


RE invest

A ROADMAP FOR RESILIENCE

Investing in resilience,
reinvesting in communities.



CONTENTS

re:FOCUS PARTNERS | 2015

02 INTRODUCTION

Cities and communities around the world are struggling to finance and replace aging, failing, or inadequate infrastructure systems. Not only are local leaders faced with the challenge of building or rebuilding infrastructure at city-wide scales, they are being asked to do so in a time of strained public resources and greater challenges—like climate change, urbanization, shifting population demographics, and rapid technology change.

The American Society of Civil Engineers estimates that US cities need $3.6 trillion dollars in basic infrastructure investment in the next 20 years. This estimate is just to update what cities already have—not to build the smarter, cleaner, greener, and more robust systems designed to address new challenges, like flooding, rising sea levels, heat waves, and more.

We need to think differently about infrastructure.

The future doesn't look like the past. As budgets for public services continue to shrink, cities large and small need new approaches to providing services and investing in infrastructure upgrades that can meet the demands of the next hundred years, not only the last hundred years.

Despite these disturbing trends, there is good news. Political will and leadership abound. Cities across the world are taking charge where state and national politics are deadlocked. In the recovery from the 2008 global financial crisis, leading private sector companies and investors have expressed strong interest in reinvesting in stable assets like roads, power systems, and water infrastructure.

Most importantly, there is growing consensus that we need to act now to not only build infrastructure, but more resilient infrastructure. Still, there is a disconnect between public and private sector interest in expanding infrastructure investment.

Cities lack access to capital. And investors lack a clear pipeline of high-quality investable projects.

Currently, political leaders have few incentives to take on projects whose benefits extend beyond their current political cycles. Similarly, investors lack incentives to finance large-scale projects when political turnover is predictable and investment risks are unmanageable. Leaders from both the public and private sectors have called repeatedly for new public-private partnerships. Even with these seemingly aligned goals, large projects have been few and far between and overall infrastructure investment is still lagging.

This report offers a new framework for bridging this gap. As a 2-year national effort launched with the generous support of the Rockefeller Foundation, the RE.invest Initiative tackled the problem of infrastructure predevelopment—all of the activities that go into designing and planning large-scale infrastructure projects prior to construction.

This report summarizes the outcomes of RE.invest, an 18-month predevelopment process with eight US cities and teams of leading private sector design, engineering, law, and finance experts. The results are examples of the types of projects made possible using a new framework for reimagining civic infrastructure systems to create both public value and private investment opportunities, especially for vulnerable communities.

The concepts and examples developed through RE.invest offer a new approach for public and private sector leaders to forge innovative partnerships to build resilience around the world.

04 HOW TO READ THIS REPORT

This report is designed to inspire a wide range of readers interested in addressing the challenge of creating a robust pipeline of investable resilient infrastructure projects. It captures how RE.invest reimagined the predevelopment process for resilient infrastructure to integrate early design and financing decisions and help cities make the leap from crafting a vision for resilience to generating a set of financeable large-scale projects.

A FRAMEWORK FOR INNOVATION

This document is organized in five main sections. The first lays out the key challenges in urban infrastructure investment and makes the case for investing in resilience. The second presents a new guide for predevelopment using principles of design thinking and systems innovation to address the barriers to resilient infrastructure investment. The third section captures the RE.invest process and the fourth provides an overview of all eight RE.invest partner city solutions. The final section provides recommendations for government officials, developers, financiers, and communities engaged in investing in resilience and reinvesting in communities.

The new framework and recommendations captured in this report can be applied around the world to generate new ideas for re-envisioning communities, infrastructure systems and resilience investment opportunities.

Figure 1 highlights the RE.invest six-step systems approach to predevelopment alongside the major insights and lessons learned at each phase of the process in all eight RE.invest partner cities.

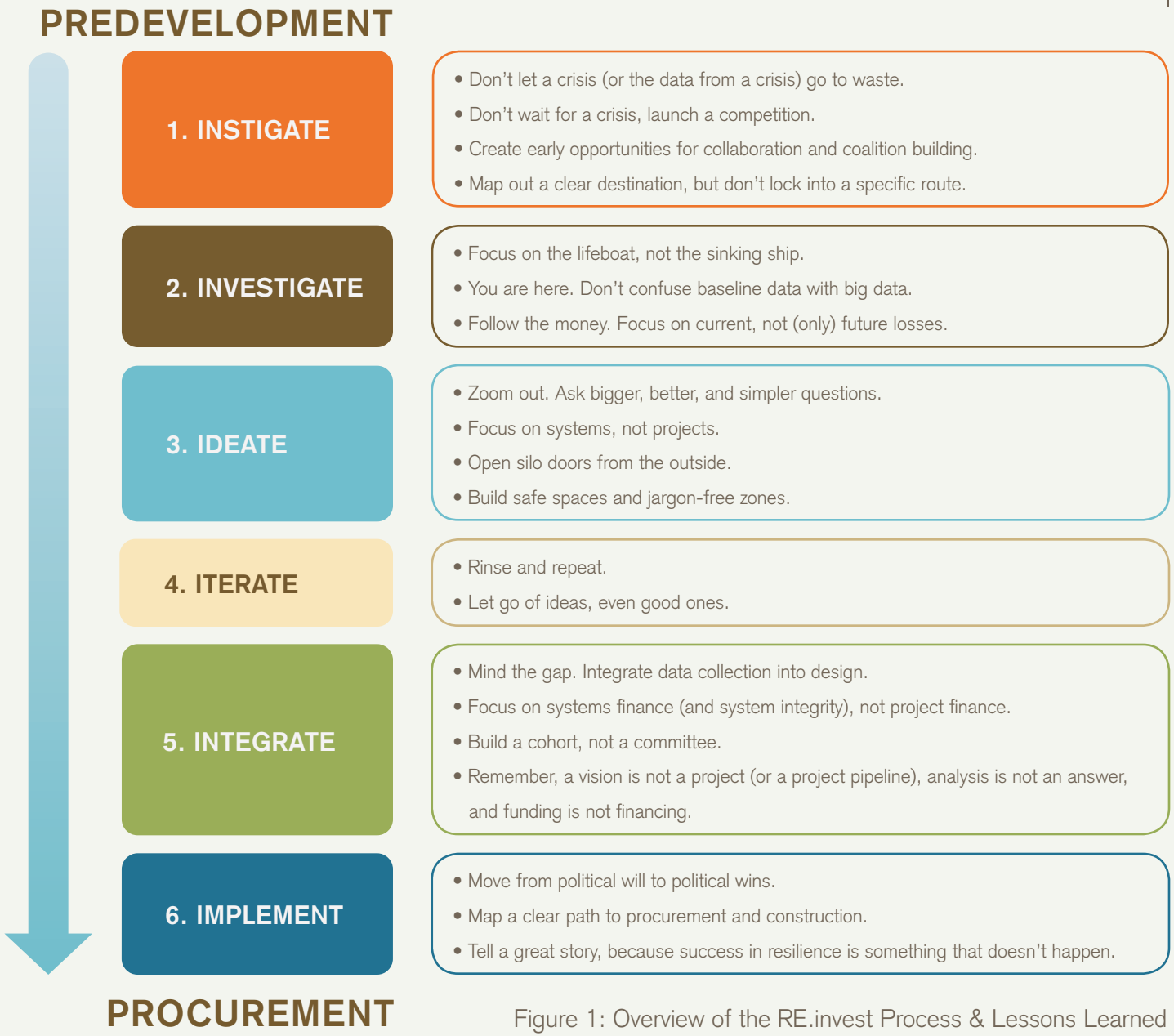


Figure 1: Overview of the RE.invest Process & Lessons Learned

GUIDANCE FOR READERS

Given the number of stakeholders involved in building urban resilience, this report is written for a wide audience with specific recommendations for various institutions summarized in Figure 2. In particular, the Systems Approach section is organized to help governments and philanthropies encourage predevelopment and close the gap between conceptual design and procurement of infrastructure. Similarly, the Partner City Solutions section is intended to inspire designers, project developers, and investors to integrate infrastructure planning across sectors and identify new investment opportunities. Finally, the Guide for Infrastructure Innovation aims to provide these institutions and community-based organizations with new points of entry for enhancing traditional planning and procurement processes in their cities to build greater resilience.

For readers interested in an overarching view of the challenges and opportunities of resilient infrastructure planning, this report offers a high-level description of the RE.invest process and the resulting city-specific solutions. For more technical readers or readers interested in specific local issues, each city solution is expanded in a set of individual city reports (see www.reinvestinitiative.org)

Although all of the featured examples are based in US cities, RE.invest was designed as a springboard to catalyze resilient infrastructure investment around the globe. To this end, the general resilience design concepts outlined in the Activities and Building Blocks (engineering) section are intended to serve as an entry point for any city seeking a new pathway to cross-sector design and finance innovation.

Figure 2. Summary of Recommendations	Federal/State Government	City/Local Government	Philantrophies/ Funders	Project Designers/ Implementers	Investors	NGOs & Academic Institutions
Connect Predevelopment Funding Directly to Procurement	G					
Consider Options for Predevelopment Cost-Recovery	G	C	F	D		
Leverage Infrastructure Exchanges	G	C		D		
Expand Government Technical Assistance Programs to Include Outside Experts	G		F		$	N
Create More Competitions	G		F			N
Reform Capital Planning Processes to Support Resilience Innovation		C				
Leverage Program Related Investments (PRI) for Predevelopment			F		$	
Create “Inspiration Engines” and Support Procurement Experiments		C	F			N
Define the Project Pipeline					$	
Design Based on Cash Flows, Not Only Costs				D		
Launch New Data Initiatives to Monetize Avoided Losses			F			N
Extend Tax-Increment Finance (TIF) to Support Private Investment in Public Goods	G	C				

08 WHY RE.INVEST?

There has been significant coverage in the media about chronic underinvestment in urban infrastructure.

The impacts of Superstorm Sandy across the Northeast US and more recent massive snowstorms are a wrenching example of how failing infrastructure systems have made it increasingly difficult for cities to meet growing demand and respond to severe weather events. In the face of these and similar challenges, cities across the country recognize that as their need to replace aging water, energy, and transportation systems grows more urgent, there is a tremendous opportunity to transition to more cost effective, flexible and integrated systems that can meet not only current needs, but also address future challenges.

Technological advances have allowed us to imagine futuristic infrastructure systems with city-wide linkages of smart meters and high-tech sensors that are tailored to optimize everything from traffic to trash pick-up neighborhood by neighborhood. Unlike traditional infrastructure—highways, bridges, power plants, and large water mains under city streets—resilient infrastructure systems, like many distributed and smart infrastructure networks, are often made of many small pieces and parts. For example, a green stormwater management system might include thousands of street trees, green roofs, wetlands, and repaved roads to absorb water. Similarly, a large power plant might be replaced with a more sustainable network of small neighborhood generators that turn food waste into energy or electricity to reduce waste everyday and create a more secure energy source in case of emergency. These systems are deliberately designed to provide the same services as traditional infrastructure, but they also offer the added resilience benefit of flexibility, so they can easily expand and adjust or facilitate repair and replacement of parts to meet changing needs and conditions.

Despite these benefits, the same qualities that make green infrastructure systems more resilient and community-focused are also what make them difficult for investors to find, evaluate, and eventually finance. Project developers don't have the upfront capital or resources to design large systems, and investors don't have clear pathways to discover small projects for large-scale investment. Even large investors who have resources and have made commitments to investing in sustainable infrastructure face significant obstacles to identifying projects at-scale and aggregating complex cross-sector projects in ways that can produce market rates of return. Meeting the demand for infrastructure using sustainable and resilient solutions requires new approaches to realign incentives and design new delivery mechanisms at the right scales to systematically aggregate, monetize, and capture benefits that are usually left off project balance sheets entirely or simply described as "co-benefits."

The RE.invest Initiative was based on the idea that designing new types of projects—not just building more of the same—is essential. Shifting the focus to large-scale resilience projects that generate multiple benefits, and as a result generate multiple revenue opportunities, has the potential to bring more funding and financing to infrastructure, where even traditional projects are facing significant barriers to investment and implementation.

In order to systematically conceptualize and carry forward these types of complex projects (systems), governments, private developers, and investors alike need to rethink the conventional process for infrastructure design and planning, known broadly in the industry as predevelopment. The next sections provide an overview of the landscape for infrastructure investment in the US and offer a compelling case for reimagining the predevelopment process to focus on resilience.

THE CASE FOR RESILIENT INFRASTRUCTURE INVESTMENT

Investing in resilience is complicated. Like healthcare, there are multiple strategies that can and should be combined to improve overall health. For example, there are things you can do regularly to ward off risks (preventative care), other options to address acute conditions (medical treatments), and finally actions you can take to make sure that illness doesn't bankrupt you or those who depend on you (health and life insurance).

Local governments from around the world have emerged as leaders in exploring all of these strategies; however, many city officials still struggle to identify which specific resilience solutions to pursue. Often the best-available technologies, projects, and services are difficult to find and translate to local needs. Moreover, standard government purchasing processes are not well suited to procuring comprehensive resilience projects, which are often comprised of multiple interventions and technologies that fit together.

Focusing on system design—planning for whole systems and networks of projects—can help break down these procurement barriers by maximizing value and minimizing risk for both local governments and investors.

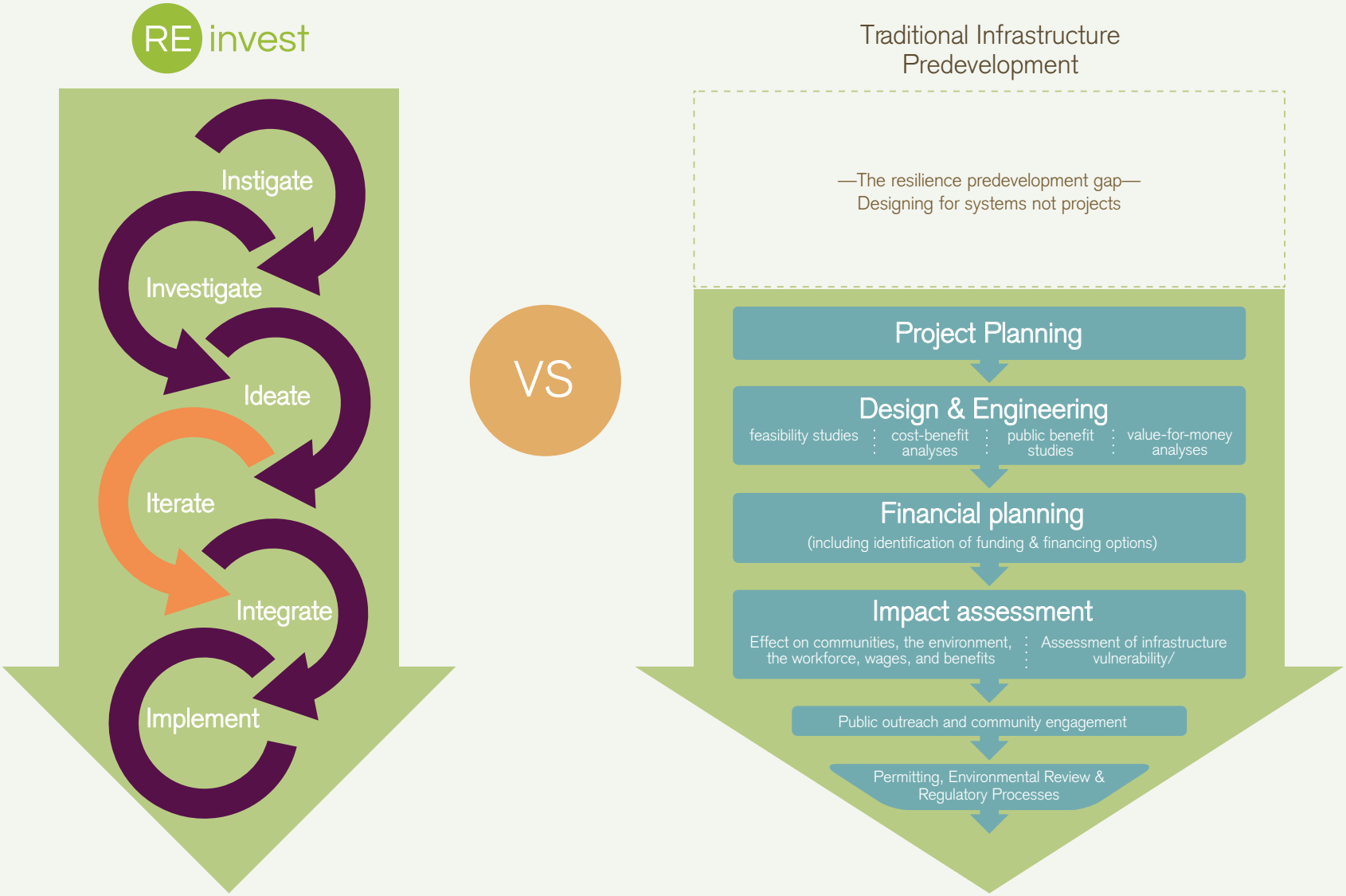


Figure 3: The RE.invest Predevelopment Process vs. Traditional Infrastructure Predevelopment

THE INFRASTRUCTURE DEVELOPMENT LIFECYCLE (AND ITS GAPS)

In January 2015, the White House issued a Presidential Memorandum on funding for predevelopment of infrastructure, including roads, bridges, water, energy and other critical systems. The memo defines predevelopment as all the "phases of infrastructure project development that precede actual construction." These phases range from conceptualizing a project to conducting feasibility studies and impact assessments on various alternatives.

Most technical descriptions of infrastructure development focus (unsurprisingly) on the technical aspects of predevelopment. The RE.invest Initiative was designed to test a different approach. By starting with new types of questions, the aim was to assess if and how cities could move from traditional project-based planning and incremental upgrades to system-wide urban infrastructure investments that could create multiple resilience benefits. For example, "How can my city finance a new more energy-efficient water treatment plant?" is a very different question than: "What options do we have for reducing combined sewer overflows and localized flooding in our city?" Both questions offer resilience opportunities, but the latter creates space for game-changing innovations in design and financing.

How a need or question about any infrastructure project is framed necessarily drives the set of viable solutions that emerge in response. The first question assumes a pre-defined solution: a new treatment plant is the best (or only) way to address local water and energy needs. The second opens up space for new ideas.

Typical predevelopment processes start after an initial project idea is already conceptualized by a government agency, developer, or development team. This idea is then developed in more detail and evaluated to see if it is viable in practice.

In the case of cities seeking resilience solutions, it is not always clear what specific project or intervention should take top priority. Resilience building requires a systems approach and a mix of hard and soft solutions. There is no single stakeholder who has responsibility for a whole system, and as a result, any project proposed from the perspective of a single sector is unlikely to take advantage of the opportunity to create and capture cross-sector benefits in the final project design and financing structure, such as energy and water savings.

Although all infrastructure is site-specific and driven by the local context in which a project is situated, resilient infrastructure projects are often more complex because of the multiple objectives they are designed to address. This is both the strength and weakness of resilience predevelopment processes. The larger scope creates opportunities to generate

multiple benefits and capture value across sectors and geographies. However, the complexity increases transactions costs, project timeframes, and risks for project developers and investors.

As a result, large-scale resilient infrastructure predevelopment activities require significantly more time and investment to iteratively create viable and effective design and engineering alternatives. The length of time required for predevelopment depends on the complexity of the underlying problem and infrastructure solution.

In a follow-up report to the Presidential Memo on predevelopment, the US Treasury Department and Department of Transportation issued a set of Recommendations of the Build America Investment Initiative Interagency Working Group. This document specifically emphasizes that increasing resilience and improving cross-sector coordination are strategic opportunities that should be part of federal efforts to reverse decades of underinvestment in US infrastructure and support intelligent investments moving forward.

The RE.invest process preceded these recommendations by nearly two years, but offers a clear path forward to address the call for more coordinated and resilient infrastructure investments echoed by these and other newer resilience initiatives. The following sections make the case for taking an integrated design and financing approach to resilience planning and reimagining the predevelopment process from a systems perspective to create a template that can be applied in cities around the world to first generate, then refine, and finally finance innovative resilience solutions.

The US Department of Transportation Federal Highway Administration defines predevelopment costs as: "those associated with activities that provide decision-makers the opportunity to identify and assess potential infrastructure projects and modifications to existing infrastructure projects, and to advance those projects from the conceptual phase to actual construction. […] Predevelopment activities may include, but are not necessarily limited to:

(i) project planning, feasibility studies, economic assessments and cost-benefit analyses, and public benefit studies and value-for-money analyses;
(ii) design and engineering;
(iii) financial planning (including the identification of funding and financing options);
(iv) permitting, environmental review, and regulatory processes;
(v) assessment of the impacts of potential projects on the area, including the effect on communities, the environment, the workforce, wages, and benefits, as well as assessment of infrastructure vulnerability and resilience to climate change and other risks; and
(vi) public outreach and community engagement.

Predevelopment costs include predevelopment activities and associated costs, such as flexible staff, external advisors, convening potential investment partners, and legal costs.

Excerpted from: Predevelopment Costs for Public-Private Partnership Projects – Federal-Aid Highway Program Eligibilities FAQs (Jan 2015)

A NEW APPROACH TO INTEGRATED DESIGN & FINANCING

Infrastructure predevelopment is complicated even when a project developer already has a strong idea of what they want to build. Without a clear picture of which projects or investments will best meet local needs, it is easy for a city to get stuck waiting for more data or the next best solution.

To break this cycle, RE.invest was based on three core ideas:

First, resilience is about systems, not just projects. Careful integration, coordination, and sequencing are essential to make sure that when one structure fails it doesn't take down a whole system. In practice that means that green, resilient, and sustainable infrastructure systems are not made up of a few large projects, but many small pieces and parts. Designing whole systems and networks requires a different approach to engineering.

Second, cities need new ways to align public and private interests to bundle together multiple small projects into large systems to invest at scale. Costs and benefits associated with resilient infrastructure systems are often spread across sectors—therefore coordination during project design is critical—not just for governments, but also investors. Aligning these stakeholders requires new legal tools to build and maintain partnerships that have integrity over long project lifetimes.

Third, when it comes to resilient systems, success is often something that doesn't happen. The city didn't flood, the power didn't turn off, even though the storm hit. Capturing those benefits and savings over time requires thoughtful design and advance planning, and a new approach to funding and financing for resilient infrastructure.

By focusing on a new integrated approach to developing resilient infrastructure solutions, RE.invest served as a large-scale experiment for resilient infrastructure predevelopment that brought together engineering, legal and financial decision-making to drive a high volume of small interventions in every community in a city, rather than concentrating development in the wealthiest or fastest growing regions. For example, repaving city streets with porous, water-absorbing materials, offers a path to reach poorer communities through a new channels and speed the improvement of roads that might not have been scheduled for near-term repair or maintenance otherwise. RE.invest also aimed to take pressure off municipal resources and free up resources for other priorities by focusing on private finance opportunities.

