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ICLEI USA Local Governments for Sustainability

Resilience Finance Guidebook for Local Governments

From Resilience Goals to Financeable Projects

Connecting risk reduction to funding, financing, and investment decisions

Credits & Acknowledgments

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Author's Note

This guide grew from a question I encountered repeatedly throughout my career: why is it still so difficult to finance resilience, even when the need is clear and the value is widely recognized? I first encountered this challenge while serving as chief resilience officer for the City of Oakland, CA, through the Rockefeller Foundation's 100 Resilient Cities initiative. The risks communities faced did not fit neatly within a single department, jurisdiction, or budget cycle. The solutions were often regional, long-term, and interconnected, while funding systems remained fragmented and short-term. It became increasingly clear that grants alone would not be sufficient to address the scale of the challenge. That lesson deepened during my service as deputy administrator for resilience at FEMA. Communities were often doing the difficult work of defining risk, protecting people, and strengthening systems, yet still struggled to translate that work into the evidence, structures, and financing approaches needed to attract capital.

After leaving the Administration, I was honored to join the Board of Directors of ICLEI USA. Local governments are on the front lines of climate resilience, and ICLEI plays a vital role in helping them move from plans into implementation. As the largest local government sustainability network in the United States and part of a global network of cities and regions advancing climate action, ICLEI helps communities of all sizes assess risk, build capacity, learn from peers, and turn climate priorities into implementation. This guide reflects that mission by helping communities connect resilience priorities with financing strategies that can move projects from concept to delivery.

Across local governments, investors, insurers, infrastructure leaders, philanthropy, academia, and community organizations, I repeatedly observed a common challenge: stakeholders frequently approached the same resilience outcomes using different language, incentives, and decision frameworks. Public officials discussed safety, continuity, equity, and community protection, while investors focused on risk, return, asset performance, and cash flow, meaning how infrastructure such as roads, utilities, buildings, housing, ports, transit, energy systems, or natural assets holds value and functions over time. Although many shared a recognition of accelerating climate risks and infrastructure vulnerabilities, collaboration was often hindered by differing institutional perspectives and financial frameworks. **This guide seeks to help close that gap.**

Resilience cannot remain something addressed only after disasters or funded solely through episodic grants. It must become something communities can plan, structure, measure, finance, and implement before losses occur. Resilience should be understood not only as a public good, but also as an investment in the systems that support communities, infrastructure, housing, economies, and essential services. This guide is intended to support a clearer translation from resilience goals to financeable projects, from shared concern to coordinated action, and from growing climate risk to the investments and partnerships needed to strengthen long-term resilience.

This work was made possible through my time as Climate Leader in Residence at Duke University, which provided the opportunity to connect ideas across sectors and reflect on lessons from practice. I am especially grateful to ICLEI for its partnership and for grounding this work in the realities faced by hundreds of local governments working on resilience and adaptation. And to my husband and partner in life, Craig Isakow: thank you for your constant encouragement, your belief in me, and the steady love that helps me keep going.



A Reader's Map to This Guide

Start with the task in front of you. Then go to the chapter that helps you move forward.

Chapter 1		**Diagnose why a project is stuck** Is this project financeable as currently structured, or is something missing?
Chapter 2		**Explain resilience in financial terms** How does the project reduce losses, protect services, improve performance, or strengthen the community?
Chapter 3		**Prepare for conversations with capital providers** What do funders, lenders, insurers, investors, or intermediaries need to see?
Chapter 4		**Match the right tools to the right parts of the project** What combination of funding, financing, revenue, grants, credit support, or catalytic capital could fit?
Chapter 5		**Learn from real projects** How have other communities moved from risk to structure, capital, and implementation?



Use this page as the guide's navigation tool: read in sequence for the full logic, or jump to the chapter that matches your current question.

Use of Artificial Intelligence Tools

Artificial intelligence tools, including Claude and ChatGPT, were used during the development of this guide to support background research, synthesis of concepts, drafting assistance, editing, visual development, and iterative refinement of language and structure.

Consistent with Duke University guidance on responsible AI use, AI-generated outputs were treated as provisional and subject to verification. Sources, examples, citations, and factual claims were reviewed against original materials wherever possible. All framing, analysis, strategic direction, conclusions, and final editorial decisions were led by the author. This guide reflects a human-led development and technical review process informed by practitioner experience, interdisciplinary collaboration, and responsible use of AI-enabled tools.

Introduction

Resilience is the capacity of communities, infrastructure systems, natural systems, and institutions to anticipate, prepare for, adapt to, withstand, and recover from disruption while continuing to function under changing conditions. Resilience is not only about surviving the next flood, wildfire, heat wave, power outage, or economic shock. It is about whether the systems people depend on for daily life and long-term prosperity keep working when they are needed most, and whether they keep supporting growth, health, safety, investment, and quality of life over time.

Avoiding damage is the floor. Sustained continuity, stability, and conditions for communities to thrive are the goals.

Across the United States, local governments already understand their vulnerabilities. They know which roads flood, which neighborhoods face the greatest heat burden, which facilities need backup power, which utilities are exposed, which housing is at risk, and which communities have the least room to absorb another disruption. The barrier is rarely awareness, but rather that the value created by resilience investments is not routinely translated into the language, evidence, repayment structures, and approval pathways that move capital to invest in communities at scale.

Most guides on resilience finance either explain the problem—the funding gap, the scale of risk, the case for action—or describe individual tools. This guide does something different. It helps local governments work through the harder middle question of why resilience investments so often stall between a clear need and available capital—and what to do about it.

The five chapters in this guide, each with diagnostic steps, value frameworks, and case studies, work toward a common answer. The barrier is usually not a missing tool, but a missing structure—unclear value, unproven performance, unresolved authority, or a mismatch between what the project produces and what capital requires.

This guide gives practitioners a working framework for diagnosing those gaps and closing them, including how to define what must keep working; translate risk reduction into financial terms that budgets, insurers, lenders, and investors recognize; build credible proof; confirm legal authority; and match each part of a project to the funding or financing role it can realistically support. For communities trying to move beyond episodic grants toward investment strategies that match the scale of today's climate and infrastructure risks, it offers a practical path from resilience goals to financeable projects.



Who This Guide is For

This guide is written primarily for the local government leaders and teams who shape how communities plan, build, budget, insure, and invest. This includes not only resilience and sustainability staff, but finance directors, public works and utility managers, planners, economic development officials, emergency managers, and the elected officials and budget officers who ultimately decide what gets funded and built. If the systems communities depend on are going to be protected and strengthened at the scale the moment requires, those decisions have to be made across departments and disciplines.

Capital providers and intermediaries working with those communities—lenders, insurers, investors, philanthropies, green banks, and municipal advisors—are an equally important audience, because structuring these investments well requires both sides of the table to understand what the other needs. Tribal governments also share many of these challenges, but face distinct legal, governance, and capital realities that are beyond the scope of this guide.

Why This Guide Exists: The Resilience Translation Problem

The scale of investment required to modernize aging infrastructure, design systems for future conditions, restore natural systems, and strengthen local economies far exceeds what grants, annual budgets, and post-disaster recovery funds can deliver on their own. The American Society of Civil Engineers (ASCE) estimates a $3.7 trillion gap between planned US infrastructure investment and what is needed to put the nation's infrastructure in good working order (ASCE 2025). In 2024 alone, the United States experienced 27 billion-dollar weather and climate disasters at a cost of $182.7 billion—the fourth-highest annual total on record. At the same time, the five-year average annual cost from 2020 through 2024 reached $149.3 billion, more than double the 45-year historical average (NOAA NCEI 2025).

Grants remain essential, especially for projects that protect safety, public health, equity, ecosystems, and community stability. But they are limited, competitive, episodic, and often fragmented across programs and timelines. Likewise, capital improvement plans, public debt, and private and institutional capital can be both necessary and powerful mechanisms, but have challenges of their own. Capital improvement plans are frequently organized by department, infrastructure type, or funding source rather than by systemwide risk. Public debt can be harder to authorize and explain when it concerns prevention rather than visible new construction. Private investors and large institutions have significant money to invest, but they usually need a clear way to be repaid. They are less likely to finance benefits that are spread across many people, hard to measure, not linked to a revenue source, or not legally available to repay the investment.

Over time, these setbacks create a familiar pattern: communities identify interconnected risks, narrow solutions to what is currently fundable, implement partial fixes, and then face those same vulnerabilities again when the next disruption occurs. The effort is genuine, but the impact is limited. The cycle of disaster-related human suffering continues.

The problem is not that resilience lacks value. The benefits are real, but they are often distributed among many beneficiaries, measured in avoided disruption, and spread across multiple budgets and balance sheets. The problem is that the true value of resilience often appears in forms that conventional finance does not automatically recognize: A drainage investment may keep a commercial corridor open while protecting housing. A microgrid may keep a hospital operating through an outage and maintain water supply. A watershed project may reduce wildfire intensity and simultaneously preserve downstream infrastructure. Each investment will have many interlocking benefits.

The evidence for acting now to increase investment into adaptation is compelling and mounting:

- World Resources Institute's 2025 analysis of 320 adaptation investments across 12 countries found that every dollar invested in adaptation and resilience generates more than $10 in benefits over 10 years, with average returns of between 20% to 27% (Brandon et al. 2025).
- Aon reports that in 2024, natural disasters caused $218 billion in economic losses in the United States. Of these, $113 billion, or about 52%, was covered by public and private insurance, leaving households, businesses, and governments exposed to the remaining losses (Aon 2025).
- The US Chamber of Commerce and Allstate found that every $1 invested in climate resilience saves $13 in damages, cleanup costs, and economic impact. Failing to invest costs communities up to $33 in lost future economic activity per dollar not spent (US Chamber of Commerce et al. 2024; 2025).
- Brookings researchers document that 80 percent of US public infrastructure spending is paid for by state and local governments, yet the traditional bond-and-assessment finance model was not designed for the complexity and urgency of today's climate threats (Posner and Briggs 2025).

This is the resilience translation problem: real risk-reduction value on one side, real long-duration capital on the other, and no shared framework for expressing one in terms the other can act on.

Communities describe benefits in terms of safety, continuity, recovery, health, and quality of life. Capital providers look for repayment, cash flow, cost stability, asset performance, insurability, and risk-adjusted return. Both may be describing the same outcome: systems that keep functioning, revenues that keep flowing, and places that remain livable and economically viable. Without translation, projects are narrowed to what can be funded incrementally, rather than structured around what is needed to reduce risk.

The same recognition failure appears in different parts of the financial system. Insurers see it as a protection gap: losses that are economically real but not insured. Lenders and rating analysts see it as an underwriting problem: risk reduction may matter, but the evidence, metrics, repayment implications, and disclosure practices are not yet standardized enough to act on at scale. Local governments experience it as a project-development problem: they can see the risk and the value of acting, but they may not yet have the structure, authority, proof, or partners needed to move from concept to implementation.

The central task is to move from resilience as a public good to an investable and financeable proposition by making resilience value visible and actionable through the chain that connects risk reduction to capital deployment. That means identifying what must keep working, mapping where value appears, determining whether any of that value can be captured, building credible proof, confirming authority and governance, and matching each part of the project to the capital role it can realistically support.

What Is a Resilience Project?

A ***resilience project*** is designed so that infrastructure and services continue operating through both acute shocks (such as storms or outages) and chronic stresses (such as heat, aging infrastructure, or sea level rise) and can adapt and recover as conditions change over time. These projects account for how systems interact, address multiple risks, and are structured to maintain performance under a range of future conditions. They are often designed to deliver co-benefits—meeting community needs while also improving system reliability, reducing costs, and stabilizing economic activity. Some resilience investments also create option value—preserving flexibility to adapt systems over time as risks evolve, rather than locking in fixed designs that may become obsolete under changing conditions. When done well, resilience projects align what communities need with what funding and financing require.

Figure 1, on the next page, shows one example of how a resilience project can address multiple shocks and stresses through integrated systems and layered financing, introducing a way of seeing how systemic risk reduction and co-benefits can work together in a single investment.

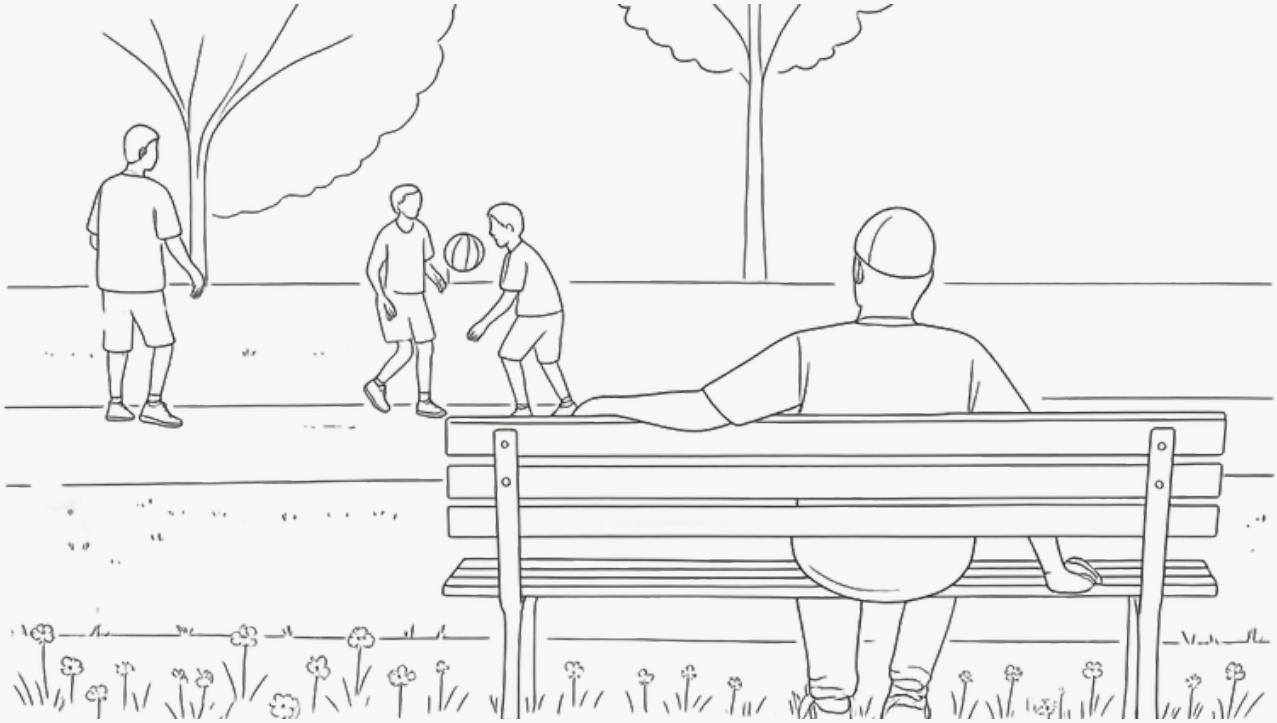


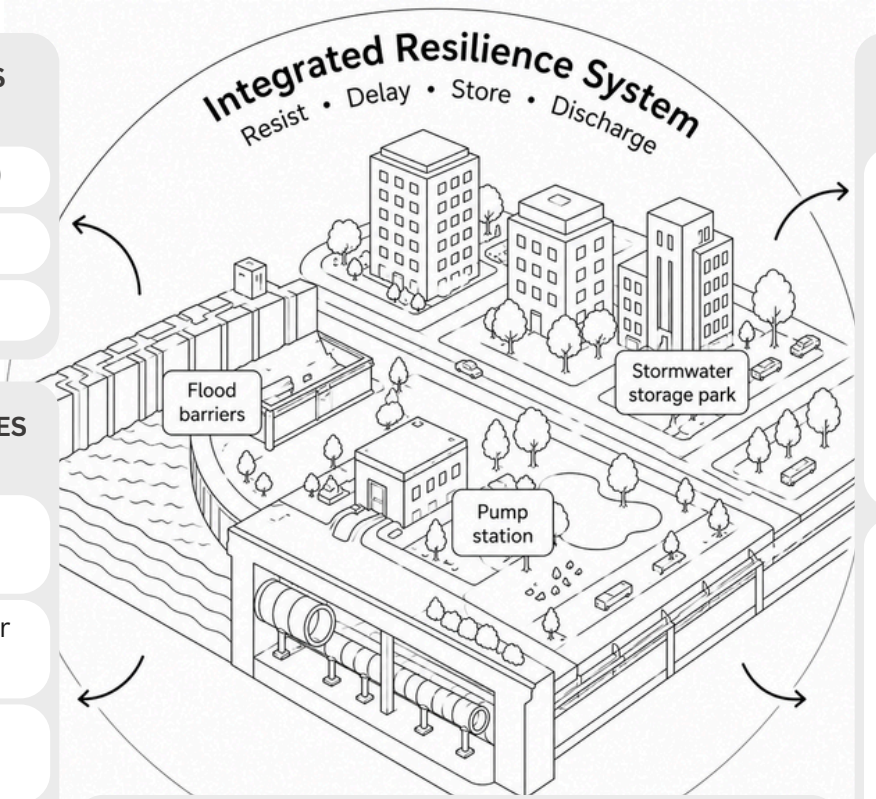
Figure 1. Anatomy of a resilience project

SHOCKS & STRESSES ADDRESSED

- Coastal flooding (shock)
- Extreme rainfall (shock)
- Sea-level rise (stress)

SYSTEMS & STRATEGIES

- Flood barriers & deployable walls
- Parks & public spaces for stormwater storage
- Upgraded drainage & high-capacity pumps
- Redesigned streets & green infrastructure



KEY OUTCOMES

Community Impact

- Less flooding
- Safer, more reliable neighborhoods
- Protected transportation access

Financial Value

- Avoided emergency repair costs
- More stable property values
- Reduced long-term fiscal risk

LAYERED FINANCING

- Federal disaster recovery grants
- State low-interest loans
- Local capital aligned with land-use planning

CORE PRINCIPLE:

Resilience projects maintain performance through shocks and stresses, integrate multiple systems, and use layered financing to deliver co-benefits reducing risk, improving reliability, and protecting long-term community and economic stability.

What Resilience Finance Means in This Guide

In this guide, resilience finance means the practice of translating risk reduction and system performance into structures that can support investment decisions. It is not one financing tool, one funding source, one type of investor, or one type of infrastructure. Instead, it includes the full range of public, private, and mission-driven tools that communities use to fund and finance resilience, including:

- Bonds
- Utility rates and fees
- Taxes
- Special districts
- Grants
- Capital improvement plans
- Mission-driven and catalytic capital
- Philanthropy
- Green banks
- Community development financial institutions (CDFIs) and other community development lenders
- Insurance
- Public-private partnerships
- Outcome-based financing and risk-transfer tools, where appropriate for the project

The central question is not "what is the most innovative financing tool?" Rather, it is "what does each part of the project need to move forward?" One component may need a repayment source; others may need public funding or predevelopment support. Some will require insurance recognition, a stronger evidence base, a public vote, an interlocal agreement, or a governance structure that can coordinate beneficiaries across a district or system.

Resilience finance therefore starts before the financing tool is chosen. It begins with the structure of value: what is being protected, who benefits, who can pay, what evidence will be trusted, who has authority to act, and what gaps must be closed before capital can participate.



What This Guide Is and Is Not

This guide is a translation framework. It helps local governments, public agencies, and capital providers describe resilience in terms that can support decisions about budgets, grants, debt, insurance, rates, fees, districts, public-private agreements, and mission-driven capital. It is also a structuring guide. It helps readers identify which parts of a resilience project may be financeable, which parts are likely to require public funding or subsidy, and which parts need stronger evidence, clearer authority, additional partners, or policy change.

This guide is not a promise that every important resilience investment can or should be privately financed. Many essential investments protect lives, health, essential services, vulnerable communities, ecosystems, cultural resources, and long-term community stability in ways that do not create a direct revenue stream or a return private capital can capture. In those cases, public funding, grants, utility revenues, taxes, philanthropic support, concessional capital, or mission-driven investment may be the right tools. Nor does this guide assume that capital markets already price resilience perfectly—they do not. Some mechanisms discussed here are emerging, specialized, limited, or highly context-specific. Where a financing tool is not yet routine, this guide says so explicitly.

The guide is intentionally practical. Use it to distinguish early between the parts of a project that can support financing, the parts that need public or concessional funding, and the gaps that require stronger evidence, clearer authority, aggregation, partnerships, or a different structure.

This guide also assumes that financing comes after a foundational step: systemic risk assessment. Communities first need to understand which systems are exposed, what must keep working, who and what is vulnerable, and what future conditions those systems must withstand. That work is essential, but it is not treated in depth here because strong resources already exist to support it, several of which are highlighted in this guidebook.

Teams that have not yet completed a systemic risk assessment are encouraged to begin there before using the financing diagnostic in ***Chapter 1*****.**

Finally, this guide focuses primarily on what local governments and public institutions can do. That focus is intentional. The cost of resilience far exceeds what grants alone can cover, and local governments play a central role in shaping the projects, policies, authorities, revenue tools, partnerships, and capital stacks needed to move resilience from planning to implementation.

At the same time, community-scale resilience is not created by government alone. Household and business decisions are among the most important drivers of how well a community withstands and recovers from disruption. Whether families can afford insurance, retrofit their homes, evacuate safely, absorb income loss, or return after a disaster affects neighborhood recovery, housing stability, school continuity, and the local tax base. Whether businesses can protect their buildings, equipment, inventory, data, and supply chains; keep operating; support workers; and reopen quickly affects employment, essential services, local revenues, and economic recovery. These private decisions compound across a community; they can either reduce systemic vulnerability or deepen it. This guide recognizes those actors as essential to resilience, but focuses on the public and institutional financing structures that local governments can shape directly.

How to Use This Guide

The Resilience Finance Guide is organized around a simple set of questions:

- What system must keep working?
- Where does the value of resilience show up?
- Can any of that value support funding or repayment?
- What proof is needed?
- Who has the authority and capacity to act?
- How do you align capital to move your project forward?

Those questions form the backbone of this guide. They help practitioners move from resilience goals to financeable projects by testing value, capture, proof, authority, and feasibility before choosing a funding or financing tool.

The guide is intentionally practical. It does not assume every resilience investment should generate a direct financial return. Some investments protect life, health, essential services, public trust, cultural resources, ecosystems, and community stability in ways that warrant public funding or policy action even when no dedicated revenue stream exists. The purpose is to make distinction early between which parts of a project can support financing, which parts need public or concessional funding, and which gaps require better evidence, stronger authority, aggregation, partnerships, or a different structure.

The most useful way to engage with this guide is to bring a real project, program, district, infrastructure challenge, public facility , or system and ask five questions before choosing a financing mechanism.

If you need to...	Go to...
Test whether a project is financeable as structured	Chapter 1
Explain how resilience creates financial value	Chapter 2
Understand how different capital providers evaluate resilience	Chapter 3
Choose tools and assemble a funding and financing strategy	Chapter 4
Learn from examples and case studies	Chapter 5

Where different readers may want to start

Suggested starting points by role.



ELECTED OFFICIALS & SENIOR LEADERS

Start with the big picture and the case for action.

Start with

Intro, Ch. 1, Ch. 2, and Ch. 5



FINANCE DIRECTORS, BUDGET OFFICERS & MUNICIPAL ADVISORS

Focus on structure, tools, and capital strategies.

Start with

Ch. 1, Ch. 3, and Ch. 4



PUBLIC WORKS, PLANNING, RESILIENCE & EMERGENCY MANAGEMENT STAFF

Understand value, evidence, and what capital looks for.

Start with

Ch. 1 and Ch. 2, then Ch. 3



COMMUNITY DEVELOPMENT, HOUSING, OR NONPROFIT PRACTITIONERS

Center community value, benefits, and partnership models.

Start with

Ch. 1, Ch. 2, and Ch. 5



INVESTORS, FUNDERS, INSURERS, COMMUNITY DEVELOPMENT FINANCIAL INSTITUTIONS & INTERMEDIARIES

Focus on structure, tools, and capital strategies.

Start with

Ch. 2, Ch. 3, and Ch. 5

Glossary of Key Finance Terms

This glossary defines the core finance and risk terms used throughout the guide. These terms are included because they shape how resilience projects are evaluated, structured, funded, financed, and explained. A project may create real public value, reduce risk, support repayment, attract capital, or justify public funding—but each of those claims means something different and requires different evidence, authority, partners, or financing structures. Using these terms precisely helps readers understand what a resilience project can support, what still needs to be proven, and what kind of funding or financing role may be appropriate.

Term	What it means in this guide
Funding	Money that does not have to be repaid, such as grants, appropriations, taxes, fees, or philanthropic support.
Financing	Money provided upfront that must be repaid over time, usually through rates, fees, taxes, assessments, contract payments, or other revenue.
Public funding	Government money used to pay for public benefits, especially when benefits are broad, shared, or not linked to a specific repayment source.
Repayment source	The money that will be used to pay back debt or financing, such as utility rates, stormwater fees, property taxes, district revenues, or contract payments.
Revenue-supported	Backed by an identified revenue stream that can support repayment or cost recovery.
Valuable	Creates meaningful public, social, environmental, or economic benefit, whether or not that benefit can be captured financially.
Beneficiary	A person, institution, utility, business, agency, or community that receives value from a project, whether or not they pay for it.
Fundable	Can justify public, grant, or philanthropic spending based on public benefit, even without repayment.
Financeable	Can support cost recovery, repayment, or structured capital because there is a credible path to recoup investment over time.
Bankable	Meets a lender's requirements, including a creditworthy borrower, a legally pledgeable repayment source, and enough evidence to support a loan.
Investable	Fits the risk, return, timing, and scale requirements of a specific investor or capital provider.
Cost recovery	A way to recover project costs over time through rates, fees, taxes, assessments, savings, or contract payments.

Term	What it means in this guide
Dedicated revenue	Money legally or administratively set aside for a specific purpose, such as a stormwater fee, utility rate, assessment, or tax increment.
Monetizable	Could produce cash flow or payment under the right conditions, but has not yet done so.
Monetized	Has produced an actual payment, savings, premium reduction, rate recovery, tax increment, contract payment, or other verified revenue stream.
Value capture	A way to turn some of the value created by a project into funding or repayment, such as a fee, tax, assessment, rate, district revenue, or shared contribution.
Capital stack	The mix of funding and financing sources used to pay for a project, with each source playing a different role.
Enabling authority	Legal permission for a public entity to use a tool, raise revenue, borrow money, create a district, enter a contract, or deliver a project.
Concessional capital	Repayable capital offered on more flexible or favorable terms than conventional financing, such as lower interest rates, longer repayment periods, or subordinate repayment.
Catalytic capital	Flexible or risk-tolerant capital used to unlock other funding or financing that would not participate on its own.
Predevelopment	Early work needed before a project can attract funding or financing, such as scoping, design, benefit analysis, legal review, community engagement, permitting, and financial structuring.
First-loss or de-risking layer	Capital that absorbs early losses or uncertainty so other lenders, investors, or funders are more willing to participate.
Benefit-cost analysis	A method for comparing a project's expected benefits with its costs; in resilience, it may miss benefits that are long-term, uncertain, distributed, or tied to future climate conditions.
Expected annual loss	The average yearly loss expected from a risk, based on probability and potential damage.
Avoided loss	Damage, disruption, or cost that does not occur because a resilience investment reduced risk.
Tail risk	Low-probability, high-consequence risk that may not dominate average loss estimates but can overwhelm budgets, reserves, infrastructure, or recovery capacity.
Risk transfer	A tool, such as insurance or a catastrophe bond, that shifts defined financial losses from a local government to another party in exchange for a premium or payment.

The Resilience Finance Chain

Figure 2 on the next page shows resilience finance as a chain of decisions, not a single tool or transaction—and provides a roadmap for the chapters that follow. The work begins with understanding system risk, then moves through value, capture, evidence, authority, capital alignment, and implementation. Each step helps answer a different question: what must keep working, where value appears, whether it can support funding or repayment, what proof decision-makers need, who has authority to act, and what financing role each source of capital can realistically play.

This chain is also aspirational. Resilience finance is still an emerging discipline, and not every project will move through each step cleanly. Some will stall because evidence is incomplete, authority is unclear, benefits are hard to capture, or the financing structure does not yet exist. But the path matters. The more local governments, capital providers, insurers, philanthropies, and technical partners test these approaches, close gaps, and share what they learn, the closer we get to a future where resilience can be planned, financed, implemented, and sustained. That is why this guidebbook exists: to help communities build resilience before disruption becomes disaster.



Figure 2. The Resilience Finance Chain



Systemic Risk Assessment

Define the hazards, exposed systems, vulnerabilities, and dependencies. Identify what infrastructure and services must keep working and the future conditions they must withstand. Set the risk scope and clear problem definition before choosing solutions.

What It Produces

- Risk priorities and scope
- Mitigation options assessed
- System and service definition
- Future-conditions baseline



Identify and Assess Value

Estimate the full range of benefits the investment creates: avoided loss, service continuity, faster recovery, lower long-term costs, workforce reliability, and co-benefits. Map who benefits and how value shows up across households, businesses, utilities, agencies, insurers, and the tax base.

What It Produces

- Benefit map
- Value inventory across 6 pathways
- Who benefits and how
- Wrong-pocket problem identified



Value Capture

Determine whether identified value can support repayment, shared funding, or public finance. Distinguish what can be financed through rates, fees, taxes, assessments, or avoided costs from what needs grants, subsidy, or voter authorization because it protects broad public welfare.

What It Produces

- Capture pathway or public-value case
- Repayment logic
- Financing vs. funding split
- Beneficiary contribution map



Evidence for Decision-Making

Build credible proof that the investment will change how a system performs under stress. Match evidence to the decision and audience: engineering analysis, benefit-cost analysis, lifecycle cost, operational data, modeled loss reduction, verified standards, or insurance recognition.

What It Produces

- Evidence and analysis package
- Benefit-cost results
- Investment case
- Audience-matched proof

Authority, Governance, and Feasibility

Confirm legal powers, governance structure, procurement path, approvals, disclosure requirements, and political feasibility. Identify what must change before financing can proceed. Align agencies where systems are interconnected across jurisdictions.

What It Produces

- Decision authority confirmed
- Roles and responsibilities
- Governance plan
- Approval and procurement pathway

Capital Alignment

Match each project component to the right funding or capital role. Structure the stack: senior repayment, public funding, catalytic capital, philanthropy, insurance solution, grants. Assign roles so each source does the job it is suited for, not the whole project.

What It Produces

- Financing strategy
- Capital stack
- Role map by capital type
- Risk and gap allocation

Implementation, Results, and Performance Proof

Deploy capital, deliver the project, and track actual risk reduction, system performance, and financial outcomes. Measure results against the claims made in earlier links. Feed verified performance back into future project development, insurance pricing, credit analysis, and the evidence base for the investment cycle.

What It Produces

- Delivered project
- Measured risk reduction
- Financial outcomes verified
- Proof feeds next cycle
- Stronger evidence base

GUIDEBOOK REFERENCE: The links in this chain connect to the guide's core concepts. **Chapter 1** diagnoses what is missing; **Chapter 2** explains resilience value; **Chapter 3** builds your capital evaluation tools; Chapter 5 applies the full chain in practice.

Chapter 1. Identifying What is Financeable

Main Messages

Start with the system that must keep working, not with the financing tool.

Define the future conditions under which the project must perform.

Map who benefits and how value shows up across the community, economy, infrastructure, and public budget.

Determine whether any of that value can be captured through rates, fees, taxes, special assessment districts, tax increment financing districts, avoided costs, shared contributions, grants, or voter-approved public finance.

Build credible proof that the project will reduce risk or improve performance.

Confirm legal authority, governance, approvals, and market feasibility before committing to a financing path.

Match each funding or financing source to the role it is best suited to play.

Use public funding, catalytic capital, aggregation, partnerships, or policy change when value is real but not yet financeable.

The Resilience Finance Diagnostic

This chapter provides a practical diagnostic that project teams can use to test whether a resilience project is financeable as structured and, if not, what needs to change. The goal is to make the right distinction early: which parts of a project can support financing, which parts need public or concessional funding, and which gaps require stronger evidence, authority, governance, or partners. Answering these questions before a project is fully designed can prevent local governments from forcing the wrong financing tool onto the right public investment.





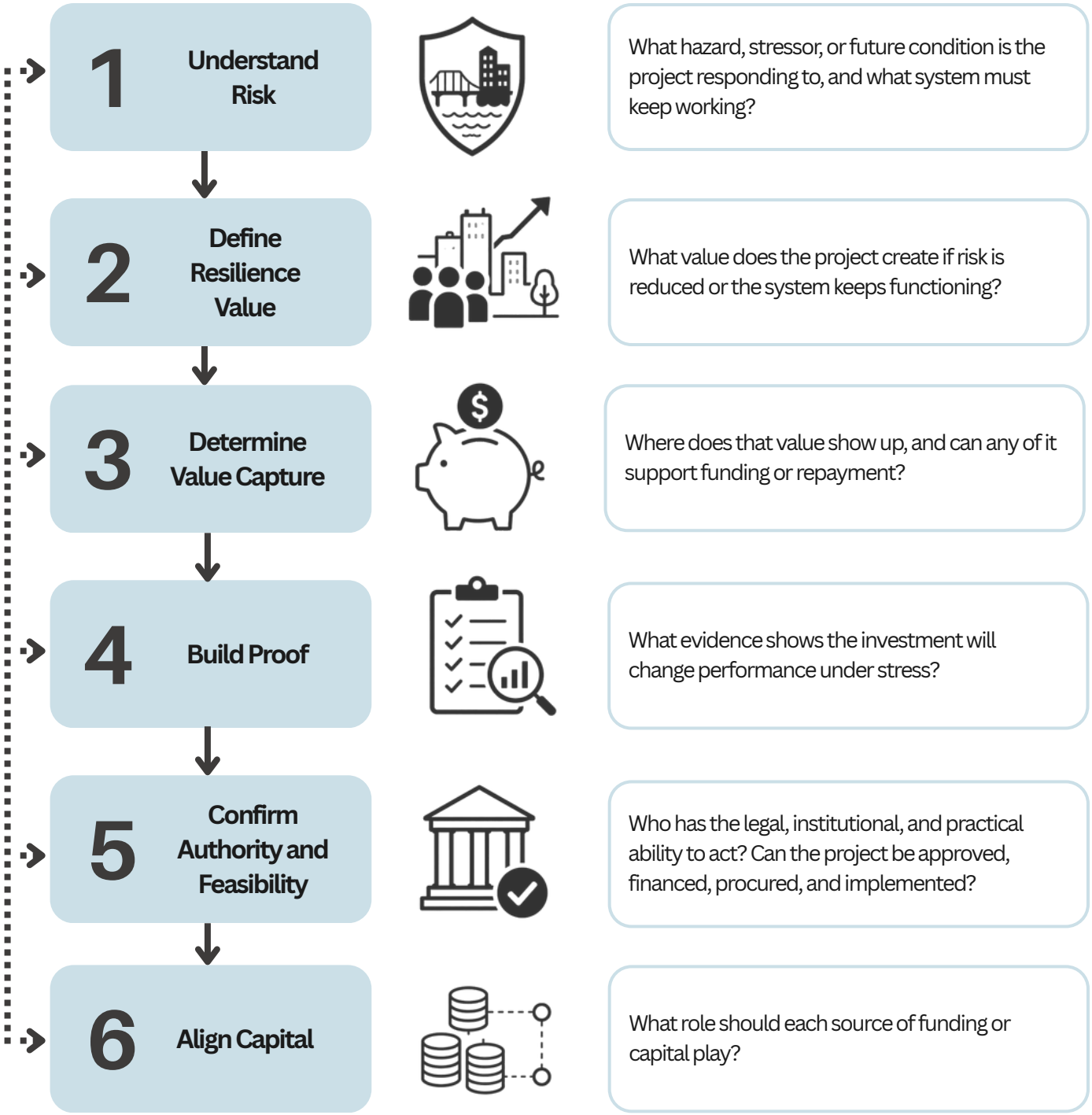
The Resilience Finance Diagnostic has six steps:

1. Start with system risk and future conditions.
2. Identify where the value appears.
3. Determine whether value can be captured.
4. Establish credible proof.
5. Confirm authority, governance, and market feasibility.
6. Align capital.

At each step, the question is whether the project still holds together from a finance perspective. If not, the diagnostic helps identify what is missing: a clearer risk problem, a stronger value proposition, a way to capture value, credible evidence, legal authority, implementation capacity, or a better capital match.

The goal is not to force every resilience project into private finance. The goal is to clarify what kind of funding, financing, partnership, or public action is actually needed.

Figure 3. From Resilience Goal to Financeable Project



Note: Capital alignment comes last, but project teams should revisit earlier steps when new evidence, partners, or constraints change the project structure.

Funding versus Financing: A Critical Distinction

Funding refers to who ultimately pays for a project. This may include grants, public budgets, taxes, utility revenues, philanthropy, ratepayer support, or other public or private sources of repayment.

Financing refers to how capital is provided upfront to build or implement a project. This may include bonds, loans, public-private partnerships, or other financing structures that provide capital today and are repaid over time.

Many resilience projects use both funding and financing. For example, a bond may finance upfront construction costs, while taxes, utility rates, fees, or other revenues ultimately fund repayment over time.

A project can create significant public value and still not be financeable as structured unless there is a credible way to repay or recover costs. Recognizing this distinction early helps communities avoid forcing financing onto projects better suited for grants or public funding, or assuming public funding alone is the only option when parts of a project may support financing.



Who Needs To Be at The Table

The Resilience Finance Diagnostic is a team sport. The most common reason projects stall at the structure phase is that the right people were not in the room when key questions were raised.

The minimum project team for a resilience financing project includes:

- Project owner(s)—public works, utility, resilience, planning, or emergency management: Defines the risk, the system, and what must keep working
- Finance and budget office: Tests repayment, debt capacity, and capital plan fit
- Legal and bond counsel: Confirms authority to raise revenue, issue debt, form districts, and enter long-term agreements
- Procurement: Ensures the financing structure is compatible with how the community contracts for design, construction, and operations
- Grants and federal funding staff: Identifies programs and matches requirements, timing, and eligibility constraints
- Community engagement and equity staff: Ensures the project reflects the needs and priorities of affected communities, especially those most exposed to risk
- Owner or operator of the infrastructure, facility, or system: provides operational data and commits to long-term maintenance
- External engineer or technical consultant: Supplies credible hazard, performance, and cost data
- Municipal advisor or financial advisor (when debt or capital markets are involved): Structures the financing and evaluates market conditions

The goal is not to create a permanent new committee for every project. It is to make sure the project is tested early —across risk, value, proof, authority, and feasibility—before design locks in a structure that will not work.



Diagnostic Worksheet for Project Teams

	Step	Core Question	What Local Governments Need To Produce
	1 Understand Risk	What hazard, stressor, or future condition is the project responding to, and what system must keep working?	A clear definition of the system, asset, neighborhood, service, or economic activity being protected; the people and places exposed; and the future conditions the project must perform under.
	2 Define Resilience Value	What value does the project create if risk is reduced or the system keeps functioning?	A value map that identifies avoided losses, service continuity, faster recovery, asset protection, public health, economic stability, community benefits, and other resilience outcomes.
	3 Determine Value Capture	Where does that value show up, and can any of it support funding or repayment?	A benefit-and-beneficiary map that distinguishes public value, shared value, revenue or cost value, and market or investor value.
	4 Build Proof	What evidence shows the investment will change performance under stress?	Engineering analysis, risk modeling, operational data, financial analysis, benefit-cost analysis, life-cycle cost analysis, insurance evidence, or verified standards that support the project's claimed benefits.
	5 Confirm Authority and Feasibility	Who has the legal, institutional, and practical ability to act? Can the project be approved, financed, procured, and implemented?	A check on debt authority, rates, fees, taxes, assessments, special districts, procurement rules, interlocal agreements, disclosure requirements, voter approvals, governance capacity, delivery capacity, and unresolved implementation constraints— - including confirmation that operations and maintenance costs have an identified, durable funding source.
	6 Align Capital	What role should each source of funding or capital play?	A financing strategy that matches each project component to the right role: public funding, grants, voter-approved finance, rates or fees, special assessments, philanthropic or concessional capital, private capital, insurance-related value, or other sources—with a plan for gaps that cannot yet be financed.

How to Test Whether a Resilience Project Can Be Financed

Step 1. Start with Understanding Risk

Purpose: Define the system that people depend on, the conditions it must withstand, and who is exposed when it fails.

The first step is identifying at a practical level the infrastructure system, neighborhood, public service, or economic activity that people depend on to function and grow. Resilience is not only about preventing disruption. It is about ensuring that systems continue to perform as climate, demand, land use, and operating conditions change. A systems lens also reveals how failures cascade across sectors, such as when flooding interrupts transportation, power, hospital access, emergency response, or business operations.

What this step produces: A working definition of the system, asset, neighborhood, service, or economic activity being protected; the people and places exposed; and the most relevant future conditions the project must perform under.

Example—Protecting a critical transit system: After 2012's Hurricane Sandy, the Metropolitan Transportation Authority (MTA) launched a multibillion-dollar repair and resilience program to help the New York regional transit system withstand future storms. MTA reported a $7.6 billion post-Sandy program for repairs and coastal flood protection, while Federal Transit Administration awards included funding for flood protections at subway yards, substations, tunnel portals, street-level openings, stations, pump systems, and bus depots (MTA n.d.; FTA 2014). The example shows how a transit agency can frame resilience as protecting system performance, regional mobility, and the economic activity that depends on its service. (MTA 2012)

Resources: Understanding Systemic Risk

An important resource that complements this systems-based approach is *Built to Endure: A Smart Guide for US Cities to Build Resilient Infrastructure That Lasts* (Losos et al. 2026), developed through a collaboration among Duke University, Bentley Systems, AECOM, ASCE, and Microsoft. The guide encourages communities to move beyond isolated asset-by-asset approaches and instead evaluate how interconnected infrastructure systems perform under future climate stress. It also provides practical guidance on using shared data, systems thinking, scenario analysis, digital tools, and cross-jurisdictional coordination to support more resilient long-term infrastructure planning.

ICLEI USA's community resilience assessment tools and climate adaptation programs provide structured approaches for local governments assessing system-wide vulnerability. *NOAA's Climate Resilience Toolkit* offers additional frameworks for understanding physical, social, and economic exposure across communities, as well as the places, infrastructure, facilities, services, and economic resources they depend on.

Step 2. Identify Where the Value Appears

Purpose: Identify who benefits from improved system performance and how that value shows up.
Once the system and future conditions are understood, the next step is identifying where the value of risk reduction appears. Resilience investments often affect multiple parts of a community at once. Flood mitigation may stabilize property values, reduce expected claims, protect businesses from interruption, preserve emergency access, and reduce public repair costs. Water supply investments may lower treatment costs for utilities, reduce pollution and contamination risk, maintain service reliability for households and industry, and protect regional economic activity. The goal is to map who benefits, and how.

This step should include financial value and community value. Some benefits can support financing: revenues protected, costs avoided, assets preserved, or insurance risks reduced. Other benefits may be human, social, or public: fewer injuries, better health outcomes, stronger quality of life, less displacement, and more reliable access to essential services. Those benefits may not create a dedicated revenue stream, but they can still justify public funding, voter-approved bonds, or policy changes.

What this step produces: A simple map of who benefits, how they benefit, and where value appears across the system.

Community Conditions and Unintended Consequences Matter

Resilience investments do not occur in a vacuum. The same climate event can affect communities very differently. In many places, areas facing the highest climate and disaster risks are also communities with aging infrastructure, limited financial reserves, higher cost burdens, or long histories of underinvestment.

These conditions matter because they affect whether resilience investments actually reduce disruption, support long-term stability, and avoid creating new vulnerabilities or unintended harms. A project that protects one area while increasing costs, displacement pressure, service inequities, or fiscal burdens elsewhere may weaken overall community resilience even if the infrastructure itself performs as designed.



Project teams should therefore examine not only where benefits appear, but also how costs, risks, and trade-offs are distributed across households, businesses, neighborhoods, and institutions.

Questions to consider may include:

- Who benefits from the project, and who ultimately pays for it?
- Which households, businesses, or critical services remain exposed if the project does not move forward?
- Could fees, rate increases, insurance requirements, or special assessments create affordability pressures for residents or small businesses?
- Could redevelopment or rising property values increase displacement risk or reduce access to housing and services?
- Are there communities or systems that may require additional public, philanthropic, or concessional support because local fiscal capacity is limited despite high levels of risk?

