Chicago Metropolitan
Agency for Planning

Transportation Resilience Improvement Plan

2026

Acknowledgements

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Steering Committee

Argonne National Lab
Chicago Department of Transportation
Chicago Transit Authority
Cook County Department of Transportation and Highways
DuPage County Division of Transportation
Equiticity
Illinois Department of Transportation
Kane County Division of Transportation
Kendall County
Lake County Division of Transportation
McHenry County Division of Transportation
Metra
Metropolitan Water Reclamation District of Greater Chicago
Pace Suburban Bus
Regional Transportation Authority
Will County Department of Transportation
Will County Emergency Management Agency

Consultants

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What is the Transportation Resilience Improvement Plan?

Northeastern Illinois is feeling the effects of climate change. More intense storms are worsening flooding, making roads impassable, causing transit service delays, and damaging critical infrastructure. Temperatures are also on the rise, resulting in more frequent and intense heat waves that can disrupt transit and harm both travelers and transportation workers. In the future, these impacts are projected to become more frequent and intense across the region.

As the federally designated metropolitan planning organization for northeastern Illinois, the Chicago Metropolitan Agency for Planning (CMAP) seeks to improve the transportation network's resilience to extreme weather and climate change. To do this, CMAP developed this Transportation Resilience Improvement Plan (TRIP) to identify vulnerabilities in the regional transportation system and highlight how to make the system more resilient to extreme weather and climate change.

TRIP provides a roadmap to inform transportation planning and decision making at CMAP and throughout the region. It also meets the Federal Highway Administration's (FHWA) Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Program requirements for a resilience improvement plan — and will help position northeastern Illinois to compete for PROTECT funds as well as other resilience funds.

How vulnerable is northeastern Illinois' transportation system?

Flooding is one of the biggest climate-related risks to the transportation system. It impacts all forms of transportation and can damage physical assets, disrupt operations, and threaten user safety. About a third of the region's highway miles and roughly half of its bus and train stops are at high or very high risk from flooding.

Extreme heat can damage infrastructure (such as cracked pavement or rail buckling) and impact electrical services and backup power. It also poses particular risk to people, including both transportation users and outdoor workers who keep the system running. Those who depend on transit face particular risks from extreme heat, as they lack transportation alternatives and often walk to and wait outside for transit.

Severe storms and **extreme cold** also bring notable risks to the transportation system, although not quite to the same extent as flooding and extreme heat. For transit-dependent individuals, these hazards present additional health and safety risks due to prolonged exposure while accessing transit services, especially in areas lacking adequate shelter or heating infrastructure. While more moderate in nature, the risks posed by increased frequency of **freeze-thaw cycling** must also be recognized.

How can the system become more resilient?

Investments can be made throughout the region's transportation system to make it more resilient. To this end, TRIP highlights **64 unique resilience projects** identified by partner agencies and evaluated by CMAP to prioritize investments that increase system resilience. With their inclusion in a federally determined resilience improvement plan, these projects become more competitive for PROTECT grants and eligible for a reduced cost-share. CMAP further refined the project list to identify the 20 highest priority projects to help CMAP and the region focus their support for potential project funding and coordination.

TRIP identifies and describes **21 project resilience strategies**. These are an assortment of structural, nature-based, and hybrid strategies that can increase flood or heat resilience.

Finally, TRIP highlights **25 organizational resilience strategies** that partner agencies and stakeholders can adopt to embed resilience into common decision-making practices with the goal of lowering barriers to resilience.

The Morton Arboretum's permeable paver parking lot and bioswales reduce flood risk and improve the quality of water in Meadow Lake. Photo credit: CMAP.

Introduction

As the federally designated metropolitan planning organization for northeastern Illinois, CMAP has a unique perspective on how targeted investments in the region's transportation system can improve its safety, reliability, and efficiency. To fulfill its role, CMAP must proactively address all of the challenges the transportation system faces, including those associated with a changing climate.

From flash floods to heat waves to blizzards, northeastern Illinois faces a wide range of extreme weather events and natural disasters. Although its transportation system was designed to withstand extreme weather events, the increasing frequency of severe weather is bringing costly damages and service interruptions. For example:

Flooding: Summer flooding brings travel disruptions and dangerous conditions for drivers, transit operators, and transit users. On July 8, 2025, 5 inches of rain fell in 90 minutes, leaving several cars stranded in the resulting flash floods and requiring water rescues.[1] July storms also brought flooding in 2011 when 7 inches of rain fell in just 3 hours, and in 2023 when 9 inches fell in a single day.[2]

Extreme heat: Extreme heat brings dangerous conditions to people, especially pedestrians, transit users, and outdoor transportation workers. In July 1995, the Midwest experienced a historic heatwave, with Chicago suffering the brunt of its impact.[3] This stretch claimed over 700 lives in the city alone and saw record-breaking temperatures, including the highest ever recorded at Midway Airport (106°F), and peak heat indices reaching 124-125°F.[4] In 2023, Chicago experienced extreme summer heat waves with heat indices reaching 120°F.[5]

Extreme cold: Recent winter weather events have been severe even by Chicago standards, causing significant impacts on the transportation system and the safety of transportation users and workers. Extreme cold events in January 2019 brought bitter temperatures to Chicago, causing fatalities and economic impacts.[6] Just a few years later, in mid-January 2024, a disruption of the polar vortex brought frigid Arctic air down to Chicago; wind chills were as low as -20 to -30°F.[7] In early 2025, winter storms impacted traffic on roadways and extreme rain flooded interstates and viaducts, requiring multiple water rescues.[8]

The transportation system is vital to region's residents and their daily lives. Extreme events not only cost money but interfere with the transportation of goods, limit people's ability to conduct their daily lives, and inflict challenges on local businesses. They can pose health and safety risks to drivers, bicyclists, pedestrians, and transit users, and hamper the mobility of emergency vehicles, impacting response times and access. As climate change increases the frequency and severity of extreme weather, transportation-related impacts on residents will worsen unless the region takes proactive action now.

TRIP purpose and goals

CMAP created this plan to drive targeted investments in the resilience of the region's transportation system. TRIP lays the groundwork to advance regional resilience planning, investment, and coordination, preparing the region's transportation network for current and future extreme weather events.

TRIP also positions partner agencies to apply for federal funding under the FHWA's PROTECT Discretionary Grant Program. Through PROTECT, the FHWA will issue over $1.4 billion in grants for transportation projects that increase resilience to extreme weather and other natural hazards. The resilience projects identified in TRIP are eligible for a seven percent match reduction in the non-federal share of project costs for the PROTECT Program competitive grants.

CMAP developed TRIP in collaboration with partners to advance regional resilience planning and identify opportunities to invest in more resilient infrastructure. Regional partners include implementers from the transportation, stormwater, and emergency management sectors, including state, county, and municipal agencies and departments.

The Lyons Fire Department evacuates residents along the Des Plaines River following a flood in May 2020. Photo credit: CMAP.

Plan goal and objectives

TRIP's goal is to identify opportunities and strategies to improve the resilience of the transportation network to extreme weather events.

TRIP's key objectives are to:

1. Identify and prioritize major vulnerable assets across transportation systems.
2. Identify and prioritize investments to build resilience and reduce climate risks.
3. Propose fair and inclusive resilience investments.
4. Identify strategies to embed resilience considerations into routine planning and decision making for CMAP and other transportation agencies in the region.
5. Engage and educate partners about climate resilience planning.

Plan overview

TRIP contains all the requirements of a resilience improvement plan under the PROTECT program, including the following sections:

> ### What is resilience?
>
> The FHWA defines resilience as, "The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions."

Context for transportation resilience planning: TRIP exists in a broader context of transportation- and resilience-related planning efforts within Chicago, northeastern Illinois, and the state. CMAP coordinates with multiple partners, including transit agencies, county departments of transportation, emergency and stormwater management agencies, and the Illinois Department of Transportation (IDOT), as well as various community-based organizations. TRIP complements and builds upon other existing planning initiatives within CMAP and beyond. A summary of important planning efforts and other related initiatives are summarized in the *Context for transportation resilience planning* section.

Understanding vulnerability: As a foundational step, CMAP needed to identify key climate-related risks and where they impact the system. A detailed understanding of these risks is essential for identifying the appropriate strategies and investments to enhance resilience. The resulting risk-based vulnerability assessment looked at scientific literature, climate projection data, flood modeling, and infrastructure sensitivities to identify asset types and specific locations with the greatest vulnerabilities. The *Understanding vulnerability* section summarizes the approach and key findings of the vulnerability assessment.

Advancing resilience: Having identified key vulnerabilities, TRIP explains how to best address them. The *Advancing resilience* section identifies specific projects that should be prioritized for investment in the near-term, as well as future strategies to increase resilience.

- **Priority project list:** TRIP includes a list of transportation projects identified by regional partners as an investment priority from a resilience perspective. Some of these projects were previously identified by regional partners and were evaluated based on their potential to enhance climate resilience of the transportation system. Priority projects listed in TRIP are more competitive for PROTECT grants and eligible for a reduced cost-share. High priority projects are identified to help the region in target resilience projects where investments will have the most positive impact. This list, coupled with an overview of its development process, is in the *Priority projects for investment* section.

- **Resilience strategies:** CMAP's responsibility to promote resilience does not end with identifying priority projects. Resilience should be incorporated throughout all stages of project planning and organizational decision making. To facilitate this, TRIP includes resilience strategies that can be employed by CMAP and/or regional partners. These strategies are categorized into two main types: project and organizational. These strategies are described in the *Resilience strategies* section.

Looking ahead: TRIP implementation: Completing TRIP is a major step in building a more resilient transportation system. The *Looking ahead: TRIP implementation* section highlights key implementation steps for TRIP, details on monitoring progress and impact, and potential future enhancements.

Approach to TRIP development

CMAP combined data analysis and flood modeling, literature reviews, partner interviews, workshops, and other approaches to understand the region's risks and to determine ways to reduce those risks. The subsections below describe the key elements of the approach, scope of the assessment, and how partners were involved.

TRIP scope

Informed by existing regional transportation planning processes, TRIP is designed to support regional resilience planning and decision making and position its partners to compete for resilience funding opportunities. CMAP defined the project scope as follows:

Geographic scope: TRIP guides northeastern Illinois resilience planning, covering 284 municipalities in 7 counties — Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will — containing more than 3.3 million households with a total population of approximately 8.5 million.[9] The risk-based vulnerability assessment covers roads, bridges, culverts, Chicago Transit Authority (CTA) and Metra rail stations and lines, CTA and Pace bus stops and routes, and regional trails across the region.

Timeframe: TRIP is intended to inform immediate and long-term regional transportation resilience investments and aligns with the goals outlined in the region's comprehensive plan, ON TO 2050. The risk-based vulnerability assessment considers both climate trends and future projections through mid-century (2035-2064) and late-century (2065-2094), so that projects can be designed to anticipate future climate hazards. However, the plan emphasizes the mid-century horizon to better align with more immediate decision-making timeframes.

Climate hazards: TRIP focuses on the following climate hazards:

- Extreme heat
- Precipitation and flooding (urban, riverine, coastal)
- Severe storms (rain, snow, ice, wind)
- Extreme cold
- Freeze-thaw cycling

Of these, extreme heat and flooding were identified as priority hazards based on the findings from the risk-based vulnerability assessment and stakeholder input.

Transportation assets: TRIP includes asset categories that are major components of the regional transportation system and identified as likely to be impacted by climate events. The selection of these transportation asset categories was based on previously published work, expert knowledge, and past hazard impacts:

- Roadways
- Bridges (road and rail) and culverts
- Roadway facilities
- CTA and Metra rail lines and stations
- CTA and Metra rail facilities
- CTA and Pace bus service and stops
- CTA and Pace bus facilities
- Electrical services and backup power
- Bicycle and pedestrian facilities

Key elements of the approach

CMAP used a systemic approach to assess the transportation system's vulnerability and identify strategies and areas for future resilience investments. TRIP was carried out in two phases: Phase 1, consisting of the foundational risk-based vulnerability assessment, and Phase 2, focused on TRIP development (Figure 1).

Figure 1: Overview of TRIP elements

Summary of TRIP phases and key elements

Phase 1: Risk-based vulnerability assessment

Purpose: Evaluate climate risks to the region's transportation system and carry out a comprehensive analysis of the most at-risk transportation assets to feed into TRIP.

Key elements:

- **Climate analysis**: Evaluates recent trends and future projections for key climate hazards.
- **System-level vulnerability analysis**: Assesses the sensitivity of a wide range of transportation system asset types to various climate hazards.
- **Asset-level vulnerability analysis**: Assesses priority transportation asset type and hazard pairs identified in the system-level analysis to locate specific individual assets and geographic areas at high risk.
- **Transit rider vulnerability analysis**: Assesses factors that increase transit riders' vulnerability to extreme heat events to inform potential resilience improvements.

Timeframe: Early 2023 – mid 2024

Phase 2: TRIP development

Purpose: Develop TRIP to inform regional transportation planning, identify priority resilience projects and strategies, provide additional analysis to support project development, and position CMAP and regional partners to be competitive for federal funding opportunities.

Key elements:

- **Priority project list**: Identifies priority resilience projects gathered from regional implementing agencies.
- **Resilience strategies**: Provides a list of strategies for building resilience to flooding and extreme heat impacts. Includes project strategies, which focus on roadway, bridge, and transit infrastructure, and organizational strategies, which focus on agencywide changes.
- **Economic analysis**: Guides investment decisions by providing a tool to analyze the economic impacts of flooding on transportation system users for any given site.
- **Flooding solutions analysis**: Provides site-level analysis of flood solutions at three example sites to inform regional project investments.
- **Implementation considerations**: Discusses role of CMAP and regional partners in implementing and advancing regional transportation resilience and outlines future TRIP enhancements.

Timeframe: Mid 2024 – late 2025

Engagement with partners

Collaboration and communication with regional partners are a cornerstone of TRIP. CMAP conducted extensive partner engagement throughout the planning process to verify findings and ensure that the plan aligns with the resilience needs and priorities of regional partners and stakeholders. CMAP created a steering committee representing state, city, and county transportation planners; emergency responders; stormwater engineers; asset managers; transit operators; as well as researchers and community-based organizations focusing on resilience, equality, and mobility justice. The steering committee included:

- Argonne National Laboratory
- Chicago Department of Transportation
- Chicago Transit Authority
- Cook County Department of Transportation and Highways
- DuPage County Division of Transportation
- Equiticity
- Illinois Department of Transportation
- Kane County Division of Transportation
- Kendall County
- Lake County Division of Transportation
- McHenry County Division of Transportation
- Metra
- Metropolitan Water Reclamation District of Greater Chicago
- Pace Suburban Bus
- Regional Transportation Authority
- Will County Division of Transportation
- Will County Emergency Management Agency

CMAP also solicited input from steering committee members and other regional partners through workshops, focus groups, interviews, and CMAP's Board and committees. Partner engagement provided valuable insights that facilitated:

- Verifying findings from the risk-based vulnerability assessment.
- Improving the plan outline as well as the priority project selection and prioritization process.
- Developing the priority project list through the project solicitation process.
- Refining resilience strategies to ensure they are actionable and reflect regional priorities.

Figure 2 summarizes key stakeholder engagement activities conducted throughout the two phases of TRIP's development process. Prior to initiating TRIP, CMAP hosted a series of workshops to engage and build capacity with partners on understanding the climate challenges in the region and solicit feedback to inform the scope of work.

Figure 2: Overview of TRIP stakeholder engagement activities

TRIP Phase 1 stakeholder engagement activities

June 2023 Steering Committee meeting 1	August 2023 stakeholder workshop 1	December 2023 Steering Committee meeting 2	June 2024 stakeholder workshop 2
Provided an overview of the TRIP project and discussed system-level analysis approach	Vetted the preliminary results from the system-level analysis	Solicited feedback on the approach for the asset-level analysis	Vetted the preliminary results from the asset-level analysis

TRIP Phase 2 stakeholder engagement activities

February 2025 Steering Committee meeting 3	May 2025 stakeholder workshop 3	July 2025 Steering Committee meeting 4	September 2025 Steering Committee meeting 5
Presented key findings from the vulnerability assessment and solicited feedback on TRIP outline	Discussed resilience project submission process and solicited feedback on draft resilience strategies	Provided an update on TRIP project list, resilience strategies and TRIP completion timeline	Presented final TRIP project list, discussed key findings and next steps

Context for transportation resilience planning

CMAP and its regional partners have already completed significant work to advance climate resilience in northeastern Illinois, from climate adaptation plans to flooding studies to infrastructure improvement projects. CMAP intentionally developed TRIP with these efforts in mind, to build on the region's strong foundation of climate resilience work and facilitate the implementation of TRIP recommendations.

This section provides an overview of climate resilience planning at CMAP, describes key plans from the region and their connection to TRIP, and discusses the interdependencies of the energy, communications, and emergency management sectors.

Climate resilience planning at CMAP

CMAP has led efforts to address the impacts of climate change for many years. Much of this work provided the foundation that supported and fed into TRIP development. Key efforts include:

- A flood susceptibility index (both urban and riverine) to identify priorities across the region for flood mitigation activities.[10]
- A flood investment guide which helps engineers, planners, and community leaders decide which flood resilience investments to make and highlights successful examples.[11]
- The *Guide to Flood Susceptibility and Stormwater Planning*, which details how communities can identify problem areas, flooding causes, and improvements that can reduce flooding. Also highlighted are several local plans where CMAP used the guide, including the City of Berwyn, City of Des Plaines, Village of Midlothian, and Village of South Holland.[12]
- A partnership with the Metropolitan Water Reclamation District of Greater Chicago to develop comprehensive land use plans addressing flooding and advancing other community goals, including the Calumet City Subarea Plan.[13]

- In collaboration with the American Planning Association, *Using Climate Information in Local Planning: A Guide for Communities in the Great Lakes*, which helps planners incorporate available climate data into comprehensive and capital improvement plans.[14]
- The *Climate Adaptation Guidebook for Municipalities in the Chicago Region*, a resource for communities interested in adapting their planning and investment decisions to a changing climate.[15]

CMAP is committed to addressing the impacts of climate change and increasing the resilience of the transportation system, both directly through its work and by providing resources to its partners. This work will evolve as new information is gained and strategies are implemented, with CMAP continuing to play an active role in transportation resilience.

Relevant existing plans

While this is the region's first formal resilience plan, many organizations have already addressed climate resilience through existing planning documents and reports. Identifying pre-existing resilience efforts was a critical step in developing TRIP.

To ensure a coordinated, aligned, regional approach to transportation resilience, CMAP conducted a detailed review of complementary plans in the region. TRIP builds on this substantial body of existing work, including:

- **Regional and state transportation plans**, such as ON TO 2050, Regional Greenways and Trails Plan, Central Council of Mayors Transportation Resilience Plan, IDOT Transportation Asset Management Plan, IDOT All-Hazards Transportation System Vulnerability Assessment, and Move Illinois (IDOT's long-range transportation plan).[16] ON TO 2050 is a foundational document aimed at, among other things, advancing resilience, preparing the region for climate change, and creating a transportation system that works better for everyone. TRIP helps advance specific strategies outlined in ON TO 2050 to improve the resilience of the transportation network's resilience to weather events and climate change.

Alignment with ON TO 2050

ON TO 2050, the region's comprehensive plan, identifies strategies for implementing its recommendations. Many strategies in TRIP are aligned with, and supportive of, the ON TO 2050 implementation strategies. Both plans recommend strategies that relate to:

- Addressing climate resilience
- Addressing flooding in climate-impacted areas
- Adjusting operations in response to weather
- Collecting and sharing data
- Coordinating with regional partners
- Ensuring comfortable and safe transit and bike use
- Improving communications with transportation users
- Improving structural solutions and green infrastructure
- Increasing staff capacity
- Providing technical assistance
- Reducing future flood risk
- Pursuing state and federal funding
- Reducing future flood risk
- Increasing staff capacity

- **Transit plans**, such as the Regional Transportation Authority (RTA) Chicago Regional Green Transit Plan, RTA Flooding Resilience Plan for Bus Operations, Plan of Action for Regional Transit, Metra Strategic Plan: My Metra, Our Future, Pace Driving Innovation Plan, and CTA, Metra, and Pace's respective transit asset management plans.[17] Transit agencies play a pivotal role in the transportation system and the services they offer are essential to maintaining regional resilience.
- **State and county hazard mitigation plans (HMP)** play a key role in identifying risks and outlining strategies to reduce impacts and protect community lifelines, including transportation. The State of Illinois and all seven counties in northeastern Illinois (Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will) have a Federal Emergency Management Agency (FEMA)-approved HMP.[18]
- **Municipal plans**, which represent local resilience planning efforts, provide key insights into community priorities. Many of the climate hazards and resilience strategies included in local plans mirror those in TRIP, such as initiatives to address heat impacts on vulnerable communities and focus on green infrastructure and stormwater management. Further, many regional communities have transportation and climate action plans that align with TRIP.

Critical connections

To capture essential interdependencies, the risk-based vulnerability assessment, described in the *Understanding vulnerability* section, incorporated critical destinations (e.g., hospitals, schools) as factors in asset scoring.

Many municipalities have developed stormwater management and resilience plans to reduce the impacts of urban flooding. Photo credit: CMAP.

Community interdependencies

The transportation network is just one component of a much larger and interconnected regional system. The transportation system is interdependent with other sectors, such as energy, communications, and emergency management. CMAP recognizes this, as well as the potential cascading impacts from outages or failures in other sectors. For example, transportation networks rely on energy and communications systems to support congestion management and operations, such as stoplights and other traffic or transit signals. Transit agency shifts to electric vehicles increase the transportation system's reliance on electricity. Similarly, the transportation network supports other sectors, such as emergency management. First responders rely on the transportation network to reach people during emergencies, which can be impacted by natural hazards.

Increasing the resilience of transportation assets and services will benefit all interdependent critical systems. The result will be better connectivity during extreme weather events and natural disasters which, in turn, will help communities recover more quickly.

While TRIP is focused on the transportation network, the region could benefit from a broader understanding of community-level hazard impacts across the interdependent systems. Doing so, however, would require a separate study focused more specifically on existing community interdependencies. CMAP will continue to work with partners to support regional and local emergency management efforts and planning activities (e.g., HMPs) as well as other regional resilience preparedness efforts (e.g., expanding the tree canopy).

Understanding vulnerability

A foundational component of any resilience improvement plan is a clear understanding of the transportation system's vulnerabilities to extreme weather and climate. Therefore, CMAP's risk-based vulnerability assessment determined the region's hazards, the types of assets most threatened by those hazards, and the areas where vulnerable assets are concentrated. CMAP also sought a deeper understanding of where transit users face vulnerabilities when walking to or waiting at transit stops.

This section provides an overview of the approach to and summarizes the key findings of the risk-based vulnerability assessment. The results of this risk-based vulnerability assessment were used to inform the resilience planning described in the *Advancing resilience* section. Detailed information on the findings and approach can be found in *CMAP's Risk-based Vulnerability Assessment*. [19]

Approach overview

Table 1: Scope of CMAP's *Risk-based Vulnerability Assessment*

Scope component	Description
Geographic area	Cook, DuPage, Kane, Kendall, Lake, McHenry, and Will counties
Climate hazards	Extreme heat Extreme cold Freeze-thaw cycling Precipitation and flooding (urban, riverine, coastal) Severe storms (rain, snow, ice, wind) Compounding hazards (e.g., severe storm followed by high heat; ice storm followed by a cold snap)
Future timeframes	Mid-century (2035-2064), as the primary focus to align with planning horizons Late-century (2065-2094), also reviewed in the climate analysis

Scope component	Description
Emission scenarios*	Medium emissions scenario (SSP2-4.5) High emissions scenario (SSP5-8.5)
Transportation asset categories	Major roadways** Bridges and culverts*** Rail lines, stations, and facilities Bus routes, stops, and facilities Electrical services and backup power Bicycle and pedestrian facilities

* Emission scenarios represent projections of future greenhouse gas emissions based on varying assumptions on energy use, socioeconomic growth, and technological development. Shared socioeconomic pathways (SSPs) were developed as part of the framework used in the Intergovernmental Panel on Climate Change's Sixth Assessment Report. SSPs are used in combination with climate models to describe potential climate futures and guide mitigation and adaptation policies. While SSP2-4.5 represents a "middle-of-the-road" scenario where global development and emissions follow historical trends with moderate mitigation efforts, SSP5-8.5 is a high-emissions scenario characterized by rapid economic growth, limited climate policy, and high energy demand (often considered as a worst-case scenario).

** The analysis for roads excludes the local road functional classification.

*** The analysis for bridges and culverts only includes structures from IDOT's Structure Information Management System, the vast majority of which have a total span of over 20 feet.[20]

The vulnerability assessment's four key components provided a systematic understanding of climate impacts to the region's transportation network. CMAP adopted the latest best practices from the FHWA's Vulnerability Assessment and Adaptation Framework, along with insights gained from other transportation agencies, to define the approach. [21]

Table 2: Key components of CMAP's *Risk-based Vulnerability Assessment*

Analysis	Description	Purpose
Climate	Evaluates recent trends and future projections for key climate hazards included in the assessment.	Provides the foundation for understanding future climate change (e.g., increased rainfall).
System-level	Screens priority asset categories for risk across the transportation system, assessing their sensitivity to specific climate hazards.	Identifies the asset categories most likely to be at risk from climate-related events and which require additional evaluation in the asset-level analysis.
Asset-level	Assesses the priority asset/hazard pairs identified in the system-level analysis to identify specific places, as well as individual assets (e.g., a road, rail segment, bus stop) with particularly high risk to climate hazards.	Determines the assets and places most at risk to regional climate hazards to help prioritize resilience investments and identify the types of investments that may be most effective for reducing risk.
Transit rider vulnerability	Assesses factors that lead to increased heat vulnerability at transit points.	Provides an understanding of how increased heat impacts transit riders.

This approach allowed CMAP to consider a wide range of hazards and assets before focusing on specific hazards (flooding and extreme heat) and transportation asset categories (which varied by climate hazard) for a more detailed assessment.

Please see CMAP's *Risk-based Vulnerability Assessment* for a complete explanation of the methodology and a supporting set of maps.[22]

Key findings

Flooding and extreme heat pose particular risk to the region's transportation system, with the potential to inflict costly damage to infrastructure, disrupt travel, and threaten the health and safety of travelers. Other hazards, such as thunderstorms and snowstorms, are also expected to become more frequent and severe in the future, bringing additional risks to transportation infrastructure and travelers. Please see CMAP's *Risk-based Vulnerability Assessment* for detailed findings, which are summarized below.[23]

Climate analysis: Recent and future climate hazards in northeastern Illinois

Climate hazards are increasingly causing damage and disruption to the transportation system, affecting both service and usability. The assessment demonstrates the risks to critical transportation infrastructure in northeastern Illinois and shows that these hazards are worsening. Transportation users and infrastructure assets such as roads, bridges, culverts, bus stops, and rail stations and lines are particularly affected by flooding and extreme heat. Table 3 discusses how climate is expected to change in northeastern Illinois in the future.

Table 3: Climate hazard summary for northeastern Illinois

Hazard	Future conditions (high emissions scenario, SSP5-8.5)
Extreme heat	▪ Both average and extreme high temperatures are **expected to increase**. ▪ Average temperature is **expected to increase** for all months of the year, and the monthly average could increase by up to 7°F by mid-century and 11°F by late-century. ▪ The number of days with extreme high temperatures and the frequency of heat waves is **expected to increase**, with the annual average number of days over 95°F increasing from 2 days historically to 18 days by mid-century and more than 45 days by late-century.
Extreme cold	▪ Extreme cold temperatures are **expected to occur less frequently**. ▪ The annual average number of days under 15°F is **expected to decrease** from about 5 days historically to 1 day by mid-century and 0 days by late-century. ▪ The annual average number of days with maximum temperature under 32°F is **expected to decrease** from 43 days historically to 23 days by mid-century and 14 days by late-century. ▪ Although the average number of extreme cold days is **expected to decrease** in the future, the Midwest may still experience extreme cold events, and **there is uncertainty** regarding how the intensity of these events may change in the future. ▪ Freeze-thaw cycles are **projected to decrease** approximately 7-9 percent by mid-century and 12-29 percent by late-century.
Precipitation and flooding	▪ Flooding is **expected to worsen**. ▪ Total monthly precipitation is expected to decrease slightly in summer months and increase in the fall, winter, and spring. ▪ The frequency and intensity of extreme precipitation events is **expected to increase**, with the maximum daily (24-hour) precipitation amount increasing by 8 percent by mid-century and 21 percent by late-century. ▪ The most significant flood events will become more severe. Two-dimensional modeling of future flooding conducted for this assessment indicates that the 100- and 500-year flood events* are **expected to increase in severity** by 5 to 10 percent by mid-century.
Severe storms (rain, snow, ice, wind)	▪ Severe storms are expected to be **more frequent and intense** in the future. ▪ Increases in severe storms will **drive an increase** in the risk of flooding, heavy precipitation, and extreme wind associated with these storms.
Compounding hazards	▪ Compounding hazard scenarios explore the effects of multiple hazards occurring one after another. ▪ Severe storms followed by high heat are expected to be **more frequent and severe**. ▪ Ice storms followed by a cold snap are expected to be **more frequent and severe**.

* A 100-year flood has a 1-percent chance, or a 1 in 100 chance, of occurring each year. A 500-year flood has a 0.2-percent chance, or a 1 in 500 chance, of occurring each year.
Source: CMAP's *Risk-Based Vulnerability Assessment*.[24]

System- and asset-level analysis

Flooding and extreme heat are the primary climate hazards threatening the region's transportation system and users. These hazards pose risks to physical assets and their operational reliability, including causing traffic and transit service disruptions.

They also pose health and safety concerns. For example, flooding can cause unsafe driving conditions. Transit riders, in particular, are vulnerable to these (and other) climate hazards because they are directly exposed to hazards while waiting at unsheltered bus stops, walking to and from stations, or transferring between modes.

Severe storms and extreme cold also bring notable risks to the transportation system, although not to the same extent as flooding and extreme heat. Freeze-thaw cycling poses more moderate risks.

Flooding

Flooding presents the most widespread and severe risks to northeastern Illinois' transportation network. Risk to infrastructure is particularly high for roadways, bridges, culverts, CTA and Metra rail lines and stations, electrical services and backup power, and bicycle and pedestrian facilities. Risk to service operation and user experience is also high. Flooding physically damages infrastructure, disrupts operations, increases maintenance and emergency response needs, and reduces accessibility and safety for users.

