

Integrated Water Management, Risk and Resilience

Our infrastructure, organizations, businesses, agencies, and asset systems are under increasing pressure. In addition to aging infrastructure, rising capital and energy costs, workforce shifts, and rapid advances in technology, organizations must respond to a growing set of complex and interconnected external threats. These include supply chain disruptions, extreme weather, cyber risks, and other natural and human-caused threats.

With limited resources to address competing priorities, more constraints, more data, and more stakeholders at the table than ever before, organizations are being asked to **make better decisions, faster, under greater uncertainty and at larger scales.**

As a result, we are no longer simply asking “what is the risk?”

Our clients are asking: “How do we act, at speed, under uncertainty, to mitigate the risk and thrive into the future?”



Connecting the Full Lifecycle of Resilience

Delivering resilience requires organizations to **connect the full lifecycle of decision-making and action**, including:

- Understanding climate risk and disruption
- Planning and prioritization
- Design and engineering
- Funding strategy
- Delivery mechanisms
- Construction and implementation
- Long-term operations, asset management, and stewardship

Resilience is not a one-time effort. As risk conditions continue to evolve, organizations must continuously adapt and embed resilience into the way they plan, invest, deliver, and operate.

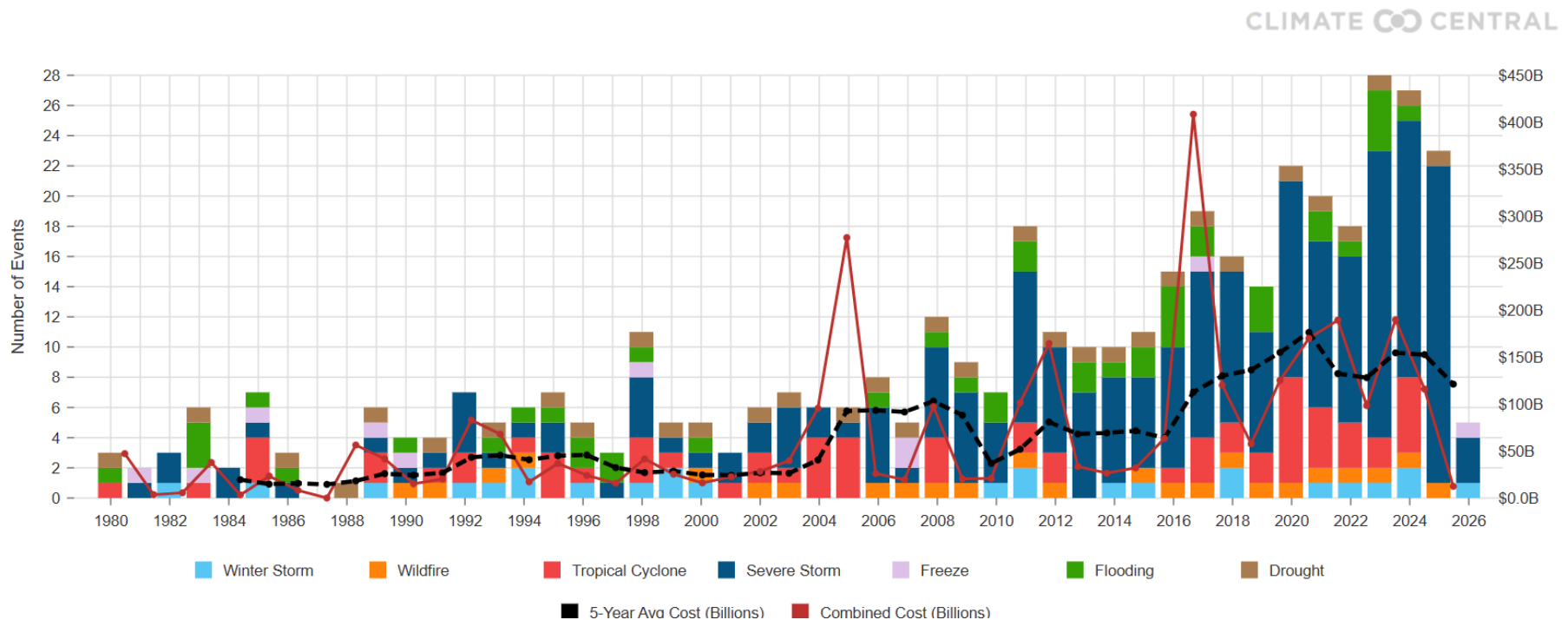
Recognizing the Systemic Nature of Risk

Climate and operational risks are **not isolated events; they are systemic and interconnected**.

To be effective, organizations must shift from managing individual risks to **operating across interdependent systems**, where coordination and awareness of cross-system impacts are essential.