These questions are not separate from finance or project structuring. They are part of understanding whether a resilience strategy will be durable, publicly supportable, and effective over time.

Example—Value distributed across many actors in Annapolis, MD: The City of Annapolis's historic downtown waterfront district experiences regular tidal flooding that disrupts businesses, damages, property, corrodes infrastructure, and closes public facilities. To combat this, the city has invested in seawall repairs, storm drain improvements, and roadway elevations. The value of reduced flooding appears differently depending on who is looking. For the city, it means lower emergency response and repair costs, more reliable parking and utility revenues, and a protected tax base in a district that generates a disproportionate share of municipal revenue. For property and business owners, it means fewer closures, lower damage claims, reduced insurance exposure, and more stable operating conditions. For insurers, it means lower expected claims frequency in a concentrated, high-value area. For the state transportation and utility systems that run through the district, it means fewer disruptions to shared infrastructure. No single actor captures enough of that value to pay for the full investment alone, but mapping where value lands across each is what makes the case for shared funding structures, a special assessment district, or a combination of city capital, state grants, and federal hazard mitigation dollars. The value is real and distributed.

Step 3 is where the team asks whether any of it can be captured. (City of Annapolis n.d.a; City of Annapolis n.d.b; Torre and Mason 2023)



Step 3. Determine Whether Value Can Be Captured

Purpose: Determine whether any of the value can support financing or shared funding.

This step is not about first choosing a tool. It is about determining whether a capture pathway exists:

- Can the value identified in Step 2 translate into revenues, cost savings, avoided costs, protected economic activity, shared contributions, or public support that can sustain investment?
- Is this primarily a protective resilience project or resilience embedded within a broader investment?

Some resilience projects are designed primarily to reduce risk and protect people, assets, or systems from disruption—including transportation, water, stormwater, energy, digital infrastructure, public facilities, housing, and environmental or natural infrastructure—as well as the broader systems that depend on them. Projects such as flood barriers, wildfire fuel breaks, heat refuges, and buyouts often create value mainly through avoided losses, public protection, and reduced disruption. These projects' benefits may be substantial but diffuse. They often rely more heavily on public funding, grants, taxes, mandates, or concessional capital because results are broad, shared, and difficult to tie to a dedicated repayment stream.

Other projects embed resilience within housing, water, energy, transportation, redevelopment, or utility investments that already support economic activity or operating revenue. These projects may also reduce costs, improve service reliability, extend asset life, stabilize revenues, or support broader community and economic goals in ways that align with existing capital plans and financing structures. A stormwater upgrade embedded within a utility rate structure may be easier to finance than the same investment framed solely as a standalone flood project. A wildfire-resistant roof standard integrated into housing development may be easier to finance than a separate community firebreak.

The Resilience Finance Diagnostic helps clarify which type of project is being pursued and what financing pathway may be most realistic. Projects focused primarily on protection often require stronger public, philanthropic, or concessional support because their broad benefits are difficult to monetize directly. Projects that embed resilience within existing infrastructure, redevelopment, or service systems may be better positioned to align with revenue-supported financing approaches.



Figure 4. Protective versus multi-benefit resilience projects

Why some projects need public funding—and others can unlock broader value

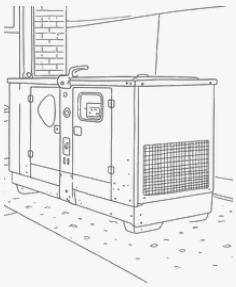
PROTECTIVE RESILIENCE PROJECTS

Investments whose primary purpose is to **reduce risk, protect people and assets**, and increase the ability to withstand disruption so recovery is faster.

Tsunami Evacuation Tower
Provides safe vertical evacuation during tsunami events.



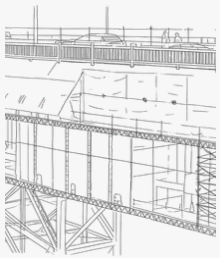
Generator for Critical Facilities
Provides temporary power to keep critical facilities operating during extended outages.



Home Elevation
Reduces flood damage by elevating a structure above expected flood levels.



Soft-Story Retrofit
Strengthens weak open ground floors to improve earthquake performance and prevent collapse.



MULTI-BENEFIT RESILIENCE PROJECTS

Investments that reduce risk while also providing **broader community, economic, environmental, or operational benefits** that support adaptation, recovery, and long-term thriving.

Community Resilience Hub
Provides services daily; serves as a shelter, cooling center, and staging site in disasters.



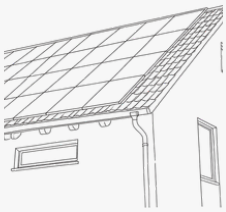
Green Infrastructure
Enhances livability and manages stormwater while improving urban environmental quality.



Elevated Transit Infrastructure
Improves mobility and supports economic activity while withstanding flooding.



Solar + Storage Microgrid
Provides clean energy and ensures reliability during outages.



PROTECTIVE RESILIENCE PROJECTS **Key Characteristics**	MULTI-BENEFIT RESILIENCE PROJECTS **Key Characteristics**
Primary goal is protection	Delivers resilience plus other benefits
Benefits are most visible during disruptions or emergencies	Generates value in normal times and during disruptions
Often protects public health, safety, and the environment	Supports economic activity, community goals, adaptation, and system performance
Often avoids losses and supports faster recovery	Multiple value streams may support financing
FOCUSED ON BUILDING THE ABILITY TO WITHSTAND Essential for reducing risk, protecting communities, and enabling faster recovery after shocks.	BUILDS RESILIENCE WHILE ADVANCING BROADER GOALS Integrates resilience with adaptation, everyday value, and community thriving.

BOTH TYPES MATTER

Protective projects provide essential risk protection. Multi-benefit projects integrate resilience into everyday systems and can unlock added value and financing opportunities.

In many cases, resilience investments protect systems that already generate economic activity or operating revenue. A more reliable water system may stabilize utility operations and treatment costs. Flood protection may preserve property values and the tax base that supports municipal services. Energy resilience investments may reduce outages that disrupt businesses or critical public services. When these financial effects exist, resilience investments can often be incorporated into existing capital planning, utility finance, district finance, or public debt structures.

In other cases, value is distributed across multiple beneficiaries. A flood mitigation project may protect homes, businesses, transportation infrastructure, municipal services, and insurers at the same time. If no single entity captures enough value to pay alone, the financing strategy may require multiple contributors, such as utilities, developers, public agencies, philanthropy, state programs, and community-serving lenders. Insurers are different from traditional investors: they often support resilience by rewarding verified risk reduction through pricing, coverage, underwriting, or standards, rather than by directly paying for a project. In some cases, however, insurers or insurance-linked vehicles may also help mobilize capital for resilience.

Scale and time horizon also matter. Many resilience investments are individual projects tied to specific sites, although capital providers may prefer portfolios, programs, or infrastructure systems. Aggregating projects across districts or networks can make investment easier to evaluate.

Similarly, resilience benefits often accrue over decades, although financing structures may require clearer near-term revenue or budget signals. Recognizing these constraints early helps project teams determine whether value can support financing directly, must be combined across beneficiaries, or requires public funding or policy tools.

What this step produces: A clear view of whether value can translate into revenue, cost savings, shared funding, public finance, or voter support, and whether a viable financing pathway exists.

Example—Aggregating value across beneficiaries: Wildfire mitigation in forested watersheds benefits many actors at once, including water utilities, communities exposed to wildfire risk, federal land managers, insurers, and downstream infrastructure owners. The Forest Resilience Bond model, first developed by Blue Forest, addresses this problem by aggregating beneficiary contributions and investor capital to fund forest restoration and wildfire-risk reduction (Blue Forest 2026a, 2026b). In California's Yuba River watershed, the Yuba Water Agency supported the first Forest Resilience Bond pilot with a $1.5 million cost-share contribution, helping leverage additional capital for forest management work. The US Environmental Protection Agency (EPA) describes the model as a financing structure supported by contractual payments from a downstream water utility and grants from public agencies (Yuba Water Agency n.d., EPA Water Infrastructure and Resiliency Finance Center 2021). The Yuba example also shows that aggregation depends on predevelopment work to prove who benefits, quantify avoided losses, and make those benefits legible to payors and investors.



Step 4. Establish Credible Proof

Purpose: Demonstrate that expected risk reduction is real, measurable, and durable enough to support decisions.

Narratives about generic benefits rarely satisfy finance officers, elected officials, voters, insurers, lenders, or investors. They need credible evidence that a proposed investment will change how a system performs under stress or over time. Credible proof does not mean perfect certainty. Rather, it means the project team can show a reasonable, documented link between the investment, the expected performance improvement, and the financial or public value being claimed.

Table 1. What Counts as Credible Proof

Level	Type of Evidence	What It Shows
1	Narrative claim	The project team can explain the risk and expected benefit.
2	Technical evidence	Engineering, design standards, hydrologic modeling, asset assessments, or hazard projections support the claim.
3	Operational evidence	Service interruptions, outage duration, maintenance records, emergency response data, or performance history show how the system fails and what improvement would matter.
4	Financial evidence	Life cycle–cost analysis, benefit-cost analysis, avoided repair costs, protected revenue, insurance effects, or reduced downtime show why the investment is worth funding.
5	Validated standard or market signal	A standard, inspection process, insurance recognition, rating disclosure, or investor acceptance shows that outside actors can rely on the evidence.

Note: Projects rarely need every type of evidence. The level of proof should match the decision being made, the risk being claimed, and the capital source being asked to participate.





Credible proof usually combines several types of evidence: engineering and design evidence, operational evidence, hazard and exposure evidence, financial modeling, and market or policy evidence. Financial modeling is especially important when the question is whether higher upfront costs are justified by lower long-term risk. For example, a resilient housing or building standard analysis may compare conventional construction costs, resilient construction costs, expected rebuilding costs, downtime, insurance premiums, deductibles, and avoided displacement.

The National Institute of Building Sciences finds that federal mitigation grants save about $6 for every $1 invested, and that adoption of modern building codes can save about $11 for every $1 invested. Those national ratios do not replace project-specific analysis, but they help demonstrate why local financial modeling should include avoided losses and life cycle performance rather than only upfront cost (Multi-Hazard Mitigation Council 2019).

What this step produces: A package of evidence, such as engineering analysis, modeling, performance data, life cycle–cost analysis, benefit-cost analysis, financial modeling, or verified standards, that shows the project is likely to deliver the expected risk reduction and value.

Example—Verified risk reduction in building standards: The Insurance Institute for Business & Home Safety (IBHS) FORTIFIED standard shows how resilience can be validated through performance data. A 2025 study in Alabama showed FORTIFIED homes suffered less damage and generated fewer insurance claims than conventional homes during 2020's Hurricane Sally. Results demonstrated 55% to 74% fewer claims and 14% to 40% less severe claims for FORTIFIED homes compared with noncertified homes (IBHS 2025). This example shows why credible proof matters: a standard, inspection process, and claims data can make risk reduction legible to insurers, lenders, homeowners, and public officials.



Step 5. Confirm Authority, Governance, and Market Feasibility

Purpose: Confirm the project can be implemented and financed within real-world constraints.

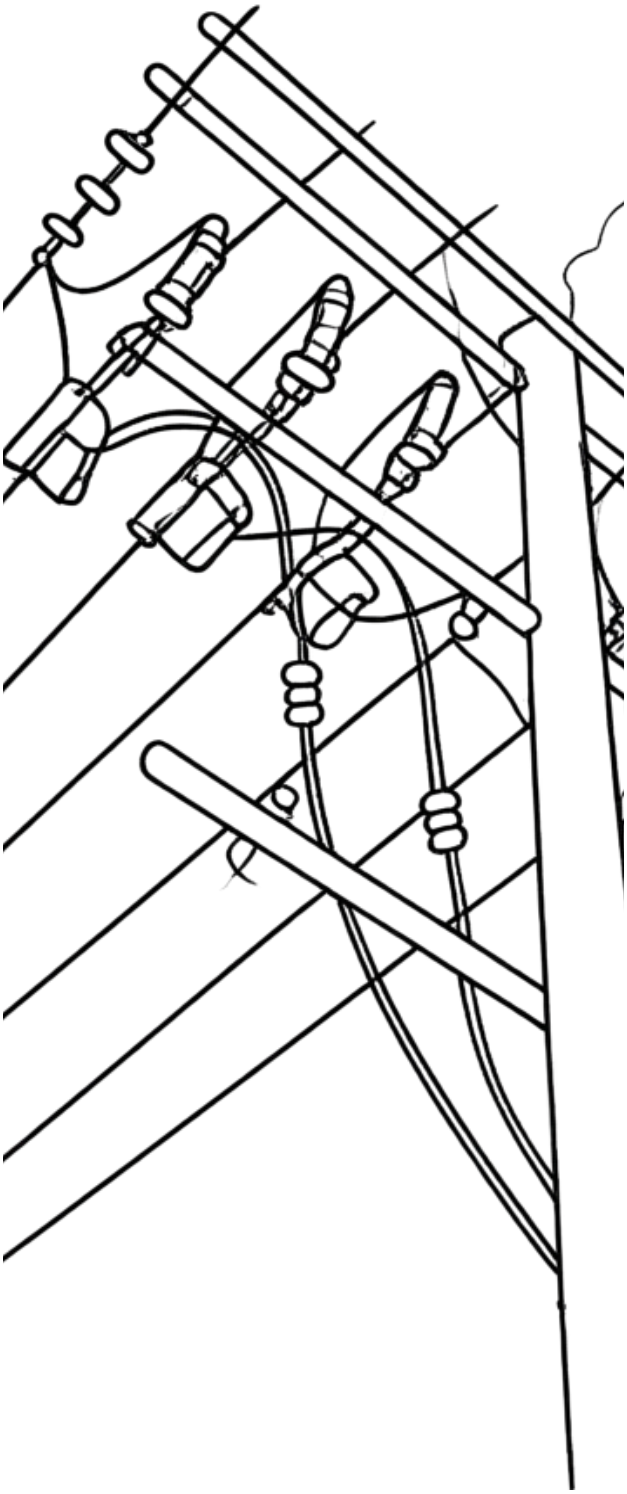
Even when a project creates value and is technically sound, project teams must confirm whether it can be implemented and financed within the jurisdiction's legal, institutional, and market conditions. Local governments operate within rules that shape whether they can issue debt, adjust rates, create districts, dedicate revenues, enter long-term contracts, or receive and deploy outside capital. These frameworks protect public resources and transparency, but they also determine which financing pathways are feasible and how quickly projects can move forward.

Project teams should confirm whether they have authority to issue municipal debt or enter long-term financing agreements; establish or adjust rates, fees, taxes, or assessments; dedicate tax revenues or create district funding mechanisms; enter contracts that support infrastructure investment over time; coordinate across agencies, jurisdictions, utilities, and private or institutional partners; and clearly disclose risks, capital plans, and long-term obligations to decision-makers and markets.

Market feasibility also depends on disclosure and governance. When governments issue bonds, investors rely on official statements and continuing disclosures to understand financial conditions, project risks, and long-term obligations.

The Municipal Securities Rulemaking Board (MSRB) Electronic Municipal Market Access website provides free access to official statements and continuing disclosures. MSRB states that continuing disclosures help investors assess the suitability of a bond and risks associated with the issuer's credit (MSRB n.d.a, b). Clear disclosure of risk management strategies, capital plans, and infrastructure condition can help show that long-term risks are understood and actively managed.

What this step produces: A determination that the project can move forward within existing authority, governance, and financing structures, or a clear list of what must change before it can move forward.



Step 6. Turning the Diagnostic into a Capital Alignment Strategy

Purpose: Match each part of the project to the funding or financing role it can realistically support, and close the gaps that remain.

The six steps of the Resilience Finance Diagnostic produce the raw material: a defined system, a benefit map, a value capture pathway, a credible evidence package, and confirmed authority. The last step assembles those into a financing strategy. The challenge is less about finding more money and more about matching each project component to the role that different funding and financing sources can realistically play while being honest about what cannot be financed, and why.

Capital alignment means assigning roles before selecting tools. Starting with the tool rather than the role is one of the most common ways resilience projects get misdirected.

Use Tools Based on How Value Can Be Captured

Existing financing tools often work when they match how value shows up. Debt works where repayment is clear. Districts work where benefits are shared geographically. Utility models work where service reliability supports rates or fees. Public funding works where the benefits are broad, diffuse, or equity-focused. Insurance can validate or transfer risk but does not usually pay for the project. The financing strategy should begin with the value pathway, not with the most familiar tool:

- Select tools based on how value can be captured, not familiarity alone.
- Structure projects so each component aligns with a funding or financing role
- Use public funding for parts of the project that produce broad public value but lack repayment capacity.

Match Capital to Role, Not to the Whole Project

Different types of capital participate for different reasons. Lenders look for repayment stability. Infrastructure investors look for asset performance and returns. Insurers look for measurable risk reduction. Philanthropy may support predevelopment, engagement, equity, or first-loss support. Public funding may cover broad benefits or gaps that the market cannot finance. A project can move forward when these roles are clearly assigned across the system.

Solutions:

- Match debt to stable revenues, cost savings, or legal repayment sources.
- Use private and institutional capital where assets generate or protect long-term returns.
- Use insurance to validate and transfer residual risk where appropriate.
- Reserve public, philanthropic, and catalytic capital for gaps, predevelopment, first loss, and systemwide benefits.

Close the Last-Mile Gap

Many projects stall in the last mile. The value exists, but it does not fully translate into finance. A portion of the project may not generate revenue. Benefits may be too diffuse. Risks may not be sufficiently proven. Authority may be unclear. These gaps can be small relative to total project cost, but decisive for implementation.

Solutions:

- Match debt to stable revenues, cost savings, or legal repayment sources.
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Solutions:

- Close gaps with targeted public funding, philanthropy, or catalytic capital.
- Adjust rates, fees, project scope, procurement, or governance to strengthen alignment.
- Separate financeable components from components that require public-value justification.
- Aggregate benefits across districts, systems, and partners.

Address Institutional Constraints Early

Legal limits on revenue, debt, procurement, and governance are not side issues. They are part of the finance strategy. Projects succeed when teams account for these constraints early rather than discovering them after technical design is complete.

Solutions:

- Confirm authority to raise revenue, issue debt, enter long-term agreements, or form districts before design locks in a structure that will not work.
- Identify alternative entities or partners when one agency lacks authority to act.
- Engage residents, ratepayers, voters, and elected officials when projects require public support.
- Align agencies and jurisdictions where systems are interconnected.

Use Catalytic Capital to Unlock Alignment

Concessional funding, guarantees, first-loss capital, and mission-driven investment can reduce risk and improve project economics. They work best when they address a specific gap, such as predevelopment, borrower capacity, proof, scale, first loss, or a bridge to follow-on capital. They should not mask a weak structure that lacks a plausible path to repayment, governance, or implementation.

Solutions:

- Use catalytic capital to de-risk or bridge gaps that prevent participation.
- Avoid using catalytic capital to compensate for unresolved structural misalignment.
- Make clear what larger funding or financing source the catalytic layer is meant to unlock.

Recognize When Public Funding is the Right Answer

Not all resilience investments can be financed through repayable capital. Some projects generate real value but do not produce revenue, fit neatly within a district, or create a measurable return to a specific payer. Recognizing this early is a strength. It allows communities to focus financing where it works and direct public funding where it is needed.

Solutions:

- Distinguish early between financeable and nonfinanceable components.
- Make the public-value case for life safety, health, service continuity, equity, and quality of life.

- Use grants, appropriations, voter-approved bonds, or public revenues when benefits cannot be captured by a specific payer.

What this step produces: Early consideration of all project steps leads to a capital alignment strategy—a practical financing blueprint that identifies what system is being protected, where value is created and who benefits, which portions can support financing and how, which capital types are best suited to each project component, where gaps remain and how they will be closed, and who has authority to act and move implementation forward.

Table 2. Benefits of a Capital Alignment Strategy

From	To
Reacting to disasters	Reducing risk systematically
Isolated investments	Coordinated system-level strategies
Searching for funding	Structuring finance
One-time projects	Repeatable pathways for resilience investment



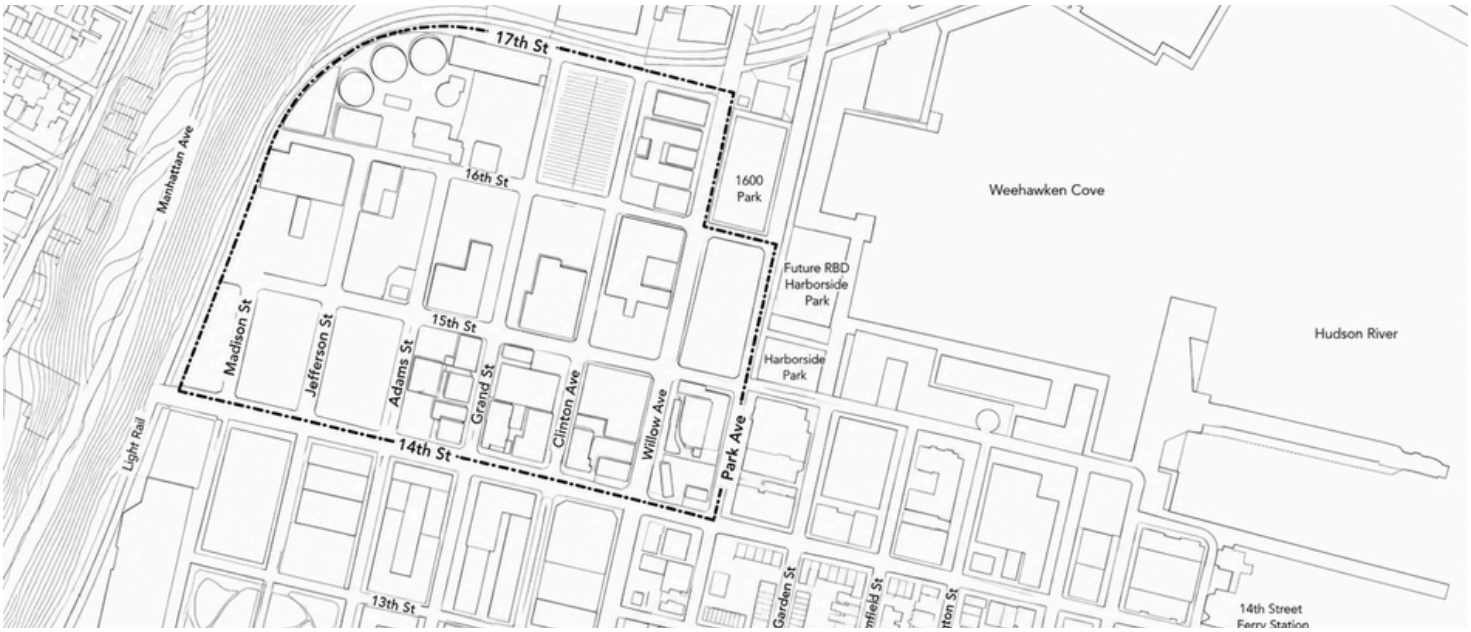
Example—Layering capital roles across a single project: After a 1,000-year rainfall event caused flooding in the St. Vrain Creek corridor in 2013, the City of Longmont, Colorado built a capital alignment strategy over more than a decade. The incremental approach assembled multiple types of FEMA funding (e.g. multiple sub-sections of Public Assistance, Pre-Disaster Mitigation; Hazard Mitigation Grant Program funds), HUD Community Development Block Grant-Disaster Recovery (CDBG-DR) dollars, US Army Corps of Engineers (USACE) cost-share, voter-approved storm drainage bonds, customer rates and fees, and Great Outdoors Colorado grants (funded from lottery proceeds).

Each layer played a specific role: federal grants covered federally eligible repair and mitigation, voter-approved bonds and storm drainage rates anchored the local match and funded above-standard design components, and state and conservation funds filled gaps that federal benefit-cost analysis (BCA) rules could not recognize (see Chapter 4 for more on federal BCA). Prepositioned governance in the form of a storm drainage utility with dedicated revenue powers made each successive layer usable as it became available. Not every community needs these many sources of capital. But alignment means knowing what role each funding source can play before it is requested (City of Longmont 2026).



Figure 5. Applying the diagnostic: Hoboken's North End

A local example of how resilience, redevelopment, mobility, and infrastructure value can be structured into a financeable strategy



Layering

- North End redevelopment area is in or near mapped flood risk
- Must support mobility, redevelopment, public space, and flood-resilient infrastructure
- Future system includes streets, transit access, drainage, and neighborhood viability

Define Resilience Value

- Redevelopment and property value growth
- Tax base growth and neighborhood vitality
- Transit access and mobility benefits
- Reduced stormwater risk and improved public space

Determine Value Capture

- Developer community benefits contributions
- District finance
- Public debt and agency capital budgets
- Shared funding across beneficiaries

Build Proof

- Redevelopment plan and engineering analysis
- Light rail feasibility study
- Flood-risk and drainage evidence
- Financial analysis of who benefits and who pays

Confirm Authority and Feasibility

- City of Hoboken
- North Hudson Sewerage Authority
- Transit and infrastructure partners
- Confirm which entity can approve, implement, and pay

Align Capital

- Redevelopment: developer contributions and district finance
- Stormwater and flood resilience: public debt, utility, and grant funding
- Mobility and public realm: transit, city, and shared capital sources

Note: Capital alignment comes last, but project teams should revisit earlier steps when new evidence, partners, or constraints change the project structure.

Example of the Full Diagnostic

Hoboken, NJ: Using the Diagnostic to Structure a District-Scale Resilience and Redevelopment Strategy

Hoboken illustrates how the six-step diagnostic can help communities structure complex, multi-benefit resilience investments that combine infrastructure protection, stormwater management, redevelopment, transportation, housing, and public space improvements.

Located on a low-lying area along the Hudson River, Hoboken faces recurring chronic flooding from coastal storm surge, intense rainfall, and sea level rise. During Hurricane Sandy, roughly 80% percent of the city flooded, disrupting transportation, damaging homes and businesses, and shutting down critical infrastructure and economic activity.

In response, Hoboken developed a citywide resilience strategy called Resist, Delay, Store, Discharge. The strategy integrates multiple infrastructure and land-use approaches across the city, including flood barriers and deployable protections for coastal surge, parks and open spaces designed to store stormwater during heavy rainfall, upgraded drainage infrastructure and pumping systems, and redesigned streets and public spaces that improve both flood performance and neighborhood quality of life.

ResilienCity Park, formerly Northwest Resiliency Park, shows how this diagnostic can work in practice. The park combines stormwater storage, pumping infrastructure, recreation space, and neighborhood revitalization in one project.

It is not simply a park with resilience benefits added on. It is a piece of public space, stormwater infrastructure, sewer-system improvement, neighborhood investment, and flood-risk reduction infrastructure designed to work together.

Step 1. Understand risk: What system must keep working?

The Hoboken example starts with system risk. The city needed streets, drainage systems, homes, businesses, public space, transportation access, and neighborhood economic activity to keep functioning during coastal storms and intense rainfall. Hurricane Sandy made the system failure visible: flooding disrupted mobility, damaged homes and businesses, overwhelmed infrastructure, and interrupted economic activity.

The diagnostic matters because Hoboken's problem could not be solved by a single asset or a single financing tool. The risk was systemic. The response therefore had to address how water moves through the city, how streets and public spaces perform during storms, how sewer and stormwater infrastructure functions under stress, and how neighborhoods continue to operate before, during, and after flood events.



Step 2. Define resilience value: What value does risk reduction create?

The value created by Hoboken's resilience investments appears across multiple beneficiaries and systems. Flood infrastructure reduces stormwater risk and helps maintain neighborhood viability. Resilient streets and public spaces improve daily quality of life while also improving flood performance. Better drainage and stormwater storage reduce disruption for residents, businesses, emergency responders, and public agencies.

ResilienCity Park makes that value visible in one completed project. The park provides recreation, open space, and neighborhood amenities in normal conditions. During heavy rainfall, it stores and manages stormwater, supports pumping and drainage functions, and helps reduce the kind of flooding that previously disrupted the city. Its value is therefore not just recreational or environmental; it also supports service continuity, avoided disruption, public confidence, and neighborhood stability.

Step 3. Determine value capture: What revenue, cost savings, or funding sources connect to that value?

The value-capture question is not whether the park itself generates a single direct revenue stream. It is whether the value created by stormwater management, flood reduction, water-quality improvements, public space, and neighborhood stabilization can connect to actual funding or financing sources.

In Hoboken, different pieces of value connected to different funding and financing pathways. ResilienCity Park was advanced through a layered approach that included federal resilience funding, local capital investment, county open space funding, and low-interest infrastructure financing through the New Jersey Infrastructure Bank .

Because the project addressed stormwater management and combined sewer overflow needs, part of the value could be tied to fundable water infrastructure categories rather than relying only on general municipal funds.

The value also shows up through avoided and protected costs. For residents and businesses, reduced flooding means fewer damaged homes and storefronts, less disruption, and more reliable access to transportation and services. For the city, it can mean reduced emergency response burden, greater confidence in long-term redevelopment and capital planning, protection of property values, and a stronger public case for continued investment. For sewer and stormwater agencies, it supports drainage performance, combined sewer overflow management, and long-term control planning.

Step 4. Build proof: What evidence supports the claim?

Before construction, the Rebuild by Design process helped establish the citywide Resist, Delay, Store, Discharge strategy and connected coastal defense, stormwater storage, drainage improvements, parks and other public-space improvements, and pumping systems into an integrated resilience approach. Grant funding helped pay for the predevelopment work needed to move resilience concepts toward implementation, including technical analysis, legal review, and financing strategy.

The proof base was reinforced through citywide resilience planning, engineering analysis, flood-risk and drainage evidence, cost estimates, infrastructure financing eligibility, and analysis of who benefits and who may be able to contribute. For ResilienCity Park, the project design demonstrates the theory of change: store stormwater, reduce pressure on the drainage and sewer system, pump water more effectively, reduce street flooding, and provide public space when the system is not under stress.

The results have also been tested after implementation. In 2025, the North Hudson Sewerage Authority and the City of Hoboken announced the installation of new stormwater pumps at ResilienCity Park capable of pumping 30 million gallons per day as part of ongoing flood mitigation efforts. During subsequent heavy rainfall events that caused flooding elsewhere in the region, Hoboken's upgraded stormwater infrastructure helped prevent the widespread flooding that previously disrupted parts of the city. Local officials and observers have referred to these moments as "the flood that didn't happen." In the language of the diagnostic, this is observed performance evidence: the project is not only expected to reduce risk; it has helped demonstrate improved system performance under stress.

Step 5. Confirm authority and feasibility: Who can approve, implement, operate, and pay?

The project also shows why authority and feasibility matter. ResilienCity Park required coordination among the City of Hoboken, the North Hudson Sewerage Authority, and other state, federal, county, and financing partners.

The City of Hoboken played the lead role in local resilience planning, open space and recreation, capital investment, and community benefits. The North Hudson Sewerage Authority contributed through sewer, stormwater, drainage, and long-term control planning responsibilities. State, federal, county, and infrastructure financing partners helped make different components of the project financially feasible.

This institutional alignment was essential. The public amenity, underground storage, pumping infrastructure, drainage function, financing package, and long-term operations could not be treated as separate decisions. They had to be structured so that the entities with authority to plan, finance, build, operate, and maintain the relevant components could act together.

Step 6. Align capital: What role should each source of funding or capital play?

ResilienCity Park demonstrates capital alignment in practice. Early grant funding and predevelopment support helped move the resilience concept toward an implementable project. Federal resilience funding supported risk reduction. Local capital investment demonstrated city commitment and helped deliver public benefits. County open space funding supported the park and community-benefit components. Low-interest infrastructure financing helped support stormwater and water-quality infrastructure.

The broader lesson is that one financing tool did not fund the entire resilience strategy. Instead, Hoboken matched different capital sources to different project goals: resilience funding for flood-risk reduction , infrastructure financing

for stormwater and combined sewer benefits, local and county funding for public space and community value, and agency coordination for operations and implementation. The project worked because the city did not treat resilience as a standalone avoided-loss project. It embedded resilience into infrastructure, public space, water management, and neighborhood investment.

The City has taken the learnings from the ResilienCity Park project and is applying the same steps in other large-scale redevelopment projects. The city's broader North End redevelopment planning shows how the same diagnostic can extend from a completed resilience investment to future district-scale investments. Planning materials identify a future Hudson-Bergen Light Rail station near 15th Street, affordable housing, pedestrian-oriented redevelopment, public open space, and elevated streets capable of accommodating underground flood infrastructure. Although this project is still in the planning stage, it demonstrates how a diagnostic approach to resilience investment can be replicated.

While part of the North End project project is under construction, it is not the completed proof point in the same way ResilienCity Park is. But it shows how the same questions can guide a broader capital strategy: what system must keep working, where value appears, which benefits can support funding or financing, what proof is needed, which entities have authority, and how capital sources should be aligned. (City of Hoboken 2021; Ulloa 2025)

This example does not suggest that a single financing tool can fund an entire resilience district. Rather, it illustrates why the full diagnostic matters.

Project teams must define the system being protected; identify where value appears and who benefits; determine whether value can be captured; establish credible engineering and financial evidence; clarify which entities have authority to approve, implement, operate, and finance each component; and align capital sources to the right project roles. In Hoboken, that means connecting redevelopment value, stormwater and sewer infrastructure, public space, transportation access, public debt, grants, agency budgets, utility finance, and shared funding into a more coherent district-scale resilience and redevelopment strategy.



Chapter 1 Key Takeaways

Define what must keep working: Start with the infrastructure system, neighborhood, public service, or economic activity that must perform under future conditions.

Identify the risk the project is solving: A financeable project needs a clear link between the hazard, the exposed system, the expected disruption, and the investment being proposed.

Map who benefits: Resilience value may appear for residents, businesses, utilities, agencies, insurers, property owners, employers, or the broader tax base.

Separate public-only value from financeable value: Some benefits can support repayment or shared funding. Others protect life, health, ecosystems, or public trust and may need grants, public revenues, or voter approval.

Test whether value can be captured: Ask whether the project can generate or protect revenues, reduce costs, avoid future spending, support a fee or district, attract shared contributions, or justify public finance.

Build the evidence package: Use engineering, modeling, operational data, benefit-cost analysis, life cycle–cost analysis, financial analysis, or verified standards to show that the project will deliver the claimed value.

Check authority and governance early: Confirm who can act, who can approve, who can pay, who can own or operate the project, and whether state or local law allows the financing tool.

Match tools to the value pathway: Use debt where repayment is clear, districts where benefits are shared geographically, utility finance where service reliability supports rates, public funding where benefits are broad, and catalytic capital where a specific gap needs to be bridged.

Close the last-mile gaps: If value exists but the project still does not pencil out, adjust the scope, aggregate projects, add partners, use grants or concessional capital, strengthen proof, or change policy.

Turn the diagnostic into a financing strategy: The final product should show what system is being protected, where value is created, what can support financing, what needs public funding, which partners are needed, and how implementation will move forward.

Chapter 2. How Resilience Creates Financial Value

Main Messages

The core financial value of resilience is continuity under stress—keeping revenues flowing, operations running, and assets performing when conditions deteriorate. Do not dismiss a project because the value is protected rather than newly generated.

The same project has different financial meanings depending on who is evaluating it. Translating value for the right audience is as important as identifying it.

Resilience value is fragmented across professional languages, but it describes the same underlying result. Avoided loss, service continuity, reduced claims, stronger repayment reliability, lower physical-risk exposure, and revenue stability are different ways of saying that systems kept functioning under stress.

Determine whether any of that value can be captured through rates, fees, taxes, special assessment districts, tax increment financing districts, avoided costs, shared contributions, grants, or voter-approved public finance.

When benefits are spread across households, businesses, utilities, insurers, and public agencies but costs fall on a single sponsor, the financing structure has to do the work of connecting beneficiaries to the investment.

Value must be made visible before it can be captured. This chapter provides six pathways for doing that—a set of lenses for connecting what a project does to the financial signals that control whether it moves forward.

Be precise about what can and cannot be monetized.

Resilience value is the benefit a community gets when people, infrastructure, businesses, and services are better able to withstand disruption and recover faster. Financial value is how that benefit shows up in a decision that affects money: a budget, insurance policy, credit analysis, capital plan, rate case, property value, or operating cost. They are connected, but are not the same thing.

Part of what makes this connection difficult is that resilience value is described using different language depending on who is doing the describing. A city calls it *avoided loss*. An operator calls it *service continuity*. An insurer calls it *reduced claims*. A lender calls it *stronger repayment reliability*. A rating analyst calls it *lower physical-risk exposure*. An investor calls it *revenue stability* or *asset value protection*.

Figure 6. Finding common ground between communities and investors

Same Project, Two Languages

Finding common ground between communities and investors



"We need to make sure families are safe and the community is protected when storms hit."

"We need to make sure the system keeps generating revenue and doesn't fail."



Same Goal, Different Language

Public & Community Perspective

- Protect families & neighborhoods
- Avoid damages & losses
- Long-term safety
- Local resilience

Financial & Investor Perspective

- Maintain operational continuity
- Reduce downside risk
- Revenue stability
- Asset performance

Community View "Assets"



People, Trust, & Local Networks

Physical Infrastructure & Cash Flows

Investor View "Assets"



Different Language, Same Outcome

A system that works when people need it.

These are not separate outcomes. Rather, they are different ways of describing the same underlying result—systems continuing to function under stress—refracted through the decision framework of whoever is evaluating them. The six pathways in this chapter are organized around that translation challenge to demonstrate how the same investment can be described in terms each decision-maker already uses.

To make translation between different stakeholders work in practice, local governments need to connect three things for any project:

1. **What the project does**: Does it reduce risk, protect an asset, keep services running, strengthen community conditions, or speed recovery?
.

2. **How to know whether it worked:** What evidence shows better performance: fewer outage hours, faster recovery time, fewer claims, lower flood depth, or more people with access to critical services?
.

3. **Why that matters financially:** Does the improvement protect revenue, reduce costs, improve insurability, stabilize the tax base, lower future capital needs, or reduce credit risk?

Every project does not need to construct a complicated financial model, but may instead choose a small number of metrics that match the decision being made.

Resilience investments create financial value through six pathways. Each pathway describes how a type of risk reduction or performance improvement shows up in terms that budgets, insurance, debt, rates, or capital decisions can recognize. They are not a checklist, but a translation tool to connect what a project does to the financial signals that control whether it moves forward.

Expected annual loss—the average cost of disruption across all probable events—is one important signal throughout this chapter, but resilience decisions often depend on more than average expected losses. *Tail risk*—the low-probability, high-consequence end of the distribution—service continuity thresholds, and catastrophic failure scenarios may matter as much or more, particularly for infrastructure systems where partial failure is not acceptable and where a single severe event can permanently impair fiscal stability.

The discussion that follows *Table 3. Pathways to Financial Value* returns to this because, for many resilience investments, the most important financial question is not what happens on average, but what the community can absorb when the worst-case scenario arrives.

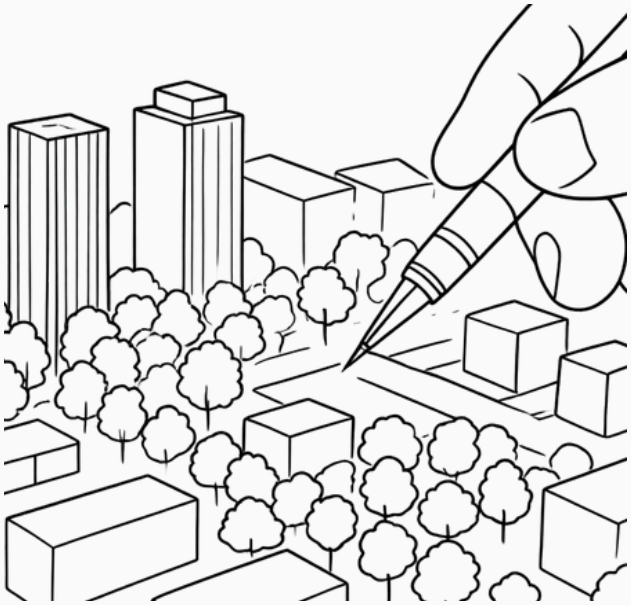


Table 3. Pathways to Financial Value

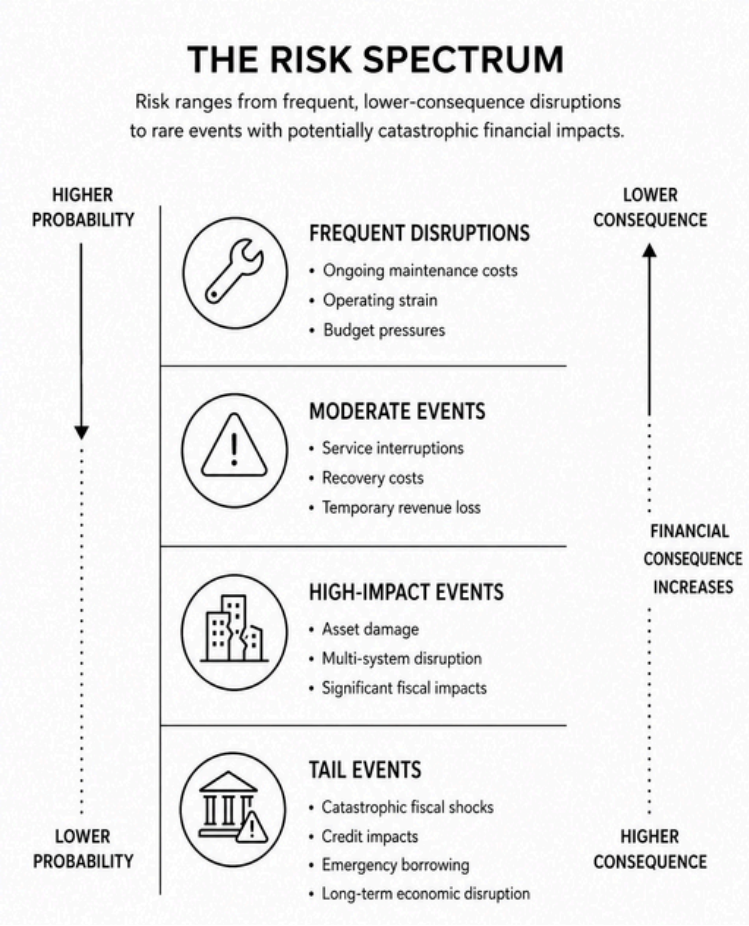
Pathway	What it Protects or Improves	Key Financial Signal
1 **Avoided loss**	Reduces exposure to financial shocks from damage, emergency costs, and cascading failures	Lower expected annual loss, reduced claims, stronger insurability, less emergency borrowing
2 **Reliable infrastructure**	Lowers long-term cost of ownership through longer asset life and fewer failures	Life cycle cost savings, lower capital renewal needs, more predictable operating budgets
3 **Operational continuity**	Protects revenue and cost stability by keeping services running during disruption	Service uptime, debt-service coverage under stress, rate and fee continuity
4 **Workforce reliability**	Reduces economic downtime by keeping workers, businesses, and essential services functioning	Lost workdays avoided, business continuity, local tax-base stability
5 **Faster recovery**	Shortens the period over which losses accumulate after an event	Time to recovery, revenue recovery rate, lower cumulative disruption costs
6 **Co-benefits**	Strengthens underlying community and economic conditions	Property value uplift, health cost savings, employment and economic activity, stronger long-term tax base

The six pathways in this chapter are only as useful as the risk analysis that underlies them. If the cost of inaction is underestimated—because tail risk is ignored, risk tolerance is never defined, or the analysis is anchored to historical averages rather than future conditions—the financial value of a resilience investment will also be underestimated, sometimes by orders of magnitude.

Understanding where a project sits on the risk spectrum is one of both the most consequential and most commonly overlooked inputs to a sound financing decision. Risk may range from frequent, lower-severity disruptions that erode budgets and operating performance year over year to rare, high-severity events that can permanently impair an asset, destabilize a community's fiscal position, or trigger cascading failures across interconnected systems.