To date, innovative financing for infrastructure has focused largely on developing new funds or incentive programs—such as stormwater credit trading instruments—to capture social and environmental benefits. This is tremendously important work; however, it is only one part of the solution.

Cities and communities must also put forward viable projects for financing.

The premise of RE.invest is that design and financing are fundamentally parallel and complementary activities. Designing abstract solutions is unlikely to produce financing. Creating a fund does not help a city figure out what to build or buy.

RE.invest was designed to help cities move beyond stating needs to identifying investable public-interest projects through a rapid, structured design and delivery process. The next sections of this report describe the objectives, partnerships, building blocks, and key activities of the RE.invest team in crafting a resilience-focused approach to predevelopment and developing specific projects in all eight RE.invest partner cities.

16 A GUIDE FOR INFRASTRUCTURE INNOVATION

Recognizing the gaps in existing predevelopment processes, the RE.invest Initiative established a new framework for "design thinking" and systems innovation in resilient infrastructure predevelopment. What makes the process novel is its application to traditionally opaque and technical decisions associated with urban planning, engineering, and infrastructure finance.

Transforming city systems requires system-scale innovation in both design and financing. On the design side, systems thinking often remains stuck at the level of visioning or master planning and rarely translates to fundable projects that get to the starting line for financing or procurement. Conversely, on the finance side, the focus has remained on establishing new funds or finance mechanisms and streamlining regulatory and permitting processes to help projects cross the finish line. Both of these bookends are important, but in order to be effective, they also need to be connected to one another.

The premise of RE.invest was that design and financing are fundamentally parallel and complementary activities. A design vision is unlikely to produce financing. Similarly, a fund does not help a city prioritize procurement decisions. RE.invest offers a model of a structured 18-month predevelopment process for cities (and developers and philanthropies) to go from a vision to a blueprint to a clear financing strategy, such as a public-private partnership. This approach does not replace the important work of visioning and participatory priority setting, but it does create a path for translating ideas to action.

Because resilient infrastructure development does not occur organically, all of the lessons below are offered as a guide for predevelopment—from instigating or jumpstarting the process to setting a formal implementation strategy in motion. The ultimate aim of presenting this new framework is to move beyond one-off planning exercises to help developers and investors create a robust pipeline of large-scale resilience projects in collaboration with cities and communities. Some of the insights listed here are general and can be extrapolated far beyond infrastructure to social or health resilience investments. Others are narrower, based on the specific engineering solutions and implementation strategies developed for RE.invest partner cities. When combined, all are intended to help demystify the process of resilient system design and finance.

INSTIGATE

in·sti·gate /ˈinstəˌgāt/ verb. bring about or initiate (an action or event)

Predevelopment can be reactive, in the wake of a disaster, or proactive, taking action before a disaster happens. Instigation serves as a "pull mechanism" to draw forward a coalition of the ready and willing to conduct an efficient and tightly structured design process.

1 Don't let a crisis (or the data from a crisis) go to waste.

Infrastructure is often invisible until it fails. Superstorm Sandy was a catalyst for an enormous shift in how governments at all levels approach the problem of building resilience. A variety of initiatives, including RE.invest, were launched to help affected communities build back stronger and reshape infrastructure investment moving forward. The scale of the disaster highlighted where failures in one sector resulted in a collapse in an entirely different area, and offered a compelling (and wrenching) set of examples of the need for coordinated long-term investment in infrastructure. Crises can highlight where the greatest opportunities for systems change exist. Looking after a disaster or disruption for the critical paths of failure can offer a new entry point for integrated design and create a political window for reframing the need for ambitious infrastructure upgrades and investments beyond replacing or rebuilding what was originally there. Disasters can also inform our understanding of the costs of failure in future, making a strong case for quantifying avoided losses and investing in resilience upgrades with savings from predictable short and long-term expenses.

Within RE.invest, the City of Hoboken experienced extensive damages during Superstorm Sandy, and the physical and financial flood damage data collected during and following the disaster offered a point of departure for the RE.invest team to design an integrated underground parking structure and stormwater detention chamber to solve two problems—limited street parking and local flooding—with a single solution.

2 Don't wait for a crisis, launch a competition.

Just as a disaster can break through incremental planning processes to shine a spotlight on bigger picture and longer-term needs, competitions can also serve as a catalyst and offer safe spaces for governments to experiment and generate new ideas. Typically, public officials have few arenas where they can think big and fail safely without the challenge of raising expectations of their constituents and stakeholders. A well-designed

competition can help a local government generate urgency, set a timeline and target for results (without pre-judging specific outcomes), and align stakeholders, all while managing their constituents' expectations about a range of potential solutions. Placing value on a catalyst, separate from any single solution, can also help positively recalibrate stakeholder views on the opportunities available to a community.

RE.invest was strategically designed to start with a competition for all of these reasons. Since its launch in January 2013, there have been a variety of innovative philanthropic and government competitions, including the Rockefeller Foundation supported Rebuild by Design, 100 Resilient Cities, and the National Disaster Resilience Competitions that have served as global "pull mechanisms" for innovation in resilience.

3 Create early opportunities for collaboration and coalition building.

Systems (re)design requires the engagement of multiple stakeholders. RE.invest was structured to help all participating cities build coalitions and engage allies through the competition process itself. The call for applications included an option for cities to attach supporting letters as part of their submission. This approach kick-started an early outreach process that was essential to the long-term success of the initiative and the resulting design proposals. Applicant cities identified important constituencies for the RE.invest team to work with over the course of the design process. The strongest applications included a wide cross-section of supporting letters from State and county officials, local industry leaders, NGOs, communities, and national organizations.

Recognizing where a city has strong alliances was important, but almost equally important was spotting gaps and quickly assessing who was missing from the discussions to anticipate and head-off contentious issues during the design process. Most importantly, the RE.invest process gave each city (1) a specific reason for reaching out widely to collaborate on resilient infrastructure design and finance and (2) a clear expectation but flexible framework for fostering input over an 18-month timeline. Too often, requests for collaboration and stakeholder participation are abstractly defined and linked to indefinite processes. Creating a structured framework for predevelopment can help local leaders simultaneously manage expectations and overcome general participatory fatigue, distrust, or frustration.

4 Map out a clear destination, but don't commit to a specific route.

Staying focused on a tangible destination or marker of success—even if the path to that destination is not yet visible—is critical. Within RE.invest, the overarching vision was to support all of our partner cities in getting as close as possible to a Request for Proposals (RFP) for procuring and financing a resilient infrastructure solution.

Setting an RFP as one clear marker of success helped all parties stay focused over a long-term collaborative process. Having this type of commonly understood target, also helped avoid the types of miscommunications that can occur when one stakeholder group views predevelopment as a planning process while another perceives it as a vehicle for data collection or technical research. This mismatch in expectations can doom any predevelopment process to an academic exercise. Because the term resilience is so broad, this type of focus is especially important for resilient infrastructure planning.

When starting the design process with each RE.invest partner city, the team kept all options open. For example, it was not obvious if a city needed or prioritized recycled water or renewable energy systems or both. Moreover, it was not clear if a city had sufficient baseline information to assess the viability of either.

Setting an overarching goal of getting to the starting line of a procurement process and creating the greatest potential possible for leveraging private financing helped ensure that everyone shared the same objective, even if what was being procured inevitably shifted over time.

INVESTIGATE

in·ves·ti·gate /inˈvestəˌgāt/ verb. carry out a systematic or formal research or study into (a subject, typically one in a scientific or academic field) so as to discover facts or information

The investigation phase of predevelopment should engage partners to gather relevant baseline data, identify key resilience challenges and priorities, and reveal critical data gaps for further data collection, research, and/ analysis.

5 Focus on the lifeboat, not the sinking ship.

Continuing to tell someone in greater detail how and how much their ship is sinking does not help them find, build, or use a lifeboat. City officials are often inundated with research on the problems they face, but few of these same studies offer solutions, beyond vague recommendations for policy change. RE.invest was designed to focus on practical and implementable solutions from the start of the design process. By keeping the process focused on what each partner city could tangibly build, fix, or buy, the RE.invest team was able to cut through “analysis paralysis” and move every design discussion quickly beyond generic ideas (green infrastructure) to specific locally appropriate options, such as blue roofs in Norfolk or recycled water systems in San Francisco and Honolulu. You can always refine your

lifeboat as you make your way off the sinking ship, but better understanding how you are sinking—literally in the case of some cities—does not in and of itself tell you where to go to improve your situation.

6 You are here. Don't confuse baseline data with big data.

It is hard to overemphasize the importance of robust baseline data. Just as disasters can help generate data on system failures and financial losses, cities need to have solid data to anchor potential design solutions. These data can vary from hydrological information on changes to the groundwater table to the total leakage in a water system. Getting the right data early in the process is essential in order to inspire ideas.

The RE.invest competition required cities to provide links to publicly-available baseline data on their resilience priorities as part of the application process to help the team quickly identify data gaps and needs in both selecting cities and moving forward with the final set of partner cities. At the early stages of investigation and conceptual design, the team focused on the key pieces of information to help quickly generate, evaluate (on the back of an envelope), and discard ideas.

It is important to note that baseline data does not need to be big data. Just as a doctor starts by taking a pulse and then using a stethoscope before running more complicated or costly scans. Baseline data should help a predevelopment team take the pulse of a city to identify and frame the key problems and opportunities before digging deeper to evaluate specific options.

At the early stages of investigation, predevelopment teams should not underestimate the value of "anecdata" (anecdotes + data) or proxy data. Within RE.invest, several cities lacked detailed hydrological monitoring information or precise measures of leakage in the water system. As a result, the design team looked for simple analogs, such as the pattern of sandbag purchases in a city, that could help anchor the next phase of predevelopment (ideation), while better data could be found, collected, or modeled.

7 Follow the money. Focus on current, not (only) future losses.

Research on resilience typically centers on where cities or communities are likely to lose money in future as a result of climate change or other hazards. These uncertain projections frequently get ignored in the face of current budget realities. Within RE.invest, the data collection process focused on a different question: *Where is your city losing money today?*

This approach is similar to energy efficiency valuations, which target interventions that can reduce a property owner's current utility bills.

Flipping the question has three benefits. First, focusing on pain points, like current (not future) losses, creates opportunities for savings-based financing, similar to property-assessed clean energy (PACE) bonds and finance instruments for solar power and energy efficiency projects. Second, identifying opportunities for cities to reduce existing expenses can help various departments see their common financial interest in a large project without creating internal conflicts and competition over resources. Money already spent or obligated is less controversial than new money that could be used for other priorities. Third, and most importantly, the most vulnerable communities are often where existing losses are greatest and most diffuse. These historically underserved communities, where green infrastructure (street trees) can both reduce flooding and potentially lower childhood asthma rates and costs, offer the greatest potential opportunities for combining and capturing multiple revenue streams.

IDEATE

i·de·ate /ˈīdēˌāt/ verb. form an idea of; imagine or conceive.
The ideation process typically involves reframing existing questions from different angles and bringing together combinations of existing ideas across disciplines, sectors, or geographies to reveal new connections or otherwise unrecognized risks and opportunities.

8 Zoom out. Ask bigger, better, and simpler questions.

Often the simplest questions yield the best insights. Cities are complex systems, and it can be easy to get lost in the details of any single problem in energy, water, or transportation. Finding breakthrough resilience opportunities takes a disciplined approach to zooming out and asking different questions than the ones that have created current crises or resource constraints. In this process, the greatest challenge is framing a question so an answer is sufficiently broad to identify opportunities for innovation across sectors yet sufficiently specific to be pragmatic and implementable in a structured predevelopment and planning process.

For example, “How can my city become more resilient?” is too broad to be actionable. Similarly, “How do I fortify my seawall?” is too narrow and may be missing other more cost-effective opportunities to achieve the same result, such as replacing failing sea walls or storm barriers with dunes, mangroves, or other natural infrastructure systems.

The RE.invest process honed in on the following focus questions and pain points:

1.) Where is your city currently losing money or seeing increased costs (e.g. spending more money for the same things)?
2.) What is your city's greatest unfunded need or mandate?
3.) What specific risks, threats, and hazards are driving your city's resilience priorities?
4.) Do these risks or issues have anything in common? In other words, is this risk a root cause of several problems or a symptom of another underlying problem?
5.) If there were one thing you could start to build or change in your city in the next two years, what would it be?

Discussing problems doesn't produce solutions, problem solving does. These questions are relevant to cities of all sizes and types. Framing the right question is the hardest part of any idea generation process. Often needs and risks are framed too narrowly, and cities end up solving one problem only to create another. Conversely, problems that are too broad to seem tractable foster dialogue but not action.

The Goldilocks "just right" framing is an essential prerequisite for ideation. Simple questions, framed effectively, can help maximize the range of possible solutions. Instead of "how do we build a better mousetrap?" think: "what are all of our options for catching mice?"

9 Focus on systems, not projects.

Resilience is all about systems—systems that are more efficient, more robust in the face of shocks and stresses, and quicker to recover after disruptions. As the questions to the left demonstrate, planning at the scale of projects rather than systems inherently misses opportunities to create broader resilience benefits.

The RE.invest engineering, legal and finance teams kept the focus on systems design by participating in multiple rounds of problem-framing and idea generation. Each of the core focus questions were asked to many different city officials across multiple sectors. The gaps and overlaps among various city departments' responses offered innovative angles from which to approach intractable problems. The result was a process that lifted up cross-sector solutions, for example, solutions that served both the parks department and water utility, and integrated key finance considerations early in the design process. Staying focused on capturing value (revenues) at the seams of multiple sectors can also help reduce internal competition for resources within municipalities. Win-win solutions are great, but there are rarely solutions with only wins. Most involve trade-offs.

Generating resilience design ideas that cut across sectors and address multiple priorities can help various city departments see beyond their sector to support projects with clear benefits

for their agency within a larger set of benefits. This seems like common sense; however, it is far more common for a project in one sector to disrupt operations in another. Take for example the problem of sequencing road repaving and broadband expansion. Although there are tremendous cost savings of laying new broadband or fiber while roads are being repaved, only with new "dig once" policies has this kind of coordination become more of a norm. The RE.invest team's approach was to find opportunities for interdepartmental coordination by seeking solutions where one agency could offset another's costs with the savings achieved through a common project.

10 Open silo doors from the outside.

Silos can only be broken from the outside. Breaking a silo from within is rebellion. Breaking more than one is anarchy. Governments are easy to criticize for not being innovative or internally coordinated, but this is not entirely fair. All large organizations are designed to withstand silo-busting behavior, even where it might be helpful.

Within RE.invest, we took the simple approach of opening silo doors from the outside and inviting contributions from various agencies and departments. The result was ideas that were more easily received and openly evaluated. Instead of each department taking a territorial or defensive posture of how another's "innovation" could affect their bottom line or workload, the result was (more often than not) shared problem solving.

RE.invest also served as a catalyst for new leaders to emerge from within their silos. One of the best examples came early in the RE.invest process when one city official spotted a critical gap between new building codes to support green infrastructure and health programs designed reduce the spread of mosquitos. Because the context for the discussion was broader than the agenda for either department, two individuals were able to review the code on the spot, make small tweaks to align interests, and ensure both priorities were met all before the text went out for public comment later that week.

Why wouldn't this happen on its own? Simple: the incentives are wrong. If the health department had approached the green infrastructure team directly to raise the issue, it likely would have been perceived as an extra effort, or worse, a deliberate obstruction, and vice versa. By respecting existing silos, but still opening doors to specific and strategic discussions, RE.invest fostered targeted problem solving around common objectives rather than generic dialogue or collaboration.

11 Build safe spaces and jargon-free zones.

One of the greatest barriers to idea generation on highly technical issues, like infrastructure design, is the industry or sector-specific jargon that can dominate discussions and intimidate individuals—even experts from other fields—from sharing potentially transformational ideas. Wherever possible the RE.invest team avoided technical or financial industry jargon.

It is important to emphasize that dropping jargon does not mean being less detailed or precise.

Through the design process, the RE.invest team worked to continuously create comfort zones where expertise was not a prerequisite for contributing an idea. For example, in discussions on green infrastructure, rather than describing details of stormwater management technologies, the goal of design sessions was to convert a section of a city "from a funnel to a sponge." By facilitating collaborative discussions with easily visualized descriptions and analogies, the team created space for non-technical experts to offer constructive solutions—where to hold or absorb water—from their own fields.

Ideation is not brainstorming. Design thinking is a formal process that needs to be tightly structured to produce actionable outputs rather than a grab bag of mismatched ideas or lists on a whiteboard. Just as technical jargon can be a deterrent to generating practical solutions, a lack of a precise goal of a design exercise can also deter effective participation from within silos where everyone has very real resource and time constraints. The sweet spot is to create safe spaces (outside of existing silos) for new ideas to solve real and specific problems that can be described in plain language.

ITERATE

it·er·ate /ˈitəˌrāt/ verb. perform repeatedly; to say or do again with the aim of improvement

The iteration phase of predevelopment is where ideas transform from a vision to a project. This process is especially critical to refine resilience projects, where changes in one part of a system can result in complex interactions within and between other parts of a system.

12 Rinse and repeat.

Infrastructure projects are often rejected after a significant investment of time and resources in predevelopment and planning because there were too few feedback loops early in the process. Good design, like resilience itself, is flexible and allows for continuous improvement. However, infrastructure design processes are often completed out of sight of the political leaders, permitting agencies, and investors who have the final say over whether a project is viable. The RE.invest team deliberately brought together an interdisciplinary mix of designers, engineers, finance experts, lawyers, and former policy makers to maximize the opportunities for iterative feedback and refinement within the process. The ideation phase was organized to allow the team to generate and rapidly prototype basic ideas.

The ideas that emerged were then taken to the next level of detail to assess their real world potential. In other words, the process was structured to prevent the perfect from becoming the enemy of the possible.

13 Let go of ideas, even good ones.

Not all ideas should survive a predevelopment iteration process. If they do, the predevelopment process was not innovative enough. Examples of rejected ideas from the RE.invest team included micro-hydro projects—small turbines designed to generate electricity as water flows downhill inside drinking water or stormwater pipes—and financing strategies for water system upgrades based on ESCO-style energy efficiency improvements and cost savings. The team also explored options for leveraging the City of New Orleans Sewer and Water Board's internal fiber-optic utility to link broadband upgrades with green infrastructure (porous pavement). Similarly, El Paso floated ideas for new waste-to-energy investments to manage waste from unusual sources, such as the local branch of the Federal Reserve and the local zoo.

These ideas remain interesting and potentially viable, but after multiple iterations, they proved to be a poor stand-alone fit for the cities where they were considered, and instead evolved into components of larger design strategies, such as the RE.invest innovation park concept. Iteration should separate the truly viable innovations from interesting, but impractical (or not yet practical) conceptual designs.

INTEGRATE

in·te·grate /ˈin(t)əˌgrāt/ verb. combine (one thing) with another so that they become a whole. bring (people or groups with particular characteristics or needs) into equal participation in or membership of a social group or institution.

Resilience predevelopment is inherently cross-sectoral. Integration is the process of creating design solutions and collaborations where the whole is greater than the sum of its parts.

14 Mind the gap. Integrate data collection into design.

Any resilience predevelopment process that focuses on cross-sector issues is inevitably going to encounter data gaps. Because planning and designing for resilience is complex, there will always be a tendency for decision-makers to want more data before making final decisions.

Solid baseline data is essential for effective idea generation; however, it is important to note that more detailed data collection and analysis can also be a part of predevelopment, instead of a necessary prerequisite for design.

Within RE.invest, the team looked for opportunities to fill data gaps through the design process itself. In the case of Miami

Beach, the largest data gap was the lack of property-level data on Miami Beach's current and historical losses from storms and flooding. The last hurricane to cause significant damage to the City of Miami Beach was Hurricane Andrew in 1992. In the 20+ years since, there has been limited funding to systematically track and document the costs of chronic flooding in the city. Because of these data gaps, the RE.invest team relied on existing data to evaluate the City's needs and options for upgrading its seawalls, but also built in options for crowdsourcing data on flood related costs and losses into an integrated implementation strategy for the City.

Government agencies, such as NASA, have used crowdsourcing tools for several years to engage communities in participatory monitoring and citizen science programs. In Miami Beach, there are a variety of pathways for working with insurance companies to quantify reported losses and to engage residents and small businesses in data collection on unreported flood costs and losses.

Data partnerships can help the city track local expenditures on "indicator" products—sand bags, drywall repair supplies, pump rentals, mold clean-up—associated with flood related repairs.

These data are essential for being able to monetize and capture the benefits generated from any seawall repairs designed to reduce long-term flood risks and damages. Most importantly, they can be collected even as the city moves forward with other technical aspects of project design.

15 Focus on systems finance (and system integrity), not project finance.

Project finance has long been the industry standard for private investment in infrastructure. This approach relies on collecting an anticipated stream of revenues, such as highway tolls, to secure up-front financing for a large-scale project. The process necessarily drives projects to simple, single sector cash flow opportunities. In the case of resilient infrastructure investments, the benefits generated are more diffuse, and it is less likely that any single benefit is sufficiently large to fund a whole project.

More often a well-designed resilience upgrade to a water system will produce both water savings and energy efficiencies. Counterintuitively, having access to multiple revenue streams does not make an investment more attractive. Rather it increases the potential risk to investors looking to recoup their initial investment. As a result, any predevelopment process for resilient systems needs to incorporate finance into the up-front design thinking to identify specific and pragmatic value capture opportunities.

Ensuring that projects are not sliced and diced into their component parts is essential for designing and building resilient systems where the whole creates more value than the sum of the parts. Focusing on systems finance rather than project finance is more like planning for the Olympics than designing a single stadium. For the former, the system only works if the

investments in the airport, roads, and stadium all go forward in concert with one another. Simply building one piece of the system does not meet the overarching need. The RE.invest design proposal for Hoboken is an example of where a systems approach produced an integrated design solution and a cross-sector financing strategy to bring in parking fees to complement traditional water system funding. Similarly, the innovation park design concept focused on streamlining cities' access to multiple technologies that can improve system performance rather than one-off projects.

16 Build a cohort, not a committee.

Bold decisions are hard. Tackling integrated resilient infrastructure projects across-sectors and at large-scales is really hard. In this process, cities are alone together. Each city has unique challenges, but at the same time cities have only each other to look to when seeking others facing the similar challenges and seeking solutions.

RE.invest was designed to provide both strength and safety in numbers. By working with eight partner cities simultaneously, the RE.invest team was able to establish a loose cohort and offer each partner city an anchor within a larger group without creating complex committees. Cities don't necessarily need to convene or partner in elaborate ways to reap the benefits of having another city tackling the same problem. Simply having a common umbrella can have value.

Because there are few precedents for large-scale resilient infrastructure projects, providing political leaders with clear examples to support a course of action is essential. The RE.invest team was able to help partner cities learn from one another, transfer design ideas, and take a measure of confidence from another city conducting a parallel experiment in on-the-ground design and finance. Perhaps most importantly, when working with local stakeholders or making the case for a bold decision, city officials were able to point to another city in the group that was taking similar steps. Networks like the US Sustainability Directors Network, the C40, and the 100 Resilient Cities program all offer the benefits of a broad cohort. The RE.invest process showed that these benefits are relevant even for more short-term predevelopment processes.