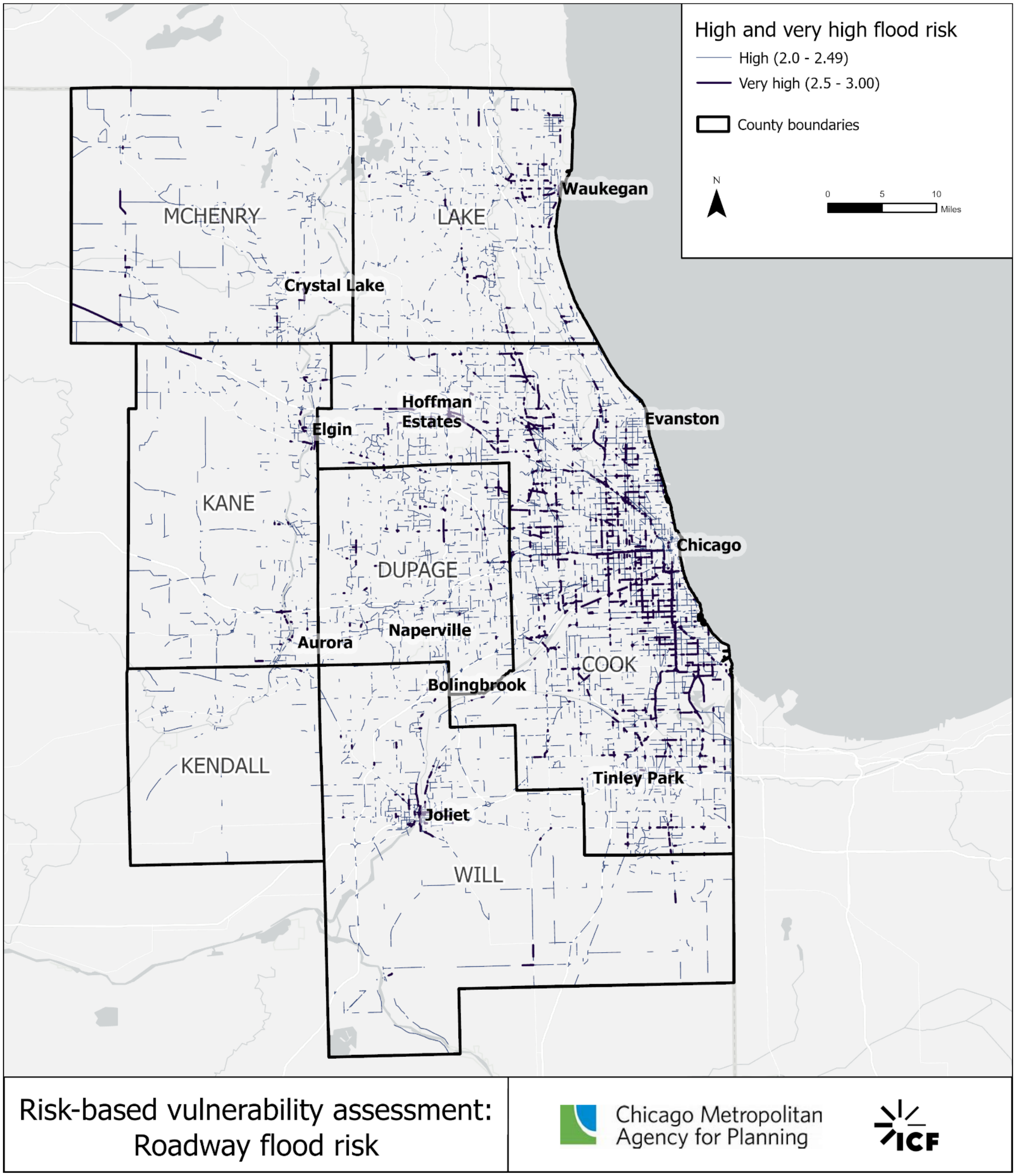
TRIP's assessment finds that:[*]

- 70 percent of road miles are at risk of experiencing at least 0.5 feet of flooding during a 500-year event by mid-century, with high-risk clusters in Cook County and other urban centers such as in Elgin, Joliet, and Waukegan (as shown in Figure 3).
  - 34 percent of road miles studied have high or very high flood risk.
  - Most high- and very high-scoring roadways have experienced past flooding and/or could experience 2 feet or more of flooding during a 500-year flood event by mid-century.
- 15 percent of bridges and 39 percent of culverts are at risk of flooding.
  - 8 percent of bridges and 19 percent of culverts have high or very high flood risk.
  - Very high-risk bridges and culverts are concentrated in Cook County (especially in the south and west suburbs), with additional clusters in Aurora, Elgin, Joliet, Naperville, and Waukegan.
- 64 percent of CTA bus stops and 47 percent of Pace bus stops are at risk of flooding.
  - 29 percent of CTA stops and 16 percent of Pace stops have high or very high flood risk.
  - All bus stops with very high flood risk scores either have past flood experience and/or are expected to experience nearly 2 feet (1.8 feet) of flooding during the 500-year flood event by mid-century. Additionally, almost all very high-scoring bus stops have high social vulnerability scores and are located in regional freight or employment clusters.
  - Several of the CTA's most heavily used bus routes — including Ashland, Garfield, Kedzie, Pulaski, 79th, South Kedzie, and Western — fall along corridors with very high flood risk.

[*] These findings are based on asset-level risk analysis that scored assets on a scale of "very high," "high," "medium," "low," and "not exposed." Details about methodology and risk scoring results are available in CMAP's *Risk-based Vulnerability Assessment*.

- 36 percent of CTA rail stations and 31 percent of Metra rail stations are at risk of flooding.
    - 32 percent of CTA stations and 10 percent of Metra stations have high or very high flood risk.
    - All CTA and Metra stations with very high flood risk scores are in areas that could experience more than a foot (1.2 feet) of flooding during a 500-year flood event by mid-century.
- Of the approximately 1,400 miles of trails in the region, 1,376 miles (97 percent) could experience at least 0.5 feet of flooding during a 500-year flood event by mid-century.
    - 33 percent of regional trails have very high flood risk, and 28 percent have high flood risk, with many trails following waterways, such as the Chicago Lakefront Trail along Lake Michigan.

Figure 3: Example map of vulnerability assessment results (roadway flooding)



Extreme heat

Extreme heat poses growing risks to transportation infrastructure and the health of transportation users and workers. Risk to infrastructure is particularly high for CTA and Metra rail lines and stations and electrical services and backup power. Risk to service operation and user experience is also high. Extreme heat can lead to pavement and rail buckling as well as strained electrical systems, and affect the comfort and safety of both transit users and outdoor workers.

TRIP's assessment finds that86 percent of CTA rail stations and 99 percent of Metra rail stations are at risk of extreme heat. [†]

- 77 percent of CTA rail stations and over half of Metra rail stations (54 percent) have high or very high extreme heat risk.
- All CTA and Metra stations with very high-risk scores are in areas projected to experience more than 20 days per year with temperatures over 95°F by mid-century.
- 92 percent of CTA rail lines and 71 percent of Metra rail lines have high or very high extreme heat risk.

Transit rider heat vulnerability assessment

Transit users are particularly vulnerable to extreme heat as they are directly exposed to weather while walking to or waiting at transit stops. When severe weather hits, some riders may not have access to alternative modes of travel; they face the choice of walking and waiting in uncomfortable or dangerous conditions or staying home.

Transit riders' vulnerability to heat is influenced not only by extreme temperatures, but also by social and health factors and transit stop conditions. **Social and health factors** include age (e.g., young and elderly riders), prevalence of underlying health conditions, socioeconomic disadvantage, and transit dependence (e.g., households without a car). **Transit stop conditions** include the presence or absence of shade (such as a tree canopy), service frequency, and proximity to stops — all of which influence a rider's exposure and ability to cope with extreme heat.

- More than half (52 percent) of bus stops in northeastern Illinois scored as having high or very high vulnerability. [‡] At a service agency level, 70 percent of CTA bus stops and 38 percent of Pace bus stops scored high or very high vulnerability ratings.
- The majority of the region's bus stops (79 percent of CTA bus stops and 92 percent of Pace bus stops) are unsheltered, exposing riders to the elements. [§]
- More than half (55 percent) of rail stations in northeastern Illinois scored as having high or very high vulnerability. At a service agency level, 72 percent of CTA rail stations and 45 percent of Metra rail stations scored high or very high vulnerability ratings.

[†] These findings are based on asset-level risk analysis that scored assets on a scale of "very high," "high," "medium," "low," and "not exposed." Details about methodology and risk scoring results are available in CMAP's *Risk-based Vulnerability Assessment*.

[‡] These findings are based on transit rider vulnerability analysis that scored vulnerability of transit riders on a scale of "very high," "high," "medium," and "low." Details about methodology and scoring results are available in CMAP's *Risk-based Vulnerability Assessment*.

[§] The availability of shelters can influence conditions experienced by transit riders waiting at bus stops. Riders waiting at unsheltered stops can be more directly exposed to extreme heat effects than those at sheltered stops. Since only a small percentage of CTA and Pace bus stops have shelters, this shelter availability was not included in calculating the transit rider vulnerability rating. However, the prioritization of bus stops which are unsheltered and have a high or very high rating for shelter improvement projects would reduce vulnerability for transit users at these locations.

In terms of geographic distributions (as shown in Figure 4 and Figure 5):

- Aurora, Elgin, Joliet, and Waukegan; the south and west sides of Chicago; and the near south and west suburbs of Cook County have large clusters of bus stops with high and very high ratings.
- A majority of bus stops along the Chicago Department of Transportation and CTA's Better Streets for Buses network also have high and very high ratings.[25]
- Rail stations in urban areas generally have higher ratings than suburban and rural areas since urban areas are projected to have high exposure to extreme heat (indicated by days above 95°F) and also have concentrations of people with higher socioeconomic and health vulnerabilities.
- The CTA Pink Line stations from 18th to 54th/Cermak all have very high vulnerability. This means they are in areas expected to experience a high number of days above 95°F degrees and are surrounded by populations that tend to have higher social and health vulnerability index scores and be more transit dependent.
- All stations on the CTA Green, Orange, and Red lines south of the Loop have high and very high vulnerability ratings for the reasons described for the Pink Line above.

People waiting at bus stops are particularly vulnerable to extreme heat. Investments in shelters and trees can help reduce exposure. Photo credit: CMAP.

Figure 4: Map of transit rider heat vulnerability assessment results (bus stops)

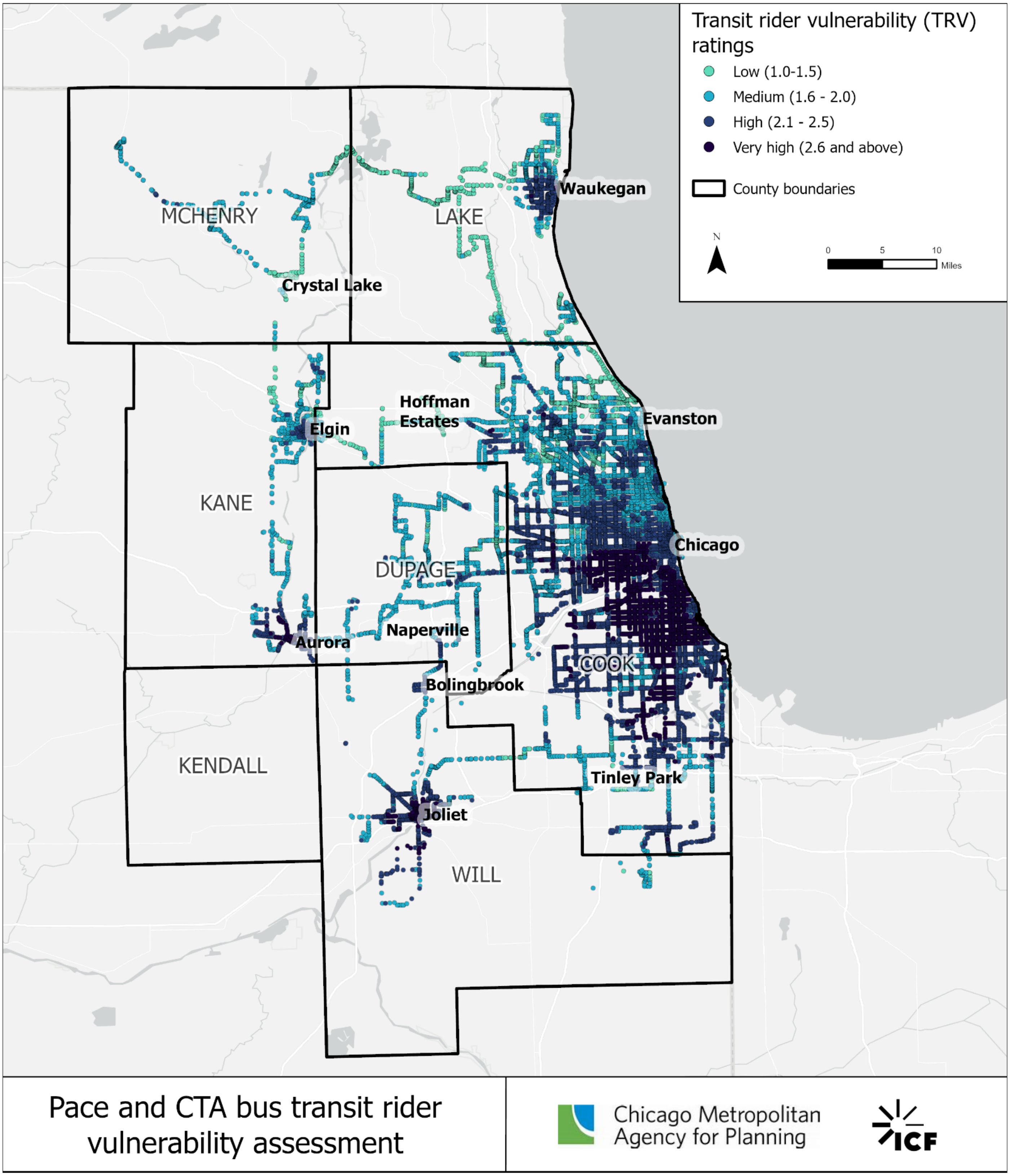
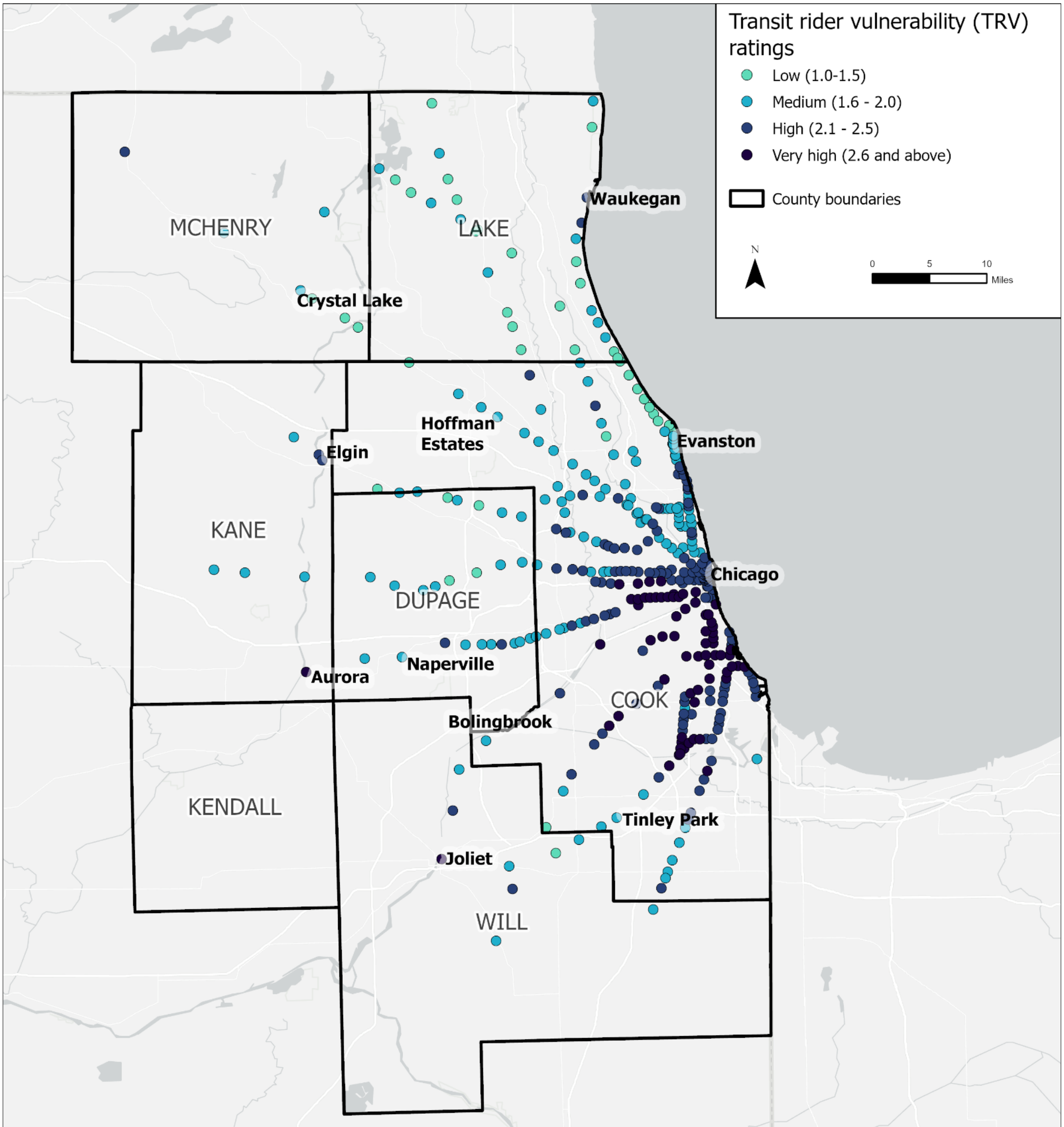


Figure 5: Map of transit rider heat vulnerability assessment results (rail stations)



Metra and CTA rail transit rider vulnerability assessment

Chicago Metropolitan Agency for Planning

ICF

Advancing resilience

The risk-based vulnerability assessment provided a foundational understanding of where the region's transportation system is most vulnerable to climate hazards. Building on these insights, TRIP lays out a multi-pronged approach to improving system resilience.

Regional partner agencies already have transportation projects under consideration, many of which CMAP evaluated to identify those that offer the greatest resilience benefits. The resulting list of **priority projects** will help CMAP and regional partners focus their attention and investments. A project's inclusion on the list also helps partners pursue funding opportunities, such as the PROTECT Program. Find the full list of priority projects in *Appendix C: Priority resilience investments*.

In addition, TRIP presents a suite of **project resilience strategies** that can inform site-specific designs to address local vulnerabilities to flooding or extreme heat. TRIP also recommends **organizational strategies** to embed resilience into routine planning, design, and investment decisions — ensuring that resilience becomes a continuous and integrated component of regional transportation decision making.

Priority projects for investment

In collaboration with implementers, CMAP created a prioritized list of projects that address risks and increase the resilience of the region's transportation system. The list's 64 projects range across surface transportation asset types, hazards, resilience improvement strategies, and implementing agencies. Many of these projects were already under consideration by CMAP's partner agencies for a variety of reasons — such as improving safety, mobility, or asset condition — and were not necessarily designed with resilience as a primary objective. Some projects serve as standalone resilience projects that will reduce flood impacts to the transportation system and surrounding properties.

CMAP further evaluated these projects to identify those which offer the greatest risk reduction potential. CMAP's project scoring process identified the projects that addressed the greatest resilience **needs** in the region and would have the greatest **impact** on addressing those needs. Projects that scored the highest are flagged as "high priority" and can serve as focal points for the region's targeted resilience investments. While all priority projects are included in TRIP, this shorter list of high-priority projects is provided to identify the highest regional priorities from a resilience perspective.

The project solicitation approach, scoring criteria, and full list of prioritized projects are included in *Appendix C: Priority resilience investments*. As noted elsewhere, while the list is intended to highlight current regional priority resilience projects, other relevant projects may arise or be identified. The project list can be updated as needed by CMAP and its regional partners.

The priority project list includes **49 road and bridge projects** and **15 transit projects**, with over half included in CMAP's Transportation Improvement Program (TIP). Most projects focus on flooding issues using a diverse range of strategies, including wetland restoration, bridge replacements, roadway elevation, stormwater infrastructure upgrades, transit facility waterproofing, and detention basin construction. Additionally, one shoreline reconstruction project addresses coastal flooding and erosion along Lake Michigan. Other projects target risks from extreme heat and cold affecting transit riders and workers, including roof and heating, ventilation, and air conditioning (HVAC) replacements or upgrades, and the modernization of transit station shelters. Non-infrastructure projects include studies to assess hazard impacts and infrastructure needs, as well as improvements to communication and evacuation systems to support emergency response and coordination.

CMAP evaluated the list of priority projects to identify those that scored particularly well on the resilience criteria. The top third of each project group (road/bridge and transit) is considered a high priority project based on their overall scores, for a total of 20 high-priority projects. Table 4 shows the breakdown of projects by lead agency. Figure 6 and Figure 7 show the breakdown of project types for the priority and high priority project lists, respectively. Note that four projects were added shortly before publication of TRIP, after the scoring was completed. These projects are included in the priority project list but were not scored or considered when determining the top third of each project group.

Calculating the economic impact of flooding

Flooding creates significant and costly delays and disruptions for all transportation system users. A flooded road or rail segment can disrupt commutes, goods movement, and tourism. Despite these real costs, transportation-related disruptions are rarely factored into estimates of infrastructure impacts, which help guide levels of investment.

To help close that gap, CMAP developed an Excel tool to estimate the costs associated with flooding impacts on the transportation system. The tool estimates the cost of closures from flooding at a specific location, for a defined period, based on the number of users and standard delay costs and assumptions. The tool was tested in five different regional locations representing varied infrastructure and user types (e.g., highways, transit, etc.). For a one-hour disruption, the results illustrated a range of costs from $15K to $140K, depending on the level of traffic, congestion, and transit service disruption.

The tool can help planners and engineers understand the costs and benefits of reducing flood-related closures, further supporting the asset-protection benefits for building more resilient infrastructure. Please contact CMAP at info@cmap.illinois.gov for access to the tool.

Table 4: Breakdown of lead agencies for priority projects

Lead agency	Number of priority projects	Number of high priority projects
Chicago Department of Transportation (CDOT)	1	0
City of Aurora	2	0
City of Batavia	1	0
Cook County Department of Transportation and Highways (DoTH)	5	2
CTA	12	4
DuPage County Division of Transportation (DuDOT)	5	3
IDOT, District 1	20	4
Kane County Division of Transportation (KDOT)	1	0
Lake County Stormwater Management Commission (SMC)	6	2
McHenry County Division of Transportation (MCDOT)	2	0
Metra	3	1
Metropolitan Water Reclamation District of Greater Chicago (MWRD)	2	2
Village of Burr Ridge/WBK Engineering	1	1
Village of Downers Grove	1	1
Village of Orland Park	1	0
Village of Oswego	1	0
Total	**64**	**20**

Figure 6: Breakdown of project types for all priority projects

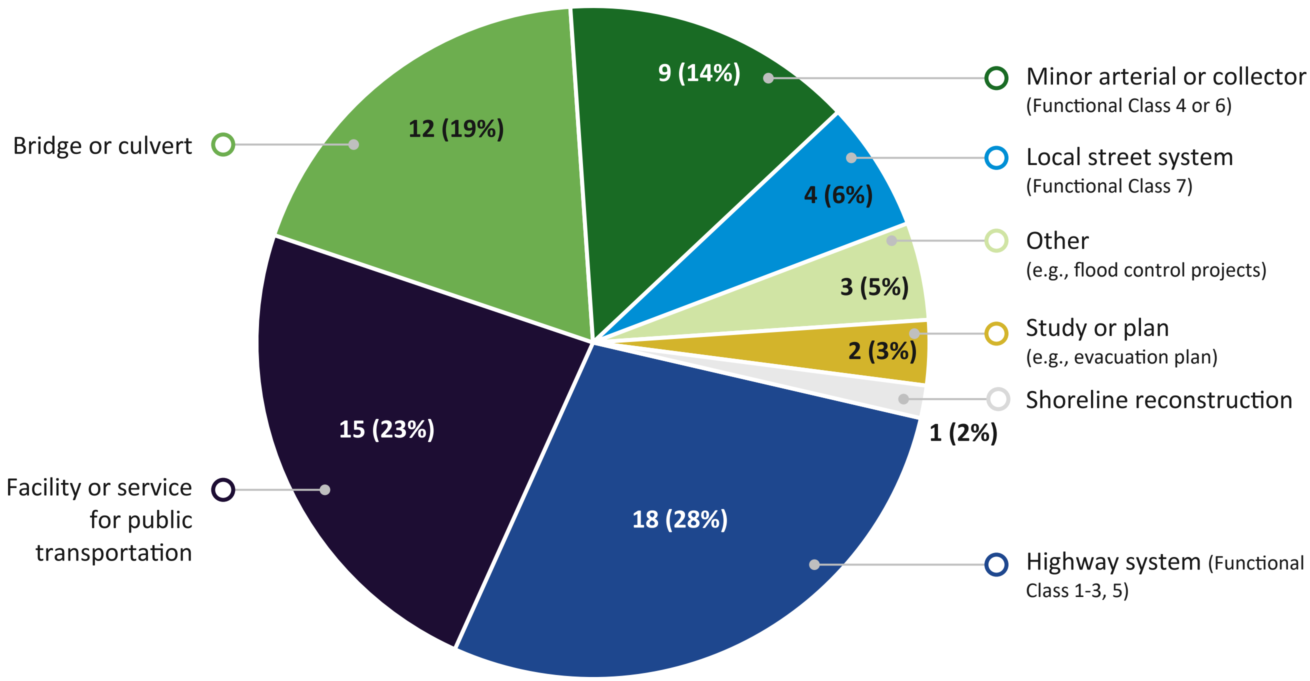
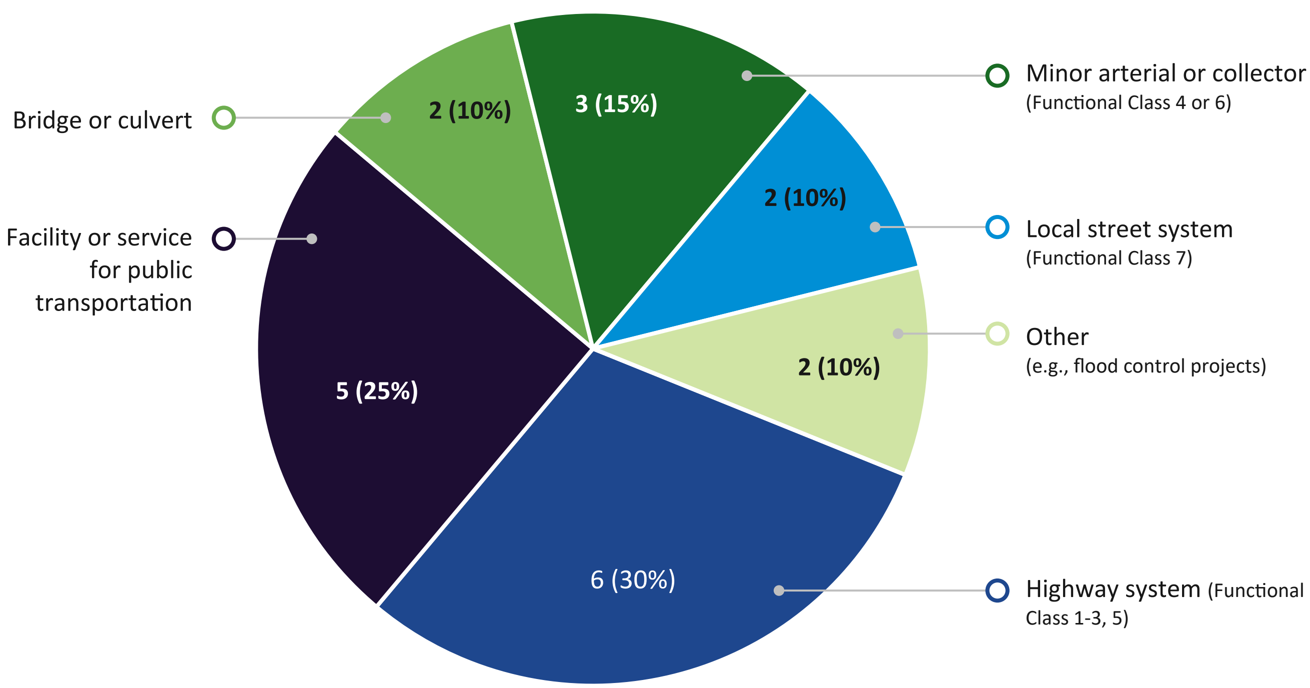


Figure 7: Breakdown of project types for high priority projects



Resilience strategies

Reducing the transportation system's exposure to and impact from climate events is a critical step in building resilience. Doing so requires action from all levels of government and at all scales. In addition to identifying key projects for resilience improvements, TRIP recommends a suite of resilience strategies to limit or prevent the impact of climate hazards, primarily flooding and extreme heat. These strategies are grouped into **project** and **organizational resilience strategies**. Project strategies include roadway, bridge, and transit infrastructure. Organizational strategies focus on agencywide changes that can integrate resilience through key planning and decision-making processes.

Project resilience strategies

In collaboration with regional partners, CMAP developed a list of project resilience strategies to limit the impacts of the region's main climate hazards: flooding and extreme heat. These strategies focus on changes that can be incorporated into future roadway, bridge, and transit project designs. Because hazards, such as flooding, are often difficult to mitigate through a single transportation project, this list presents strategies that can reduce impacts to transportation systems and the broader communities in which they are located.

The strategies are broadly categorized into structural solutions and nature-based solutions. In practice, resilience improvement projects often use a combination of these solutions to increase the effectiveness of the project. For example, gray stormwater infrastructure improvements could be combined with stream or wetland restoration to reduce flooding risk.

The strategies listed in Table 5 and described below address either flooding or extreme heat. They reduce risks to, and improve, overall public health and safety. All of these strategies can provide benefits beyond increased resilience.

Table 5 indicates which strategies also have the following additional co-benefits:

- **Air or water quality**: Enhances air or water quality, with associated environmental and public health benefits.
- **Sustainable ecosystems:** Supports healthy habitats and biodiversity.
- **Affordability and economic vitality:** Delivers cost savings and fosters local economic development.
- **Quality of life:** Makes an area more beautiful, reduces noise pollution, provides shade for pedestrians or bicyclists, or increases public space.

Any given project could also reduce disproportionate impacts to under-resourced communities, depending on the project site, by providing targeted support to communities that need it most.

Table 5: Summary of project resilience strategies and associated co-benefits

Strategy	Hazard	Air or water quality	Sustainable ecosystems	Affordability and economic vitality	Quality of life
Structural solutions					
Elevate bridges	Flooding		o	✓	o
Elevate or relocate roadways	Flooding		o	✓	o
Install flood walls to prevent flooding of roadway	Flooding	✓		✓	
Install geotextiles on embankments	Flooding	✓	o		
Improve or deepen drainage ditches	Flooding				
Upgrade or install culverts and other stormwater management infrastructure	Flooding	o	o	✓	o
Implement flood protection measures for transit tunnels	Flooding				
Upgrade rail infrastructure, particularly interlockings	Extreme heat				
Install shade structures and shelters along sidewalks and at outdoor transit stops	Extreme heat	✓			✓
Use cool pavement technologies	Extreme heat	✓			✓
Nature-based solutions					
Manage streams to reduce erosion and overtopping	Flooding	✓	✓	✓	✓
Implement natural revetments	Flooding	✓	✓	✓	
Reconnect river floodplains to increase flood storage	Flooding	✓	✓	✓	
Use flood buyouts in flood-prone areas	Flooding		✓	✓	✓
Create a natural high-flow bypass	Flooding	✓	✓	✓	
Restore, enhance, and create wetlands	Flooding	✓	✓	✓	✓
Install stormwater detention facilities	Flooding	✓	✓	✓	✓
Install swales and infiltration practices	Flooding	✓	✓	✓	✓
Use permeable pavements and grass medians	Flooding	✓		✓	✓
Recycle greywater on site	Flooding		✓	✓	
Provide shade trees along trails, sidewalks, and at transit stops	Extreme heat	✓	✓	✓	✓

o potential co-benefit, depending on specific project design and location ✓ likely co-benefit, regardless of project design and location

Structural solutions

Elevate bridges

Raising bridges above the worst-case scenario future flood level completely removes the bridge deck from the area of flooding exposure. Elevating bridges reduces service interruptions during flood events and enhances long-term infrastructure reliability. Additionally, bridges can act as barriers to water flow, contributing to upstream flooding. Elevation increases clearance beneath the bridge, improving hydraulic capacity and reducing flood risk upstream.[26]

South Branch of the Kishwaukee River bridge elevation

IL 176 over the South Branch of the Kishwaukee River, in McHenry County, was prone to flooding which created hazardous conditions, delayed or prevented emergency response, and led to roadway closures. When the existing bridge needed replacement, the roadway was elevated and the waterway crossing replaced with a much longer bridge and overflow culvert to prevent overtopping.

Photo credit: IDOT.