Both ends of the spectrum matter financially, but they matter differently. Expected annual loss captures the recurring drag on revenues, operating budgets, insurance costs, and maintenance needs. Tail risk is where catastrophic fiscal shocks, credit downgrades, insurance market withdrawals, and long-term economic disruption originate. A project that modestly reduces expected annual loss may look marginal in a standard benefit-cost analysis but provide enormous value by reducing the probability of a tail event that would otherwise overwhelm reserves, trigger emergency borrowing, or destabilize the tax base for years. Conventional risk models are structurally unsuited to this moment precisely because they are calibrated to the past and anchored to single-point forecasts, a method that systematically underweights the tail events that increasingly define real-world outcomes (Dembo 2021). For resilience finance, the practical implication is that investments primarily targeting tail risk may be undervalued by conventional BCA frameworks, which heavily discount long-term and low-probability benefits.

They may be better justified through stress testing, scenario analysis, reserve depletion modeling, or insurance-based metrics that capture the full cost of catastrophic outcomes. This may include costs that do not appear in a single project's benefit column because they fall on other budgets, other sectors, or future fiscal years. Making truly risk-informed investment decisions requires understanding not just what is likely to happen on average, but what the community can and cannot absorb when the tail event arrives.



What Good Resilience Analysis Looks Like—Working With Uncertainty

Resilience value is inherently probabilistic. Avoided losses depend on hazard probabilities that are themselves changing under future climate conditions. Improved system performance is measured against a counterfactual—what would have happened without the investment—that cannot be directly observed. And because resilience investments often protect multiple systems and beneficiaries at once, attributing a specific financial outcome to a single intervention is rarely straightforward (Bond et al. 2017; Hallegatte et al. 2012).

These challenges are real. Recent research documents that local governments face significant data and modeling gaps in assessing uncertain changes in hazards, exposure, and vulnerability across plausible futures, and that the lack of evidence on how resilience investments can be structured to attract capital is one of the primary barriers to action at the local level (Buchtmann et al. 2025). Even the most sophisticated risk models carry substantial uncertainty. Swiss Re Institute's 2026 analysis of natural catastrophe losses finds that missing or incomplete data can lead to significant underestimation of loss potential—in one documented case, final loss estimates were nearly triple initial figures—and that accurate data reflecting evolving exposure, hazard, and vulnerability is essential to sound risk assessment (Swiss Re Institute 2026).

These are not reasons to abandon the analysis. They are reasons to conduct it carefully and honestly, and to recognize that the tools to do so are increasingly accessible.

FEMA's Benefit-Cost Analysis Toolkit uses probabilistic methods to estimate expected annual benefits across a range of hazard scenarios, not just a single most-likely event (FEMA 2026a).

The RAND Resilience Dividend Valuation Model provides a framework for estimating net benefits across shock, recovery, and co-benefit scenarios—explicitly accounting for the possibility that the shock may not occur during the analysis period (Bond et al. 2017). Robust decision-making approaches, used by the World Bank and others, test whether an investment's benefits hold across a wide range of future conditions rather than anchoring to a single forecast—a discipline that is particularly important when climate projections carry significant uncertainty (Hallegatte et al. 2012; Kalra et al. 2014).

In practice, sound resilience analysis does four things.

1. It works with ranges rather than point estimates, showing plausible high and low outcomes rather than a single number.
2. It makes the counterfactual explicit—clearly stating the baseline and what would be expected to happen without the investment.
3. It is transparent about attribution, acknowledging where benefits are distributed across multiple actors or systems and where a single project's contribution cannot be fully isolated.
4. It matches the level of analytical rigor to the decision at hand: a capital budget request, a grant application, a bond measure, and a rate case each require different levels of evidence.

Uncertainty, handled honestly, strengthens rather than weakens the case for resilience investment. Decision-makers like budget officers, lenders, rating analysts, elected officials are accustomed to evaluating investments under uncertainty. What they need is not false precision, but a credible, documented analysis that shows the assumptions, acknowledges the range, and demonstrates that the project team understands the limits of the evidence. A well-structured resilience analysis that shows a 2:1 to 6:1 benefit-cost ratio across a range of scenarios is more persuasive than a single number that cannot withstand scrutiny.

Pathway 1: From Avoided Loss to Reduced Financial Shocks

[1]

This pathway encompasses the insurance and expected-loss signals. When a flood damages a pump station, a wildfire destroys transmission lines, or a heat wave shuts down a transit system, the financial consequences ripple outward: emergency repair costs, service interruptions, business closures, insurance claims, and fiscal stress that can take years to resolve. Avoided loss is what resilience investments prevent from happening in the first place and, in financial terms, it represents reduced exposure to those shocks.

In financial analysis, this value is usually expressed probabilistically. Useful signals include expected annual loss, probable maximum loss, reductions in uninsured loss, reduced contingent liabilities, reduced disaster-related fiscal shocks, and lower exposure to low-frequency, high-impact events. Cascading effects matter as much as direct damages. Examples include flooded substations triggering water-system failures, boil-water notices, business closures, and housing disruption; insurance market disruption straining housing markets; and declining property values eroding the tax base that supports debt service.

Claims about avoided-loss resilience value should be grounded in evidence that connects the project to specific hazards, exposed assets or populations, vulnerability, and expected damages, using sources such as claims data, engineering analysis, benefit-cost analysis, or verified risk models.

Avoided loss becomes actionable when it changes a variable that can be priced, underwritten, budgeted, or financed —showing up in insurance terms, borrowing conditions, operating costs, revenue continuity, or contractual performance.

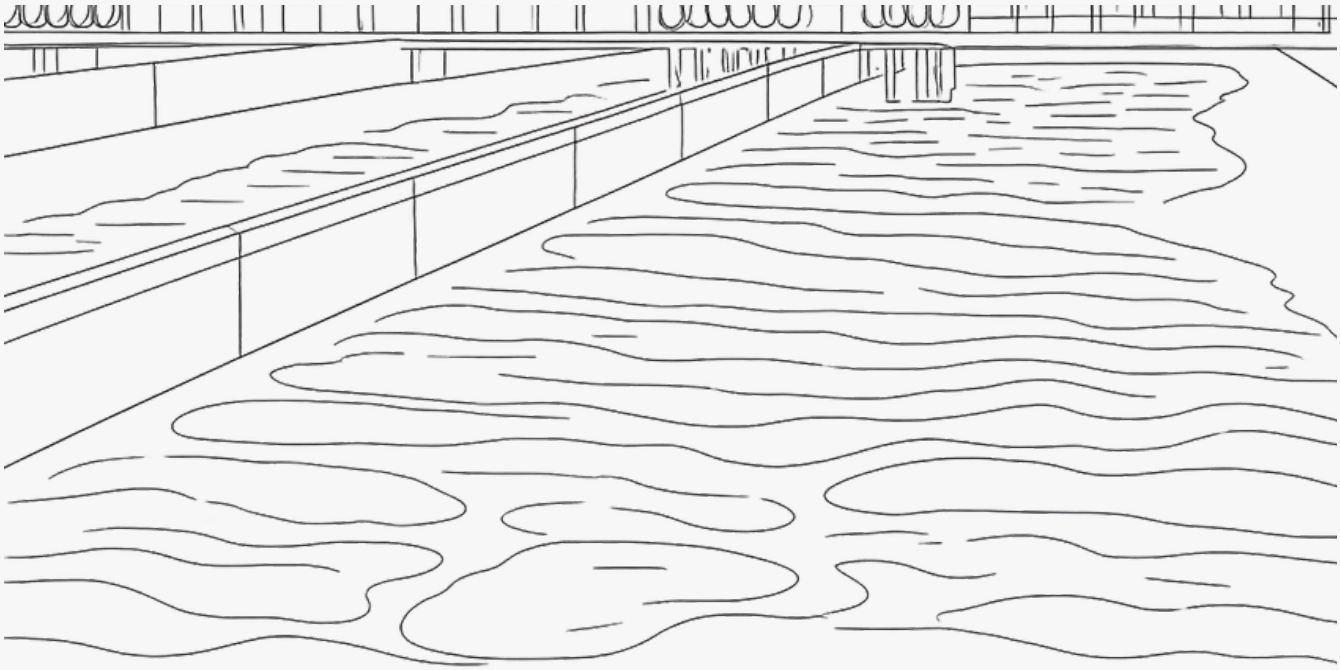


Table 4. Finding Value in Avoided Loss

Where Value Appears	What to Look For
Insurance	Lower premiums, deductibles, and loss ratios; improved coverage availability
Borrowing	Stronger credit conditions, lower reserve needs, less pressure on future debt
Operating costs	Fewer emergency repairs, lower volatility, reduced emergency procurement
Revenue continuity	Less interruption in fees, taxes, rents, and service payments
Contractual performance	Reduced risk of penalties, defaults, litigation, or missed obligations

Example: Denver Water—From Forests to Faucets Partnership

Following the 2002 Hayman Fire, Denver Water faced more than $27 million in dredging, water-quality treatment, initial recovery efforts, and related costs. In 2010, the utility partnered with the US Forest Service on a roughly $33 million combined commitment to proactive forest management in source watersheds. The partnership was renewed and expanded in 2017 to include the Colorado State Forest Service and Natural Resources Conservation Service through a second $33 million commitment, and again in 2022 to include the Colorado Forest Restoration Institute through an additional $30 million commitment. Each agreement used a 1:1 matching structure: Denver Water provided half of the funding through customer rates, while its partners contributed the other half from a variety of sources.

These sustained investments reduce the risk that future wildfire will damage source-water quality, send sediment and debris into the system, and increase Denver Water's treatment and other operating costs. For now, the program is funded through utility rates and partner contributions rather than a separate investment based on the expected savings from avoiding wildfire damage (Denver Water n.d.). As evidence of those savings grows, that kind of market-based financing could become possible for similar projects.

Example: FORTIFIED Home—Verified Standards as Avoided-Loss Proof

IBHS developed the FORTIFIED standard to strengthen roofs and building systems against high winds and wind-driven rain (IBHS 2025). The financial case rests directly on claims data. A study following Hurricane Sally found that FORTIFIED homes suffered 55% to 74% fewer claims and 14% to 40% less severe claims than noncertified homes (Aoun Angueira 2025). University of Alabama research found that FORTIFIED designation increased home resale values by nearly 7% in coastal Alabama, and expected insurance cost reductions averaging $1,533 per year for multifamily homes with FORTIFIED roof designation in windborne debris–prone regions (Awondo et al. 2016; Powell et al. 2022).

The avoided-loss logic is straightforward: a verified standard produces documented claims reduction, which produces measurable premium savings, which themselves produce a recurring financial signal that the investment changed the risk. That chain—standard, inspection, claims data, premium—is what makes avoided loss legible to insurers, lenders, homeowners, and public officials. Without the verification infrastructure, the risk reduction is real but invisible to the financial system.

Insurance-related claims should be tied to documented premium changes, deductible changes, programmatic discounts, verified standards, underwriting data, or claims reduction; otherwise, the value should be described as reduced risk or improved insurability rather than guaranteed savings.

For local governments, the implication is that community-wide adoption of resilience standards can shift insurance market conditions at scale—lower aggregate claims, improved coverage availability, and more stable premiums for residents and businesses—in ways that strengthen the broader tax base and reduce fiscal exposure to post-disaster recovery costs.



Pathway 2: From Reliable Infrastructure to Lower Long-Term Costs

Infrastructure is expensive not only to build, but also to operate, maintain, repair, insure, and eventually replace. The financial question resilience raises for this pathway is not whether an asset lasts longer in ideal conditions, but whether it performs reliably under the climate conditions it is likely to face. And likewise, what the difference in total lifetime cost is between an asset designed for those conditions and one that is not.

Climate-informed design, redundancy, higher-quality materials, nature-based solutions, and better maintenance may increase upfront costs. But they reduce total lifetime costs by lowering failure risk, avoiding premature replacement, reducing emergency repair costs, and making operations more predictable. The useful financial signals here are life cycle cost savings, net-present value of avoided maintenance or replacement, maintenance backlog reduction, capital renewal rate, and cost volatility under stress.

The key distinction from other pathways is the time horizon. This pathway is not about what costs are avoided in a single event; the financial benefit of reliable infrastructure accumulates over decades, appearing in operating budgets, capital plans, cash-flow stability, and borrowing conditions, and in the steady reduction of cost and risk over an asset's lifetime.

Example: Drought Resilience by Reducing Long-Term Water Costs Through Recycled Water

San Antonio, TX, shows how resilience can lower long-term infrastructure costs by reducing dependence on scarce potable water. The region is facing severe drought pressure: in 2025, the Edwards Aquifer Authority declared its highest level of pumping reductions for the San Antonio Pool, requiring affected permit holders to cut withdrawals by 44%. (EAA 2025) As drought deepens and population grows, reliable water becomes more expensive because utilities must invest in new supplies, storage, treatment, reuse, pipelines, conservation, or other capital-intensive options. Texas' draft 2027 State Water Plan estimates that communities may need $174 billion over the next 50 years to meet future water needs. (TWDB 2026; Nogueras Ramos and DeGuzman 2026)

San Antonio Water System's recycled water, or "purple pipe," network helps manage that long-term cost pressure. Instead of using drinking-quality water for every purpose, the utility delivers highly treated recycled water for irrigation, industrial processes, power plant cooling, parks, universities, military facilities, healthcare facilities, and other large-volume users. In 2025, recycled water supplied through the system totaled about 60,500 acre-feet, or 18.3% of the utility's total potable and non-potable demand (SAWS 2026).

The value is not a single avoided loss from one drought. It is the cumulative benefit of reducing potable water demand, reserving drinking water for higher-value uses, and delaying or reducing the need for more expensive future supply projects.

This is the core logic of the pathway: infrastructure that performs reliably under expected climate stress can reduce total lifetime costs, not just protect against a single disaster.

The value of San Antonio's recycled water system is not measured only by what it prevents during a single drought. Its larger benefit comes from changing the city's long-term water cost curve. By using recycled water for irrigation, cooling, industrial processes, parks, universities, military facilities, and other non-drinking uses, San Antonio can reserve potable water for the purposes that truly require it.

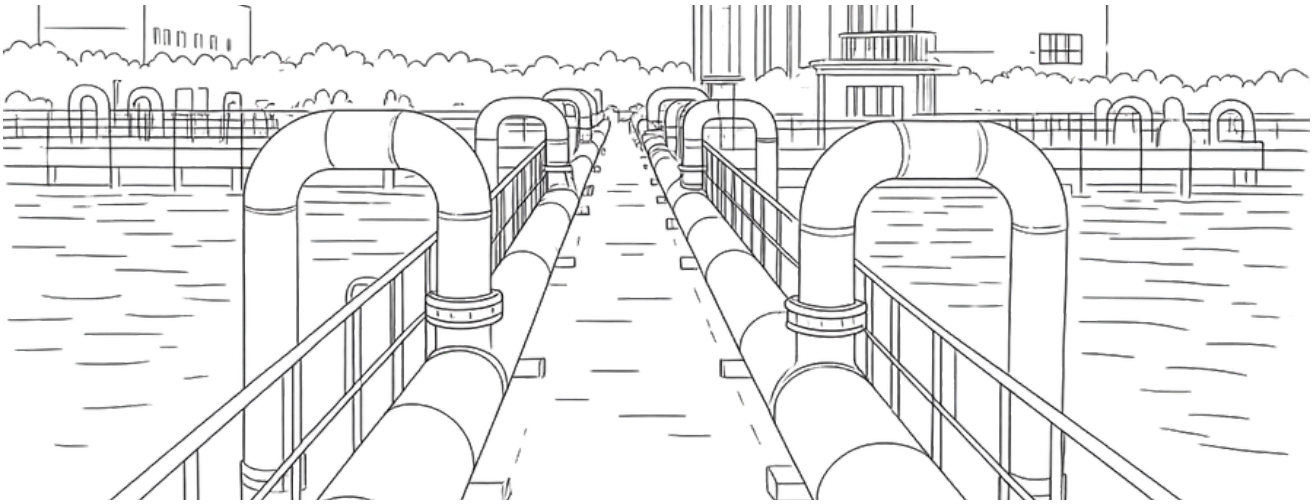
Over time, that reduces pressure on drinking water supplies, helps the utility manage growth under worsening drought conditions, and can delay or reduce the need for more expensive future supply projects. In that sense, the purple pipe system is not just a conservation measure. It is resilience infrastructure: an investment that helps the city perform more reliably under climate stress while lowering total lifetime costs.



Table 5. Finding Value in Lower Long-Term Costs

Where Value Appears	What to Look For
Operating costs	Lower maintenance and operating expenses; improved budget capacity
Capital planning	Longer useful life and delayed replacement; reduced future capital needs
Cash-flow stability	More predictable expenditures; stronger operating margins and debt-service coverage
Borrowing	Improved credit conditions and lower long-term cost pressure

Across *Table 5. Finding Value in Lower Long-Term Costs*, the strongest claims are those that connect reliable infrastructure to measurable reductions in long-term cost pressure, cost volatility, asset failure risk, emergency repair exposure, and revenue instability. For borrowing, this value should be described as credit-relevant risk reduction rather than a guaranteed lower interest rate, unless there is direct evidence that the investment changed borrowing terms. The point is to show that the project improves the financial conditions lenders, rating analysts, and investors may recognize: more predictable capital needs, stronger cash-flow stability, and lower exposure to costly infrastructure failure.



Pathway 3: From Operational Continuity to Stable Revenue and Costs [1]

For utilities and enterprise systems that recover costs through rates and fees, financial health depends less on growth than on consistency of operations. When services are interrupted—for example, by a flood, outage, or equipment failure—revenue collection stops, emergency costs spike, and the operating budget absorbs losses it was not designed to handle. Operational continuity is what keeps that from happening, and its financial value is measurable in the signals utilities and bond analysts use every day.

Utilities and enterprise systems cannot simply replace lost revenue by adding customers, and they may have less reserve cushion than large private firms. When services continue during disruptions, revenues are collected as expected and costs remain more predictable.

Useful signals include service uptime under stress, availability factor, outage duration, time to recovery, value of lost load, revenue maintained during disruption, days cash on hand, liquidity coverage, operating cash burn during disruption, and debt-service coverage under stress.

When services keep running during disruption, the financial benefit shows up immediately and directly in the revenue that keeps flowing, the obligations that keep being met, and the cost spikes that never happen.

Table 6. Finding Value in Operational Continuity

Where Value Appears	What to Look For
Rate and fee continuity	Ongoing collection of water, wastewater, electricity, transit, and stormwater payments
Contractual performance	Service obligations met, penalties and missed payments avoided
Debt-service coverage	Predictable revenue maintained to meet bond and loan obligations
Operating cost stability	Shutdowns, restart costs, emergency operations, and overtime spikes avoided

Example: Bronzeville Community Microgrid

When a grid outage hits critical facilities, the financial consequences compound quickly. Emergency generators burn fuel, staff work overtime, services degrade, and transactions stop. Commonwealth Edison's Bronzeville Community Microgrid was designed to reduce that exposure by helping a portion of Chicago's Bronzeville neighborhood maintain power during grid disruptions.

The Illinois Commerce Commission approved the project in 2018 as a regulated utility investment. The project was designed to protect police, power, and other key municipal operations, and to connect with the nearby Illinois Institute of Technology microgrid to create a utility-operated microgrid cluster (Clarion Energy Content Directors 2018). ComEd announced completion of the neighborhood-scale microgrid in 2024, reporting that it would enhance power resiliency for more than 1,000 customers on Chicago's South Side and that its footprint includes critical facilities such as Chicago Public Safety Headquarters, public works buildings, health clinics, public transportation, educational facilities, and places of worship (ComEd 2024).

The project demonstrates this pathway because its value is operational continuity: keeping essential services running, reducing outage exposure for critical customers, and avoiding the cost spikes that come with emergency response, service interruption, and restart after failure. Importantly, the project did not depend on monetizing every avoided outage loss upfront as a direct revenue stream.

The National Association of State Energy Officials and the National Association of Regulatory Utility Commissioners note that ComEd did not attempt to quantify the value of resilience in its request, but instead positioned the project as an opportunity to test and validate 58 resilience metrics for future regulatory proceedings (Rickerson et al. 2022).

Research summarized by the National Association of State Energy Officials and the National Association of Regulatory Utility Commissioners shows why this matters. In a separate New York Prize microgrid case, avoiding a one-day outage was valued at $9.7 million, including $5 million in avoided lost sales and $3.1 million in avoided regional gross domestic product impacts (Rickerson et al. 2022). The lesson for local governments is that resilience can support investment when it protects continuity of service, even when every avoided loss cannot be precisely monetized in advance.



Pathway 4: From Workforce Reliability to Reduced Economic Downtime

[1]

Infrastructure and services depend on people as much as physical assets. Extreme heat, flooding, wildfire smoke, power outages, housing disruption, school closures, and transit failures can shut down operations even when buildings remain intact. This pathway captures what happens to financial performance when people cannot safely work, travel, care for family members, or return home.

This value is often missed because traditional asset models focus on physical damage. Yet many of the largest economic losses from disasters come from operational downtime, reduced productivity, and service disruption rather than direct asset destruction alone.

Workforce reliability also connects business continuity to broader community conditions. Access to power, transportation, childcare, pharmacies, grocery stores, banks, healthcare, safe housing, and other daily services can determine whether workers and businesses recover quickly or face prolonged disruption. Investments that improve worker safety and reduce exposure to hazardous conditions can also reduce operational liability, emergency staffing pressures, and long-term workforce strain.

Useful signals include lost workdays avoided, workforce availability during disruption, labor productivity loss avoided, business interruption losses, supply-chain disruption duration, customer disruption, revenue concentration in exposed areas, overtime and emergency labor costs, and local tax revenue stability.
When workers can safely reach jobs, staff essential services, and sustain daily routines, the financial benefit flows through service delivery, operational capacity, worker safety, revenue stability, and the local economic activity that communities and tax bases depend on.

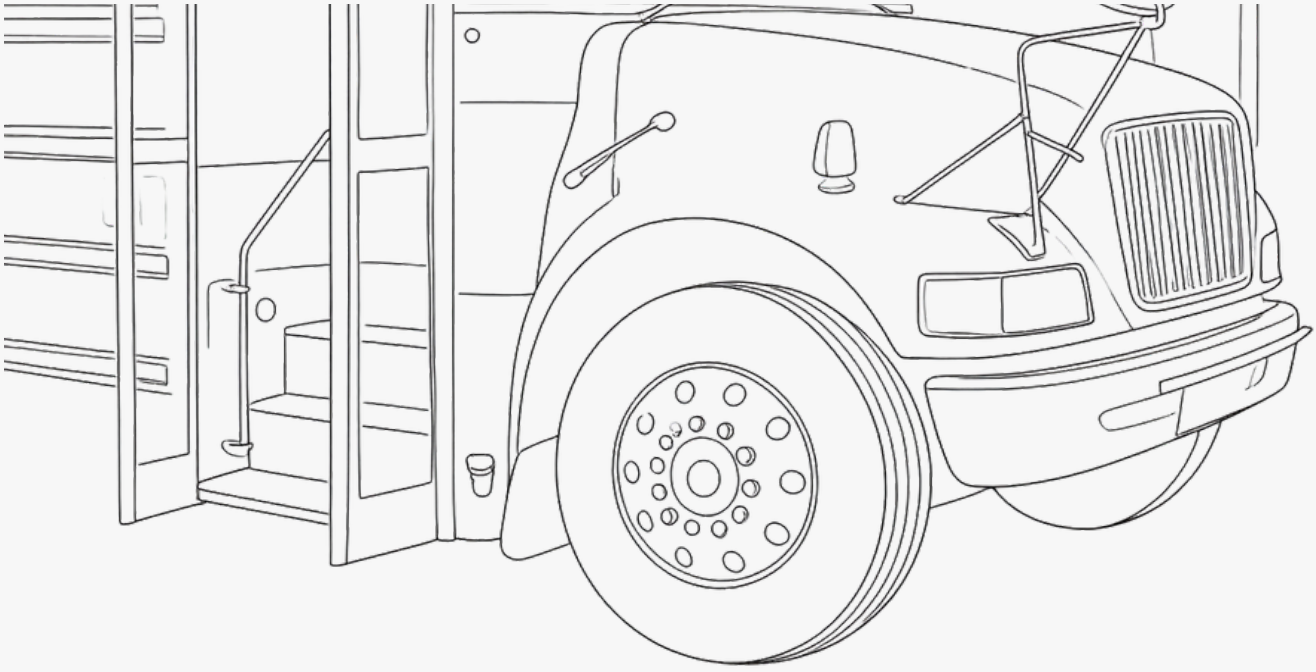


Table 7. Finding Value in Workforce Reliability

Where Value Appears	What to Look For
Service delivery	Essential public functions continue because workers can safely reach and staff facilities
Operational capacity	Utilities, hospitals, schools, businesses, and public agencies remain functional
Worker safety	Fewer dangerous conditions, lower injury exposure and emergency staffing pressure
Revenue stability	Shutdowns interrupting production, services, fees, sales, or tax receipts are reduced
Local economic activity	Employment and business operations sustained, cascading disruption reduced

Example: Winter Storm Uri

The cascading impacts of Winter Storm Uri show why workforce reliability is a core resilience value, not a secondary consideration. In February 2021, the storm caused widespread grid failures that left millions of Texans without power, while water outages, boil-water notices, frozen pipes, school and childcare closures, unsafe roads, and housing disruption made it difficult or impossible for many people to work, even where buildings themselves were not destroyed. Hospitals, utilities, emergency services, food suppliers, manufacturers, and small businesses all faced staffing constraints at the same time that service demand was rising.

For many workers, the problem was not only job-site damage, but also the loss of the surrounding conditions that make work possible: electricity, heat, water, transportation, communications, safe housing, and care for family members. The Federal Reserve Bank of Dallas estimated that the freeze and outage may have cost the Texas economy $80 billion to $130 billion in direct and indirect losses (Golding et al. 2021). The aftermath of Winter Storm Uri illustrates Pathway 4 logic clearly: when lifeline systems fail, workforce availability falls, business interruption deepens, essential services become harder to maintain, and economic losses compound far beyond the direct physical damage to assets.

Pathway 5: From Faster Recovery to Shorter and Less-Costly Disruptions

Two communities can experience the same initial damage and arrive at very different financial outcomes depending on how quickly they recover. Every additional day of disruption compounds losses: revenue continues to fall, businesses close, households destabilize, public services strain, and emergency operations costs accumulate. Faster recovery compresses that window. The financial signals that distinguish this pathway from Pathways 1 and 3 are time-based rather than probability-based—not the depth of the initial loss, but the slope and duration of the recovery curve.

Faster recovery reduces the duration over which losses accumulate. Even if initial damages are unchanged, shortening the disruption period can significantly reduce total economic loss. This makes time-to-recovery one of the most important translation metrics in resilience finance.

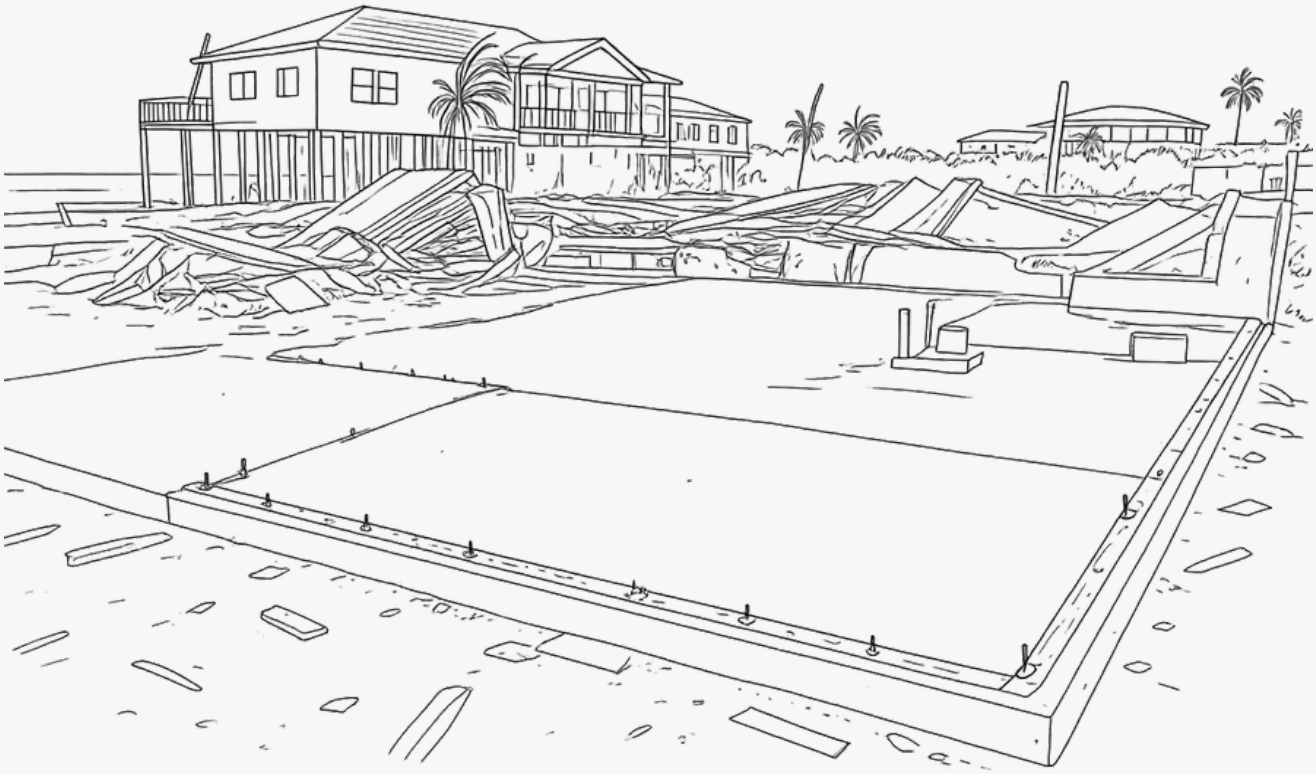
Useful signals include time to recovery, time to revenue recovery, restoration time for critical assets, community-scale recovery time, population affected, access to critical services, displaced households, business reopening rates, and duration of revenue loss for utilities, businesses, and local governments.

The financial value of faster recovery is measured in time—how quickly revenue returns, services are restored, and cumulative costs stop compounding—and appear across compounding losses, secondary impacts, public confidence, and recovery costs.



Table 8. Finding Value in Faster Recovery

Where Value Appears	What to Look For
Reduced compounding losses	Shorter disruptions prevent escalating costs and revenue declines
Lower secondary impacts	Fewer business closures, lost workdays, supply-chain delays, household instability
Preserved confidence	Faster service restoration supports public trust and long-term investment
Lower cumulative recovery costs	Less time in emergency operations, temporary service delivery, and repair cycles



Example: Downtown Flood Protection

Much of downtown Mount Vernon, WA, sits within the Skagit River floodplain. To protect the historic downtown, wastewater treatment plant, public buildings, transportation assets, and local businesses, the city built a FEMA-certified flood protection system along the river: a floodwall, earthen levee, riverwalk, trail connections, and public riverfront space. The project was designed not only to hold back floodwater, but also to remove downtown from the FEMA 100-year mapped floodplain and make reinvestment in the downtown core easier.

The project removed 223 buildings from the regulatory floodplain at a cost of nearly $31 million dollars and produced a 40% reduction in flood insurance premiums for affected property owners (City of Mount Vernon 2019a). On a simple scale basis, that equals roughly $139,000 per building removed from the regulatory floodplain, before counting avoided flood damage, reduced emergency costs, shorter business closures, protected public infrastructure, or faster return of downtown economic activity. City materials state that the floodwall protects "vital downtown property, commerce, and infrastructure," removes downtown from FEMA's 100-year base flood elevation, and is expected to increase developer and business interest in the downtown core (City of Mount Vernon 2019b). After the floodwall and riverwalk were completed, the city noted increased downtown development momentum and announced a $10 million private investment in a formerly derelict property that would become a revenue-producing commercial and residential project.

For the city, the financial value was not direct monetization of avoided losses, it was protected fiscal capacity: fewer buildings and businesses exposed to prolonged flood disruption, lower cumulative recovery costs, stronger continuity of downtown activity, and better protection of the property and commerce that support the local tax base. In Pathway 5 terms, the key financial signals are time to revenue recovery, avoided duration of business interruption, reduced cumulative recovery costs, protected tax-base function, and faster return to normal economic activity.



Pathway 6: From Co-Benefits to Stronger Economic Performance [1]

Resilience investments can do more than reduce risk. They can strengthen the underlying conditions that make communities healthier, more productive, more stable, and more attractive to investment. These benefits are often described as co-benefits in public planning. In financial terms, they may show up as stronger economic performance, more stable property values, better health outcomes, reduced environmental costs, lower household vulnerability, stronger workforce productivity, and more durable tax bases.

This pathway adds a different type of value from the earlier ones. It is positive value creation, not only avoided loss. A stormwater park, urban tree canopy program, living shoreline, floodable public space, microgrid, or resilient housing investment may reduce risk. It may also improve public space, mobility, heat reduction, air quality, water quality, biodiversity, health, recreation, and neighborhood confidence.

Useful signals include stable property values and tax revenues, reduced healthcare and environmental costs, employment and economic activity, access to critical services, heat illness reduction, mental health impacts, reduced displacement, household recovery capacity, and measures of community trust and adaptive capacity.

Table 9. Finding Value in Co-Benefits

Where Value Appears	What to Look For
Workforce productivity	Safe housing, reliable transportation, cooling, clean air, and dependable services support the ability to work and learn
Business performance	Stable operations and fewer disruptions help firms maintain customers, workers, and supply chains
Human capital	Health, education, and service access enable people to participate in the economy
Local economic vitality	Communities become more attractive for investment, tax base is strengthened, and fiscal volatility reduced

PHILADELPHIA'S GREEN CITY, CLEAN WATERS

Philadelphia's 25-year, $2.4 billion Green City, Clean Waters program uses green stormwater infrastructure—including rain gardens, tree trenches, green roofs, planters, wetlands, and related systems—to reduce combined sewer overflows and meet Clean Water Act requirements. Its broader co-benefits are what make it a Pathway 6 case.

An Econsult Solutions analysis for the Sustainable Business Network found that proximity to the first 496 green stormwater infrastructure projects was associated with an estimated 10.3% increase in nearby residential property values, representing approximately $1.3 billion in added property value and about $18 million in additional annual property tax revenue for the City of Philadelphia and its school district (ESI 2016). Lincoln Institute of Land Policy research similarly found that Philadelphia homes near green stormwater infrastructure installations appreciated by up to 15% and examined how land value capture tools could help recover and reinvest some of that value. A later Sustainable Business Network update estimated that Green City, Clean Waters and related green stormwater infrastructure activity would generate approximately $4 billion in total economic impact over 25 years, support an average of 1,160 jobs per year, and produce additional modeled benefits related to public safety, recreation, and health.

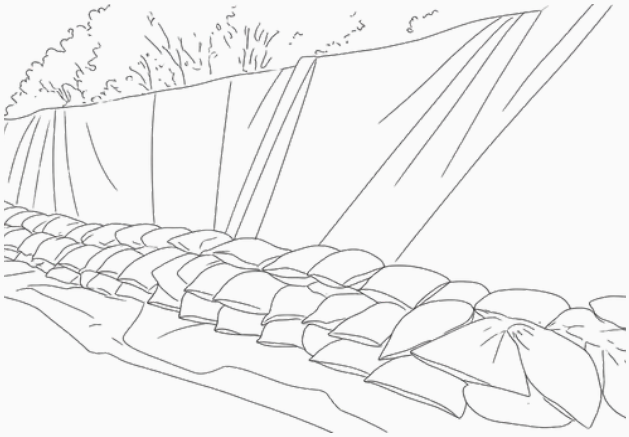
Philadelphia's Green City, Clean Waters program was also its long-term strategy for meeting federal Clean Water Act obligations to reduce pollution from combined sewer overflows—the events that occur when stormwater and wastewater in older shared sewer pipes exceed system capacity and discharge into waterways. Together, these findings show how stormwater investments justified for regulatory compliance may be undervalued if only water-quality outcomes are measured. (SBN 2019; J. Cohen et al. 2024).

The financing mechanism for Green City, Clean Waters is covered in ***Chapter 4.***



Putting Numbers to It: Three Worked Examples

The following examples are not universal promises. Instead, they are simple illustrations of method. A project in one community may have a different result because hazards, exposure, construction cost, insurance regulation, discount rate, asset life, and benefit capture all vary. The purpose is to show how local governments can move from a resilience action to a financial signal.





Avoided-Loss Worked Example: Flood Defense Package

Think of the benefit-cost ratio as a simple return-on-investment signal: for every dollar spent, how many dollars in damage, disruption, and recovery cost does the community avoid? Swiss Re Institute's review of flood adaptation studies found benefit-cost ratios above 1:1 across several modeled measures, including 1:2.6 for raising coastal dikes under a high-emissions scenario, 1:7.4 for structural measures for European river flooding, and 1:2.3 for European river floodproofing measures (Gahlot et al. 2024).

In plain terms, if a city spends $30 million on a flood-defense package and achieves a 1:2.6 benefit-cost ratio, it avoids roughly $78 million in future losses—a net benefit of about $48 million. That avoided-loss figure is the core financial signal: it tells a budget officer what the city is no longer on the hook for, a rating analyst that fiscal shock risk has declined, and an insurer that expected claims are lower (Gahlot et al. 2024).

Metrics to show: Modeled avoided losses, benefit-cost ratio; expected annual damage before and after the project, reduction in recovery costs, avoided days of service disruption, and reduced fiscal exposure from future flood events.

A separate benefit, which must be counted discretely to avoid double-counting, is insurance savings. Communities that take qualifying flood-reduction actions can earn discounts on National Flood Insurance Program premiums through FEMA's Community Rating System, ranging from 5% to 45% depending on how much the community does. That premium reduction is real money back in the pockets of property owners and businesses every year, and it is a direct, recurring financial signal that the investment changed the risk (FEMA 2026b).

Metrics to show: Community Rating System class, premium discount achieved, number of policies receiving the discount, annual aggregate premium savings, repetitive-loss properties reduced, and floodplain management actions credited.

Avoided-Disruption Worked Example: Critical Facility Microgrid

Think of avoided disruption as the value of keeping critical services operating when the grid fails. Research for the New York State Energy Research and Development Authority on the proposed Rockville Centre community microgrid in Nassau County, NY, found that avoiding a one-day outage could produce approximately $9.7 million in social welfare benefits. A related regional economic analysis estimated that sustaining power during a one-day outage could also avoid up to $5 million in lost sales and $3.1 million in lost regional GDP (Industrial Economics 2018; Rickerson et al. 2024).

In plain terms, if a critical-facility microgrid prevents even one or two major outage days over its useful life, the avoided-disruption value can become a major part of the investment case. This is even before counting routine benefits like lower energy bills, backup power savings, or reduced emissions. Those additional benefits make the case stronger; they are not what carries it.

The financial signals that matter here are different from things like flood defenses. A budget officer wants to know what emergency operations and recovery cost the city the last time the power went out.

A utility regulator wants to see service uptime and customer interruption data. A lender financing the project wants confidence that the revenue stream—often an energy service agreement, participant contribution, or utility rate recovery—remains stable under disruption scenarios.



Metrics to show: Value of lost load, avoided outage days or hours, critical services maintained, restoration time avoided; avoided emergency operating costs, and debt-service coverage or rate-recovery performance under a simulated outage scenario.

Risk Reduction Worked Example: Higher Building Standards

Think of risk reduction as making damage less likely and less expensive before the next storm, flood, fire, or other hazard happens. The financial question here is whether the upfront cost of building or retrofitting to a higher standard pays for itself over time. Insurance claims, premium costs, and real estate values can provide measurable signals that the risk has changed.

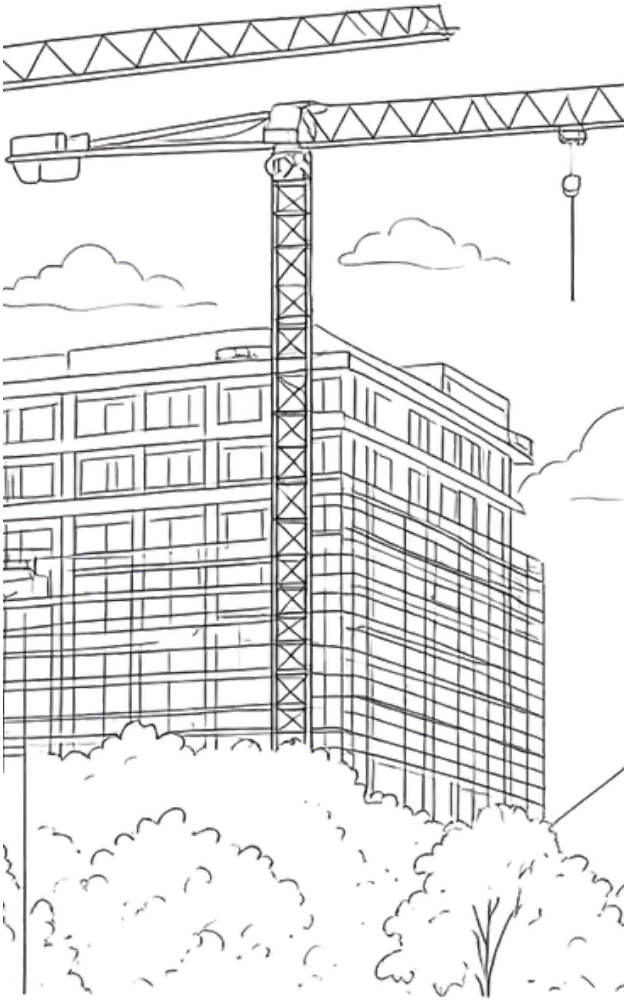
In addition to the FORTIFIED study on reduced claims shared in Chapter 1, a separate resale-value study found that FORTIFIED designation increased home resale value by nearly 7%, holding other factors constant) (Awondo et al. 2016). For multifamily properties, a study estimated that a FORTIFIED roof designation reduced expected insurance costs by an average of $1,533 per year in a windborne debris–prone region (Powell et.al. 2022). More broadly, the National Institute of Building Sciences found that above-code design can save about $4 for every $1 spent across large portfolios of buildings (Multi-Hazard Mitigation Council 2019).

In plain terms, if a multifamily owner spends $10,000 to upgrade to a FORTIFIED roof standard and saves $1,533 per year in expected insurance costs, the premium savings alone will repay the upfront cost in just under seven years (Powell et al. 2022). Over 15 years, those annual savings total about $23,000 before discounting. Discounted at 6%, the present value is roughly $14,900—about $4,900 more than the initial retrofit cost. That calculation does not count avoided claim costs if a storm hits, reduced displacement time, faster re-occupancy, or potential resale value effects.

For local governments, the translation is slightly different. The question is whether building code upgrades or community-wide hardening programs reduce aggregate claims, stabilize insurance markets, and protect property values and tax revenues at scale.

The FORTIFIED evidence base—verified standards, documented claims reductions, insurance cost effects, and resale value research—is the kind of proof that can support conversations with homeowners, insurers, lenders, budget officers, and rating analysts.

Metrics to show: Annual insurance cost reduction, simple payback period, present value of premium savings, net-present value after retrofit cost, claim frequency reduction, claim severity reduction, loss-ratio reduction, resale value effect, and avoided occupancy downtime.



Putting Measurement into Practice

Local governments do not need to measure everything; they simply need enough evidence to support the specific decision in front of them. Different actors weight the same evidence differently: an insurer focuses on claims frequency and severity, a rating analyst on fiscal shock and reserve depletion, a lender on cash flow reliability, and a budget officer on avoided emergency costs. The goal is not to satisfy all of them at once—it is to pick the evidence that matches the decision being made.

1 Start by naming the decision. A project team trying to justify a capital budget request needs different evidence than one seeking to improve insurance terms or attract a mission-driven lender. Once the decision is clear, define the stress scenario the project is designed to withstand—meaning the level of storm, heat, wildfire, drought, outage, or compound disruption the system must be able to perform through—and identify which systems must keep working (e.g., water, power, transportation, housing, healthcare, schools, emergency services, business districts, or natural systems).