Ultimately, resilience is about more than responding to disruption. It is about sustaining your mission, maintaining trust, and securing a thriving future in a world where change is constant.

THE HISTORY OF BILLION-DOLLAR DISASTERS IN THE UNITED STATES EACH YEAR FROM 1980 TO 2025



Source: Climate Central, Time Series, U.S. Billion-Dollar Weather and Climate Disasters

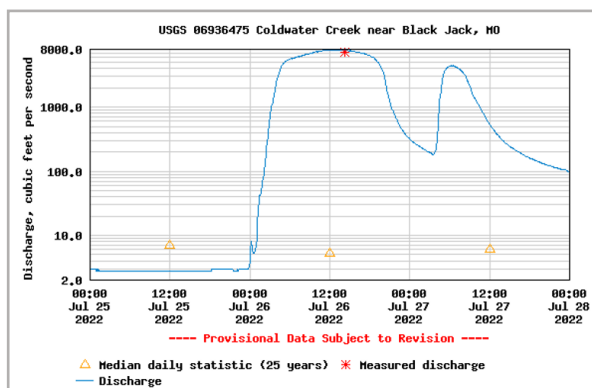
Current Landscape & Trends

Risks are intensifying and exposure is increasing

Hazards are intensifying and exposure is increasing as more people, assets, and infrastructure concentrate in high-risk or technologically vulnerable areas. The magnitude and frequency of these hazards are outpacing traditional planning assumptions, while growing climate risks and deeper insights into socioeconomic impacts, driven by advances in AI, are widening the gap between awareness and the implementation or retrofiting of integrated solutions.

Since 2000, over 75% of New Jersey's rainfall stations have recorded increased extreme rainfall, sometimes over 10% higher than past century-end projections, indicating that current design standards may underestimate flood risks. Simultaneously, parts of New Jersey are facing historic drought and wildfire threats, such as the 2024 Jennings Creek Wildfire, which burned over 5,000 acres and triggered multi-state evacuations. Many communities now regularly see reservoir levels at historic lows.

In 2022, Missouri experienced a record-setting storm near a manufacturing plant, with 9 inches of rain falling in 24 hours. Within 12 hours, rainfall equaled 25% of the city's annual average, and the peak 6-hour period constituted a 1,000-year event. The creek alongside the plant overtopped, and flows spiked from 3 to 8,000 cfs in just 12 hours.