Elevate or relocate roadways

Relocating or elevating roadways out of high-risk flood zones prevents their flooding. This can be accomplished by shifting road alignments or raising the road profile above anticipated flood elevations. While this strategy completely removes the road surface from the area of flood exposure, it can be costly and often requires significant space to implement.[27]

Knollwood subdivision flood mitigation and road improvements

Partnering with Lake County Stormwater Management Commission, the Village of Fox Lake made improvements to reduce flooding in the Knollwood subdivision. This project elevated approximately 4,100 feet of roadway an average of 1.4 feet to reduce road flooding and closures. It also included new storm sewers and improved drainage conveyance.

Photo credit: Lake County SMC.

Install flood walls to prevent roadway flooding

Flood walls are permanent barriers constructed along roadways to prevent floodwater from reaching the road. This strategy is especially effective for roadways that are located near waterways or in flood-prone areas with limited space. In addition to protecting roadways, flood walls can also stabilize slopes and help prevent erosion.[28]

Rand Park flood control and multi-use trail connection

This project includes the construction of flood walls, levees, and a pump station to address major recurring flooding along the Des Plaines River. It also includes a box culvert beneath Miner Street, which serves as a tunnel for the Des Plaines River Trail and provides additional flow conveyance during high water. This project was made possible through a partnership with the Illinois Department of Natural Resources and the cities of Des Plaines and Park Ridge.

Photo credit: U.S. Army Corps of Engineers, Chicago District.

Install geotextiles on embankments

Geotextiles are synthetic (polypropylene or polyester) or vegetated fabrics made of degradable materials (straw, wood, coconut, jute, or blend) that are bound into a mat to provide structural reinforcement, stabilize soil, and prevent erosion. These blankets or mats are typically bound together with plastic or photo-degradable mesh or netting on one or both sides. Geotextiles are often combined with vegetation to provide long-term soil stability. Geotextiles on road embankments are typically vegetated with low-maintenance, non-invasive plant species, including grasses, sedges, and shrubs. This strategy is especially effective where embankments are exposed to high water flows.[29]

I-490 erosion control blanket

The Illinois Tollway requires erosion control blanket to be placed immediately after permanent seeding when slopes meet or exceed 1:10 (vertical to horizontal). Double net blanket is needed for steeper slopes, and blanketing with biodegradable netting should be used whenever possible to reduce plastic use or wildlife entrapment. This installation was completed as part of the Tollway's I-490 project, in partnership with the MWRD.

Photo credit: Illinois Tollway.

Improve or deepen drainage ditches

Improving or deepening drainage ditches can increase their capacity to convey or redirect stormwater, reducing surface runoff. Ditch improvements can help reduce the likelihood of floodwater reaching the roadway surface and are relatively low-cost. This strategy is especially effective where insufficient ditch capacity is the primary cause for roadway flooding during storm events.[30]

Boca Rio Ditch

Cook County DoTH, in partnership with MWRD and the City of Oak Forest, installed dual 7.5 by 4-foot box culverts under 151st Street and approximately 1,700 feet of channel improvements along Boca Rio Ditch to reduce the risk of flooding for up to 28 residential structures in Oak Forest. Further, the project incorporates streambank stabilization and a naturalized channel section with sedimentation basins to reduce the potential for siltation and erosion of the Boca Rio Ditch and migration of silt downstream of 151st Street.

Photo credit: MWRD.

Upgrade or install culverts and other stormwater management infrastructure

Upgrading or installing culverts and other stormwater management infrastructure (e.g., pipes and drains) can improve conveyance and increase available storage for surface runoff during storm events. There are many different approaches to upgrading stormwater management infrastructure, including right-sizing culverts or reconfiguring restrictive culverts to fit natural channel profiles. This strategy could also include adding underground storage beneath roads. Implementing underground storage as a flood control with roadway improvement projects is ideal in heavily urban environments where space is not available or land is too valuable for aboveground storage, where strict flood controls are required and large storage volumes are needed, and where utilizing stormwater management for co-benefits is less of a priority.

By increasing the system's capacity to convey and store stormwater runoff, this strategy reduces the risk of standing water and transportation assets being inundated during flooding events. It is especially effective for addressing flooding due to undersized or outdated drainage infrastructure.

Burr Oak Area stormwater detention/storm sewer project

New storm sewers and roadway drainage along Alden Lane and Western Avenue, along with underground stormwater storage/detention below Western Avenue, were installed in Lake Forest. The project remediates flooding of basements, garages, lobbies, streets, and yards that periodically occurred along Western Avenue due to the estimated two-year storm design capacity of the previous drainage system.

Photo credit: City of Lake Forest.

Implement flood protection measures for transit tunnels

Flood protection measures can be used within and outside transit tunnels to prevent or reduce flooding risk. They can include permanent and deployable flood barriers to prevent water from entering transit tunnels. Wet and dry floodproofing can also be used to protect critical equipment in transit tunnels, such as installing flood vents, using flood-resistant building materials, or elevating critical electrical or mechanical equipment. Pump stations can also collect excess runoff during storm events.[31]

Homewood Station improvements

As a part of the $20.7 million Homewood Station reconstruction project, Metra rehabilitated the pedestrian tunnel under the station to include improved ventilation, trench drains, a drip pan ceiling, and false walls. Both entrances flanking the Homewood tunnel are fully enclosed, which improves resilience. Similar tunnel upgrades are being designed for the Van Buren, Olympia Fields, and Evanston Davis Street Metra stations, among others.

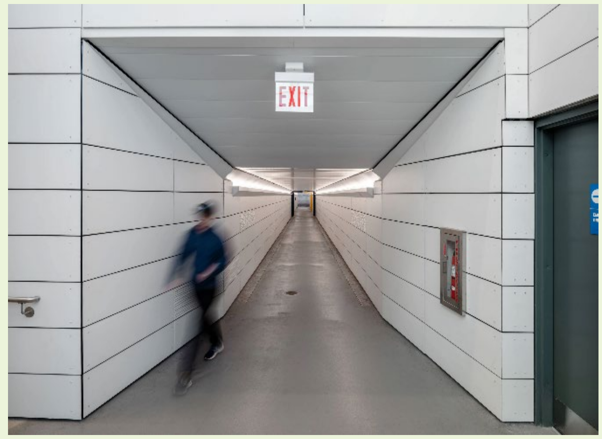


Photo credit: Metra.

Upgrade rail infrastructure, particularly interlockings

A large portion of CTA and Metra delays are caused by faulty or antiquated interlockings. Upgrading interlockings, including by adding crossovers, can improve resilience. Such upgrades allow for quicker operating speeds, the ability to schedule more trains, and faster recovery when there is a train breakdown or track failure.

In general, older and deteriorating rail lines and track elements are more vulnerable to damage from extreme temperatures. In these cases, replacing old track elements to maintain a state of good repair can help increase resilience.[32]

Rail renewal

Metra funds numerous capital projects each year to refurbish and replace rail, switches, crossovers, and interlockings across the system. These projects are necessary to maintain safe operations, track speeds, and on-time performance by preventing rail buckling. Metra's Continuous Welded Rail (CWR) policy follows industry standard for the rail-neutral temperature set for the Chicago region as required by FRA.

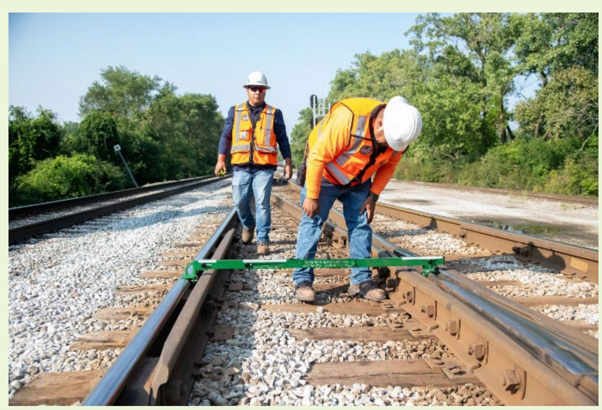


Photo credit: Metra

Install shade structures and shelters along sidewalks and at outdoor transit stops

Temporary or permanent shade structures — such as shade sails, canopies, or shelters — can be installed at outdoor transit stops, along sidewalks, and on trails to reduce extreme weather impacts. These structures provide protection for transit riders and pedestrians from extreme weather conditions, including excessive heat, intense sun exposure, and storms. By improving comfort and safety in public spaces, shade structures support equal access to transit and active transportation options, especially during increasingly frequent extreme weather events.[33]

Modern station shelters

Metra is installing modern shelters at stations across the Metra system to provide passengers with climate-controlled waiting space. The shelters are strategically planned at stations that lack an enclosed warming house on one platform as well as high-ridership stations that experience overcrowding. The new shelters are designed with large roofs that extend several feet to provide shade around the exterior of the enclosed area.

Photo credit: Metra.

Use cool pavement technologies

Cool pavement technologies employ materials or coatings that reflect sunlight and absorb less heat than traditional pavements, lowering ambient temperatures and reducing potential for extreme heat.[34]

Chicago Green Alleyways program

CDOT has an ongoing program to reconstruct flood prone alleys to improve stormwater drainage, reduce extreme heat, and conserve energy. The program incorporates lighter-colored and reflective concrete to help reduce the urban heat island effect. Other techniques, such as permeable pavements and drainage improvements, are also used to reduce flooding.

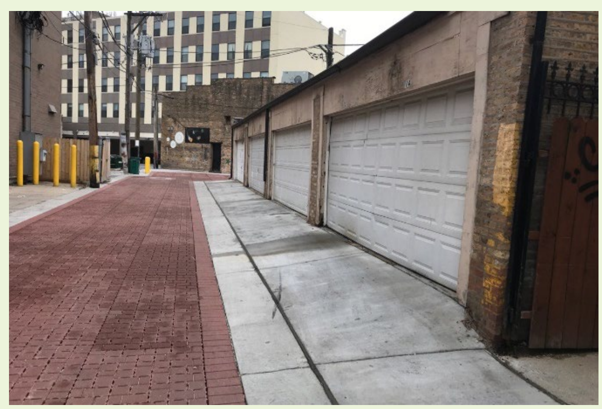


Photo credit: CDOT.

Nature-based solutions

Manage streams to reduce erosion and overtopping

Stream management strategies aim to reduce water energy and erosion in stream channels to reduce the risk of overtopping and flooding. There is a wide range of stream management strategies, including daylighting streams, revegetating riparian areas, stabilizing streambanks, reconfiguring stream channels, placing large woody debris, and implementing rocky in-stream techniques. Daylighting streams can restore natural stream function by opening and restoring aboveground water flow for streams that were previously diverted underground. Revegetating degraded riparian sites with plants and riprap can help stabilize streams, decrease erosion, and dissipate wave energy. Reconfiguring stream channels involves modifying channels to improve stream conditions, enhance floodplain connectivity, and reduce flooding. Placing large woody debris (fallen trees, logs, and branches) or rocks in stream channels can help dissipate water energy and redirect the flow of water, reducing downstream flood risks.[35]

Dixie Creek Reach restoration

Led by the Village of Algonquin, this project reshaped eroded creek banks, reinforced portions of creek bank that received erosive water flows, and used vegetation to stabilize surrounding soils. It resulted in 1,500 feet of restored stream, as well as an associated, high-quality, wetland identified as a critical restoration area in the Jelkes Creek watershed-based plan, which covers the Dixie Creek tributary.

Photo credit: Village of Algonquin.

Implement natural revetments

This strategy involves supporting projects that move from traditional, hard engineering coastal or shoreline structures (such as seawalls, concrete revetments, and breakwaters) to softer, greener approaches. Natural materials such as rocks, logs, and vegetation can be placed along river or stream banks, as well as coastal shorelines, to address flooding. Natural revetments are primarily used to restore eroding areas along waterways and reduce flood damage. They can help stabilize banks and dissipate water energy during floods. These methods are becoming more prevalent around the Great Lakes. They include options such as underwater rubble ridges, artificial reefs, and hybrid approaches that combine gray infrastructure with natural vegetation. These nature-based approaches to shoreline protection lead to multiple benefits, reducing coastal flooding and erosion while simultaneously creating habitat and preserving the natural lakefront.[36]

Illinois Beach State Park

This U.S. Army Corps of Engineers project constructs a rubble ridge along the shoreline of Illinois Beach State Park to protect the park's dunes, wetlands, and nearshore aquatic habitats from erosion. The project includes a five-year monitoring effort to track erosion rates and the ecosystem value of various habitats.

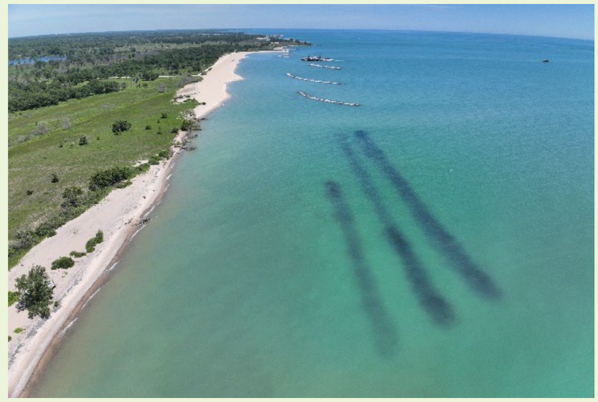


Photo credit: Illinois State Geological Survey.

Reconnect river floodplains to increase flood storage

Removing barriers along rivers can help reconnect the river to its historical floodplain or create a new floodplain, increasing available storage for floodwaters. This strategy helps spread floodwater over a larger area during high flows, reducing flood heights and downstream risks. This strategy is especially effective where peak river flows exceed the main channel's capacity and there is available space for flood storage.[37]

Spring Brook No. 1 restoration

This project reconnects an impaired stream in DuPage County to its original floodplain, previously channeled in another direction and dammed. The work involved re-meandering the stream, removing the dam, and restoring remnant woodlands and wetland and prairie plant communities. These changes improved flood mitigation for Illinois Tollway initiatives through increased flood resilience, thriving habitats, and improved public access.

Photo credit: Forest Preserve District of DuPage County.

Use flood buyouts in flood-prone areas

Purchasing properties or lands in high flood risk areas and converting the land to open space or natural floodplains can help reduce flooding impacts. In addition to protecting vulnerable infrastructure, this strategy helps increase available flood storage to reduce the severity of flooding during storm events.[38]

Partnering with Kane County to purchase flood-prone property

Over the years, the Village of South Elgin has successfully pursued property buyouts to prevent flooding and expand open space. Some buyouts were funded locally, while others were funded by FEMA through a partnership with Kane County. When accounting for land acquired through buyouts as well as the village's subdivision ordinance, South Elgin has over 230 acres of open space within the 100-year floodplain.

Create a natural high flow bypass

A natural high flow bypass can be created by constructing or restoring side channels or diversion channels that are directly connected to the main river channel. This strategy creates alternative flow paths, diverting excess water away from vulnerable infrastructure during storm events and periods of high flow. Bypasses are especially effective in locations where peak flows exceed the main channel's capacity and space exists to temporarily redirect water.[39]

Fargo-Moorhead area diversion project

The Metro Flood Diversion Authority's large-scale flood diversion project aims to protect the Fargo-Moorhead metropolitan area from flooding associated with the Red River and North Dakota tributaries. The project (anticipated completion in 2027) will include a 30-mile diversion channel that will serve as a high flow bypass, a 20-mile earthen embankment, multiple road and rail crossing, and several hydraulic structures, including aqueducts and inlets.

Photo credit: Metro Flood Diversion Authority.

Restore, enhance, and create wetlands

Communities can construct new wetlands or protect and rehabilitate degraded ones to reduce flooding. As opposed to turf grass, native vegetation helps absorb and store stormwater runoff, allowing wetlands to act as buffers during flood events. Wetlands also improve water quality and can provide habitat, carbon storage, and groundwater recharge.[40]

Crystal Lake constructed wetland

With funding from the Illinois Department of Natural Resources, the City of Crystal Lake acquired five flood-prone homes to create a constructed wetland. The project serves as regional detention in a neighborhood that experienced repeated flooding, providing over 170,000 gallons of stormwater storage. The use of native vegetation provides wildlife habitat and creates a beautiful asset for the community.

Photo credit: McHenry County Planning and Development.

Install stormwater detention facilities

Detention facilities collect, temporarily store, and filter stormwater runoff. Whether a wet pond or native vegetation dry-bottom design, detention facilities store stormwater and release it gradually. A more gradual release reduces peak runoff and downstream flooding and provides water quality benefits.[41]

Robbins Heritage Park and Midlothian Creek restoration project

The MWRD and the Village of Robbins are creating a stormwater park to provide flood protection for the project area. The park features a detention facility with native vegetation along the creek, a diversion channel to the Cal-Sag Channel, and channel improvements in the existing creek. The project will reduce flood risk for 92 structures and area roadways.

Photo credit: MWRD.

Install swales and infiltration practices

Installing vegetated swales and infiltration practices — including infiltration trenches, curb bump-outs, and road medians — can improve stormwater drainage. Swales channel stormwater away from roads and structures, while infiltration practices, planted with native species wherever feasible, capture and filter runoff. This strategy can help reduce flooding in addition to increasing slope stability and improving runoff water quality.[42]

Vegetated curb bump-outs

OAI, Inc. piloted green infrastructure in communities across south Cook County, including Blue Island. Installations include curb bump-outs and parkway rain gardens to lessen the effects of flooding, improve water quality, and increase habitat. Residents were hired to perform installations and maintenance, creating economic opportunities and growing the local green infrastructure workforce.

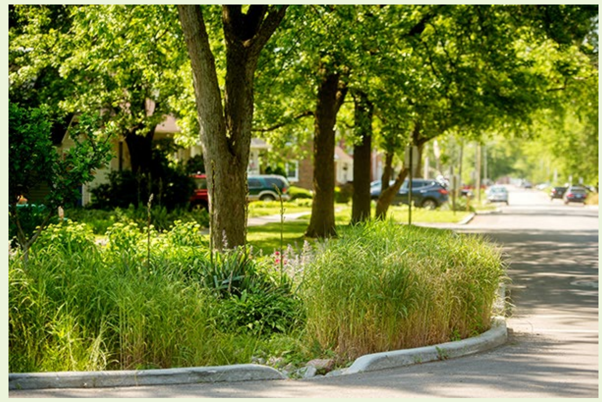


Photo credit: CMAP.

Use permeable pavements and grass medians

Permeable pavements and grass medians support stormwater mitigation. Permeable pavements can be used in road diet projects and low traffic areas (such as alleys and parking lots) to slow, filter, and clean stormwater runoff. Grass medians absorb rainwater and are especially effective at managing stormwater on roads where permeable pavements are not feasible.[43]

Permeable parking

Warrenville piloted permeable pavement on different city streets. Permeable pavers were installed in diagonal parking spots along Warren Avenue and the Hubble Middle School parking lot. These projects reduce stormwater runoff, which mitigates local flooding and improves water quality.

Photo credit: City of Warrenville.

Recycle greywater on site

Recycling greywater involves installing systems to collect, treat, and reuse water for non-potable purposes. For example, greywater can be recycled in rail yards and bus garages and used to wash vehicles or equipment. Recycled greywater can also be a useful resource during periods of drought or extreme heat to maintain nature-based solutions, such as vegetated embankments or grass medians.[44]

Transit water recycling

The CTA's water reclaim system captures and recycles water used to wash rail cars. The first 20 percent of the wash water goes directly out to the sewer while the final 80 percent is diverted to the water reclaim system. The system uses settlement tanks and charcoal filters to clarify the water and balance pH if needed. The CTA uses the reclaimed water to wash trains and equipment.

Photo credit: CTA.

Provide shade trees along trails, sidewalks, and at transit stops

Planting shade trees along trails, sidewalks, and at transit stops reduces extreme heat. Trees can help reduce the urban heat island effect, making active transportation options more comfortable. Additionally, trees can help absorb rainwater and improve air quality.[45]

Bellwood tree planting

Openlands partners with local communities and municipalities to plant shade trees along trails and sidewalks. The work prioritizes planting large and mature native tree species that can withstand future climate pressures. Planting events include education about the benefits of a healthy urban canopy, including reducing urban heat for human health.

Photo credit: Openlands.

Organizational resilience strategies

Enhancing transportation resilience is a continuous and iterative process that requires integrating resilience throughout key planning and decision-making processes. This integration is essential for meaningful and continued progress. In addition to the priority project list and project resilience strategies, CMAP and regional partners can implement organizational resilience strategies to accomplish this sustained approach to resilience.

CMAP has identified a set of specific organizational actions that the agency and regional partners can take to promote a culture of resilience and to make informed resilience investments. These strategies each fall within one of the following broad action areas:

- **Plans** refer to long-range transportation plans, asset management plans, and other policy-based planning documents where resilience goals and strategies can be embedded. These plans already exist, are updated regularly, and guide many elements of a transportation organization's decision-making processes.
- **Policies** refers to guidance for partners to update design and development standards, such as restricting redevelopment in vulnerable areas, promoting urban heat island mitigation, and incentivizing development in resilient zones.
- **Project development and design** refers to strategies that incorporate climate projections and adaptive design principles into specific infrastructure projects.
- **Coordination and capacity-building** refers to activities to build partners' capacity to implement resilience strategies. This includes regional coordination committees to align resilience efforts, peer exchanges to share best practices, community outreach to understand local needs, training sessions or roundtables to discuss resilience, and the development of case studies to support partners with project implementation.

Advancing resilience across northeastern Illinois relies on support and implementation by both CMAP and regional partners. These partners include public transit agencies and state, county, and municipal departments of transportation and public works. County stormwater and emergency management agencies also play a significant role in advancing resilience through their authorities and overall missions.

CMAP relies on its partners to implement resilience projects and adopt supporting policies, codes, and standards. While CMAP cannot require its partners to adopt specific policies or standards, the agency plays a significant role in guiding planning and development, which can be used to create a more resilient region.

These strategies are described in more detail in the subsections below. *Appendix D: Key implementing agencies for organizational resilience strategies* summarizes the organizational strategies and indicates key agencies that could be involved in their implementation.

Plans

Incorporate TRIP recommendations into the 2026 Regional Transportation Plan

CMAP is guiding the development of the 2026 Regional Transportation Plan (RTP) for northeastern Illinois. The plan will shape how the region will manage, operate, fund, and improve the transportation system — including public transit, highway, freight, bicycle, pedestrian, and accessible transportation — over the next two decades. TRIP findings and recommendations should be reflected in the RTP to ensure that long-term planning decisions are made with resilience in mind.

Key implementers: CMAP (lead)

Incorporate resilience into asset management plans, systems, and investment processes

Partners who own and manage transportation infrastructure can integrate resilience considerations into transportation asset management plans and into their investment prioritization processes. Implementers could adjust data inventories and condition assessments to include details on extreme weather vulnerability, such as frequency of historical flooding. For example, the CTA maintains hazard logs to track potential safety hazards, including extreme weather events, and could explore opportunities to improve weather tracking and further advance resilience.

Transportation owners and operators can also take a more proactive, preservation-focused approach to their asset management programs rather than prioritizing assets that are in the worst condition. Small-scale, preventive maintenance can help partners maximize the service life of transportation assets.

CMAP can play a role by developing guidance to assist implementers, including county-level transportation departments and public transit agencies.

Key implementers: Transportation agencies (lead); CMAP (supporting)

Incorporate best-available climate data into transportation-related plans

Partners can advance climate resilience by incorporating best-available climate data in transportation-related plans. Counties can update their long-range transportation plans and other key planning documents to support climate resilience efforts. Municipalities can incorporate climate data and emergency management into comprehensive plans. CMAP can lead by maintaining up-to-date climate information and making this information widely accessible to regional partners. Regional partners can make it policy to default to CMAP-provided climate data. Centralizing data management in this way reduces the overall cost of data maintenance and ensures consistency in underlying assumptions across agencies.

Key implementers: CMAP (lead); transportation agencies and local governments (supporting)

Integrate resilience into corridor planning and technical assistance programs

CMAP and the RTA's local planning activities can play a key role in helping to advance resilience. For example, CMAP will conduct comprehensive corridor studies to help manage congestion and meet other regional transportation goals, which can include addressing vulnerabilities to flooding and extreme heat. Another avenue is CMAP's technical assistance program, which supports local planning efforts, including plans for Americans with Disabilities Act (ADA) self-evaluation and transition, capital improvement, corridors, and pavement management. Through these projects, CMAP can introduce resilience concepts into plans which may not have climate resilience as a stated goal. Additionally, CMAP can expand its technical assistance offerings to include resilience plans, with a focus on reducing flood and heat impacts to the transportation system.

The RTA's community planning program, which encourages transit-supportive land uses and infrastructure around transit assets, presents another opportunity to embed resilience considerations into both transportation and land use recommendations.

Key implementers: CMAP and RTA (lead)

Develop local resources and guidance to complement TRIP

TRIP is a regional plan and its implementation will largely occur at the county and municipal levels. Using TRIP's vulnerability assessment data, resilience strategies, and project list, CMAP could create additional resources that support local implementation. These resources could include county-level summaries and interactive data visualization tools. CMAP can also support partners by maintaining up-to-date climate projections and guidance on using the latest information.

Key implementers: CMAP (lead)

Policies

Promote climate-resilient land use and development policies

CMAP and regional partners can help promote the adoption of climate-resilient land use and development policies. Climate-resilient policies encourage development in resilient areas, prevent development in vulnerable areas, and require the adoption of climate-smart standards. For example, municipalities could designate resilient zones for development — areas near transit hubs or areas less prone to flooding — and identify financial incentives for projects in these zones (e.g., fee waivers, tax breaks). These zones could also be prioritized for bike lanes and other features that would encourage multiple options for transportation modes, which can enhance resiliency.

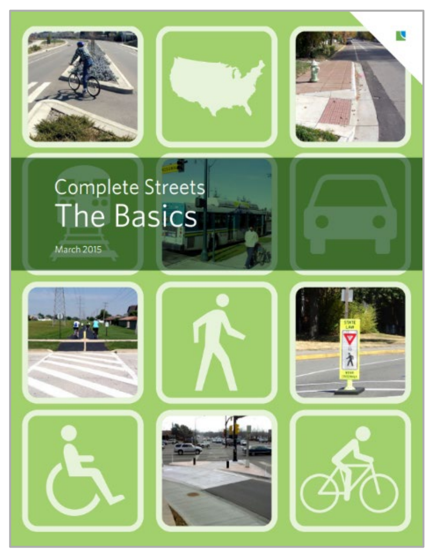
Municipalities could also pass zoning restrictions (e.g., floodplain overlay districts) as well as policies that advance the implementation of nature-based solutions for developments in vulnerable areas (e.g., encouraging communities to adopt stormwater ordinances and regulations that promote the use of green infrastructure). Yet another option is to adopt policies that facilitate flood zone buy-out programs.

CMAP and regional partners can advocate for the inclusion of these strategies in local activities such as zoning ordinances and comprehensive plans. To support these efforts, CMAP can also create guidance that highlights strategies and codes local communities can adopt to encourage new developments in climate-resilient areas.

Key implementers: CMAP and local governments (lead); stormwater agencies (supporting)

Incorporate resilience into the Complete Streets approach

Complete Streets is a transportation approach that requires streets that are planned, designed, operated, and maintained to enable safe, convenient, and comfortable travel and access for all road users, regardless of age, ability, or mode of travel. CMAP can support this strategy by incorporating simple and cost-effective resilience upgrades into CMAP's *Complete Streets Toolkit*.[46] Partners can incorporate these strategies into efforts to implement Complete Streets.



For example, with marginal additional effort and cost, communities can add stormwater bump-outs, bioswales, tree boxes, or parkways planted with native plants to a Complete Streets sidewalk construction project. It would capitalize on the project's existing ground disruption, labor, and equipment requirements. This synergy is bolstered by the fact that resilience practices improve safety by creating a barrier between vehicles and pedestrians, advancing the Complete Streets goal of reclaiming streets for people while enhancing climate resilience.

Key implementers: Local governments, transportation agencies, and stormwater agencies (lead); CMAP (supporting)

Continue to incorporate resilience criteria in scoring for fund programs and other key project prioritization processes and lists

CMAP and regional partners can further consider resilience in funding decisions. For example, projects could receive a higher score if they address identified climate vulnerabilities, enhance redundancy (e.g., provide multiple alternatives for travel for when a preferred route or mode is unavailable), are located on key routes serving hospitals or other critical facilities, or incorporate innovative strategies that provide co-benefits (such as nature-based solutions). Specifically, CMAP can incorporate resilience project scoring criteria for its fund programs (e.g., Congestion Mitigation and Air Quality Improvement Program, Surface Transportation Program Shared Fund, and Transportation Alternatives Program) and other key project lists (e.g., Regional Capital Projects).

Key implementers: CMAP and transportation agencies (lead)

Develop resilience indicators to track progress on improving resilience

CMAP and regional partners can use resilience indicators to track the extent to which resilience projects are being implemented across the region (activity-based metrics) and advancing resilience (outcome-based metrics). Several transportation and stormwater agencies are already tracking resilience indicators, including IDOT and the MWRD. As of the publication of TRIP, CMAP is exploring potential regional resilience indicators to track, which could include:

- Percent of roadway miles/bridges/culverts at high or very high flood risk (outcome-based)
- Percent of transit stops at high or very high flood risk (outcome-based)
- Number routes closed per year due to flooding or extreme events (outcome-based)
- Number of flood-flow deficient bridges and culverts (activity-based)
- Number of resiliency-related projects programmed in the TIP (activity-based)
- Percent of new projects using risk-based design with climate projections (activity-based)

Key implementers: CMAP, transportation agencies, and stormwater agencies (lead); local governments (supporting)

Project development and design

Provide regional data on flood susceptibility

The regional flood susceptibility index helps identify priority areas for flood mitigation activities. Created in 2018, the index has been used by CMAP and county, municipal, and other regional partners to inform planning and investment decisions. CMAP can continue to serve regional partners by maintaining and updating the index as needed and working with stakeholders to identify other data needs.

Key implementers: CMAP (lead); stormwater agencies and local governments (supporting)

Incorporate *Bulletin 76: Projected Precipitation Frequency for Illinois* into project design criteria to account for future precipitation values

CMAP and regional partners can support efforts to update hydrologic and hydraulic design guidelines to be more forward-looking. Specifically, the guidelines could incorporate updated rainfall projections published in the Illinois State Water Survey's Bulletin 76 for the 2050, 2075, and 2100 "middle-of-the-road" scenarios (SSP2-4.5).[47] Like

Bulletin 75, precipitation frequency estimates are provided for durations ranging from 5 minutes to 24 hours and for recurrence intervals from 2 months to 500 years. While designs based on *Bulletin 75* are appropriate for today's climate, they may not be adequate for the year 2050 and beyond. These adapted standards would allow new stormwater structures to withstand larger storms and more severe flooding events.

CMAP is already supporting this strategy by developing guidance on how to use *Bulletin 76* in project design and applying that guidance to three case study locations within the region. For more information on this strategy, please see *Appendix E: Using future precipitation projections in project design* for additional information.

Still, there is more work to be done to address barriers to using *Bulletin 76*. For instance, some funding sources will not reimburse additional capital costs associated with designing for future precipitation values. CMAP and partners can therefore support efforts to build momentum around the use of future precipitation projections. Such efforts could include demonstrating the monetary benefits of doing so, raising awareness of the barriers, and advocating for decision makers to adjust cost reimbursement rules.

Flood resilient design: A closer look

A changing climate means that the infrastructure we design today must be able to handle the rainfall that we can expect to see by mid-century.

How can engineers and planners use future rainfall projections to inform project design solutions? CMAP used *Bulletin 76* to examine three sites identified as having high flood risk:

- Route 6/159th Street in Orland Hills, Orland Park, and Tinley Park
- An area around North Cedar Lake Road in Round Lake Beach
- An area around 47th Street and Archer Avenue in Chicago

This analysis estimated the volume of stormwater runoff at each site for the projected mid-century 500-year storm. Then CMAP sited different project resilience strategies to illustrate opportunities to reduce flood risk at each location.

These case studies provide insights into how conceptual plans and studies can take future rainfall into account to meet both current and future stormwater needs.

Implementers — such as transit agencies, stormwater agencies, IDOT, and the Illinois Tollway — can support this strategy by adopting resolutions or policies that encourage or require the use of *Bulletin 76* projections. These implementers can also do their part to communicate the need for adjustments in cost reimbursement rules.