2 From there, choose a small number of metrics that connect what happens on the ground to what it costs; for example, match time to recovery—how long it takes a road, building, utility, or business district to reopen or return to normal service—with revenue loss; flood-depth reduction—how much lower floodwaters are expected to be after the project—with expected annual loss; or uptime with debt-service coverage—the project's ability to generate enough revenue to make required debt payments. Use existing data first: capital plans, maintenance records, claims data, outage logs, emergency costs, tax revenues, and flood maps are usually enough to start.

3 Finally, be honest about uncertainty. Resilience benefits are probabilistic and may appear only when an event occurs. Good analysis shows a range of plausible outcomes, who benefits, who pays, and why the investment is prudent under future conditions.

One distinction matters throughout: outputs are not outcomes. Dollars spent, acres restored, assets elevated, or homes retrofitted show that action is happening—but action is not the same as impact. A microgrid installed is an *output*; critical facility uptime maintained during grid outages is an *outcome*. Ten thousand homes elevated is an output; a 40% reduction in repetitive-loss insurance claims is an outcome. A watershed treated for wildfire fuel is an output; lower sediment loads and avoided water treatment costs are *outcomes*. The financial value lies in whether those actions reduce downtime, lower claims, shorten recovery, protect revenue, or reduce future costs. Measure the outcome, not just the activity.

Local governments often begin with the action they want to take and only later ask how to justify, fund, or finance it. Table 10 is designed to help with that translation. It shows how common project goals can be paired with the practical evidence local governments may already have, and then connect that evidence to the financial signals that matter for budgets, insurance, debt, rates, grants, and investment decisions.

Table 10. Evidence for Value

Project Goal(s)	Evidence	How Value Can Show Up Financially
Reduce flood, wildfire, heat, drought, or outage risk	Hazard maps, exposed assets, flood depth or fire-risk modeling, claims history, emergency repair history, expected annual loss or probable maximum loss where modeled	Lower expected annual loss, reduced claims, lower uninsured loss, lower emergency spending, lower reserve draw, reduced contingent liabilities, improved insurance availability or terms
Keep services running	Outage logs, service uptime, service interruption frequency, service-level compliance, rate or fee collection during disruption, value of lost load where available	Revenue maintained during disruption, rate or fee continuity, avoided shutdown and restart costs, avoided penalties or default costs, stronger debt-service coverage under stress, lower operating cash burn
Speed recovery	Time to restore service, repair duration, emergency operations duration, time to reopen facilities, time to revenue recovery where tracked, temporary-service or relocation costs	Shorter revenue-loss period, lower cumulative recovery costs, lower emergency operating costs, lower temporary service or relocation costs, reduced need for emergency borrowing, faster restoration of taxable activity

Table 10. Evidence for Value continued on next page

Table 10. Evidence for Value *continued*

Project Goal(s)	Evidence	How Value Can Show Up Financially
Protect public and private assets	Asset condition assessments, useful life, maintenance backlog, repair and replacement frequency, life cycle–cost analysis, assessed value, property value trends	Lower life cycle cost, delayed capital replacement, avoided asset impairment, protected assessed value, protected net operating income, lower future borrowing need, reduced insurance claims or deductibles
Reduce business and workforce downtime	Lost workdays where available, school or childcare closure days, transit disruption days, business closure days, emergency staffing/ overtime, sales or production downtime where available	Avoided wage and productivity losses, protected business revenue, protected sales-tax or income-tax receipts, lower business-interruption losses, lower overtime or emergency staffing costs, more stable employer operating income
Strengthen community stability and co-benefits	Property value trends, vacancy rates, displacement or housing instability indicators, heat illness or health-cost data where available, utility bill savings, local spending or business occupancy trends	Protected property tax base, avoided public service costs, healthcare cost savings, utility bill savings, energy or water cost savings, tax increment or assessment capacity, stronger long-term revenue base

Chapter 2 Key Takeaways

Define the risk and the system that must keep working. Before discussing financing, identify the assets, services, neighborhoods, lifelines, or economic activities that must continue under future conditions, and the hazards, stresses, and cascading failures that threaten them.

Explain the financial consequence of failure. Show what happens if the system does not perform: repair costs, emergency spending, lost revenue, business interruption, service outages, displacement, insurance pressure, reserve depletion, or tax-base loss.

Identify who benefits and who could help pay. Map the value across residents, businesses, utilities, public agencies, insurers, developers, employers, and the broader economy. This is what reveals whether the project needs public funding, shared funding, utility finance, district finance, grants, or another structure. It also shows where the "wrong pocket" problem may arise: when one party is expected to pay, but others receive most of the benefit. In those cases, deliberate aggregation or policy tools may be needed to solve the financing gap.

Separate value protection from new revenue. Avoided losses, lower volatility, faster recovery, and service continuity are financially important even when they do not produce new cash flow. The key is to show where protected value reduces real financial pressure—on budgets, insurance costs, credit quality, tax-base stability, or household and business costs—and whether that reduced pressure can help justify investment.

Use a few decision-ready metrics. Pick metrics that travel from planning into finance conversations: expected annual loss reduction, time to recovery, outage hours avoided, claims reduction, life cycle cost, premium differential, tax-base exposure, reserve draw avoided, or debt-service coverage under stress.

Be precise about what can and cannot be monetized. Use the term *monetized* only when there is an actual payment, rate recovery, premium reduction, fee, tax increment, credit, contract, or revenue stream. Otherwise, say the value is *measured, recognized, protected*, or *made visible*.

Treat insurance and credit as possible signals, not guaranteed savings. Resilience can improve the conditions insurers, lenders, and rating analysts care about, but savings depend on location, hazard, underwriting practice, regulation, project design, and proof.

Make the chapter's core test practical. Ask what does the project do, how do we know it works, and why does that matter financially?

Chapter 3. How Capital Evaluates Resilience

Main Messages

The capital available to finance resilience is not a specialized pool. It is the same diverse universe that finances long-lived investments of all kinds—municipal bond markets, pension funds, insurers, banks, community development financial institutions, green banks, philanthropies, and public agencies.

Repayment-focused capital—including bondholders, lenders, infrastructure investors, utilities, green banks, and community development financial institutions —evaluates resilience through the lens of financial return—whether a project protects a tax base, reduces expected claims, stabilizes utility revenues, or preserves asset value. Philanthropy and public subsidy ask what public benefit justifies the investment and what gap would go unfilled without it. The same project can answer both questions—what changes is the translation.

Matching the right capital to the right role is the core structuring task; mixing them up is one of the most common errors.

Most local governments engage municipal advisors, bond counsel, state revolving funds, green banks, community development financial institutions, community foundations, insurers, and state agencies, not large infrastructure funds or institutional asset managers directly. Knowing what each needs to see is more useful than understanding global capital markets in the abstract.

Capital tends to flow first to "safe bets"—projects with clear revenue streams, strong credit, and lower perceived risk —leaving more complex or community-serving investments harder to finance. The result is that resilience investments may be hardest to access in the places that need them most. Communities facing disproportionate climate risks may also face greater barriers to getting projects funded, including limited staff capacity, weaker access to capital, and a history of underinvestment.

Local governments often describe resilience in terms of public outcomes. Capital providers usually evaluate the same outcomes through a different lens: whether a project protects repayment, stabilizes revenues, reduces operating volatility, preserves asset value, improves insurability, or creates a credible pathway for future investment.

This does not mean each capital provider needs a completely different story. Most begin with a similar set of questions. What differs is the role they play, the type of risk they can hold, the scale they require, the evidence they need, and the constraints they operate under.

For local governments, the task is not to invent a separate resilience narrative for every investor, lender, or funder. The task is to understand how the same resilience outcome—systems continuing to function under stress—shows up differently depending on the capital provider's role.

A flood mitigation project, for example, may be described by a city as protecting neighborhoods from repeated flooding. A lender may see it as protecting the property tax base that supports repayment. An insurer may see it as reducing expected claims. A community development financial institution or green bank may see an opportunity to demonstrate a replicable model in an underserved community. A foundation may see an early-stage project that needs predevelopment funding, community engagement, or first-loss support before other capital can participate. The project is the same. The lens is different. Resilience finance is rarely a straight line from project idea to funding source. Most projects move forward when several pieces come together: public authority, a credible project sponsor, evidence that risk is being reduced, a funding or repayment source, and partners that can provide capital, technical support, risk validation, or implementation capacity.

Before moving into the landscape of capital providers and financing sources, it helps to have a shared vocabulary. These terms appear throughout this chapter and in Chapter 4, where they show up in financing structure examples.



Key Terms Used in This Chapter

Term	What It Means
Capital stack	The combination of funding and financing sources used to pay for a project, where each source has a specific role: repayment anchor, gap-filling, public value coverage, or risk absorption. Most resilience projects use more than one source, and the capital stack is the structure that shows how they fit together.
Concessional capital	Repayable money offered on easier-than-market terms, such as lower interest rates, longer repayment periods, more flexible conditions, guarantees, or a subordinate position—meaning it is repaid only after senior lenders are made whole.
First-loss capital	Funding that absorbs the earliest or most uncertain losses in a project, reducing risk for other investors or lenders who participate alongside it. By taking the first hit if a project underperforms, first-loss capital makes it possible for more risk-averse lenders to participate. It is often provided by philanthropy, government, or mission-driven investors.
Catalytic capital	Investment that accepts more risk, lower return, longer time horizons, or more flexible repayment than conventional capital in order to generate impact and unlock other funding or investment that otherwise would not participate. It may be used for predevelopment, first loss, proof of concept, affordability, or bridge funding.
Guarantee	A commitment by one party—often a government agency, foundation, or mission-driven institution—to repay a lender if the primary borrower cannot. Guarantees reduce the risk a lender takes on, making it more likely they will participate in a project they might otherwise pass on.
Green banks	Public, quasi-public, or nonprofit finance entities that use public or mission-driven capital to attract private investment into eligible clean energy, climate, resilience, or other green infrastructure projects.
Community development financial institutions	Mission-driven lenders certified by the US Treasury that provide financing and services to communities that mainstream finance does not traditionally reach.
Mission-driven lender	A plain-language umbrella term for lenders that consider public, community, or environmental benefits alongside repayment. This includes community development financial institutions, green banks, and other public-purpose lenders.
Program-related investments	Loans or equity made from a foundation's endowment to advance its charitable mission rather than its investment portfolio. Unlike grants, they are repayable but structured to serve mission rather than maximize financial return.

Figure 7 provides a roadmap for the chapter. It shows the broader landscape of actors that may shape whether a resilience project can be funded, financed, insured, procured, or scaled.

Figure 7. The Resilience Finance Landscape

The Financing Ecosystem

Who Participates and What Role They Play

Infrastructure is rarely funded by one source. A range of investors and partners work together, each with a different role, to turn community priorities into investable projects that deliver lasting value.

Infrastructure is rarely funded by one source. A range of organizations work together to move projects from planning to implementation. Direct participants provide capital, own assets, finance projects, deliver services, or operate infrastructure. They are the organizations most directly responsible for making resilience investments happen.

DIRECT PARTICIPANTS
Invest in or operate specific projects or assets

Who They Are	**PUBLIC ENTITIES** Cities, utilities, transit agencies, special districts	**LENDERS & BOND INVESTORS** Banks, bondholders, credit unions	**INFRASTRUCTURE & PRIVATE INVESTORS** Infrastructure funds, private equity, strategic investors
What They Do	Set priorities, own assets, raise revenue, issue debt, and coordinate investments	Provide debt financing that must be repaid over time	Invest equity in assets or companies and may operate them
What They Look For	Community impact, affordability, reliability, fiscal responsibility, and long-term value	Repayment reliability, stable revenue or tax base, strong credit, and sound governance	Long-term earnings, operational performance, cost stability, and growth potential
Examples	• General obligation bonds • Utility revenue bonds • State revolving funds • Special assessments • Public-private partnerships	• Bank loans • Municipal bonds • Private placement debt • Loan programs • Lines of credit	• Private equity • Infrastructure funds • Strategic investors • Direct investment in assets or platforms

Not every organization finances or owns infrastructure directly. Enabling participants create the conditions that make investment possible. They provide technical assistance, establish standards, reduce risk, coordinate partners, aggregate projects, strengthen evidence, and help communities prepare projects for funding and financing.

INDIRECT PARTICIPANTS

Enable, validate, aggregate, and shape the conditions for investment

Who They Are 	**INSTITUTIONAL INVESTORS** Pension funds, insurance companies, asset managers	**CATALYTIC & IMPACT INVESTORS** CDFIs, green banks, philanthropy, impact funds	**INSURANCE MARKETS** Insurers, reinsurers, risk pools
What They Do 	Invest at scale through funds or portfolios rather than individual projects	Provide early capital, take on more risk, or improve project readiness to attract other investors	Assess and price risk. Provide coverage that protects assets, operations, and investors
What They Look For 	Scale, standardization, diversification, long-term stable returns, and risk management	Impact, innovation, community benefits, leverage of other capital, and scalable potential	Risk reduction, resilience measures, loss history, and system reliability
Examples 	• Pension fund allocations • Insurance company investments • Infrastructure funds • Separate accounts	• CDFI loans • Green bank financing • Grants and guarantees • First-loss capital • Technical assistance	• Property insurance • Parametric insurance • Catastrophe bonds • Risk modeling services

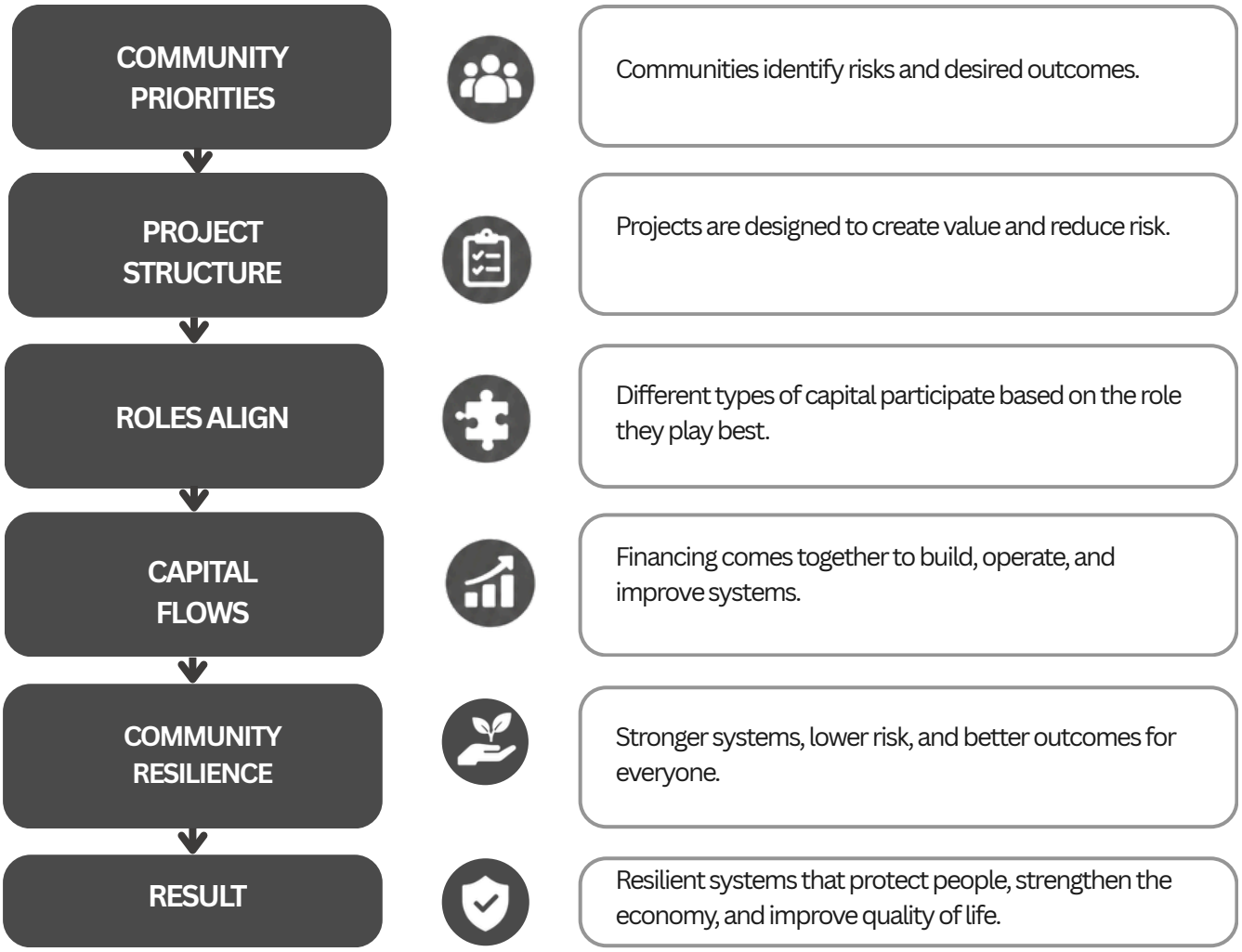
A SYSTEM, NOT A MENU

Financing works best when different types of capital play different roles, aligned to a common purpose. Projects move forward when value is structured clearly, roles are coordinated, and risks are managed across the system.

KEY TAKEAWAY

Successful projects align community needs with the right mix of capital and make each investor's role clear. It's not about finding one source of funding. It's about building partnerships that work together to deliver resilient, equitable, and thriving communities.

HOW IT ALL COMES TOGETHER



NOT EVERY INVESTOR IS RIGHT FOR EVERY PROJECT. Understanding roles helps cities structure projects and build partnerships that unlock the capital needed to create lasting value.

Sources of Resilience Finance

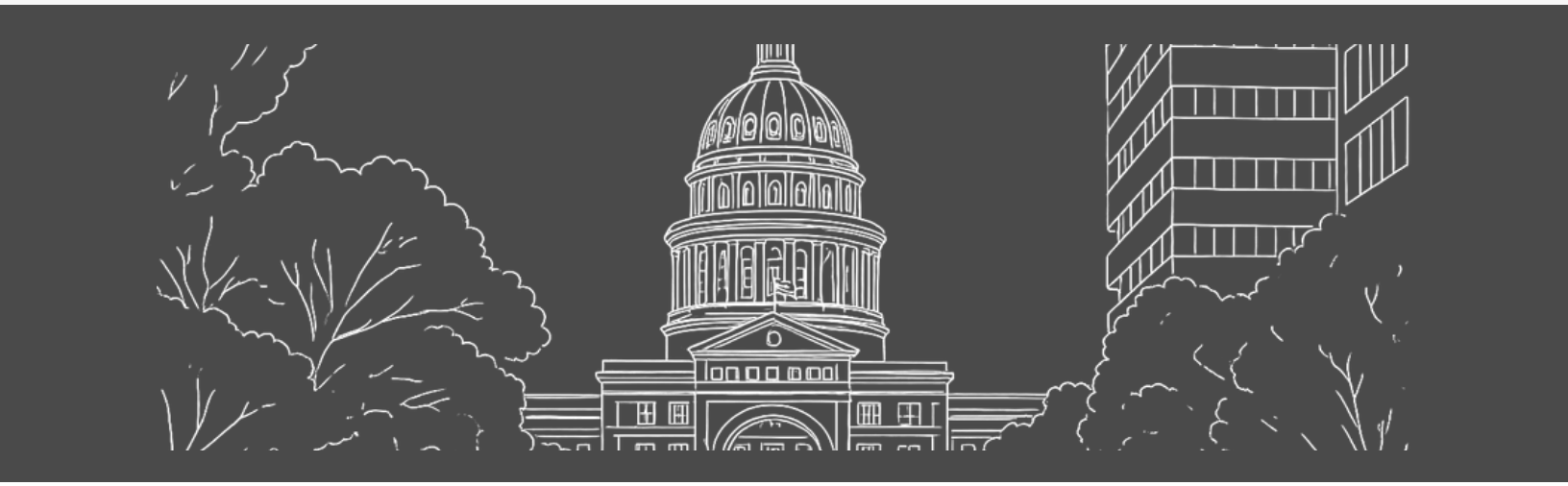
Debt

Debt is the dominant financing tool for local infrastructure in the United States. It is borrowed money that must be paid back over time, usually with interest. The US municipal bond market held approximately $4.2 trillion outstanding at year-end 2024 (Johnson 2025; SIFMA 2026). State revolving funds are another important source of low-cost debt. Although they often begin with federal capitalization, programs such as EPA-supported water infrastructure state revolving funds and FEMA's Safeguarding Tomorrow Revolving Loan Fund are administered by states as revolving loan funds that can finance eligible projects over time, including water, wastewater, stormwater, green infrastructure, hazard mitigation, and resilience projects (**EPA 2026a, b; FEMA 2026**).

In this chapter, the term lenders refers broadly to the full debt ecosystem: commercial banks, public lenders such as state revolving funds, bondholders who buy municipal bonds and collect interest payments, and the underwriters and advisors who help governments bring bonds to market.

Two instruments matter most for resilience. General obligation bonds are backed by the full faith and credit of the government and its taxing authority. They typically require voter approval and a clear public purpose argument, which means the investment case for resilience has to be made explicitly and publicly. Revenue bonds are repaid from a dedicated stream, such as utility rates, stormwater fees, tax increment, special assessments, and do not require voter approval in most states. However, they do require a legally pledgeable revenue source connected to the project. Both instruments require state law authorization and defined eligible uses. Both also draw on a community's limited ability to borrow, because debt must be repaid within legal limits, annual budgets, credit rating expectations, and what taxpayers or ratepayers can afford. If resilience is presented as a separate project category, it may be seen as competing with roads, schools, water systems, housing, and other infrastructure needs; if it is framed as protecting those systems, it can become part of the core capital strategy.

For resilience, the most important structuring decision often happens before the bond is drafted. Bond language that defines eligible uses narrowly—naming only a specific asset type—can inadvertently exclude the hazard mitigation components, higher design standards, green infrastructure, drainage redundancy, or backup power that make the investment perform under stress. Broad eligible-use language, drafted with resilience in mind, lets a conventional bond finance more than a narrowly drawn resilience bond ever will.



Rating agencies are increasingly attentive to physical risk exposure, deferred maintenance, and fiscal shock vulnerability. A community investing in flood protection, grid hardening, or watershed restoration has a better long-term credit story than one that is not, because those investments can reduce the likelihood of major damage, service disruption, revenue loss, or emergency spending. But rating agencies and investors need to see that connection clearly. That story will not appear in a rating analysis unless the community puts it there through official statements, continuing disclosures, and investor presentations.

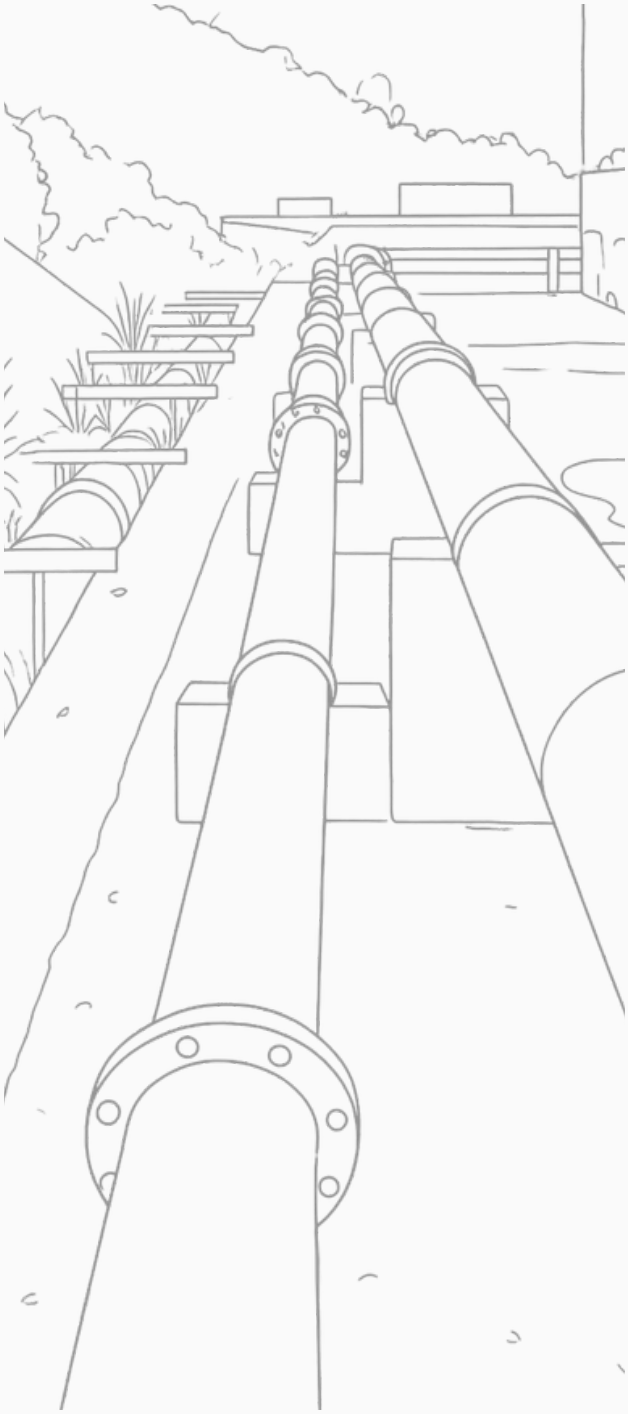
Water-sector rating actions in 2025 and 2026 show why this translation matters. Corpus Christi illustrates the downside: in December 2025, Moody's downgraded the city's general obligation, sales tax revenue, and utility ratings after citing the region's urgent need to secure additional water supply before projected demand exceeds availability. (City of Corpus Christi 2025)

Atlanta shows the positive version of the same credit story: in March 2026, S&P upgraded the city's water and wastewater bonds after sustained infrastructure investment, reduced regulatory risk, and disciplined financial oversight, while the city pointed to those investments as making the system more reliable, resilient, and prepared to serve residents over time. (City of Atlanta 2026, S&P Global Ratings. 2026).

Together, the examples show that rating agencies are not simply looking for projects labeled "resilience"; they are looking for evidence that a community is reducing risks to essential services, revenues, and long-term financial stability.

Implications for Local Government

- Show the connection between the investment and what it protects: the tax base, the rate revenue, the service reliability that supports repayment.
- Confirm bond language includes resilience-relevant eligible uses before the measure is drafted.
- If federal grants are in the capital stack, identify early which components fall outside federal BCA eligibility so the bond can be sized to cover them.
- Use debt capacity deliberately for long-lived capital assets with clear repayment logic, not for components better funded through grants, operating budgets, or concessional capital.



When Borrowing is Harder Than it Should Be: Smaller Communities and the Bond Market

The municipal bond market—where cities, counties, utilities, and special districts borrow by selling bonds to investors that include pension funds, insurance companies, mutual funds, and individual savers—is the backbone of public infrastructure finance in the United States. The market issued a record $582 billion worth of bonds in 2025, with more than $4 trillion outstanding (MSRB 2026). This is more than just a borrowing tool, it is the primary mechanism through which long-duration private capital reaches public projects. When communities underuse this market—because they lack a credit rating, cannot absorb the cost of issuance, or issue too infrequently to build investor relationships—they pay more to borrow, attract a narrower pool of capital, and often defer the resilience investments that would reduce their long-term costs.

Of the roughly 37,000 governments that participate in the municipal bond market, most are small, infrequent borrowers that together account for only 10% of total debt outstanding (Gaughan and Tomer 2024). About 34% of local bond issues carry no credit rating at all, meaning investors have no independent assessment of creditworthiness and typically demand higher returns to compensate (Peppe and Unal 2022).

Many of these communities may have more borrowing room than they realize. The ratio of local debt to GDP has fallen from roughly 20% in 2010 to around 10% today, and credit rating agencies evaluate governments on financial performance, reserves, and liquidity management as much as on debt levels (Devitt 2024, Pedrosa 2025). The barrier is rarely the debt limit itself. Instead, it is the cost and complexity of market access: rating fees, legal counsel, financial advisors, disclosure obligations, and annual reporting that a small town's finance office may not have the capacity to manage. A federal tax rule helps smaller governments borrow from local banks at lower cost, but its $10 million annual limit has remained largely unchanged since 1986, making it less useful as inflation and construction costs have risen. (GFOA n.d.).

For communities that cannot easily issue bonds on their own, several pathways remain available. A state bond bank issues bonds on behalf of many communities at once and lends the proceeds at the same low rates large issuers get, but only 13 states have active bond banks (Gaughan and Tomer 2024). A revenue bond issued through a water, wastewater, or energy utility borrows against customer fees—a cleaner repayment source than a small town's general budget and typically employed without the need for voter approval. A county, regional authority, or special district can issue on behalf of a multijurisdictional project using a stronger credit profile. And where credit quality is the barrier, a state agency, bond insurer, or federal program can backstop the bond, reducing perceived risk and broadening investor participation.

The right question to ask is: whose financial standing, legal authority, or dedicated revenue can best anchor a bond issuance for this project? For example, a resilience investment protecting a water treatment plant may be better bonded through the water utility than through a small town's general fund. A regional flood project may need a county authority or state bond bank to issue on its behalf. When none of these paths work, the project may need grants, concessional capital, or other non-debt sources before it is ready for the bond market.

Institutional Investors

Institutional investors are organizations that manage or allocate large pools of capital on behalf of many people or institutions. Examples include pension funds, insurance companies, university endowments, sovereign wealth funds, and similar entities. The money they control is often called institutional capital. Institutional capital can reach resilience-related infrastructure in several ways. It may be used to buy municipal bonds, invest in infrastructure funds, support private infrastructure platforms, or participate indirectly in public-private partnerships. In many cases, asset managers, infrastructure funds, developers, or concessionaires invest this capital on behalf of the original asset owners.

This distinction matters for local governments. A city may learn that pension capital or insurance capital is part of a project, but the city is usually not negotiating directly with a pension system or insurance company. It is more likely negotiating with a concessionaire, developer, fund manager, underwriter, or operating company.

Private infrastructure investors and private-equity-backed platforms often invest directly in operating assets or companies. Examples include energy systems, water infrastructure, ports, data centers, health care facilities, wastewater-to-energy projects, and utility platforms. These investors focus on whether the asset can operate reliably, generate steady cash flow, manage costs, and hold or grow its value over time.

Investors often use the term EBITDA as shorthand for this question. EBITDA stands for earnings before interest, taxes, depreciation, and amortization. In plain English, it asks whether an asset can reliably make money after paying its operating costs. A resilience upgrade matters to this audience when it reduces downtime, avoids repairs, stabilizes costs, protects revenue, extends asset life, lowers insurance costs, or increases the asset's value when it is later refinanced or sold. For a city evaluating a public-private partnership, this is the question a private partner will be asking about the asset you're asking them to finance or operate.

Implications for Local Government

- Very large investors rarely finance one-off local resilience projects directly; they finance bonds, funds, concessions, utilities, real estate portfolios, and large infrastructure platforms.
- The city's job is to decide whether a project is best embedded in a larger transaction, bundled with others, pooled across jurisdictions, or kept as a publicly funded effort when the benefits are too broad to assign to specific payers.

Impact and Catalytic Capital

Impact capital is not one thing—and that is the most important thing to understand about it. Impact capital investments share one characteristic: they seek to produce measurable social or environmental benefit alongside a financial return. The Global Impact Investing Network estimated the market at approximately $1.571 trillion in 2024, spanning a wide range of actors with different mandates, return expectations, and definitions of what counts as a beneficial outcome (Hand et al. 2024).

For local governments, the most relevant actors are community development financial institutions (mission-driven lenders certified by the US Treasury to serve underserved communities), green banks (public or quasi-public institutions focused on clean energy and climate projects), loan funds, and foundations using program-related investments (loans or equity made from a foundation's endowment to advance its charitable mission rather than its investment portfolio). Community development financial institutions hold significant scale: as of mid-2025, approximately 1,378 certified institutions collectively held about $446 billion in assets nationwide (Scott et al. 2026).

Catalytic capital is a subset of impact capital. It deliberately accepts more risk, lower return, longer time horizons, flexible repayment, a subordinate position (paid back only after other lenders are made whole), guarantees, first-loss protection (where the investor absorbs the first losses if the project underperforms, shielding other investors), or technical assistance, all to make a project or market possible that otherwise would not be. Not every good resilience project is catalytic, and not every impact investor wants to prove a new model. Some simply finance community-benefit projects on flexible, but repayable, terms. Others deliberately use grants, guarantees, or below-market investments to reduce risk enough that mainstream lenders are willing to participate, making it possible for larger flows of conventional capital to follow. Predevelopment is one of the most common and highest-leverage uses of catalytic capital in resilience finance; Chapter 4 covers how it works in practice.

Implications for Local Government

- Use mission-driven and catalytic capital where conventional finance does not fit: predevelopment, proof of concept, low-income or underserved markets, small borrowers, first-loss layers, guarantees, flexible repayment, or projects that span multiple sectors or jurisdictions and do not align neatly within a single program or funding source. For predevelopment specifically, see Chapter 4.
- Do not assume impact means free money; most impact capital expects repayment. Philanthropy and public grants should be used strategically to make the overall capital stack workable.

Philanthropy and Community Foundations

Unlike catalytic capital, which expects some form of repayment or return, philanthropy asks only what public benefit the investment serves and what would go unfunded without it. It is rarely a primary source of infrastructure funding. Foundations seldom pay for large construction, particularly when others may later generate revenue from the asset. They tend to engage earlier in the project life cycle or in the parts of a project hardest to fund through normal channels: planning, community engagement, data collection, pilot programs, and risk reduction that helps other funders participate.

Philanthropy can also share risk directly—for example, by covering a first-loss position or backstopping a loan through a guarantee (a promise to repay the lender if the borrower cannot). These tools do not pay for the project itself, but they can make other lenders more willing to contribute.

Implications for Local Government

Philanthropy is most likely to help in the parts that are hardest to fund or most risky. For how predevelopment funding fits into a financing strategy, including what it costs, who funds it, and how it connects to the rest of the capital stack, see Chapter 4.

This is especially true if philanthropic contribution makes it possible for other lenders or investors to participate.

large construction, particularly when others may later generate revenue from the asset. They tend to engage earlier in the project life cycle or in the parts of a project hardest to fund through normal channels: planning, community engagement, data collection, pilot programs, and risk reduction that helps other funders participate.

Philanthropy can also share risk directly—for example, by covering a first-loss position or backstopping a loan through a guarantee (a promise to repay the lender if the borrower cannot). These tools do not pay for the project itself, but they can make other lenders more willing to contribute.

Public Funding and Concessional Capital

Public funding is money from government sources—grants, appropriations, tax or fee revenue, federal formula programs—that generally does not have to be paid back. Concessional capital is money that does

have to be repaid, but on easier-than-market terms: lower interest rates, longer payback periods, more flexible conditions, or subordinate positions. Both often come from public or mission-driven sources, but they function differently in a financing structure.

Public funding matters most where a project's benefits are broad or shared and cannot be assigned to any single person or entity who could be charged for them. Flood protection, nature-based solutions, and community-scale risk reduction often fall into this category. Public funding can cover a project's full cost or pay for one layer in a larger funding plan. Concessional capital improves feasibility by lowering cost, extending repayment timelines, or covering gaps that conventional lenders will not touch. Its value lies less in the dollars themselves than in what they unlock: a concessional loan or guarantee is often the piece that makes the rest of the financing workable.

The key distinction for a local government practitioner: public funding generally is not repaid. Concessional capital is—just on gentler terms than a bank or private investor would offer.

Implications for Local Government

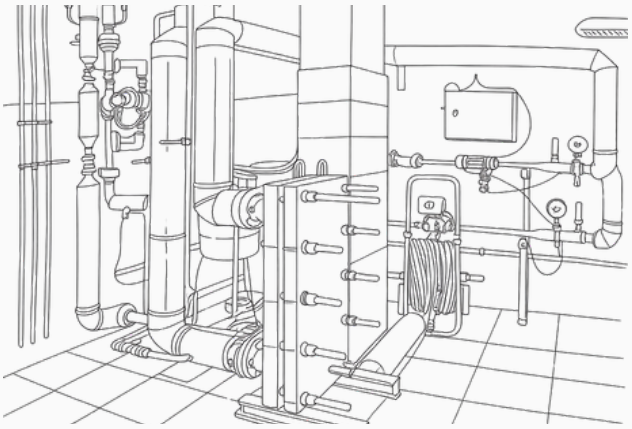
- Identify where a project can realistically support financing—meaning it can generate enough revenue or demonstrated savings to justify repayment—then use grants and concessional capital strategically for the parts that are harder to repay or harder to assign to a specific payer.
- Do not treat concessional capital as a substitute for grants; most of it expects repayment. Use philanthropy and public grants to cover the pieces that cannot be financed, and concessional dollars to bridge the gap between what conventional lenders will accept and what the project actually requires.t

The Common Logic Across Capital Providers

Most capital providers are not asking whether a project is resilient in the abstract. They are asking whether the project changes risk, performance, or financial stability in a way they can evaluate.

Across capital types, the core questions are similar:

- What asset, system, or economic activity is being protected? This could be a utility system, transportation corridor, hospital, housing portfolio, downtown district, watershed, energy system, or the broader tax base of a local government.
- How does the project affect cash flow, cost stability, or asset performance? Does it protect existing revenue, reduce operating volatility, avoid costly disruptions, lower life cycle costs, or preserve asset value?
- What risks are being reduced, and for whom? Does the project reduce physical damage, service outages, business interruption, insurance claims, credit risk, or fiscal stress?
- Who benefits, and who can pay? Does the value accrue to the project owner, local government, utility, insurer, property owners, businesses, residents, or multiple beneficiaries across a district or system?
- Is the risk reduction credible and measurable? Can the project's benefits be supported through engineering analysis, modeling, performance data, insurance standards, asset management plans, or other evidence?
- Is there authority to act? Can the relevant entity raise revenue, issue debt, adjust rates, create a district, enter into a long-term contract, or receive and deploy outside capital?



These questions are common, but capital providers use the answers differently. A lender asks whether the answers strengthen repayment. An infrastructure investor asks whether they protect long-term asset performance. An insurer asks whether they reduce expected losses in a way that can be reflected in underwriting. A catalytic investor asks whether the project can become financeable or scalable. A foundation may ask whether a relatively small grant, guarantee, or first-loss position could unlock larger flows of capital.

The core principle is that resilience matters to capital when it protects performance, reduces volatility, improves reliability, or makes risk more measurable. What differs across capital providers is how those outcomes enter their decision-making.

The sections above describe the major sources of resilience finance. Table 11 brings them together by showing what each type of capital needs to see before it can engage. The same resilience project may protect a neighborhood, stabilize a utility, reduce claims, or strengthen a tax base, but each capital provider evaluates that value through a different decision lens.

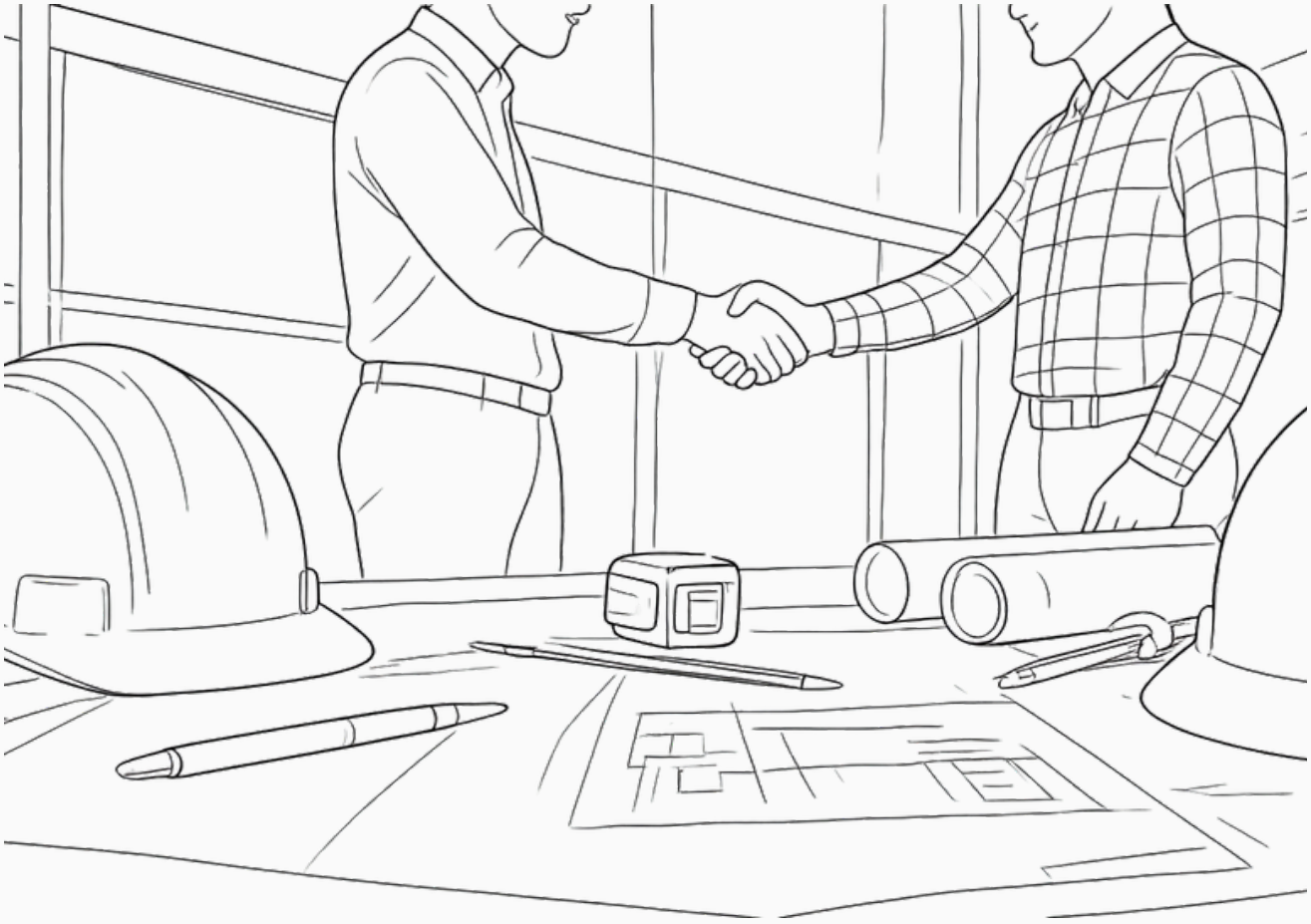


Table 11. Translating Resilience Value by Capital Type

Capital Type	What They Need to See	How Resilience Shows Up
Debt and public lending	Repayment stability, credit quality, and adequate disclosure	Protected revenues and tax base, stronger debt-service coverage, lower emergency borrowing, reduced fiscal shock risk
Institutional investors	Long-term portfolio performance and manageable climate exposure	Revenue durability, lower tail risk, maintained insurability, protected portfolio value
Infrastructure and private equity	Value creation, operating performance, and exit conditions across a defined fund life	Protected earnings before interest, taxes, depreciation, and amortization (EBITDA); maintained insurability at exit; reduced operational liability; stronger resale conditions
Insurance and reinsurance	Risk reduction at sufficient scale to shift the aggregate loss distribution, verified through models or regulatory frameworks	Community-scale loss reduction, interventions in catastrophe models or Community Rating System (CRS), verified standards with claims history, maintained market availability
Community development financial institutions, green banks, and mission-driven lenders	A creditworthy borrower in an underserved market with a credible repayment path and documented community benefit	Flexible repayment aligned with cash flows, documented community benefit, replicable structure, technical assistance needs identified

Table 11 Translating Resilience Value by Capital Type continued on next page

Table 11. Translating Resilience Value by Capital Type *continued*

Capital Type	What They Need to See	How Resilience Shows Up
Impact investors and catalytic capital	A specific structural barrier their capital can solve that unlocks larger flows	First-loss or guarantee opportunity, proof-of-model potential, aggregation structure, clear path to follow-on capital
Philanthropy and community foundations	A public benefit or market gap aligned with mission where conventional capital will not reach	High-risk, low-capacity communities; early-stage feasibility or engagement needs; components with public benefit but no repayment stream
Public funding and grants	Eligibility, scoring criteria, and alignment with program rules and applicable plans	Specific eligible project components tied to program mission, fit with hazard mitigation or recovery plan requirements, statutory compliance



Cross-Cutting Challenges

Several challenges recur across almost every capital type, and understanding them helps explain why resilience finance requires more than identifying a new source of money.