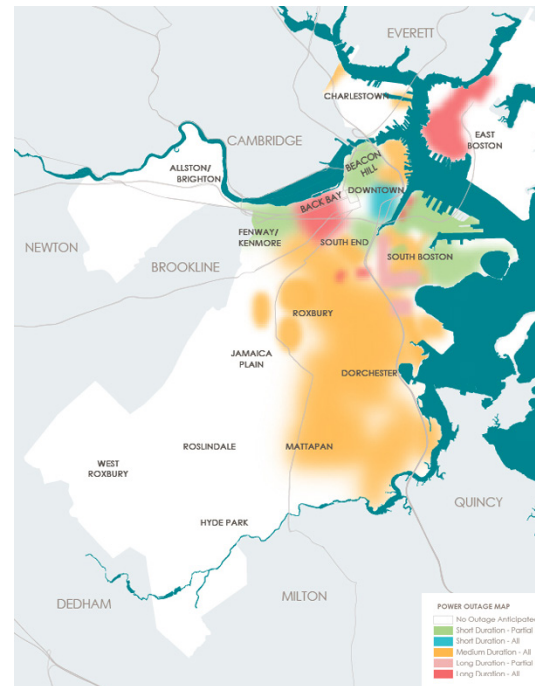


CLOUDBURST
RECORD STORM
EVENT IN
MISSOURI

Impacts are cascading across interconnected systems

Disruptions no longer remain isolated; they cascade across interconnected systems, amplifying impacts and consequences.

- Infrastructure systems are tightly coupled and interdependent (water, power, movement of goods and people, digital, land use and ecosystems)
- Many organizations have increasing reliance on external systems (energy, supply chains, data)
- Disruptions propagate across regions, sectors, and supply chains



Boston and its infrastructure providers were early adopters of the power of modeling interdependencies across public and private infrastructure to evaluate cascading impacts.

EVERSOURCE POWER OUTAGE
VULNERABILITIES AND
DURATIONS FOR LATE-CENTURY
SEVERE COASTAL STORMS

Source: *Climate Ready Boston, Final Report*

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Design expectations are shifting from Single-Purpose to Multi-Functional Systems

The era of single-purpose infrastructure (e.g., flood protection, conveyance, or treatment) is over. Resilient systems must simultaneously deliver multiple functions with quantifiable and qualitative benefits, with physical infrastructure that doubles as social infrastructure. It must now:

- Address multiple risks and needs
- Deliver community benefits
- Integrate with surrounding systems and within the community fabric
- Adapt over time

Traditional infrastructure was designed for predictability and limited performance criteria. Today's systems must balance risk reduction, community value, environmental performance, and long-term adaptability.

Waterfronts, urban corridors, and critical infrastructure systems now serve as multi-functional platforms. Design must consider interdependencies, public interface, and future adaptation, not just immediate performance.



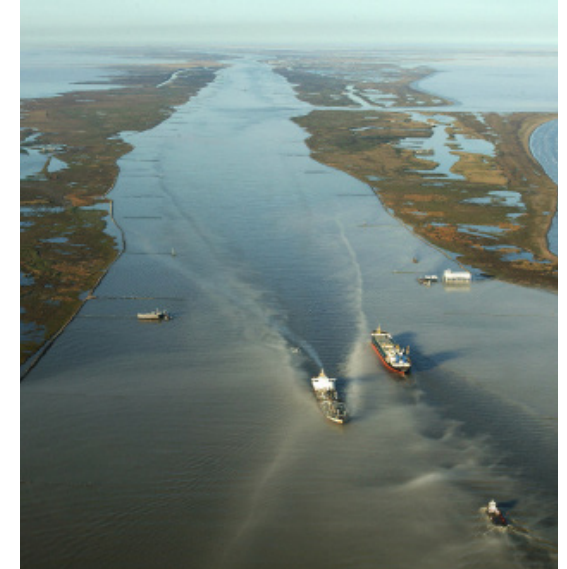
The San Francisco Seawall Program illustrates the shift from single-purpose to multi-functional infrastructure, simultaneously addressing flood resilience, seismic stability, economic continuity, public improvements, and adaptability overtime, while providing the opportunity to create identity as its waterfronts become more resilient.