Key implementers: IDOT, Tollway, transit agencies, and stormwater agencies (lead); CMAP and Illinois State Water Service (supporting)

Incorporate nature-based solutions when designing projects that manage stormwater

Transportation agencies should seek opportunities to incorporate nature-based solutions (or green infrastructure) into site-specific upgrades and renovations. For example, they can identify opportunities across impervious areas — such as parking lots, roundabouts, and medians — where cumulative nature-based solution investments can yield significant resilience and environmental benefits. A comprehensive approach to integrating nature-based solutions at individual sites can maximize impact and support broader climate adaptation goals. CMAP can support this strategy by developing case studies and best practices, and encouraging coordination among agencies, such as transportation and stormwater departments. Counties and municipalities can support this strategy by adopting practices that will elevate the consideration of systemwide green infrastructure benefits, rather than focusing only on the project at hand.

Key implementers: Transportation agencies (lead); stormwater agencies, local governments, and CMAP (supporting)

Explore improvements to transit shelter design

Transit agencies and local governments can support improved transit shelter design by encouraging the development and piloting of creative shade solutions that enhance rider comfort while maintaining accessibility. Traditional bulky shelters may not be feasible in all locations due to space constraints or accessibility concerns, particularly for wheelchair users. This strategy promotes the exploration of alternative shelter designs — such as modular or low-profile shading structures — that provide effective protection from sun and rain without impeding access. Transit agencies and local governments can also support the development of updated design standards or best practices that ensure shade features are adequate, to avoid situations where a transit stop is considered sheltered but does not adequately provide shade or shelter in practice.

Key implementers: Transit agencies and local governments (lead)

Develop tools to simplify resilience integration throughout the project development process

CMAP can help transportation agencies incorporate resilience into project design by creating checklists, guidelines, decision trees, and other tools to support each stage of the project development process, from scoping to implementation. These tools could include resilience scores/rankings for regional infrastructure to guide project prioritization, a list of resilience goals and outcomes to guide project scoping, or screening tools to support decision making. For example, during the project scoping phase, partners can first evaluate whether the project is in a high-risk area and adjust the project design accordingly. Value engineering analysis and third-party benefit cost analyses could be used to systemically review the resilient components of project plans. CMAP can also work with implementers to help streamline the project development process, so that it is simple and integrates resilience considerations.

Key implementers: CMAP (lead); transportation agencies (supporting)

Provide case studies of transportation project resilience strategies

CMAP can support its partners by cataloging case studies of successful resilience projects and resources from peer organizations from across the region and country. These resources could include resilience strategies, features that engineers can consider in new projects, examples of how peer transit agencies have incorporated nature-based solutions into facility or station projects, or sustainable funding opportunities. The case studies can cover both structural engineering solutions and nature-based solutions. Each solution could also include estimated costs and benefits to help engineers determine where and when to implement them.

Key implementers: CMAP (lead); transportation agencies (supporting)

Support adaptive design and adaptive management

Adaptive design aims to produce projects that are not only climate-resilient, but climate-responsive. For example, engineers can build to a lower design flood elevation now while anticipating future increases in design flood elevation. Adaptive management plans can outline potential adjustments to projects if certain flood thresholds are reached. Transportation and stormwater agencies can actively seek opportunities to incorporate adaptive design in areas with potentially high future risks.

CMAP can work with partners to develop a range of resources to incorporate adaptive design in new projects and develop future adaptive management plans. This could include reviewing existing stormwater ordinances and design guidelines for transportation and stormwater infrastructure to ensure they include straightforward and up-to-date resilience considerations. From this review, CMAP can recommend specific updates to both expand and simplify adaptive design guidance (e.g., how to incorporate resilience into station design standards).

Key implementers: Transportation agencies and stormwater agencies (lead); CMAP (supporting)

Integrate long-term maintenance planning into green infrastructure projects

Green infrastructure projects often face long-term maintenance challenges due to unclear responsibilities and lack of dedicated funding. For instance, installation responsibilities and decisions may be led by one department while the responsibility for long-term maintenance lies with a different department. In some cases, planning and funding is focused on installation, and the planning and funding for maintenance activities are not adequately addressed. This is particularly an issue in right-of-way areas where ownership and jurisdiction may be unclear.

Transportation and stormwater agencies can establish clear agreements or protocols for maintenance from the outset, helping to ensure that these projects continue to deliver resilience and environmental benefits over time. These agreements should define who is responsible for ongoing upkeep and ensure coordination across departments. To address the common funding gap, implementers could also identify and secure dedicated resources for long-term maintenance early in the project lifecycle, potentially through capital improvement planning or integrated budgeting frameworks. Partners can develop a culture where the maintenance plan must be established prior to proceeding with installation.

Key implementers: Transportation agencies and stormwater agencies (lead); local governments (supporting)

Prioritize projects that increase alternative mobility options

Regional partners can prioritize projects that expand the network of dedicated lanes for alternative mobility options, such as bus and bike lanes. These facilities improve the reliability, safety, and comfort of non-car travel, encouraging greater use of transit and active transportation. Dedicated lanes also enhance system resilience by providing alternative routes when roadways are congested or disrupted — ensuring that people can still move, evacuate, or access essential services during extreme events.

Investment decisions should consider not only current usage but also the potential for *increased* ridership when infrastructure is made more accessible, pleasant, and efficient.

Key implementers: Transportation agencies and local governments (lead); CMAP (supporting)

Coordination and capacity-building

Participate in national-level peer exchanges, conferences, and online workshops to exchange best practices and lessons learned

CMAP and regional partners can increase participation in the national dialogue on climate and resilience topics by exchanging ideas and lessons learned with peer agencies across the country. These forums can provide opportunities for peer entities to discuss their best practices, lessons learned, and creative approaches to driving resilience in their respective regions. Agencies can share support they have provided to partners that worked well, and how they are working to align resilience efforts across their partner agencies and internally. CMAP could maintain a list of upcoming peer exchanges and conferences or virtual meetings that may be good forums for peer-to-peer learning and share this list with regional partners via newsletters. If opportunities are limited, CMAP could coordinate and host its own peer exchange with invitees from around the country.

Key implementers: CMAP, transportation agencies, stormwater agencies (lead); local governments, emergency management agencies, Illinois Environmental Protection Agency (IEPA), environmental departments, and community organizations (supporting)

Convene regional resilience working group and regional peer exchanges

CMAP can facilitate cross-agency coordination to advance resilience, mediated through a working group of partner organizations. This working group can track planned and ongoing infrastructure projects and funding opportunities, coordinate strategic opportunities to align resilience efforts across agencies and departments, and identify opportunities to pilot innovative resilience features.

Either within or separate from this working group, CMAP can also facilitate regional peer exchanges. These exchanges could provide a forum for key local partners to meet and collaborate, identify opportunities for funding and partnerships, and discuss best practices for advancing regional resilience. Additionally, CMAP can use these exchanges to encourage partnerships with other organizations that share overlapping goals and to highlight opportunities for aligning stormwater and transportation projects — especially where infrastructure investments overlap and multi-agency coordination is needed.

Key implementers: CMAP (lead); transportation agencies, stormwater agencies, local governments, emergency management agencies, environmental protection agencies, and community organizations (supporting)

Expand technical assistance offerings to build local staff capacity to advance resilience

CMAP's planning technical assistance program helps expand local governments' capacity to seek grant opportunities and implement past CMAP or RTA plans. CMAP can seek ways to expand its grant readiness and plan implementation assistance to help local communities obtain funding for and implement resilience projects and strategies outlined in TRIP. This could include identifying funding options to support resilience project implementation and including resilience opportunities in resources that outline potential funding options.

Key implementers: CMAP (lead)

Complete data gap analysis and needs assessment

Resilience data, such as flood reports and implemented projects, is essential for making climate-smart investments and tracking progress. CMAP can lead an effort to document the resilience data already collected across the region and then conduct a gap analysis and needs assessment to determine what additional data is needed going forward. This work can also identify opportunities to incorporate new data (e.g., green transit and bus flooding studies).

Key implementers: CMAP (lead); transportation agencies, stormwater agencies, and local governments (supporting)

Encourage watershed-wide planning and coordination

CMAP can serve as a regional convener and facilitator for watershed-wide collaboration across jurisdictions. Addressing stormwater and flooding challenges at a single site is often ineffective without considering upstream and downstream impacts. This strategy promotes the use of advanced modeling tools and encourages coordination among counties, municipalities, and neighboring states within watersheds. CMAP can help connect existing watershed-based plans and their stakeholders and explore mechanisms — such as a regional flood model or shared data platform — to ensure all partners have access to consistent, high-quality information to guide cost-effective, system-wide solutions.

This strategy would require collaboration among asset owners and operators, local public works departments, and other local agencies and departments at the nexus of stormwater management and transportation.

Key implementers: CMAP (lead); local governments, stormwater agencies, Illinois Department of Natural Resources, IEPA, watershed organizations, and community organizations (supporting)

Assess and improve communication tools for service disruptions and rider/driver preparedness

Transit agencies can improve how transit riders receive information about service delays, disruptions, and reroutes by developing a study to identify options for a unified communication platform. Improvements could include a service for real-time updates, proactive alerts tailored to individual transit use, and expanded signage at stops with wait-time information. To complement these tools, transit agencies can also create short educational videos to help demystify transit use and improve rider preparedness — particularly during extreme weather events. These efforts can enhance system usability, reduce uncertainty, and support resilience by ensuring riders are informed and able to adapt during disruptions.

On roadways, investments in intelligent transportation systems and improved public communication can likewise improve travel during events. Targeted communication alerts, as well as establishing a central source of information, can ensure that drivers are aware of relevant delays, detours, and route options before traveling.

County emergency management agencies typically update their HMPs on a five-year cycle to remain eligible for FEMA funding. These agencies can use HMP updates as an opportunity to review and adopt emergency alert and early warning system technologies and best practices for implementing these solutions.

Key implementers: Transit agencies and roadway agencies (lead); emergency management agencies and local governments (supporting)

Better understand transportation resiliency needs and increase community engagement and preparedness through community outreach and education

CMAP and regional partners can engage directly with communities to discuss local climate impacts, projects to improve transportation and stormwater resilience, and the steps residents can take to prepare for and respond to extreme events. Outreach efforts can also help demonstrate the benefits of nature-based and structural solutions, particularly in communities where there may be skepticism or limited awareness of their cost-effectiveness and co-benefits. CMAP and regional partners can support these efforts by developing regional case studies and educational materials to raise awareness about resilience strategies and resources, and partner with local environmental, biking, and community groups.

Key implementers: CMAP and local governments (lead); community organizations (supporting)

Looking ahead: TRIP implementation

TRIP marks a significant milestone in the region's efforts to advance regional transportation resilience by providing a comprehensive understanding of the region's most significant climate vulnerabilities and prioritizing resilience projects to begin addressing those vulnerabilities. This plan is the first step in formally tackling regional transportation resilience and is intended to be a continuous and iterative process. As highlighted throughout this plan, further integrating resilience within key planning and decision-making processes is essential for meaningful and continued progress.

Implementing TRIP recommendations

The suite of strategies detailed in the *Advancing resilience* section provides CMAP and regional partners with a starting point for achieving a more resilient transportation system.

CMAP plays a lead role in coordinating the implementation of these strategies, as the region's designated metropolitan planning organization, with key partners taking action. These partners broadly involve transportation, stormwater, and emergency management agencies, including but not limited to, counties, municipalities, IDOT, Illinois Tollway, RTA, CTA, Metra, Pace, MWRD, Illinois Emergency Management Agency and Office of Homeland Security, Illinois Department of Natural Resources, Illinois Environmental Protection Agency, Illinois State Water Survey, and U.S. Army Corps of Engineers. CMAP can provide these implementers with strategies tailored to the region and resources so they can begin implementation.

Concurrently, key partners are responsible for leading priority transportation projects, which includes applying for funding like PROTECT. These partners can also consider other ways to incorporate TRIP findings, tools, and recommendations into their work, such as through long-range and asset management planning, project development, and tracking performance.

CMAP also can undertake activities internally, such as incorporating resilience into long-range planning and programming activities, conducting further studies, developing resources, and facilitating capacity-building and collaboration (see the *Resilience strategies* section for more detail). For example, CMAP can ensure that the 2026 RTP reflects TRIP objectives and recommendations.

Monitoring process and impact

As part of TRIP implementation, CMAP will begin monitoring resilience projects and strategies that have been completed, as well as tracking barriers that complicated implementation. CMAP will do this through direct communication with partners as well as through tracking resilience criteria within CMAP's programs, such as tracking how many submitted projects have a resilience component or how often high-scoring resilience projects receive funding. CMAP may also consider incorporating TRIP criteria into the scoring frameworks of its funding programs, such as the Congestion Mitigation and Air Quality Improvement Program, Surface Transportation Program Shared Fund, and Transportation Alternatives Program to better align investment decisions with regional resilience goals. Partners play a critical role supporting these tracking efforts, as they are often in the best position to record essential information (e.g., frequency of flooding). This information will provide insights into where more attention or resources may be needed, as well as the resilience impact of associated investments.

CMAP developed an initial list of potential resilience indicators while developing TRIP. One of the key organizational resilience strategies noted earlier is to further refine and implement tracking of these resilience indicators. The goal is to track progress and better understand the effectiveness of resilience investments. At the time of TRIP's publication, resilience indicators are still under development by CMAP, but could include:

- Percent of roadway miles/bridges/culverts at high or very high flood risk
- Percent of transit stops at high or very high flood risk
- Number of routes closed per year due to flooding or extreme events
- Number of flood-flow deficient bridges and culverts
- Number of resiliency-related projects programmed in the TIP
- Percent of new projects using risk-based design with climate projections

Future TRIP enhancements

CMAP is committed to advancing resilience in northeastern Illinois. While this document represents a significant step toward that, the impacts of climate change will continue to pose a challenge to the region. Therefore, CMAP aims to make improvements to the risk-based vulnerability assessment and TRIP as opportunities arise.

For example, CMAP can periodically rerun the vulnerability assessment with new or additional inputs and updated data. As the datasets underlying the vulnerability assessment are updated, the results from the assessment will consequently shift as well. These datasets include, but are not limited to, the climate projection data, asset layers, and flood incidents. Several resilience strategies in the *Advancing resilience* section address improved data collection and coordination, meaning that a richer set of inputs could be considered in the future.

Similarly, the list of priority projects should also be periodically revisited. Some projects will be completed and removed from the list. In other cases, some projects may become more urgent as conditions change, and new priority projects could be identified.

CMAP, in coordination with its partners, developed TRIP to provide a strong foundation of transportation resilience work that advances the region's climate resilience goals. TRIP includes several valuable resources for the region, such as a detailed vulnerability assessment, the results of which are mapped and available for all. With the publication of TRIP, CMAP and regional partners are better positioned to make climate-informed decisions about future investments.

Appendices

Appendix A: Glossary

This appendix provides definitions for key terms used throughout TRIP. The following definitions are consistent with the Intergovernmental Panel on Climate Change's most recent glossary of terms and have been customized to be more relevant to this project.[48]

Term	Definition
Adaptation	Measures to reduce the impacts of climate change, including but not limited to hardening of infrastructure and operational changes to improve the ability of the transportation system to recover from damage and disruptions. Adaptation and resilience are often used interchangeably but have slightly different meanings. Adaptation refers to specific measures that can reduce climate-related impacts, while resilience is used more broadly to describe the ability of the transportation system to anticipate, prepare for, or adapt to impacts and/or disruptions from climate hazards. For the purposes of this assessment, CMAP primarily uses the term resilience.
Climate hazard	A climate-related event or condition that may cause physical damage to infrastructure, disrupt operations, or injure people. For this vulnerability assessment, CMAP investigated the following hazards: extreme heat, extreme cold, flooding, freeze-thaw cycling, and severe storms, including rain, snow, ice, and wind.
Climate projections	Modeled future climate conditions that are based on assumptions about changes in greenhouse gas concentrations. For example, the number of additional days over 95°F estimated for mid-century under a medium global emissions scenario.
Criticality	The level of importance of an asset to the transportation system. For example, roads with higher volumes and/or fewer alternative routes are considered highly critical. The impact to the transportation system is significant for highly critical assets. Criticality also considers social vulnerability indicators, such as transportation access.
Emission scenarios (sometimes referred to as SSPs)	Emission scenarios are applied to a climate model or a suite of models to project future climate conditions based on that scenario. Shared socioeconomic pathways (SSPs) are scenarios of projected socioeconomic global changes that, together with representative concentration pathways (RCPs), can be used to determine how greenhouse gas emissions and concentrations may change with different climate policies. These combined SSP/RCP scenarios are the current global standard for discussing future climate scenarios. The high emissions scenario (SSP5/RCP 8.5) assumes greenhouse gas concentrations continue to rise throughout the twenty-first century, while the medium emissions scenario (SSP2/RCP 4.5) assumes significant greenhouse gas emission mitigation prior to mid-century. These scenarios are referred to as SSP5-8.5 and SSP2-4.5, respectively.
Exposure	Indicates whether an asset is in an area that is affected by climate hazards. All other things equal, assets with high exposure are more likely to be affected by hazards than those with low exposure.

Term	Definition
Green infrastructure	A type of nature-based solution that integrates natural elements with built structures. Green Infrastructure can be used for stormwater management, urban cooling, among other uses.
Greenhouse gases	Gases such as carbon dioxide, methane, and nitrous oxide, that absorb heat in the atmosphere near the Earth's surface, preventing it from escaping into space.
High priority projects	In TRIP, the projects on the priority project list that scored highest on CMAP's regional resilience prioritization criteria and represent the projects most likely to have the greatest resilience benefits to northeastern Illinois.
Nature-based solutions	Adaptation strategies that utilize natural materials or are integrated into the natural environment, like sand dunes, pocket beaches, or rain gardens.
Organizational resilience strategies	Resilience approaches that address ways that resilience can be baked into a partner's policies, plans, or other decision-making processes. These strategies are not site-specific. Rather, they focus on how resilience can be embedded in everyday decision making.
Resilience	The ability of a transportation system to anticipate, prepare for, respond to, and recover from climate hazards. Adaptation and resilience are often used interchangeably but mean have slightly different meanings. Adaptation refers to specific measures that can reduce climate-related impacts, while resilience is used more broadly to describe the ability of the transportation system to anticipate, prepare for, or adapt to impacts and/or disruptions from climate hazards. For the purposes of this assessment, CMAP primarily uses the term resilience.
Risk	Potential threats to the transportation system due to climate hazards. These threats can include physical impacts to infrastructure and disruptions to services and operations. Risk is often used interchangeably with vulnerability, although some studies make distinctions between the terms; for example, risk may refer to the potential harm caused by vulnerabilities if an event happens.
Risk-based vulnerability assessment	An analysis of the degree to which a system may be adversely affected by impacts of climate change. For this project, risk-based vulnerability assessment refers to the process of identifying and evaluating the level of exposure to and impact of climate change on the transportation system and its assets.
Resilience indicators	Specific indicators of a project's efficacy that can be tracked, quantified, and assessed to demonstrate progress toward the project's goals.
Priority project list	FHWA requires that resilience improvement plans produced under the PROTECT Program put forth a list of resilience projects that are a priority for funding. CMAP's priority projects were selected and confirmed through a collaborative process with CMAP and regional partners.
Project resilience strategies	Resilience approaches appropriate for a specific site, where a project seeks to address a particular vulnerability to heat or flooding. TRIP showcases several solutions to address localized flooding or

Term	Definition
	heat risks, including examples of where the strategy has been successfully deployed. Regional partners can refer to these strategies when developing site-specific projects.
Sensitivity	The degree to which a system is affected by exposure to a climate hazard.
Structural solutions	Traditionally engineered, built-infrastructure projects like dams, pipes, riprap, or gutters. These solutions can also be referred to as gray infrastructure. Structural adaptation strategies are components of the built environment.
Transit rider vulnerability analysis	An assessment of factors that lead to increased vulnerability at transit points and identification of potential resilience improvements to help reduce extreme heat risk to transit riders.
Uncertainty	An expression of the degree to which future climate conditions are unknown. Climate uncertainty is caused by the complexity of the climate system, the ability of models to represent it, and the unpredictable nature of future societal changes.
Vulnerability	The susceptibility of the transportation system or its riders to adverse impacts from climate hazards. Exposure and sensitivity can be used to determine how vulnerable a transportation asset, or its riders are to climate hazards.

Appendix B: PROTECT requirements checklist

This appendix lists the required and optional components of a Resilience Improvement Plan (RIP) per the PROTECT program guidelines.[49] Table 6 lists each component and corresponding TRIP section.

Note that while FHWA refers to *RIP*, CMAP calls its plan *TRIP*. CMAP's TRIP fits the FHWA's definition of RIP.

Table 6: Required and optional PROTECT RIP components

The RIP…	Corresponding TRIP section
Shall…	
Be for the **immediate and long-range planning activities** and investments of the State or metropolitan planning organization with respect to resilience of the surface transportation system within the boundaries of the state or metropolitan planning organization, as applicable	Approach to TRIP development
Demonstrate a **systemic approach** to surface transportation system resilience	Approach to TRIP development
Be **consistent with and complementary of the state and local mitigation plans** required under section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5165)	Context for transportation resilience planning An internal memo detailing the findings of a review of complementary plans is available upon request
Include a risk-based assessment of vulnerabilities of transportation assets and systems to current and future weather events and natural disasters, such as severe storms, flooding, drought, levee and dam failures, wildfire, rockslides, mudslides, sea level rise, extreme weather, including extreme temperatures, and earthquakes (23 U.S.C. 176(e)(2)(A-C))	Understanding vulnerability
Shall, as appropriate…	
Include a description of **how the agency is prepared to respond** to the impacts of weather events, natural disasters and is prepared for changing conditions	Approach to TRIP development Context for transportation resilience planning Advancing resilience
Describe the **codes, standards, and regulatory framework**, adopted and enforced by the agencies, to ensure there are resilience improvements within the impacted area of proposed projects included in the RIP	Context for transportation resilience planning Advancing resilience

The RIP…	Corresponding TRIP section
Consider the benefits of combining hard surface transportation assets, and **natural infrastructure**, through coordinated efforts by the federal government and the states	Advancing resilience
Assess the resilience of **other community assets**, including buildings and housing, emergency management assets, and energy, water, and communication infrastructure	Community interdependencies
Include such **other information** as the state or metropolitan planning organization considers appropriate	Looking ahead: TRIP implementation
May also…	
Designate evacuation routes and strategies, including multimodal facilities, designated with consideration for individuals without access to personal vehicles	Not applicable
Plan for **response to anticipated emergencies**, including plans for the mobility of emergency response personnel and equipment and access to emergency services, including for vulnerable or disadvantaged populations	Not applicable
Describe the resilience improvement policies, including strategies, land use and zoning changes, investments in natural infrastructure, or performance measures that will inform the transportation investment decisions of the state or metropolitan planning organization with the goal of increasing resilience	Resilience strategies
Include an **investment plan** that includes a list of priority projects and describes how funds apportioned to the State under section 104(b)(8), or provided by a grant under the PROTECT Program would be invested and matched, which shall not be subject to fiscal constraint requirements	Priority projects for investment Appendix C: Priority resilience investments
Use science and data and indicate the source of data and methodologies	Understanding vulnerability

Appendix C: Priority resilience investments

This appendix provides the full list of priority resilience projects, grouped by roads/bridges and transit, as well as the approach to develop the list.

Approach

CMAP worked closely with its regional partners to identify priority resilience projects for inclusion in TRIP. This process focused on identifying existing projects addressing resilience, supplemented by vulnerability assessment results to uncover additional projects with potential to address identified vulnerabilities.

To advance this work, CMAP solicited candidate projects from regional implementing agencies. Each submission was reviewed and evaluated to establish a prioritized, manageable set of projects that represent the highest regional priorities.

Priority project solicitation process

Between May and June 2025, CMAP invited its partners to submit resilience projects for consideration using a project submission form (see Figure 8). To streamline the process, CMAP used two versions of the form: one to collect information while the other was a spreadsheet to allow the submission of multiple projects with an accompanying simplified form to capture spatial project location. In addition to key information about the project, the submission forms included questions to support the secondary project evaluation process.

To accompany the submission form, CMAP also provided agencies with **resilience project guidance** to support agencies interested in submitting projects.[50] The guidance provided definitions and examples of strong resilience projects, more information on the submission process, and CMAP's criteria for evaluating eligible resilience projects. Submitters were encouraged to submit projects that met the following criteria:

- Advances economic prosperity and public health
- Improves asset condition
- Incorporates innovative resilience solutions
- PROTECT eligible project/asset type
- Provides environmental and economic co-benefits
- Qualifying project type for PROTECT
- Reduces risk of impacts from climate hazards
- Targets high priority areas

Figure 8: Resilience project submission form

Welcome to the TRIP resilience project submission form

CMAP is soliciting transportation resilience projects to include in the Transportation Resilience Improvement Plan (TRIP) project list. This list will **help identify priority resilience projects** within northeastern Illinois and will also support implementers interested in applying for Federal Highway Administration's (FHWA) Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Discretionary Grants for resilience improvement projects. If a project is listed in the TRIP project list, the PROTECT grant applicant would get the following benefits:

- Preference during the awards process
- Exclusion from benefit-cost analysis requirement
- 7-10% reduction in the non-federal cost-share for awarded projects

Project submissions will be accepted through June 3, 2025. Please submit one project per form. We encourage you to provide as much detail as possible about your planned project. Questions marked with an asterisk (*) are required. While most sections are optional, the more information you include, the more comprehensive the project review process can be.

Information on project location is not required for projects that have already been submitted to the Transportation Improvement Program, FFY2026-2030 call for projects, or request for Regional Capital Projects.

For more information regarding the TRIP project solicitation process, CMAP's evaluation criteria for resilience projects, and examples of resilience projects, see CMAP's transportation resilience project guidance. If you have questions, feel free to contact Kate Evasic at kevasic@cmap.illinois.gov or 312-386-8782.

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To further assist agencies, CMAP shared a list of potential existing resilience projects in high vulnerability areas, as described in the text box below. CMAP also hosted an optional question and answer session, and shared responses from that session to clarify the submission process.

CMAP received 69 project submissions via the form. As a final step, CMAP filtered out projects that did not apply to eligible surface transportation infrastructure or otherwise meet the PROTECT requirements of resilience projects. The remaining 64 projects constitute the priority project list.

Project prioritization

While all relevant priority projects are included in TRIP, CMAP sought to identify a shorter list of high priority projects from a regional resilience perspective. CMAP developed a scoring process to identify the projects that addressed the greatest resilience **needs** in the region and would have the greatest **impact** at addressing those needs. The approach, summarized in Figure 9 and described in more detail below, balanced a mix of data-driven and judgment-based scoring.

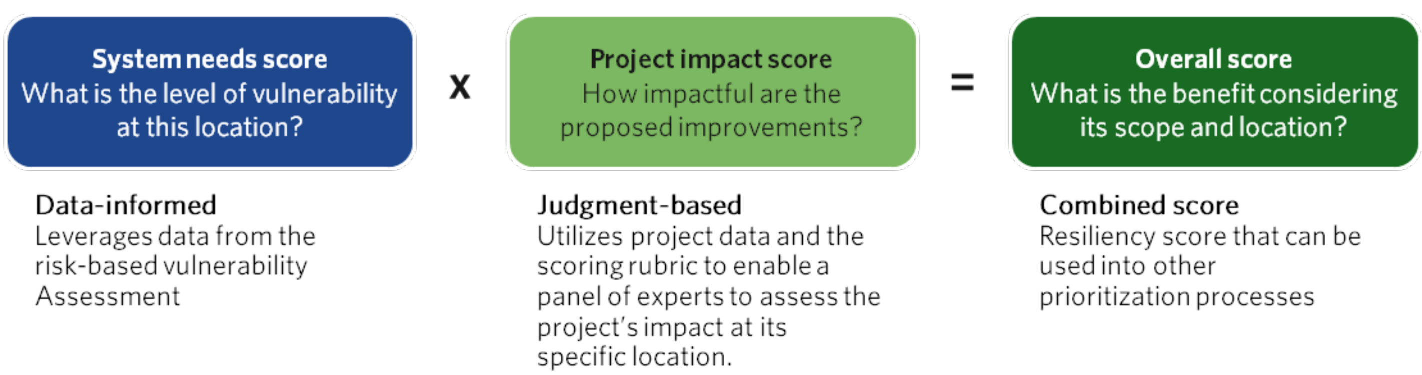
Incorporating resilience into existing projects

CMAP compared assets with high and very high vulnerability (as identified through the risk-based vulnerability assessment) with priority projects from other planning efforts in the region, including:

- Projects in the Transportation Improvement Program
- Projects submitted to CMAP's federal fiscal year 2026-2030 transportation call for projects
- Projects submitted through CMAP's Regional Capital Projects form for the 2026 Regional Transportation Plan
- Transportation-related projects outlined in county hazard mitigation plans

This compiled list was shared with partners, who were encouraged to submit if the projects addressed resilience or could be updated to do so.

Figure 9: Summary of project prioritization scoring approach



System needs score calculation

CMAP calculated need scores as shown in Equation 1 and Equation 2. For roadway and bridge projects, the score incorporates exposure, criticality, and sensitivity (Equation 1). For transit projects the score reflects exposure and sensitivity only (Equation 2). Both scoring approaches align with the vulnerability assessment framework applied in the systemwide analysis.

Equation 1: Roadway and bridge projects need score calculation

System needs score = (1/3) exposure + (1/3) criticality + (1/3) sensitivity

Equation 2: Transit projects need scores calculation

System needs score = 50% exposure + 50% sensitivity

Exposure represents the degree to which an asset may be affected by a given hazard (e.g. flooding for roadways, bridges, and bus facilities; flooding and extreme heat and cold for rail assets). **Criticality** reflects the role the asset plays in network connectivity and its socioeconomic importance. **Sensitivity** uses the asset's physical condition to understand the severity of potential impacts from hazards. Table 7 summarizes the data sources used for scoring sensitivity for each asset type.

Table 7: Summary of sensitivity data sources for each asset type

Asset type	Sensitivity score inputs
Roadways	Pavement condition ratings from the Condition Rating Survey
Bridges	Condition ratings from the National Bridge Inventory
Rail and bus	Ratings from the Transit Economic Requirements Model (TERM)* and CTA's Transit Asset Management Plan Scoring

*TERM is a standardized scale used by the Federal Transit Administration (FTA) to assess the physical condition of transit assets, ranging from 1 (poor) to 5 (excellent). Assets rated 3 or higher are considered to be in a state of good repair. The scale reflects an asset's condition and remaining useful life. Ratings are typically based on inspections, engineering assessments, or age-based proxies and are a key component of FTA's transit asset management requirements.

For projects involving multiple assets, the maximum need score across the assets was used as the final need score.

Project impact score calculation

CMAP calculated project impact scores using the qualitative criteria listed in Table 8. Each criterion was rated on a scale of 1 (lowest impact) to 5 (highest impact). Scores were based on the information provided through the project priority solicitation process. A standard rubric was used to ensure consistent evaluation across projects.

Table 8: Summary of impact score criteria

Criteria	Definition
Risk mitigation	To what extent does the project protect transportation assets from extreme weather events and climate hazards?
Green infrastructure/structural solutions	How well does the project integrate green infrastructure or structural solutions for long-term resilience?
Modernization	Does the project modernize assets to reflect or go beyond standard design requirements for resilience and future climate adaptation?
Extent of benefits	How effectively does the project enhance system-wide resilience, benefiting multiple assets or transportation networks?
Service continuity	To what extent does the project prevent long-term service disruptions (weeks to months) due to climate hazards?
Recovery time	How well does the project improve infrastructure resilience, reducing damage and repair needs after extreme weather events?
Innovation	To what extent does the project incorporate advanced technology or data- driven solutions to enhance resilience?
Broader environmental benefits	Does the project provide additional co-benefits beyond resilience, such as improvements in air quality, water quality, ecosystem health, or community well-being?