- **The translation barrier.** Local governments describe resilience as *community protection* or *avoided loss,* while capital providers evaluate financial performance, repayment, asset value, cost stability, or reduced claims. Even when both sides are looking at the same project, they are speaking different languages.
- **The value capture barrier.** Resilience benefits are often distributed across households, businesses, insurers, utilities, and public agencies simultaneously, and no single entity captures enough value to pay for the investment alone.
- **The evidence barrier.** Resilience benefits are inherently difficult to prove in financial terms, especially when the value lies in disruptions that do not occur.
- **The scale barrier.** Many resilience projects are too small, bespoke, or locally specific to attract larger pools of capital unless they are aggregated into a portfolio, program, district, or repeatable structure. Aggregation is the most commonly cited solution, and the most commonly left as a conceptual idea without a concrete path. In practice, aggregation only works when practical governance, financing, and implementation steps are completed:
    - Group similar projects within a defined geography or risk type
    - Identify a common payer or intermediary that can act on behalf of the pool
    - Create a governance vehicle that can enter contracts and hold funds
    - Allocate costs and benefits fairly across participants
    - Standardize evidence and contracting so the pool behaves like a single transaction
    - Create enough scale for capital to engage: typically $5 million or more for community development lenders, $20 million or more for bond markets, $50 million or more for institutional investors

    If any of those steps cannot be completed, aggregation will stall.



From Projects to Portfolio—Broward County, FL

The Resilient Cities Network's 2025 report Under Pressure, Overdue: The Portfolio Approach and Financing Cities for Resilience, developed with Tokio Marine Group, examines how cities around the world are financing resilience at scale. One of its US examples—Broward County, FL—illustrates what project aggregation and a portfolio approach look like in practice.

When recurring flooding and insurance premiums that had risen more than 400% in some areas created a crisis point, county leaders convened elected officials, finance staff, engineers, and local business leaders, brought in outside consultants to model the economic cost of inaction against two adaptation strategies, and calculated a return on investment before any financing decisions were made. The resulting portfolio was not a single project. It combined multiple types of flood-risk-reduction and adaptation investments, including pumps and drainage systems, distributed stormwater storage, elevated seawalls designed for future sea-level-rise conditions, and redevelopment strategies that could reduce exposure over time. Local businesses proposed a sales tax increase to fund the work. The municipal bond market and insurance sector became structural partners from the start.

That is the portfolio approach in action: not one project designed around available funding, but a connected set of investments that can reduce risk across a system. Aggregation mattered because it allowed Broward County to evaluate costs, benefits, insurance implications, and financing needs across a larger package of work, giving public officials, businesses, bond investors, and insurers a clearer basis for action over time.

- **The authority barrier.** The practical first question is always governance: who has the authority and mandate to bring the projects and partners together, make decisions, and manage the shared funding or financing structure? A local government may identify a financeable opportunity but lack the legal power to raise revenue, issue debt, form a district, or enter into the necessary agreement, thus constraining core parts of the financing strategy.
- **The fiscal capacity and access problem.** Communities facing the highest climate and disaster risks—often lower-income, rural, or historically underinvested places—usually have the least fiscal capacity and lowest creditworthiness. Without deliberate structuring—public co-investment, first-loss capital, guarantees, concessional financing, or dedicated technical assistance—capital tends to flow toward wealthier, higher-capacity communities already better positioned to repay and absorb risk, bypassing the places where resilience investment is most urgently needed.

Headwaters Economics documents this empirically: counties with lower staff and fiscal capacity received 19 times less BRIC pre-disaster mitigation funding than high-capacity counties, even when climate risk was equally high (Smith 2024). Urban Institute research confirms that federal climate-resilience programs often reach communities that are already better positioned rather than those most exposed (Hermans et al. 2025).

[2]

Addressing these challenges requires deliberate structuring at every stage: public funding and concessional capital for components that cannot support conventional repayment, mission-driven lenders and green banks that are designed to serve under-resourced borrowers, technical assistance to help communities build project readiness, and first-loss capital and guarantees to bring other lenders in.

RAND's Resource Guide for State and Local Financial Resilience shows how states and local governments can use tools such as parametric insurance, catastrophe bonds, and revolving loan funds to manage disaster costs, especially in under-resourced communities e (Clancy et al. 2023). Urban Institute's framework for climate-resilient affordable housing provides complementary guidance on integrating resilience into housing and community development planning where fiscal stress and climate risk overlap most acutely (Cohen et al. 2024).

Taken together, these challenges explain why resilience finance is not simply about finding more capital. It is about structuring projects so that value, evidence, authority, repayment, and risk are aligned—and doing so deliberately enough to reach lower-income, lower-capacity, and higher-risk communities, not just those already well-positioned to attract investment.

One way to make that structuring choice explicit is to ask what kind of risk-financing job a project, policy, or financing tool is performing. In practice, governments manage risk in four basic ways: they retain it, reduce it, transfer it, or share it.



Table 12. How Risk-Financing Choices Shape Capital Alignment

Risk-Financing Choice	What it Means	Best Fit
Retain the risk	The local government pays through reserves, deductibles, operating budgets, emergency funds, or deferred projects	Smaller, more predictable losses the community can absorb
Reduce the risk	The local government invests in mitigation, stronger standards, maintenance, land-use changes, or operational improvements	Risks that can be lowered through physical, policy, or operational action
Transfer the risk	The local government pays an insurer, risk pool, reinsurer, or capital-market structure to cover defined losses	Larger, volatile, or fast-moving losses that could strain the budget
Share the risk	Multiple agencies, utilities, districts, private partners, or higher levels of government contribute to protection or recovery	Risks that cross jurisdictions, systems, or beneficiaries

Most resilience strategies combine more than one approach. A flood protection project may reduce risk, insurance may transfer some of the remaining risk, reserves may retain a portion of what remains, and state or federal programs may share costs after a disaster. Understanding which role a tool plays helps local governments build more complete financing strategies and choose the right sources of capital.

Resilience Enablers

Some tools do not finance resilience projects directly, but they do strongly shape whether resilience investments can move from concept to implementation. Two of the most important are insurance and procurement.

Insurance and Reinsurance: Risk Validation, Pricing, and Transfer

Insurance does not usually finance resilience projects directly. Its primary role is to price, validate, and transfer risk. That role is powerful because insurance affects whether assets can be built, financed, operated, bought, sold, or refinanced. If a property, facility, or infrastructure system becomes too expensive or difficult to insure, lenders and investors may pull back. If resilience investments reduce expected losses in a way insurers can recognize, they may improve coverage availability, premiums, deductibles, or other risk-transfer options.

Insurance and reinsurance ask a practical question: Is the risk reduction measurable enough to affect expected losses? Insurers care about whether a resilience measure reduces expected claims or catastrophic tail risk; can be verified through standards, inspections, or data; can be incorporated into underwriting or catastrophe models; improves insurability; and supports faster recovery after an event.

The distinctive issue is verification. A local government may believe a project reduces risk, but insurers need evidence that can be used in underwriting, pricing, or modeling. That evidence may come from engineering standards, building codes, flood models, wildfire mitigation standards, claims history, inspections, or catastrophe models. Insurance markets also have structural constraints: Premiums may not adjust quickly or directly in response to local risk reduction, and pricing can be shaped by regulation, litigation, reinsurance costs, market withdrawal, residual markets, or annual policy cycles. This means resilience investments may improve real-world risk without immediately producing lower premiums.

Insurance should therefore be treated as part of a broader risk-financing strategy. It can help manage residual risk and accelerate recovery, but it is not a substitute for reducing risk at the source.



When Risk Reduction is Standardized and Recognized

FEMA's Community Rating System (CRS) provides a clear example of risk reduction being acknowledged through insurance pricing. Communities that exceed minimum floodplain management standards can receive National Flood Insurance Program premium discounts ranging from 5% to 45% **(FEMA 2024)**. Tulsa, OK, reached Class 1—the highest CRS rating—making residents eligible for a 45% discount beginning in April 2022 (City of Tulsa 2021).

Tahoe Donner shows how documented risk reduction can affect insurance terms. Tahoe Donner, one of the country's largest homeowners' associations, entered into a novel wildfire resilience insurance policy that recognized its forest management and fuel-reduction practices through a lower premium and deductible. The policy covers 1,345 acres of association-owned open space, forested, and recreation land. It does not cover individual homeowner policies, individually owned lots, or structures. The policy had a 39% lower premium and 89% lower deductible than the modeled cost would have been without documented mitigation, based on fire-behavior modeling and predicted suppression conditions with reduced fuel loads compared with pre-treatment conditions (TNC 2025; WTW 2025).

The association had decades of forest management behind it, including a long-standing and evolving Forestry Department, a Forest Health Management Program that began in the 1990s, and years of documented treatments such as thinning, prescribed fire, fuel breaks, and ongoing maintenance across association-owned land. That history gave insurers something concrete to evaluate. Working with partners, Tahoe Donner translated those activities into the language of insurance: treatment records, wildfire-risk modeling, underwriting analysis, and a parametric policy structure tied to measurable wildfire conditions. That process helped make the risk reduction visible, credible, and usable in a commercial insurance transaction. In doing so, the policy became more than a source of coverage; it became a market signal that adaptation measures can affect price and terms when they are sustained, documented, and evaluated in ways insurers can use.

The Tahoe Donner policy does not mean insurance will automatically finance risk reduction or reduce every homeowner's insurance bill. Its significance is narrower and more useful for this chapter: documented forest treatment, modeling, and parametric policy design made the risk reduction visible enough for insurers to recognize it in writing and reflect it in commercially placed insurance terms. Tahoe Donner's longer-term goal is to apply a similar methodology to quantify risk reduction in ways that could eventually inform homeowner insurance, but the current policy's validated lesson is more specific: sustained and documented resilience work can become usable evidence for capital and insurance markets.



Implications for Local Government

- Local governments should assign a small team that combines finance, risk management, and project expertise to engage insurers, brokers, and risk modelers early. The goal is to understand what evidence they need to recognize risk reduction in premiums, deductibles, coverage, or underwriting. Insurance is not a substitute for project funding, but it can help define what the market will accept as proof of reduced risk.
- Engage insurers, brokers, and risk modelers early to understand what proof they need to recognize risk reduction in premiums, deductibles, coverage, or underwriting. Insurance is not a substitute for project funding, but it can help define what the market will accept as evidence of reduced risk.
- Building officials, floodplain managers, emergency managers, risk managers, public works, resilience staff, and finance and budget teams should identify which standards or actions could affect premiums, deductibles, coverage, or insurability—such as CRS participation, stronger building codes, FORTIFIED or wildfire standards, verified floodproofing, or documented vegetation management.
- Elected and executive leaders can turn that technical analysis into community progress by backing the policy, budget, and implementation choices that make mitigation real: adopting stronger standards, funding communitywide risk reduction, supporting affordability measures, and advocating for state insurance or building-code reforms.

Procurement: Using Public Purchasing Power to Deploy Adaptation and Resilience Solutions

Procurement is one of the most practical but underused levers in resilience finance. Local governments shape resilience beyond funding and financing through what they already buy: engineering services, construction, building materials, pumps, sensors, cooling systems, backup power, vegetation management, software, maintenance contracts, and risk tools.

The scale is large enough to matter. State and local governments spent $3.7 trillion in direct general government expenditures in fiscal year 2021, including $1.9 trillion by local governments (Urban Institute 2024). Tailwind Futures estimates that government demand for adaptation and resilience solutions totaled $737 billion globally in 2023, including $290 billion in the United States, as part of more than $1.4 trillion in annual global demand for adaptation and resilience solutions (Mazzacurati and McDonald 2024).

For local governments, procurement can move resilience from planning to implementation. A city or county can write resilience into scopes of work, technical specifications, design standards, evaluation criteria, life cycle–cost analysis, vendor qualifications, and performance requirements. Instead of buying the lowest-cost option that meets today's minimum standard, procurement can ask how a solution will perform under future flood, heat, wildfire, drought, storm, or outage conditions.

How local governments buy can help shape the adaptation and resilience market. When cities, counties, and utilities clearly describe the problems they need solved—such as cooling public facilities during extreme heat, keeping stormwater systems working under heavier rainfall, or maintaining power for critical services—they send a demand signal to vendors, entrepreneurs, researchers, and investors. That signal matters because many adaptation and resilience solutions already exist, but buyers often have not created clear pathways to purchase them (Mazzacurati and McDonald 2024). It also matters because resilience is increasingly being recognized as an investable market.

The Global Adaptation and Resilience Investment Group and partners identified more than 800 publicly listed companies with products and services that contribute to climate adaptation and resilience (GARI 2024).

ICLEI USA frames sustainable public procurement as a tool local government can use to advance climate action and while also generating social and economic benefits through purchasing decisions (ICLEI USA 2024). Cooperative purchasing, regional solicitations, prequalified vendor lists, challenge-based procurement, and master contracts can help cities and counties aggregate demand, reduce transaction costs, and give vendors a clearer signal that there is a market for better resilience products and services. The National League of Cities similarly notes that cooperative purchasing can reduce prices through bulk buying power, and performance-based contracting can pay suppliers for results rather than activity (Gregory and Mehrotra 2024).

Procurement is not a substitute for funding. Local governments still need budget authority, grants, rates, fees, bonds, or other revenue to pay for what they buy. But procurement determines whether those dollars purchase resilience or simply replace vulnerable assets with newer vulnerable assets. The Government Finance Officers Association's (GFOA's) life cycle–costing guidance is directly relevant: acquisition cost is only one part of the cost of owning an asset, and life cycle analysis helps governments evaluate long-term maintenance, failure risk, and cost-effectiveness rather than simply selecting the cheapest upfront option (GFOA 2024).

Implications for Local Government

- Procurement staff, public works, utilities, capital planning, resilience and sustainability teams, emergency management, IT/data teams, risk managers, and budget staff should work together before solicitations are written. Their opportunity is to translate resilience goals into what the jurisdiction buys: scopes of work, design standards, life cycle–cost criteria, performance requirements, vendor qualifications, maintenance terms, and evaluation points.
- Executive and elected leaders can help when procurement requires policy direction, through approving best-value procurement, adopting higher standards, supporting pilots, pooling demand with nearby jurisdictions, or accepting higher upfront costs to reduce long-term risk.
- The key question is not only "how do we pay for this project?" but "are we using the dollars we already spend to buy down future risk?"

Translating Resilience Value Into Capital Conversations

The same resilience project can look different depending on who is evaluating it:

- A public works department may see a drainage upgrade.
- A finance director may see protection of the tax base.
- A lender may see stronger repayment stability.
- An insurer may see reduced claims.
- A foundation may see a chance to support predevelopment in an underserved community.
- A green bank may see an opportunity to aggregate similar projects into a pipeline.

That does not mean local governments need multiple competing narratives. It means they need one clear project story that can be translated into the decision logic of different actors—and a structure that assigns each type of capital to the role it is best suited to play.

Making that translation practical means knowing what each actor needs before the conversation starts. A lender needs a repayment story. A green bank needs a documented environmental benefit and a viable repayment path.

A CDFI needs a community benefit rationale and an explanation of why conventional financing does not fit. A foundation needs a specific gap to fill and evidence that its contribution unlocks something larger. A state agency administering federal programs needs a project that fits its priorities and deadlines.. Getting these conversations right is less about mastering global capital markets and more about knowing which door to knock on, when, and with what in hand. Chapter 4 provides that operational guide.

When the answers to the core questions are clear—what system is being protected, what value that protection creates, who benefits, what evidence supports the claim, and which capital provider is best suited to each role—resilience becomes easier for capital providers to evaluate and easier to finance. When those answers are not clear, projects often remain dependent on grants, one-time appropriations, or fragmented funding sources, even when the underlying value of reducing risk is substantial.



Chapter 3 Key Takeaways

Match the resilience benefit to the right payer, evidence, authority, and financing tool. Capital providers do not all evaluate resilience the same way. Projects often stall because value is spread across too many beneficiaries, evidence is not strong enough, repayment is unclear, the project is too small, authority is missing, or the community lacks fiscal capacity. Address those gaps deliberately through stronger analysis, a different project boundary, a shared-funding agreement, a public or philanthropic gap layer, credit enhancement, pooled financing, or policy change.

Follow the cash flow or cost signal. If a project creates revenue, reduces costs, or protects an existing repayment source, it may support borrowing, performance contracts, service agreements, public-private partnerships, environmental markets, or long-term offtake agreements. If the benefits are real but cannot be tied to a specific payer or repayment source, do not force a revenue story. Use grants, public funding, philanthropy, or concessional capital for the parts of the project that protect public value but lack a clear repayment stream.

Structure for scale and feasibility early. Many resilience projects are too small, locally specific, or complex to attract larger capital on their own. If scale is a barrier, consider pooled bond programs, state revolving funds, green banks, state infrastructure banks, regional authorities, district-scale financing, portfolio procurement, or aggregation across similar projects.

Confirm legal authority, governance, procurement, revenue powers, and approval pathways early. A project can create real value and still stall if the responsible entity cannot raise revenue, issue debt, form a district, or enter the needed agreement. If authority is missing, consider changing the project sponsor, using a district or regional authority, partnering with a utility or state financing entity, adjusting procurement, or pursuing state law or policy change.

Treat insurance as a signal, not a solution. Insurance can make risk visible, affect premiums, deductibles, coverage availability, lender confidence, and recovery funding, but does not usually pay for the resilience project itself. Local governments should connect insurance incentives to building codes, design standards, verified mitigation, public grants, capital planning, and risk-reduction investments.

Chapter 4. Financing Mechanisms That Turn Resilience Value into Investment

Main Messages

Resilience can often be funded through the tools communities already have: bonds, rates, fees, taxes, districts, grants, public-private partnerships, insurance, and outcome-based contracts.

Debt only works when there is a credible way to pay it back, such as utility rates, stormwater fees, property taxes, district revenues, grants, or beneficiary payments.

Most resilience projects need a mix of funding and financing: public dollars, dedicated revenues, long-term debt, concessional capital, insurance, and community safeguards.

Match the tool to the value created. A flood project, wildfire program, microgrid, stormwater upgrade, or post-disaster rebuild may each require a different financing mix because each creates value in a different way.

Ask the practical finance questions early: Who benefits? Who can pay? What evidence will they trust? What authority does the community have to capture that value?

The goal of financing is not just to raise money, but also to connect resilience investments to visible benefits like fewer disruptions, lower long-term costs, safer neighborhoods, and stronger local economies.

Most resilience projects are paid for with more than one source of money. A project may use a fee, tax, or utility rate to create a steady repayment source; a bond or loan to provide money upfront; grants to cover parts of the project that do not generate repayment; and public, philanthropic, or mission-driven capital to fill gaps, reduce risk, or support communities that cannot afford the full cost. Mission-driven capital means funding or investment from organizations—such as foundations, community development financial institutions, green banks, or impact investors—that are willing to consider public, community, or environmental benefits alongside financial return.

This mix is often called a *capital stack*. In plain language, it means each source of money has a job. One source may repay debt. Another may cover the local match. Another may pay for planning or community engagement. Another may protect residents from unaffordable fees or displacement. The goal is to match each part of the project to the source of money best suited to pay for it, not find a single perfect source.

The pattern is recognizable across most resilience projects: a senior revenue layer (the predictable income stream that anchors the project), senior debt (the main loan, sized to what that revenue can repay), a first-loss or de-risking layer (capital that takes early or harder-to-price risk so other funders or lenders are more willing to participate), and grants filling what no capital can bridge.

Chapter 1 introduced capital alignment as the process of matching each funding or financing source to the role it is best suited to play. Chapter 3 introduced the main types of capital providers and how they evaluate resilience, along with the key financing terms used throughout this guide. This chapter shows how those sources and tools fit together in practice through financing structure examples. In this chapter, the Capital Alignment Framework turns that idea into six practical questions that help project teams assemble the right mix of revenue, repayment, public funding, gap capital, partners, and authority.

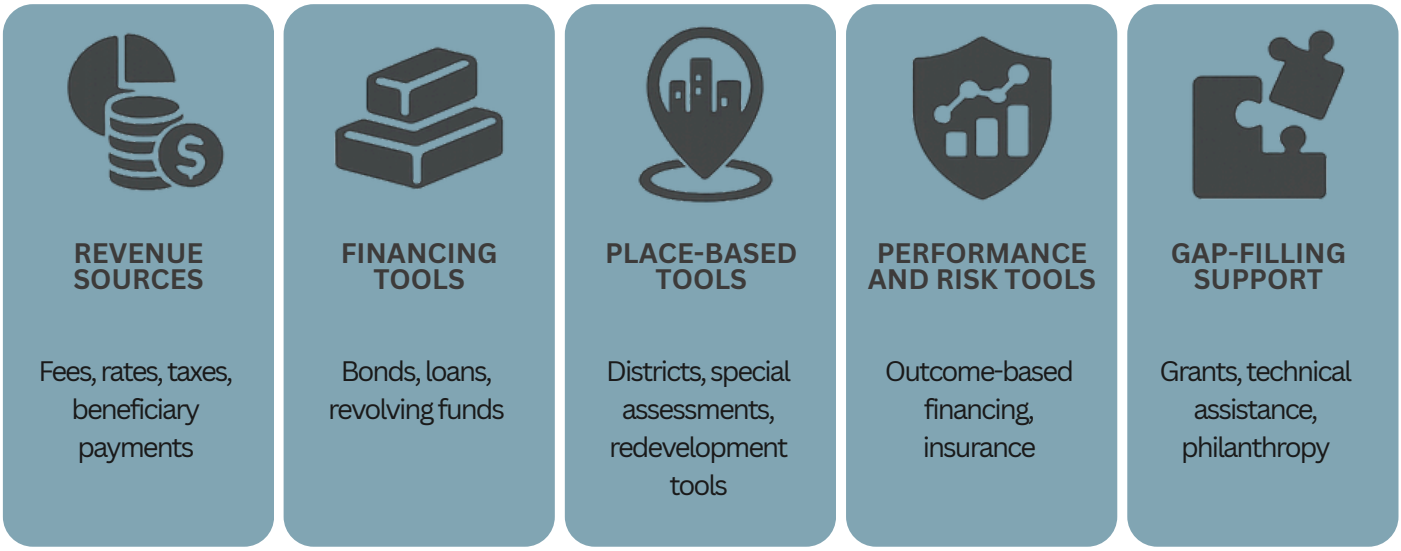
The Capital Alignment Framework

A financing strategy should answer six questions:

1. **What is being protected? The system, asset, neighborhood, service, or economic activity at risk.**
2. **Who benefits? The residents, businesses, agencies, utilities, property owners, insurers, or broader public that gain from reduced risk or improved performance.**
3. **Who can fairly and legally help pay? The parties with authority, benefit, responsibility, or willingness to contribute.**
4. **What can support repayment or long-term funding? Revenue, savings, fees, taxes, rates, grants, insurance value, or beneficiary payments.**
5. **What gaps remain? The parts that need public funding, philanthropy, mission-driven capital, concessional capital, or other gap funding.**
6. **What must be solved before implementation? Timing, authority, governance, affordability, procurement, operations, maintenance, or delivery constraints.**

This chapter is organized in three parts. It begins with example financing mixes to show how different sources of capital can work together in practice. It then reviews the major funding and financing tools available to local governments, organized by the role they play in a capital stack. It closes with cross-cutting topics—including federal benefit-cost rules, distributional impacts, team roles, insurance, predevelopment funding, and sequencing—that help communities move projects from concept to implementation.

The tools in this chapter are organized by the role they play in a financing strategy:



How Resilience Projects Are Paid For: Example Financing Mixes

The examples that follow show how these pieces can fit together. They are not templates to copy. They are illustrations of how local governments can match each source of money to a specific job in the financing plan.

For each example, apply the Capital Alignment Framework: identify what is being protected, who benefits, who can help pay, what can support repayment, what gaps remain, and what must be solved before implementation.

Urban Stormwater Green Infrastructure

Philadelphia restructured its stormwater fee around parcel characteristics, including impervious surface area, and used stormwater utility revenues to support Green City, Clean Waters, its 25-year green infrastructure program for meeting Clean Water Act obligations. The program was initially estimated at $2.4 billion, turning a regulatory requirement into a long-term infrastructure financing commitment backed by a dedicated utility revenue stream. (TNC and Environmental Finance Center, University of Maryland 2022; PWD n.d.)

Philadelphia's example shows what a senior revenue layer means in practice: before a city can borrow or attract financing, it usually needs a dependable source of money to pay the bills over time. Philadelphia's stormwater fee created that dependable source. The fee generates recurring revenue for stormwater management and green infrastructure, and that recurring revenue can also give lenders or bondholders confidence that the city has a way to repay borrowing if debt is used.

Philadelphia also shows that the stormwater utility is not just a source of revenue; it is the governance and revenue authority that makes the financing strategy usable. The Philadelphia Water Department had the institutional home, billing structure, and long-term program responsibility needed to collect stormwater revenue, manage Green City, Clean Waters, and sustain investment over time. Similar projects need a stormwater utility or equivalent public authority with the ability to charge fees or rates, manage funds, deliver projects, maintain assets, and support repayment if financing is used.

An environmental impact bond is a bond or loan-like structure that provides upfront capital and links part of repayment or investor return to whether the project achieves agreed, measured outcomes. DC Water went a step further in 2016, issuing a $25 million environmental impact bond to finance construction of Rock Creek A green infrastructure in the Rock Creek sewershed and one year of maintenance, DC Water's first large-scale green infrastructure project. The bond tied part of investors' return to independently verified stormwater performance. The bond functioned as the upfront financing layer, providing capital before the stormwater performance benefits were known. Investors provided the upfront capital and earned a base return, and an independent third-party evaluation, conducted by WSAthen adjusted the payout across three tiers: an additional outcome payment if performance exceeded expectations, a risk-share payment back to DC Water if performance fell short, or no adjustment if performance landed in the expected range.

1. If performance was better than expected—runoff reduction greater than 41.3%—DC Water repaid principal and interest plus an additional $3.3 million outcome payment.
2. If performance was within expected bounds—runoff reduction between 18.6% and 41.3%—DC Water repaid principal and interest, with no outcome payment.
3. If performance was worse than expected—runoff reduction below 18.6%—DC Water still repaid principal and interest, but investors made a $3.3 million risk-share payment back to DC Water. DC Water confirmed that final measured performance landed in the middle tier, between 18.6% and 41.3%, so no outcome payment or risk-share payment was triggered; the bond was repaid through principal and interest only. (DC Water 2016)

The structure let DC Water share performance risk with investors rather than bearing it alone, and it showed that outcome-linked financing can work for a public utility without a new legal structure or a specialized market. (EPA Water Infrastructure and Resiliency 2017; Quantified Ventures 2021).

DC Water's example also shows the governance side of outcome-linked financing. The financing worked because DC Water had a public utility structure that could issue financing, repay investors, contract with technical partners, and support third-party performance evaluation. For similar projects, the authority to measure outcomes and make payments based on verified results is as important as the bond itself.

Together, Philadelphia and DC Water show two different but complementary parts of an urban stormwater financing structure. Philadelphia shows how a dedicated stormwater fee can create the recurring revenue foundation for green infrastructure.

DC Water shows how an outcome-linked bond can provide upfront capital while sharing performance uncertainty with investors. DC Water also has other funding and financing mechanisms for Clean Rivers infrastructure, including the Clean Rivers Impervious Area Charge and green bonds; this example focuses on the environmental impact bond because it illustrates outcome-linked financing. Both examples also show that stormwater finance depends on a stormwater utility or equivalent public authority that can collect revenue, manage a long-term program, borrow or enter financing agreements, contract with partners, maintain green infrastructure, and verify outcomes.

Other layers—such as state revolving fund loans, federal or state grants, philanthropic support, or mission-driven lender support—may also be used in similar stormwater projects to reduce borrowing costs, cover affordability gaps, pay for predevelopment, or support project elements that cannot be fully repaid through fees. Those additional layers are included on the next page in Table 13 as tools that can complement the Philadelphia and DC Water examples, not as a claim that each was used in both cases.

The table below uses Philadelphia and DC Water as real-life examples while drawing out broader capital-stack roles that similar urban stormwater green infrastructure projects may need. Where Philadelphia or DC Water used a specific tool, the table names it directly. Where another community might use a different tool to perform the same financing role, the table says so explicitly.

These examples, along with ones from Atlanta, GA, (Chapter 4), and Hampton, VA (Chapter 5) show how utility revenue, public debt, and performance-based payments can work as complementary layers in an urban stormwater capital stack—each doing a different job, and each making the others more credible.



Table 13. Example Financing Structure for Urban Stormwater Green Infrastructure

Financing Role	Transferable Tools	Why it Matters
Main repayment source (senior revenue layer)	**Philadelphia used**: stormwater utility fees tied to stormwater management costs and parcel characteristics, including impervious surface. **Similar projects could use**: stormwater fees, utility rates, drainage fees, dedicated local fees, or other recurring charges where legally authorized.	Creates a dependable stream of money to pay for stormwater services, operations and maintenance, green infrastructure investment, and potential debt repayment. This is the revenue foundation that makes the rest of the capital stack more credible.
Stormwater utility / governance and revenue authority	**Philadelphia used**: a stormwater utility fee administered through the water department. DC Water used: a public utility structure with authority to issue financing, repay investors, contract with partners, and support performance verification. **Similar projects could use**: a stormwater utility, water authority, public works department, regional water agency, special district, interlocal agreement, or other entity with revenue and delivery authority.	Provides the institutional home for the financing strategy: the entity that can charge fees or rates, manage funds, borrow or enter financing agreements, maintain green infrastructure, contract with partners, verify outcomes, and sustain the program over time.
Incentive or credit structure	**Philadelphia used**: stormwater credits that can reduce a property owner's monthly bill when the property manages runoff on-site. **Similar projects could use**: stormwater credits, fee discounts, rebates, grant incentives, development standards, or stormwater retention requirements.	Turns the fee from only a charge into an incentive, encouraging private runoff reduction and helping lower the public cost of stormwater management over time.

Financing Role	Transferable Tools	Why it Matters
Main loan or bond (senior debt)	**DC Water used**: a $25 million environmental impact bond for construction of Rock Creek A green infrastructure in the Rock Creek sewershed. **Similar projects could use**: municipal bonds, revenue bonds, state revolving fund loans, state infrastructure bank loans, green bonds, or other utility-backed borrowing, depending on legal authority and repayment source.	Provides upfront capital that can be repaid over time from utility revenues, fees, or other pledged repayment sources, rather than requiring the full cost to be paid all at once. For outcome-linked structures, repayment terms may also reflect verified performance.
Payment tied to measured results	**DC Water used:** an environmental impact bond with payments tied to verified stormwater performance. Similar projects could use: environmental impact bonds, pay-for-performance contracts, outcome-based grants, or other performance-linked structures.	Shares performance uncertainty when green infrastructure benefits are real but uncertain before construction, and helps prove whether the project achieved agreed stormwater outcomes.
Gap-filling /pre-development	**Similar projects could use**: foundation grants, public planning funds, technical assistance funds, philanthropic support, community development financial institution or other mission-driven lender support, or green bank support.	Pays for project scoping, engineering, modeling, benefit-cost analysis, legal structuring, community engagement, transaction costs, affordability needs, or project elements that are difficult to repay through fees alone.
Public funding to close the gap	**Similar projects could use**: EPA, state, or local grants; state revolving fund subsidies; technical assistance funds; or other public funding.	Covers match requirements, planning costs, water-quality benefits, affordability gaps, or public benefits that cannot be fully repaid through stormwater fees or utility revenues.
First-loss or de-risking capital	**Similar projects could use**: recoverable grants, guarantees, subordinated loans, community development financial institution or other mission-driven lender support, green bank support, or other concessional capital.	Takes early or harder-to-price risk so other funders, lenders, investors, or beneficiaries are more willing to participate.

Coastal Flood Protection in a Redevelopment District

Chapter 1 uses Hoboken to show how the diagnostic connects risk, value, proof, authority, and capital alignment. This chapter returns to Hoboken for a narrower purpose: to show how different funding, financing, governance, and implementation layers played distinct roles in a district-scale capital stack. After Hurricane Sandy flooded roughly 80% of the city, Hoboken and its partners built a layered financing strategy rather than relying on a single grant or bond. This example illustrates the authority and payer questions in the Capital Alignment Framework: the challenge was not proving resilience value, but aligning multiple funding sources and institutions with authority over different parts of the project.

The stack included $380 million in HUD Community Development Block Grant Disaster Recovery funds through Rebuild by Design, ra layered local and infrastructure-bank financing approach for complementary stormwater and resiliency-park investments, and $100 million from the State of New Jersey for Harborside Park flood mitigation infrastructure. That local and infrastructure-bank layer included Hoboken Open Space Trust Fund-backed resources, Hudson County Open Space Trust Fund grants, and low-interest financing through the New Jersey Infrastructure Bank and the EPA Clean Water State Revolving Fund for ResilienCity Park and the Southwest Resiliency Park expansion. Later FEMA and American Rescue Plan resources extended the approach (City of Hoboken n.d, NJDEP 2025).

Each source had a distinct job. Federal recovery funds provided the largest grant layer for eligible flood protection components. State funding helped close a major gap for Harborside Park, allowing the park to function as both public open space and flood mitigation infrastructure. City funding through the Hoboken Open Space Trust Fund provided a local funding layer for complementary parks, stormwater storage, and related resilience improvements. The low-interest New Jersey Infrastructure Bank loans served as the main loan layer: they provided borrowed capital that could be repaid over time, rather than requiring the city to pay the full cost upfront.

Governance was also part of the capital stack, not separate from it. The city's Resist, Delay, Store, Discharge strategy gave funders and agencies a shared framework for understanding how each investment fit into the whole. Coordination across the city, the North Hudson Sewerage Authority, state agencies, federal programs, and delivery partners made it possible for different funding and financing layers to be used as they became available. (Rebuild by Design n.d.)

Chapter 1 explains how Hoboken's resilience investments protect redevelopment value and the tax base. Here, the financing point is narrower: tax-base protection is not the same thing as tax-base capture. Capturing property tax revenue for repayment requires a legally authorized tool—such as tax increment financing, redevelopment area bond financing, payments in lieu of taxes, special assessments, or district revenues—that dedicates part of future property value growth or redevelopment revenue to public improvements.

For large, multi-phase projects, insurance and parametric risk-transfer tools may also help keep work moving by providing faster liquidity after a triggering event, reducing the risk that a storm, flood, or construction-period loss drains local reserves or delays later phases. This was not a documented Hoboken funding layer, but it is a tool similar projects should consider.

The table below uses Hoboken as a real-life example while drawing out broader capital-stack roles that similar district-scale flood resilience projects may need. Where Hoboken used a specific tool, the table names it directly. Where another community might use a different tool to perform the same financing role, the table says so explicitly.

The lesson for local governments is not to repeat the full Hoboken diagnostic here, but to see how the capital stack translated the strategy into usable funding, financing, governance, and implementation roles. Hoboken's ability to coordinate across the city, the North Hudson Sewerage Authority, state agencies, and federal programs made each layer usable as it became available.

Table 14. Example Financing Structure Coastal Flood Protection in a Redevelopment District

The table below uses Hoboken as a real-life example while drawing out broader capital-stack roles that similar district-scale flood resilience projects may need. Where Hoboken used a specific tool, the table names it directly. Where another community might use a different tool to perform the same financing role, the table says so explicitly.

Financing Role	Transferable Tools	Why it Matters
Federal recovery grants layer	**Hoboken used**: HUD Community Development Block Grant Disaster Recovery funds through Rebuild by Design and FEMA funds. **Similar projects could use**: FEMA disaster recovery and hazard mitigation programs and infrastructure grants	Provides major non-repayable capital for eligible flood-risk reduction components that may be too large to fund locally.
State funding to close a major project gap	**Hoboken used**: State of New Jersey funding for Harborside Park flood mitigation infrastructure. **Similar projects could use**: state resilience grants, capital programs, appropriations, or infrastructure programs.	Helps complete major project elements that federal funds, local revenues, or borrowing do not fully cover, especially when a project combines flood protection, public space, stormwater, mobility, or redevelopment benefits.
Local funding layer	**Hoboken used**: Hoboken Open Space Trust Fund. **Similar projects could use**: local trust funds, dedicated taxes, stormwater fees, local capital funds, or voter-approved local revenues.	Provides flexible local funding for match, complementary improvements, public space, stormwater storage, parks, or related resilience investments.
Main loan or bond (senior debt)	**Hoboken used**: low-interest New Jersey Infrastructure Bank loans. **Similar projects could use**: a state infrastructure bank loan, state revolving fund loan, revenue bond, general obligation bond, green bond, or voter-approved bond measure, depending on legal authority and repayment source.	Provides borrowed capital that can be repaid over time, allowing a community to finance major infrastructure costs without paying the full amount upfront.

Table 14. Example Financing Structure Coastal Flood Protection in a Redevelopment District continued on next page

Table 14. Example Financing Structure Coastal Flood Protection in a Redevelopment District *continued*

Financing Role	Transferable Tools	Why it Matters
Governance and delivery structure	**Hoboken used**: coordination among the City of Hoboken, North Hudson Sewerage Authority, the electric utility PSE&G, state agencies, federal programs, and project delivery partners. **Similar projects could use**: an interlocal agreement, utility partnership, redevelopment authority, flood district, infrastructure authority, joint powers authority, or other multi-agency governance structure.	Provides the coordination structure needed to align flood protection, sewer modifications, parks, stormwater storage, public space, funding agreements, construction phases, and long-term maintenance.
Tax-base protection and redevelopment alignment	**Hoboken used**: redevelopment planning, public-space investments, and long-term property-value protection in the same district-scale resilience strategy. **Similar projects could use**: zoning, redevelopment plans, public-space investments, land-use incentives, development standards, or district planning.	Shows how flood protection can protect the value and functioning of a district, support continued investment, and reduce disruption to local revenues, even when the project does not directly capture property tax growth for repayment.
Additional tool for similar projects: capturing property tax growth	**Similar projects could use**: tax increment financing, redevelopment area bond financing, payments in lieu of taxes, special assessments, or other district revenue tools where legally authorized.	Converts some portion of future property tax growth, redevelopment payments, or district assessments into a repayment source for public improvements. This should be presented as a potential tool for similar projects, not as a Hoboken-specific funding layer unless a source confirms it was used.
Additional tool for similar projects: insurance or risk transfer tools	**Similar projects could use**: insurance, parametric coverage, builder's risk coverage, or other risk-transfer products tied to construction-period risk, residual flood risk, emergency liquidity, or public-budget protection.	Helps large, complex projects manage shocks that could otherwise delay construction, force redesign, drain reserves, or interrupt later phases. Insurance or parametric coverage can provide faster post-event liquidity, protect the public budget from residual losses, and reduce the risk that a major flood or storm sets the project back before the full resilience investment is complete.

Watershed-Scale Wildfire Fuel Reduction

Wildfire risk in forested watersheds is a classic distributed-benefit problem. A single fire can devastate downstream water quality, disrupt hydropower generation, raise infrastructure repair costs, and drive up insurance claims for actors who have no formal relationship with each other and no existing mechanism to share costs.

As introduced in Chapter 1, the Yuba River watershed example shows how distributed benefits can be organized into beneficiary payments that support a larger resilience financing structure. This example illustrates the beneficiary question in the Capital Alignment Framework: the challenge was identifying who benefited from reduced wildfire risk, proving the value of those benefits, and creating a structure through which those beneficiaries could contribute to the cost of restoration. The Forest Resilience Bond model developed by Blue Forest was designed to solve exactly that problem. Rather than waiting for a single funder to cover the full cost, it aggregates contributions from multiple beneficiaries—water utilities, hydropower operators, insurers, local governments, and conservation funds—into a single financing structure that pays for forest restoration upfront and recovers costs over time through contractual payments. (EPA 2021; Blue Forest 2026a; Vajjhala and George 2026).

The model creates a structure for combining beneficiary payments, public funding, implementation agreements, and upfront capital. In similar watershed projects, potential beneficiaries or contributors may include water utilities, hydropower operators, insurers, local governments, public land managers, and conservation funders. In the Yuba example, the key downstream beneficiary was Yuba Water Agency, while CSAA Insurance Group participated as an upfront investor rather than as a beneficiary-payment source. (Blue Forest 2026b)

The Yuba case also illustrates the predevelopment work that resilience finance requires. A July 2026 Epicenter article describes the model as becoming finance-ready through early work to prove who benefits, quantify the value of avoided losses, and build the partnerships that make private capital possible. In Yuba, Blue Forest worked with the World Resources Institute and academic researchers at UC Merced and Stanford to make the economic and environmental benefits legible to payors and investors. That analysis helped show how forest restoration could protect water supply, reduce fire and flood risk, and support hydropower value. The same analysis also helped demonstrate that the financial value delivered to Yuba Water Agency could exceed its cost-share contribution. This predevelopment work also helped Blue Forest secure early-stage support from the Rockefeller Foundation's Zero Gap Portfolio, illustrating that early analytical and partnership-building work can be the bridge between an unfunded resilience concept and a financeable project. (Epicenter Insights 2026; Blue Forest 2021; Vajjhala and George 2026).

In the first Yuba Forest Resilience Bond, the financing structure included several distinct pieces. Yuba Water Agency participated as a downstream water and hydropower beneficiary, contributing fixed cost-share payments because forest restoration helped protect its source watershed, water supply, and hydropower interests. Yuba Water Agency supported the first pilot with a $1.5 million cost-share contribution, which helped leverage an additional $4 million in capital for forest management work. Public partners, including the US Forest Service and CalFire, contributed funding, in-kind support, planning, and project oversight. The Forest Resilience Bond then provided $4 million in readily available upfront capital from investors, including the Rockefeller Foundation, Gordon and Betty Moore Foundation, CSAA Insurance Group, and Calvert Impact Capital. The National Forest Foundation served as the implementation partner, while Blue Forest served as the financial sponsor and managing partner. (EPA 2021, Yuba Water Agency n.d.; Blue Forest 2026b) A July 2026 Epicenter article

summarizes the final structure as including $4 million in upfront investor commitments from four lenders, alongside more than $4.3 million in funding paid by beneficiaries to investors. (Epicenter Insights 2026)

The project also produced biomass from restoration treatments, but the documented repayment structure relied on contracted public and beneficiary payments rather than biomass or timber-sale revenue. For similar projects, biomass, timber, carbon, or other restoration-related value streams may help offset costs if they are reliable and legally available, but they should not be treated as the core repayment source unless they are actually contracted.

That structure matters because the Forest Resilience Bond is not simply a source of money. It is a financing and partnership model that connects beneficiary payments, public and restoration funding, implementation agreements, and upfront capital. In the Yuba case, the National Forest Foundation's implementation role and the Forest Service's stewardship agreement helped create the delivery pathway for work on national forest land, while the upfront capital helped pay contractors and accelerate treatment before all public and beneficiary funds were received.

The pilot project in the Yuba River watershed started small—$4 million inaugural financing—and demonstrated the core viability of the model: beneficiaries would pay, investors would provide upfront capital, and the partnership structure could accelerate forest restoration at meaningful scale. Yuba Water Agency reports that the partnership allowed the Yuba Project to be completed six years earlier than it would have been otherwise. That proof of concept helped justify a much larger follow-on effort of $25 million, covering more acres and bringing in more partners. Yuba Water later committed to a second, $6 million Forest Resilience Bond, and the Yuba II structure leveraged $25 million in total funding for priority work in the North Yuba Forest Partnership area. (Yuba Water Agency n.d.; Blue Forest 2026c)

The most important lesson from the Yuba project is that watershed-scale resilience finance is a coordination problem before it is a capital problem. Some of the money often exists among beneficiaries and public partners, but it is not automatically organized into a financeable structure. The money often exists within the beneficiary group. What is missing is the structure, the governance, the proof of value, and the patient early-stage work to bring contributors together under a shared agreement.

The table on the next page uses Yuba as a real-life example while drawing out financing roles that similar watershed-scale wildfire resilience projects may need. The "Transferable Tools" column names what Yuba used and then shows what similar projects could use to perform the same role.