Creating cohorts of interdisciplinary experts within cities is also important. Resilient infrastructure projects by nature cut across multiple sectors and departments. The type of open design and ideation process used in RE.invest brought forward a collection of unusual suspects from various city departments and agencies. These were individuals with powerful ideas and platforms in city government or public utilities. Ensuring that these integrators and champions remained connected to one another through the process was also an important foundation for ensuring that all design proposals had a clear pathway to implementation and retained a cohort of internal leaders at multiple levels to carry a project forward beyond the predevelopment phase.

17 Remember a vision is not a project (or a project pipeline), analysis is not an answer, and funding is not financing.

Integrated planning forces everyone involved in a design process to zoom out and take a broader perspective on a potential project opportunity. In this frame, it is easy to forgot to zoom back in to develop design documents and a financing strategy that are sufficiently detailed to support.

The RE.invest team took a pragmatic approach to ensure that design concepts didn't just remain concepts, but were actually pushed into the next phase of development. The benchmark for design and engineering was: *could a project's design parameters and cost estimates be used as the basis for a procurement of design-build services?* In other words, could a city write the specifications for an RFP, based on the predevelopment work completed through RE.invest? This was a much higher bar for completion than a visioning or conceptual design exercise; however, it was also an essential part of the process to make sure that the results were technically and financially viable.

Within the RE.invest team, all project proposals were revisited at regular intervals to make sure they were evolving into real procurement and implementation opportunities. Where there were missing pieces, such as data gaps, the team focused on integrating data collection into a broader strategy. At the end of the day, the goal of RE.invest was to help cities implement—not only identify— solutions.

IMPLEMENT

im·ple·ment /ˈimpləmənt/ verb. put (a decision, plan, agreement, etc.) into effect.
The end goal of any predevelopment process is to lay a strong foundation for long-term construction and operation. This phase is where the design process meets political implementation processes (e.g. public procurement, public-private partnership, etc.).

18 Move from political will to political wins.

Lack of political will is a frequent and convenient excuse for why many infrastructure projects fail. There is no such thing as generic political will. Governments, like any other institutions, need to make a strong case for pursuing any given project, strategy, or opportunity. This is why the aftermath of a disaster is such a powerful catalyst for bold and urgent political action.

The RE.invest Initiative was carefully structured to maximize the potential for political wins. By offering external technical support on a defined timeline, the RE.invest team was organized to help cities reach beyond traditional political agendas without significant downside risk of diverting resources (staff time or funds) from other priorities. Combining design solutions across sectors to create benefits that were broadly distributed across departments and agencies also offered a pathway through internal political struggles. Integrating multiple priorities helped open the door

to thoughtful compromises rather than win-lose situations. The focus on finding innovative finance solutions as part of the design process also helped reduce internal concerns about resources and funding demands. Finally, having a set timeframe for predevelopment (18 months) accelerated the process of coordination when it might have otherwise been pushed aside to address more urgent short-term needs.

Local champions with the power to act are the difference between an abstract idea and an implementable project. The RE.invest process drew out internal leaders by requiring clear points-of-contact at the outset of the process (through the competition application criteria) and a commitment to remain engaged for the full length of the initiative. The team then engaged other champions who emerged at multiple levels through the design process.

The RE.invest process demonstrated the tremendous political will and interest in resilient infrastructure development and the potential for innovation within local government. It is easy for long-term resilience thinking to fall by the wayside in the daily pressures of managing a city. Having a clear goal and timeframe from the start of predevelopment can help motivate action, attract internal champions, and ensure continuity and consistency in the process to create political wins along the way.

19 Map a clear path to procurement and construction.

All of the insights and lessons to this point focus on translating a vision to a financeable project; however, having a well-framed project is only the beginning of the process. Making the leap from design to construction also requires a thoughtful up-front strategy. In the case of resilient infrastructure, there are countervailing forces that drive political interests and financial interests at the final stages of project design. Investors want to invest in large projects—generally project sizes of $100 million or more. If an investment bank has to do the same amount of work (due diligence and structuring) to finance a $25 million project as a $100 million project, the larger of the two will always be more attractive. In contrast, a city often faces pressure from taxpayers and other stakeholders, such as city council, to reduce the overall price tag of a project. As a result, the tendency from governments is to break a project down into small(er) pieces. This not only reduces private investment interest, but it also increases the risk that not all of the components of a system will get built, which can negatively impact both the resilience benefits and potential cash flows.

The RE.invest team focused on countering both of these pressures by creating templates for public-private partnerships that would ensure system integrity and set a clear trajectory for implementation, either through a local Request for Proposals (RFP) or other relevant procurement channel. There is no single recipe or one-size-fits-all approach that cities can take, but thinking big

and taking an implementation approach that resembles an Olympic bid—with lots of different project components that all need to be completed as part of an overall strategy—can help a local leader or project champion make a strong case to keep all the pieces and parts together over time.

20 Tell a great story, because success in resilience is something that doesn't happen.

Unlike some traditional infrastructure projects, such as roads and bridges, which can create immediate benefits in access or reduced traffic congestion, the benefits of resilient infrastructure projects are not always clearly visible. For example, a stormwater detention chamber is only visible through the floods it helps prevent. Similarly, a back-up power supply or alternative energy generation system may only operate in extreme conditions and remain silent at all other times. Resilience solutions come in all shapes and sizes. The most complex systems are distributed across wide areas and can even be geographically distant (far upstream) from the communities they serve most directly. These are not easy projects to showcase with a ribbon cutting.

Local leaders need to be celebrated for investing in resilience solutions. The mainstream news media rarely, if ever, covers events that didn't happen, so a non-flood is not a success for an elected official. Finding ways to celebrate these types of quiet successes will require more creative approaches to data collection, monitoring and evaluation, story telling, and media coverage of a hurricane that hit, but the flood that was avoided. Within RE.invest, many of the finance options developed through the initiative included components that quantified savings from water or energy efficiencies or avoided losses from storm or flood damages. These types of data are equally important for making both the financial case and public case for investing in a resilient infrastructure solution.

Many government agencies—from homeland security to environmental protection— face this same problem, but in the case of resilient infrastructure investment, there are so many underlying factors that affect whether a storm becomes a disaster that we need new approaches to help local officials tell their stories and create a virtuous cycle for resilient infrastructure predevelopment and investment. The RE.invest process and this report offer one platform from which to celebrate the leadership and innovation of all eight of our partner cities, but cities and local leaders need many more.

INNOVATE

in·no·vate /ˈinəˌvāt/ verb. make changes in something established, especially by introducing new methods, ideas, or products.
Together these steps form the basis for system-wide innovation. Resilient infrastructure predevelopment processes must ensure that cities move beyond replacing what they currently have today to creating the solutions they need for the future.

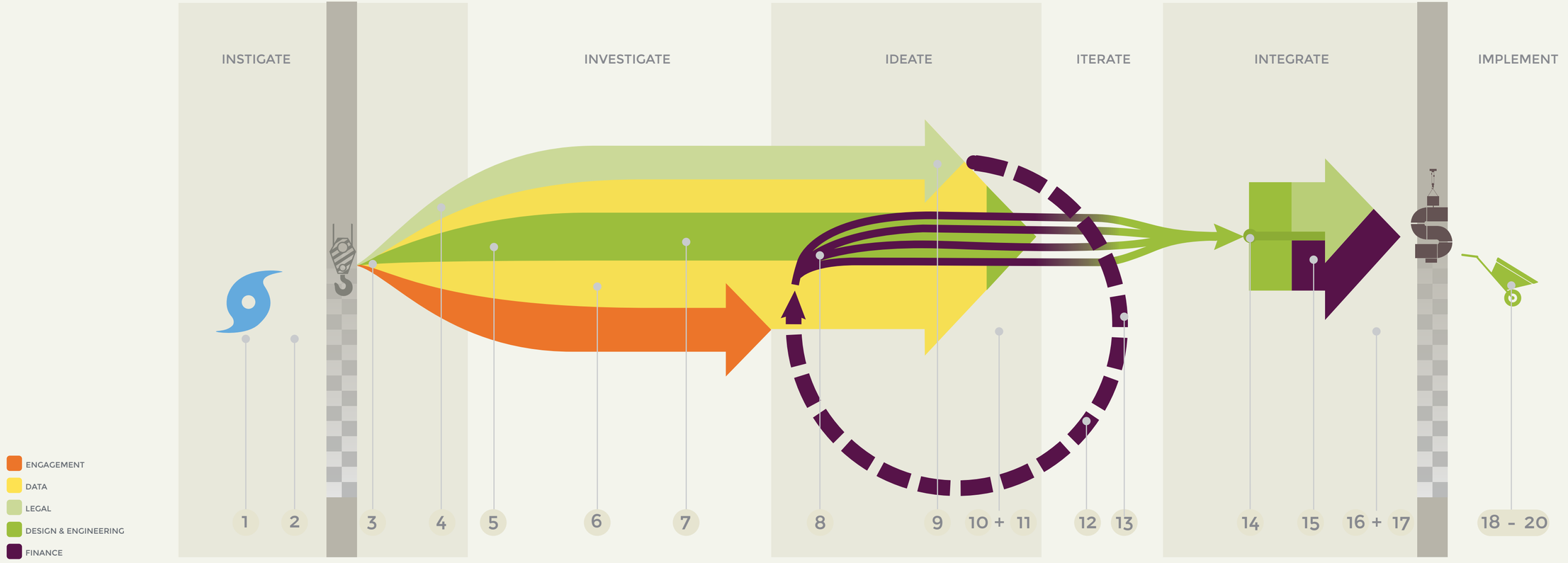


FIGURE 5: The RE.invest Predevelopment Process and Lessons Learned.

33 THE RE.INVEST PROCESS

Integrating resilience design and finance is complex.

In order to test a new approach to predevelopment, RE.invest was specifically structured as a collaborative program that brought together an interdisciplinary team of engineering, legal, investment, and policy experts.

The initiative was officially announced in January 2013 by re:focus partners, in collaboration with the Bechtel Corporation (engineering); Akin Gump Strauss Hauer & Feld, LLP (legal); and Wall Street Without Walls (finance); with generous support from the Rockefeller Foundation.

RE.invest was launched with a 3-month national competition, where all city applicants were required to submit a letter from a mayor identifying at least one senior political and one senior technical expert to serve as lead points-of-contact for the full two-year length of the initiative. The core team received more than 50 expressions of interest and over 700 pages of application material from interested cities. Based on selection criteria, including the strength of their completed applications and geographic diversity, the following cities were selected as RE.invest partner cities: El Paso, TX; Hoboken, NJ; Honolulu, HI; Miami Beach, FL; Milwaukee, WI; New Orleans, LA; Norfolk, VA; and San Francisco, CA.

After the announcement of all partner cities in May 2013, RE.invest followed a structured, two-year, three-track process to design new resilient infrastructure projects and implementation strategies that were innovative and met local needs, but were also transferable to other cities. As an independent technical assistance program, RE.invest provided each partner city with the additional support necessary to aggregate resilient infrastructure projects across sectors, identify specific legal and policy hurdles, and pinpoint actionable financing strategies.

OBJECTIVES

At a time when public resources and municipal staff are increasingly strained, the main objectives of RE.invest were to develop strategies that lessen the burdens of government, use public resources to leverage large-scale private investment, and deliver resilient infrastructure and services to underserved communities.

- **Lessen the burdens of government**
  Public resources are increasingly scarce and stretched thin. As a result, local officials are often forced to be reactive rather than making integrated long-term planning decisions. RE.invest was designed to provide cities directly with much-needed technical planning and analytical support in concert with long-term funding and implementation options.

- **Mobilize private capital to protect communities**
  Private investors are seeking stable large-scale investment opportunities to hedge against market volatility. RE.invest was structured to reduce transactions costs and political risk for project developers; match investors to large-scale, long-term sustainable investment opportunities; and overcome problems with project discovery, due diligence, and scale that often undermine sustainable and resilience-focused investment opportunities.

- **Increase resilience of vulnerable cities and systems**
  Taking a “systems approach” to designing and financing urban infrastructure offers a national model for resilient systems planning, delivery, and investment. The goal of RE.invest was to shape a new model for public-private partnerships that can support learning, flexibility, and continuous improvement in infrastructure delivery.

- **Improve integrated planning capacity at the municipal level**
  RE.invest was designed to test and refine a template for an 18-month predevelopment process that could be applied to help cities around the world generate and implement innovative resilient infrastructure solutions. By offering cities opportunities to meet multiple needs simultaneously—such as repaving roads, expanding broadband access, and improving stormwater capture—RE.invest aimed to improve coordination and reduce competition between departments for resources and make it more cost-effective for cities to reach historically underserved, marginalized, or vulnerable communities.

PARTNERSHIPS

The RE.invest core team of engineering, legal, finance and policy experts was specifically selected to provide all RE.invest partner cities with a dedicated yet flexible technical assistance team to address local priorities. Each of the partner organizations and cities is described below.

re:focus partners is an innovative design firm dedicated to developing integrated resilience solutions and new public-private partnerships for vulnerable communities around the world The re:focus team designed the overall structure of the RE.invest Initiative, coordinated all aspects of its implementation, and contributed innovative design, legal, finance and policy expertise in the development of all city-specific projects.

The Bechtel Corporation is a world-class engineering, project management, and construction company. Since it's founding in 1898, Bechtel has worked on more than 22,000 projects in 140 countries on all 7 continents. Bechtel provided all engineering and design services required for project preparation in each city. All engineering design work and technical analysis was led by a central group of staff based in Reston, VA and supported by key engineering experts in each RE.invest partner city for specialized local or sector-specific analysis, as needed.

Akin, Gump, Strauss, Hauer & Feld LLP is an international law firm with over 800 attorneys and advisors. As the lead law firm for all RE.invest public-private partnership (P3) design and development services, the Washington, DC based Akin Gump legal team focused on developing a replicable strategies and P3 models for delivering cross-sector systems of infrastructure while building both public trust and investor confidence.

Wall Street Without Walls is a national organization designed to mobilize capital market institutions and financial products for communities in need. In order to support all eight RE.invest partner cities, Wall Street Without Walls tapped a network of senior and retired Wall Street investment banking professionals with backgrounds in municipal finance, real estate, corporate finance, emerging markets, and structured finance to create a dedicated Financial Technical Advisory Team. This team worked to identify locally-appropriate financing options and evaluate investment risks for the cross-sector RE.invest project pipeline.

El Paso, Texas

Due to its arid climate, El Paso faces unique challenges and opportunities for green energy and resilient infrastructure development. To reach the goals laid out in the City's Sustainability Plan, the city worked through RE.invest to explore new options for increasing sustainable energy infrastructure, enhancing integrated recycled water and stormwater infrastructure, and attracting large-scale private business investment in a way that promotes sustainability alongside local economic development.

Honolulu, Hawaii

Based on an island with limited freshwater capacity, the City of Honolulu prioritized the need to limit freshwater withdrawals from an already overburdened freshwater supply, reduce impacts of stormwater runoff on coastal natural resources, and improve adaptation to the local effects of climate change. Leveraging investment in the Honolulu High-Capacity Transit Corridor Project, the city worked through RE.invest to explore strategies to integrate recycled water systems into park maintenance and broader Neighborhood Transit Oriented Development plans.

Hoboken, New Jersey

In response to disasters like Superstorm Sandy and other city-wide flooding events, increasingly regular localized flooding, and constrained parking capacity, the City of Hoboken worked with the RE.invest team to integrate green infrastructure and open space plans with innovative new solutions for sub-surface stormwater detention and expanded parking capacity.

Miami Beach, Florida

As a low-lying barrier island, Miami Beach experiences significant tidal flooding. Through RE.invest, the City worked to identify an engineering solution and mechanism for increasing the efficacy of the 63 miles of seawall in the City, most of which are privately owned, to protect against chronic city-wide tidal flooding and coastal erosion and address long-term sea-level rise and the threat of more severe storm surges.

Milwaukee, Wisconsin

Already a leader in integrating green stormwater practices into planning and development, the City of Milwaukee worked through RE.invest to develop a catalytic project to spur regional innovation and local economic development, while highlighting the broader city-wide Sustainability Plan intended to align economic and environmental interests to improve Milwaukee's quality of life.

Norfolk, Virginia

In recent years, the City of Norfolk has made significant investments in expanding and improving its traditional stormwater infrastructure to address significant recurring flooding issues; however, the age and size of the existing system coupled with limited public funding for new public works has created a backlog of high-priority projects. Through RE.invest, Norfolk worked to develop a pipeline of integrated and scalable flood management projects ranging from green infrastructure to self-deploying flood barriers.

New Orleans, Louisiana

Since Hurricane Katrina in 2005, the City of New Orleans has dedicated tremendous resources to improving regional stormwater planning and management. The City worked through RE.invest to focus on projects that support regional water management innovation and neighborhood revitalization by attracting large-scale private business investment in new smart technologies, systems, and networks.

San Francisco, California

The City of San Francisco has been a leader in creating new "eco-districts" in their most rapidly growing neighborhoods to create sustainable transit, employment, and housing options. With the support of the RE.invest Initiative, San Francisco examined the feasibility and the roles of public and private partners for developing on-site and district scale water recycling opportunities to support a portfolio of resource efficiency and conservation efforts within specific eco-districts.

ACTIVITIES & BUILDING BLOCKS

From its inception, RE.invest was organized around three main tracks of activities—engineering, legal, and finance—intended to generate a set of building blocks needed to successfully develop any resilient infrastructure project. These activities and the building blocks they produced set the stage for an integrated predevelopment process that aimed to (1) catalyze large-scale systems solutions, (2) build pragmatic public-private partnerships, and (3) monetize and capture multiple benefits and revenue streams created by resilient infrastructure projects. Building on the assumption that any predevelopment process lacking one or more of these activities or building blocks is unlikely to connect the dots between vision and implementation, RE.invest tested a new systems approach to predevelopment and design of innovative resilience investment opportunities.

Engineering

The engineering and design track of RE.invest was an 18-month process that centered on the investigation, ideation, iteration, and integration phases of the predevelopment process highlighted in Figure 2. The timeline of activities included investigation sessions (June-August 2013), a conceptual design and ideation phase (July-December 2013), and a 12-month iteration and integration focused schematic design phase (January-December 2014) to develop the engineering drawings, plans, and cost estimates for potential resilient infrastructure solutions in each RE.invest partner city.

Each city was assigned an engineering expert with access to contributions from RE.invest legal and finance partners on delivery mechanism design and system return on investment. That expert was then responsible for coordinating with a set of “on-demand” personnel who had specialized skills and could play a technical support function for all participating cities.

Specifically, the core team of engineers supported project development by conducting baseline research and data collection, pulling from City contracted reports and publicly available information. After an initial “keep-or-toss” brainstorming session with the broader RE.invest team to decide which resilience solutions should be prioritized and what general solutions were viable given the local context, the engineering team led a conceptual design phase which included internal idea generation and external input from local partners. This part of the process was key in confirming local support for different types of resilience projects and evaluating what had already been tried, what had succeeded or failed, and why.

The engineering and design concepts described on the following pages are examples of the results of that process and served as building blocks for city-specific project development. Once a general conceptual design strategy was approved by a partner city, the engineering team focused on a basic technical feasibility analysis that included evaluation of baseline data and existing conditions in the context of the proposed project and initial cost estimation. The timeline for analysis varied based on the availability and quality of local baseline data. Upon completion of the basic feasibility study, the team undertook a broader benefits

analysis to identify the direct financial value—for example, water rates, energy efficiency savings, or parking fees—and also the indirect benefits—such as physical risk reductions and potential insurance savings—based on site-specific project designs.

This broader economic benefits evaluation is the missing link in current predevelopment processes. Because resilience benefits are often diffused across sectors and diverse types of beneficiaries, who are willing to pay for improved services or protections, incorporating this step into predevelopment is essential for producing viable investments instead of proposals that are subsequently "value-engineered" to reduce costs at a loss of overall system resilience.

Engineering & Design Concepts

In order to jumpstart the investigation and ideation phases of predevelopment, the RE.invest team created a set of initial design concepts that could be tested with multiple RE.invest partner cities to catalyze discussion on integrated cross-sector design and finance opportunities. All of these design concepts were original ideas crafted by the RE.invest team, based on the common challenges that were evident from the RE.invest application process. What makes these concepts unique is their built-in link to potential financing solutions that enabled the design team to evaluate options for capturing multiple cross-sector revenue streams throughout the engineering design process—from conceptual design to detailed schematic design.

Looking across all eight RE.invest partner cities to identify common problems and potential cross-cutting solutions, the team developed the following six innovative packages of infrastructure options that creatively address multiple resilience challenges with integrated and implementable projects: re:park, re:cycle, re:pave, re:wire, re:energize, and re:inforce. Each is described briefly here and then expanded in the section on Partner City Solutions, where they were mixed-and-matched and refined to develop city-specific projects.

re:park

is a vision for a new type of urban "innovation park" designed to integrate public green and open spaces with stormwater management, underground parking (where appropriate), and environmental technology demonstration spaces. Because underground parking garages and basements are some of the first spaces to flood during severe rain events, this concept takes a simple approach to proactively combine green and traditional surface and subsurface stormwater retention and flood management systems with underground parking to integrate their design for cost savings and connect two separate revenue streams, water rates and parking fees. Installation of underground water management systems could also help city agencies and building owners reduce the energy costs of pumping out water in areas with high groundwater tables or significant chronic flooding. Further combining parking and stormwater detention with green and open spaces, offers additional revenue generation potential from corporate investment outdoor museum-style above ground demonstration spaces to showcase resilient infrastructure technologies.

re:cycle

is a concept to help cities sustainably manage freshwater withdrawals and expand the use of recycled water. Many large-water customers, such as developers and golf course operators, currently pay a premium to use freshwater for irrigation. A switch to recycled water would result in significant cost savings. This concept offers an entry point for exploring scalable onsite recycled water treatment for non-potable reuse with integrated micro-hydro or solar energy that could be financed by electric utilities with renewable energy mandates and paid for through utility fees or water and energy savings in an Energy Services Company (ESCO) style model.

re:pave

is design concept for coordinating and sequencing road repaving and other capital improvements with cost-saving strategies for expanding street-level green infrastructure. The RE.invest team focused on creating opportunities for integrating surface green infrastructure strategies, such as porous pavement, site grading, tree trenches, with other streets and parking upgrades. For example, designing surface parking areas to retain stormwater overflow can create multiple benefits at lower construction cost, while also tapping into street parking revenues as a source for repaying private investors who provide upfront investment capital.

re:wire

is a pathway for engaging IT and telecom companies as partners in street and water system upgrades. By identifying IT upgrade priorities (e.g. wireless, broadband, fiber-optic, camera, and monitoring systems), cities can plan capital improvements that create additional revenue generation opportunities. For example, building on the push for new “dig once” policies to proactively to lay conduit while repaving roads or upgrading sewers can allow cities and companies to coordinate on accessing and expanding high-priority space below city streets at lower cost and with fewer disruptions from uncoordinated construction projects. The re:wire concept has the added benefit of limiting wear-and-tear on porous streets in ways that can lower their effectiveness for stormwater management.

re:energize

is a proposal to help cities expand renewable energy production and innovative distributed power generation systems through a stable supply source for critical city functions to improve overall resilience. For example, energy costs make up the highest percentage of the costs of desalination in highly water-constrained cities. Renewable energy sources with stable “fuel” supplies and low operating costs, like concentrated solar power arrays or waste-to-energy systems, can significantly reduce the operating costs of desalination plants. They also can provide a back-up power supply to improve system resilience for essential institutions, like schools, hospitals, or cooling centers, in severe weather events.

re:inforce

is a vision for transforming the way that coastal cities manage and upgrade their coastal protection systems. Currently, many seawalls are the responsibility of private property owners. When any property-owner fails to maintain their wall, their neighbors in the community are all more vulnerable to the

next storm or flood. Repairing these seawalls is more cost effective when large-sections of the walls are built all at once to avoid creating unnecessary seams. The re:inforce concept focuses on comprehensive strategies and incentives for property owners to participate collectively in expanding coastal protection systems—including seawalls and natural infrastructure—and payback costs over time through property value increases and savings on insurance bills.