Final impact scores were calculated by assigning equal weights to each criterion and averaging the resulting values.

Overall score calculation

Finally, CMAP combined the system needs and project impact scores to calculate the overall project scores, as shown in Figure 10. The top-third scoring projects are considered high priority. Final overall project scores are presented with the priority project list in Table 9 and Table 10 below.

Figure 10: Overall project score calculation

Overall score = 50% **X** System needs score + 50% **X** Project impact score

Priority project list

Table 9 lists the full priority project list for roads and bridges, and Table 10 lists the priority transit projects. Projects marked with "!" are projects that were in the top third of the prioritization scores and noted as high priority projects. Note that four projects were added shortly before TRIP's publication, after the scoring was completed. These projects are included in the priority project list but were not scored and were not taken into account when determining the top third of each project group.

Table 9: Priority resilience project list for roads and bridges

! Denotes high-priority project

Project ID and title	Agency	Project type	Hazard addressed	Project description
Aurora_01: Mastodon Lake Drainage Overflow	City of Aurora	Minor arterial or collector (Functional Class 4 or 6)	Flooding	The project involves construction of storm sewer/grass channel for conveyance and a regional stormwater management facility designed to address urban flooding, reduce stormwater runoff, and improve water quality. The stormwater facility will provide overflow storm storage for Mastodon Lake in Aurora. The area in the immediate vicinity (including the surface transportation assets of Ashland Avenue and Union Street) is within the floodplain and subject to flooding during storm events. The improvement of this drainage system will reduce risks to the surface transportation network during rain events.
Aurora_02: Turkey Creek Storm Sewer	City of Aurora	Minor arterial or collector (Functional Class 4 or 6)	Flooding	The Turkey Creek storm sewer was installed by the Fox Metro Water Reclamation district in the 1950's and has an ultimate approximate drainage area of 2,120 acres. However, approximately 20 percent of that area is still tributary to older combined sewers. The outfall is currently at capacity with surcharging events occurring near the Prairie Street and IL Route 31 intersection during some recent 2-5 year equivalent storms. A relief sewer to the Fox River is proposed to provide additional capacity to the system allowing for the continuation of future sewer separation projects.
Batavia_01: Main Street Reconstruction Project	City of Batavia	Minor arterial or collector (Functional Class 4 or 6)	Flooding	The project involves the reconstruction of Main Street from Randall Road to Van Nortwick Avenue in the City of Batavia, converting the existing rural two-lane roadway into an urban collector with curb and gutter, a new storm sewer system, and multimodal facilities including a shared-use path and bike lanes. As a major east–west corridor serving a fire station, Batavia High School, and Engstrom Park, the roadway provides critical community access during emergencies. The project will improve drainage capacity, reducing roadway and private property flooding and protecting access for emergency services, students, and residents. These improvements enhance resilience to climate-related flooding and support sustainable, low-emission transportation.

Project ID and title	Agency	Project type	Hazard addressed	Project description
! BurrRidge_01: South Frontage Road Outfall Improvements	Village of Burr Ridge	Local street system (Functional Class 7)	Flooding	South Frontage Road in the Village of Burr Ridge is located next to regulatory wetlands and is a degraded outlet for stormwater runoff from the Village of Willowbrook and adjacent I-55 highway. During significant rainfall events, the roadway overtops and becomes impassable during more severe events. This stretch of I-55 is designated a high-risk/priority section of infrastructure. This project seeks to identify the deficiencies in the existing system, causes of the frequent roadway flooding, and to provide solutions to minimize the frequency that the road becomes impassable, improve the drainage outlet for the I-55 runoff and Village of Willowbrook drain tile, and potentially expand and improve the neighboring wetland/detention area to provide increased capacity for stormwater management.
CDOT_01: Morgan Shoal	Chicago Department of Transportation (CDOT)	Shoreline reconstruction	Flooding	Reconstruction of the shoreline revetment to address ongoing erosion and coastal storm damage that have affected parkland and threaten the stability of US 41 within the City of Chicago by installing revetments that are designed to manage wave attack and flooding potential. The proposed action is an evolved iteration of the 2015 Morgan Shoal Framework Plan, influenced by physical and computational coastal engineering modeling, community input, and agency coordination. Generally, the coastal structure would include a combination of rubble mound and dynamic revetment, stepped stone blocks, and a transitional section of steel sheet pile and concrete revetment to connect to the existing structure at 51st Street. The project would add up to approximately seven acres of new usable parkland by providing more width to the narrowest parts of the park.
Cook_01: Kedzie Avenue over Prairie Creek – Structure Number 016-3102	Cook County Department of Transportation and Highways (DoTH)	Bridge or culvert	Flooding	Kedzie Avenue over Prairie Creek, which is also known as the Calumet Union Drainage Ditch, is an identified location with localized flooding challenges that may require a full bridge replacement or significant drainage and structural investment to improve the corridor and mitigate against climate flooding hazards.
! Cook_02: Lake Cook Road from Waukegan Road to Ridge Road/Lee Road	Cook County DoTH	Highway system (Functional Class 1-3, 5)	Flooding	The project aims to address a key corridor with pavement reconstruction, with enhanced drainage investments, and a bridge profile raise and replacement.
Cook_03: Plainfield Road from County Line Road to East Avenue	Cook County DoTH	Highway system (Functional Class 1-3, 5)	Flooding	The project aims to address a key corridor through pavement reconstruction with enhanced drainage, traffic signal improvements, and multimodal transportation improvements along Plainfield Road from County Line Road to East Avenue. The project will bring drainage elements and structures to current standards and reduce flooding risks.

Project ID and title	Agency	Project type	Hazard addressed	Project description
Cook_04: Pulaski Road Corridor Improvement - 159th Street to 127th Street	Cook County DoTH	Highway system (Functional Class 1-3, 5)	Flooding	The project aims to improve the corridor with enhancements to pavement, intersection upgrades, and enhancing pedestrian and bicycle accommodations with the goal to improve mobility and safety and replacing drainage and storm sewer infrastructure to mitigate future local flooding risks.
! Cook_05: Sauk Trail from Ashland to Western Avenue – Including SN 016-3005	Cook County DoTH	Bridge or culvert	Flooding	Work will address local flooding along a corridor with a bridge replacement and structural work to improve the bridge profile and retaining walls on a county corridor that experiences bridge flooding and roadway flooding. The work would support flood mitigation for a low resource capacity community and enhance community access to forest preserves after heavy rain events.
! Downers Grove: Deer Creek (Downers Grove) and King Arthur Court (Westmont)	Village of Downers Grove	Bridge or culvert	Flooding	St. Joseph Creek runs through Westmont Park District, King Arthur Court, and Deer Creek before flowing under Fairview Avenue. This area has a floodplain and floodway associated with the creek. During large storms, Fairview Avenue, Wilcox Avenue, 56th Street, Cumnor Road, and King Arthur Court are flooded, blocking access to residents and emergency vehicles.
! DuPage_01: 63rd Street at Williams Street Drainage (St. Joseph's Creek)	DuPage County Division of Transportation (DuDOT)	Minor arterial or collector (Functional Class 4 or 6)	Flooding	An abrupt sag vertical curve profile on 63rd Street west of Williams Street in Westmont, IL is periodically flooded when the St. Joseph's Creek headwaters overtop the roadway, leading to road closures of the 5-lane roadway in an urbanized residential area. The proposed solution involves raising 63rd Street two feet to reduce the roadway flooding.
DuPage_02: 63rd Street Drainage (Richmond Avenue to IL 83)	DuDOT	Minor arterial or collector (Functional Class 4 or 6)	Flooding	63rd Street, from Richmond Avenue to IL Route 83 in Willowbrook, floods every few years during intense storm events, impacting access to adjoining properties in this urban residential and commercial corridor. The proposed solution will provide above-ground flood volume storage at various locations along the corridor.
DuPage_03: DuPage County DOT Stormwater Network GIS	DuDOT	Study or plan	Flooding	The project entails completion of the DuPage County DOT stormwater GIS atlas. This involves typical DuDOT major, minor arterials, connections to IDOT and Tollway system storm sewer assets, inventory of storm sewer types and sizes, culverts, open drains, elevations, capacities and flow directions. There are numerous unidentified connections that require field investigations to resolve as well as in depth investigation of archival plans to resolve types and capacities. The outcomes of the work will be used to evaluate upgrades to storm sewer and culvert and to determine whether the County needs to provide more detention for extreme climate events.

Project ID and title	Agency	Project type	Hazard addressed	Project description
! DuPage_04: Highland Avenue Drainage (Lacey Creek, 31st Street to 35th Street)	DuDOT	Highway system (Functional Class 1-3, 5)	Flooding	Lacey Creek periodically overtops Highland Avenue near 35th Street with flooding depths of 2 to 4 feet causing the road to close. This severely impacts emergency services traveling to and from the Good Samaritan Hospital just south of the project and impacts travel to and from residences along the west side of Highland Avenue. The proposed solution would raise Highland Avenue to an elevation above the 100-year base flood elevation.
! DuPage_05: Madison Street Drainage (Executive Drive to 74th Street)	DuDOT	Minor arterial or collector (Functional Class 4 or 6)	Flooding	Madison Street near 74th Street in the Village of Willowbrook, floods frequently during intense rain events. Typically, a 1-inch rainfall may cause the road to be closed, impacting access to numerous businesses in the adjacent business park. The proposed solution would raise Madison Street's sag vertical curve profile so that both lanes are above the high-water elevation.
IDOT_01: 25th at Salt Creek 0.3 Mi South of Cermak Road	Illinois Department of Transportation (IDOT), District 1	Bridge or culvert	Flooding	Bridge replacement over a waterway known for flooding. Project includes scour protection.
IDOT_02: 95th at Stony Island Avenue	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Improve local flooding and bottleneck elimination.
IDOT_03: I-55: IL 113 to I-80	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Key evacuation route with significant bridge infrastructure from 1956.
! IDOT_04: I-290: US 12/45/20 Mannheim Road to Racine Avenue	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Key evacuation route with significant bridge infrastructure from 1956.
! IDOT_05: I-90/I-94 Kennedy and Dan Ryan Expressway Reconstruction (Hubbard Street to 31st Street) RSP -136	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Key evacuation route with significant bridge infrastructure from 1956.

Project ID and title	Agency	Project type	Hazard addressed	Project description
IDOT_06: I-90 Kennedy Expressway RSP -138	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Key evacuation route with significant bridge infrastructure from 1956.
IDOT_07: I-90/I-94 Kennedy Expressway Reconstruction (Edens Junction to Hubbard Street) RSP -140	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Key evacuation route with significant bridge infrastructure from 1956.
! IDOT_08: I-94 Bishop Ford Expressway Reconstruction RSP-135	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Key evacuation route with significant bridge infrastructure from 1956.
IDOT_09: I-94 Edens Expressway Reconstruction RSP -139	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Key evacuation route with significant bridge infrastructure from 1956.
! IDOT_10: I-94: West of Martin Luther King Drive to Little Calumet River	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Currently I-94 does not meet a 50-year storm event and has been closed a significant number of times, including 40 records of full closure due to flooding between 2010-2020. IDOT is installing large parallel sewers to alleviate the full closures of this expressway which is also an evacuation route.
IDOT_11: IL 43: 47th Street to Sanitary and Ship Canal	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Creating a new outfall to the Sanitary and Ship Canal to both alleviate flooding of IL 43 and be compatible with regional flooding reduction efforts by MWRD.
IDOT_12: IL 43: Archer Ave: IL 171 to Il 43 and IL 43: Archer Avenue to 63rd Street	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Creating a new outfall to sanitary and ship canal to both alleviate flooding of IL 43 and be compatible with regional flooding reduction efforts by MWRD.
IDOT_13: IL 53: Sout of IL 56 to Park Boulevard	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	The roadway floods worked with DuPage to move the road and act like a berm to protect homes and park space. Due to roadway flooding, the project will include intersection and drainage improvements along with roadway realignment to create a larger floodplain to help alleviate/minimize flooding. Secondary partners include DuPage DOT and IEPA.

Project ID and title	Agency	Project type	Hazard addressed	Project description
IDOT_14: I-290 at I-355	IDOT, District 1	Highway system (Functional Class 1-3, 5)	Flooding	Key evacuation route with significant bridge infrastructure from 1956.
IDOT_15: IL 50 at Cal Sag Channel	IDOT, District 1	Bridge or culvert	Flooding	Bridge rehab/replacement over a waterway known for flooding. Project includes scour protection.
IDOT_16: IL 62 at Spring Creek 1.4 Mi W of Il 59	IDOT, District 1	Bridge or culvert	Flooding	Bridge replacement over a waterway known for flooding. Project includes scour protection.
IDOT_17: IL 7 at Des Plaines River and Sanitary and Ship Canal	IDOT, District 1	Bridge or culvert	Flooding	Bridge replacement over a waterway known for flooding. Project includes scour protection.
IDOT_18: US 41 at 0.5 mi., North of IL 176 (Rockland Road)	IDOT, District 1	Other	Flooding	Currently US 41 floods frequently and this project will alleviate the flooding events.
IDOT_19: Touhy Avenue at North Branch Chicago River 0.6 mi. East of IL 43	IDOT, District 1	Bridge or culvert	Flooding	Bridge replacement over a waterway known for flooding. Project includes scour protection.
IDOT_20: Willow Road at W Fork of North Branch Chicago River	IDOT, District 1	Bridge or culvert	Flooding	Bridge replacement over a waterway known for flooding. Project includes scour protection.
Kane_01: Montgomery Road - Briarcliff Road to Hill Avenue	Kane County Division of Transportation	Minor arterial or collector (Functional Class 4 or 6)	Flooding	The project includes widening Montgomery Road to provide a two way left turn lane, closed drainage, sidewalk, multi-use path and intersection improvements.
Lake_01: Four Corners Basin/IL 120 Drainage Improvements	Lake County Stormwater Management Commission (SMC)	Highway system (Functional Class 1-3, 5)	Flooding	Conceptual engineering is in progress to alleviate depressional flooding in this area with no natural outlet, referred to as the "Four Corners Basin" which lacks adequate downstream capacity. SMC is in the process of acquiring properties. Additional land acquisition and construction funding needed (approx. $4M).

Project ID and title	Agency	Project type	Hazard addressed	Project description
! Lake_02: Grassmere, Haverton, and Oaksbury Pond Drainage Improvements Project	Lake County SMC	Minor arterial or collector (Functional Class 4 or 6)	Flooding	The scope of this project consists of removal, replacement and installation of storm sewers and culverts, wetland restoration, and channel conveyance improvements to alleviate roadway flooding that routinely and frequently occurs on IL 59 south of IL 22 in North Barrington.
Lake_03: Knollwood Community Drainage Improvement	Lake County SMC	Study or plan	Flooding	Project includes a combination of storm sewer construction and swale/ditch improvements as well as construction of a detention/storage basin to reduce overall flooding depth and areal coverage across the ~350-acre community.
Lake_04: Montesano Avenue Drainage Improvements	Lake County SMC	Local street system (Functional Class 7)	Flooding	Current stormwater infrastructure capacity is insufficient for intensity of present precipitation patterns. Upsizing storm sewer and box culverts, installation of new storm sewer pipe, installing backflow preventers, and installation of a restrictor system will prevent flooding in the affected area for the foreseeable future.
Lake_05: Round Lake Drain Improvements - Phase I	Lake County SMC	Bridge or culvert	Flooding	Two restrictive culverts at Village Drive and Fairfield Road, crossing the Round Lake Drain, cause significant structural flood damage to residential homes (low income), state and local roads, Metra rail line, critical public works infrastructure, ComEd transmission right-of-way, and school. Conceptual designs have been prepared to increase the capacities of Village Drive and Fairfield Road. Additional funding is needed for construction (approx. $3M).
! Lake_06: West Scranton Avenue Viaduct Project	Lake County SMC	Local street system (Functional Class 7)	Flooding	Project will reduce flooding at the Scranton Avenue viaduct (Sheridan Road/Union Pacific railroad/Elgin, Joliet and Eastern railroad). Project components include a new storm sewer line from viaduct along North Avenue to outfall at Maple Avenue. Improvements are in design and IDOT coordination is ongoing. Approx. $10M in funding is needed.
McHenry_01: Algonquin Road Bridge Replacements	McHenry Department of Transportation (MCDOT)	Bridge or culvert	Flooding	The proposed improvement would replace three aging concrete box-beam bridges on Algonquin Road: Structures 056-3164, 056-3165, 056-3166. Algonquin Road carries roughly 32,000 ADT and is an NHS Route. MCDOT's 2024 inspections showed a marked reduction in their condition. The superstructure rating (as well as the overall rating) on all the bridges dropped from either 7 or 8 to a 5, out of a scale of 0-9 with 9 being new and 0 being closed. MCDOT begins evaluations and programming of bridges when this box beam type structure reaches a level 5 rating.
McHenry_02: River Road Bridge	MCDOT	Bridge or culvert	Flooding	Transitioning a multi-culvert road crossing (056-3000) to a bridge. Elevating the roadway to reduce flooding risk.

Project ID and title	Agency	Project type	Hazard addressed	Project description
! MWRD_01: Central Road Flood Control Project	Metropolitan Water Reclamation District (MWRD)	Other	Flooding	Flood control project to alleviate roadway and structure flooding in Unincorporated Northfield, Maine Township, and Glenview. This project will be done through a partnership with IDOT and MWRD.
! MWRD_02: Prairie Creek Flood Control Project	MWRD	Other	Flooding	In partnership with IDOT, this is a flood control project to alleviate roadway and structure flooding in Unincorporated Maine Township and Park Ridge.
Orland Park: 143rd Street from Wolf Road to US 45 LaGrange Road	Village of Orland Park	Minor arterial or collector (Functional Class 4 or 6)	Flooding	This project will widen 143rd Street to 5-lanes to improve traffic flow and reduce congestion. There are drainage issues in the corridor as parts of it are in the floodplain, causing frequent flooding, road closures, and safety issues. The project will improve the drainage significantly and provide treatment for rainwater so that first flush contaminants are not discharged directly into downstream systems.
Oswego_01: Harrison Street Reconstruction	Village of Oswego	Local street system (Functional Class 7)	Flooding	This project is a reconstruction of Harrison Street which is mostly in a floodplain. There is a culvert that outlets to the Fox River that carries a majority of the downtown's storm water with a high velocity. This project will help protect the businesses on the southside of Harrison Street from the floodplain, as well as, reconstruct the eroding outfall and help with water quality and prevent further scouring at the outfall.

Table 10: Priority resilience project list for transit

! Denotes high-priority project

Project ID and title	Agency	Project type	Hazard addressed	Project description
CTA_01: Capital Track Improvements - Water Management	Chicago Transit Authority (CTA)	Facility or service for public transportation	Flooding, severe storms	Water infiltration has created a damp, corrosive environment in CTA's rail environment that has compromised the condition of track and tunnel infrastructure. Water management and track improvements are needed in subways and areas that are particularly vulnerable to flooding from increased storm severity. These projects will manage water infiltration, restore track integrity, and extend the useful life of CTA assets to ensure operational efficiency, functionality, and safety. The following locations are high priority for water management and track improvements: Dearborn Kimball Subways, O'Hare Subway, O'Hare Tollway Tunnel, State Street Subway, and North Mainline Armitage Incline.
! CTA_02: Forest Park Branch Modernization Program	CTA	Facility or service for public transportation	Extreme heat, flooding, severe storms	This Program compiles track improvement projects to address the most immediate critical track needs on the Congress Branch to enable its continued safe and reliable operation. The Congress Branch is approaching 60 years old with aging infrastructure assets that are nearing or beyond the end of their useful life. In recent years, track conditions have eroded at an increasing pace, prompting the need to establish slow zones. Running rail, ties, fasteners, ballast, sub-ballast, contact rail, contact rail chairs, duct bank, and drainage all require replacement.
! CTA_03: CTA System Control and Communication Enhancements	CTA	Facility or service for public transportation	Extreme heat, flooding, severe storms	The Operations Control Center (OCC) is located apart from CTA headquarters in a secure location and coordinates day-to-day transit (bus and rail) services, service restoration and emergency responses. The OCC can be considered the central nervous system of all CTA operations and is vital to CTA's ability to function. Projects within this bundle focus on improving critical communications infrastructure to ensure safe CTA operations during business as usual and climate-related shocks and stressors. Project specific work includes replacing or rehabilitating deteriorated facilities that are essential to the safe operation of signal systems, upgrading the QuicTrac system to QuicTrac™ to provide a consistent and more reliable means of providing information on track occupancy to the OCC, and improving communication capacity and components, particularly the handheld radios, that are obsolete and failing.
CTA_05: Facility Critical Needs - Garage and Shop Waterproofing, Roof Replacement, HVAC	CTA	Facility or service for public transportation	Extreme heat, flooding, severe storms	This Program addresses the most immediate critical needs at CTA facilities system-wide to ensure their safe and reliable operation. Many of CTA's oldest bus and rail facilities are now over 100 years old and overdue for a "mid-life overhaul" or replacement to not only improve but maintain safe and reliable transit service. These facilities provide storage, maintenance and repair, and power to rolling and non-rolling transit stock which allows CTA to operate on a day-to-day basis. Many of these facilities require roofing, waterproofing, and HVAC upgrades or replacements to protect them from the damaging effects of extreme weather events, particularly those involving excess water or heat.

Project ID and title	Agency	Project type	Hazard addressed	Project description
CTA_06: Facility Critical Needs - Substation Roof Replacement and Waterproofing	CTA	Facility or service for public transportation	Extreme heat, flooding, severe storms	This Program addresses the most immediate critical needs at CTA facilities system-wide to ensure their safe and reliable operation. Substations provide power to CTA's rail network and are crucial for ensuring continued operations during and after extreme weather events. Failures to substations can result in the failure of the safety-sensitive equipment they house. Many substation roofs are worn, damaged, and beyond their life expectancy. Replacing roofs will provide safer environments for workers, protect existing facility structures and equipment from water damage, reduce the facility energy usage, and reduce roof repair and maintenance expenditures. Substations in a state of disrepair cause water infiltration that will worsen over time and cause damage and worker safety issues. Priorities include Skokie, Douglas, Kolmar, Archer, Edmunds, Gage, Pershing, and Springfield.
CTA_07: Halsted and 79th Street Bus Turn Around - ADA and Site Improvements	CTA	Facility or service for public transportation	Extreme cold	Work includes: Reconstruction of the concrete island platform with ADA ramps, guardrails, and required barriers; addition of an accessible sidewalk path to the island platform crosswalk; complete reconstruction of the bus turnaround and associated pavement, including new ADA curb ramps; new signage, LED lighting, cameras, passenger windbreaks, and landscaping; upgraded toilet facilities for accessibility with new utility connections; addition of public art; and addition of push button for audio for next bus/train schedule, tactile path, tactile signage, heat lamps and LED lights.
CTA_09: South Halsted Corridor Bus Enhancements	CTA	Facility or service for public transportation	Severe storms	The South Halsted Bus Enhancement project will provide bus improvements for riders utilizing CTA and Pace services on the 11-mile South Halsted corridor, which connects customers on the Far South Side and South Suburbs to connecting bus and rail services, including the CTA Red Line at 95th Street and 79th Street. The purpose of the project is to improve transit connectivity and reduce travel times for customers in this area who have some of the longest commutes in the region and are more likely to be dependent on transit. The following elements would be included in the CTA corridor, pending approvals by CDOT during future phases: Queue jump at 79th and Vincennes, Bus lanes on Halsted from 87th to Vincennes, Enhanced CTA bus stops north of 95th Street, Traffic Signal Optimization and Transit Signal Priority (TSP) throughout the corridor. Corridor enhancements will increase resilience to climate hazards that can result in service disruptions.
! CTA_10: Subway Deep Well Pumps and Controls Rehabilitation	CTA	Facility or service for public transportation	Flooding, severe storms	Deep well pumps and controls in the subway systems have exceeded their useful lives and require replacement. The scope of work includes a system-wide program to modernize all equipment including new pump systems and controls. Work may require electrical upgrades and structural modifications. The work will be prioritized based upon evaluations of the existing equipment. Current plans are for replacement of West Bank and Franklin pumps as the highest priority. Upgrading modern subway pump systems and controls allows CTA to better manage water infiltration during heavy rainstorms and flooding events which will significantly reduce risk of service disruptions and infrastructure damage.

Project ID and title	Agency	Project type	Hazard addressed	Project description
CTA_11: Subway Evacuation Improvements	CTA	Facility or service for public transportation	Extreme heat, flooding, severe storms	CTA must ensure the safe, functional, and effective evacuation of rail facilities for transit customers and workers especially in the face of climate hazards. Projects within this bundle install, replace, and improve necessary emergency exit infrastructure so customers can safely evacuate subway systems during emergencies. This includes the replacement of emergency exit systems, and creation of safe foot paths for emergency egress in the event of an emergency rail car evacuation in the subways. Emergency exit systems include call boxes, exit signs, MARS lights, hatches at street-level and doors within subways, and spiral and concrete staircases system-wide in all subways.
CTA_12: Subway Vent Shaft Sewer Restoration	CTA	Facility or service for public transportation	Flooding, severe storms	Original sewer lines for routing water in the vent shafts are clogged and improperly working, which results in water overflowing and causing deterioration of the subway tracks. The scope of work includes reviewing the current conditions to determine a comprehensive solution to prevent infiltration and remove any water via drainage connections to sewers and sump pumps along the State Street and Dearborn subways.
! CTA_13: Rail Yard Improvements	CTA	Facility or service for public transportation	Flooding, severe storms	Many of CTA's existing rail yards have a backlog of trackwork and related infrastructure needs which must be addressed to enable these facilities to properly function. Both running rail and contact rail have experienced excessive wear, ties and fasteners have deteriorated, ballast has degraded, drainage has been impaired, and some locations have obsolete rail sections and special trackwork configurations. Many of these infrastructure components are now at or beyond their useful life. The purpose of this Program is to address State of Good Repair conditions and extend the period of infrastructure stability to minimize the likelihood of future disruptions due to track deficiencies. Priority locations for rail yard improvements include Des Plaines Rail Yard as it not only serves the Forest Park (Congress) branch of the CTA Blue Line but has high flooding exposure.
CTA_14: System-wide Bus Garages – Drainage Improvements and Trench Drain Replacements	CTA	Facility or service for public transportation	Flooding, severe storms	This program will rehabilitate and replace drainage systems at bus garages. Preliminary drainage issues identified include piping corrosion, failing trench drains, and poor water pressure. In addition, the metal drain covers, such as those used for trench drains, and surrounding concrete have been damaged due to constant heavy vehicular traffic and need to be repaired or replaced, and years of debris have created blockages within sewer and drain lines. Depending on the treatment necessary to address drainage issues work may include, but is not limited to, excavation, removal and replacement of drainage piping, replacement of metal drain grating, and associated/incidental pavement work that will be required as part of the drainage improvement. Priority locations have been identified as Forest Glen, Kedzie, 103rd and 74th garages.
Metra_01: Metra Rail Yards and Operationally Critical Facilities (47th Street Yard)	Metra	Facility or service for public transportation	Extreme heat, flooding	Metra has two dozen rail yards at which locomotives, railcars, and multiple electric units are maintained and serviced. Rail yards and the numerous facilities within also house Metra's cost-efficient railcar rebuild and locomotive overhaul programs. Below are specific rail yard projects from Metra's 2025-2029 Capital Program that are needed to improve the resilience of Metra's rail yards to climate impacts.

Project ID and title	Agency	Project type	Hazard addressed	Project description
				▪ 18th Street MU Shop, MED District: 5961 – Roof Rehab; ▪ 14th Street Yard, BNSF District: 5866 – Crew Facilities; ▪ 47th Street Yard: 5963 – Building Imp-47th Street Yard Exhaust, BI-241 – Roof Rehab-47th Street Diesel, BI-242 – Roof Rehab-49th Street Shop, Flooding: parking south side of 49th Street Training Building, Extreme heat: inside 49th Street Sheetmetal shop (water jet machine); ▪ 5957 – Yard Improvements MDW: Elgin Rail Yard; ▪ 5958 – Yard Improvements RID: Joliet Rail Yard; ▪ Kensington Yard: YI-03 – Roof Rehab-Kensington Yard ME Shop; ▪ Blue Island ENG Yard: YI-05 – Roof Rehab – Blue Island ENG Shop; ▪ 5959 – Yard Improvements UPR: M19A Yard: Storehouse and Mechanical shop area (UP District).
! Metra_04: Metra Station Modernization	Metra	Facility or service for public transportation	Extreme cold, extreme heat, flooding	With 243 stations and four terminals, Metra has more stations than any other commuter rail system in the U.S. Many of Metra's stations are more than a century old and are past due for major renovations or reconstruction. The selected stations included under this project are identified as having high flood, heat, or cold risks and are currently scheduled for major rehabilitation or reconstruction. ▪ Van Buren Street Station ▪ Olympia Fields Station and Parking ▪ Riverside Station ▪ Ivanhoe Station ▪ West Pullman Station ▪ LaSalle Street Station ▪ Western Avenue Station ▪ University Park Station ▪ O'Hare Transfer Station
Metra_05: Metra's Modern Station Shelters	Metra	Facility or service for public transportation	Extreme cold, extreme heat, flooding	Numerous Metra stations lack enclosed station depots or shelters at each boarding platform. Metra has developed a modern station shelter prototype outfitted with on-demand heat systems, large glass windows for transparency, generous roof overhangs, bench seating, and updated signage and wayfinding. The station shelters are a cost-effective method to deploy across Metra's system to improve rider experience, especially during high-precipitation events, heat waves, and extreme cold weather snaps. ▪ Hickory Creek ▪ Braeside ▪ 91st/Beverly ▪ Ashburn ▪ Lisle

Project ID and title	Agency	Project type	Hazard addressed	Project description
				▪ Edgebrook ▪ Evanston Central Street ▪ Hollywood Zoo Stop ▪ Midlothian ▪ Downers Grove Main St. ▪ Indian Hill ▪ Summit ▪ Willow Springs

Appendix D: Key implementing agencies for organizational resilience strategies

Table 11: Key implementers of organizational resilience strategies

Strategy	Lead implementer	Supporting implementer
Plans		
Incorporate TRIP recommendations into the 2026 Regional Transportation Plan	CMAP	
Incorporate resilience into asset management plans, systems, and investment processes	Transportation agencies	CMAP
Incorporate best-available climate data into transportation-related plans	CMAP	Transportation agencies, local governments
Integrate resilience into corridor planning and technical assistance programs	CMAP, RTA	
Develop local resources and guidance to complement TRIP	CMAP	
Policies		
Promote climate-resilient land use and development policies	CMAP, local governments	Stormwater agencies
Incorporate resilience into the Complete Streets approach	Local governments, transportation agencies, stormwater agencies	CMAP
Continue to incorporate resilience criteria in scoring for fund programs and other key project prioritization processes and lists	CMAP, transportation agencies	
Develop resilience indicators to track progress on improving resilience	CMAP, transportation agencies, stormwater agencies	Local governments

Strategy	Lead implementer	Supporting implementer
Project development and design		
Provide regional data on flood susceptibility	CMAP	Stormwater agencies, local governments
Incorporate Bulletin 76: Projected Precipitation Frequency for Illinois into project design criteria to account for future precipitation values	IDOT, Tollway, transit agencies, stormwater agencies	CMAP, Illinois State Water Service
Incorporate nature-based solutions when designing projects that manage stormwater	Transportation agencies	Stormwater agencies, local governments, CMAP
Explore improvements to transit shelter design	Transit agencies, local governments	
Develop tools to simplify resilience integration throughout the project development process	CMAP	Transportation agencies
Provide case studies of transportation project resilience strategies	CMAP	Transportation agencies
Support adaptive design and adaptive management	Transportation agencies, stormwater agencies	CMAP
Integrate long-term maintenance planning into green infrastructure projects	Transportation agencies, stormwater agencies	Local governments
Prioritize projects that increase alternative mobility options	Transportation agencies, local governments	CMAP
Coordination and capacity-building		
Participate in national-level peer exchanges, conferences, and online workshops to exchange best practices and lessons learned	CMAP, transportation agencies, stormwater agencies	Local governments, emergency management agencies, Illinois Environmental Protection Agency (IEPA), environmental departments, community organizations
Convene regional resilience working group and regional peer exchanges	CMAP	Transportation agencies, stormwater agencies, local governments, emergency management agencies, environmental protection agencies, community organizations

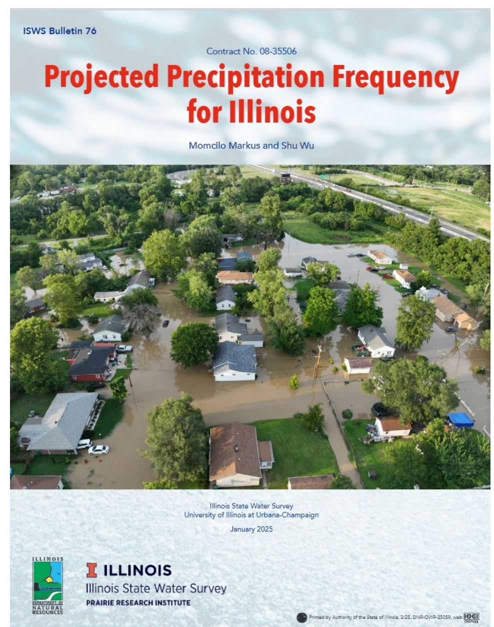
Strategy	Lead implementer	Supporting implementer
Expand technical assistance offerings to build local staff capacity to advance resilience	CMAP	
Complete data gap analysis and needs assessment	CMAP	Transportation agencies, stormwater agencies, local governments
Encourage watershed-wide planning and coordination	CMAP	Local governments, stormwater agencies, Illinois Department of Natural Resources, IEPA, watershed organizations, community organizations
Assess and improve communication tools for service disruptions and rider/driver preparedness	Transit agencies, roadway agencies	Emergency management agencies, local governments
Better understand transportation resiliency needs and increase community engagement and preparedness through community outreach and education	CMAP, local governments	Community organizations

Appendix E: Using future precipitation projections in project design

Precipitation frequencies are used by engineers to determine how infrastructure should be designed. However, a changing climate means that the infrastructure we design today must withstand the rainfall projected for mid-century. To account for these increases, engineers should consult precipitation projections when designing drainage, stormwater management, and flood mitigation projects.