Accountability is expanding, requiring commensurate changes to governance

Responsibility for resilience is diversifying and broadening as the consequences of inaction grow. This reality requires new governance models and clearer accountability across agencies and stakeholders. We are seeing:

- Increased role of state and local leadership in resilience and recovery
- Multi-agency and cross-geography coordination is now the norm, not the exception
- Integration of public and private sector stakeholder responsibilities and assets around resilience
- Asset owners and operators are expected to take earlier, more proactive action and are being held accountable when failures happen
- Long-term O&M, monitoring, and replacement costs increasingly influence upfront decision-making
- Funding must support full lifecycle performance, not just capital delivery
- Uncertainties and limitations around workforce, inflation / rising costs, insurance, funding variability, among others

A slow-moving, storm system dropped 20–30+ inches across large areas of southern Louisiana causing loss of life, over \$10 billion in damages to over 145,000 homes, and Federal disaster declarations across 56 of 64 parishes. The storm exposed a key common governance flaw: water flows by watershed and doesn't obey the political boundaries in which policies are made. Louisiana dealt with this by creating the [Louisiana Watershed Initiative](#).



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Decision-making is more complex while expectations to deliver resilience at scale are much higher

Organizations must make higher-stakes decisions with constrained resources, increased complexity, and limited margin for error due to:

- Complex and uncertain funding potential
- Long implementation timelines vs urgent need
- Workforce, cost, and insurance pressures
- More data, but less time to act

Resilience is no longer a planning exercise; for both the private and public sectors it is increasingly becoming a high-stakes delivery challenge that must visibly, sustainably perform at scale. For example:

- Megaprojects with regional and national visibility
- Portfolio-level accountability
- Long-term stewardship and adaptability expectations
- Expectations that projects move from planning to construction quickly without sacrificing due diligence and stakeholder engagement



Virginia Beach's Flood Protection Program, the Ripple Effect, demonstrates how the urgent need to deliver large-scale flood protection has called on decision-makers to balance escalating costs, fragmented and uncertain funding, complex stakeholder and permitting constraints, and long federal timelines while being held publicly accountable to accelerate visible, citywide resilience outcomes.

Click on the links to read more on:

- [Workforce](#) strain as an amplifier of risk.
- [Intelligent Water](#) addresses the challenges of accelerating decision timelines and data complexity.
- Portfolio-scale risk requires [Advanced Asset Management](#).

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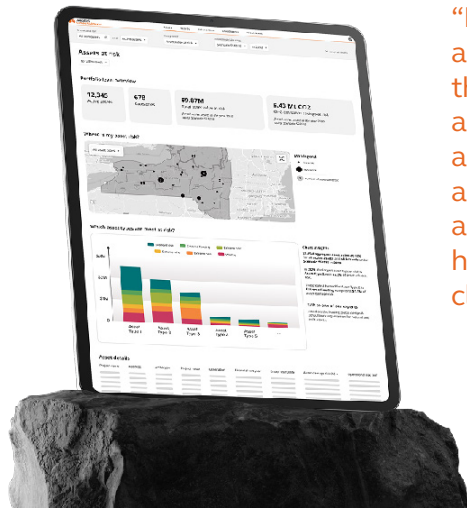
These shifts demand a fundamentally different approach, one that enables organizations to act across systems, at speed, under uncertainty. That sounds like a tall order, but with the right framework, solutions become clearer.

Mission-Centric Solutions: Portfolio-Scale Risk Intelligence

To act effectively, organizations must move from understanding risk in individual assets to prioritizing action across entire portfolios and systems.

- Shift from asset-level to portfolio-level decision-making
- Prioritization based on mission impact, consequence, and system criticality
- Scenario-based evaluation enabling decisions under uncertainty
- Defensible trade-offs across competing investments

See [Advanced Asset Management](#) for depth on methodology.



“Resilience planning done right creates a situation where the whole is greater than the sum of its parts. That will take a move away from asset-level thinking and into systems-level thinking. Carefully assessing the entire system, including aspects like mobility, energy and ecology, helps stakeholders see benefits and costs clearly. That’s critical to bankability.”

Edgar Westerhof, Arcadis National Director for Flood Risk and Resilience

Visit nexus.arcadis.com to discover Arcadis platform designed to model multiple asset types and create a comprehensive view of climate risk.