What makes these ideas innovative is their pragmatic combination of elements from across sectors, developed with near-term financing and implementation in mind from the start. By bringing together project ideas from multiple sectors, each of these design ideas opens up the potential to capture multiple revenue streams and access different sources of financing. These solutions are intended to move cities beyond urgent short-term fixes to enduring systems solutions. Generating broad conceptual designs that are relevant across multiple different contexts, allowed the RE.invest engineering and design team to lay the groundwork for transferring these ideas across RE.invest partner cities and to other cities around the world.

These concepts are intended to serve as inspiration for cities to explore new solutions to their existing infrastructure challenges. Each concept is designed as a springboard to be mixed and matched in various combinations with other ideas to catalyze systems thinking and design innovation. It is important to note that these concepts are simply starting points for further design development. Not all concepts will apply to all cities. Nor will all of them automatically yield viable or locally-appropriate investment opportunities. Smaller, rural cities will necessarily apply these strategies differently than large or dense metropolitan areas. Each requires significant further analysis; however, all cities can use these concepts to kickstart their own resilience ideation process.

Legal & Policy

In recent years the term public-private partnership (P3) has expanded to encompass everything from coordinated social investments by government and industry to privatization of public infrastructure and services. The RE.invest Initiative aimed to develop new P3 models that preserve public ownership of assets but attract large-scale private investors in order to support comprehensive city-wide resilient infrastructure development. For example, a city disaster management agency might benefit more than a water authority from the installation of new green stormwater system that reduces flood or landslide risks. However, disaster response agencies are typically not allowed to directly finance infrastructure. By creating new collaborative models with the legal and financial authority to work across agencies and sectors, RE.invest aimed to support cities to use public resources more efficiently and help public and private investors capture not only direct revenues, such as water or energy fees, but also savings and avoided losses across systems, such as reduced disaster recovery costs.

The legal and policy track of RE.invest began two months after the start of the engineering process (August 2013) and focused on developing the legal and policy building blocks needed to help deliver an integrated set of projects that could leverage both public funding and private financing. The legal team reviewed public-private partnership

options with appropriate legal and transactional authorities (e.g. bidding, contracting, procurement, liability, etc.); local legal issues, such as land title and development rights transfer mechanisms; governance; and structured exits for investors and public agencies. Rather than focusing on city-specific legal and policy adjustments, the legal team looked at national models that could be structured to support expanded investment in resilient infrastructure projects more broadly.

The RE.invest team defined a successful P3 as one where the private sector delivers high-quality infrastructure improvements at a cost savings to the government while realizing a reasonable profit. Successful P3s have a few common features, including underlying laws and policies that (1) define the process for identifying P3 opportunities, evaluating the desirability of P3s, procuring P3s, and overseeing contracts; (2) set criteria for determining cost effectiveness, value for money, and risk/reward; (3) create clear responsibility within a governmental entity for evaluating and procuring P3s and overseeing contract performance; (4) establish transparent procurement processes that allow for innovation; (5) build broad stakeholder and community support; and (6) issue contracts that define performance metrics and payment terms for the appropriate length of time to fairly balance risks and rewards, manage risk, and provide a reasonable return on investment.

These characteristics of successful single-asset P3s are also essential for new public-private investment in resilient infrastructure systems. However, a resilient infrastructure P3 also requires additional legal considerations that enable broader cross-sector coordination and contracting across various government and corporate parties to capture multiple revenue and payback streams. These considerations include:

- *Changes to enabling laws:*
  A city may need to change its enabling laws to authorize P3s that integrate different types of infrastructure improvements in one contractual vehicle.

- *Creation of a dedicated resilience P3 authority for integrated infrastructure:*
  Cities may want to establish a P3 Authority or office within the city to evaluate resilient infrastructure improvements that can be undertaken under a single contract. Typically, these types of authorities are established with the mandate of economic development; however, for resilience projects, cities could consider placing a new P3 Authority under the oversight of a Chief Resilience Officer or other senior official with a sustainability and resilience mandate. The Authority should rely on the expertise of relevant city departments, but should make recommendations to the mayor or city council regarding whether to pursue an integrated P3, the contract delivery approach, the contract terms, and the awardee. A P3 Authority could be a single individual or a group comprised of appointees of the mayor and/or city council. The P3 Authority would be responsible for reviewing resilient infrastructure projects for potential integration into a single P3 in order to most effectively

and efficiently capture savings from within government budgets. Functionally, a resilience P3 Authority, like any other standard P3 Authority, would need to work with city departments and undertake a feasibility study, value for money analysis, and any other legal and financial reviews necessary to make a recommendation to the mayor and city council regarding whether to move forward and what procurement approach to take.

The P3 Authority would oversee the procurement with advice and counsel from the city departments and make a recommendation to the mayor and city council regarding selection of a consortium and Special Purpose Entity (SPE) to design, finance, build, operate, and maintain the integrated project. The mayor and city council would need to approve execution of a contract or concession agreement.

The P3 Authority could then serve as the umbrella entity responsible for contract performance, but would need to delegate oversight of contract performance to the appropriate city departments. The P3 Authority would also be responsible for addressing disputes during the period of the concession. Contractual arrangements should provide a mechanism for assessment of penalties in the event the project consortium does not meet such metrics or termination in the event of an incurable breach. The best approach for managing risk would be to define all relevant cash flows and relationship structures at the point a city enters in a contract with the special purpose entity rather than allowing new projects to enter a pre-established P3.

Feasibility Analyses

Feasibility analyses, including cost-benefit, desireability, convenience, and value for money analyses, are critical for a city to determine whether there is an advantage to integrating otherwise unrelated cross-sector resilient infrastructure improvements and whether it is advantageous for the private sector to deliver these improvements through a P3. A city should have laws or regulations in place that require it to undertake an analysis of whether and how to structure a P3 that integrates resilient infrastructure projects. Among other things, the city should consider the following:

- Costs and benefits of improvements
- Cost savings from integrating infrastructure improvements v. risks of integration
- Difference in cost of public sector funding versus private sector financing
- Benefits of bundling design and construction with operations and maintenance
- Demand for integrated projects and potential revenue
- Payment structure
    - Existing and proposed user fees and level of control city will give private partner over setting of user fees
    - City assessments
    - Shadow fees based on number of users or beneficiaries of improvements
    - Future tax revenues
    - Grants and revolving loans
    - Incentive payments based on savings generated
- Contract term(s)

Financing & Revenue

Once established, an SPE responsible for executing the project should be required to obtain financing for the approved integrated project. In this process, the SPE could contribute equity during the development and/or operations phases. A city may agree to provide access to grants or low interest loans or tax-exempt financing. Once the SPE delivers the infrastructure improvements, the city would pay it over time with fees paid by residents and businesses, availability payments structured at a pre-agreed rate of return, or a combination of the two, provided the SPE meets all performance requirements.

Overall, based on early discussions with partner cities, the RE.invest legal team analyzed a variety of structures—including Olympic Delivery Authorities, existing P3s, and policy based mechanisms—which could be designed to integrate public and private financing to support a series of integrated resilience infrastructure projects. Over the course of two years, the team laid out the foundational aspects of a semi-public local delivery authority able to raise both public and private financing to support a series of projects, and also identified more specific strategies that cities could pursue without needing to stand up an entirely new authority, all of which are captured in the set of individual RE.invest city reports (see www.reinvestinitiative.org) All of the strategies developed under this building block were based on extensive research and a series of collaborative sessions with the broader RE.invest engineering and finance teams.

Finance

Despite the growing interest in resilient infrastructure investments, the pipeline for infrastructure remains stubbornly stuck in traditional projects, such as toll roads and bridges, and planning for resilient systems and improvements is still largely a public investment challenge. Most resilience projects are viewed as public goods that generate diffuse benefits long into the future. As a result resilient infrastructure projects are typically supported by federal, state, or local funds, and risk reductions are rarely evaluated at a level of detail required to support the development and issuance of investment-grade financing.

Like the problem of energy efficiency, resilience project developers and investors need to be able to forecast the potential savings from efficiency improvements before designing a financing mechanism to capture those savings. In the case of resilience projects, the data on the types of interventions that create measureable risk reductions are not as readily available or as easily extrapolated across projects. Everything is site and context specific. Unlike replacing lightbulbs to reduce energy use and associated bills, reinforced seawalls, for example, can have wildly different risk reduction profiles in different locations.

In order to develop viable and procureable projects, the finance team focused on value-capture instruments that could be tweaked to support water efficiency projects, green infrastructure, coastal protection investments and other investments aimed at reducing the physical risks of chronic and acute resource constraints and environmental impacts. The investment track of RE.invest began in parallel to the legal track

(August 2013) and focused first on making the case for investors as to why investing private capital into resilient infrastructure system is a bankable idea, specifically reviewing existing project finance models based on value-capture financing. Once the scope of work was defined by each municipality and the engineering team (January 2014), the team focused on the following building blocks necessary to support resilient infrastructure project finance:

- assessing the types of capital available based on project type,
- analyzing how to stabilize and secure project-specific cash flow streams,
- collaborating with engineering and legal experts to iteratively adjust the project economics for city-specific proposals through design changes, and
- developing options for mechanisms that could be utilized by cities to access private capital for resilient infrastructure.

Beyond supporting specific financing strategies for RE.invest Partner City Solutions, the finance team looked at existing hurdles to financing, and how to address them by revamping existing models and mechanisms to support the broader scope of the various RE.invest infrastructure projects.

Traditional project financing is complicated, but designing and financing a system to include multiple projects across sectors introduces another layer of difficulty. Recognizing that, the RE.invest team identified the following key finance considerations that must be taken into account in order for any resilient infrastructure deal to move forward.

1. Underwriting and Guarantees

Generally deals are underwritten or guaranteed by some combination of a public state infrastructure bank, credit enhancement, private insurance, or institutional hedge. Even though resilient infrastructure is different from traditional infrastructure projects, it is expected that the same level of coverage must be met for any integrated set of resilient infrastructure projects.

2. Creditworthiness of Existing Owners

Public infrastructure deals are often based on the creditworthiness of municipal or state institutions, so even for the types of projects developed through RE.invest, it is unlikely that a deal would move forward unless the relevant public entity meets basic credit rating thresholds.

3. Quality of Cash Flows

Many public infrastructure deals have failed because real cash flows end up being very different than initial project forecasts and projections. The more that can be done to clearly quantify potential payback streams, and the more predictable those cash flows, the better the potential deal is from the perspective of a city and any project developers and investors.

4. Clarity of Payments

Not only is it important that cash flows are clear and credible, but it is also important that there is clear legal responsibility for payments assigned to the entity that is capturing and

aggregating multiple direct and indirect revenues from a resilience project, in order to ensure investor confidence in a sound deal.

5. Clarity of Responsibilities

As in any project, having clear roles and responsibilities is important. But particularly when dealing with system financing, where there is not just one project but rather many projects, clear contracts and legally agreed delineation of responsibilities is essential. For example, a third party consortium in a public-private partnership would likely prefer a single point of contact in a city for both evaluation and payment. If that is impossible, having clear roles and responsibilities defined at the outset is one way to reduce perceived political risk.

On the revenue side, project financing is often based on public sector subsidies, user fees, and depending on the type of project, other cash flows, such as availability payments. By focusing on system financing, the RE.invest team identified sources of revenue that may be available to finance integrated resilient infrastructure systems.

1. Public Money

Traditional capital that can be used to cover infrastructure upgrades includes municipal, state, federal budget dollars through either tax income, public sector subsidies, user fees and depending on the system, availability payments or programs like the US EPA State Revolving Loan Funds for water and wastewater.

2. Grants

Given the social and environmental benefits from resilient systems, another source of project financing and revenue could be supported in part by grants from state, federal, non-profit, or philanthropic foundations funds aimed at supporting development of best practices and increased urban sustainability.

3. Aggregated User Fees

While traditional infrastructure upgrades are often covered by one set of user fees, wastewater fees cover wastewater treatment upgrades or tolls pay for toll-road upgrades, integrated resilient infrastructure systems allow for capturing multiple user fees to pay for the same projects. For example, if the city lays down porous pavement to both repave Main Street and increase stormwater absorption, the city then has the ability to capture some portion of the user fees associated with streets and transportation upgrades and wastewater/stormwater.

4. Aggregated Savings

Integrated resilient infrastructure upgrades create benefits that are distributed across sectors and both public and private entities. While the savings to one property owner or utility may not be sufficient to cover costs of large-scale system upgrades, the savings to a system en masse are likely greater. This is why the RE.invest team focused on identifying entities that are not only likely to save in the future based on upgrades but also

those entities that are currently losing significant amounts of money because of the system failures. For example, private property owners along most seaways are seeing their annual insurance premiums skyrocket because of an increase in predictable storms and flooding. An entire seawall system upgrade would significantly reduce those premiums but no single owner has the incentive to act alone. By upgrading the system as a whole rather than in pieces, the city can guarantee performance and more easily capture payments from sources like private property owner insurance savings.

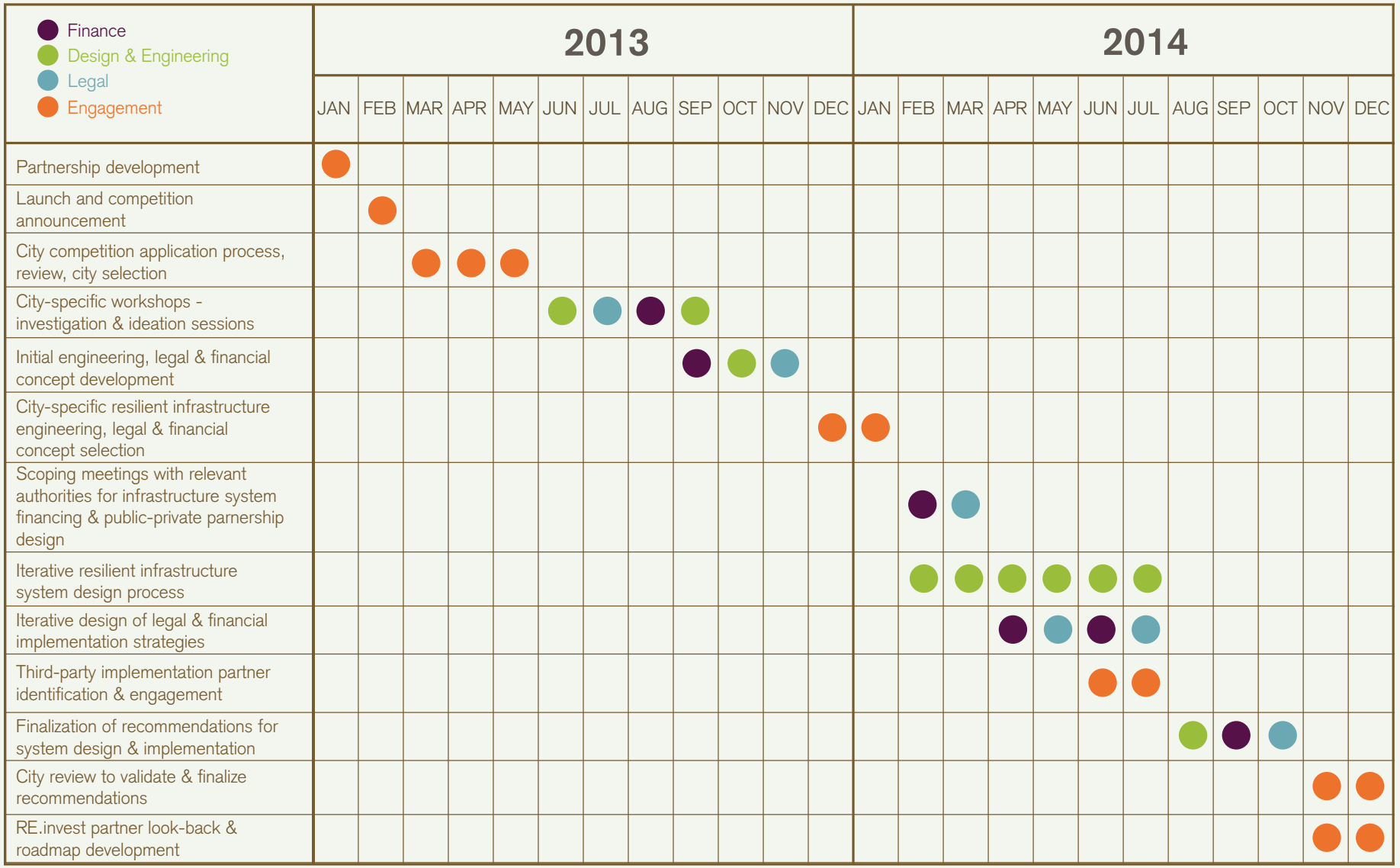
5. Corporate Fees

By focusing on system design, the RE.invest team actively identified ways to build in corporate sponsorship or leasing opportunities to supplement more traditional payback streams. For example, if the city lays down porous pavement to both repave Main Street and increase stormwater absorption, the RE.invest team will recommend laying down empty conduit in the process of construction. These proactive low cost upgrades to already planned projects could produce significant revenue through lease agreements with telecommunication companies that are looking to expand into key underserved markets and

All three of the building blocks described in this section encompassed a wide range of activities included in typical predevelopment processes. The innovation within the RE.invest predevelopment process was to ensure that all three were structured to maximize interaction among the engineering, legal and finance teams at strategic points of the conceptual design, cost estimation, schematic design development, and procurement planning processes. These interactions are described further in the next section. In addition to the design of all city specific projects and implementation strategies, all three teams of RE.invest experts—engineering, legal and finance—contributed insights and ideas towards reshaping the broader resilience predevelopment process.

TIMELINE

RE.invest was tightly structured around the three core activities and building blocks described above, but managed as a flexible and collaborative process to provide space for maximum creativity and innovation in the design process. Figure 4 (following page) summarizes the main activities and deliverables over the full two-year RE.invest process.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Partnership development
Launch and competition announcement
City competition application process, review, city selection
City-specific workshops - investigation & ideation sessions
Initial engineering, legal & financial concept development
City-specific resilient infrastructure engineering, legal & financial concept selection
Scoping meetings with relevant authorities for infrastructure system financing & public-private parnership design
Iterative resilient infrastructure system design process
Iterative design of legal & financial implementation strategies
Third-party implementation partner identification & engagement
Finalization of recommendations for system design & implementation
City review to validate & finalize recommendations
RE.invest partner look-back & roadmap development

Figure 4

49 A SYSTEMS APPROACH TO PREDEVELOPMENT

As described in the previous sections, predevelopment is a broad set of activities that range from generating ideas for new infrastructure projects to conducting the technical assessments required to ensure a project is viable for implementation. One of the major goals of RE.invest was to create a flexible process for predevelopment to generate innovative resilient infrastructure solutions.

The 6-step approach outlined below is the result of an iteratively refined set of activities the spanned the full two years of the RE.invest Initiative. These six steps are structured to take 18-months to 2-years from start (instigation) to finish (implementation/procurement). Each step is described in detail below and illustrated with specific RE.invest partner city examples.

STEP 1: INSTIGATE

Predevelopment can be reactive, in the wake of a disaster, or proactive, taking action before a disaster happens. The instigation process serves as a "pull mechanism" to draw forward a coalition of the ready and willing to conduct an efficient and tightly structured design process.

RE.invest was launched in January 2013 with a national competition that served as a 3-month "instigation" phase. After the initial announcement of the initiative, the RE.invest team issued an online call for expressions of interest from cities, followed by a formal application process. The application criteria set a very high bar for eligibility. Complete applications were required to include a letter from the mayor, background on the city's commitment to green and resilient infrastructure, examples of past public-private partnerships, and a statement that the city had (or could pursue) that relevant legal authorities to implement new public-private partnerships for financing cross-sector design solutions. By taking this approach, the application process itself offered a screen for "political will" one of the key barriers to resilient infrastructure investment identified by private investors. There were five key ingredients to the RE.invest instigation process.

First, cities were required to demonstrate a high-level of internal coordination. As part of the call for applications, several city agencies expressed strong interest in applying on behalf of their city, but were unable to produce a high-level commitment outside of their sector or "silo," making their applications ineligible. Without a strong basis for multi-department collaboration, the RE.invest approach to finding cross-sector design and finance solutions would fall flat. The structure of the instigation process helped attract the cities that were most likely to succeed.

Second, each city was required to identify two senior officials (one technical expert and one political/policy expert) to serve as points-of-contact for the RE.invest team for the full length of the initiative. Because these champions, who were already operating across city silos, were identified through the application process rather then designated afterward, cities could hit the ground running and open new doors to city-wide integrated planning and innovation.

Third, the call for applications included an option to submit supporting letters as part of the application package. This approach kick-started an early coalition-building and outreach process essential to the long-term success of RE.invest and identified important constituencies for the RE.invest team to work with over the course of two years on

contentious issues, such as, local procurement problems. The strongest applications included a wide cross-section of supporting letters from State and county officials, companies, NGOs, communities, and national organizations with specific examples of past collaborative programs or projects.

Fourth, the RE.invest team conducted extensive outreach through city organizations and associations, including the International City and County Management Association (ICMA), the Urban Sustainability Directors Network, Living Cities, C40 Cities, the Brookings Institution Metropolitan Policy Program, the US Green Building Council, and a variety of other institutions to share information and encourage cities to apply. Working with diverse city-focused organizations early in the process helped identify under-represented areas and interests and reveal potential barriers to participation.

Finally, the application process was deliberately structured around a very tight deadline (6 weeks) to pull forward those cities that could act most quickly and effectively to coordinate across city departments and agencies and secure a high-level commitment to participate in a long-term resilience planning and finance effort.