CMAP acknowledges that federal and other cost reimbursement rules can disincentivize design for future precipitation levels. It typically costs more to design for more runoff, and many funding sources would consider these additional costs ineligible for reimbursement under current rules, leaving the local agency on the hook for the cost difference. For this reason, one TRIP recommendation is for CMAP and local partners to advocate for more flexible funding sources. Please see page 44 for more information on this recommendation.

Overview of precipitation frequency studies for Illinois



The Illinois State Water Survey (ISWS) publishes its precipitation frequency studies through a series of bulletins, namely *Bulletin 75* and the recently published *Bulletin 76*. Published in 2020, *Bulletin 75: Precipitation Frequency Study for Illinois* provides precipitation frequency estimates for different "design storms" for geographic areas throughout Illinois. Design storms are hypothetical rainfall depths based on statistical likelihood that can be expected for different storm durations (ranging from 5 minutes to 240 hours) and recurrence intervals (ranging from 2 months to 500 years). *Bulletin 75* is recognized as the standard rainfall dataset for use by engineers when determining how infrastructure should be designed based on anticipated precipitation events for Illinois. The values in *Bulletin 75* are based on observed data through 2017 and do not consider how climate change may affect rainfall values. Therefore, designs based on *Bulletin 75* are appropriate for today's climate but may not be adequate for the year 2050 and beyond.

The ISWS released *Bulletin 76: Projected Precipitation Frequency for Illinois* in early 2025. *Bulletin 76* is similar to *Bulletin 75*, but provides projected rainfall for the years 2050, 2075, and 2100 for the middle-of-the-road climate change scenario (SSP2-4.5).[*] The precipitation values in *Bulletin 76* are therefore more likely to represent the types of rainfall events the region may experience at the given time horizons.

[*] Emission scenarios represent projections of future greenhouse gas emissions based on varying assumptions on energy use, socio-economic growth, and technological development. Shared socioeconomic pathways (SSPs) were developed as part of the framework used in the Intergovernmental Panel on Climate Change's Sixth Assessment Report. SSPs are used in combination with climate models to describe potential climate futures and guide mitigation and adaptation policies. While SSP2-4.5 represents a middle-of-the-road scenario where global development and emissions follow historical

Table 12 compares the regional rainfall estimates from different sources from two different design storms: the 24-hour, 1 percent annual exceedance probability event (1 percent event) and the 72-hour, 1 percent annual exceedance probability event. The 1 percent event is commonly referred to as the 100-year event. As the table shows, projected future rainfall estimates from *Bulletin 76* are greater than the estimates that are currently used for design under *Bulletin 75*.

Table 12: Comparison of 1 percent event for 24-hour and 72-hour rainfall estimates for northeastern Illinois

Data source (publication year)	1% annual exceedance probability, 24-hour rainfall	1% annual exceedance probability, 72-hour rainfall
ISWS *Bulletin 75* (2020)	8.6 inches	9.9 inches
ISWS *Bulletin 76* (2025)	8.9 inches	10.2 inches

This comparison clearly shows the importance of the data source in determining the design rainfall value for infrastructure. Using *Bulletin 76* values over *Bulletin 75* values, for instance, means that engineers can design to accommodate an additional one-third of an inch of water in 24 hours when designing for the 1 percent event. This is a critical design element considering that, when spread across a watershed area of one acre, one-third of an inch of additional rainfall produces an additional runoff volume of 1,210 cubic feet. Failure to account for that additional volume could create future flooding and water quality issues.

To future-proof the region's infrastructure, CMAP recommends that transportation and stormwater implementers, including municipalities, use the *Bulletin 76* estimates for projects with lifespans extending into mid-century or beyond.

Is a third of an inch of rain significant?

While a third of an inch of rain may seem insignificant, the cumulative impact across a larger area — like a watershed — can be significant. For example, the Waukegan River watershed in Lake County is approximately 7,400 acres. An additional one-third inch of rainfall across the entire watershed would create enough stormwater runoff to fill more than 100 Olympic-sized swimming pools, or approximately 200 acre-feet.

Using *Bulletin 76* in project design

When designing projects, engineers should consider the following:

Select precipitation projection date based on expected lifetime of project. *Bulletin 76* provides estimates for 2050, 2075, and 2100. Using the precipitation value from the projection date that most closely matches the expected lifetime of the project would provide the estimated future capacity necessary to reach that infrastructure's lifespan.

trends with moderate mitigation efforts, SSP5-8.5 is a high-emissions scenario characterized by rapid economic growth, limited climate policy, and high energy demand (often considered as a worst-case scenario).

Manage cost by considering alternative design solutions. Simply upsizing stormwater infrastructure is one way to design to higher precipitation estimates, but this approach can be cost-prohibitive. As an alternative, engineers can take a more integrated approach to stormwater management, by combining gray infrastructure with nature-based solutions to increase infiltration and allow for a more systematic strategy. An integrated approach can alleviate the large upfront cost of implementing oversized gray infrastructure alone.

For aging infrastructure that is under-performing and was designed to outdated standards, retrofitting with green infrastructure or simply updating to increase capacity to a future design storm is recommended to keep assets functioning.

Account for other flood risk factors through flood modeling. Precipitation is only one factor that contributes to the flood risk of an asset. Other factors — such as soil type, topography, or proximity to bodies of water — can also influence the risk of flooding. Understanding the impact of increased rainfall on various types of infrastructure is also important; drainage capacity for roadways and highways, floodplains and floodways for bridges and culverts over river systems, and urban storm sewer systems are impacted differently by different rain events.

When designing a new project or retrofitting an existing site, these additional factors need to be considered. Flood modeling and mapping are important tools for understanding areas most at risk of flooding. *Bulletin 76* provides the most up-to-date information to support detailed, site-specific flood modeling.

For example, a risk assessment for projected increases in rainfall should look at the different return periods and durations currently used for designing various types of infrastructure. That is:

- Local drainage along roads should be designed for a more frequent event like the 10 or 25-year (10 percent or 2.5 percent annual exceedance probability (AEP));
- Bridges, culverts, and anything impacting a riverine floodway/floodplain should be designed for at minimum the 100-year event (1 percent AEP);
- 500-year events (0.5 percent AEP) should be used for roads serving as emergency detour and evacuation routes or connecting critical infrastructure like hospitals, schools, and cooling centers; and
- Urban stormwater infrastructure that is more sensitive to the high intensity shorter duration precipitation events should be assessed for more critical durations (e.g., 30 minutes to 2 hours).

When designing a project, regional partners should perform these assessments and develop updated flood maps with *Bulletin 76* data for desired time horizons. Identifying where the most significant increases in surface flooding are likely to occur would provide a way to focus stormwater management practices and prioritize implementation to alleviate current flooding hazards and reduce future flood risk.

Example impacts on runoff volumes: *Bulletin 75* vs. *Bulletin 76*

The following figures demonstrate how projected rainfall depths increase runoff volumes. Each of the figures presents different calculated volumes for the current *Bulletin 75* rainfall depths and *Bulletin 76* projected rainfall depths for the 2050, 2075, and 2100 time horizons. These figures visually demonstrate implications for runoff volumes when choosing *Bulletin 76* values over *Bulletin 75* values, and can be used by planners and engineers to understand how using *Bulletin 76* values changes necessary stormwater storage volumes.

- Figure 11 provides an overview of the calculated runoff volume during the 10-year, 2-hour event for 1-acre of tributary area under different percent impervious conditions.
- Figure 12 provides an overview of the calculated runoff volume during the 100-year, 24-hour event for 1-acre of tributary area under the same percent impervious conditions.

- Figure 13 provides the required volume needed for a stormwater management feature, assuming an allowable release rate of 0.2 cubic feet per second/acre (cfs/ac) during the 100-year, 24-hour event.

In both Figure 11 and Figure 12, runoff increases with each subsequent time horizon; meaning that runoff volumes based on 2100 projected rainfall are greater than volumes based on 2075 projected rainfall. These figures illustrate how *Bulletin 76* is more consequential when considering longer time horizons.

Figure 13 illustrates how even relatively small percentage increases in runoff can require substantial additional storage requirements. For example, under 0 percent impervious conditions, Figure 12 shows that selecting the 2050 value for the 100-year, 24-hour event results in an additional 1,177 cubic feet of runoff for a 1-acre area, a 5 percent increase compared to the *Bulletin 75* value. Meanwhile, Figure 13 shows that, under the same conditions, additional runoff would require a 20 percent increase in storage volume for a stormwater management feature. Using the 2100 value, meanwhile, indicates that a 52 percent increase in storage volume is required. As the percent impervious goes up, the total additional volumes also increase, albeit at a lower percent change.

Figure 11: Total runoff for 1-acre during 10-year, 2-hour event with different percent impervious scenarios

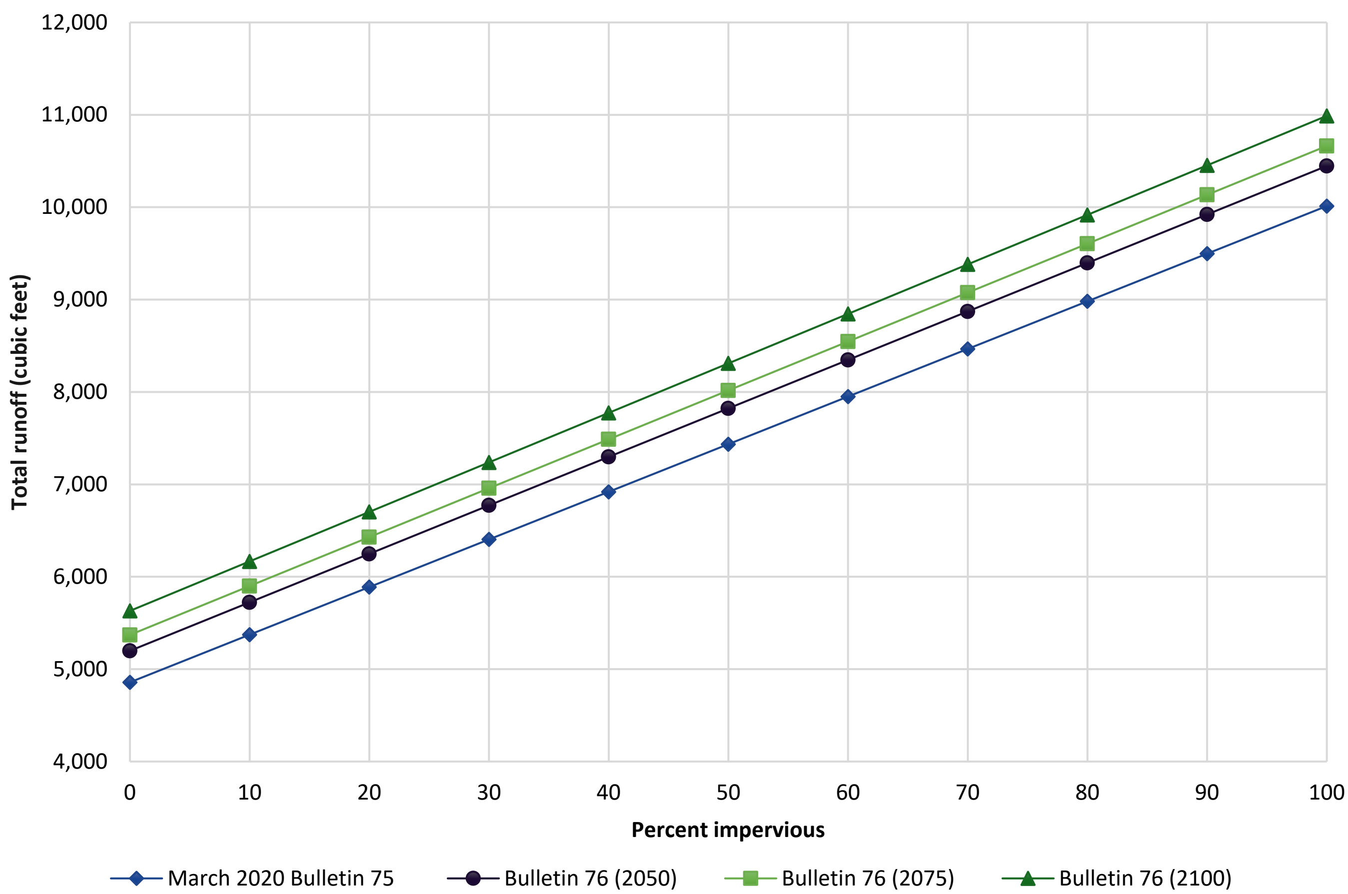


Figure 12: Total runoff for 1-acre during 100-year, 24-hour event with different percent impervious scenarios

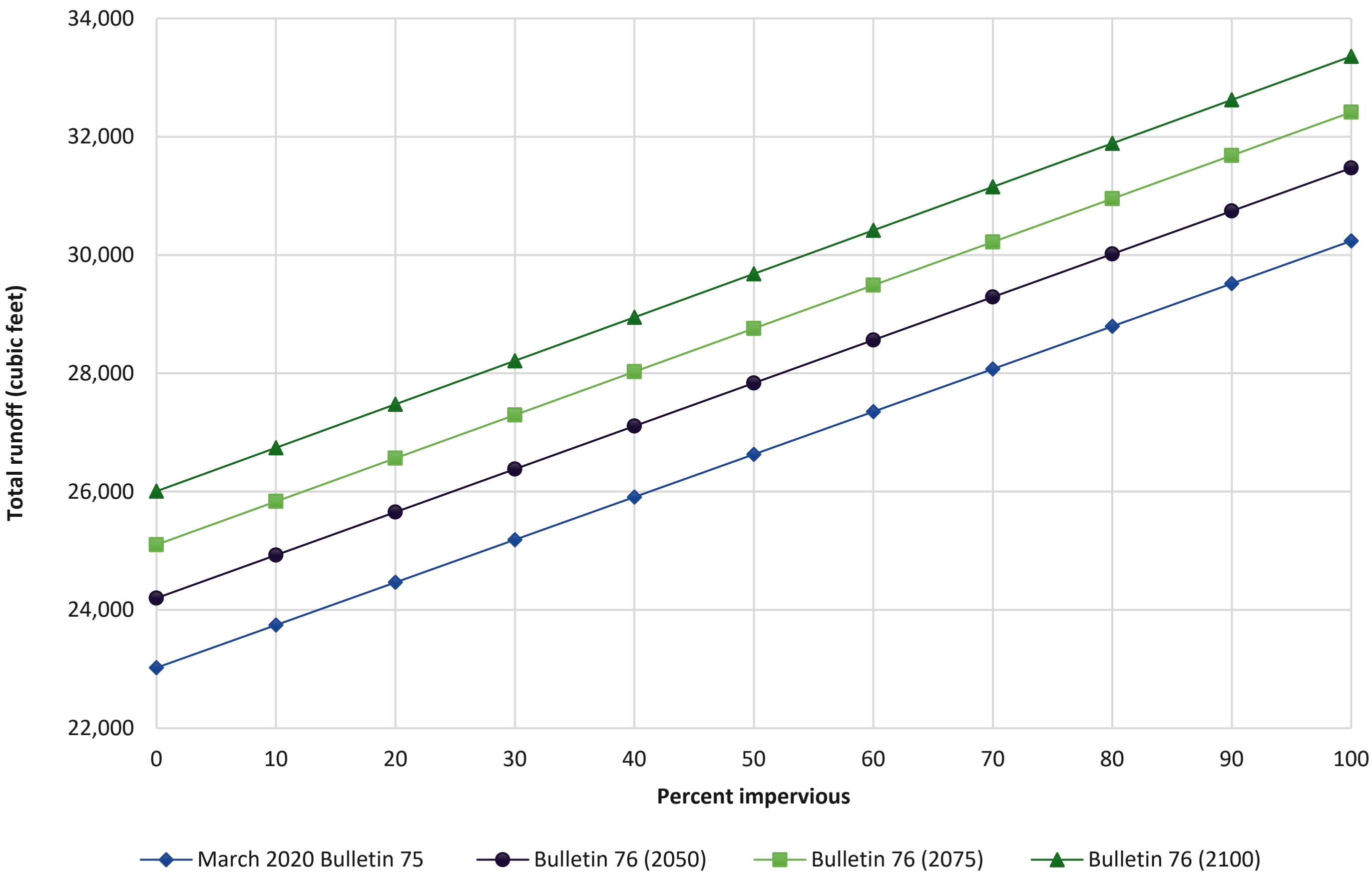
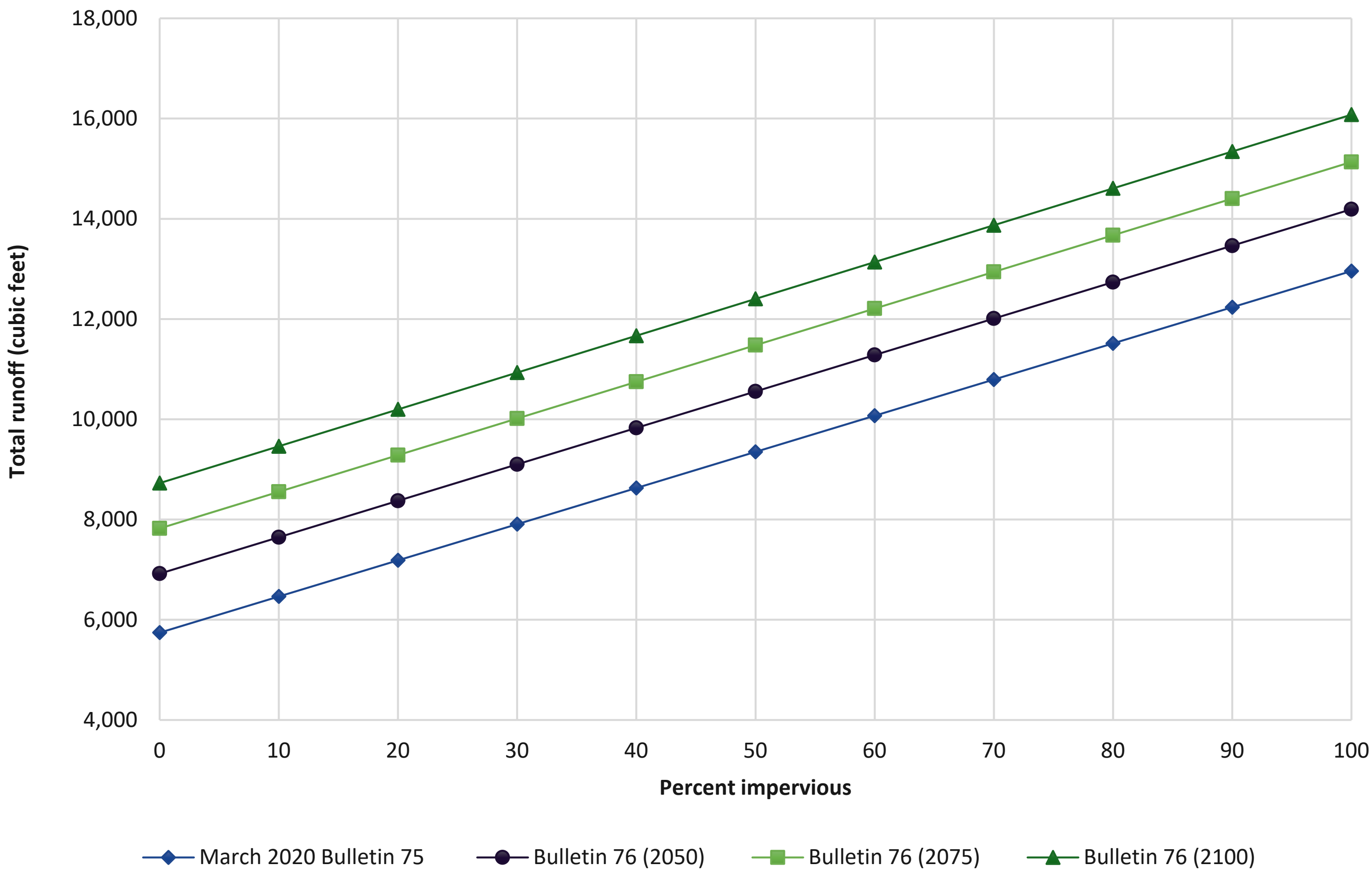


Figure 13: Required storage volume for 1-acre during a 100-year, 24-hour event assuming an allowable release rate of 0.2 cfs/ac



Estimating future runoff and designing for flood resilience

CMAP conducted further flood analysis to demonstrate how future precipitation values can be used to inform flood-resilience designs using a data-driven approach. By quantifying how projected rainfall depths increase runoff volumes and reduce the manageable drainage area, the analysis informs the sizing and screening for green infrastructure and other stormwater features. This approach aims to help regional partners understand how future rainfall will affect runoff volumes and infrastructure needs, while highlighting practical strategies to mitigate flood risk. This analysis shows how green infrastructure can be used alongside other stormwater features to effectively reduce flood risks. Green infrastructure can also provide co-benefits such as cooler surfaces, more aesthetically-pleasing features, and increased greenspace.

The subsections below provide an overview of the:

- Three selected sites
- Approach and key findings for estimated runoff volumes
- Examples of engineering designs that show flood resilience for the estimated runoff volumes

Overview of selected sites

The flood analysis and conceptual designs were completed for three representative transportation sites, each facing distinct flooding challenges as identified in the risk-based vulnerability assessment (see CMAP's *Risk-based Vulnerability Assessment*):

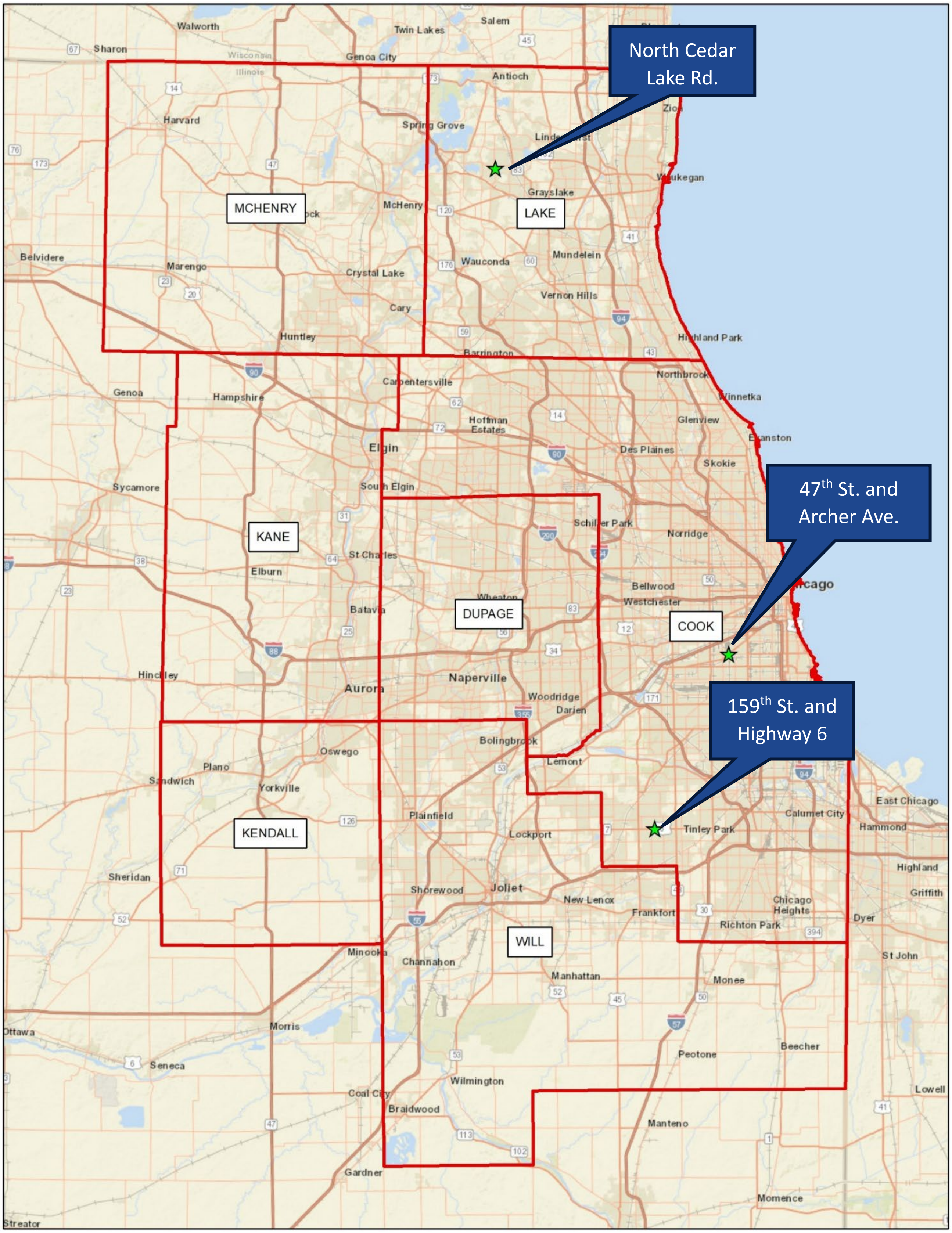
159th Street/Highway 6 in Orland Hills, Orland Park, and Tinley Park (Cook County). This segment of 159th Street/Highway 6 is a busy suburban commercial corridor with a documented history of flooding. It was also identified as having high social vulnerability during the risk-based vulnerability assessment (see the *Advancing resilience* section). Flooding here disrupts traffic, threatens safety, and impacts local businesses and residents. These conceptual designs show that future rainfall will require larger and more robust green infrastructure and stormwater management features to keep roads open and safe. The green infrastructure will also offer co-benefits such as heat risk mitigation, improved safety, enhanced streetscape, and flexible adaptation for both public and private properties.

North Cedar Lake Road in Round Lake Beach (Lake County). This site is a suburban corridor with a documented history of flooding and large-scale drainage challenges, making it a prime candidate for integrated stormwater and flood resilience strategies. Flooding in this area is caused by many factors, presenting an opportunity to implement a variety of green infrastructure solutions that not only mitigate flooding, but also help mitigate heat risk and provide community amenities. The conceptual designs show how comprehensive flood mitigation can address a wide array of documented flooding issues.

47th Street and Archer Street in Chicago (Cook County). This intersection features a viaduct in a densely urbanized area with a mix of industrial and residential uses, high transit criticality, and a history of flooding. Flooding and extreme heat in this corridor are driven by a combination of factors, including low-lying topography and a density of impervious surfaces, creating an opportunity to deploy a diverse mix of resilient solutions that also enhance community livability. The roads running through and near this intersection serve as key transit routes, and provide access to commercial, industrial, and residential areas. These features make it an optimal location for climate resilience measures. The conceptual designs highlight distributed flood mitigation solutions suitable for space-constrained urban environments, including green infrastructure and underground storage.

See Figure 14 for a map of these locations.

Figure 14: Locations of flood-prone transportation sites selected for climate change flooding analysis and conceptual designs



Estimate of projected flooding risk: Approach and key findings

CMAP completed a runoff analysis by comparing baseline rainfall depths from *Bulletin 75* (2.99 inches) to projected depths from *Bulletin 76* (3.17 inches) for the 10-year, 2-hour event—an increase of about 6 percent, or 0.18 inches. These volumes informed the sizing of best management practices and storage volumes using standard engineering details and conservative assumptions.

As shown in Table 13, this analysis shows that the projected *Bulletin 76* rainfall depth would result in a 6.7 to 8.1 percent increase in runoff volumes across the area. These seemingly small percentages translate to a significant increase in volume for a given site; for example, at 159th Street and 84th Avenue, there would be an additional acre foot of runoff to be managed. Tributary areas with lower amounts of impervious surfaces (such as the North Cedar Lake Road area) would see a greater percentage increase in runoff volumes. This is because the amount of water the soil can hold will not increase; therefore, if precipitation increases, more rainfall will fall after the ground is already saturated.

Table 13: Summary of study sites and runoff estimates

Study site (location # on map)	Size of study area (acres)	% impervious for study area	Estimated *Bulletin 75* runoff volume (ac-ft)	Estimated *Bulletin 76* runoff volume (ac-ft)	Increase in runoff volume
159th Street/Highway 6					
159th Street & 84th Avenue (#1)	71	66%	13.5	14.5	7.4%
94th Street to Parkhill Drive (#2)	162	63%	30.2	32.4	7.4%
159th Street & Harlem Avenue (#3)	66	78%	13.5	14.4	6.7%
North Cedar Lake Road					
North Cedar Lake Road & West Rollins Road (#1)	268	43%	43.5	47.1	8.1%
North Cedar Lake Road & Golfview Drive (#2)	27	44%	4.4	4.8	7.9%
North Cedar Lake Road & Beachview Drive (#3)	27	53%	4.6	5.0	7.8%
47th Street and Archer Avenue					
Spaulding Avenue & 46th Street (#1)	12	63%	2.2	2.3	7.3%
Drake Avenue & 47th Street (#2)	5	80%	1.0	1.0	7.4%

Study site (location # on map)	Size of study area (acres)	% impervious for study area	Estimated *Bulletin 75* runoff volume (ac-ft)	Estimated *Bulletin 76* runoff volume (ac-ft)	Increase in runoff volume
Saint Louis Avenue & 47th Place (#3)	5	92%	1.1	1.2	7.1%

Designs for flood resilience

Once the runoff values were calculated, CMAP developed conceptual designs that identify opportunities for distributed green infrastructure and stormwater management practices to alleviate flood risk along roadways. The designs aim to illustrate the implementation of a combination of nature-based solutions (e.g., bioretention facilities, green roofs/rainwater harvesting, and naturalized detention basins) and structural solutions (e.g., permeable pavement, underground storage, and removing/depaving impervious surfaces). To effectively minimize flooding risk, implementers should coordinate with adjacent landowners, jurisdictions, community organizations, and other regional stakeholders to assess all opportunities for implementing flood resilience measures.

