponsors to provide information that can improve evacuation effectiveness, particularly since the cost to improve evacuation effectiveness is significantly less than implementation



U.S. ARMY CORPS OF ENGINEERS



A VIEW OF THE TERRACED FLOODWALL THAT ALSO SERVES AS WALKING PATH ALONG THE NAPA RIVER, CALIFORNIA (SOURCE: USACE/DEDE CORDELL, [HTTPS://FLIC.KR/P/AQWPUG](https://flic.kr/p/AQWPUG)).

Improvements in evacuation effectiveness is a relatively inexpensive risk management action which directly reduces loss of life.

of levee infrastructure improvements and evacuation effectiveness directly reduces risk to loss of life.

As a nation, we know little about the condition or risks associated with levees outside those inspected and assessed as part of the USACE levee

portfolio. As such we do not have a true national look at the risks and benefits levees provide to the nation or whether people know that they live or work behind a levee. USACE continues to promote awareness of the location of levees in the nation and the risks associated with levees. USACE is coordinating with states, tribes, local communities, and private levee owner-operators to conduct a one-time inspection and risk assessment for all levees in the nation. USACE will include information on the location, condition, risks, and benefits of these levees in the National Levee Database to increase accessibility

of levee information to those living and working behind levees, and to improve understanding of the nation's benefits and risks related to levees.

FOR MORE INFORMATION

For more information on the activities of the USACE Levee Safety Program, please visit <http://www.usace.army.mil/Missions/Civil-Works/Levee-Safety-Program/>.

The National Levee Database, <http://nld.usace.army.mil>, is a publicly-available inventory of the Nation's levees, including the location, condition, risks, and benefits of levees in the USACE Levee Portfolio.