The RE.invest approach to instigating a predevelopment process with a competition was a deliberate effort to create a “pull mechanism” rather than traditional push mechanisms, such as regulations, codes, or mandates. System-wide resilience is not something that can be easily required by laws, which typically need to be very specific in order to be enforceable. Telling a city to be more resilient is a bit like telling them to do more or be better. Easily agreed in principle, but too generic to execute in practice.

Making system wide resilience improvements requires creativity and flexibility to identify diverse opportunities and solutions. As a result, creating a strong pull mechanism through the RE.invest competition helped draw forward a coalition and lay a strong foundation for an efficient and tightly structured design process.

STEP 2: INVESTIGATE

The investigation phase of the resilience predevelopment is designed to engage partners in gathering relevant baseline data, identifying key resilience challenges and priorities, and revealing critical data gaps for further data collection, research, and/ analysis.

Following the close of the RE.invest competition (instigation phase) in May 2013, over the course of the next three months, the RE.invest team coordinated 2-day workshops and site visits with all eight partner cities. The core team met with local officials to discuss the infrastructure needs, challenges, and priorities. These visits were carefully structured to build on the key resilience issues already

identified through the RE.invest national competition and application process. Through a set of city-wide meetings, the RE.invest team examined the on-the-ground implications of these challenges and explored how multiple problems could be addressed through common solutions.

The team engaged directly with mayors and municipal leaders in a workshop-style facilitated discussions to understand which existing infrastructure systems were failing, which ones were most expensive for the city to operate and maintain, which needs were unmet or unaffordable given current budget realities, and what system improvements could create both economic and political value. In some cases, this process revealed different challenges than the RE.invest team (and sometimes even city officials) initially identified or anticipated. For example, in their original applications, most cities identified flooding—caused by increasing intensity and frequency of storms, sea-level rise, and tidal surges—as their primary resilience challenge. However, through discussion and observation, the team found that several of cities had failing sea walls and lacked stormwater backflow prevention valves, which contributes to local flooding, where seawater pushes into city sewers during high tides.

Similarly, these working sessions revealed other high-priority issues that were not initially viewed as traditional resilience challenges, such as greater risk of mosquito breeding and infectious disease. During the New Orleans kick-off meetings, a multi-agency discussion resulted in an unexpected insight (and immediate coordination) on mosquito control issues related to a new green infrastructure building code.

The team also found that multiple partner cities had common priorities that emerged through discussion, including expanding the use of recycled water to reduce pressure on freshwater resources, diversifying and improving energy system reliability, and integrating smart meters and other technology upgrades to improve system efficiencies. In the process of bringing forward these additional priorities, the RE.invest team was able to build a more comprehensive picture of each city's current and future needs, and also identify different constituencies who could financially benefit from cross-cutting resilience solutions.

For example, Honolulu noted that any infrastructure system improvements linked to the city's high-speed rail line would not only help access Transit-Oriented Development (TOD) financing, but would also build significant political support. Milwaukee identified a specific site, where severe flooding issues were hampering economic development in an area with some of the city's most economically disadvantaged communities. Based on those discussions with Milwaukee, the RE.invest team shifted its focus to target system upgrades along the 30th Street Corridor.

By engaging city officials in intensive brainstorming conversations, the RE.invest team not only created strong relationships and trust, but perhaps more importantly, all participants built a shared broader understanding of how integrated solutions could meet multiple interests in each local context. These initial kick-off meetings laid the foundation for collecting qualitative and quantitative baseline data and putting forward non-traditional ideas and collaboratively designing solutions that were innovative yet realistic for each city.

STEP 3: IDEATE

The ideation process is a creative exercise that typically involves reframing existing questions from different angles and bringing together and testing various combinations of existing ideas across disciplines, sectors, or geographies to reveal new connections or otherwise unrecognized risks and opportunities.

Early in resilience predevelopment processes, local leaders often need a thought-partner to frame (or in many cases reframe) their greatest resilience challenges. Public officials are regularly confronted with symptoms of a chronic problem, but few ways to identify or address an underlying condition. For example, a city facing regular flooding and exploring green infrastructure solutions may need to "zoom out" to address issues associated with failing seawalls for maximum benefit. In order to help tackle systemic issues and create short-term wins in a long-term strategy, the RE.invest team served as an innovation and brainstorming partner to frame key questions and help partner cities identify catalysts for action across sectors. By inviting local officials out of their traditional planning silos, the RE.invest team helped connect the dots between ongoing priorities, budget constraints, and long-term goals to identify new opportunities for resilience investment.
After an initial period of data review and preliminary analysis, the RE.invest team worked with each partner city to generate a broad set of ideas that could help solve a major challenge. Often the opportunities for innovation were greatest at the seams of two or more sectors, such as water and energy efficiency solutions.

After each city visit, the RE.invest team engaged in an intensive data gathering exercise to assemble engineering, legal and financial data from and about every partner city. In reviewing existing city infrastructure gaps; current construction, operations, and maintenance expenditures; funded projects and future development plans, the team looked for "seams" or gaps in each city's infrastructure systems that could create previously unrecognized risks and opportunities. For example, in areas where a city water authority is the largest electricity consumer, how could improvements in energy-intensive water system operations (e.g. pumping and treatment) benefit local electric utilities and create opportunities for co-financing?

In other cases, idea generation focused on bringing together two or more priorities identified by a partner city. For example, El Paso noted that sustainable access to potable water would continue to be the city's greatest resilience challenge. The city also prioritized waste and energy system upgrades. To integrate these priorities, the RE.invest team developed a set of ideas that combine recycled water treatment, desalination, and renewable energy at specific sites to reduce pressure on local aquifers for freshwater withdrawals and expand the use of waste-to-energy systems to reduce the costs of desalination. Similarly, New Orleans initially focused on implementing the green infrastructure aspects of their Greater New Orleans Water Management Strategy, but later expanded their priorities to encompass the city's significant

IT system needs, including streetlight upgrades. This broader problem framing led the RE.invest team to generate ideas on integrating broadband upgrades with leakage monitors/sensors to improve and capture water system efficiencies.

STEP 4: ITERATE

The iteration phase of predevelopment is where ideas transform from a vision to a project. This process is especially critical to refine resilience projects, where changes in one part of a system can result in complex interactions within and between other parts of a system.

The city-specific solutions described in the next section are all the result of an iterative ideation process. Upon completion of a comprehensive ideation process, the RE.invest team focused on refining each potential option to eliminate technically or financially unrealistic ideas and elevate actionable projects. The team did this by engaging engineering and design, policy, and finance experts in multiple collaborative discussions to rework, recombine, and revise different project features. Each iteration brought the project designs to a greater level of detail to continuously assess and compare the viability and feasibility of different solutions. For example, as the integrated design solution for the City of Hoboken took shape, the iteration process involved multiple working discussions with local officials, the water and sewer authority, and other local technical experts to evaluate different configurations and sizes for a parking garage, stormwater detention chamber, and package of green infrastructure. The resulting design options ranged from a two- to four-level underground structure with 300-1200 parking spaces and 10-40 million gallons of water storage capacity. Iteration is the "rinse and repeat" phase, as it often takes a few cycles to identify and refine solutions to the point where they are both transformational and pragmatic.

STEP 5: INTEGRATE

Resilience predevelopment is inherently cross-sectoral. Integration is the process of creating design solutions and collaborations where the whole is greater than the sum of its parts.

Cross-sector integration is an inherent element of any resilience ideation and design process. In the context of predevelopment, however, integration has broader value and importance. Ensuring that projects are not sliced and diced into their component parts is essential for designing and building resilient systems where the whole creates more value than the sum of the parts. The integration phase of predevelopment focuses on the engineering, legal and financial

elements of the project and process that can ensure system integrity. This approach is more similar to planning for an entire Olympics than designing a single stadium. For the former, the system only works if the investments in the airport, roads, and stadium all go forward in concert with one another. Simply building one piece of the system does not meet the overarching need.

The RE.invest design proposal for Hoboken is an example of where a systems approach produced an integrated design solution and a cross-sector financing strategy to bring in parking fees to complement traditional water system funding. Similarly, the innovation park design concept focused on streamlining cities' access to technologies that can improve system performance rather than one-off projects.

Creating an actionable roadmap for moving from conceptual to schematic design involves a careful consideration of relevant policy constraints, partnership options, legal structures, financing models. Integration is the key step in transforming an idea into a viable project.

STEP 6: IMPLEMENT

The end goal of any predevelopment process is to lay a strong foundation for long-term construction and operation. This phase is where the design process meets political implementation processes (e.g. public procurement, public-private partnership, etc.).

Implementing any infrastructure project is a long-term undertaking. This is especially true in the case of resilient systems, where long-term operations and maintenance over the lifetime of a complex system can be as important and costly as construction. That said, there are steps that can be taken to increase the likelihood of success of any given project. This last phase of the RE.invest predevelopment process focused on creating a clear procurement and financing strategy. The RE.invest legal team crafted locally relevant options for public-private partnerships that would ensure system integrity in the project delivery cycle. The team also worked with each partner city, as appropriate, to develop a strategy or specific procurement documents, such as Requests for Information (RFI), Qualifications (RFQ), or Proposals (RFP).

There is no single recipe or one-size-fits-all approach to implementing a resilient infrastructure project, but thinking big and taking an implementation approach that resembles an Olympic bid—with lots of different project components that all need to be completed as part of an overall strategy—can help a local leader or project champion keep all the pieces and parts of a project together over time.

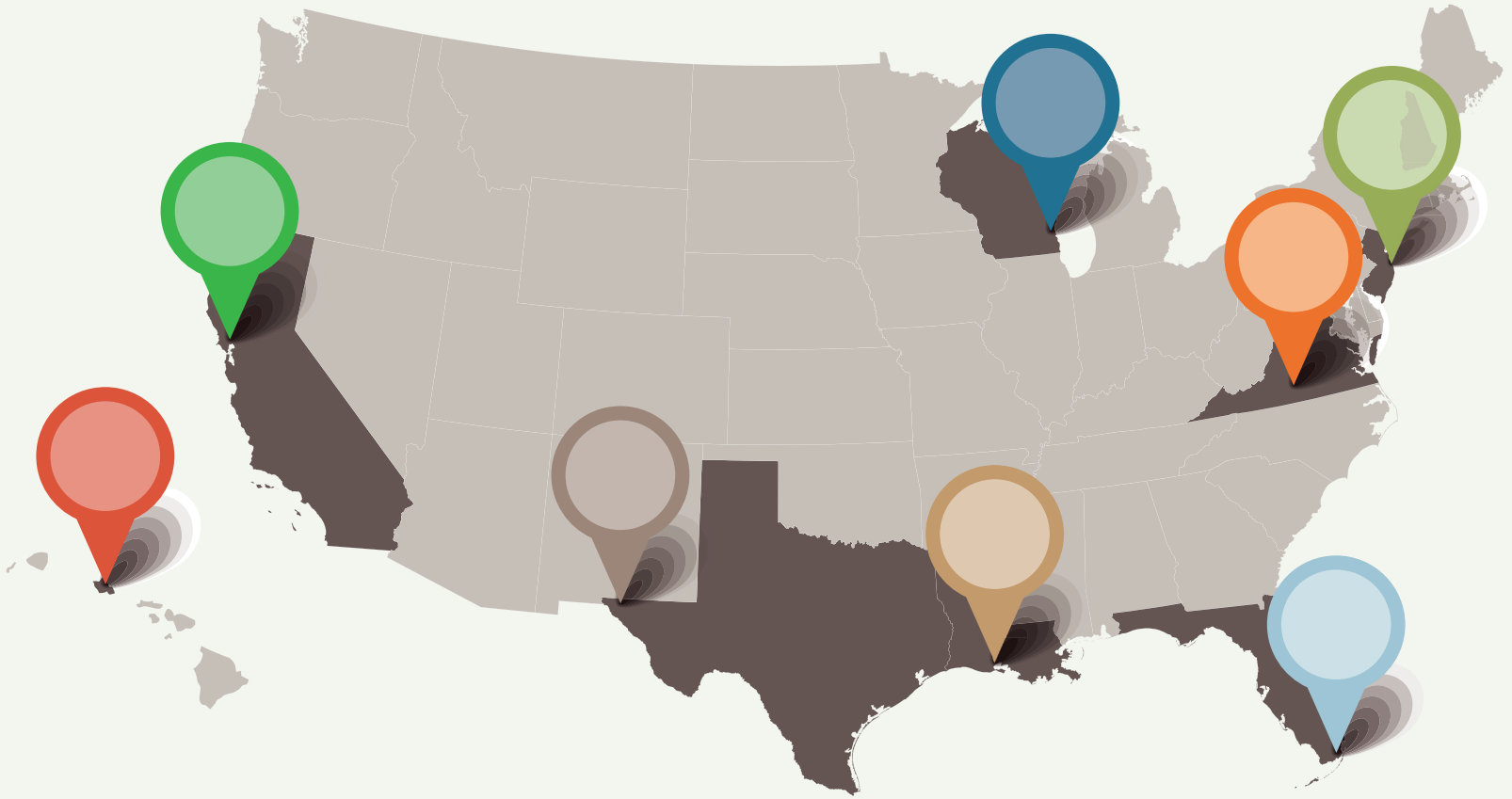
56 PARTNER CITY SOLUTIONS

Using the 6-step predevelopment process described in the previous section, the RE.invest team worked with each partner city to develop a set of design and financing solutions intended to creatively address multiple local resilience challenges simultaneously. The resulting projects combined elements from across sectors and were developed with near-term financing and implementation in mind.

Together they represent a set of market-tested technologies and services that can be mixed-and-matched in new combinations to meet individual city needs and generate greater benefits than traditional infrastructure projects.

In the process of developing the following city-specific projects, the RE.invest team identified six general strategies for targeting cross-sector infrastructure upgrades that can be used by any city to instigate their own investigation and ideation processes. These strategies are summarized in the engineering building block section (see pages 39-41) to serve as inspiration for project developers, planners, and local officials.

For more technical readers or readers interested in specific local issues, a separate in-depth report on each partner city solution described in this section can also be found at www.reinvestinitiative.org.



- El Paso
- Hoboken
- Honolulu
- Miami Beach
- Milwaukee
- New Orleans
- Norfolk
- San Francisco

EL PASO, TX

INNOVATION DISTRICT + DESALINATION + RENEWABLES

Population: 649,121 (2010 Census)
Area: 255.3 sq. mi.

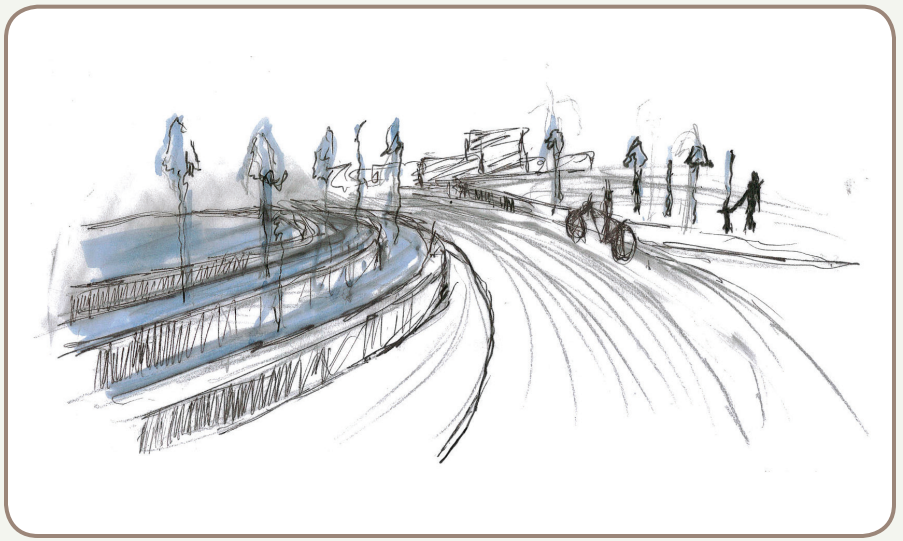
El Paso is located in far west Texas, bordering Mexico and New Mexico, and is known for being a leader in international trade serving as a major shipping thoroughfare. In recent years, the City has worked to focus more strategically on long term urban resilience, for example, by instituting a water conservation ordinance that limits lawn watering, a bike-share program, and other social resilience efforts.

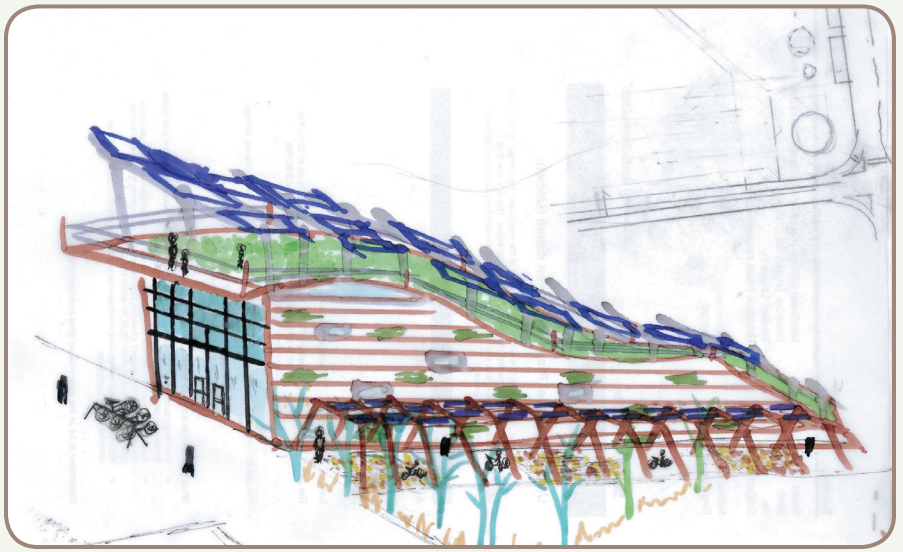
Existing Land Use Plan

The Challenge

With only 8.4 inches of rain per year on average, El Paso has become a national, and international, leader on water reuse and conservation practices. The City of El Paso is also in the midst of an exciting revitalization. The City has increased investments in green and sustainable programs, expanded incentives for productive industrial and commercial development, and recently announced a new Clean Energy Incubator hosted by the University of Texas at El Paso.

Looking to build on local economic development momentum, the City has identified an area that was recently rezoned through the City's SmartCode Title 21, which enables and incentivizes walkable, mixed use, and compact places to serve as an innovation district. Based on the Airport's master planning efforts, the proposed innovation district can integrate space for commercial, retail and hotel use with office and industrial development, open park space, and a Science and Technology Park to facilitate testing and evaluation of defense related products. In addition, the area is co-located with the El Paso Water Utility Desalination Plant, featuring an interactive TecH20 educational center and a planned brine treatment facility that would treat and prepare the concentrate produced from the desalination process for sale.



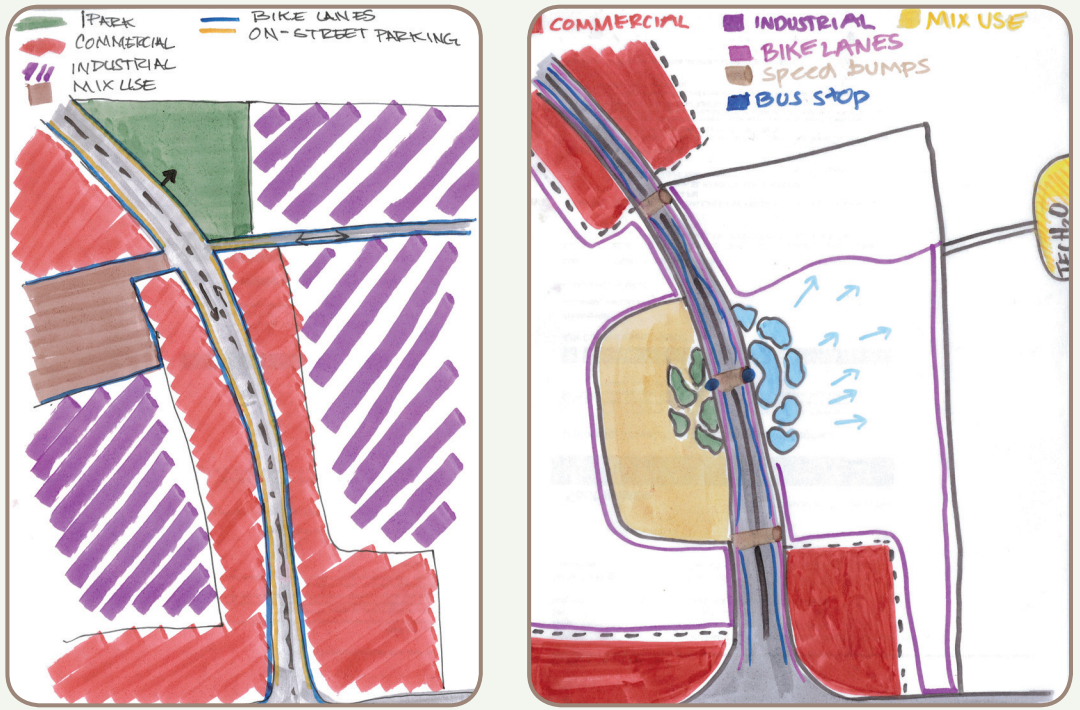


Texas Tech University College of Architecture
Innovation Park Design Charrette Drawings

The RE.invest Solution

Currently, municipal governments lack access to best-available technology based on limited opportunities to “try before buying” through conventional procurement processes. At the same time, innovative companies face multi-year permitting and review processes, and because of these transaction costs often avoid communities that have the greatest infrastructure upgrade needs.

To catalyze innovation district development in the short-term, the City can collaborate with local and national partners to design a series of park-lets that feature demonstration space for innovative water and energy nexus technologies. In doing so, the City of El Paso can engage the public in broader innovation district development, encourage public-private partnerships and economic development; educate residents and businesses; and train students in cutting-edge technologies.



Texas Tech University College of Architecture
Innovation Park Design Charrette Drawings

Innovations

- Leverage underutilized parcels of land for outdoor museum-style technology demonstrations and exhibits
    - Test renewable energy systems that could decrease the high electricity costs of inland desalination
    - Feature green infrastructure and flood management technologies to increase regional uptake of best management practices
    - Enable better environmental performance data collection from in-situ installations

- Incentivize corporate investment in local resilience building and catalyze local economic development by creating new innovation districts
    - Leverage planned development and public expenditures on green and open space to generate greater private investment interest in the region
    - Connect local procurement decisions to global innovation in environmental technology markets
    - Use innovative contracting structures to ensure that corporate demonstrations generate public benefits and revenues, as allowed under local procurement rules and regulations

"We are honored and excited to work toward a more sustainable future for the City of El Paso. As our community continues to grow and evolve, it is imperative that we give the utmost attention to designing, developing and financing these initiatives to ensure the economic viability of this city."