Table 15. Example Financing Structure for Watershed-Scale Wildfire Fuel Reduction

Financing Role	Transferable Tools	Why it Matters
Payments from beneficiaries	**Yuba used**: early analytical work by Blue Forest, World Resources Institute, UC Merced, Stanford, and other partners to quantify benefits and make the project's value legible to beneficiaries and investors. **Similar projects could use**: philanthropic grants, technical-assistance funds, university partnerships, public planning funds, or other early-stage support to identify beneficiaries, quantify avoided losses, and build confidence in repayment pathways.	Helps move a project from a broad resilience concept to a financeable structure by proving who benefits, who can pay, and what evidence supports the value of the intervention.
Upfront capital for restoration work	**Yuba used**: Forest Resilience Bond capital from investors including foundations, CSAA Insurance, and Calvert Impact Capital. **Similar projects could use**: forest resilience bonds, environmental impact bonds, mission-driven loans, green bank capital, or other upfront financing models.	Provides money before restoration work is completed, allowing forest treatment to move faster than if the project waited for each beneficiary payment, grant, or reimbursement.
Public Funding	**Yuba used**: U.S. Forest Service and CalFire funding, in-kind support, planning, and project oversight. **Similar projects could use**: federal land management funds, state forestry grants, wildfire resilience funds, conservation funds, or public restoration programs.	Covers public land management, ecological restoration, planning, and benefits that no single beneficiary can pay for alone.
Money that absorbs early losses / first-loss capital	Not shown as a separate Yuba-specific first-loss layer in this example. **Similar projects could use:** foundation grants, public agency support, community development financial institution or mission driven lendelender support, green bank support, or other concessional capital.	Helps cover early uncertainty, especially for new or less-proven watershed resilience approaches, and can make other funders, lenders, or beneficiaries more comfortable participating.

Table 15. Example Financing Structure for Watershed-Scale Wildfire Fuel Reduction continued on next page

Table 15. Example Financing Structure for Watershed-Scale Wildfire Fuel Reduction *continued*

Financing Role	Transferable Tools	Why it Matters
Revenue or value from restoration byproducts	**Not central to the Yuba example as presented here. Similar projects could use:** timber value, biomass utilization, carbon revenue, conservation credits, or other restoration-related value streams where feasible.	Can help offset project costs, but should usually be treated as a supplemental source rather than the core repayment strategy unless the revenue is reliable and legally usable.
Decision-making authority (governance)	**Yuba used**: Blue Forest as financial sponsor and managing partner, the National Forest Foundation as implementation partner, and a Forest Service stewardship agreement for work on national forest land. **Similar projects could use**: a nonprofit intermediary, watershed collaborative, joint powers authority, special purpose vehicle, public agency agreement, stewardship agreement, or other multi-partner governance structure.	Provides the structure to contract with beneficiaries, receive and manage funds, coordinate implementation, oversee restoration work, and make decisions across jurisdictions or land ownerships.



Post-Disaster Rebuild to Higher Standards

When a 1,000-year rainfall event in the mountains above Longmont, Colorado, tore through the St. Vrain Creek watershed causing a 100-year flood event, the city faced a choice that confronts many communities after a major disaster: rebuild what was there as quickly as possible, or take the harder, slower path of rebuilding to a higher standard that would reduce the risk of the same thing happening again. This example illustrates the gap-funding question in the *Capital Alignment Framework*: federal recovery programs could fund portions of the rebuild, but additional local revenue and financing were needed to cover stronger standards and long-term resilience improvements. Longmont chose the second path—and then spent more than a decade planning, collaborating, strategizing and applying for funding to pay for it. (Clavin et al. 2017)

The Resilient St. Vrain project ultimately assembled more than ten funding and financing sources across multiple phases: FEMA Public Assistance funds for eligible repair costs, including from section 406 mitigation, HMGP dollars for risk-reduction components, HUD CDBG-DR funds, USACE cost-share contributions (Barnes 2025), voter-approved drainage bonds, utility rates and user fees, and Great Outdoors Colorado grants funded from lottery proceeds for parks and trail components. The city also used partnerships where project needs overlapped with other infrastructure owners, including a ditch-company partnership supported by Colorado Water Conservation Board financing for the Bonus Ditch St. Vrain Diversion Replacement within the project's City Reach. (Colorado Water Conservation Board 2018)

Each source covered a different slice of the project—federal programs paid for what their rules allowed, local bonds and storm drainage rates covered above-standard design components that federal benefit-cost rules could not recognize, conservation funds supported the ecological and recreational elements that made the project worth doing in the first place, and targeted partnerships helped integrate related infrastructure into the broader rebuild. (City of Longmont 2023)

Longmont officials emphasized that the ability to be nimble, change course quickly, and draw on a diversified funding stack—strengthened by city ownership of utilities—was central to shaping the rebuild process.

What made this possible was the governance that was in place before the disaster, not assembled after it, making rapid refinements during and after the incident feasible. For example, the City adjusted many policies during the early stages of the recovery process, including its local procurement policies to align with Federal funding and FEMA requirements. Longmont's Storm Drainage Utility gave the city clear contracting authority and legal standing to enter agreements with multiple state and federal partners simultaneously.

The lesson for other communities is not to replicate Longmont's specific funding mix—every project and every disaster is different—but to build the governance infrastructure before it is needed so the pieces can be assembled when the moment comes (City of Longmont 2026).

"This was a multi-year, multi-staff, multi-department, multi-agency effort. A core method of our strategy was to design projects with eligibility in mind as we moved through the process... By integrating funding specialists with the design and implementation processes, we were able to align the project scope with best-fit funding sources continuously (all the way to closeout) to help optimize project and funding source compatibility."

Peter Gibbons, Flood Recovery Manager, City of Longmont Recovery Office

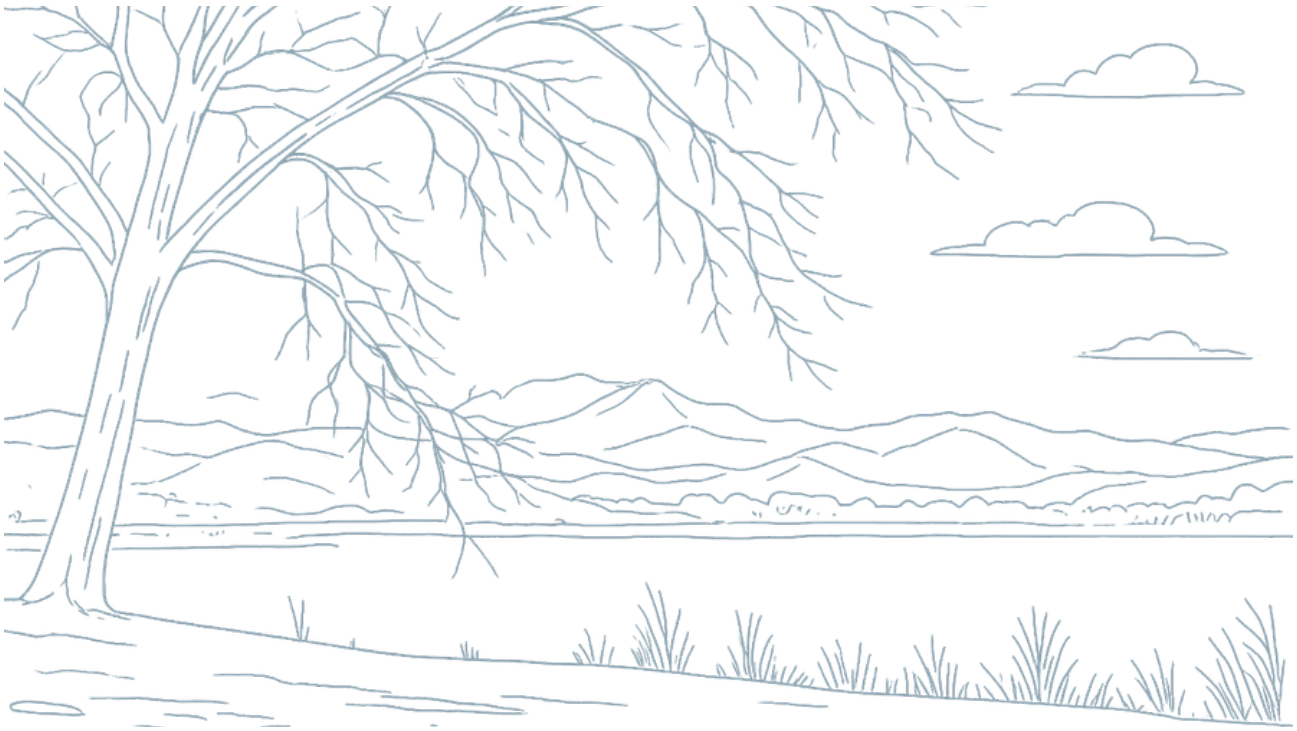
Table 16. Example Financing Structure for Post-Disaster Rebuild to Higher Standards

Financing Role	Transferable Tools	Why it Matters
Main federal recovery funding	**Longmont used**: FEMA Public Assistance Section 406 mitigation funding, Section 428 (previously, 'Alternative Procedures'), and HUD CDBG-DR funding.	Helps pay for eligible mitigation when damaged public infrastructure is repaired or rebuilt.
Required local contribution (cost share)	**Longmont used**: Local funds, insurance proceeds, state funds, or other grant funds that are allowed to be used as match or project elements. **Similar projects could use**: HUD CDBG-DR as local match, when authorized and aligned with the HUD-approved Action Plan.	Covers required nonfederal share or repair costs not fully covered by FEMA.
Added cost of building stronger than the minimum code or standard	**Longmont used**: state funding, local bond funds. **Similar projects could use**: Mission-driven lender, green bank, or (while a nascent trend) philanthropic capital supporting partners like Habitat for Humanity (i.e. Habitat Strong) to build more resiliently.	Pays for the difference between minimum eligible repair and a stronger design for future conditions.
Short-term money used while waiting for reimbursement (bridge financing)	**Longmont used**: an emergency reserve used as short-term money while waiting for reimbursement, or borrowing from funds to repair infrastructure, which then get paid back by the reimbursement. **Similar projects could use**: Revolving loan, bridge loan, or short-term loan from a mission-driven lender	Covers costs while the community waits for federal reimbursement.

Financing Role	Transferable Tools	Why it Matters
Ongoing savings or validation	**Longmont used**: flood risk reduction measures to improve its standing in FEMA's National Flood Insurance Program Community Rating System, earning a 25% premium reduction for flood insurance policy holders in the Special Flood Hazard area **Similar projects could use**: FORTIFIED standard, insurance discount associated with improved and mitigated rebuilding standards, or other verified mitigation standard	Helps translate stronger construction into lower risk, lower claims, or potential premium savings.

The examples above show how capital stacks come together in practice. Across all four examples, the lesson is the same: each source of money needs a clear job. A strong financing plan does not simply stack money together; it explains why each source belongs in the project and what gap it solves. It also facilitates the interface between each funding source to control risk by eliminating duplication of benefit and policy-based incompatibilities between each funding source.

The sections that follow examine the cross-cutting constraints and individual tools that commonly shape those roles, and the conditions under which each tends to work best.



Resource: Adaptation Clearinghouse

The Georgetown Climate Center's Adaptation Clearinghouse is an online library of adaptation plans, policy tools, legal resources, funding examples, and case studies for state and local governments. One useful entry is HUD's Financing High-Performance Infrastructure fact sheet, which provides a high-level overview of tools such as green bonds, resilience bonds, public-private partnerships, and federal financing programs. It is a helpful starting point for readers looking for additional tools and examples after working through the financing questions in this chapter (Georgetown Climate Center n.d.; HUD 2016).

How Federal Benefit-Cost Rules Shape the Capital Stack

Nearly all of these capital stacks relied on federal funding—and many federal grant programs come with a benefit-cost constraint that affect everything built around them.

When federal funds are part of a capital stack, federal benefit-cost analysis (BCA) rules shape far more than whether a grant is approved. They help determine which project scope is eligible, which benefits are recognized, how outcomes for lower-income communities are measured, and when a project can proceed. Local governments should understand these constraints before design is complete, because they often decide what can be funded, what must be restructured, and where nonfederal, philanthropic, or concessional capital has to fill the gap. Communities that encounter these constraints early—rather than at the grant application stage—have far more room to restructure the project, add a nonfederal layer, or pursue a different program path.

FEMA's benefit-cost analysis process evaluates whether the expected benefits of a hazard mitigation project outweigh its costs (FEMA 2026). It is used to demonstrate cost-effectiveness for major hazard mitigation programs, including Building Resilient Infrastructure and Communities, Flood Mitigation Assistance, and the Hazard Mitigation Grant Program (FEMA 2025a). The difficulty in applying benefit-cost analysis to resilience is structural rather than merely administrative: standard benefit-cost methods can struggle to fully recognize future risk conditions, avoided disruption, the co-benefits of nature-based solutions, and the long-horizon value of drought resilience, heat adaptation, and ecosystem restoration. Because many of those benefits accrue over decades and are probabilistic rather than certain, the discount rate—the rate used to convert future benefits into present-day dollars—can determine whether a sound long-term resilience investment appears cost-effective. (FEMA 2025).

The discount rate is not a technicality; it changes which projects qualify. In late 2023, the federal discount rate for benefit-cost analysis was lowered from 7% to 3.1%, materially improving the economic case for long-lived investments whose benefits accrue over 20 to 50 years—exactly the profile of nature-based solutions, drought resilience, and heat adaptation (OMB 2023). On April 8, 2025, the Office of Management and Budget reinstated the 7% rate, sharply reducing the recognized present value of those long-term benefits (OMB 2025). A project that cleared the threshold in 2024 may fail it in 2025—not because the project changed, but because the accounting did (ASFPM 2025). Practitioners should confirm the current applicable rate before structuring a project around federal benefit-cost analysis, as this has been an area of active policy change.

A second, compounding problem falls on the communities least able to absorb it. Headwaters Economics documents that federal BCA systematically disadvantages smaller, rural, and lower-income communities, because the calculated dollar value of protected assets and economic activity is lower where property values and incomes are lower—even when the relative risk and the recovery burden are greater (Pape and Smith 2021). The methodology generates smaller benefits precisely where the need is most acute, making federal investment hardest to justify in the places that can least self-finance.

The practical implication for capital-stack design is direct. Federal dollars bring federal benefit-cost constraints with them, regardless of what other capital sits alongside them in the stack. Communities pursuing higher design standards, nature-based solutions, or future-conditions design typically have to cover the difference outside the federal scope—through local bonds, state funds, philanthropic capital, or concessional financing—because federal analysis will not recognize it. Identifying that gap early is what gives a community room to build the nonfederal layer while there is still flexibility to do so.

Ensuring the Financing Structure Works for the People it is Meant to Protect

Capital stacks are more than just financing decisions—they are distribution decisions. Every choice about which revenue tool to use, which communities or assets to prioritize, and which financing structure to apply determines who ultimately pays for the investment and who captures its benefits. In many resilience projects, particularly those serving lower-income, rural, or historically underinvested communities, those two groups are not the same.

Resilience financing decisions should account for how the project may affect housing costs, small-business costs, property values, redevelopment pressure, fees, assessments, and who can afford to remain in place. Housing, community development, legal, and economic development partners can help identify the affordability, anti-displacement, small-business, community benefit, and land-stewardship tools needed to make the investment work for the people and places it is meant to protect. In those cases, these tools are not separate from resilience finance; they are part of what makes the financing strategy fair, durable, and publicly supportable.

Before finalizing a capital stack, project teams should ask whether:

- The residents and businesses who benefit from the investment are represented in project governance
- The burden of paying—through fees, assessments, taxes, or rates—is proportional to the benefit received
- The communities bearing the risk if the project does not happen are already facing high climate exposure and limited fiscal capacity
- The financing mechanism increases affordability burdens for households or small businesses and, if so, whether the project includes ways to reduce or delay those costs for people who cannot afford them
- The project protects existing residents, and small businesses, or raises land values in ways that could accelerate displacement
- Housing, community development, legal, or economic development partners need to be involved because the project may affect rents, property values, fees, taxes, or small-business costs
- The stack requires public, philanthropic, or catalytic capital specifically because the community cannot support conventional repayment terms

If the answer to the last question is yes, that is not a weakness in the project or a failure of the financing strategy. It is an accurate diagnosis that the project needs a different structure, and that public, philanthropic, or catalytic capital is the optimal tool, not a fallback.

The preceding four capital stack examples each made deliberate choices about how costs and benefits were distributed. Hoboken used federal recovery funds to cover the largest flood infrastructure investments rather than passing the full cost to local ratepayers. Philadelphia built income-sensitive credits into its stormwater fee structure so that green infrastructure investment did not disproportionately burden lower-income property owners. Longmont used voter-approved local bonds and a community-wide user rates and fees —broad-based revenue tools—rather than special assessments that would have concentrated cost on the properties closest to the creek. These choices were what made each project publicly supportable and financially durable over time.

Who Does This Work, and When Does it Start?

Building a capital stack is a team sport with no natural home in most local governments. Finance owns debt. Grants staff owns state and federal programs. The utility director owns rate-based financing. The resilience or sustainability coordinator may hold the overall strategy, but often lacks authority to direct other departments.

Brookings Institute researchers have documented that many local and tribal government leaders lack the staff, training, or partnerships to successfully stack grants, tax credits, and loans, even when communities are eligible and programs are funded (Posner and Briggs 2025, Gregory and Mehrotra 2024). The solution is explicit executive sponsorship—a city manager, chief administrative officer, or chief financial officer with authority to direct multiple departments toward a shared financing outcome—combined with a cross-functional team that includes the right people at the right moment.

Infrastructure financing is always complex, but resilience adds layers that most standard capital planning processes were not designed to handle. A road reconstruction, a school renovation, or a water main replacement has a defined asset, a clear owner, an established funding category, and a predictable useful life. Resilience investments often have none of those things in the same clean form: the benefits are distributed across multiple systems and beneficiaries, the value shows up as avoided disruption rather than new revenue, the legal authority may span multiple jurisdictions, and the financing tools that fit the project best may not yet be in the capital improvement plan or the grant pipeline.

Therefore, assembling a resilience capital stack requires more deliberate cross-departmental coordination, earlier in the project life cycle, than most communities are accustomed to. Likewise, specialized outside support is often not a sign of capacity weakness, but a recognition that the problem is genuinely harder than the standard infrastructure finance playbook was built for.

GFOA recommends that capital improvement program review committees include the finance officer; representatives from planning, engineering, project management, and operations departments; and that the process assess fiscal capacity from the outset so the final capital plan reflects what can realistically be funded (GFOA 2013). For resilience capital stacks, that core team expands to include roles that conventional capital planning often leaves out:



Table 17. Roles in the Capital Stack

Role	Contribution to Capital Stack Assembly
City manager or chief administrative officer	Convening authority across departments, political alignment, executive decision-making on risk and structure
Finance director and budget officer	Debt capacity, repayment structure, capital plan integration, affordability analysis
Legal and bond counsel	Authority to issue debt, raise revenue, form districts, and enter long-term agreements
Grants and federal funding coordinator	Program eligibility, match requirements, timing, sequencing, and compliance
Public works and utility directors	Technical scope, cost estimates, asset data, life cycle analysis, rate-based financing structures
Chief resilience or sustainability officer	Systems-level risk framing, connection to hazard mitigation plans and federal program eligibility, integration across departments and long-range plans
Emergency manager	Hazard exposure data, FEMA program eligibility, disaster declaration history, continuity planning
Economic development director	Tax base data, tax increment and district finance opportunities, connection to redevelopment and business investment
Planning director	Land use authority, development agreements, district boundary authority, long-range plan alignment
Community engagement lead	Distribution of costs and benefits, affordability and anti-displacement provisions, public support for voter authorization
Municipal or financial advisor	Capital market structuring, credit analysis, investor relations—essential when debt or capital markets are involved

Before contacting any funder, lender, or partner, project teams should also ask whether the project stands alone or could be strengthened by connecting it to related work—other departments, utilities, neighboring jurisdictions, or agencies planning improvements in the same place or facing the same risk.

If so, the project may be more fundable as part of a larger package, shared application, or bundled pipeline. A reference table later in this chapter sets out, for each partner, what to prepare before the conversation and what they need to move a project forward.

Capital stack thinking should start during project scoping, not after design is complete, a grant application is submitted, or a bond resolution is drafted. The choices made during project definition determine which financing tools are available. Discovering a capital stack problem after design locks in a scope is one of the most expensive mistakes in resilience finance.

For complex projects—multisource financing, district formation, public-private structures, green bank or mission-driven lender partnerships, or environmental impact bonds—a specialized intermediary is often as important as a financial advisor:

- The consulting agency **Quantified Ventures** helps municipalities and quasi-governmental authorities structure innovative financing deals and move them forward, helping communities tap state revolving funds, environmental impact bonds, and federal dollars they have never accessed before.
- The **Milken Institute's Community Infrastructure Center** offers free technical assistance, project advancement tools, and connections to impact and institutional investors, federal and state grants, philanthropy, and project development expertise, designed specifically to help underserved communities build investment-ready project pipelines without navigating those markets alone.
- **PRE Collective** works with local governments in the earliest predevelopment stage—before a project has a structure, a financing model, or a clear path to capital—helping communities define what they need before committing to what they can currently fund. Their founder played an early role shaping the Hoboken ResilienCity Park project that has become a national model for district-scale resilience finance (see Chapter 1).

Funding and Financing Tools

The sections that follow cover each major source of financing—debt, tax and fee tools, place-based mechanisms, pay-for-performance structures, and insurance—in that order. For each one, the same questions must be answered: who pays, or what value is being captured; what revenue or public funding exists to support the project; what financing instrument structures and advances that money over time; and what gaps remain that no single source can fill. Debt comes first because it is the most common instrument—not because repayment is the only consideration, but because debt structures the conversation about how every other source fits around it.

Debt: Financing Infrastructure That Performs Under Stress

Debt is the dominant financing tool for local infrastructure and the mechanism through which long-duration capital most reliably reaches public projects. **Chapter 3** explains how debt investors evaluate resilience and what they need to see. This section focuses on how to use debt effectively for resilience: which tools fit which projects, which structuring decisions matter most, and which common traps local governments should avoid. (Devitt 2024)

The opportunity for resilience is not to invent a new debt category for every hazard, but to embed risk-informed design into the infrastructure communities are already financing. A drainage project, road reconstruction, utility upgrade, public facility, or energy investment becomes a resilience investment when designed to perform under future conditions and reduce the risk of service failure.

Green, *climate*, and *resilience* labels can signal purpose, but labels do not change the underlying repayment obligation. The deeper question is whether a label expands the investor base, improves pricing, or supports credible reporting. If it does not, the label is secondary.

GFOA recommends governments weigh the additional disclosure and reporting costs against the benefits of attracting impact investors, and use third-party verification or self-certification to support any label (GFOA 2022). The priority is to ensure bond language, eligible uses, capital plans, and project scopes are broad enough to support risk-informed infrastructure.

"RESILIENCE BOND" CAN MEAN DIFFERENT THINGS

The term *resilience bond* is often used to describe very different financing structures. Broadly, these approaches fall into three categories.

1. **Insurance-linked resilience structures. Insurance-linked securities or reinsurance programs connected to investments intended to reduce physical risk, expected losses, or claims exposure.**
2. **Municipal or green-style resilience bonds. Traditional municipal debt in which bond proceeds are dedicated to resilience-related infrastructure or programs. In 2025, the Tokyo Metropolitan Government issued the world's first certified climate resilience bond under the Climate Bonds Resilience Taxonomy, with proceeds supporting flood protection, coastal defense, and disaster-risk infrastructure. (Tokyo Metropolitan Government 2025)**
3. **Outcome-based resilience financing models. Structures that use upfront private or philanthropic capital to fund projects expected to generate measurable resilience outcomes over time, with repayment supported by shared environmental and socioeconomic benefits.**



Table 18. When Debt Tools Fit

Use Debt When...	Be Careful When...
The project has a long useful life and benefits future users as well as current residents	The asset may not last as long as the debt repayment period
There is a credible repayment source, such as taxes, rates, fees, assessments, district revenue, or contract payments	The project creates public value but no clear way to repay borrowing
The project is ready enough to scope, price, authorize, and explain to voters, councils, lenders, or investors	Design is still uncertain, costs are unstable, or authority is unresolved
The investment protects essential services, revenue-generating assets, the tax base, or system performance	Resilience features are treated as optional add-ons and cut from the financed scope
Bond language can be written broadly enough to include risk-reduction components	Eligible uses are too narrow to pay for backup power, drainage, heat, wildfire, slope, or service-continuity measures



Practitioner Checklist

- **Match the debt tool to the repayment source**. Use general obligation bonds when the project protects community-wide assets, essential services, or the tax base; revenue bonds when repayment depends on utility or enterprise revenues; and district, authority, or transportation finance when the project supports a defined service area, redevelopment area, or economic activity.
- **Treat resilience as part of credit strength**. Projects that reduce service interruptions, protect revenue-generating assets, stabilize the tax base, lower emergency repair exposure, or reduce long-term operating volatility can strengthen the financial case for borrowing, even when they do not create a new revenue stream.
- **Clarify whether resilience strengthens the repayment case**. For revenue bonds, show how the project protects system operations, customer service, rate stability, or revenue continuity. For general obligation bonds, show how it protects the tax base, public safety, essential facilities, or community-wide economic stability. For district or authority financing, show how the investment supports the value or functioning of the defined area.
- **Write eligible uses broadly enough to cover resilience components**. Before bond language is finalized, make sure eligible uses can pay for the design features that allow the asset to perform under stress—such as backup power, redundant systems, heat mitigation, fire-resistant materials, communications reliability, water conservation, slope stabilization, vegetation management, floodproofing where relevant, and other risk-reduction measures. If the language is too narrow, the government may be unable to finance the very components that make the project resilient.
- **Connect resilience features to the useful life of the asset and the term of the debt**. Long-term debt should not finance infrastructure designed only for past conditions. Bond-financed projects should be scoped for the heat, drought, wildfire, flooding, extreme cold, high winds, grid disruption, or service-continuity risks the asset is likely to face while the debt is still being repaid.
- **Avoid locking in future vulnerability with today's borrowing**. Debt creates a long repayment obligation. Local governments should avoid borrowing for projects that solve an immediate capital need but leave the asset exposed to foreseeable climate, operational, or service-continuity risks.
- **Use bond proceeds for complete projects, not partial fixes**. Resilience features are often cut when budgets tighten because they look like add-ons. Debt planning should treat them as part of the core capital scope when they are necessary to keep the asset functioning under future conditions.
- **Coordinate debt-financed projects across entities that share infrastructure risk**. Municipal capital plans should be aligned with utilities, schools, universities, hospitals, transportation agencies, housing authorities, major employers, and private developers when they depend on the same roads, power systems, water systems, communications networks, or emergency access routes. This helps avoid one entity issuing debt for a stronger asset while connected systems remain vulnerable.
- **Use shared risk assumptions in project scopes and capital plans**. Where possible, entities financing related infrastructure should use consistent assumptions for future heat, drought, wildfire exposure, flood elevations, power outages, emergency access, service continuity, and recovery time. Shared assumptions make it easier to justify costs, compare projects, and explain why resilience features belong in the bond-financed scope.
- **Use labeled bonds only when the label improves the financing or accountability**. Green, climate, or resilience labels may help attract mission-oriented investors, support public reporting, or clarify eligible uses. They should not be used if ordinary public debt is simpler and the added disclosure, verification, or reporting burden does not create a clear benefit.

Starting Where You Are—A Resilience Scan for the Existing Capital Improvement Plan (CIP)

A practical entry point for many communities is not a new capital stack. It is the capital program they already have. A drainage replacement, road reconstruction, utility upgrade, park improvement, or public facility renovation can become a resilience investment when its design standards, eligible uses, and project scope are set for the conditions the asset will face over its useful life, not only the conditions it has faced in the past. That decision usually happens during scoping, before design, procurement, bond language, or grant eligibility is locked in.

A finance office or CIP review committee can run a simple scan on projects already in the pipeline by asking four questions:

1. Will the asset still be in service after 2040? If yes, ask whether the design reflects future conditions, such as projected flood elevations, heat loads, storm intensities, drought exposure, or sea level rise over the years the asset will actually operate.
2. Is the project in or connected to a known hazard area? Flood zones, heat-vulnerable corridors, wildfire-adjacent areas, coastal zones, and riverine areas are often identifiable today. If the project has known exposure, the scope should ask whether hardening, drainage, redundancy, backup power, fire-resistant materials, or service-continuity features are needed.
3. Are the eligible uses broad enough? Before bond language, grant applications, or scope documents are finalized, confirm that the funding source can cover resilience features that allow the asset to perform under stress. Narrow language can exclude these components even when funding exists.
4. Would a modest scope change reduce long-term repair or disruption costs? A relatively small upfront addition may avoid repeated emergency repairs, extend asset life, reduce operations and maintenance costs, or preserve service continuity during future events. Life-cycle cost analysis, not only first cost, should inform that comparison.

Some governments are already formalizing this kind of scan. Baltimore scores CIP requests against resilience criteria, including whether projects reduce hazard exposure, support sustainability and climate goals, and protect public health and safety. San Francisco integrates its Hazards and Climate Resilience Plan into its ten-year Capital Plan, helping move resilience needs from planning documents into capital project pipelines (City of Baltimore Planning Department n.d.; City and County of San Francisco, Office of Resilience and Capital Planning 2025).

Massachusetts shows how the same logic can operate at the state level. Communities that complete a Municipal Vulnerability Preparedness climate risk assessment become eligible for state Action Grants to implement priority resilience projects. MassDOT's five-year Capital Investment Plan also screens transportation investments for climate exposure and funds statewide flood-risk assessment work to inform project scoping before design begins. Together, these examples show a practical sequence: identify risk, translate it into project scope, and then connect the project to capital access (Mass EEA n.d.; Commonwealth of Massachusetts 2025).

This approach does not require a separate resilience capital plan. It uses the existing CIP process to ask whether planned investments can be scoped, designed, and financed in ways that reduce future risk. GFOA recommends multi-year capital plans that identify project scope and cost, funding sources, operating and maintenance impacts, life-cycle costs, fiscal capacity, and environmental or sustainability considerations; those same practices can be extended to climate resilience within the normal capital planning process (GFOA 2022). Colorado's Planning for Hazards guide provides additional approaches and case studies for communities looking to integrate hazard mitigation into capital improvement planning (Colorado Department of Local Affairs n.d.).

Tax and Fee Tools: The Revenue Foundation

Tax and fee tools are the revenue side of resilience finance. They can pay directly for projects, support ongoing operations and maintenance, or provide the repayment source for debt. Their distinction from debt matters: debt determines how costs are spread over time; taxes, fees, rates, and assessments determine where the money comes from to pay those costs. In practice, debt is rarely useful without a reliable repayment source, and the communities that have done the most ambitious resilience work are almost always those that built a dedicated revenue foundation first.

These tools especially matter for resilience because many investments deliver systemic benefits that do not map cleanly to a single user or asset. Flood protection, heat mitigation, watershed restoration, wildfire risk reduction, grid hardening, and ecosystem management protect households, businesses, public facilities, roads, utilities, emergency access, and the broader tax base. Broad-based revenues, dedicated fees, and district tools can spread costs across the full range of beneficiaries.

The communities that have used these tools most effectively tie the revenue structure to the benefit or burden being addressed, design credits and exemptions to make the charge fair, and pair financing with affordability protections so that investment does not displace the people it is meant to protect. Done well, dedicated resilience revenue can be politically durable across administrations, attract additional state and federal funding, and give communities the borrowing capacity to act at scale.

How Tax and Fee Tools Show up in Practice

- Raleigh, NC: Raleigh bases its stormwater utility fee equitably on impervious surface—charging more to properties that contribute more runoff—and also offers credits when properties detain more stormwater than required. The credit structure provides an incentive encouraging property owners to help manage runoff on-site and reduce stormwater impacts. The city also dedicates approximately 2% of its annual stormwater utility fee revenue to the innovative Raleigh Rainwater Rewards program, which helps property owners install rain gardens, cisterns, permeable pavement, and other beneficial stormwater improvements. The program cost-shares 90% of eligible project costs citywide and offers an additional 10% subsidy to qualifying applicants, nonprofits, and places of worship. City of Raleigh n.d.).

- Marin County, CA: Wildfire protection. Marin County established the Marin Wildfire Prevention Authority in 2020 with a voter-approved parcel tax that funds fuel reduction, home hardening, evacuation planning, and community education across the county. The authority has become one of the clearest examples in the country of a broad-based local revenue tool designed specifically for wildfire risk, demonstrating that communities can build a dedicated, recurring funding stream for prevention rather than waiting for disaster recovery dollars after the fact (MWPA n.d.)

- New York: Environmental funds that outlast political cycles. New York's Environmental Protection Fund—supported by a dedicated share of the state real estate transfer tax—has sustained land conservation, water quality, parks, flood protection, and climate adaptation investment across multiple administrations and budget cycles (NY DEC n.d.). New York voters reinforced that commitment in 2022 by approving a $4.2 billion Clean Water, Clean Air, and Green Jobs Environmental Bond Act. Together, the recurring fund and the voter-approved bond show how dedicated revenue tools and public finance can work in combination to build long-term resilience investment capacity that does not depend on annual appropriations or episodic federal programs (NY DEC 2026).

- Longmont, CO: Broad-based local taxes. As part of the Resilient St. Vrain Project, Longmont voters approved issuing $20 million in debt to be paid from storm drainage rate revenue to fund flood risk reduction and creek restoration, spreading costs across the full community rather than concentrating them on the properties closest to the creek. That revenue stream and debt issuance was what made each successive federal and state funding layer usable as it became available, because it provided the local match and covered above-standard design components that federal benefit-cost rules could not recognize.



The design of any revenue tool should reflect three questions:

1. Who contributes to the problem?
2. Who benefits from the solution?
3. Who has the ability to pay without hardship?

Where a single fee or assessment does not answer all three, it can be paired with broader taxes, district revenues, or affordability protections to ensure that public investment does not inadvertently burden the communities it is meant to protect.

Two patterns recur in successful local revenue measures. First, sustained public education matters: stormwater fees, parcel taxes, and special assessments succeed when residents understand them as service charges tied to a specific risk-management function, and fail when they read as hidden taxes. Second, dedicated funding streams outlast political cycles—communities that tie resilience revenue to a specific source rather than annual appropriations are far more likely to sustain investment across administrations and budget pressures.

Polluter-pay models—"Climate Superfund" laws enacted in Vermont and New York in 2024, and proposed elsewhere—may create future revenue, but face active legal challenges. Treat these as potential future tools, not reliable near-term financing.

Table 19. When Tax and Fee Tools Fit

Use Tax and Fee Tools When...	Be Careful When...
The project needs a recurring revenue source for repayment, operations, or maintenance	The charge is politically framed as a hidden tax rather than a service or risk-reduction tool
The benefit, burden, or service connection can be clearly explained	The fee does not match who contributes to the problem or who benefits from the solution
A utility, stormwater program, district, or public service already has a revenue structure that can be adapted	State law does not authorize the fee, assessment, district, or dedicated revenue use
The community needs a durable source that can support debt or attract matching funds	Annual appropriations would be too uncertain to support long-term borrowing
Credits, exemptions, or assistance can reduce affordability burdens	The tool increases costs for low-income households, small businesses, or communities already facing high risk

Practitioner Checklist

- **Start with state authority.** Before designing a project around a revenue tool, confirm what your state actually allows: taxes, fees, assessments, districts, and financing structures all require state authorization, and the tools vary significantly by state.
- **Match the tool to how the benefit shows up.** Broad-based taxes work for systemwide public benefits. Utility-style fees work where the charge can be tied to who contributes to the problem. District tools work where risk and value are geographically concentrated.
- **Build credits and exemptions in from the start.** Fee structures that offer credits for on-site risk reduction—stormwater detention, fire-resistant landscaping, cool roofs—turn a charge into an incentive and reduce political resistance. Low-income exemptions and bill assistance programs reduce affordability burdens and broaden public support.
- **Use tax incentives and designated zones where private investment needs to be attracted.** Opportunity zones, New Markets Tax Credits, and Commercial PACE (where building owners borrow for resilience or efficiency upgrades and repay through a long-term property tax assessment) can improve project economics for redevelopment and building-level resilience.
- **Connect the revenue tool to the financing instrument early.** Property taxes back general obligation bonds. Dedicated fees back revenue bonds. District revenues back project-specific borrowing. Design the revenue source and the financing structure together; retrofitting a repayment source onto a bond that is already drafted is one of the most common and costly mistakes in resilience finance.
- **Plan for the political work.** Communities that succeed explain the charge in terms of what it does—reduced flood damage, lower disaster costs, cleaner water, safer neighborhoods—not in terms of the financing mechanism. Build the public education campaign before the vote, not after.

Place-Based Tools: Paying for Resilience Where Benefits Are Shared

Some resilience investments protect a whole place, not just one asset. A flood project may protect homes, businesses, roads, utilities, public facilities, emergency access, and the local tax base at the same time. A heat strategy may benefit residents, schools, workers, parks, transit riders, and employers. A watershed project may reduce risk for water utilities, landowners, downstream neighborhoods, and public agencies.

When benefits are shared this way, one payer often cannot or should not carry the full cost. Place-based tools help solve that problem. They create a defined geography—a district, corridor, watershed, redevelopment area, or service area—and use revenues from that place to help pay for improvements from which it benefits. The core test is simple: the geography of the financing should match the geography of the benefit.

How Place-Based Tools Work

Place-based tools can take several forms. A district can collect taxes, fees, or assessments within a defined boundary. A special assessment or special service district charges properties within a defined area for improvements or services that benefit that area. Tax increment financing is one form of value capture. It works by drawing a boundary around an area and dedicating some of the future growth in property tax revenue in that area to pay for public improvements. In plain terms, if public investment helps make a place safer, more functional, or more valuable, tax increment financing can use part of the added future tax value to help pay for the improvements that support that change. A watershed or flood authority can coordinate investment across jurisdictions. A redevelopment agreement can require private development to contribute to surrounding infrastructure when the development depends on that infrastructure to succeed.

For resilience, tax increment financing is most relevant when public improvements protect or increase the value of a defined place—such as a waterfront, business corridor, downtown, redevelopment area, or heat-vulnerable neighborhood—and when state law allows future tax growth to be dedicated to those improvements. Portland, Oregon's East 205 TIF District illustrates this broader use. The district was created on October 30, 2024, and its 30-year plan aims to prevent the displacement of residents and small businesses by supporting affordable housing, generational wealth-building opportunities, small-business support, and environmental resilience. The plan identifies heat islands and low tree canopy as district conditions and makes investments in tree canopy, green stormwater infrastructure, community solar, and climate resilience eligible for future funding. A 13-member Community Leadership Committee made up of people who live, work, worship, or attend school in the district is helping develop the first five-year Action Plan and advising city staff on which eligible investments to prioritize. (FHWA n.d.; Prosper Portland 2024a; Prosper Portland 2024b).

The Adoption Gap

State law may authorize a district, assessment, or special financing tool, but communities may not be able to use it immediately. Local governments still need staff capacity, legal work, revenue analysis, community support, interagency coordination, and a governing body able to make decisions and manage funds. This adoption gap is a major implementation challenge in resilience finance. Communities should build governance early, rather than wait until after a disaster or until a project is fully designed.



State programs can help close this gap when they fund the work that comes before construction: vulnerability assessment, community engagement, resilience planning, project scoping, engineering, grant strategy, and implementation capacity. Massachusetts' Municipal Vulnerability Preparedness Program is a useful example. The program helps cities and towns identify climate hazards, assess vulnerabilities, and develop action-oriented resilience plans; communities that complete the planning process can become eligible for MVP Action Grants to advance priority resilience projects. This sequencing helps local governments move from risk identification to a fundable project pipeline, rather than leaving each community to build the planning, governance, and implementation pathway on its own. (Mass EEA n.d)

Virginia's Community Flood Preparedness Fund offers a related flood-focused model. The fund provides grants and loans to localities for flood resilience, including capacity building, planning, studies, and project implementation, with an emphasis on projects aligned with floodplain management standards and resilience plans. This kind of state-level funding helps communities move from planning to capital deployment when local capacity is uneven, even if separate legal work may still be needed to create a new district, authority, or governing body. (VADCR 2026).

How Place-Based Tools Show up in Practice

- Norfolk, VA: Neighborhood-scale flood resilience. Norfolk's Ohio Creek Watershed Project shows how place-based resilience can combine flood protection, public space, mobility, and neighborhood investment. The city received a $112 million federal award for the project, which reduces flooding and improves public access in the Chesterfield Heights and Grandy Village neighborhoods and includes Resilience Park, which connects the two neighborhoods through a flood berm, restored tidal creek and wetland, sports field, and community gathering spaces (VADHCD n.d., Hafner 2023). The project is organized around a place where risks and benefits overlap, rather than around a single asset. Norfolk also illustrates how a special service district can create a local revenue tool. In 2019, the city adopted a Special Service District policy for flood protection that allows property owners in a defined area to help finance flood mitigation, dredging, water-quality improvements, and coastal protection projects through an added district charge. (Georgetown Climate Center 2019)

- San Francisco: Special financing districts for public infrastructure. San Francisco uses special financing districts based on future tax increment to fund public infrastructure and affordable housing in undeveloped and infill areas (City and County of San Francisco 2025). These districts can fund public improvements such as streets, shoreline protection, water and sewer systems, parks, libraries, public safety facilities, commercial to residential conversions, and affordable housing. San Francisco's 10-year Capital Plan establishes guidelines and fiscal constraints that govern the use of these tools: each district has a legislatively approved plan of finance, and the City applies an overall policy constraint that total Infrastructure Financing District debt cannot exceed 5% of annual property tax revenue. This illustrates the broader point for resilience: when public improvements make a place more functional, valuable, and serviceable, a defined district can help capture part of that place-based future value to pay for infrastructure. For resilience, the takeaway is to use available district-financing authority deliberately: define the public purpose and future benefits, set fiscal guardrails, and align each district with the jurisdiction's infrastructure and long-range plans. (City and County of San Francisco, Office of Resilience and Capital Planning 2025)

Table 20. When Place-Based Tools Fit

Use a Place-Based Tool When...	Be Careful When...
Benefits are concentrated in a defined area, such as a downtown, waterfront, corridor, neighborhood, or watershed	The people who benefit are not the same people who can afford to pay
Several properties, agencies, or infrastructure systems benefit together	Rising property values could increase displacement pressure
A project needs ongoing operations and maintenance	The revenue source may arrive too late to cover upfront costs
Public investment increases property value, business activity, or development potential	The local government lacks authority to create the district or dedicate revenue
Smaller projects need to be bundled into a larger program	The tool exists in state law, but no governance structure is ready to use it

Using Land Use Tools to Turn Shared Resilience Value into Investment

Local governments can use land use authority to align private development with the resilience systems that make growth possible. Roads, utilities, drainage, tree canopy, emergency access, public space, and natural buffers often create value across many properties at once, but the costs of maintaining those systems are not always shared in a clear or consistent way. Zoning, subdivision rules, development approvals, stormwater standards, building codes, overlay districts, impact fees, incentives, and community benefit agreements can help close that gap by linking private development value to the public and shared infrastructure it depends on.

This can happen through requirements, incentives, or negotiated contributions. Local governments can steer growth away from high-risk areas, encourage development in safer and better-served locations, require stronger site and building standards, preserve natural buffers, require on-site stormwater retention or heat mitigation, and align private projects with planned public infrastructure. These tools are especially useful in waterfronts, downtowns, transit-oriented districts, redevelopment areas, wildfire-prone edges, heat-vulnerable neighborhoods, and other places where private value depends on shared systems that must continue functioning under future conditions.

Used well, land use tools do more than regulate development. They create a practical way to turn diffuse resilience benefits into clearer contributions, better project design, and more durable private and public value.