Multi-purpose Solutions: Multi-Functional, Adaptable System Design

Organizations must rethink how infrastructure is designed, moving from single-purpose assets to integrated systems that balance risk reduction, community value, and long-term adaptability.

1) Design must integrate:

- Risk reduction
- Community interface
- Environmental performance
- Future adaptability

2) Moves beyond single-function infrastructure to multi-benefit systems. Particularly critical for:

- Waterfronts and coastal systems
- Urban and public-facing infrastructure

3) Enables alignment across:

- Funding
- Governance
- Stakeholder expectations



Battery Park City North/West Resiliency Project (BPCR) is New York City’s first large-scale Progressive Design-Build project. It will safeguard Lower Manhattan’s waterfront and surrounding communities from sea level rise, storm surge, and heavy rainfall while enhancing public spaces and access along the Hudson River. The project, valued at approximately \$1.7 billion, represents a critical investment in New York City’s long-term climate resilience and infrastructure renewal.

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End to End Solutions: Integrated Planning > Design > Delivery

Resilience outcomes depend on maintaining continuity from planning through funding, design, and construction without losing protection and performance intent. Traditional fragmentation between planning, design, and delivery introduces risk and delay.

Integrated End-to-End Solutions:

- Span lifecycle phases
- Ensure early decisions are carried through to implementation
- Reduce redesign, rework, and cost escalation



Learn in this video how the South Florida Water Management District's C-139 Flow Equalization Basin project is storing, moving, and cleaning water to protect the Everglades and its surrounding communities.

Faster Cheaper Solutions: Delivery Models that Accelerate Implementation

Organizations must adopt delivery approaches that accelerate implementation, reduce risk, and maintain alignment from vision through construction at the same time that they reduce cost and schedule.

Alternative delivery models:

- Enable earlier integration of design, funding, and execution

Early contractor involvement improves:

- Constructability
- Cost certainty

These combine to reduce delays and enable faster path from planning to implementation.



New York City Department of Environmental Protection's [Resilient NYC Partners program](#) allows the city to engage directly with the vast community of private property owners across the city's five boroughs and help fund and implement sustainable stormwater solutions on their properties. Photos above were taken at Green-Wood Cemetery where stormwater storage systems, permeable pavers, and a rain garden was installed to manage stormwater runoff and enhance the cemetery's landscape.

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Long-term Solutions: Capital Strategy & Funding Architecture

- 1) Organizations must structure investment strategies to support both delivery and long-term performance, not just upfront capital deployment.
- 2) Funding must be treated as a core design and delivery constraint, requiring alignment across:
 - Timing
 - Eligibility
 - Performance requirements
- 3) Must account for full lifecycle costs (O&M, adaptation, replacement).
- 4) There is an increasing need for:
 - Diversified funding sources
 - Innovative financing and delivery alignment



[Learn in this video](#) how to assess funding readiness, build a strategic Funding Master Plan, secure and implement funding, and stay agile with compliance amid change.

Responsive and Responsible Solutions: Governance, Partnerships & Stakeholder Alignment

- 1) Sustained resilience delivery depends on aligning governance, stakeholders, and communities to support implementation and long-term stewardship.
- 2) Multi-agency / entity coordination is now standard operating condition.
- 3) Increasing role of states, regional entities, private sector, and partnerships.
- 4) Requires:
 - Clear governance structures
 - Defined accountability
- 5) Community and stakeholder integration is critical for long-term success.
- 6) Trust and transparency with those affected by your decisions enable implementation and durability over time.



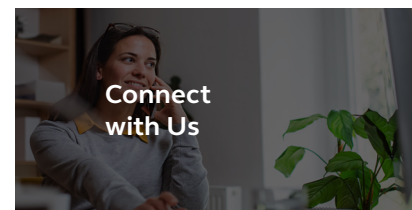
To increase resilience, the New Jersey Department of Environmental Protection developed the [Resilient New Jersey](#) initiative. Four regions across New Jersey were selected as pilot planning regions. These consisted of coalitions of community-based organizations and municipal and county governments.