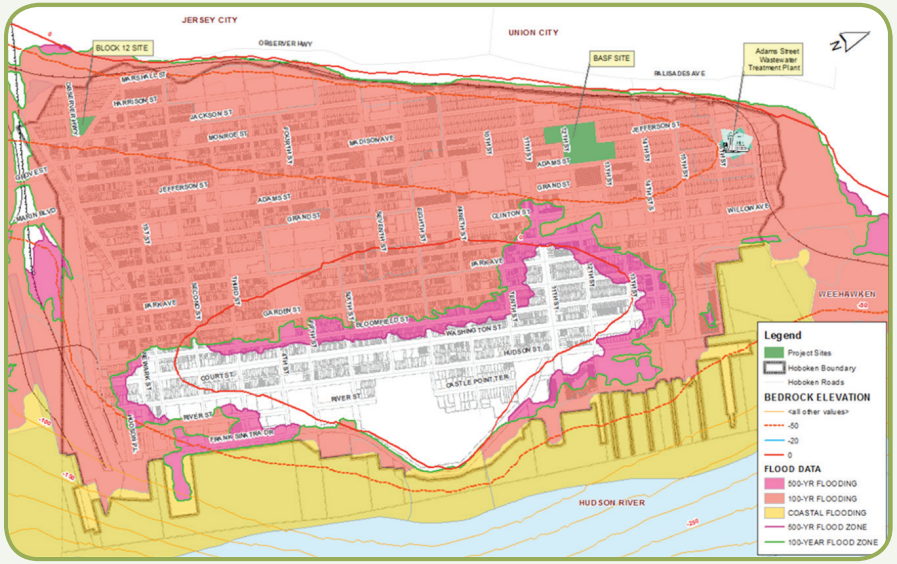
Mayor John Cook (May 2013)
City of El Paso

HOBOKEN, NJ

STORMWATER STORAGE + PARKING + GREEN INFRASTRUCTURE

Population: 55,000 (2010 Census)
Area: 1 sq. mi.

Hoboken is a riverfront community prone to flooding when heavy rain events coincide with high tides. The City has several interrelated challenges including local flooding, aging infrastructure, and an overflowing combined stormwater and sewer system–all of which are exacerbated by increasing storm frequency, greater storm surges, and rising sea levels.



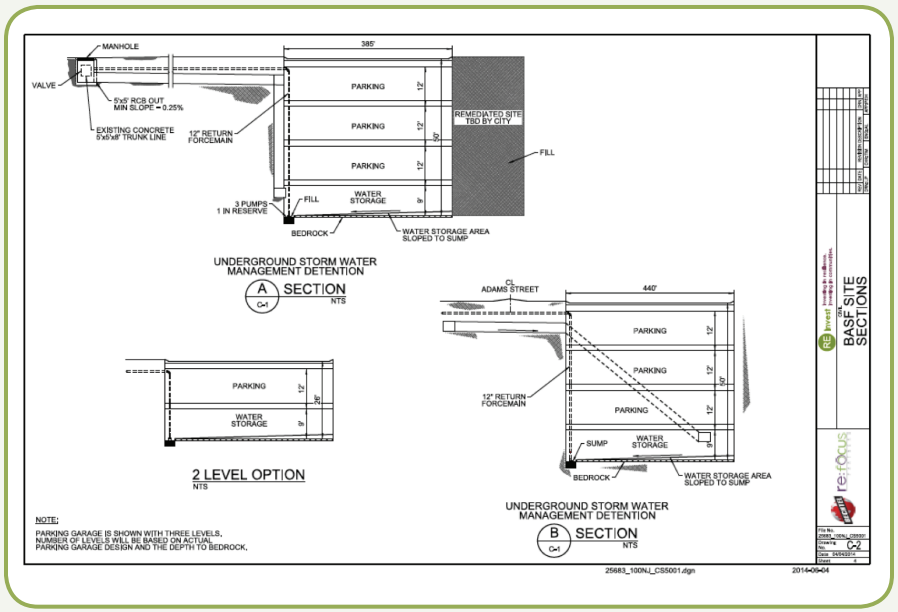
Hoboken Flood Map & Depth to Bedrock

The Challenge

Hoboken is among the older US cities with historical infrastructure dating back to the mid-1800s. The City is prone to flooding due to its coastal location on the Hudson River, low topography, the prevalence of impervious surfaces (more than 75% of the City is paved or covered with non-porous materials), and its relatively undersized combined sewer system infrastructure designed to collect rainwater runoff, domestic sewage, and industrial wastewater in the same system of pipes. In 2012, the storm surge from Superstorm Sandy affected most low-lying areas of the city with some areas inundated with 4-6 feet of flood water.

In addition to flooding challenges, open space and parking are at a premium. According to Census data, the population of Hoboken grew by 36.3%, or more than 10,000 people, from 2000 to 2010. With development plans including 10,000 units of new housing over the next 10 years the number of cars and therefore demand for parking options will only increase.

In Fall of 2014, The US Department of Housing and Urban Development (HUD) published a notice in the US Federal Register officially allocating $230 million to the state of New Jersey for the Resist, Delay, Store, Discharge project developed for Hoboken, Weehawken, and Jersey City. The flood prevention proposal, produced by a team for firms led by the Office for Metropolitan Architecture (OMA), was one of seven to win funding through the Rebuild by Design competition. Over the coming years, the City intends to leverage these federal funds to support a comprehensive set of projects to support green and grey coastal defense projects (resist); policies to enable the urban fabric to slow down water run-off (delay); a green circuit to trap water (store), and pumps to support drainage (discharge).



BASF Site Sections Highlighting Various Scenarios

Storm Depth (inches)	Storm Categorization	Storm Volume (MG)	Adjusted Volume (MG)*
2.41	1-Year	3.2	4.0
2.92	2-Year	3.9	4.9
3.69	5-Year	4.9	6.2
4.33	10-Year	5.8	7.2

Table 1 - Summary of Contributory Stormwater Runoff Volume

The RE.invest Solution

In Hoboken the RE.invest team worked to design a shovel-ready flood management project to help fulfill part of the “store” component of the Rebuild By Design strategy. To this end, the City identified a 6-acre former industrial parcel (brownfield) currently owned by BASF for the RE.invest team to explore design and financing solutions for localized flooding challenges. The RE.invest team proposed a combined surface and sub-surface plan to cover 4 contiguous acres of the broader 6-acre BASF site that would include a stormwater detention facility, underground parking garage, and surface park space with green infrastructure.

Scenario	Total Price ($M)	Excavation (CYD)	Excavation (CYD)	Waterproofing (SFT)
4 Levels Parking	114.9	314,202	68,902	252,269
3 Levels Parking & 1 Level Storage	117.3	314,202	69,811	252,269
2 Levels Parking & 2 Levels Storage	125.4	314,202	83,193	252,269
1 Level Parking & 3 Levels Storage	131.2	314,202	96,501	252,269
Smaller Scenarios				
1 Level Parking & 1 Level Storage	85.7	188,521	188,521	252,269
2 Levels Parking & 1 Level Storage	102.7	238,793	238,793	252,269
1- story Water Retention Only (1MG)	12.8	-	-	-
1- story Water Retention Only (5MG)	26.7	-	-	-
1- story Water Retention Only (10MG)	47.3	-	-	-

Table 6 - Subsurface Site Construction and Operating Costs (Part 2)

Innovations

- Design a multi-purpose infrastructure system that combines:
    - An underground parking garage
    - A sub-surface stormwater detention chamber
    - Surface recreational areas with green infrastructure for stormwater capture
- Optimize and scale total project size to match local parking demand and stormwater capacity needs
- Integrate design and construction planning to enable capture of multiple revenue streams for project payback, such as:
    - CSO Capacity Payments – Fees and/or Long-Term Lease Agreements
    - Parking Revenues – Rates and/or Long-Term Contracts
    - Avoided Flood Damages – Reduced damages and/or insurance premiums
- Assess potential "avoided losses" and savings due to both physical and financial risk reductions to support new financing mechanisms

"We were thrilled to be one of the first cities in the country chosen for this innovative partnership to develop sustainable solutions that address our flooding, transportation and other infrastructure challenges. The tremendous technical and financial guidance provided through the RE.invest Initiative helped Hoboken envision specific projects to build a more resilient community."

Mayor Dawn Zimmer (May 2015)
City of Hoboken

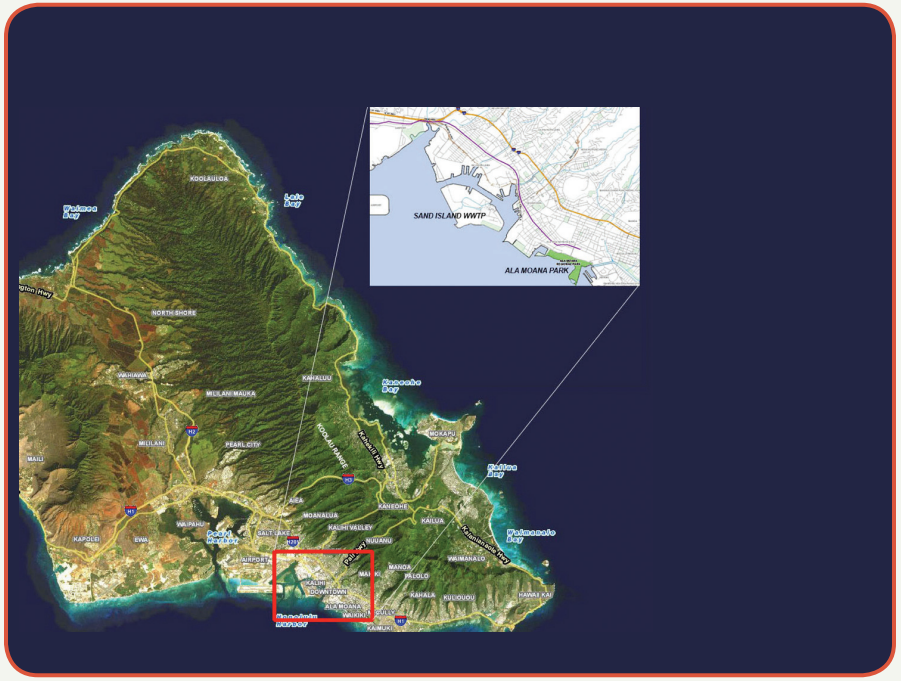
HONOLULU, HI

RECYCLED WATER + PARK IRRIGATION + TOD

Population: 390,738 (2010 Census)
Area: 68.4 sq. mi.

Although the name "Honolulu" refers to the urban area on the southeastern shore of the island of Oahu, the city and county are consolidated as Honolulu County, which covers the entire island.

The Board of Water Supply (BWS) is responsible for supplying water to the island of Oahu, and through a 2010 US EPA consent decree the City agreed to expand recycled water in addition to upgrading its wastewater collection and treatment systems more broadly.

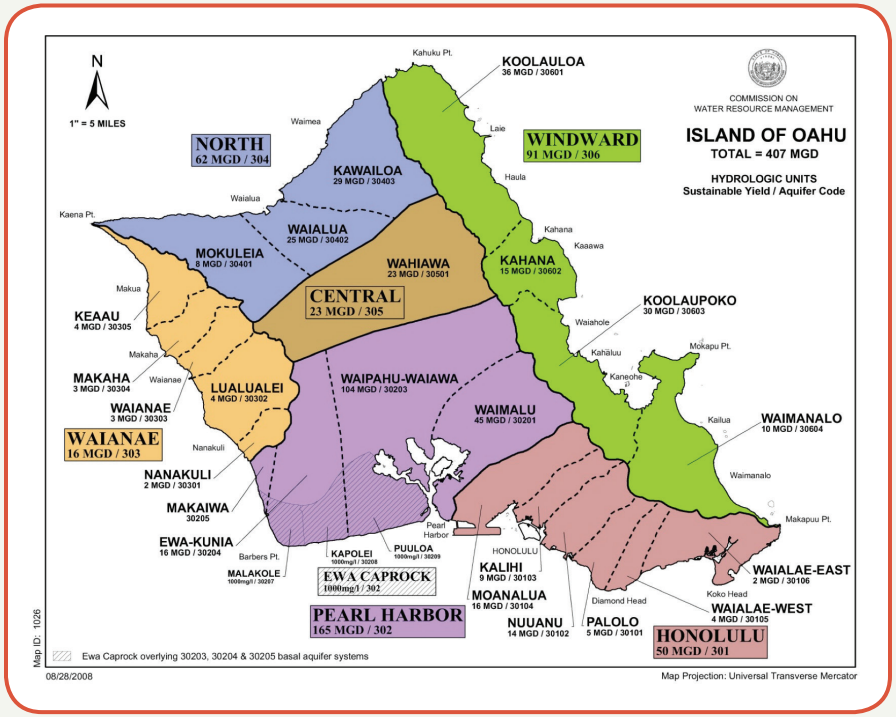


Island of Oahu (Source: HoLIS, DPP)

The Challenge

The City and County of Honolulu's level of water consumption from the Honolulu aquifer is close to its sustainable yield. As a result, Honolulu's biggest future challenges are meeting demands of anticipated growth, adapting to climate change, and providing a clean, safe, and reliable long-term water supply.

To be successful, the City needs to continue developing and implementing diversified approaches to conservation and efficiency. Honolulu has progressively identified multiple water recycling strategies that provide a series of environmental benefits, including reduced withdrawals, reduced discharges, and expanding the City's long-term sustainability and resilience to climate changes. But the City cannot solve this long-term resilience challenge on its own. Beyond environmental benefits, recycled water use can also provide savings on water and energy bills system-wide and for individual property owners.

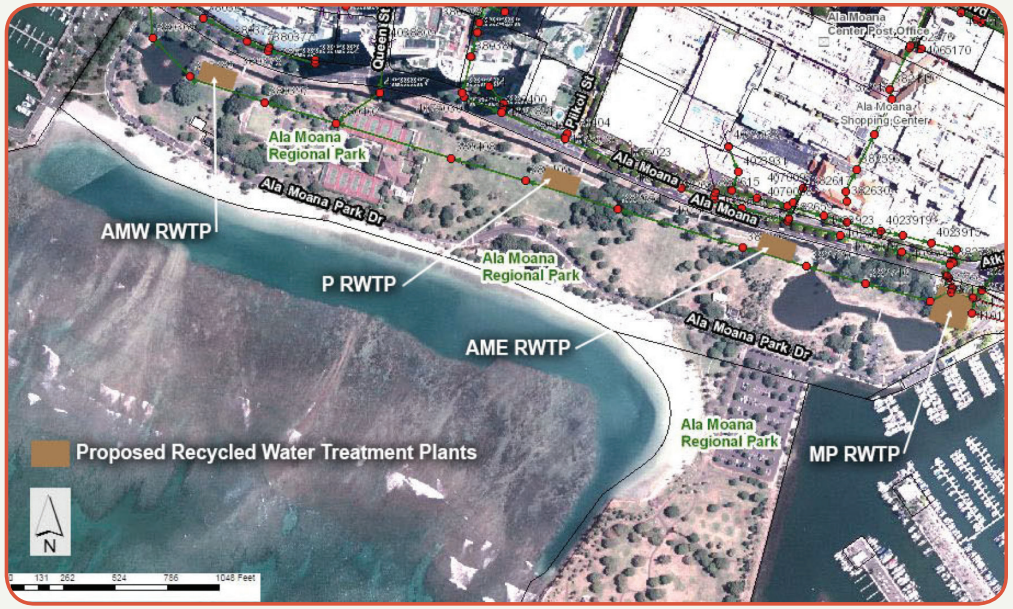


Oahu Hydrologic Units (Source: Commission on Water Resource Management, State of Hawaii)

The RE.invest Solution

The City identified Ala Moana Park and the broader Ala Moana transit oriented development neighborhood as areas that could serve as anchors for deploying distributed recycled water systems as a part of broader sustainability efforts.

In Honolulu, the RE.invest team focused on recycled water solutions to reduce or replace the use of potable water for irrigation of Ala Moana Regional Park. Beyond site-specific recommendations, the RE.invest team also focused on providing integrated analysis and recommendations to help the City of Honolulu promote privately owned recycled water systems in the Ala Moana transit oriented development (TOD) neighborhood and beyond.



Ala Moana Regional Park and Proposed Recycled Water Treatment Plants (Source: HoLIS, DPP)

LIVING MACHINE PLANT	CAPACITY GPDC	APITAL COST	ANNUAL O&M COST	POTENTIAL SAVINGS
Ala Moana West RWTP, Piikoi RWTP, Ala Moana East RWTP	80,000	$1.6-2.0M	$0.05M	$120,000—$150,000 $/yr
Moana Park RWTP	240,000	$3.1-4.0M	$0.12M	$530,000—$590,000 $/yr
MBR Plant	CAPACITY GPD	CAPITAL COST	ANNUAL O&M COST	POTENTIAL SAVINGS
Ala Moana West RWTP, Piikoi RWTP, Ala Moana East RWTP	80,000	$1.7-2.2M	$0.07M	$98,000—$130,000 $/yr
LIVING MACHINE PLANT	CAPACITY GPD	CAPITAL COST	ANNUAL O&M COST	POTENTIAL SAVINGS
Moana Park RWTP	240,000	$2.9-3.8M	$0.15M	$515,000—$570,000 $/yr

Table 5. Recycled Water Treatment Plant Options for Ala Moana Regional Park

Innovations

- Explore innovative recycled water treatment options for park spaces, individual buildings, or co-located buildings within a city block based on system-wide energy and water savings from reduced pumping and leakage

- Create incentives for local government agencies to actively support the development of privately-owned recycled water systems
    - Clarify in statute that recycled water produced on-site can be sold to adjacent properties and/or that the City will credit recycled water producers/consumers for reducing the quantity of wastewater that must be treated by the sewerage system
    - Structure a pooled fund, using energy efficiency retrofits as a model, to help provide financing for distributed recycled water treatment
    - Partner with technology firms and local businesses to collect baseline data and analyze projected efficiency benefits and savings from recycled water to reduce transaction costs for private developers

"Honolulu is investing in important infrastructure upgrades to make our island home more sustainable and improve the quality of life for our residents and visitors. We're committed to improving our mass transit and energy options, roads, sewers and water pipes in ways that help protect the environment and prepare for the future. We're pleased to be selected to participate in the RE.invest Initiative and look forward to their assistance and support in working towards our mutual goals."

Mayor Kirk Caldwell (May 2013)
City of Honolulu

MIAMI BEACH, FL

SEAWALL RETROFITS + FLOOD MANAGEMENT

Population: 87,779 (2010 Census)
Area: 18.7 sq. mi.

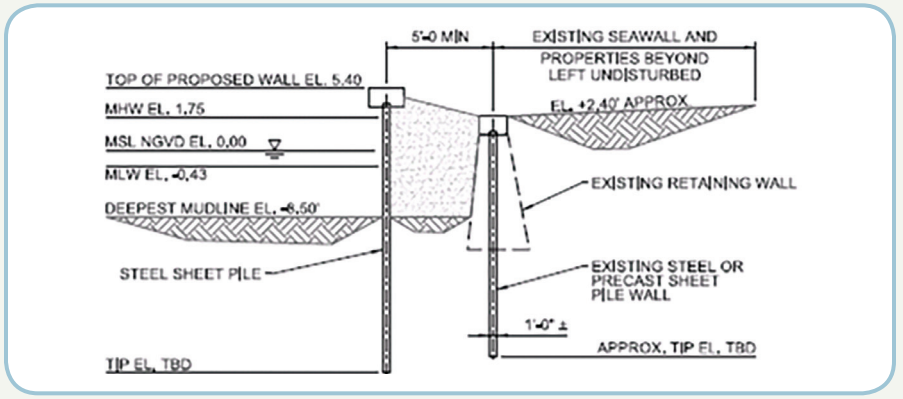
Miami Beach is a coastal city in Miami-Dade County, Florida located on a series of natural and man-made barrier islands between the Atlantic Ocean and Biscayne Bay, the latter separates the Beach from Miami city proper.

Along the bayside and canals, the City is supported by 63 miles of seawall, of which only 3 miles are publicly owned. To date nearly all of the seawalls have been deemed structurally deficient.

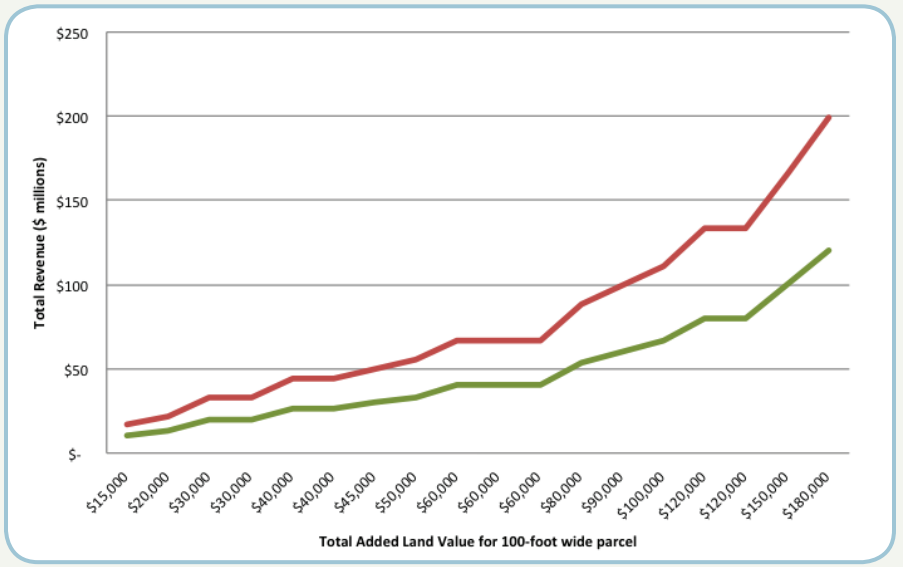
The Challenge

Cities across the country are seeing seawalls designed to protect communities against historical tides, regularly breached by new higher tidal surges - resulting in significant coastal erosion and property damage. Given the already measurable sea-level rise in cities like Miami Beach, and anticipated increases in storm frequency and intensity, existing seawalls need to be upgraded to provide adequate protection from high tides, storm surges, and salt-water intrusion in coming years.

Despite the widely recognized need for city-wide upgrades, cities like Miami Beach face significant challenges in mobilizing resources for such large-scale infrastructure investments. Another key barrier to action is that most seawalls are privately owned and managed by hundreds of individual coastal property owners.