Resource: Land Use Tools for Shared Resilience Value

Many useful guides have been written to help local governments use planning, zoning, development standards, incentives, and value-capture tools to align private development with shared resilience needs. A few especially relevant resources include:

- Urban Land Institute, Reshaping the City—Shows how zoning reform can shape private development toward public goals. Zoning is not only a land use control; it is a way to structure the terms of growth. Communities can use zoning updates, incentives, public-benefit requirements, and development standards to steer investment toward safer, better-served locations and align private development with resilience, housing, mobility, and climate goals **(**Forman et al. 2023**).**
- Lincoln Institute of Land Policy, land value capture resources—Explains why it is reasonable to recover some of the value created by public action. Public infrastructure, zoning changes, and resilience investments can increase private land value; land value capture tools provide a way to reinvest part of that value in infrastructure, public services, and shared resilience benefits. The Lincoln Institute's work on green resilient infrastructure is especially relevant because it frames resilience investments as projects that create multiple distributed benefits, some of which can be captured to help finance the public cost (Nagam et al. 2026, Jason 2022, Grafakos et al. 2019).
- American Planning Association, Planning for Climate Mitigation and Adaptation—Helps translate climate risk into plans, regulations, and implementation tools. It shows how comprehensive plans, zoning, development regulations, capital improvement planning, and implementation programs can work together so resilience becomes part of the rules and investment decisions that shape development over time (Bucchin and Tuley 2022).
- Federal Emergency Management Agency, Local Mitigation Planning Handbook—Provides a practical process for moving from hazard identification to action. The handbook helps communities identify risks, set mitigation priorities, and integrate mitigation actions into local plans, policies, regulations, and capital decisions. It is especially useful for connecting risk evidence to fundable actions, making it easier to justify resilience requirements, prioritize capital investments, and align development decisions with long-term risk reduction (FEMA 2025b).
- Coastal Hazards Center, Coastal Hazards Overlay District Guide—Provides a coastal-specific model for using zoning overlays to manage development in areas exposed to flooding, erosion, sea-level rise, and other coastal hazards. The guide offers 51 possible design standards and planning techniques organized around strategies such as avoidance, protection, accommodation, and community-led relocation, with checklists, case studies, diagrams, and implementation guidance for local governments. It is especially useful for communities that want to translate coastal risk into place-based land use rules, development standards, and district boundaries that can guide safer growth over time (Smith et al. 2025).

Practitioner Checklist

- **Define the geography**. Identify the district, corridor, watershed, service area, redevelopment zone, or neighborhood that benefits from the investment.
- **Map who benefits and who pays**. Identify residents, businesses, property owners, utilities, agencies, developers, and other beneficiaries. Test whether the proposed payment structure is fair and affordable.
- **Check state and local authority**. Confirm whether the jurisdiction can create a district, dedicate tax growth, levy assessments, charge fees, enter interlocal agreements, or negotiate development contributions.
- **Choose the revenue tool and match it to how value appears**. Use district charges where benefits are place-based, tax growth where public investment increases property value, utility fees where service reliability is the core benefit, and shared agreements where several beneficiaries gain from the same investment.
- **Build governance before the money is needed**. Decide who can sign agreements, collect revenue, manage funds, issue debt, oversee delivery, and maintain the project over time.
- **Include affordability and anti-displacement protections**. Test whether the financing approach could increase housing costs, small-business burdens, or displacement pressure. Add protections such as exemptions, income-based assistance, affordability requirements, or community benefit commitments where needed.
- **Plan for adoption, not just authorization**. A tool in state law is only useful if the local government has the capacity, political support, technical assistance, and governance structure to use it. Build those pieces early.

Pay-for-Performance and Outcome-Linked Mechanisms

Some resilience projects create real value, but the value is uncertain before the project is built. Green infrastructure may reduce stormwater runoff, but the exact amount depends on rainfall, soil conditions, maintenance, and design. A microgrid may reduce outage impacts, but the value depends on how often outages occur and which facilities stay online. Pay-for-performance tools help manage this uncertainty. They link some part of payment, repayment, return, or risk sharing to the results a project actually delivers.

These tools are most useful when three conditions are present:

1. The outcome matters financially or operationally
2. The outcome can be measured
3. Someone is willing to share performance risk

They are less useful when the project is routine, the benefits are already well understood, or traditional public financing would be simpler and cheaper. For local governments, the practical value is that these tools force discipline. They require project teams to define the result they are buying, choose metrics that match real operations, and assign performance risk to the party best positioned to manage it.

How Pay-for-Performance and Outcome-Linked Tools Show up in Practice

As introduced in the DC Water example above, an environmental impact bond links financial terms to verified performance. The examples below show how that same outcome-linked logic has been adapted in other communities.

Atlanta: First publicly offered environmental impact bond. The City of Atlanta issued a $14 million environmental impact bond, officially titled T*he City of Atlanta Water and Wastewater Environmental Impact Subordinate Lien Revenue Bonds (Proctor Creek Watershed Project), Series 2018D*. The bonds funded improvements to the City's water and wastewater system in the Proctor Creek watershed through the Department of Watershed Management's Green Infrastructure Program, including six bioretention, stream and wetland restoration, and green street projects. The bond's outcome metric was Volume Capture Capacity—the amount of stormwater the six projects could capture. (Atlanta DWM n.d.; Quantified Ventures n.d.)

An environmental impact bond is different from a conventional green bond because it links financial terms to verified performance. Instead of paying only for construction, the public agency defines an outcome in advance, measures whether the project delivers it, and uses that result to determine whether investors receive the base return, an additional outcome payment, or a reduced return through a risk-share payment.

Outcome-linked capital is most useful when four conditions are present: the outcome matters financially or operationally; the outcome can be measured; there is a repayment source that can support the financing; and a mission-driven investor is willing to share performance risk. Where those conditions do not yet exist, the work is to build them—not to find a different financing instrument.

Environmental impact bonds have moved beyond early stormwater examples into a broader set of environmental resilience applications, including green infrastructure and forest restoration. As the model has developed, issuers, investors, and intermediaries have refined deal structures, performance metrics, verification methods, and disclosure practices. Because these instruments can involve higher design, contracting, measurement, and oversight costs than conventional financing, they are most useful when verified outcomes, shared performance risk, and transparent accountability justify the added complexity. Where performance is well understood and speed or simplicity is the priority, conventional financing may be the better fit. (Brand et al. 2021; Brookings 2020.)



Table 21. When Pay-for-Performance and Outcome-Linked Tools Fit

Use This Tool When...	Be Careful When...
The project outcome matters but is uncertain upfront	The project is routine and can be financed more simply
The project has partners who can help design the metric, measurement approach, disclosure framework, and transaction structure	The project team has not budgeted for the predevelopment and structuring work needed before issuance
The outcome can be measured with credible data	The metric is too abstract, hard to verify, or disconnected from operations
A public agency wants to share performance risk with another party	The public agency will still carry most of the risk if performance falls short
The project is a pilot, first-of-kind approach, or green infrastructure strategy	Transaction costs would be high compared with the project size
Investors, funders, or regulators need proof that the project worked	Verification would require a new data system that the agency cannot maintain

Practitioner Checklist

- Start where performance is already measured. Water and wastewater utilities track runoff, overflows, and water quality. Flood programs track drainage capacity. Transportation agencies track uptime. Energy systems track outages and restoration time. These are the natural entry points.
- Define the outcome before choosing the financing structure. The key question is not, "Can we create an innovative financing deal?" It is, "What result are we trying to buy?"
- Choose metrics that match operations. Use utility performance standards, regulatory compliance measures, service delivery targets, outage data, or maintenance records. Avoid abstract indicators that do not affect real decisions.
- Build verification into existing systems. Use data the agency already collects where possible. Bring in third-party verification when credibility matters to investors, regulators, or the public.
- Assign risk to the party best positioned to manage it. Public agencies may sponsor the project. Private partners may design, build, operate, or maintain it. Investors or mission-driven lenders may absorb some downside risk. The structure should match responsibility to control.
- Use pay-for-performance and outcome-linked tools selectively. For well-understood infrastructure, traditional financing is usually simpler and cheaper.

Insurance and Risk Transfer

Governments are already paying for disasters through deductibles, emergency repairs, overtime, service disruptions, reserves, uncovered losses, delayed projects, and deferred maintenance. Localized floods, severe storms, heat waves, and infrastructure failures often occur more frequently than the large disasters that trigger federal assistance. Insurance should not be treated as the only resilience strategy. It is one part of a broader financial strategy for the risk that remains after mitigation.

Insurance and risk-transfer tools help manage some of those costs by moving a defined portion of loss to another party in exchange for a premium or other payment. These tools do not reduce the underlying hazard. Their role is different: they provide financial protection and faster access to money for the risk that remains after a community has reduced what it can. Used well, insurance complements resilience investment. Used poorly, it becomes an expensive substitute for action that should reduce risk at the source.

Chapter 3 introduced the broader risk-financing choice: what risk is being retained, reduced, transferred, or shared. This section focuses on the transfer piece—insurance, reinsurance, catastrophe bonds, and parametric tools—and how they can complement, but not replace, risk reduction.

When Insurance Recognizes Resilience, and When It Does Not

A local government may reduce real risk and still not immediately see lower premiums. Insurance pricing depends on many factors, including state regulation, market capacity, reinsurance costs, claims history, litigation, coverage limits, deductibles, and annual policy cycles. A single insurer may also have limited incentive to reward community-wide mitigation if other insurers, future policyholders, or public budgets capture part of the benefit. This does not mean mitigation has no insurance value. It means local governments should be careful about the claim they make. A project may improve insurability, reduce expected loss, strengthen underwriting evidence, or support better risk selection without immediately producing a guaranteed premium reduction.

Several emerging tools show how insurance and capital markets are beginning to connect disaster coverage to faster recovery and, in some cases, verified risk reduction. Catastrophe bonds transfer defined disaster risk to capital-market investors. Parametric insurance pays when a measurable trigger is reached—such as wind speed, rainfall, river height, earthquake intensity, or temperature—rather than waiting for a full damage assessment. These tools do not reduce the hazard itself, and poorly matched triggers can miss real losses, but they can provide faster post-event liquidity and help protect public budgets from losses that remain after mitigation (RAND Corporation 2023).

- **Cape Lookout Re 2025 catastrophe bond.** The North Carolina Insurance Underwriting Association issued this $600 million catastrophe bond to transfer hurricane risk. It was the first catastrophe bond to include an integrated disaster-resilience feature, linking the transaction to IBHS FORTIFIED roof installations (Evans 2025).
- **Parametric Re 2024 catastrophe bond.** This catastrophe bond provided parametric disaster coverage for named storms and earthquakes and was structured to benefit the government of Puerto Rico (Evans 2024).
- **Mississippi River parametric insurance pilot.** The Mississippi River Cities and Towns Initiative is working with Munich Re on a regional parametric insurance pilot for river communities. The pilot is designed to explore how river communities could use trigger-based coverage to access faster recovery funding after flood events. (Dryfoos and Schmid 2024).
- **Wildfire resilience insurance product.** The Nature Conservancy and Willis Towers Watson launched a wildfire resilience insurance product in California that combines forest management, risk analytics,

and parametric risk transfer. The model is designed to connect proactive forest restoration with insurance coverage, so risk reduction and faster post-event funding can work together rather than being treated as separate strategies. (TNC 2025)

- Natural infrastructure insurance for reefs and mangroves. The Nature Conservancy has been developing insurance models that connect the risk-reduction value of natural assets, such as coral reefs and mangroves, to resilience finance. Its coral reef work shows how parametric insurance can provide pre-agreed payouts for ecosystem repair after a storm, while broader nature-insurance work explores how the protective value of natural infrastructure can support insurance and resilience finance models. (TNC 2026)

These examples show where the market may be heading: toward tools that recognize mitigation, speed recovery payments, or connect coverage to verified risk reduction. But they are still emerging models, and they should be evaluated as residual-risk tools rather than project-funding sources, not routine local-government financing tools. For now, local governments should treat insurance as a complement to mitigation and a strategy for managing residual risk, not as a substitute for reducing risk at the source or as a guaranteed source of project funding.

Table 22. When Insurance or Risk Transfer Tools Fit

Use This Tool When...	Be Careful When...
The local government faces large, volatile, or fast-moving losses that could strain reserves or delay recovery	Insurance is being used as a substitute for mitigation that would reduce risk at the source
Speed and certainty of payout matter, such as for emergency response, temporary services, or rapid repair	The trigger does not match the actual loss the community needs to manage
The community has already reduced what it can and needs protection for residual risk	Premiums, exclusions, deductibles, or coverage limits leave major losses uncovered
Cross-jurisdictional or regional risks require a shared financial backstop	The structure is too complex for the local government to explain, manage, or renew
Mitigation may improve insurability, underwriting, or expected-loss analysis	The project team promises guaranteed premium reductions without insurer confirmation

Practitioner Checklist

- **Map how recent losses were paid for.** Include deductibles, reserves, emergency repairs, overtime, temporary services, insurance recoveries, federal reimbursements, delayed projects, and deferred maintenance.
- **Identify what risk the local government is already retaining**. Some risk is retained intentionally through deductibles, reserves, or self-insurance. Some is retained unintentionally because coverage is missing, exclusions apply, or federal aid is uncertain.
- **Decide what to retain, reduce, transfer, or share**. Smaller predictable losses may be retained. Risks that can be mitigated should be reduced. Large or volatile losses may need insurance or risk transfer. Cross-jurisdictional risks may need shared funding or regional structures.
- **Use forward-looking risk information**. Historical losses can understate future exposure. Combine future rainfall, heat, flood, wildfire, drought, earthquake, or outage scenarios with asset, operational, and financial data.
- **Pair insurance with mitigation**. If coverage becomes expensive or unavailable, the strategy should shift toward reducing risk at the source. Insurance is a bridge and a backstop, not the resilience strategy itself.
- **Use parametric coverage where speed and certainty matter**. The trigger must be carefully matched to the loss the community is trying to manage.
- **Revisit coverage as risk and mitigation change**. Capital plans, building standards, land use, asset exposure, and climate conditions change, and insurance may have to as well.
- **Connect the parts of government that manage risk**. Finance, risk management, public works, utilities, planning, emergency management, legal counsel, and resilience staff should understand the same risk picture and the same financial exposure.

From Tools to a Financing Strategy

The tools in this chapter should not be selected in isolation. They should be matched to the type of resilience outcome the project is trying to produce. Figure 8 shows how common resilience outcomes can point local governments toward different funding, financing, and implementation partners. It is not a formula, but a starting point for structuring the financing strategy.



Figure 8. From Resilience Value to Financing Pathways

This figure connects the resilience value concepts introduced in Chapter 1 to the financing pathways discussed in this chapter. The second column names the value created by the project. The third column shows tools that may capture, organize, or finance that value. The final column distinguishes who may provide upfront capital from who may ultimately pay through rates, taxes, fees, assessments, or other contributions.

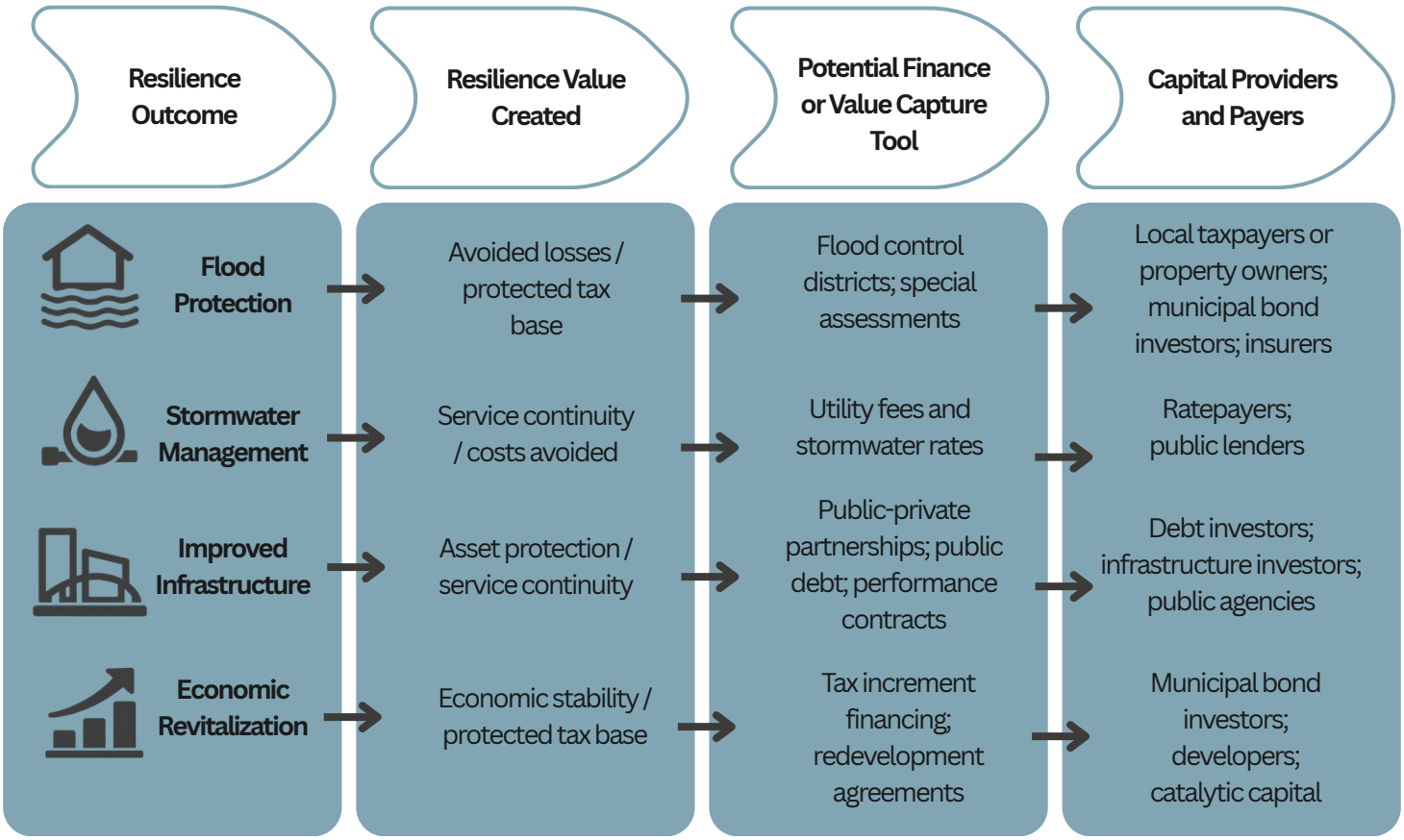


Figure 8 shows why resilience finance starts with value, not tools. A flood project may reduce losses, protect the tax base, support utility service, and improve insurance conditions at the same time. Each type of value may point to a different financing pathway. The financing strategy is the work of deciding which benefits can support repayment, which require public funding, which residual risks may need insurance or risk transfer, and which partners have the authority to act.

Use the Capital Alignment Framework to make those decisions explicit. The framework asks project teams to identify what is being protected, who benefits, who can help pay, what can support repayment or long-term funding, what gaps remain, and what must be solved before implementation. Those questions should guide the choice of tools in the sections that follow.

The Last-Mile Gaps: Predevelopment and Bridge Financing

Many resilience projects do not fail because the wrong tool was selected. They fail because the project never becomes finance-ready, or because the community cannot front costs while waiting for reimbursement. Two timing gaps consistently prevent otherwise viable projects from reaching construction: predevelopment and bridge financing.

The Predevelopment Gap

Before a project can be financed, it has to be defined. Engineering studies, benefit-cost analysis, hydrologic modeling, community engagement, environmental review, legal structuring, governance design, and feasibility analysis often have to happen before a bond can be issued, a grant can be submitted, or a lender can underwrite the project. That work costs money, but it is rarely easy to finance with repayable capital because there is no completed asset yet and the project may not move forward.

Predevelopment is not overhead; it is part of the financing strategy. For smaller or lower-capacity communities, predevelopment is often the binding constraint. The primary barrier is frequently not the absence of capital but the absence of project pipelines capable of drawing it down—making predevelopment support as important as the capital that follows (Rapson 2023; Prime Coalition 2024). The sources that can help fill this gap include philanthropic grants, state technical assistance, federal technical assistance programs, mission-driven lenders, green banks, and specialized intermediaries that help communities move from concept to finance-ready project.(Gaughan and Tomer 2024) n some cases the most important predevelopment work is institutional—building the governance structures, partnerships, and implementation capacity that make a proposal viable, not just technically compelling (Martín et al. 2016).

For outcome-linked structures in particular, predevelopment also includes measurement design, disclosure frameworks, transaction structuring, and partner coordination. That work requires specialized support and carries its own cost, but it is often what makes the difference between an interesting resilience concept and a project that funders, lenders, or investors can evaluate.

The Bridge Financing Gap

Bridge financing is short-term money used while a community waits for another funding source to arrive. This gap is common because many federal and state programs operate on a reimbursement or cost-share basis. Communities may need to spend first and wait for repayment later. For communities with limited reserves, that timing problem can stall a project even after funding has been awarded.

Bridge financing can help cover costs while a community waits for reimbursement from programs such as FEMA Public Assistance, HMGP funds, HUD CDBG-DR, EPA state revolving funds, or USACE cost-share programs. Mission-driven lenders, green banks, and revolving credit facilities may be able to accept this timing risk when conventional lenders cannot. The key is to identify the gap early, before a community is forced to delay construction, reduce scope, or abandon a project that has already been approved.

Neither predevelopment nor bridge financing is flashy, but both can determine whether a resilience project moves. Communities that build relationships with predevelopment funders, technical assistance providers, mission-driven lenders, and bridge lenders before they need them are better positioned to act when funding opportunities, disasters, or redevelopment moments arise.

Who to Engage When Building the Capital Stack

The sections above describe what different capital providers need to see before they can participate in a resilience project. This checklist takes the next step: it helps local project teams identify who to engage, what to prepare before the conversation, and what each

actor typically needs before they can help move a project forward.

Before contacting any funder, lender, advisor, or partner, project teams should also ask whether the project stands alone or could be strengthened by connecting it to related work. Are other departments, utilities, neighboring jurisdictions, school districts, housing agencies, transportation agencies, or private owners planning improvements in the same place or facing the same risk? If so, the project may be more fundable or financeable as part of a larger package, shared application, regional strategy, joint procurement, or bundled pipeline.

Table 23. Who to Engage When Building the Capital Stack

Actor	Role in the Capital Stack	When to Engage	Bring to the Conversation	Keep in Mind
Technical assistance provider	Helps turn an idea into a finance-ready project by filling gaps in engineering, financial analysis, benefit-cost documentation, grant strategy, or community engagement.	Before most financing conversations, especially when a community needs help turning an idea into a project defined enough to approach funders.	Honest gap assessment; rough project concept; staff capacity; realistic timeline; likely program fit; related departments, utilities, agencies, or jurisdictions that may need to be involved.	Technical assistance works best when the community has staff assigned to receive and implement support, not just a general interest in help. Competitive technical assistance programs may require a written application or expression of interest.
Regional council of governments or planning commission	Helps aggregate demand across jurisdictions, connect the project to regional priorities, and access grants or funding thresholds that one community may not meet alone.	Early, especially if neighboring jurisdictions share the risk or benefit.	Project description; rough cost estimate; regional, hazard mitigation, or climate plans the project supports; sense of whether nearby jurisdictions face the same problem.	Regional partners can help create a bundled pipeline, but only if local governments are willing to coordinate data, timing, and governance.
Municipal advisor	Compares financing options and helps evaluate debt, loans, fees, assessments, and other structures before the local government commits to a path.	Very early, before choosing bonds, loans, fees, grants, or another structure.	Project goals, rough scope, possible repayment source or authority, timeline, political constraints, prior bond history, debt capacity, capital plan, related utility work or bond measures.	A municipal advisor needs enough project definition to compare options and should be engaged before assumptions harden around one tool. Engage decision-makers, not only staff, because financing options often depend on policy, debt, and revenue decisions.

Table 23. Who to Engage When Building the Capital Stack continued on next two pages

Actor	Role in the Capital Stack	When to Engage	Bring to the Conversation	Keep in Mind
Grants office or grant manager	Identifies eligibility, deadlines, match requirements, compliance obligations, and how grants fit into the larger capital stack.	Early in the grant-seeking process, before applications are drafted and before departments pursue separate opportunities without a coordinated strategy.	Project description, rough cost estimate, likely funding need, timeline, known match requirements, policy documents the project connects to, related applications or departments pursuing the same program.	Grants are not just "free money." They bring timing, match, compliance, reimbursement, and reporting requirements that affect the rest of the stack.
State agency or program office	Clarifies state priorities, sequencing, plan requirements, and which federal funds flow through the state.	Before applying to federal or state programs where the state sets priorities, rankings, or sequencing.	Project alignment with state priorities or hazard mitigation plans, confirmation of which federal programs flow through the state, required local plans, expected deadlines, whether the project could fit a larger state or regional proposal.	For many federal programs, the state shapes the queue before the federal agency sees the application. State deadlines and rankings often come before federal deadlines, so waiting for the federal notice can be too late.
State revolving fund or infrastructure bank	Provides lower-cost loans for eligible infrastructure categories, often water, wastewater, stormwater, transportation, or other state-defined priorities.	Early to mid-stage; application-to-award timelines can run 18 months or more, so approach well before funds are needed.	Eligibility fit, environmental or regulatory documentation; cost estimate, schedule, repayment source; match funding if required.	These programs can be powerful but are not quick gap-fillers. Communities should confirm eligible categories, program conditions, and readiness requirements early.
Green bank	Provides repayable capital for projects with clear climate, clean energy, or resilience benefits; may also support structuring, predevelopment, or market-building.	During project development through financing.	Documented resilience, climate, or clean energy benefit; feasibility analysis; repayment or revenue path; community benefit framing; similar projects that could create a pipeline.	Green banks usually still need a repayment path, even when they are more flexible than conventional lenders. They may also look for projects with potential to replicate or scale.
Community development financial institution or mission-driven lender	Provides flexible capital for projects with strong community benefits where conventional lenders may not engage.	Predevelopment through financing, especially when conventional lenders will not engage and the project serves an underserved community.	Community benefit documentation, explanation of why conventional financing does not fit, flexible repayment analysis tied to project cash flows, technical assistance needs; relationship pathway.	Mission-driven does not mean repayment-free. These lenders still need a credible path to repayment and a clear community-benefit rationale. A warm referral from a state agency, green bank, technical assistance provider, or trusted intermediary is often more effective than cold outreach.

Actor	Role in the Capital Stack	When to Engage	Bring to the Conversation	Keep in Mind
Foundation or philanthropy	Provides grants, guarantees, first-loss capital, predevelopment support, proof-of-concept funding, or engagement resources that unlock other capital.	Earliest stages or gap-filling moments, such as feasibility, engagement, demonstration, or support that makes other capital possible.	Clear public benefit, evidence of community engagement, demographic data on who benefits, specific gap to fill, explanation of what the support would unlock, evidence that philanthropic dollars can leverage other capital.	Philanthropy is most useful when the ask is tied to a specific gap—predevelopment, engagement, first-loss support, proof of concept, or a guarantee—rather than a general funding need. Alignment with the foundation's mission, geography, and funding cycle matters.
Bond counsel	Confirms legal authority, eligible uses, tax compliance, voter or council approval pathways, and whether bond language is broad enough to cover resilience components.	During structuring, before ballot language, bond resolutions, or council approvals are drafted.	Proposed financing structure, instrument type, legal authority question, repayment source, draft eligible-uses language, approval pathway. Include whether resilience, hazard mitigation, green infrastructure, backup power, or future-conditions design should be covered.	Engage before language is locked. Narrow bond language can prevent the government from financing the resilience components that make the project work.
Bank or public lender	Provides direct loans or financing for smaller, faster, or more straightforward transactions that do not require a full bond issuance.	Financing phase, once the project is close to ready.	Cost estimate; financing amount; identified repayment source, such as rates, fees, tax increment, special assessment, or other pledge; financial statements or credit history; project readiness documents.	Lenders will focus on repayment capacity, pledgeable revenues, collateral if required, and whether the project is ready or close to ready.
Developer, concessionaire, or infrastructure fund	Supports delivery and private participation for revenue-generating assets, long-term service contracts, or large-scale infrastructure opportunities.	After the project structure and revenue model are clear.	Revenue-generating asset, long-term service contract, or clear payment mechanism; procurement pathway; draft risk-allocation framework; legal authority to enter a long-term contract; evidence of scale; related assets or jurisdictions that could create a larger opportunity.	Private participation requires significant preparation. Most partners need a clear and enforceable payment stream, transparent procurement, legal authority, and defined risk allocation before engagement is productive. Many infrastructure funds require significant scale, often $20 million or more.

The central lesson is sequencing. Technical assistance, regional partners, municipal advisors, state agencies, and grant managers can help shape the project before the financing path is chosen. Bond counsel, lenders, green banks, mission-driven lenders, philanthropy, and private delivery partners become more useful once the project has a clearer scope, value proposition, repayment or funding pathway, and legal authority. Engaging the right actors too late can leave a community with a promising resilience project but no workable structure for paying for it.



Chapter 4 Key Takeaways

Start with the system and the risk. Identify what must keep working, what could disrupt it, and the future conditions under which the project must perform.

Define who benefits. A project may benefit residents, businesses, utilities, insurers, property owners, employers, public agencies, or the broader tax base. The financing strategy depends on where the value appears and whether any of it can support funding or repayment.

Identify who can pay. Ask who can legally, practically, and fairly contribute. If the beneficiaries cannot pay, or should not carry the full burden, the project may need public funding, grants, philanthropic support, mission-driven capital or other gap funding.

Check authority early. A good financing idea only works if the community has authority to use it. Confirm what state and local law allows for taxes, fees, rates, assessments, districts, debt, public-private partnerships, interlocal agreements, and long-term contracts before the project design locks in.

Choose the revenue source before the financing tool. A bond, loan, or public-private agreement still needs a credible way to repay it. Start with the fee, tax, rate, grant, savings, beneficiary payment, or public funding source before selecting the tool that advances money upfront.

Use debt where repayment is credible. Debt is powerful for long-lived capital assets with a clear repayment source. It is not a substitute for grants, public funding, or subsidy when the project creates broad public value but no reliable repayment stream. Use grants, public funding, or subsidy for project components that create broad public value but no reliable repayment stream.

Use public, philanthropic, and mission-driven capital for specific gaps. These sources are most useful when they fund predevelopment, close affordability gaps, absorb early risk, support lower-capacity communities, cover upfront costs before reimbursement-based grants pay out, or pay for benefits that cannot be repaid by a specific payer.

Plan for timing gaps. Many projects stall before construction because communities lack funding for engineering, modeling, benefit-cost analysis, legal structuring, revenue analysis, project scoping, or community engagement. Others stall because reimbursement arrives only after local governments spend first. Identify bridge financing, reserves, state support, local funds, or other sources that can cover upfront costs before reimbursement arrives.

Treat insurance as a complement to risk reduction. Insurance can provide liquidity after a shock, but it does not reduce the underlying hazard. The strongest strategies pair coverage with investments that lower exposure, reduce losses, and improve insurability over time.

Build fairness and implementation capacity into the structure. Financing tools can reduce risk or deepen burdens depending on how they are designed. The strongest projects pair financing with affordability protections, community benefits, technical assistance, and a cross-departmental team that understands the risk, the payer, the repayment source, and the authority to act.

Chapter 5. How Resilience Projects Become Financeable

Main Messages

Case studies are useful when they reveal the structure behind a project, not when they are treated as templates to copy.

Each case study in this chapter brings the **Chapter 1 Resilience Finance Diagnostic** into practice, showing how risk, value, capture, proof, authority, and capital alignment come together in real projects.

Most resilience finance is ordinary finance structured well. Public debt, utility revenue, grants, state programs, public-private agreements, philanthropy, community development financial institution lending, insurance, and public funding all become more useful when each source has a clear job.

The strongest cases do not rely on one perfect tool. They combine repayment sources, public funding, predevelopment support, technical assistance, governance, verification, and timing.

The lesson is to extract the structure: how each project moved from risk to value, from value to funding or repayment, and from financing strategy to implementation.

How to Use this Chapter

The earlier chapters explained the diagnostic, the value of resilience, how capital providers evaluate risk and return, and the financing tools local governments can use. This chapter shows what those ideas look like in practice. Some projects also appeared in Chapter 4, but for a different purpose: there, they illustrated specific financing tools and capital-stack components; here, they show how risk, value creation, value capture, proof, authority, and capital alignment came together in real projects—and what conditions made each case work or limited its transferability. The cases are organized to make that structure visible through the project narrative itself, moving through the diagnostic without naming every step explicitly.

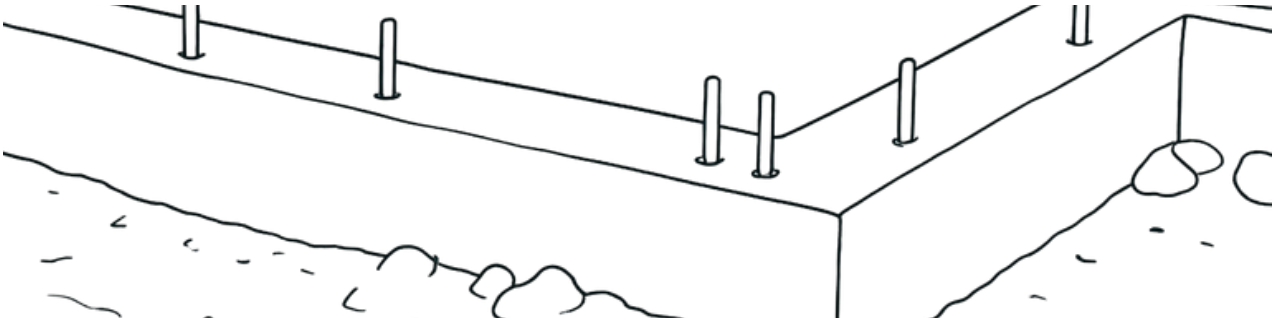
Each begins with the resilience problem, including the systemic risk being addressed and the broader system that must keep working. The project or strategy section then describes what was done to reduce risk or improve performance. The financing section explains how value was created or protected, what made funding or repayment possible, what evidence or authorization mattered, and how different sources of capital were aligned. The lessons and cautions identify what other local governments can take from the example, what conditions made it work, and what should not be overgeneralized.

The goal is not to offer model projects to copy, but to help local governments ask sharper questions about their own.

Table 24. Capital Roles at a Glance

Capital Role	What it Does	What to Look for in the Cases
Repayment anchor	Provides the source of money that repays debt or long-term obligations	Taxes, fees, rates, assessments, contracts, utility revenue, or pledged public revenues
Public-value funding	Pays for benefits that are broad, diffuse, or difficult to repay through a specific payer	Grants, appropriations, disaster recovery funds, voter-approved bonds, federal or state programs
Gap-closing capital	Solves a barrier that prevents the project from moving forward	Predevelopment, bridge financing, first-loss support, guarantees, technical assistance, or flexible loans
Aggregation or intermediary	Makes smaller or fragmented projects more financeable	State programs, green banks, infrastructure banks, regional authorities, pooled structures, or community development lenders
Insurance validation or risk transfer	Makes risk reduction visible or provides recovery funding after a defined event	Verified standards, premium discounts, risk pools, parametric coverage, or insurance-linked structures
Asset-performance capital	Invests when resilience protects operating value, service reliability, or long-term asset performance	Utilities, public-private agreements, operating assets, concessions, or platforms with durable revenue

This table should not be taken to be a capital stack—it is a role map. A single project may use several roles at once.



Public and Concessional Capital

Every case in this chapter involves public funding, concessional capital, or both. Federal disaster recovery funds, grants, state programs, voter-approved bonds, subsidized loans, and below-market financing appear in nearly every capital stack.

Public funding and concessional capital are not side issues in resilience finance; they are often the foundation that makes the rest of the structure workable. Chapter 4 covers these tools in depth. The cases here are selected to illustrate roles that are less visible in the standard public finance toolkit: how private capital engages, how intermediaries create pipelines, how philanthropy unlocks financing, how insurance validates risk reduction, and how outcome-linked structures manage uncertainty. Public and concessional capital appears in each of these cases because it does in almost every resilience finance effort.

Case 1. Harris County, TX: Public Debt for Broad Public Protection

Why This Case Matters

After 2017's Hurricane Harvey, Harris County used voter-approved debt to anchor a large flood-risk-reduction program. This case shows how resilience can move through ordinary public finance when the public-value case is clear and when a local repayment source is used to organize a broader capital strategy.

The Resilience Problem

Hurricane Harvey exposed the scale of flood risk across Harris County's 23 watersheds. The problem was not limited to one asset, neighborhood, or facility. Flooding affected homes, roads, drainage systems, public infrastructure, emergency response, businesses, and the broader tax base. The systemic risk was countywide: flood damage in one watershed could disrupt housing, mobility, public safety, business activity, and public finances across the region.

The Project or Strategy

In 2018, Harris County voters approved a $2.5 billion flood-control bond program for implementation by the Harris County Flood Control District, a special-purpose district created by the Texas Legislature in 1937 following major regional floods in 1929 and 1935. (HCFCD 2026). The program supports channel improvements, stormwater detention basins, floodplain land acquisition, buyouts, structural improvements, planning, and partnership projects. The bond was designed to work alongside federal, state, and local partner funding—a structure that matters because large flood programs often require local dollars to unlock or match outside sources. Equally important, the Harris County Flood Control District brought nearly a century of institutional capacity, technical expertise, watershed-scale planning authority, and project-delivery experience. The bond provided capital, but the district provided the governance, engineering, and implementation platform needed to deploy it.

How the Financing Worked

The bond created a local financing base and public repayment commitment for a countywide flood-risk-reduction program framed around public protection, asset protection, and tax-base continuity. The county's watershed-by-watershed flood damage analysis gave voters and commissioners an evidence base for the program and its project priorities.

When Commissioners Court approved the project list, the projects were valued at approximately $5.1 billion, supported by the $2.5 billion bond and an anticipated $2.6 billion in partnership funding, primarily from federal sources. Many projects were funded entirely with bond proceeds, while others used the bond to unlock or match outside funding. For those partnership projects, successful delivery depended on federal and state funds arriving on time, at the expected scale, and on usable terms.

What Local Governments Can Learn

A resilience project can use ordinary debt if it is framed as public protection, asset protection, tax-base protection, and service continuity. The work is not only financial. It requires public trust, voter authorization where required, clear eligible uses, credible evidence for why the program is needed and how projects will be prioritized, and a project list that can be explained to residents. Where projects include nature-based solutions, open space, trails, habitat restoration, water-quality improvements, or other visible community benefits, those localized benefits can also help residents understand what they are being asked to fund. In Harris County, for example, recreational improvements on Flood Control District facilities are generally constructed in partnership with County Precincts, the Houston Parks Board, and other outside agencies.

Local governments using bonds to unlock outside funding should also build contingency plans for what happens if federal or state layers arrive late, arrive at different amounts, or do not arrive at all. Before issuing a bond intended to unlock federal co-investment, local governments should ask: what is our plan if federal funds arrive 18 months late, or at 70 cents on the dollar?

What Not to Overgeneralize

Harris County is large, has a significant tax base, and had a highly visible disaster trigger. The bond-funded work also depended on the Harris County Flood Control District, a nearly century-old special-purpose entity with technical staff, countywide responsibilities, and the legal authority to plan and deliver regional flood-control projects. That institutional structure is not easily replicated by jurisdictions that lack a comparable district, authority, or technical delivery entity. Creating a new special district may be too costly, administratively complex, or slow to serve as a near-term solution, and many smaller communities may need state technical assistance, regional partnerships, or existing infrastructure authorities to play a similar role.

Smaller communities may not be able to issue debt at this scale and may need state bond banks, county participation, regional authorities, or grants to fill the same role as Harris County's bond.

More importantly, capital stacks built around expected federal co-investment need explicit contingency planning. By 2025, Harris County faced a shortfall estimated at $410 million—reduced from an earlier projection of more than $1 billion—driven by roughly 8% construction cost inflation and federal layers that did not arrive on the schedule or terms originally assumed (Grunau 2025, Enaje 2025). The flood control district paused 26 project groups and county officials acknowledged that not all originally promised projects would be completed. The county has since secured approximately $2.7 billion in partnership funding from local, state, and federal sources, and commissioners are evaluating a future bond election to close the remaining gap.

The lesson is not that voter-approved bonds are risky instruments. It is that when a local bond is designed to unlock federal co-investment, the local program needs to be structured to remain viable if federal layers arrive late, arrive at different amounts, or do not arrive at all.



Table 25. Capital Roles in the Harris County Resilience Project

Role	Source or Actor	What it Did
Repayment anchor	County property tax base	Provided the local borrowing commitment needed to fund projects over time
Public-value funding	Voter-approved bond proceeds ($2.5 billion)	Paid for broad public flood protection that could not be assigned to one payer
Partnership funding	Federal, state, and local partners ($2.7 billion secured)	Extended the scale of projects beyond what local debt alone could cover
Proof and prioritization	Watershed-by-watershed flood damage analysis and project planning	Helped justify the countywide program and organize projects around documented flood risk rather than isolated needs
Delivery authority	Harris County Flood Control District	Provided the public entity responsible for project delivery, prioritization, and coordination



Case 2. Pasco, WA: Resilience Embedded In An Operating Infrastructure Asset

Why this Case Matters

The Pasco project shows how resilience can be embedded in an operating infrastructure strategy rather than financed as a standalone avoided-loss project. It is also one of the clearest examples in this guide of private capital delivering genuine community benefit—not because the community negotiated charity from a private partner, but because the structure aligned private operating incentives with public needs.

The Resilience Problem

Pasco's industrial wastewater system served food processors in a growing agricultural and industrial economy. The existing system was at or near capacity and required improvements to treat increased wastewater flows, meet permitted environmental limits, support existing processors, and allow new businesses to locate in the city. Without a solution, Pasco faced a constraint that would limit economic growth, create regulatory exposure, and leave the region's food processing sector—a major employer in the area—vulnerable to service disruption. The systemic risk was not only wastewater treatment failure; it was the possibility that infrastructure capacity would constrain industrial activity, environmental compliance, employment, and regional economic resilience.

The Project or Strategy

The City of Pasco, following a competitive request for proposals (RFP), selected Burnham to develop, design, construct, finance, own, and operate a wastewater treatment and nitrogen-removal system integrated with renewable natural gas production (City Council of the City of Pasco 2023). The facility—the Pasco Resource Recovery Center—is designed to treat an average of 8.56 million gallons of industrial wastewater per day from seven local food processors, produce treated water for irrigation on city-owned farmland, generate roughly 900 MMBtu per day of renewable natural gas, and use algae-based polishing to remove nitrogen and phosphorus from the treated effluent (Burnham 2024, Turbomachinery International 2023). Construction began in spring 2023 and the facility accepted its first waste load in December 2024 (Xylem 2025). The structure is a 30-year public-private partnership in which Burnham finances, constructs, owns, and operates the system on city-owned property, with renewable natural gas sold under a 20-year offtake agreement that Burnham signed with Cascade Natural Resources.

How the Financing Worked

The financeable value was not avoided loss alone. For the city, the project supported regulatory compliance, infrastructure capacity, and economic growth; for food processors, it provided reliable wastewater service; and for the region, it supported jobs, water reuse, and renewable natural gas production.

Burnham and its capital partners could evaluate the project because the structure included a long-term municipal agreement, renewable natural gas production, Burnham's 20-year RNG offtake agreement with Cascade Natural Resources, and an operating asset with durable revenue. The renewable natural gas offtake agreement and processor treatment payments converted that value into revenue streams private capital could underwrite.

The city retains ownership of the land, while Burnham financed and constructed the facility and now operates it. Inflation Reduction Act investment tax credits—typically 30% of eligible capital costs for qualifying renewable natural gas projects—reduced upfront costs and created a financial cushion for the City's 30-year obligations if one or more food and dairy processors leave the system (Burnham 2024). Because processor payments cover construction and operating costs, maintaining affordability and long-term financial stability remains a priority for all parties. Renewable natural gas revenue is expected to further reduce net treatment costs while producing clean energy.

What the Project Means for the Community

City officials described the project as improving environmental impact, meeting state and federal environmental standards, and harnessing valuable resources while sharing costs with industry partners. Pasco's director of public works called it "a significant investment in the future prosperity and sustainability of our region," citing benefits for the community, job creation, and the potential to attract businesses with carbon-conscious priorities (Gross-Wen Technologies 2023). Construction expenditures are anticipated to exceed $200 million, support more than 1,000 jobs during construction, and contribute around $85 million in labor income across Washington state. Once operational, the project is projected to sustain roughly 25 permanent jobs and generate sufficient renewable natural gas to serve the needs of more than 4,500 Washington State residential consumers annually (Turbomachinery International 2023). A case study from Xylem—a water technology supplier on the project—notes that all six processors now have reliable, year-round service and can stay focused on their core operations rather than wastewater management (Xylem 2025).