Holistic and Optimize Solutions: Decision Support Under Uncertainty (Data + Digital)

- 1) Better decisions require integrated data, modeling, and analytics aligned to real decision processes; not simply more information.
- 2) Integrates fragmented data into usable decision insight.
- 3) Supports:
 - Scenario testing
 - forecasting
 - prioritization
- 4) Enables organizations to:
 - Act faster
 - Act with confidence
 - Focus remains on decision quality—not technology deployment



Aging infrastructure, under investment, siloed data, and pressure to justify spending decisions are crippling asset-rich organizations. Arcadis' [Enterprise Decision Analytics \(EDA\)](#) platform empowers cities, governments, and utilities to overcome these challenges with data-driven decision-making.



Implementation Strategies

Capabilities alone are not enough. Organizations must apply them differently depending on context, timing, and constraints. Here are strategies post-disaster, for dealing with change management over time, when you have challenges across diverse systems and geographies, and when there is a high degree of stakeholder interdependency.

Strategy 1: Build Resilience During Recovery

Use recovery as a pivotal moment to strengthen resilience.

- Align recovery and reconstruction with long-term risk management.
- Leverage recovery periods to accelerate business vitality.
- Prepare for unexpected disruptions by integrating resilience into every stage.

Strategy 2: Maintain Intent and Vision Under Pressure

Protect your intended outcomes, even when challenged.

- Assign a clear champion to manage efforts end-to-end.
- Ensure leadership maintains focus on strategic objectives.
- Foster accountability and clear communication throughout the process.

Strategy 3: Scale Decisions Across Systems and Geographies

Maximize impact by expanding effective approaches.

- Sequence investments to optimize resources.
- Bundle related projects and solutions for efficiency.
- Align funding and asset management cycles.
- Replicate successful strategies across locations and systems.

Strategy 4: Maximize Partnerships

Strengthen outcomes by working collaboratively.

- Identify partners with shared interests and interdependencies.
- Engage stakeholders early to align goals and resources.
- Leverage collective strengths to reduce risk and drive success.



When Hurricane Sandy hit Bay Park, New York, the flooding was devastating. The wastewater facility was overwhelmed, and quickly became inoperable. Contaminated water filled homes, overturned cars and destroyed property. Through the work completed at the [South Shore Water Reclamation Facility](#), the community now has a modern, resilient wastewater facility, and thanks to reclamation efforts in the local bay and parks, residents' quality of life is improving. Bay Park will be prepared for the next climate event.



In 2012, Hurricane Sandy roared through Brooklyn and floodwaters rushed into the [Coney Island Hospital](#). Patients were evacuated after lower floors flooded and elevators failed. Arcadis took immediate action to assist with FEMA grant applications and worked in 12-hour shifts to rebuild the hospital as a resilient, state-of-the-art facility. Disaster relief funding now enables planning for climate change and weather events in the area, and the investments will pay off as sea levels rise.

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The challenge is worth it. Investment in resilience building will save at least \$6 for every \$1 spent. This value compounds when we consider longer term value retained and the reverberating benefits of not having to invest in fixing a future “broken window”.

	IMMEDIATE	COMPOUNDING
KEEPING	Losses Avoided Direct damage and disruption costs prevented by resilience measures	Value Retained Long-term protection of property values and tax base (e.g.)
GAINING	Value Added New economic activity jobs, and amenities created through investment	Resilience Dividend Reverberating improvements in community adaptability, strength, and growth

“A common misunderstanding is this idea that resilience and sustainability are mutually exclusive. I think of sustainability as a characteristic of resilience.”