Sheet Pile Wall



Potential Total Revenue from Additional Taxable Property

Property Tax Rate $6.025 per 1000$ assessed value

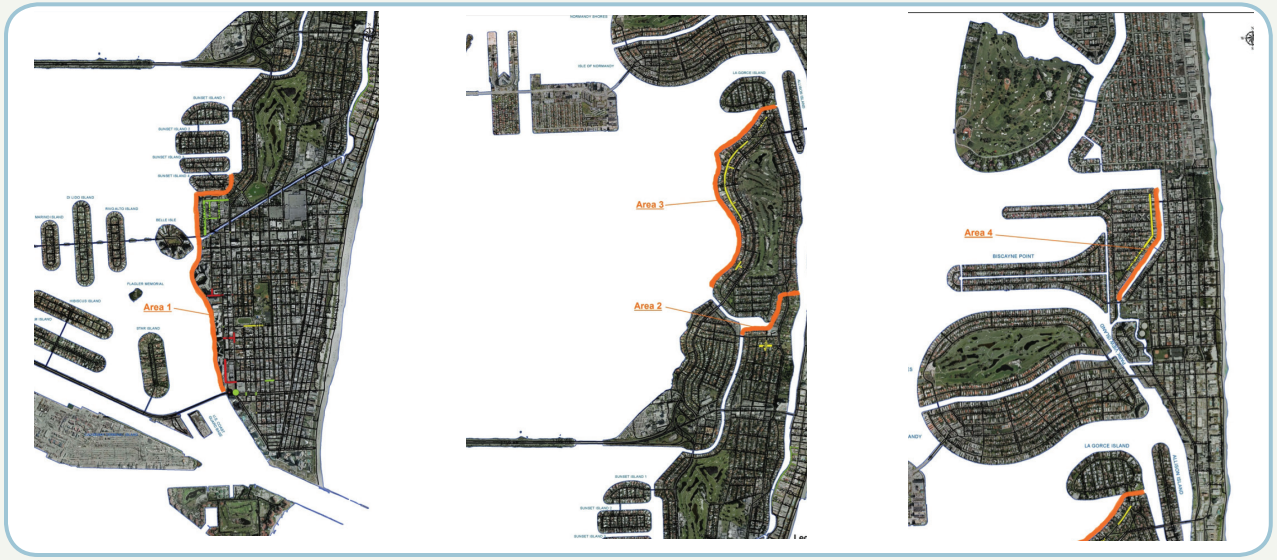
Property Tax Rate $10 per 1000$ assessed value

The RE.invest Solution

In Miami Beach, RE.invest focused on designing a comprehensive seawall upgrade plan and flood management approach to improve coastal protection for the city.

The proposed engineering solution included a new seawall to be constructed on the outside of the existing seawall. The new wall also integrates a barrier system to better manage subsurface hydrological flows. Because the proposed solution is based on adding new walls and land to each waterfront property, the additional square footage could generate additional property tax revenue. The resulting structure would also create insurance benefits for waterfront property owners and those further inland by limiting erosion, property loss, and flood and storm related risks and damages.

In addition to these structural design options, the RE.invest team also developed strategies to improve real-time hydrological data collection and expand property-level loss and damage data collection to enable new savings-based financing options.



Tidal Flood Areas (Source: Miami Beach GIS)

Innovations

- Design a multi-purpose infrastructure system that combines:
  - Seawall reinforcements to reduce erosion and tidal flooding
  - Subsurface hydrological management systems to limit saltwater intrusion and groundwater related flooding

- Consider financing options, such as tax-increment finance (TIF) or special assessment districts, designed to capture real estate value increases, based on the construction of a new wall on the outside of any existing seawalls and the resulting addition of land to associated waterfront properties

- Calculate "avoided losses" and potential financial savings due to both physical and financial risk reductions created by new coastal protection measures

- Partner with technology firms and local businesses to crowd-source data on unreported losses, such as flood damages or mold clean-up, to quantify potential savings and monetize projected benefits to accrue to residents and small businesses

"We are honored and excited to work toward a more sustainable future for Miami Beach. Miami Beach faces unique challenges in protecting ourselves from storms and surges, and we look forward to being a part of the RE.invest Initiative to provide a better future for our residents."

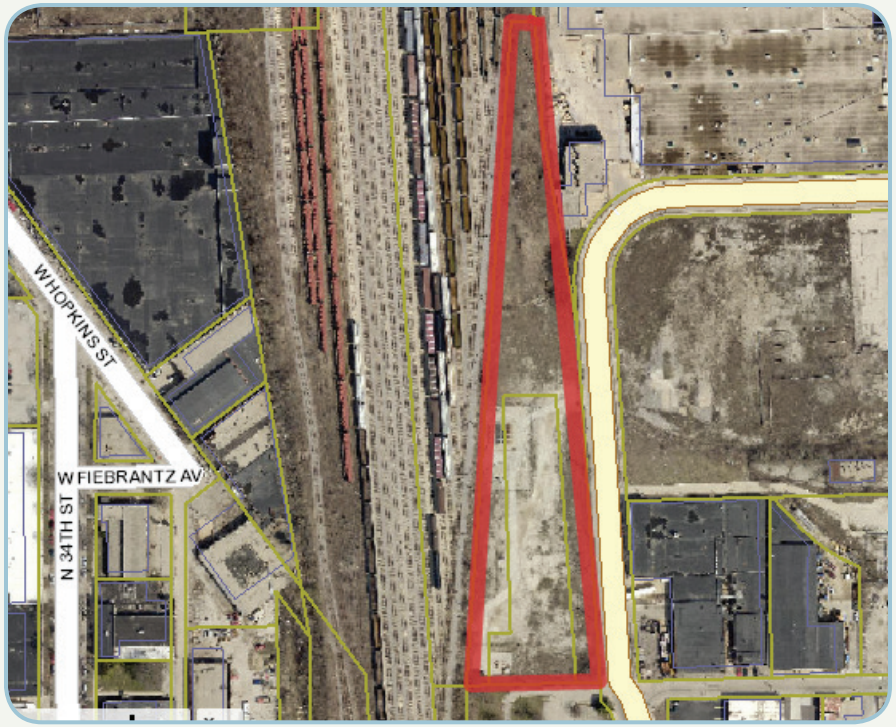
Mayor Matti Herrera Bower (May 2013)
City of Miami Beach

MILWAUKEE, WI

INNOVATION PARK + ECONOMIC REDEVELOPMENT

Population: 594,833 (2010 Census)
Area: 96.8 sq. mi.

The City of Milwaukee is in the midst of an ambitious effort to transform the 30th Street Industrial Corridor into a major modern employment center and economic hub. The 30th Street Industrial Corridor encompasses 880 acres with some 518 acres that are zoned for industrial use. The area's decline in the post-industrial economy and housing crisis of 2008 made it a focal point for redevelopment under Mayor Tom Barrett.



30th St Corridor Map

The Challenge

Building on its legacy as an industrial center for water and power companies, Milwaukee has prioritized investment in these sectors as part of revitalizing Milwaukee's 30th Street Industrial Corridor intended to serve as hub for the City's economic future. Catalytic development efforts include the Century City I and II business parks, new single and multifamily housing at Esser Paint, and a $100 million Greenway and Gateway project. Other private sector investments include the proposed development of a STEM high school and the Mid-West Energy Research Consortium's (M-WERC) Energy Innovation Center—an incubator focused on bringing energy-centric entrepreneurs to the region—are aligned with the City's goal to create a regional ecosystem of development and innovation.

The City of Milwaukee recognizes that redevelopment of the 30th Street Industrial Corridor must go beyond building business parks to attract tenants. Any long-term development strategy must also include systematic support for local workforce development and a transition plan for the nearly 100 acres of abandoned and blighted properties in the area.

DESIGN ELEMENT	CONSTRUCTION COST ($)	
4131 & 4101 N 31st ST		
Site Preparation and Remediation		
Mobilization		1,300
Paving, Landscaping, Drainage & Bioswales		
Site Grading		101,000
Landscaping including bioswales & native plantings in Demo Park		351,000
Excavation & Pervious Paving for Parking & Walkway		253,400
Stormwater Collection & Conveyance to Bio-swale		30,500
Demonstration Park	w/ Wastewater System Connection	w/o Wastewater System Connection
Fencing around MMSD areas and Demo Park	122,800	122,800
Excavation & Paving for Demonstration Park	17,800	17,800
Wastewater piping & diversion	58,900	78,300
Water piping	24,300	24,300
Stormwater diversion	11,100	NA
Electrical supply & site lighting	88,700	88,700
Startup & Commission	8,800	8,800
Demobilization	1,300	1,300
TOTAL	**$1,070,900**	**$1,079,200**

Table 1 - Cost estimates for Milwaukee iPark

The RE.invest Solution

Currently, municipal governments lack access to best-available technology based on limited opportunities to “try before buying” through conventional procurement processes. At the same time, innovative companies face multi-year permitting and review processes, and because of these transaction costs often avoid communities that have the greatest infrastructure upgrade needs and available space for large scale testing.

Leveraging the City’s investment and development interests along with local expertise in energy, power, controls and water-related industries, the RE.invest team identified an opportunity to develop an underutilized municipally owned parcel near the M-WERC Energy Innovation Center into an Innovation Park (iPark). The proposed iPark was designed to serve as a demonstration site for cutting-edge technology installations in a way that serves both community and market needs.

Milwaukee iPark Rendering

Innovations

- Leverage underutilized parcels of land for outdoor museum-style technology demonstrations and exhibits
    - Test innovative water, energy, and controls technologies to leverage regional economic strengths and interests
    - Feature green infrastructure flood management systems and services to increase regional uptake of best management practices
    - Enable better environmental performance data collection from in-situ installations

- Incentivize corporate investment in local resilience building and catalyze economic development by creating new innovation parks
    - Leverage planned economic redevelopment to generate greater private investment interest in the region
    - Connect local procurement decisions to global innovation in environmental technology markets
    - Use innovative contracting structures to ensure that corporate demonstrations generate public benefits and revenues, as allowed under local procurement rules and regulations

"As a result of our accomplishments and commitment to finding innovative solutions to 21st Century challenges, I'm excited to collaborate with The RE.invest Initiative. We welcome the program's expertise to explore new approaches for designing large-scale integrated green infrastructure investment portfolios to leverage private financing for these efforts."

Mayor Tom Barrett (May 2013)
City of Milwaukee

Milwaukee iPark Proposed Site Plan

NEW ORLEANS, LA

INNOVATION PARK + SMART TECHNOLOGIES

Population: 378,715 (2010 Census)
Area: 169 sq. mi.

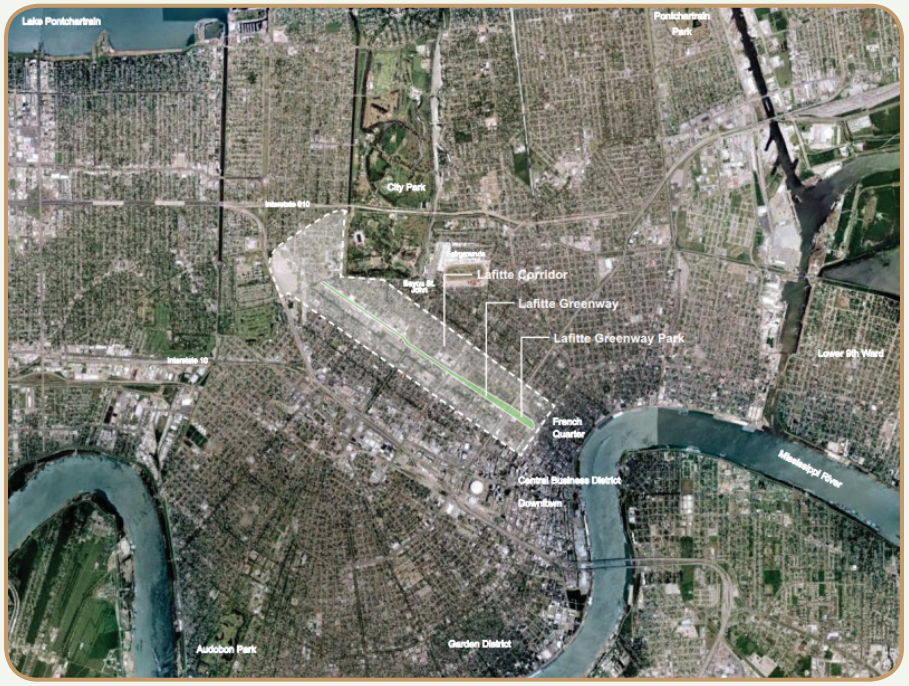
Since the devastation of Hurricane Katrina in 2005, the City of New Orleans has invested heavily in recovery and resilience, and recognizes that its sustainable future lies in improving its quality of life and maintaining its neighborhoods as great places to live. The City has prioritized multi-modal transportation options that connect new and existing housing to jobs, healthcare, and education centers; new methods of water management that mitigate threats caused by subsidence and flooding; and new, vibrant public recreation space.

Source: Lafitte Greenway Master Plan

The Challenge

New Orleans is building a new relationship with water. One example of the City's proactive investment is the Laffite Greenway. Using federal disaster recovery grants, the City designed a 2.6 mile pathway stretching along a vacant rail corridor from City Park to Armstrong Park, connecting six historic neighborhoods from Bayou St. John and Mid-City down to the French Quarter. The project's $9.1 million first phase, completed in late 2015, included a paved bike path, landscaping, lighting and ball fields on a patch of property adjacent to the Lafitte housing development near Claiborne Avenue.

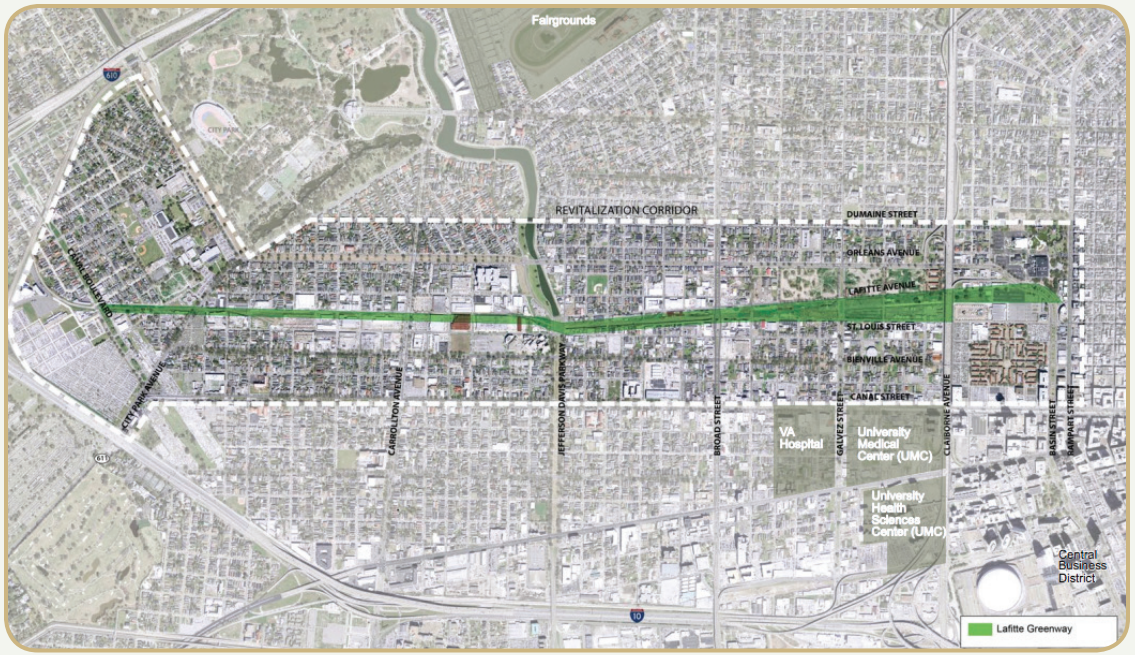
To support that project and broader redevelopment goals, the City is exploring ways to engage residents and expand appreciation for sustainable infrastructure as a major contributor to quality of life – building an understanding of the new normal of living with water in neighborhoods. Ultimately, the City hopes to cultivate a well-informed and supportive public for implementation of integrated, thriving communities that preserve the best parts of New Orleans' cultural heritage while embracing a sustainable future.



Source: Lafitte Greenway Master Plan

The RE.invest Solution

To complement ongoing efforts, the RE.invest team proposed a New Orleans Innovation Park (iPark) – an effort to develop a set of interconnected municipally owned properties to serve as demonstration sites for innovative technology installations. Similar to a World's Fair or an interactive museum, a set of carefully curated resilient technology exhibits can serve both community and local government needs, while creating channels for private sector engagement in infrastructure upgrading. Because New Orleans' water management needs are so extensive, the Innovation Park model was designed to help the City continuously improve and remain at the forefront of innovation by facilitating procurement of best available resilient water technologies over time.



Source: Lafitte Greenway Master Plan

Innovations

- Leverage underutilized parcels of land for outdoor museum-style technology demonstrations and exhibits
    - Test comprehensive smart technology systems that can improve communications, public engagement, and water and energy system efficiency
    - Feature green infrastructure to support implementation of the Greater New Orleans Urban Water Plan
    - Enable better environmental performance data collection from in-situ installations

- Incentivize corporate investment in local resilience building and catalyze local economic development by creating new innovation districts
    - Leverage planned development and public expenditures on green and open space to generate greater private investment interest in the region
    - Connect local procurement decisions to global innovation in environmental technology markets
    - Use innovative contracting structures to ensure that corporate demonstrations generate public benefits and revenues, as allowed under local procurement rules and regulations

"To ensure that New Orleans is protected and preserved for generations to come, it's essential that we have a sound storm water management strategy. We're excited about the opportunities the RE.invest Initiative will provide for collaboration, coordination, and technical expertise to help move priority projects forward with private and philanthropic support."

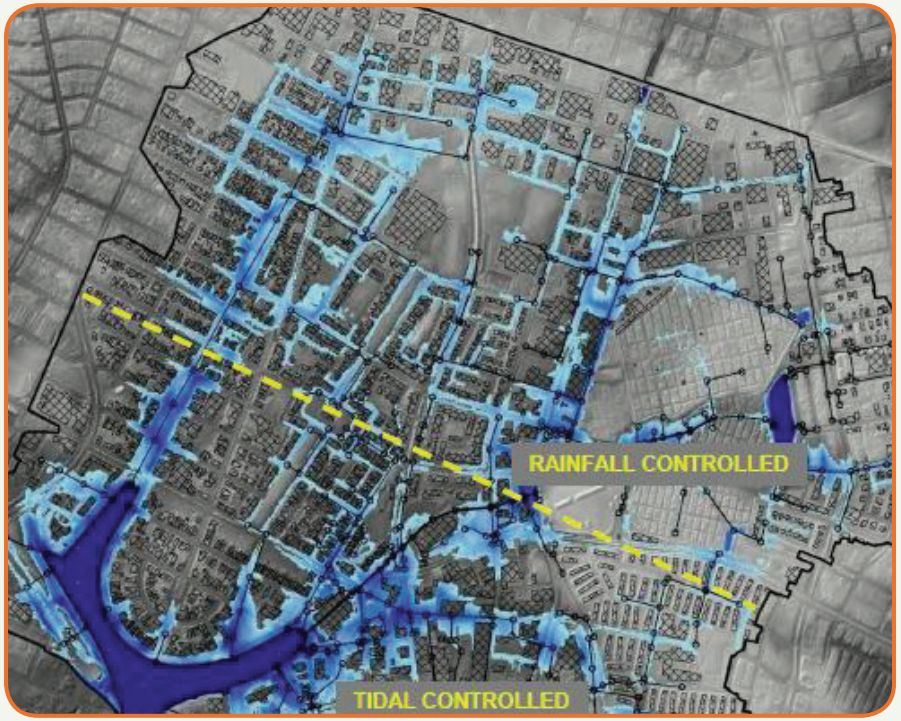
Mayor Mitch Landrieu (May 2013)
City of New Orleans

NORFOLK, VA

FLOOD BARRIERS + GREEN INFRASTRUCTURE

Population: 242,803 (2010 Census)
Area: 54 sq. mi.

The City of Norfolk is an independent coastal city located at the mouth of the Chesapeake Bay near the southern border of Virginia. The City of Norfolk was built on fill material and is today experiencing subsidence due to settlement and compaction. Its coastal location at the mouth of the Chesapeake Bay means that it also has to contend with projected sea level rise.



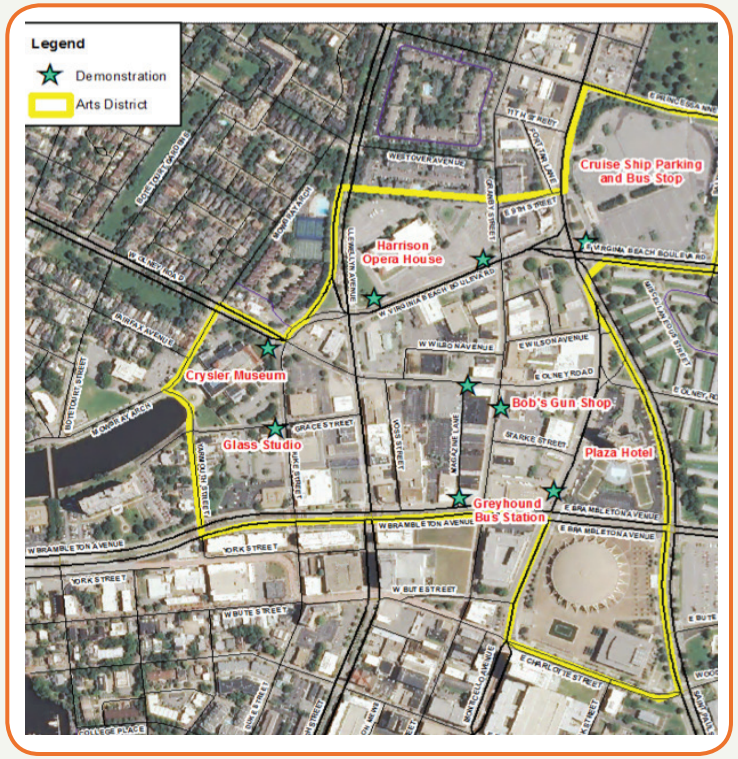
10-Year Rainfall & 10-Year Tidal Surge Event Simulation: The Hague (Source: Fugro, 2012)

The Challenge

With recent increases in flooding events, projected sea-level rise, the continuation of land subsidence due to fill settlement, and the prevalence of impervious surfaces, the flooding situation in Norfolk is only expected to worsen over time.

As a result, the City's existing municipal separate storm sewer system needs additional capacity to handle current and future backwater flows caused by storm surges and high tide. This could be accomplished by either increasing the capacity of the storm drain network or by pursuing a number of green and blue infrastructure strategies to be employed throughout the City.

Norfolk identified the Arts District as an area for redevelopment that is hampered by these existing stormwater and flooding issues. Currently the Downtown Arts District is the most paved area in the municipality with many publicly and privately owned one-story warehouse-style buildings, large surface parking lots, and alleyways. The Arts District provides an opportunity for the City to test and model strategies for addressing growing flood challenges.