What Local Governments Can Learn

The city's role here was active, not passive. Pasco was not simply encouraging a separate utility to act; it controlled the relevant public utility function. The City established and maintains a combined Water/Sewer Utility that includes the process water reuse system serving food and agricultural processors, issued a competitive solicitation, selected Burnham, negotiated a long-term wastewater treatment agreement, retained ownership of the property, and established ongoing oversight responsibilities. The city used its regulatory position, infrastructure need, utility role, and site to attract a private partner willing to finance, construct, own, and operate the system in exchange for a long-term service agreement. Some resilience investments become financeable when they are embedded inside infrastructure systems that already have users, operating needs, revenue or cost signals, and long-term contracts.

The lesson is to look for the operating value inside the resilience problem—but also to ask who controls the relevant system. In places where water, wastewater, energy, or stormwater services are managed by a separate legal entity, local governments may have fewer direct levers and may need to work through governance appointments, rate proceedings, procurement partnerships, or agreements that define shared responsibilities. These may include interlocal agreements, where two public entities agree on roles, funding, or service delivery, or franchise agreements, where a local government sets terms for a utility or private operator to use public rights-of-way or provide service in the community.

What Not to Overgeneralize

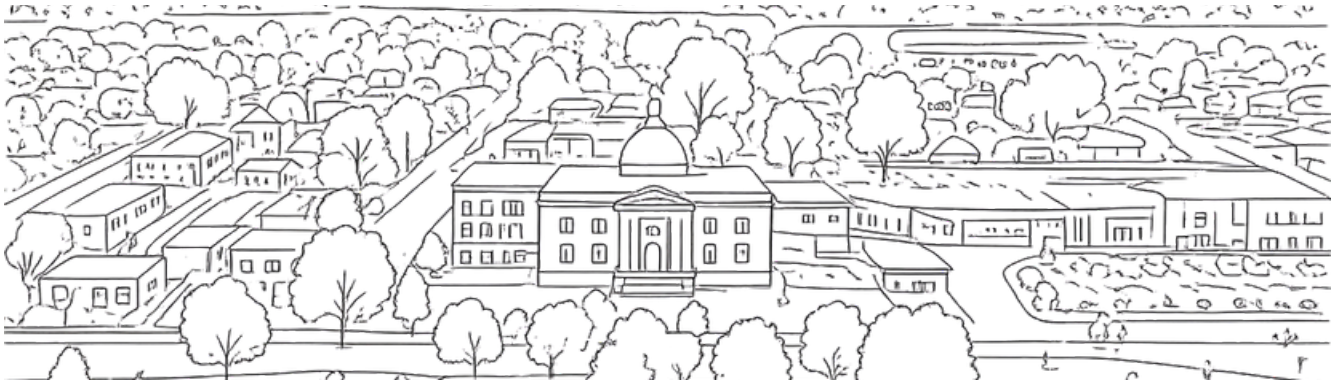
This case depends on a specific industrial wastewater context, long-term agreements, revenue potential from renewable natural gas, time-limited federal tax incentives, and a private partner with the capacity to finance, build, and operate the system. In this partnership, the City remains responsible for meeting the financial obligations of the 30-year agreement and has limited control over some operational decisions and costs. The transferable lesson is that public-private partnerships can help deliver ambitious resilience infrastructure when public needs, private capabilities, and durable revenue streams are aligned—and when the agreement clearly defines each party's responsibilities.



Table 26. Capital Roles in the Pasco Resilience Project

Role	Source or Actor	What it Did
Asset-performance capital	Burnham and infrastructure capital partners	Financed, constructed, owned, and operated the system because it had durable operating value and long-term contractual structure
Public partner and delivery authority	City of Pasco	Provided the public infrastructure need, site, regulatory authority, RFP process, and 30-year partnership commitment
Value capture / revenue support	Wastewater treatment fees from food processors and 20-year renewable natural gas offtake agreement	Converted reliable wastewater treatment and renewable natural gas production into revenue streams that private capital could underwrite.
Federal policy support	Inflation Reduction Act investment tax credits (~30% of eligible capital costs)	Reduced upfront capital requirements and provided a financial-risk cushion for the City's 30-year payment obligations, while helping lower net treatment costs for processors
Public-value benefit	City, processors, workers, and regional economy	Supported wastewater capacity, groundwater protection, water reuse, 1,000+ construction jobs, 25 permanent jobs, and clean energy for ~4,500 residential consumers annually

Sources: City Council of the City of Pasco 2023, Burnham 2024, Xylem. 2025, Turbomachinery International 2023, Gross-Wen Technologies 2023



Case 3. Connecticut: Microgrid Grant and Loan Program

Why this Case Matters

Many local resilience projects are too small, technical, or capacity-constrained to access capital on their own. Connecticut's microgrid program shows how a state program and green bank can make local critical-facility resilience more financeable through a state intermediary, and how the mechanics of that intermediary function matter as much as the capital itself.

The Resilience Problem

Local governments and public agencies need critical facilities to remain powered during outages. Police stations, fire stations, shelters, emergency operations centers, schools, and health facilities may each need resilient power, but one-off projects can be difficult to finance, procure, and standardize. During major outages, the failure of these facilities can hinder emergency operations , prevent shelters from operating, inhibit the capacity of first responders, and reduce residents access to essential services when they need them most. No individual municipality has the leverage to create a market.

The Project or Strategy

Connecticut created a microgrid program to support local distributed energy generation, including energy storage, for critical facilities, and the design and engineering to make projects implementation-ready. In the fourth and final 2017 funding round of the original Microgrid Grant and Loan Program, qualifying projects could receive capital grants of up to $4 million from the state Department of Energy and Environmental Protection and term loans of up to $2 million from the Connecticut Green Bank. Project proponents also had to provide matching funds. For many projects, energy storage is what allows critical facilities to remain operational during outages, even though it is often one of the most costly components of the system. (CT DEEP 2017, 2020)

How the Financing and Mechanics Worked

The program mechanics are the lesson, not just the funding amounts. The state defined what counted as an eligible critical facility, established application requirements, and created a review process that gave municipalities a clear pathway. Those eligibility and technical requirements also served a proof-setting function: they defined what counted as a qualifying resilience project before capital was awarded.

Combining a grant with a loan from the green bank meant that communities could reduce upfront costs through the grant while using the loan to cover remaining capital needs with repayable financing—a combination that individually would have required two separate negotiations with two separate institutions. The Connecticut Green Bank was a full partner in the program from the outset, participating in drafting the RFP and evaluating proposals for project financing feasibility and applicant creditworthiness—not only as a loan provider. That participation gave the program institutional credibility and allowed the program to recycle capital as loans were repaid rather than depleting a one-time grant pool. The program was sustained across multiple funding rounds, with the green bank participating in the final round.

While the exact schedule for Requests for Proposal was not set in advance, DEEP structured application timelines to allow full participation where possible and create a level of predictability for municipalities seeking to use the program. The original microgrid program ran through four rounds; in 2020, state legislation folded it into a broader climate resilience program in which microgrids compete alongside other resilience project types for funding.

The state's authority to define eligible facilities, set application rules, and pair grant funding with green bank lending turned a set of one-off local energy-resilience needs into a repeatable financing pathway.

What Local Governments Can Learn

The aggregation and intermediary function is what made individual projects viable. When projects are too small or specialized to finance individually, an intermediary that defines eligibility, combines grant and loan capital, provides technical assistance, and creates a repeatable pathway can change what is financeable. Local governments should look for analogous state programs, green banks, infrastructure banks, and regional authorities before assuming a one-off project must be structured and financed from scratch. The Connecticut model also illustrates the value of sustained program design: a program that runs across multiple rounds lets municipalities build capacity and relationships, while a one-time program creates a scramble.

What Not to Overgeneralize

A microgrid program depends on state authority, technical eligibility, utility regulation, and available public funding. Not every state has a green bank or comparable financing institution. Because only some states have active green banks, local governments should first check whether their state has a green bank, infrastructure bank, energy office financing program, or other public-purpose lender that can play a similar intermediary role. Where one does not exist, local governments may need to work with state energy offices, public utility commissions, regional agencies, or mission-driven lenders to create similar functions. The state's role in designing eligibility, setting standards, and sustaining the program over time cannot be replicated without political and institutional commitment.

Table 27. Capital Roles in the Connecticut Resilience Project

Role	Source or Actor	What it Did
Public-value funding	Connecticut Department of Energy and Environmental Protection (grants up to $4 million per project)	Reduced upfront costs and made projects viable for smaller municipalities that could not finance independently
Gap-closing capital	Connecticut Green Bank (loans up to $2 million per project)	Partnered in drafting the RFP and evaluating proposals for financing feasibility and creditworthiness; provided repayable loan financing; and created a structure for capital recycling across rounds
Aggregation and intermediary	State program structure	Defined eligibility, created a repeatable pathway, and reduced transaction costs for local governments
Proof-setting standards	Program eligibility criteria and technical review requirements	Standardized what counted as a qualifying critical-facility project and defined the requirements applicants had to meet before grant or loan capital could be awarded.

Case 4. National: Philanthropy and Predevelopment through the National Disaster Resilience Competition Before the Project is Financeable

Why this Case Matters

Many resilience projects fail before they ever reach a lender, bond market, grant award, or construction contract. The missing piece is often predevelopment: the analysis, design, engagement, coalition-building, and technical work that turns risk into a fundable project. The National Disaster Resilience Competition shows why philanthropic support for this early work can be decisive.

The Resilience Problem

After major disasters, communities often need to rebuild in ways that reduce future risk. But disaster recovery programs tend to reward projects that are already scoped, justified, and ready to submit. Many communities have the need, but not the project-development capacity to define regional risk, build partnerships, model alternatives, engage residents, and prepare a competitive proposal. The systemic risk was not only physical exposure to future disasters; it was the institutional gap between urgent resilience needs and the capacity to turn those needs into fundable, implementable projects.

The Project or Strategy

The National Disaster Resilience Competition was a federal competition through which HUD awarded nearly $1 billion in Community Development Block Grant–Disaster Recovery (CDBG-DR) funds for disaster recovery and long-term resilience. The competition followed Rebuild by Design and helped shape later HUD approaches to mitigation funding, including CDBG-MIT, by pairing phased federal funding with technical assistance, interdisciplinary proposal development, and benefit-cost analysis support. The Rockefeller Foundation supported a capacity-building effort that included regional Resilience Academies, individualized technical support, and tools to help applicants interpret federal guidance and develop proposals.

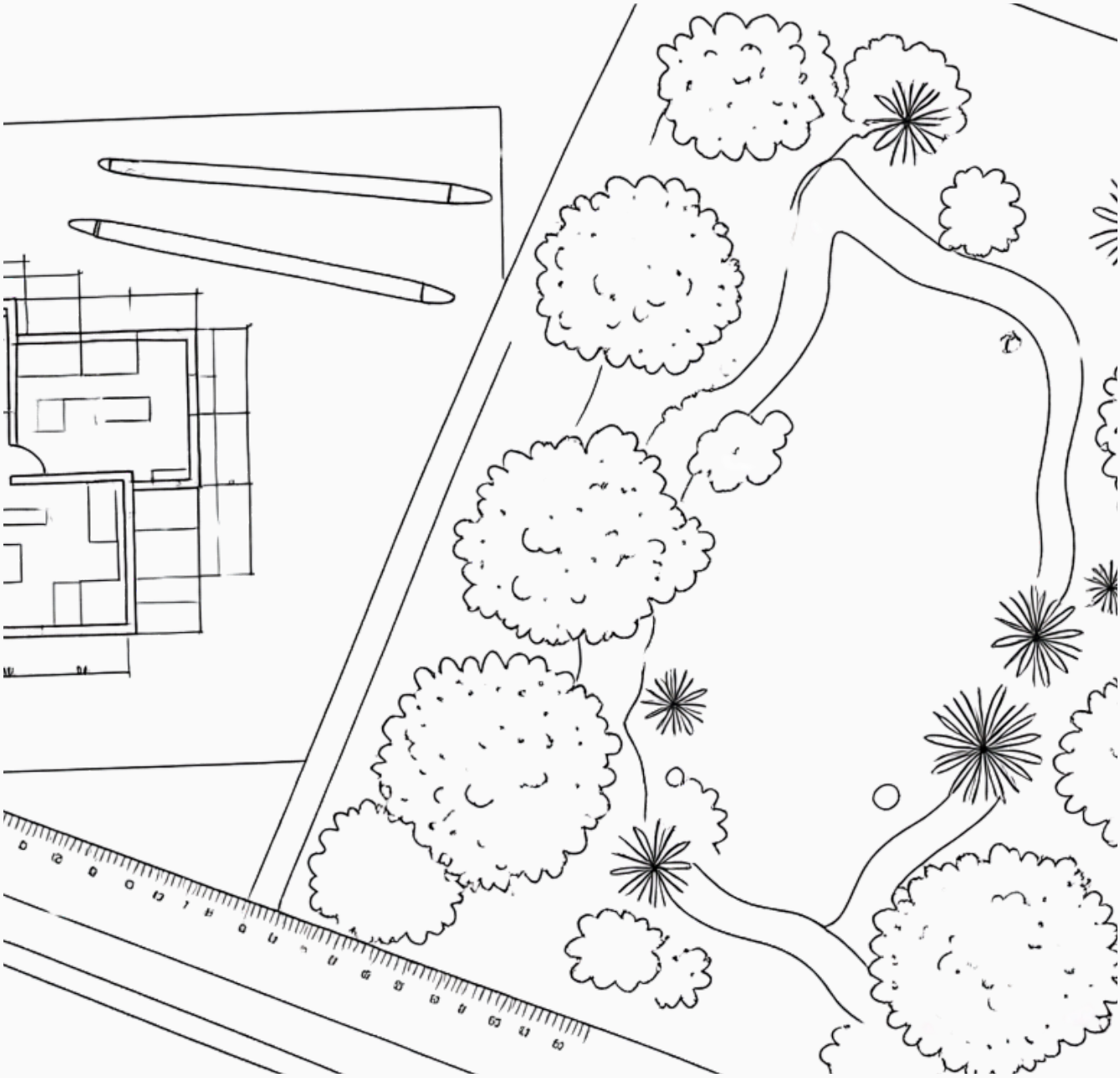
That support became more intensive as applicants moved from broad resilience framing into later-stage project definition, coalition-building, benefit-cost analysis, and implementation planning. The Urban Institute's evaluation states that the Rockefeller Foundation's Resilience Academies and Capacity-Building Initiative provided intensive regional workshops to more than 50 eligible jurisdictions and helped participants broaden their understanding of resilience and operationalize the concept into working processes and arrangements (Martín et al. 2016; HUD 2016).

How the Financing Worked

The Rockefeller Foundation did not fund construction; it funded the work that made construction funding possible: framing risk, building interdisciplinary teams, identifying projects, developing proposals, and connecting disaster recovery with long-term resilience. The HUD awards were only part of the eventual capital stack: selected projects also leveraged additional state, local, and bond financing as they moved from award to implementation. In diagnostic terms, the philanthropic support helped communities build the proof, governance, and project definition needed before implementation capital could be awarded. This is predevelopment in its most important form: not only engineering or design, but the institutional work that helps communities move from a disaster or vulnerability to a fundable, implementable strategy. The support also helped communities understand the governance structures, partnerships, and authorities they needed to make proposals viable, not just technically compelling.

What Local Governments Can Learn

Predevelopment is not overhead, it is part of the financing strategy. Funding the early work can change the quality of the project, the strength of the coalition, the credibility of the evidence, and the ability to attract federal, state, philanthropic, or private capital later. Local governments should look for flexible sources that can pay for risk analysis, engineering, benefit-cost analysis, community engagement, governance design, legal structuring, and partnership development before a project is ready for debt or grants. The community that invests in this work before a funding window opens is in a fundamentally different position than one that starts from scratch after an announcement.



What Not to Overgeneralize

The National Disaster Resilience Competition was unusually large and tied to a specific federal disaster recovery moment. Most communities will not have access to a comparable competition. The transferable lesson is in the role philanthropy played in helping communities become ready for capital, and the recognition that readiness is something that has to be built, often with flexible early-stage support, rather than assumed. The competition also shows that technical assistance is not enough by itself. Some jurisdictions participated but did not advance because they lost momentum, lacked sufficient local capacity, or could not secure the political support needed to move from concept to proposal.

Table 28. Capital Roles in the National Disaster Resilience Competition

Role	Source or Actor	What it Did
Predevelopment and gap-closing support	The Rockefeller Foundation	Funded the technical assistance, workshops, tools, and proposal development support that helped communities become ready for implementation funding.
Project development and readiness support	Technical assistance consultants, coordinated under HUD/Rockefeller oversight and supported by HR&A	Helped eligible jurisdictions define risks, develop strategies, build partnerships, prepare proposals, and strengthen the governance, benefit-cost, finance, design, engineering, hydrology, and implementation logic needed to compete for federal funding.
Public-value funding	HUD CDBG-DR (~$1 billion awarded)	Provided major implementation funding for selected resilience projects
Proof and governance support	Resilience Academies and technical advisors	Helped applicants build the evidence, partnerships, governance structures, and implementation logic needed to compete for federal funding
Local governance	Applicant cities, states, and counties	Organized local teams, priorities, and implementation pathways

Case 5. Tulsa: Insurance Recognition Through 30 Years of Verified Local Action

Why this Case Matters

Insurance usually does not finance resilience projects directly. But it can recognize risk reduction when local action is measurable, sustained, and verified. Tulsa's participation in FEMA's Community Rating System shows how local floodplain management can translate into lower flood insurance costs, and how long the sustained operational work behind that recognition actually takes.

The Resilience Problem

Tulsa experienced nine federally declared flood disasters in 15 years during the 1970s and 1980s, earning national notoriety as a flood disaster capital. A major 1984 flood that killed more than a dozen people and inundated hundreds of homes prompted citizens to demand fundamental change. The city began a comprehensive rethinking of how it managed development, open space, and stormwater—work that would take decades. The systemic risk was not only repeated flood damage, but a cycle of development, exposure, emergency response, and rebuilding that kept residents, businesses, and public finances vulnerable.

The Project or Strategy

Tulsa joined FEMA's Community Rating System in 1991 and has moved steadily up the class scale ever since. In 2021, Tulsa moved to Class 1, the highest possible rating, becoming one of only two communities nationwide—the other being Roseville, CA—to achieve that distinction among more than 1,500 participating cities and counties (City of Tulsa 2022; FEMA 2026). National Flood Insurance Program policies issued or renewed within city limits became eligible for a 45% premium discount starting in April 2022 (City of Tulsa 2021).

The Community Rating System organizes creditable activities into four categories: public information, mapping and regulations, flood damage reduction, and warning and response. Tulsa's Class 1 rating required sustained work across all four. FEMA cited specific accomplishments, including acquisition of nearly 900 flood-prone properties, preservation of more than a quarter of the city's floodplain as open space, strong building codes including a two-foot freeboard requirement above the base flood elevation, and sustained community outreach. The city has spent more than $200 million on flood management since 1990 (City of Tulsa 2026).

The rating is maintained on a three-year renewal cycle. Five departments coordinate to maintain the rating: engineering services, streets and stormwater; development services; parks, culture, and recreation; and the Tulsa Area Emergency Management Agency. Tulsa mayor G. T. Bynum noted at the Class 1 celebration that the achievement represented three decades of accumulated progress, each step building on the last since joining the CRS in 1991 (City of Tulsa 2022).

How the Financing Worked

Tulsa's case is not a conventional repayment example. The value capture pathway runs through policyholders rather than the city's capital budget: residents and businesses receive lower flood insurance premiums because the community's verified risk-reduction work is recognized through the Community Rating System. The city still needed separate public funding, fees, grants, and capital planning to pay for the underlying actions that made the discount possible. In this case, insurance did not fund the resilience work; it validated the work and made one financial benefit visible to households and businesses.

What Local Governments Can Learn

The insurance recognition Tulsa receives is the product of sustained institutional commitment—staff capacity maintained across administrations, multidepartment coordination, more than $200 million in capital investment over three decades, acquisition of nearly 900 flood-prone properties, and a development regulatory framework that prevents new vulnerability from being created. Communities that want insurance recognition need to ask not only what projects they can build, but what programs they can sustain. The CRS rating renews on a three-year cycle and must be maintained through ongoing documentation and activity. The Class 1 rating is also an outcome, not a starting point: Tulsa built from a Class 5 entry point in 1991, earning additional discount in roughly 5-percentage-point increments through documented program improvements over 30 years.

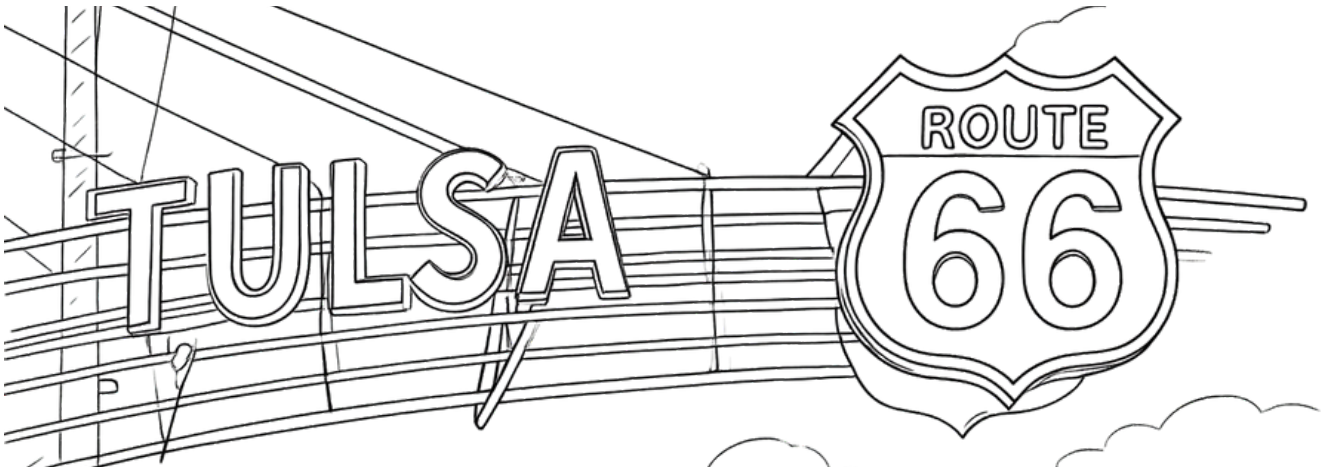
What Not to Overgeneralize

A premium discount is not the same thing as project funding. It benefits policyholders and can strengthen the political case for continued hazard mitigation and resilience investment, but it does not automatically pay for the public projects needed to reduce risk. Communities still need public funding, fees, grants, or capital planning to implement the underlying actions. The CRS also has structural constraints: state law in Oklahoma limits certain forms of direct flood protection aid to homeowners, which shaped the program's emphasis on property acquisition and open space rather than individual structure hardening.



Table 29. Capital Roles in the Tulsa Resilience Project

Role	Source or Actor	What it Did
Insurance validation	FEMA Community Rating System	Recognized local risk-reduction actions through standardized premium discounts (45% at Class 1) maintained on a three-year renewal cycle
Value capture through policyholders	National Flood Insurance Program policyholders	Received lower premiums because the community's sustained, verified risk-reduction work was recognized through a standardized federal program
Local delivery authority	City of Tulsa and its departments of engineering services, streets and stormwater, development services, parks, and emergency management	Maintained the multidepartment floodplain management, outreach, planning, acquisition, and risk-reduction practices needed for the rating across 30+ years
Long-term capital investment	City stormwater fees, federal cost-share, and state sources	Funded more than $200 million in flood management infrastructure, buyouts, and open space preservation since 1990, acquired nearly 900 flood-prone properties
Proof and verification	CRS documentation, renewal process, and creditable activities	Made local risk-reduction actions legible to FEMA and maintainable through recurring verification rather than a one-time designation



Case 6. Hampton, VA: Outcome-Linked Financing For Green Infrastructure

Why this Case Matters

Hampton approached resilience finance in a way the other cases in this chapter did not. Every other case primarily illustrates public debt, asset-performance capital, state intermediaries, philanthropy, or insurance. Hampton shows how outcome-linked financing can connect upfront capital to verified stormwater performance in lower-income communities, with mission-driven investors, a utility repayment source, philanthropic predevelopment support, and specialized structuring assistance helping turn a nature-based resilience strategy into an investable project.

The Resilience Problem

Hampton faces chronic stormwater flooding and water quality challenges in lower-income neighborhoods connected to the Newmarket Creek watershed. The problem was not simply localized drainage; it was a systemic resilience challenge affecting neighborhood stability, public infrastructure, water quality, and the city's ability to manage flood risk over time. These communities have limited capacity to absorb flooding costs and are in areas where conventional capital has historically underinvested. The city needed to demonstrate that green infrastructure—like rain gardens, bioswales, and permeable pavement—could perform reliably enough to justify investment at scale.

The Project or Strategy

Hampton used a $12 million environmental impact bond—Virginia's first—to finance three nature-based stormwater projects as part of its Newmarket Creek Water Plan and Resilient Hampton initiative. The projects were designed to slow, store, filter, and redirect stormwater in lower- to moderate-income communities and were expected to add more than 8.6 million gallons of stormwater storage capacity (Quantified Ventures 2025). To make the bond possible, Quantified Ventures and the Chesapeake Bay Foundation provided technical services to develop the projects and design the outcome metric, impact measurement approach, and disclosure framework. That structuring work was supported by philanthropic funding, including a Chesapeake Bay Foundation challenge grant matched in part by The Kresge Foundation.

How the Financing Worked

As Chapter 4 explains, an environmental impact bond links payment terms to verified performance. In Hampton, that structure mattered because the city was investing in nature-based stormwater solutions whose benefits were real but needed to be measured and communicated clearly. If the green infrastructure reduced runoff more than projected, investors received a higher return—rewarding them for the performance of the project. If it underperformed, investors received less, or in some structures could make a risk-share payment, reflecting the reduced outcome delivered. This structure allowed Hampton to share performance risk with mission-driven investors rather than bearing that uncertainty alone, while accessing upfront capital before the project's performance could be fully demonstrated. The city's stormwater utility provided the repayment stream, connecting the financing to an established operating revenue source rather than requiring a new revenue mechanism. In this way, the bond did more than finance construction; it created a structure for defining, measuring, and reporting stormwater performance over time.

Outcome-linked capital is most useful when these conditions exist:

1. The outcome matters financially or operationally
2. The outcome can be measured
3. There is a repayment source that can support the financing
4. A mission-driven investor is willing to share performance risk

The Hampton bond worked because the city had a defined resilience and watershed strategy, a stormwater utility repayment source, had engineering evidence for expected runoff reduction, and found a structuring partner willing to translate performance goals into financing terms. Local governments that want to pursue similar structures should start with performance metrics they already track, identify what outcome they are actually trying to buy, and find a partner with experience structuring outcome-linked transactions before choosing the financing instrument.

The financing depended not only on identifying a project but on completing the predevelopment work that made the bond possible. Philanthropic support from the Kresge Foundation and a Chesapeake Bay Foundation challenge grant funded Quantified Ventures' structuring work—including outcome metric design, impact measurement approach, and the disclosure framework—that had to be completed before investors could evaluate the deal. That support was not preliminary to the financing; it was the condition under which the financing became possible. Chapter 5. Case Studies: How Resilience Projects Become Financeable

A conventional revenue bond might have provided upfront capital, but it would not have created the same performance-accountability structure or shared the uncertainty associated with nature-based stormwater performance. The environmental impact bond made the project's performance logic visible, measurable, and investable.

What Not to Overgeneralize

Environmental impact bonds require measurement infrastructure, third-party verification, and a structuring partner with specialized expertise. Because structuring an environmental impact bond can require significant technical assistance, often in the range of $200,000 to $500,000, this tool is usually not appropriate for small projects unless the added accountability, risk-sharing, or replicability justifies the cost.

As the market has developed, they are no longer limited to first-of-kind pilots; they can also be useful for projects where verified outcomes, shared performance risk, or transparent accountability strengthen the case for investment. But they are not necessary for every green infrastructure project. For well-understood infrastructure where speed, simplicity, and predictable performance are the priorities, conventional financing is usually simpler and cheaper.

Hampton should therefore be read as a case about fit. The environmental impact bond made sense because the city was investing in nature-based stormwater projects where performance accountability mattered, the outcome could be measured, a stormwater utility could support repayment, and experienced partners could help design the metric, measurement approach, and disclosure framework. Communities without those elements may need to build the evidence, governance, repayment source, or technical assistance capacity before this kind of structure is realistic.

The predevelopment and structuring work required before an environmental impact bond can be issued—including outcome metric design, measurement infrastructure, and transaction structuring—typically requires significant philanthropic or catalytic capital investment, and is one reason this structure is most appropriate for projects where the added accountability and performance-sharing justify the cost of getting there.

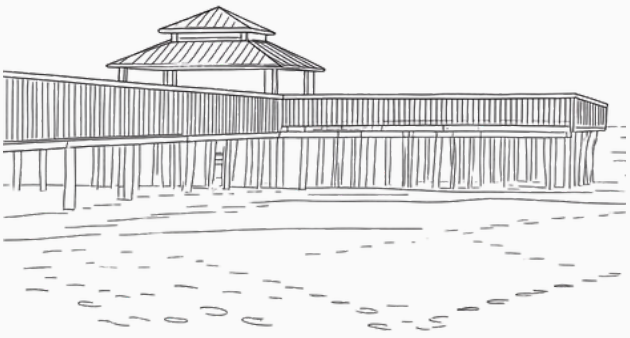


Table 30. Capital Roles in the Hampton Resilience Project

Role	Source or Actor	What it Did
Outcome-linked capital	Mission-driven investors through the $12 million environmental impact bond	Provided upfront financing through a structure tied to verified stormwater performance, creating a performance-accountability framework for nature-based stormwater investment
Repayment anchor	City of Hampton stormwater utility	Provided the recurring revenue stream that anchored repayment regardless of performance outcome
Structuring intermediary	Quantified Ventures	Designed the transaction structure, connected the city to impact investors, and provided technical assistance through deal close
Outcome measurement and disclosure support	Quantified Ventures and Chesapeake Bay Foundation	Helped define the stormwater performance metric, impact measurement approach, and disclosure framework
Predevelopment and gap-closing support	Chesapeake Bay Foundation challenge grant and The Kresge Foundation match	Helped fund the technical and structuring work needed before the bond could be issued
Public-value purpose	City of Hampton Resilient Hampton initiative and Newmarket Creek Water Plan	Set the community resilience and water quality goals the financing was designed to serve, particularly in lower-income neighborhoods

Sources: Quantified Ventures 2025, City of Hampton. n.d.



Table 31. What the Cases Show Together

Case	Primary Capital Role Illustrated	Transferable Structural Lesson
Harris County, TX	Repayment anchor: voter-approved public debt backed by the county property tax base	Ordinary public finance can support resilience when the public-value case, repayment source, evidence base, and voter authority are clear; capital stacks built on expected federal co-investment need contingency plans if outside funding arrives late, arrives at a different scale, or does not arrive at all
Pasco, WA	Asset-performance capital: private operator, public partner, and long-term revenue structure	Resilience becomes financeable when embedded in an operating asset with durable revenue, users, contractual structure, and public benefit; creative procurement can shift construction and operating risk to a private partner without sacrificing public benefit
Connecticut	Aggregation and intermediary: state program and green bank	A state program that defines eligibility, combines grants and loans, sets technical standards, and creates a repeatable pathway can make individually unfinanceable projects viable
National Disaster Resilience Competition	Predevelopment and gap-closing support; philanthropy before financing exists	Funding the early work changes the quality of what follows; communities that invest in risk framing, proof, governance, partnerships, and project definition in advance are in a fundamentally better position
Tulsa, OK	Insurance validation and value capture: sustained local action recognized through premium discounts	Insurance can make verified risk reduction visible, but the value may be captured by policyholders rather than the city's capital budget. The underlying public investments still require separate funding and long-term institutional commitment
Hampton, VA	Outcome-linked capital and predevelopment support: mission-driven investors, philanthropic support, and specialized structuring	Outcome-linked structures can make performance uncertainty manageable when the metric, measurement approach, repayment source, mission-aligned investors, and structuring support are all in place

Chapter 5 Key Takeaways

Use case studies to extract structure, not copy the surface model. Ask what was protected, who benefited, what made funding or repayment possible, who paid, what evidence mattered, who had authority, and what role each source of capital played.

Start with the financing problem the project has to solve. Is the problem repayment, public value, predevelopment, aggregation, verification, bridge funding, governance or performance uncertainty? The answer determines which capital role matters most.

Public debt works when the public purpose, repayment structure, evidence base, and authority are clear. Harris County shows both the power of voter-approved debt and the cost of assuming federal co-investment will arrive on time and at scale.

Resilience can be embedded in operating infrastructure. The Pasco project shows that private capital may engage when resilience value is tied to service reliability, long-term agreements, operating revenue, and asset performance, and that creative procurement can make this happen without requiring the public sector to carry the financial risk.

State intermediaries can make small projects financeable. Connecticut's microgrid program shows how grants, loans, technical standards, a sustained program design, and a state-level financing partner can help local projects move through a repeatable pathway rather than requiring each municipality to structure a one-off deal.

Philanthropy is most powerful before financing exists. The Rockefeller Foundation's support for the National Disaster Resilience Competition shows how flexible capital can fund the readiness work that makes later funding possible—risk framing, technical assistance, convening, engagement, governance design, and proposal development.

Insurance recognition requires sustained institutional commitment, not a single project. Tulsa's Class 1 Community Rating System rating reflects 30 years of multidepartment work, more than $200 million in investment, acquisition of nearly 900 flood-prone properties, and a regulatory framework maintained across administrations. Ask what programs can be sustained, not only what projects can be built.

Outcome-linked and mission-driven capital can help manage performance uncertainty, but only when the metric, measurement infrastructure, repayment source, and structuring expertise are in place first. Hampton's environmental impact bond shows how predevelopment support, utility repayment, verified outcomes, and mission-aligned investors can work together.

Governance must be built before the money arrives. Communities need an entity or team that can hold the strategy, coordinate partners, manage funds, meet compliance requirements, and adapt as new funding windows open. Every case in this chapter succeeded in part because governance was established before it was needed.

The strongest resilience finance strategies are disciplined about matching the financing source to the financing problem. Use repayable capital where repayment is valid. Use public funding where benefits are broad. Use predevelopment and gap-closing support where readiness barriers block progress. Use insurance where risk reduction can be verified. Use intermediaries where scale and capacity are the barriers.

Epilogue: The State Operating System for Local Resilience Finance

This guide has focused on what local governments can do. It ends with an honest acknowledgment: much of what determines whether they can do it is decided somewhere else.

State law is the operating system for local resilience finance. It determines whether cities and counties can levy a stormwater fee, dedicate a sales tax, create a flood district, issue a revenue bond, form a joint powers authority, adopt a stronger building code, use tax increment financing for hazard mitigation, or access pooled borrowing through a state bond bank.

This is not a peripheral issue. The Resilience Finance Diagnostic in Chapter 1 lays out six steps before choosing a financing tool:

1. Start with system risk and future conditions.
2. Identify where the value appears.
3. Determine whether value can be captured.
4. Establish credible proof.
5. Confirm authority, governance, and market feasibility.
6. Align capital.

State law shapes all six, but it is most decisive at Step 3. A community may have clear public value, a credible evidence base, and willing partners, and still be unable to act because it lacks authority to raise the revenue, form the district, or issue the debt that would make the project financeable. Recent work on community resilience finance argues that local tax-and-bond models and federal grants remain important but are insufficient on their own, reinforcing the need for state-level enabling systems that help communities combine grants, loans, financing tools, technical assistance, and legal authority (Posner and Briggs 2025).

The scope of that legal gap is large. The National Conference of State Legislatures documents significant variation across the 50 states in what local governments are authorized to do. In Dillon's Rule states, localities generally need express state permission to act; in home rule states, they have broader authority but may still face preemption on revenue, standards, or procurement (NCSL n.d.).

Consequently, state law is the operating system for local resilience finance. It determines whether cities and counties can levy a stormwater fee, dedicate a sales tax, create a flood district, issue a revenue bond, form a joint powers authority, adopt a stronger building code, or access pooled borrowing through a state bond bank. The same project that is legally and financially straightforward in one state can be impossible in another—not because the need is different or the project weaker, but because the enabling framework does not exist.

The evidence in this guide makes that concrete. What separates communities that can act from those that cannot is rarely the quality of the idea. It is whether the legal and financial infrastructure already exists to make the idea financeable.

Philadelphia and Hampton had stormwater utility authority. Harris County had a flood control district created by the Texas Legislature in 1937. Hoboken had the New Jersey Infrastructure Bank. Connecticut had a green bank and a state microgrid program. Longmont had a storm drainage utility, voter-approved local revenues, and state water financing already in place before the flood that tested all of them. Marin built a joint powers authority and passed a dedicated parcel tax at a two-thirds threshold that it cleared by a narrow margin. None of these were incidental details. They were the conditions that made financing possible. Communities without them may face the same risks, but lack the same ability to act at scale.

The inverse is equally important. In some states, the revenue, standards, land-use, or governance tools that local resilience finance depends on are legally uncertain, constrained, or unavailable.

- Stormwater fees have been struck down in state courts as unauthorized taxes, making the revenue foundation behind projects like Philadelphia, Hampton, and Raleigh less reliable in states where the fee-versus-tax line remains contested (Bolt v. City of Lansing 1998).
- North Carolina repealed municipal privilege license tax authority in 2015, eliminating a locally controlled revenue source with no replacement enacted (North Carolina Session Law 2014-3). The state legislature also froze residential building-code updates until 2031 over a gubernatorial veto, weakening the standards machinery that helps connect risk reduction to grants, insurance, and real-world performance (North Carolina House Bill 488 2023).
- Texas capped local maintenance-and-operations property-tax revenue growth at 3.5 percent in the same 2019 legislative session that created a state flood infrastructure fund—enabling capital investment while constraining the operating revenue that sustains long-term programs (Texas Senate Bill 2 2019).
- Oklahoma's state flood mitigation framework historically channeled grants and loans through political subdivisions for project-based mitigation rather than creating a broad direct homeowner retrofit program. In practice, that helped push Tulsa's long-term flood strategy toward acquisition, open space, regulation, and public capital improvements rather than widespread public subsidies for individual structure hardening (Okla. Stat. tit. 63, §§ 690.1, 690.4).

These constraints do not always look like resilience policy, but they determine what resilience policy can actually do.



Lower-capacity communities are hit hardest by these constraints. Headwaters Economics found that counties with lower staff and fiscal capacity received 19 times less federal pre-disaster hazard mitigation funding than high-capacity counties, even when climate risk was equally high (Smith 2024). That disparity is not only a federal program design failure. It is also a state capacity and authority problem. Communities that cannot issue debt affordably, form revenue-generating districts, sustain predevelopment work, or translate plans into finance-ready projects are often locked out of every capital source—federal, state, and private—at once.

Some of the rules that shape these outcomes long predate FEMA, modern hazard mitigation programs, and today's climate risks. Many municipal debt limits trace back to constraints written after the Panic of 1873, when states capped local borrowing following a wave of municipal bond defaults (Sbragia 1996). Those safeguards still serve a purpose. But they now govern whether communities can finance infrastructure designed to last fifty years under changing climate conditions—precisely the mismatch Posner and Briggs identify when they argue that the traditional bond-and-assessment model was not built for the complexity and scale of today's climate threats (Posner and Briggs 2025).

Two states show what it looks like when the framework is built deliberately. Illinois transformed existing public finance tools into a scalable platform that supports both capital investment and long-term resilience operations. Rhode Island paired structured risk assessment with a dedicated deployment fund through the Rhode Island Infrastructure Bank, giving small cities and towns access to capital and expertise without requiring them to master resilience finance mechanics on their own (Posner and Briggs 2025). Both made local action repeatable, not exceptional.

These are early and promising models, not yet a trend. Most states have not built this infrastructure. Doing so is genuinely hard work. It requires coordination across legislatures, executive agencies, utility commissions, insurance regulators, infrastructure banks, local governments, philanthropy, and the civic and professional organizations that can help translate policy into practice. The Lincoln Institute of Land Policy has documented how land-based finance tools can help close the climate finance gap when states authorize them clearly, but remain unavailable or narrowly drawn in many jurisdictions even where the need is acute (Nagam et al. 2026). The work ahead is to identify where state law enables and where it constrains, distinguish tools that are merely underused from tools that are structurally blocked, and sequence reforms that can actually move.

Building that enabling framework—across all 50 states—is the work this guide points toward but cannot finish. It calls for a sustained, cross-sector effort to map state enabling conditions, identify the highest-leverage reforms, and build the partnerships needed to advance them through legislatures, agencies, commissions, and financing institutions. The legal, financial, and policy groundwork will require collaboration across fields that have not always worked[1] together. That collaboration is the invitation this epilogue extends.

The question states must answer is not whether they will participate in local resilience finance. They already do and will do, through every existing and future law. The question is whether state policy helps communities act before disasters, or forces them to pay far more after damage is done.



References List by Chapter

Note: References are organized by chapter and listed alphabetically within each section. Citations marked with an asterisk (*) appear in multiple chapters and are listed in full at first appearance; subsequent chapters list author/date only.

Introduction

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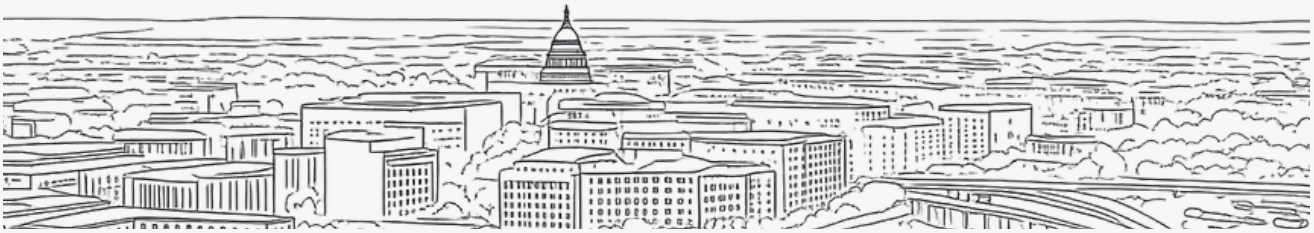
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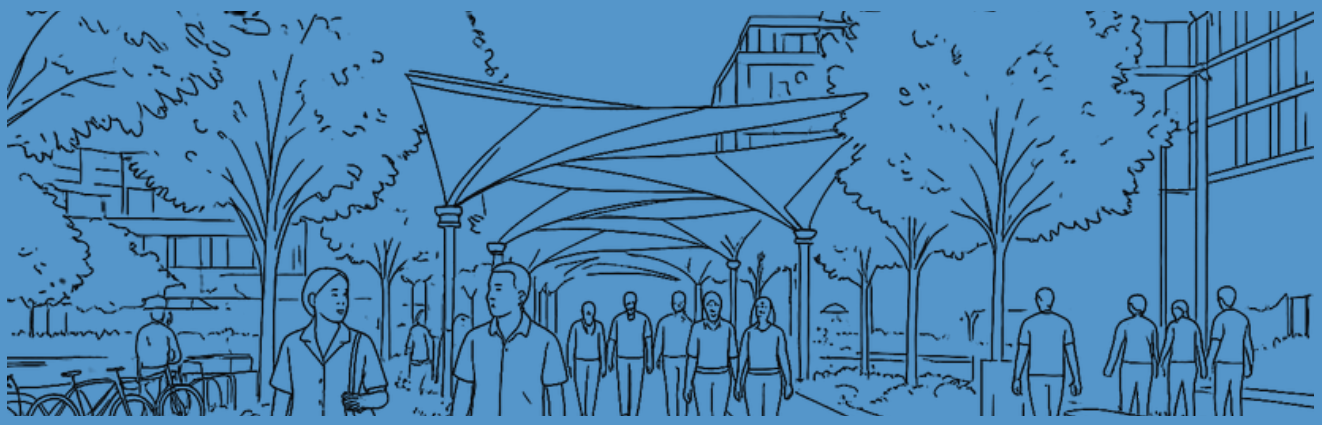
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