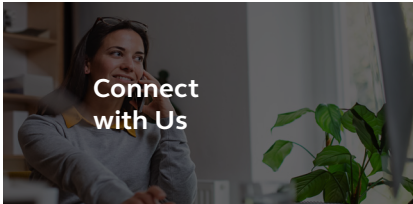
Carly Foster, Arcadis Water Management Practice Director



Norfolk, VA secured \$120.5 million in federal funding to enhance shoreline defenses, reducing flood risk for 110 acres, improving neighborhood connectivity and amenities, and creating new natural habitats.



NYC’s resiliency strategy for Lower Manhattan will protect the Financial District and Seaport, avoiding \$37.8 billion in losses and safeguarding 62,000 residents.



Services We Offer

At Arcadis, we help clients move from understanding risk to delivering resilience at the scale, speed, and sophistication today's reality demands. By integrating planning, funding, delivery, and long-term stewardship, we enable organizations to act with confidence, even in the face of uncertainty. We also specialize in helping clients deliver complex, multi-billion-dollar resilience programs; from waterfront systems to post-disaster recovery and portfolio-scale investment strategies.

Asset and enterprise risk and resilience

- All hazards risk management planning
- Asset-based risk management
- Business continuity
- Emergency and evacuation planning
- Emergency management
- Enterprise risk management
- Incident and disaster recovery
- Incident response
- Portfolio risk assessment and strategy
- Security design
- Training and exercise delivery

Climate adaptation and resilience planning

- All hazards
- Community and regional adaptation planning
- Community outreach
- Policy and program analysis and design
- Preliminary concept design
- Quantitative risk analyses
- Stakeholder engagement

Design and delivery

- Alternative project delivery

- Asset-level flood protection (e.g., hospitals, pump stations)
- Coastal and riverine risk management design and delivery
- Coastal protection
- Dams and reservoirs
- Levees, floodwalls, gates
- Marine structures
- Nature-based solutions
- Stormwater and drainage
- Tunneling / micro-tunneling

Funding and implementation support

- Capital program optimization
- Funding advocacy
- Funding and financing strategy
- Funding and implementation strategies
- Funding management
- Funding pursuits (e.g., grants, loans, P3s)

Stormwater and flood management

- Capital improvement planning
- Collaborative delivery (P3, P4P, DBFOM) program development and delivery
- Design of pluvial flood mitigation projects
- Flood visualization and forecasting

- Green stormwater infrastructure and nature based solutions planning and design
- H&H modeling: stormwater, compound flooding
- Level of service analysis
- MS4 and CSO planning and program development
- O&M and asset management and condition assessments
- One water/water reuse integration
- Policy analysis and development
- Stormwater risk and vulnerability assessments
- Property scale flood mitigation
- Stormwater flood monitoring and prediction
- Stormwater master planning
- Stormwater utilities, fee, and credit programs development

Water resources planning and hydraulic design

- Air flow studies
- Coastal planning and design
- Computational fluid dynamics
- Dam and levee safety
- Ecosystem restoration planning and design
- Flood and drought forecasting and systems management

- Floodplain assessments and permitting
- Groundwater availability assessments and modeling
- Hydrologic and hydraulic engineering design
- Hydropower resource analysis
- Morphodynamics and sediment transport
- Navigation systems and structures
- Nearshore and offshore wave modeling
- Reservoir storage allocation and reallocation studies
- Reservoir systems analysis
- Risk analysis for flood damage reduction studies
- Sustainable yield, source evaluation, water rights and surface water availability assessments
- Water control manuals and operations and maintenance manuals
- Water quality studies
- Watershed protection and improvement planning
- Water supply, security, and drought management
- Wave overtopping and runup studies



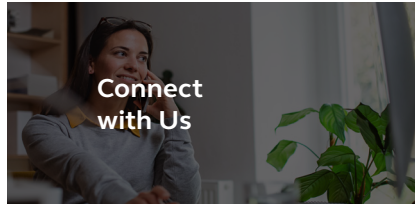
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Risk and resilience are expansive topics, offering a wealth of insights that go beyond what any single source can capture. Reach out to our experts to deepen the conversation.



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