For all example sites, due to land use constraints in the urban environment, a single strategy is not an effective way to alleviate the risk; however, a combination of strategies provides sufficient capacity to make the location more resilient to projected flooding impacts. The combination of these strategies also provides co-benefits to the communities, including improved shading, aesthetic enhancements, and reduced traffic congestion.

Nature-based solutions

- **Bioretention facilities:** Landscaped areas that absorb and treat stormwater runoff
- **Green roofs/rainwater harvesting:** Vegetated roofs or systems that capture and use rainwater
- **Naturalized detention basins:** Excavated areas designed to temporarily hold stormwater runoff

Structural solutions

- **Permeable pavement:** Special pavement that allows stormwater runoff to infiltrate into the ground below
- **Underground storage:** Subsurface systems designed to store stormwater runoff
- **Removing/depaving impervious surface:** Removing hard pavement or concrete to restore natural infiltration

These conceptual designs are shown in Figure 15 through 29, and demonstrate the following:

- **159th Street/Highway 6 in Orland Hills, Orland Park, and Tinley Park (Cook County).** The conceptual designs demonstrate how green infrastructure and stormwater management features can be effectively implemented across a wide range of land uses, while also being utilized to calm traffic, enhance pedestrian safety, and mitigate heat risks. Each of the study area maps includes a table that highlights how a green infrastructure and stormwater management feature will be able to manage and treat a less tributary area using *Bulletin 76* rainfall depths. This conceptual design prioritizes implementing bioretention facilities within the right-of-way or retrofitting existing green spaces along 159th Street to naturalized detention basins. Additionally, the design highlights stormwater management opportunities on properties along the 159th Street corridor, with an emphasis on implementing resilience measures on what is currently the impervious surfaces of parking lots.
- **North Cedar Lake Road in Round Lake Beach (Lake County).** The conceptual designs showcase opportunities to retrofit existing wetlands and detention basins by expanding storage capacity through a combination of nature-based and structural approaches that can also provide recreation. In this area, the solutions must span private and public land. These conceptual designs demonstrate how changes across private land (such as installing permeable pavements in parking lots) can be an important part of flood mitigation and complement other solutions (such as bioretention facilities) on public rights of way.
- **47th Street and Archer Street in Chicago (Cook County).** The conceptual designs illustrate unique approaches for implementing green infrastructure and stormwater management features in a space-constrained, heavily urban environment upstream of a viaduct. This example focuses on opportunities for implementing distributed flood mitigation solutions not directly adjacent to the flood location but in other areas across the sewershed. This site was unique because it presented three distinctly different types of study areas (i.e., an area directly along a major road serving public transit, an industrial area, and a residential area). Each of the study area maps includes a table that highlights how a stormwater management feature will be able to manage and treat less tributary area using *Bulletin 76* rainfall depths. This conceptual design prioritizes opportunities such as green roofs, rainwater harvesting, alley retrofits, underground detention, and bioretention facilities with an increased tree canopy.

Figure 15: Overview of transportation infrastructure flood risk scores (159th Street and Highway 6 study area)

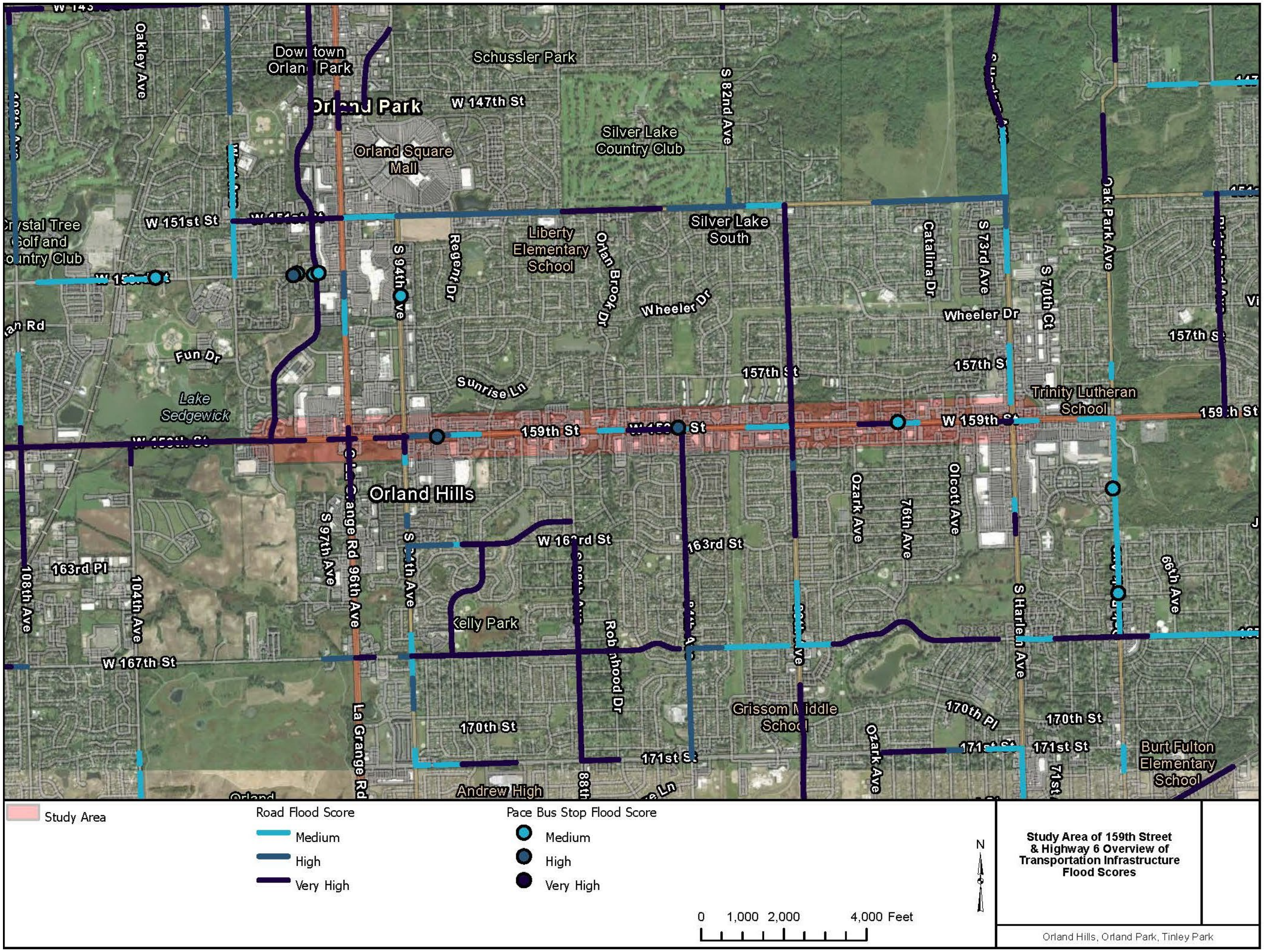


Figure 16: 159th Street and Highway 6 study area projected future flooding risk

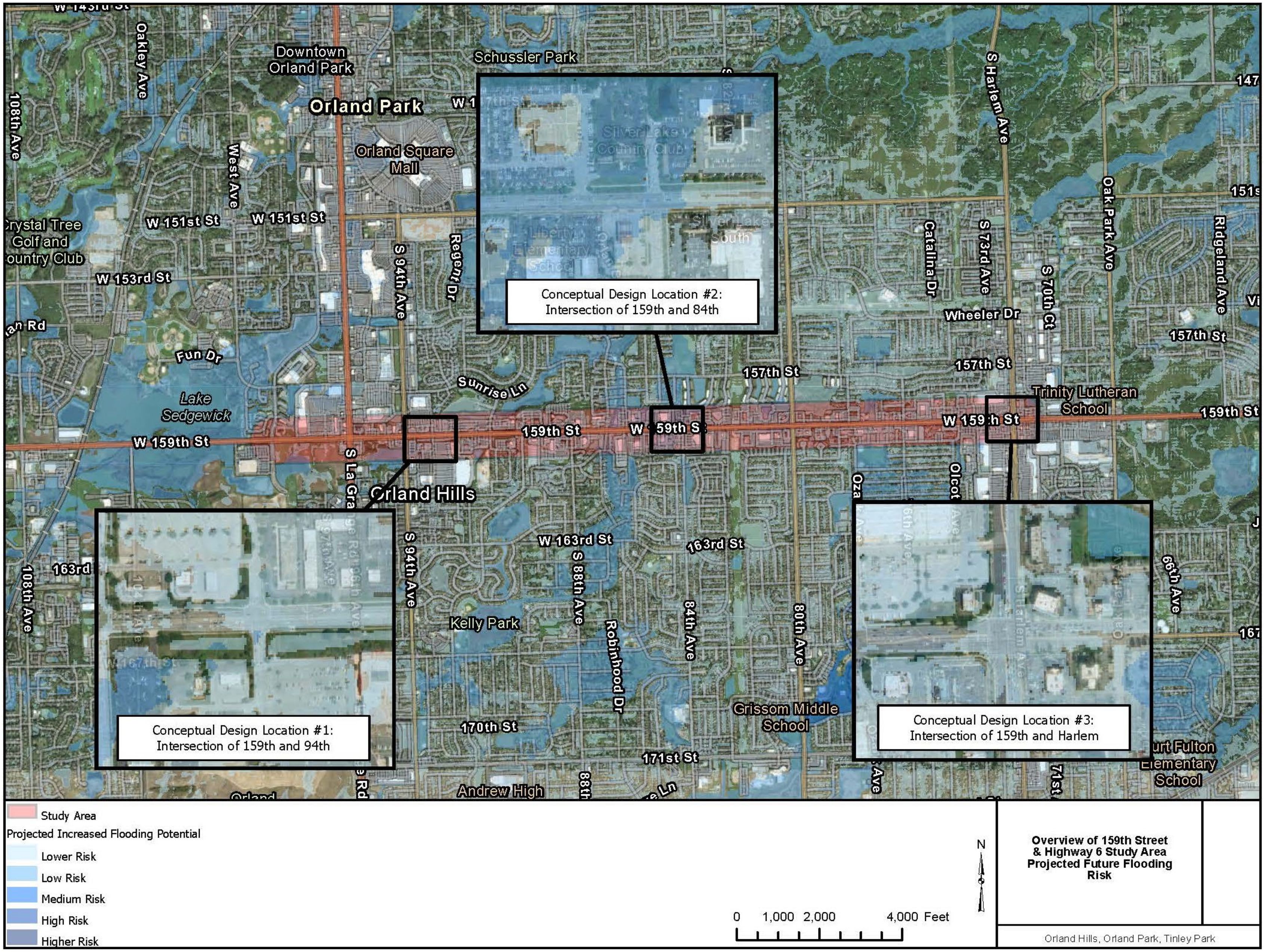
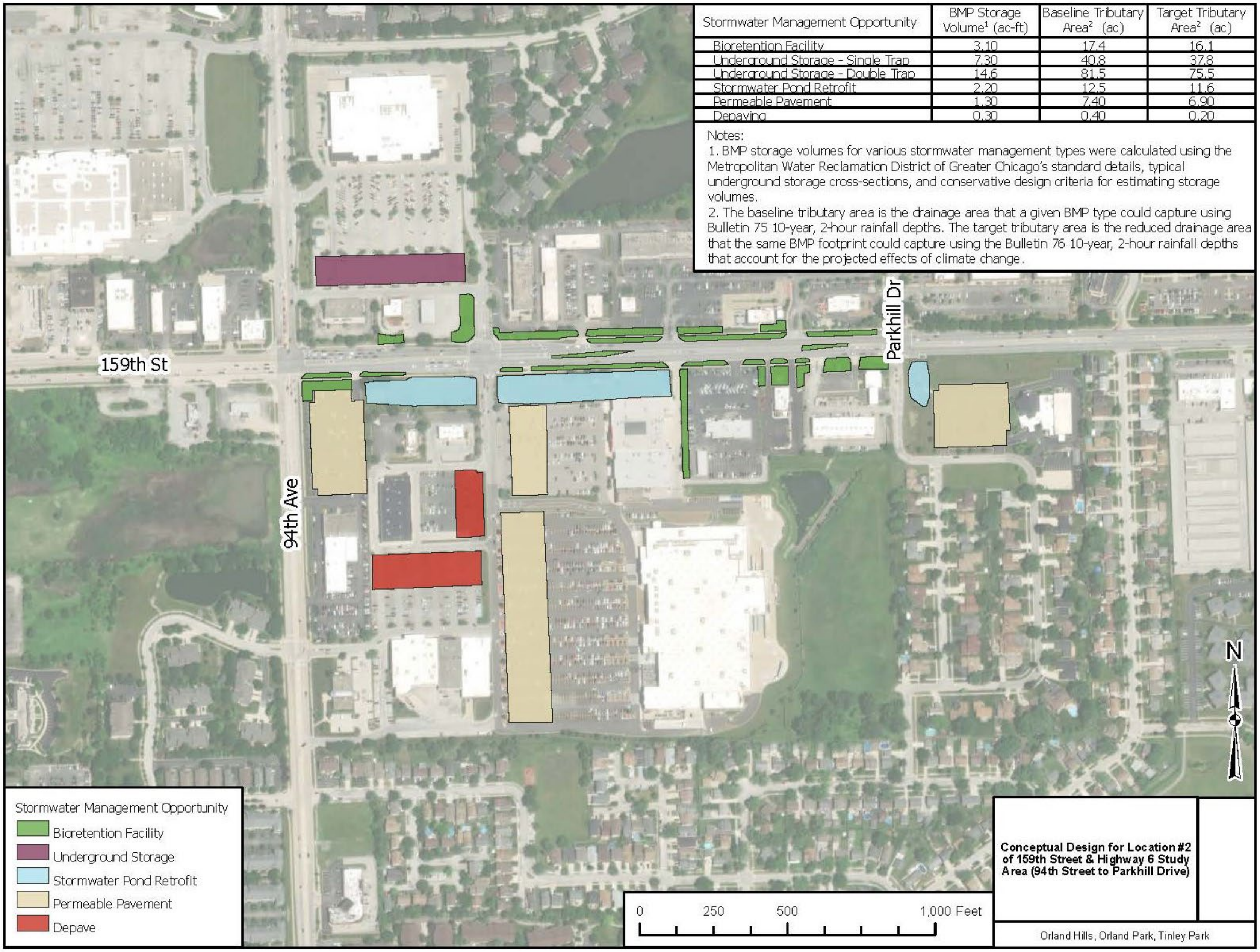


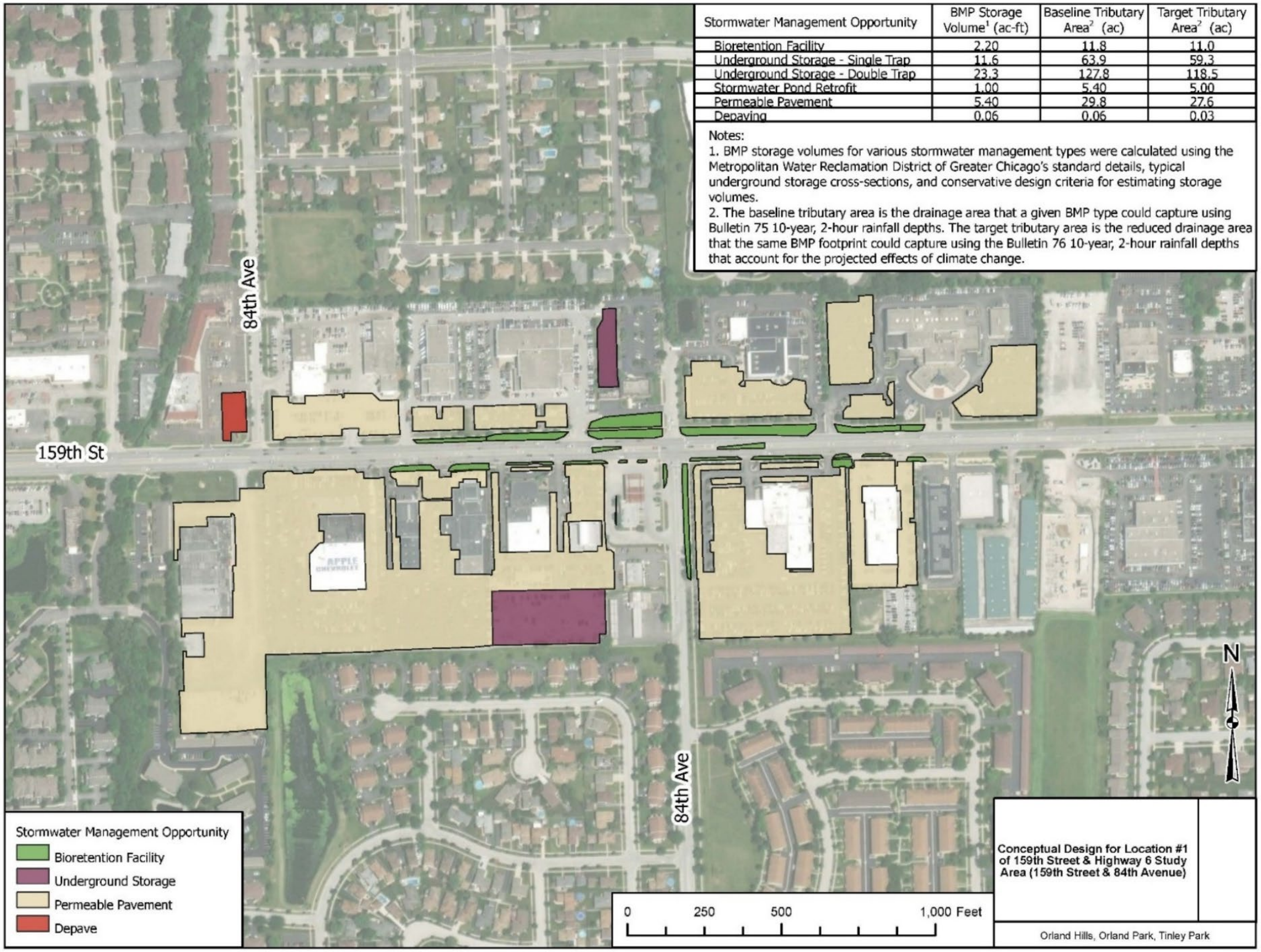
Figure 17: Conceptual design for location #1 of 159th Street and Highway 6 study area (159th Street and 84th Avenue)



Stormwater Management Opportunity	BMP Storage Volume[1] (ac-ft)	Baseline Tributary Area[2] (ac)	Target Tributary Area[2] (ac)
Bioretention Facility	3.10	17.4	16.1
Underground Storage - Single Trap	7.30	40.8	37.8
Underground Storage - Double Trap	14.6	81.5	75.5
Stormwater Pond Retrofit	2.20	12.5	11.6
Permeable Pavement	1.30	7.40	6.90
Depaving	0.30	0.40	0.20

Notes:
1. BMP storage volumes for various stormwater management types were calculated using the Metropolitan Water Reclamation District of Greater Chicago's standard details, typical underground storage cross-sections, and conservative design criteria for estimating storage volumes.
2. The baseline tributary area is the drainage area that a given BMP type could capture using Bulletin 75 10-year, 2-hour rainfall depths. The target tributary area is the reduced drainage area that the same BMP footprint could capture using the Bulletin 76 10-year, 2-hour rainfall depths that account for the projected effects of climate change.

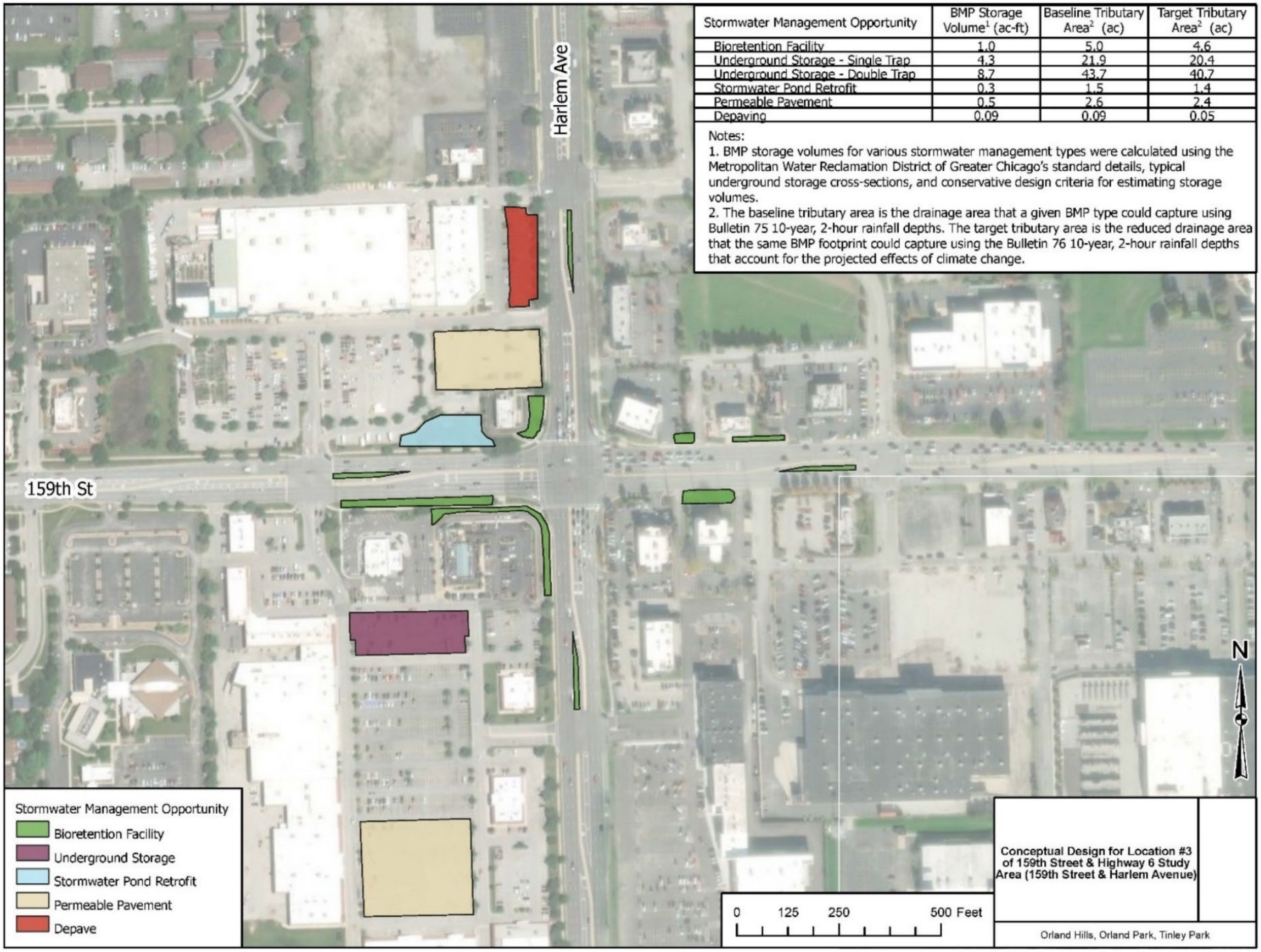
Figure 18: Conceptual design for location #2 of 159th Street and Highway 6 study area (94th Street to Parkhill Drive)



Stormwater Management Opportunity	BMP Storage Volume[1] (ac-ft)	Baseline Tributary Area[2] (ac)	Target Tributary Area[2] (ac)
Bioretention Facility	2.20	11.8	11.0
Underground Storage - Single Trap	11.6	63.9	59.3
Underground Storage - Double Trap	23.3	127.8	118.5
Stormwater Pond Retrofit	1.00	5.40	5.00
Permeable Pavement	5.40	29.8	27.6
Depaving	0.06	0.06	0.03

Notes:
1. BMP storage volumes for various stormwater management types were calculated using the Metropolitan Water Reclamation District of Greater Chicago's standard details, typical underground storage cross-sections, and conservative design criteria for estimating storage volumes.
2. The baseline tributary area is the drainage area that a given BMP type could capture using Bulletin 75 10-year, 2-hour rainfall depths. The target tributary area is the reduced drainage area that the same BMP footprint could capture using the Bulletin 76 10-year, 2-hour rainfall depths that account for the projected effects of climate change.

Figure 19: Conceptual design for location #3 of 159th Street and Highway 6 study area (159th Street and Harlem Avenue)



Stormwater Management Opportunity	BMP Storage Volume[1] (ac-ft)	Baseline Tributary Area[2] (ac)	Target Tributary Area[2] (ac)
Bioretention Facility	1.0	5.0	4.6
Underground Storage - Single Trap	4.3	21.9	20.4
Underground Storage - Double Trap	8.7	43.7	40.7
Stormwater Pond Retrofit	0.3	1.5	1.4
Permeable Pavement	0.5	2.6	2.4
Depaving	0.09	0.09	0.05

Notes:
1. BMP storage volumes for various stormwater management types were calculated using the Metropolitan Water Reclamation District of Greater Chicago's standard details, typical underground storage cross-sections, and conservative design criteria for estimating storage volumes.
2. The baseline tributary area is the drainage area that a given BMP type could capture using Bulletin 75 10-year, 2-hour rainfall depths. The target tributary area is the reduced drainage area that the same BMP footprint could capture using the Bulletin 76 10-year, 2-hour rainfall depths that account for the projected effects of climate change.

Figure 20: Overview of transportation infrastructure flood scores (North Cedar Lake Road study area)

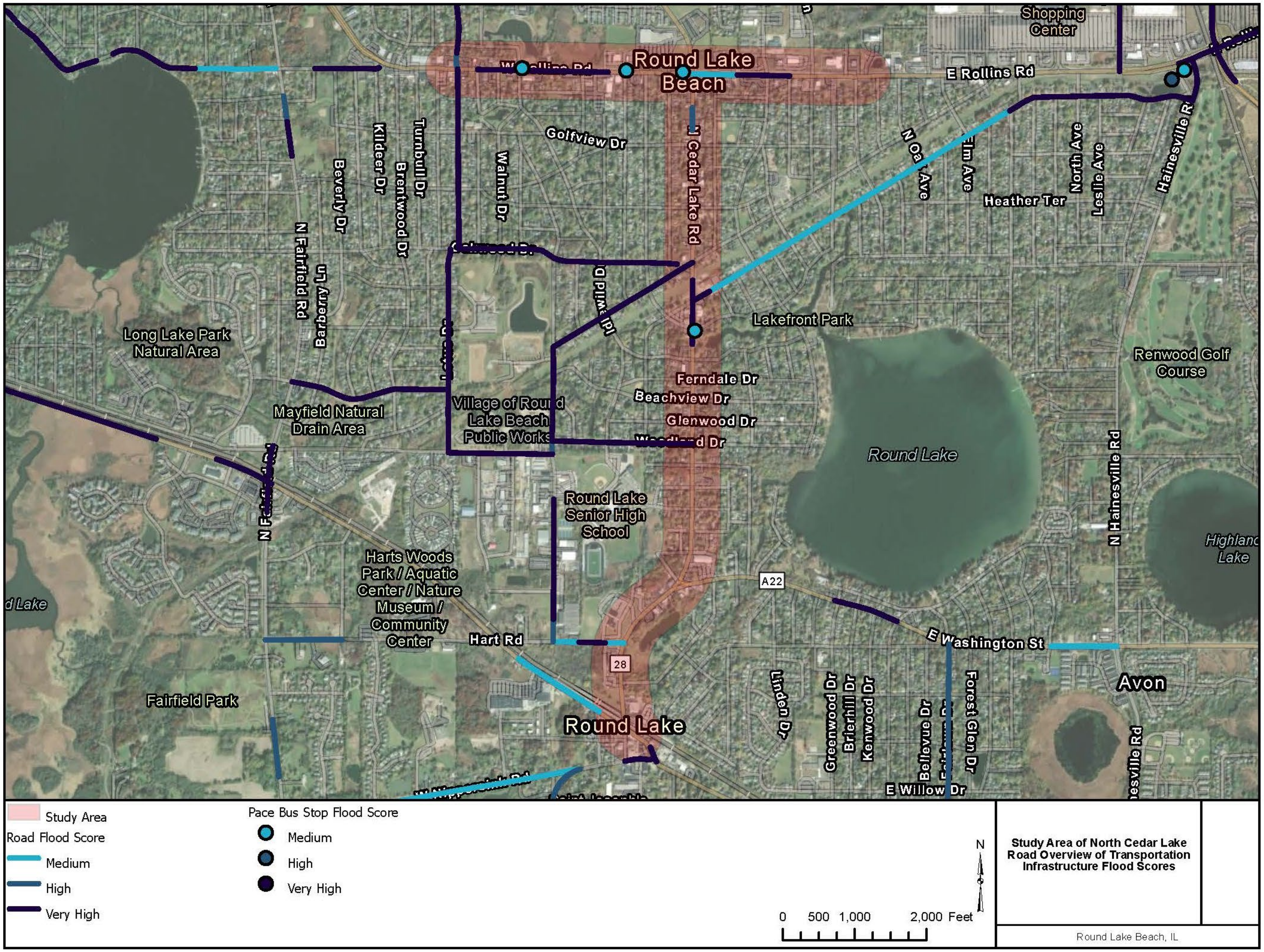


Figure 21: Overview of North Cedar Lake Road study area projected future flooding risk