Demonstration Area Siting Map

BMP	AREA (Acres)	TN LOAD REDUCTION (lb/yr)	TP LOAD REDUCTION (lb/yr)
Blue Roof/Downspout Disconnection (D.A.A)	17.45	172.91	20.77
Permeable Pavers/Green Alley (D.A.B)	12.59	115.66	16.14
Surface Depression Storage (D.A.C)	3.44	7.01	0.98
TOTAL	33.48	295.58	37.89

Table 8 - Summary of Nutrient Load Reduction due to Green Infrastructure Practices

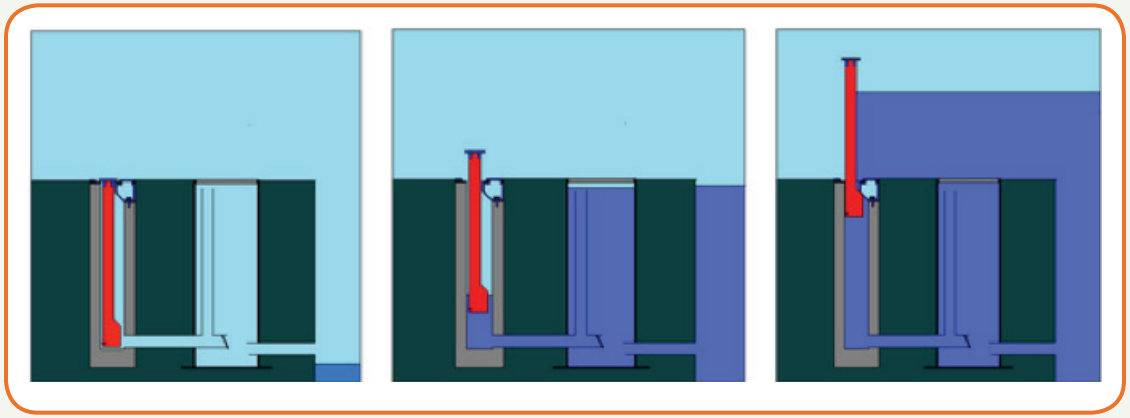
The RE.invest Solution

In an effort to reduce flooding, the RE.invest team reviewed self-deploying floodwall systems that could protect the area while maintaining the look and feel of an historical area.

To further reduce flooding in hotspots and prepare the area for redevelopment, the RE.invest team analyzed a variety of green infrastructure options –including blue roofs, raised planter boxes, green alleys, permeable pavement, stormwater tree trenches, and surface depression storage–that could be strategically distributed throughout the Downtown Arts District to reduce chronic flooding in streets and buildings.

	NO. OF FLOODED STRUCTURES	AREA OF FLOODED STRUCTURES (SQ. FT.)	NO. OF STRUCTURES SAVED	AREA OF BUILDINGS REMOVED FROM FLOODING (SQ. FT.)	VOLUME WATER HELD BACK (CU. FT.)
100-Year Flooding (7.6')	465	1,997,466	-	-	11,095,891
Phase 1 (4.0')			13	60,026	181,543
Phase 1 (5.0')			31	346,128	1,036,270
Phase 1 (5.75')			50	480,535	2,075,712
Phase 2 (4.0')			13	60,026	223,774
Phase 2 (5.0')			46	389,881	1,322,158
Phase 2 (5.75')			85	647,418	2,738,156

Table 2 - Summary of Flood Reductions due to Self-Closing Flood Barrier



Self Closing Flood Barrier Working Principle
(Source: Aggeres Flood Solutions)

Innovations

- Integrate gray and green infrastructure solutions
    - Consider how flexible flood barrier investments can be incorporated into wider redevelopment plans
    - Integrate green infrastructure into development plans and incentive programs for private developers
- Consider financing options, such as tax-increment finance (TIF), to capture real estate value increases from flood protection measures and green infrastructure upgrades
- Calculate "avoided losses" and potential financial savings due to reduced chronic flooding
- Partner with technology firms and local businesses to crowd-source data on unreported losses, such as flood damages or mold clean-up, to quantify potential savings and monetize projected benefits to accrue to residents and small businesses
- Create public programs and local competitions to encourage community-based action on a menu of green infrastructure options

"Norfolk has taken major steps to mitigate our flooding challenges through numerous studies and infrastructure improvements. Participating in the RE.invest Initiative helped Norfolk identify strategies for engaging the public and promoting private investment in integrated and comprehensive flood management solutions."

Mayor Paul D. Fraim (May 2015)
City of Norfolk

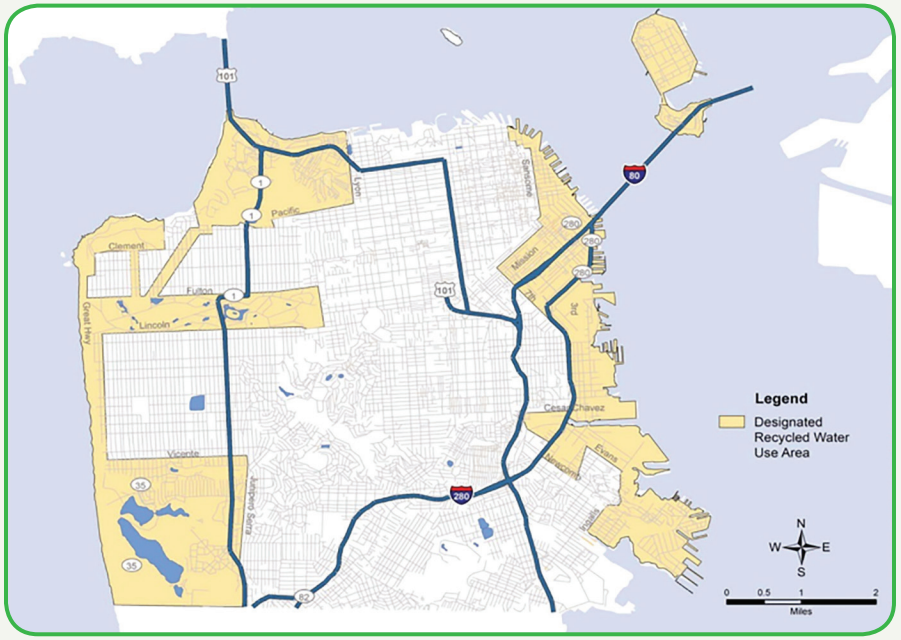
SAN FRANCISCO, CA

RECYCLED WATER + BUILDING EFFICIENCY RETROFITS

Population: 805,235 (2010 Census)
Area: 46.87 sq. mi.

San Francisco is the only consolidated city-county in California, with a density of approximately 17,179 people per square mile.

The City has been recognized for its innovation in city sustainability practices. This is due in large part to San Francisco's progressive environmental policies related to climate change, zero waste, green building, and energy and water efficiency.

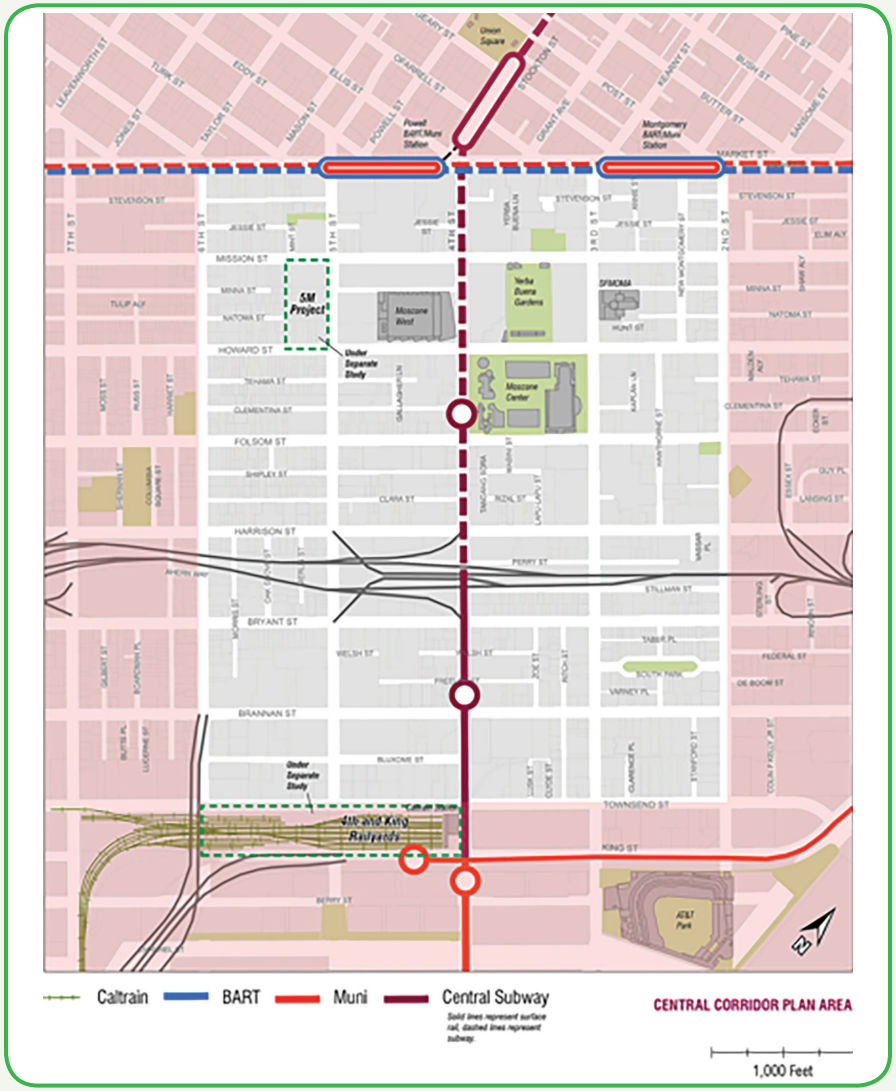


Designated Recycled Water Use Areas
(Source SFPUC)

The Challenge

In recent years, the State of California has experienced record breaking droughts. To further expand its water conservation efforts, the City is looking beyond their investments in centralized recycled water treatment facilitates to nontraditional sources of water through its Non-Potable Water Program. This program encourages the use or reuse of rainwater, graywater, and other sources on private property. The Central SoMa Area Plan provides an opportunity for the City to test and model strategies for addressing growing water demands with recycled water.

Retrofitting a developed urban area like Central SoMa with a recycled water distribution system can be expensive. Both adding dual-plumbing to existing individual buildings and updating the broader municipal infrastructure for carrying recycled water are costly. In some cases, however, the benefits of conserving potable water may justify the cost. For example, a water reuse system may be cost-effective when taking into account avoided and deferred wastewater costs, avoided and deferred water supply costs, increased water supply reliability, and decreased energy usage for normal building operations.



Central SoMa Plan Area (source: Central Corridor Plan)

The RE.invest Solution

In San Francisco, the RE.invest Team developed strategies to help the City promote privately owned non-potable water systems in Central SoMa and beyond.

Through both new construction and the retrofitting of existing building stock, RE.invest identified building and block-level strategies for expanding recycled water treatment and use. Some actions that public institutions can take include facilitating access to value capture financing structures, including leveraging the existing PACE bond models from the energy efficiency sector for application to water reuse projects. In addition, the City can review local policies to the economic viability of individual projects, and support expanded data collection on the value of recycled water to private property owners.

POTENTIAL DEVELOPMENT	RESIDENTIAL	COMMERCIAL	
Occupancy	Multi-family	General office, 250 days/year	
Gross Area	14,058,255 sq. ft.	9,391,145 sq. ft.	
POTENTIAL DEVELOPMENT	RESIDENTIAL	COMMERCIAL	
POTENTIAL DEVELOPMENT	RESIDENTIAL (gpy)	COMMERCIAL (gpy)	TOTAL (gpy)
Irrigation	51,497,535	56,310,756	107,808,291
Toilets/Urinals	-	1,098,542	1,098,542
TOTAL	51,497,535	57,409,298	108,906,833

Table 2. Projected Non-potable Water Demands in Central SoMa Development Area

TREATMENT SYSTEM	FLOW gpd	FLOW gpd	FLOW gpd	CAPITAL COST ($)	ANNUAL OPERATING COST ($)	ANNUALIZED ($)	$/af	COST OF SUPPLY & TREATMENT $/yr	SAVINGS (loss)
Membrane Bioreactor	10k	3.65M	11.2	$1.6M	$140k	$244k	$21,790	$67k	($177k)
Living Machine(as deployed in SFPUC Headquarters)	5k	1.825M	5.6	$1.0M	$17k	$82k	$14,650	$34k	($48k)

Table 5. Estimated Potential Annual Savings

Innovations

- Explore innovative recycled water treatment options at the individual building and city block scales based on system-wide energy efficiencies and savings from reduced wastewater pumping and treatment costs

- Create incentives for local government agencies and utilities to actively support the development of privately-owned recycled water systems
    - Clarify in statute that recycled water produced on-site can be sold to adjacent properties and/or that the City will credit recycled water producers/consumers for reducing the quantity of wastewater that must be treated by the sewerage system

    - Partner with technology firms and local businesses to collect baseline data and analyze projected efficiency benefits and savings from recycled water to reduce transaction costs for private developers

- Structure a pooled fund, using models developed to support energy efficiency retrofits, to help provide financing for distributed recycled water treatment

"San Francisco is committed to staying at the forefront of environmental efforts that will make cities more livable and resilient. As we invest in our aging sewer system, we are thrilled to be one of the first cities in the nation chosen for this innovative partnership to further develop our sustainable stormwater management solutions."

Mayor Ed Lee (May 2013)
City of San Francisco

91 RECOMMENDATIONS

“In theory, there is no difference between theory and practice. In practice, there is.”

— Yogi Berra (attributed)

The insights and lessons in this report were all accumulated over the full length of the RE.invest process by experimenting with multiple collaborators and partners to develop and implement real projects on the ground. Not everything worked. Many bad ideas were (thankfully) discovered and rejected when they were a poor fit for local conditions or interests. Other ideas that were developed in one city were found to be a far better fit for another city and adapted to meet a different local context and need. While each of the lessons highlighted at the beginning of this report can stand-alone as an incremental improvement to traditional infrastructure procurement processes, together they offer an alternative path to systems design and resilience finance that goes beyond the conventional steps of predevelopment.

The recommendations in this section complement these lessons and the overarching resilience predevelopment process highlighted in Figure 3. Further they support the January 2015 Presidential Memorandum entitled “Expanding Federal Support for Predevelopment Activities for Nonfederal Domestic Infrastructure Assets” and the companion set of Recommendations of the Build America Investment Initiative Interagency Working Group from the Treasury Department and the Department of Transportation. The memo and workgroup recommendations highlight the cross-cutting importance of investing in resilience and expanding funding for predevelopment. This report offers an innovative pathway for doing both.

All of the suggestions below incorporate specific action items based on the insights and lessons from the RE.invest experience. As a laboratory for developing and refining an alternative approach to predevelopment, RE.invest involved a wide range of partners, participants, contributors, and observers from all levels of government; private sector design, engineering, law firms; non-government and community organizations; and the financial sector.

Each of these groups has an important stake in the future of resilient infrastructure investment and can play an important role in predevelopment.

To that end, the specific actions described here are specifically directed to the key sectors, actors, and institutions that can take concrete steps to systematically reshape the landscape for resilient infrastructure predevelopment and investment in the US and around the world.

- G **Federal/State Government**
- C **City/Local Government**
- P **Philanthropies/Donors**
- D **Project Designers & Implementers**
- $ **Investors**
- N **NGOs & Academic Institutions**

Connect Predevelopment Funding Directly to Procurement

G

Creating new funding opportunities to cover the costs of predevelopment is an important step to building a pipeline of robust infrastructure projects. However, funding alone is not enough to ensure that high-quality projects emerge from the process. Unless there is a clear connection between predevelopment and execution, it is unlikely that many projects will reach the level of development or detail required to set design specifications for procurement (see Lesson #17). Predevelopment funding should establish clear application criteria and thresholds for the final products of funded predevelopment processes, so the results can translate directly to design specifications for procurements or public-private partnerships.

Consider Options for Predevelopment Cost-Recovery

G C P D

Federal and state agencies should consider options for leveraging predevelopment funding beyond conventional planning grants. One option is to create a predevelopment revolving fund that could incentivize and reward more detailed, in-depth project proposals and

support cost-recovery as part of project implementation. As part of the funding process, criteria could require revisions to typical RFPs to include predevelopment cost recovery provisions. Shifting the costs of predevelopment into later project financing and implementation phases can encourage technical teams of engineers, legal and financial experts (similar to the RE.invest team) to do more in-depth analysis required for large-scale and non-traditional projects and reduce the risks of absorbing the costs of this extra effort themselves. Similarly, local governments can benefit from supporting and receiving more robust project proposals and replenishing predevelopment funds as successful projects are implemented over time.

Leverage Infrastructure Exchanges

G C D

Infrastructure exchanges, like the West Coast Infrastructure Exchange, have become important vehicles for coordinating and catalyzing regional infrastructure planning and development. These types of exchanges can also play a critical role in supporting resilient infrastructure predevelopment by focusing on both bookends of the predevelopment process (see Figure 3). To kickstart structured predevelopment processes, governments should work through exchanges to frame 18-month infrastructure challenge or problem statements (see Lessons #2, #8, #10, and #11). Then as project proposals emerge from the process, regional exchanges can later serve as review and coordinating bodies, similar to an Olympic Delivery Authority (see Lesson #15) to ensure that complex resilient systems with many pieces and parts retain their integrity through long-term implementation processes.

Expand Government Technical Assistance Programs to Include Outside Experts

G $ N D

The RE.invest approach highlighted the importance of having non-traditional teams of experts engaged in predevelopment from the outset of the process. Federal and state agencies should explore options for establishing new technical assistance and train-the-trainer programs that can bring together government experts with talent from private sector engineering, legal and finance firms to support both short- and long-term capacity building and systems innovation within Federal and State agencies and also for local governments (see Lesson #3).

Create More Competitions

P G N

The Rebuild by Design process and the National Disaster Resilience Competition are extraordinary examples of the power of well-designed competitions to produce new ideas and bigger, better solutions than traditional grant offerings or procurements. We strongly recommend that federal and state agencies continue to collaborate with philanthropies to apply this model and expand it beyond reactive disaster-driven funding to proactive preventative resilience investment opportunities (see Lesson #2).

Reform Capital Planning Processes to Support Resilience Innovation

C

Predevelopment is an opportunity for local governments to develop project proposals for meeting new needs, not simply fixing or replacing existing infrastructure. Planning for what a city can afford versus what it needs will constrain predevelopment opportunities before the process begins. Local government agencies should consider new ways to expand capital planning processes to identify resilient infrastructure needs, priorities, and opportunities, separate from identifying available resources in each new fiscal year (see Lesson #7 and #8).

Leverage Program-Related Investments (PRI) for Predevelopment

P $

Similar to federal and state governments, philanthropies should also explore options for investing in structured resilient infrastructure predevelopment processes and seek cost-recovery through project implementation. Similar to social impact bonds or other impact investments, which are often supported by grant funds in initial phases before transitioning to impact investment opportunities, resilience predevelopment investments can offer a vehicle for philanthropies to also engage in social and environmental due diligence and monitoring and assessment to verify risk reductions from resilience projects (see Lessons #9 and #15).

Create Inspiration Engines & Support Procurement Experiments

P C N

One of the greatest challenges with "procuring resilience" is knowing what to build or buy. The options for configuring resilient systems are endless. Changing one component of a system opens up myriad other needs and technology options. Cities need support to become better consumers of resilience solutions. Currently, the tendency is to procure the familiar, which can keep cities locked into historical decisions that perpetuate vulnerability rather than build resilience. Philanthropies, NGOs and academic institutions should support more tools to help local governments source best-in-class resilience solutions. The RE.invest innovation park model and the complementary web platform the Adaptation Atlas (see www.adaptationatlas.com) are both tools designed to serve as inspiration engines for cities seeking infrastructure system innovation opportunities.

Define the Project Pipeline

$

Investors should set clear expectations for "how much is enough" from a project proposal to explore financing options. Rather than simply reviewing projects at the end of predevelopment process and

either accepting or rejecting them as viable financing opportunities, investors should share detailed examples and precedents that can serve as templates for the types of information and data required from predevelopment design teams at different phases (e.g. conceptual design, schematic design, design build, etc.). Creating clear benchmarks for the relevant level of detail for financial analysis and due diligence can help raise the bar for design and improve the quality of the project pipeline over time (see Lessons #9 and #15).

Design Based on Cash Flows, Not Only Costs

D

Project designers and implementers should include basic financial planning considerations into conceptual design and feasibility studies. Starting with design decisions that create savings (Lesson #8: *where is a community losing money?*) can help align incentives to maximize resilience benefits over time and open up pragmatic pathways to implementation.

Launch New Data Initiatives to Monetize Avoided Losses

N P

There are a variety of initiatives focused on quantifying ecosystem services or future losses due to climate change. Similar to the extensive data collection programs that supported the growth of the energy efficiency industry, NGOs and academic institutions working on resilience issues should expand their efforts to help generate better data on current losses and opportunities for savings and insurance-based finance (see Lessons #5, #6, and #14).

Extend Tax Increment Finance (TIF) To Support Private Investment in Public Goods

G C

Tax-increment finance has been a highly successful mechanism for catalyzing urban economic development by capturing broad future gains in a tax base to support public sector projects, such as transit systems. Federal and local government leaders should explore options for restructuring TIF in a way that allows captured funds to be distributed directly to private entities (including individual developers or public-private partnerships) for projects that generate similar broad public benefits, including recycled water co-ops and privately-owned seawalls (see Lessons #7, #9, and #15).

96 CONCLUSION

Cities are on the rise. This decade marks the first when more than half of the world's population now lives in urban areas. As the trend toward urbanization grows, local governments are being called on to provide more extensive, flexible, and efficient services than ever before. At the same time, they are doing so on weak or crumbling foundations of infrastructure. Many cities are confronting huge bills to repair or replace aging or failing energy, water, transportation, and communication systems. Others, especially in developing countries, are struggling to fill major gaps in basic services. Every day comes with new stories in the media of bridge collapses or devastation from storms or other disasters.

Investing in resilience and reinvesting in communities are among the great imperatives of our time.

The case for why we need to become more resilient is now widely accepted. Similarly, the growing number of books and studies on what resilience looks like in practice are helping to shape a global vision for the future of resilient infrastructure development. The RE.invest Initiative and this report offer a modest step toward shaping the third leg of this stool: *how* to systematically build resilience into our cities and systems.

While this report focuses on urban infrastructure, both the process and project innovations from the RE.invest experience can be extrapolated to designing and financing a wide variety of social and environmental resilience projects and practices. The collection of project designs and lessons in this report are intended to serve as examples of what is possible through a carefully structured predevelopment process.

Resilience solutions are by nature bespoke. Effective projects will necessarily be highly site, community, and impact specific. The same specificity and diversity that helps these projects create greater value on the ground also hampers investors' access to a clear project pipeline. Resilience is not going to be achieved by simply scaling or replicating projects across different geographies. Instead, we need systematic approaches to catalyze entirely new yet pragmatic design and finance solutions that offer investors a high standard of consistency without creating a sea of sameness.

The RE.invest team offers up this report as a guide for a predevelopment, but even more importantly, as inspiration for the growing community of local and international innovators seeking to build resilience around the world.

ACKNOWLEDGEMENTS

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Last, but far from least, thank you to all of the incredible city officials and dedicated public servants who participated in the RE.invest process and are leading the way in making their communities and our world more resilient.

Like the design of this report? So do we!
Check-out bCause (www.bcause.biz) to see more of their great work.