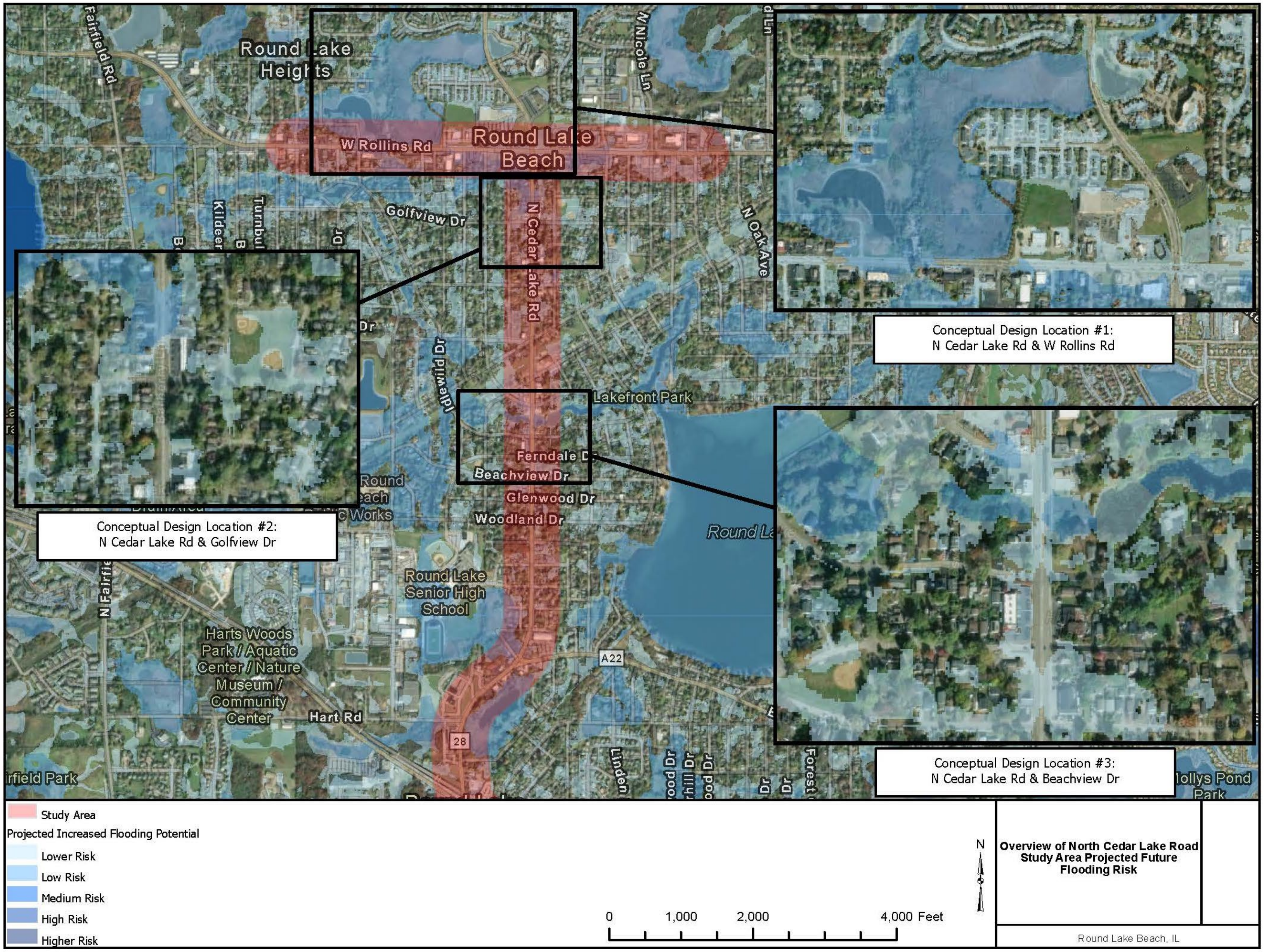
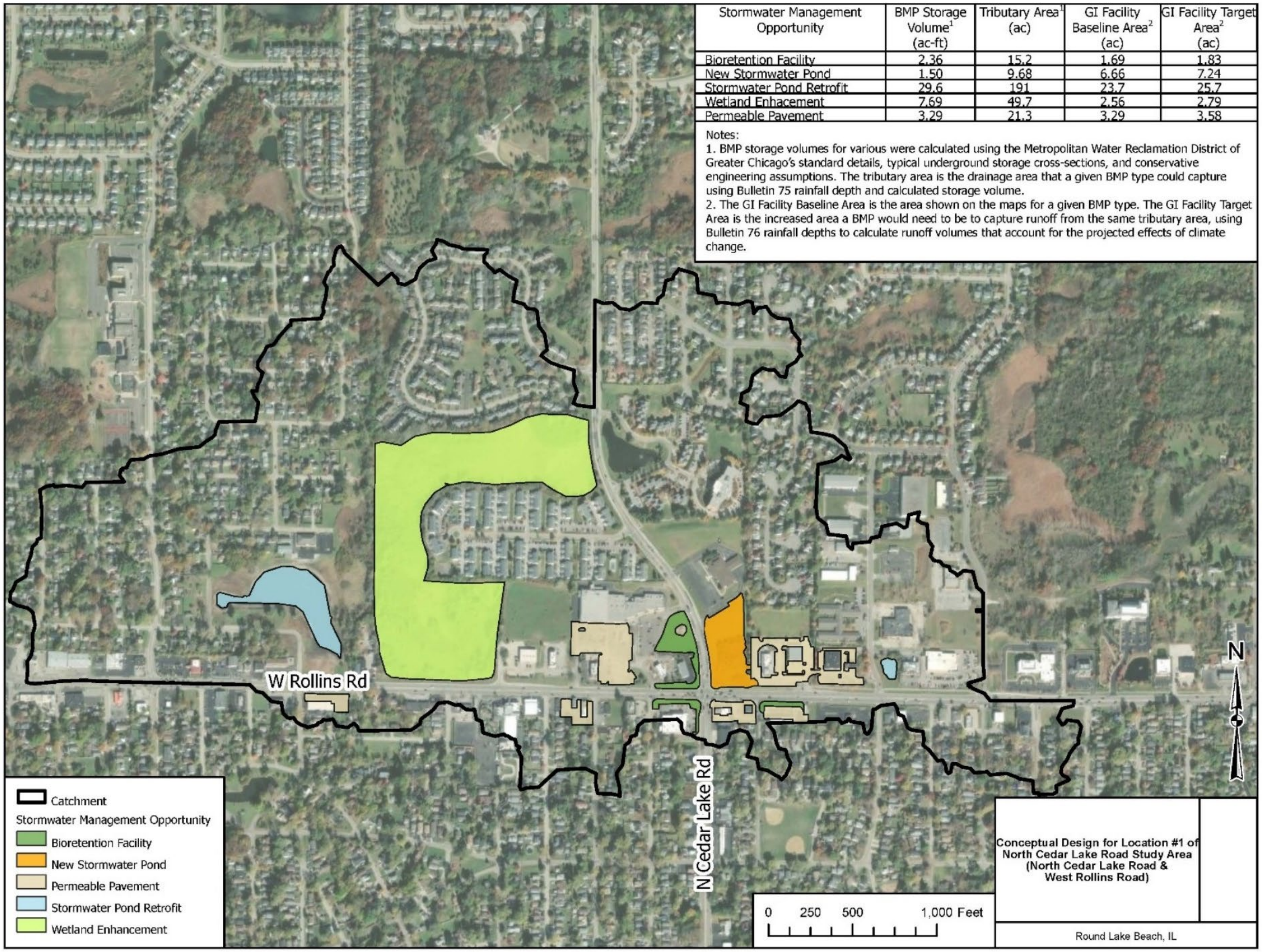


Figure 22: Conceptual design for location #1 of North Cedar Lake Road study area (North Cedar Lake Road and West Rollins Road)

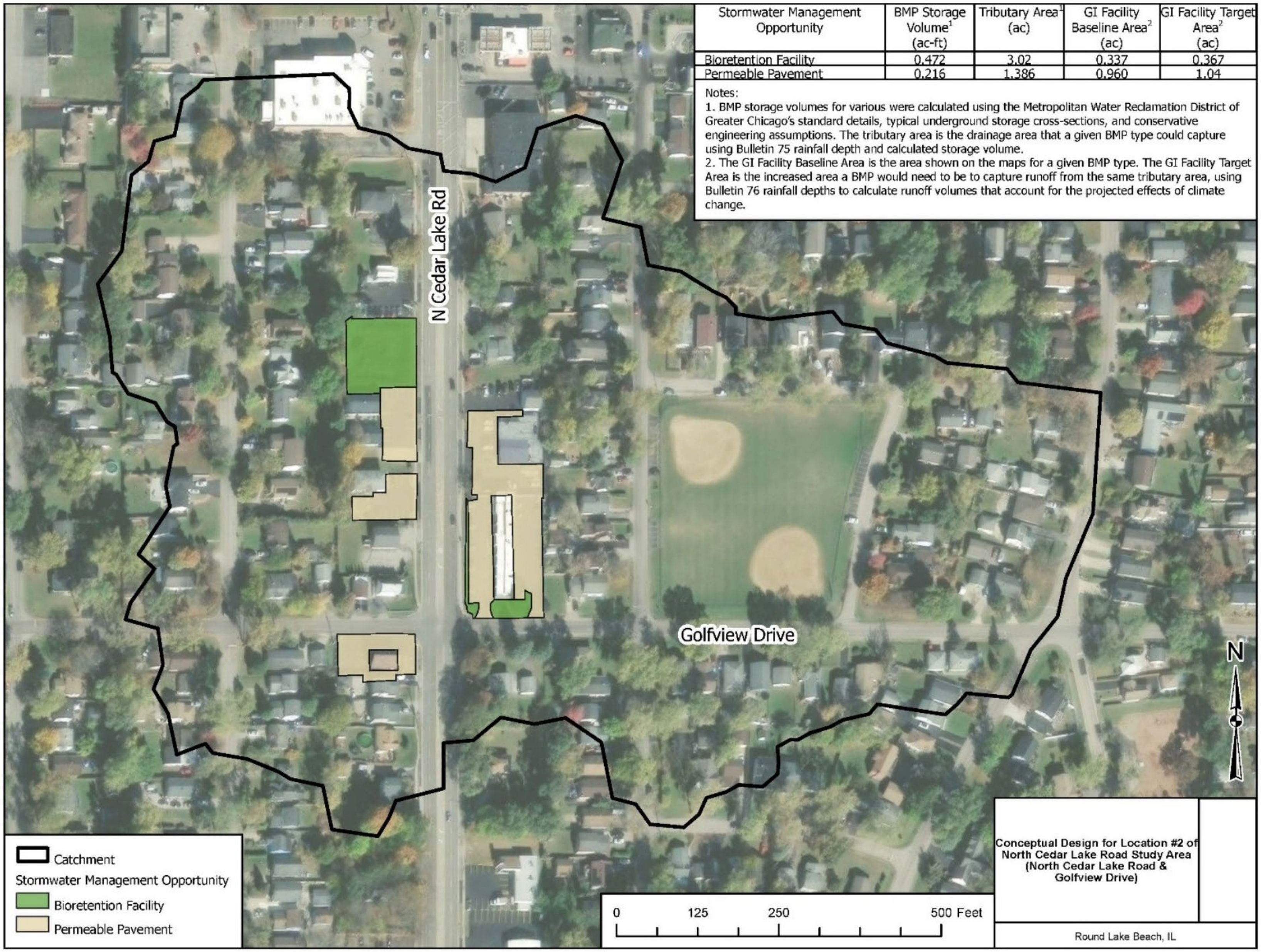


Stormwater Management Opportunity	BMP Storage Volume[1] (ac-ft)	Tributary Area[1] (ac)	GI Facility Baseline Area[2] (ac)	GI Facility Target Area[2] (ac)
Bioretention Facility	2.36	15.2	1.69	1.83
New Stormwater Pond	1.50	9.68	6.66	7.24
Stormwater Pond Retrofit	29.6	191	23.7	25.7
Wetland Enhacement	7.69	49.7	2.56	2.79
Permeable Pavement	3.29	21.3	3.29	3.58

Notes:

1. BMP storage volumes for various were calculated using the Metropolitan Water Reclamation District of Greater Chicago's standard details, typical underground storage cross-sections, and conservative engineering assumptions. The tributary area is the drainage area that a given BMP type could capture using Bulletin 75 rainfall depth and calculated storage volume.
2. The GI Facility Baseline Area is the area shown on the maps for a given BMP type. The GI Facility Target Area is the increased area a BMP would need to be to capture runoff from the same tributary area, using Bulletin 76 rainfall depths to calculate runoff volumes that account for the projected effects of climate change.

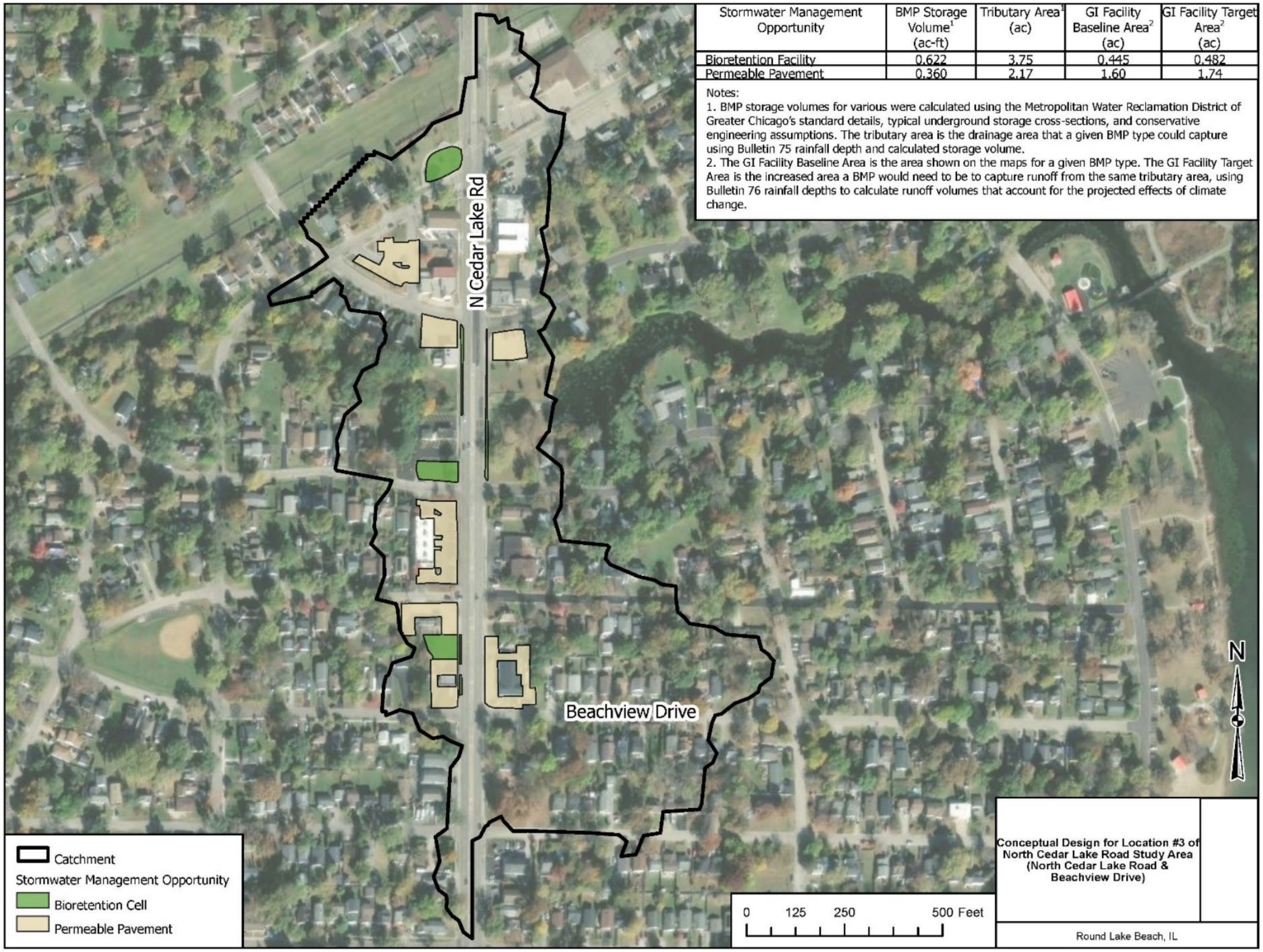
Figure 23: Conceptual design for location #2 of North Cedar Lake Road study area (North Cedar Lake Road and Golfview Drive)



Stormwater Management Opportunity	BMP Storage Volume[1] (ac-ft)	Tributary Area[1] (ac)	GI Facility Baseline Area[2] (ac)	GI Facility Target Area[2] (ac)
Bioretention Facility	0.472	3.02	0.337	0.367
Permeable Pavement	0.216	1.386	0.960	1.04

Notes:
1. BMP storage volumes for various were calculated using the Metropolitan Water Reclamation District of Greater Chicago's standard details, typical underground storage cross-sections, and conservative engineering assumptions. The tributary area is the drainage area that a given BMP type could capture using Bulletin 75 rainfall depth and calculated storage volume.
2. The GI Facility Baseline Area is the area shown on the maps for a given BMP type. The GI Facility Target Area is the increased area a BMP would need to be to capture runoff from the same tributary area, using Bulletin 76 rainfall depths to calculate runoff volumes that account for the projected effects of climate change.

Figure 24: Conceptual design for location #3 of North Cedar Lake Road study area (North Cedar Lake Road and Beachview Drive)



Stormwater Management Opportunity	BMP Storage Volume[1] (ac-ft)	Tributary Area[1] (ac)	GI Facility Baseline Area[2] (ac)	GI Facility Target Area[2] (ac)
Bioretention Facility	0.622	3.75	0.445	0.482
Permeable Pavement	0.360	2.17	1.60	1.74

Notes:
1. BMP storage volumes for various were calculated using the Metropolitan Water Reclamation District of Greater Chicago's standard details, typical underground storage cross-sections, and conservative engineering assumptions. The tributary area is the drainage area that a given BMP type could capture using Bulletin 75 rainfall depth and calculated storage volume.
2. The GI Facility Baseline Area is the area shown on the maps for a given BMP type. The GI Facility Target Area is the increased area a BMP would need to be to capture runoff from the same tributary area, using Bulletin 76 rainfall depths to calculate runoff volumes that account for the projected effects of climate change.

Figure 25: Overview of transportation infrastructure flood scores (47th Street and Archer Street study area)

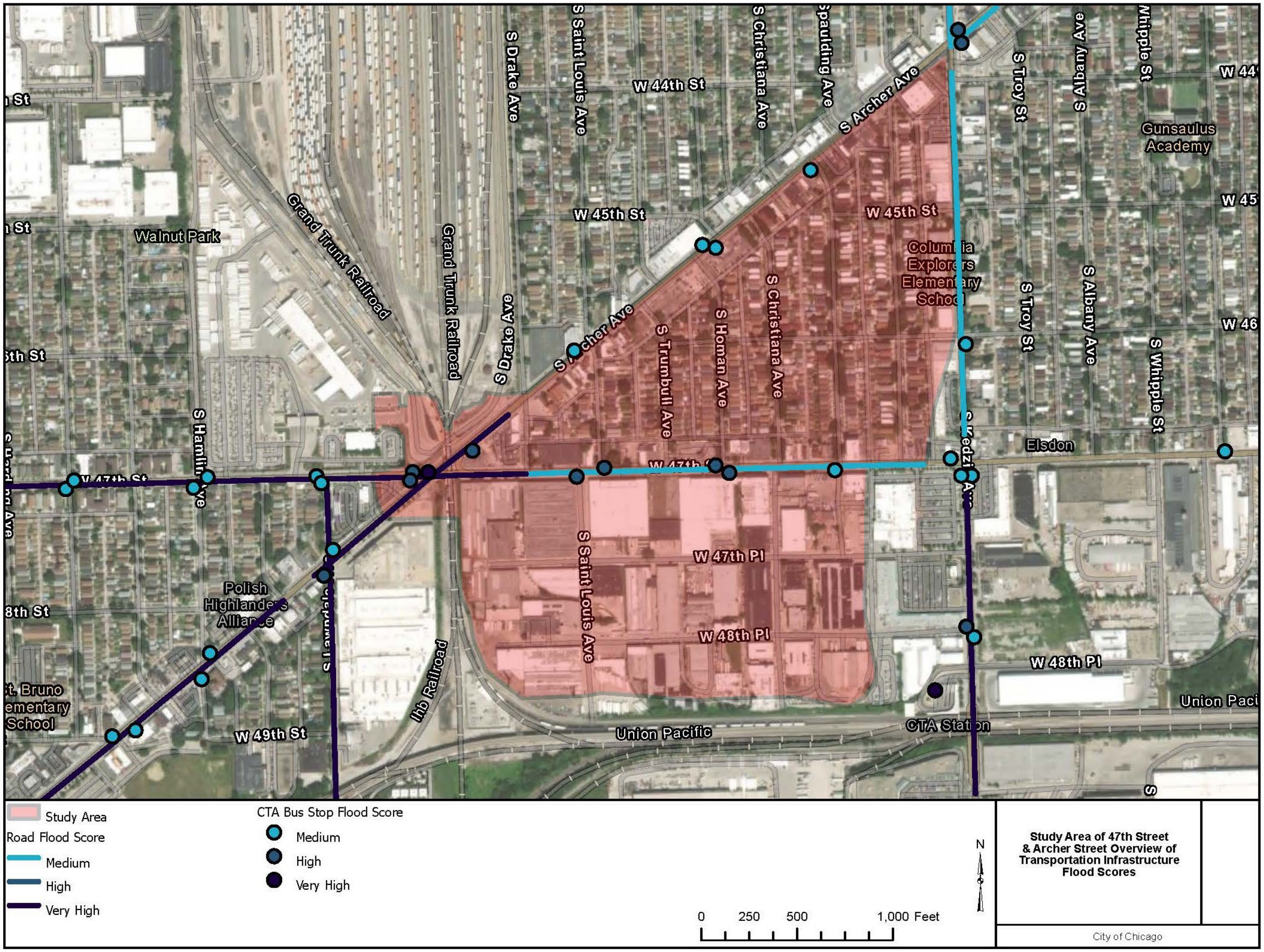


Figure 26: Overview of 47th Street and Archer Street study area projected future flooding risk

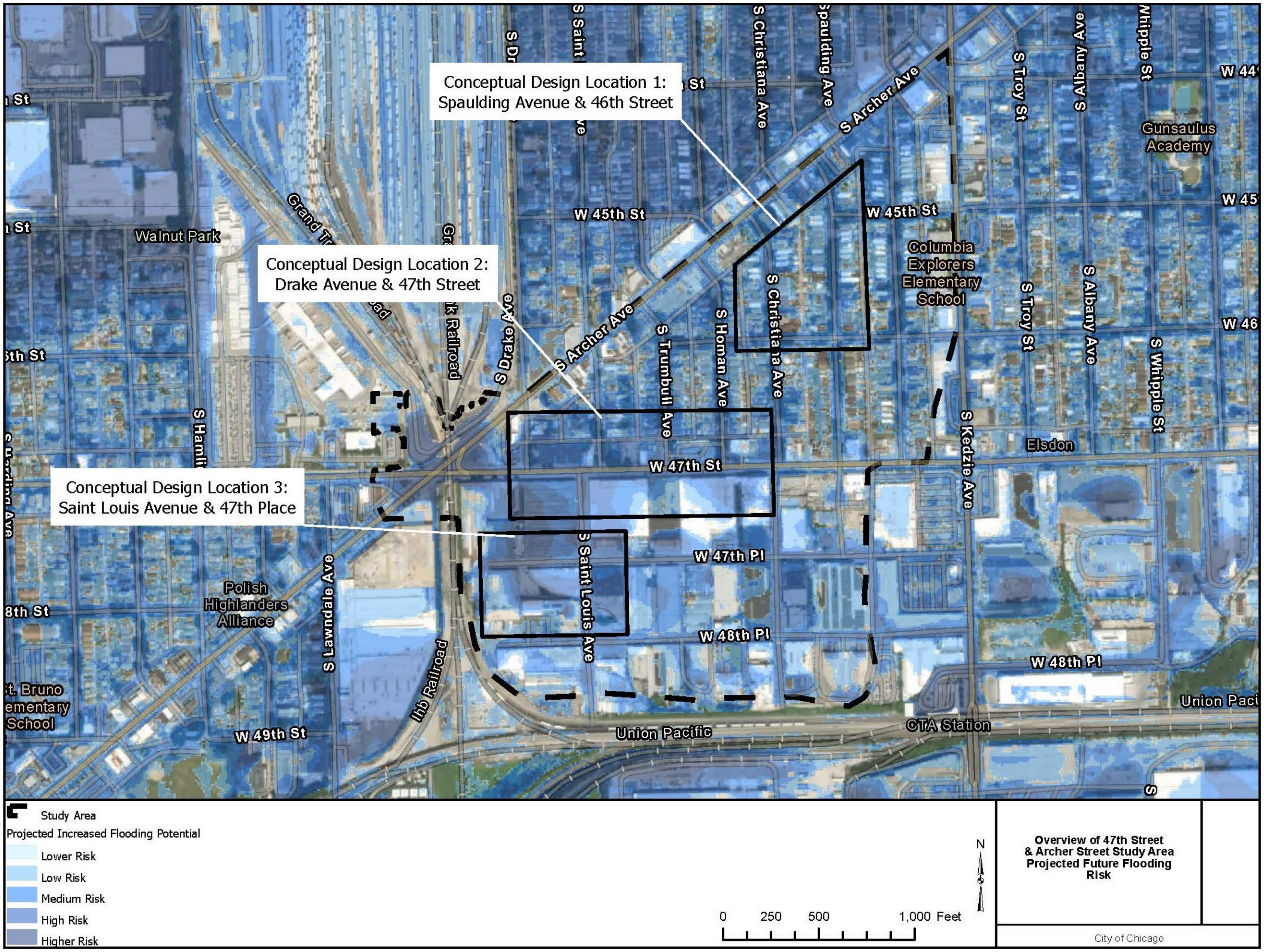
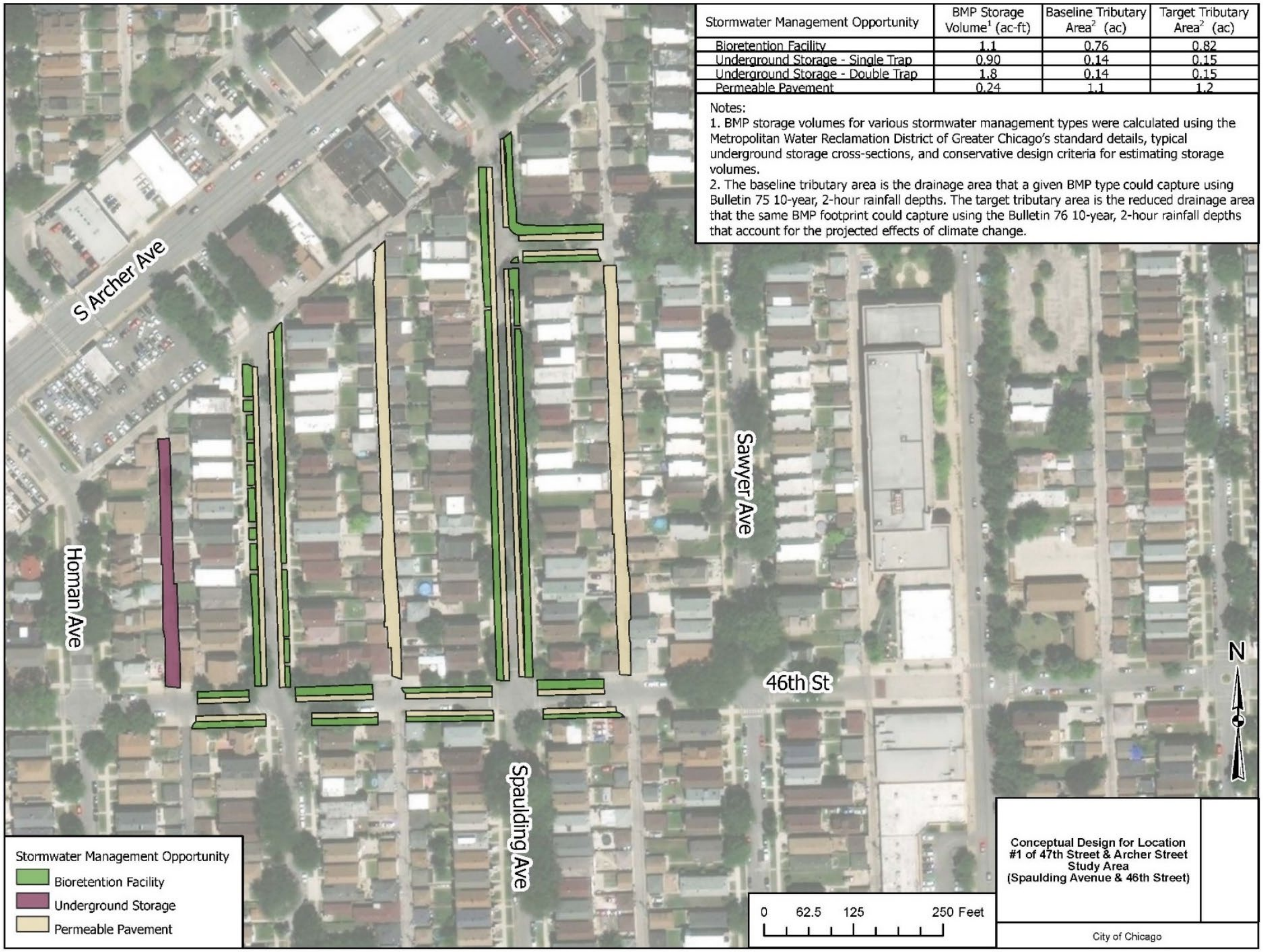


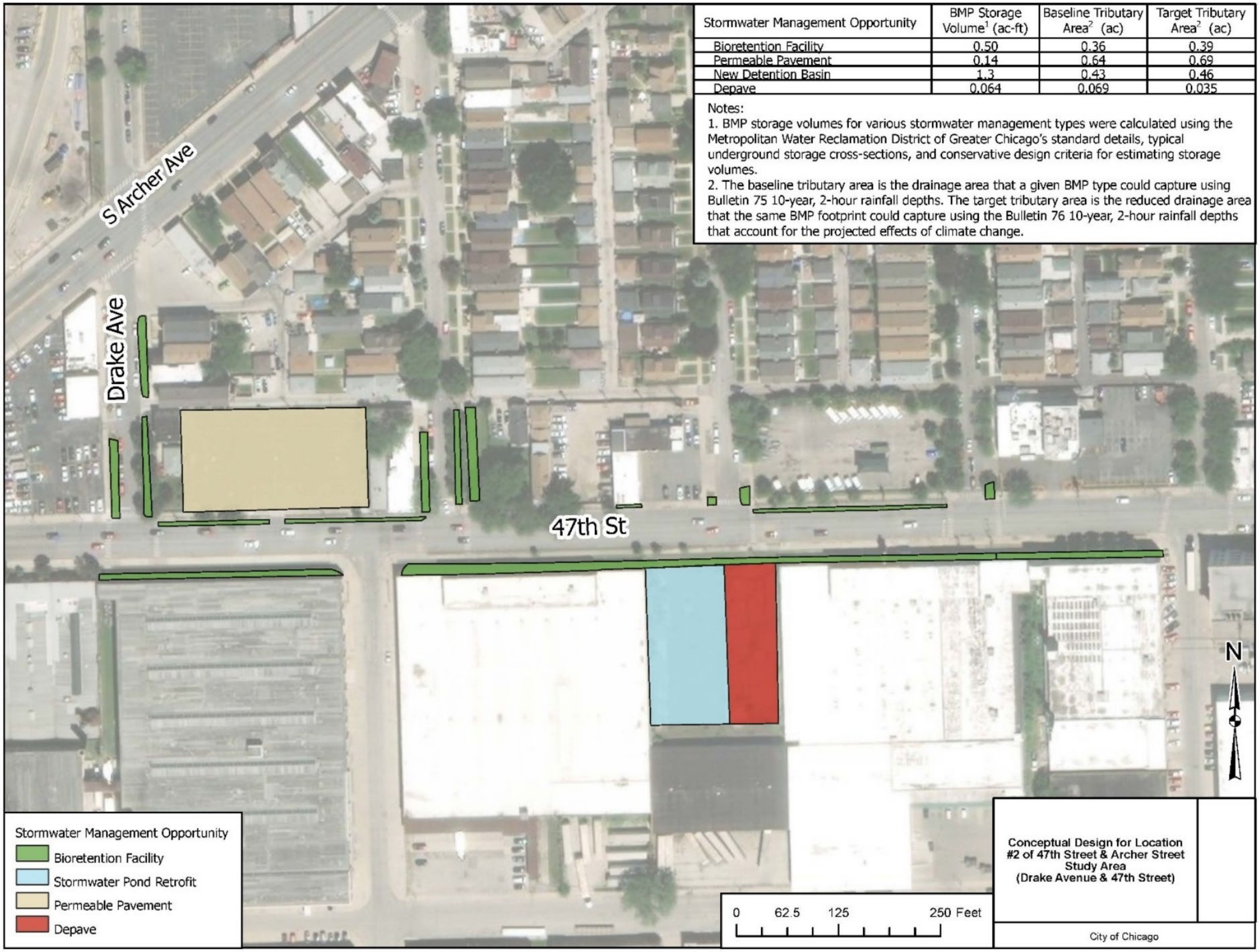
Figure 27: Conceptual design for location #1 of 47th Street and Archer Street study area (Spaulding Avenue and 46th Street)



Stormwater Management Opportunity	BMP Storage Volume[1] (ac-ft)	Baseline Tributary Area[2] (ac)	Target Tributary Area[2] (ac)
Bioretention Facility	1.1	0.76	0.82
Underground Storage - Single Trap	0.90	0.14	0.15
Underground Storage - Double Trap	1.8	0.14	0.15
Permeable Pavement	0.24	1.1	1.2

Notes:
1. BMP storage volumes for various stormwater management types were calculated using the Metropolitan Water Reclamation District of Greater Chicago's standard details, typical underground storage cross-sections, and conservative design criteria for estimating storage volumes.
2. The baseline tributary area is the drainage area that a given BMP type could capture using Bulletin 75 10-year, 2-hour rainfall depths. The target tributary area is the reduced drainage area that the same BMP footprint could capture using the Bulletin 76 10-year, 2-hour rainfall depths that account for the projected effects of climate change.

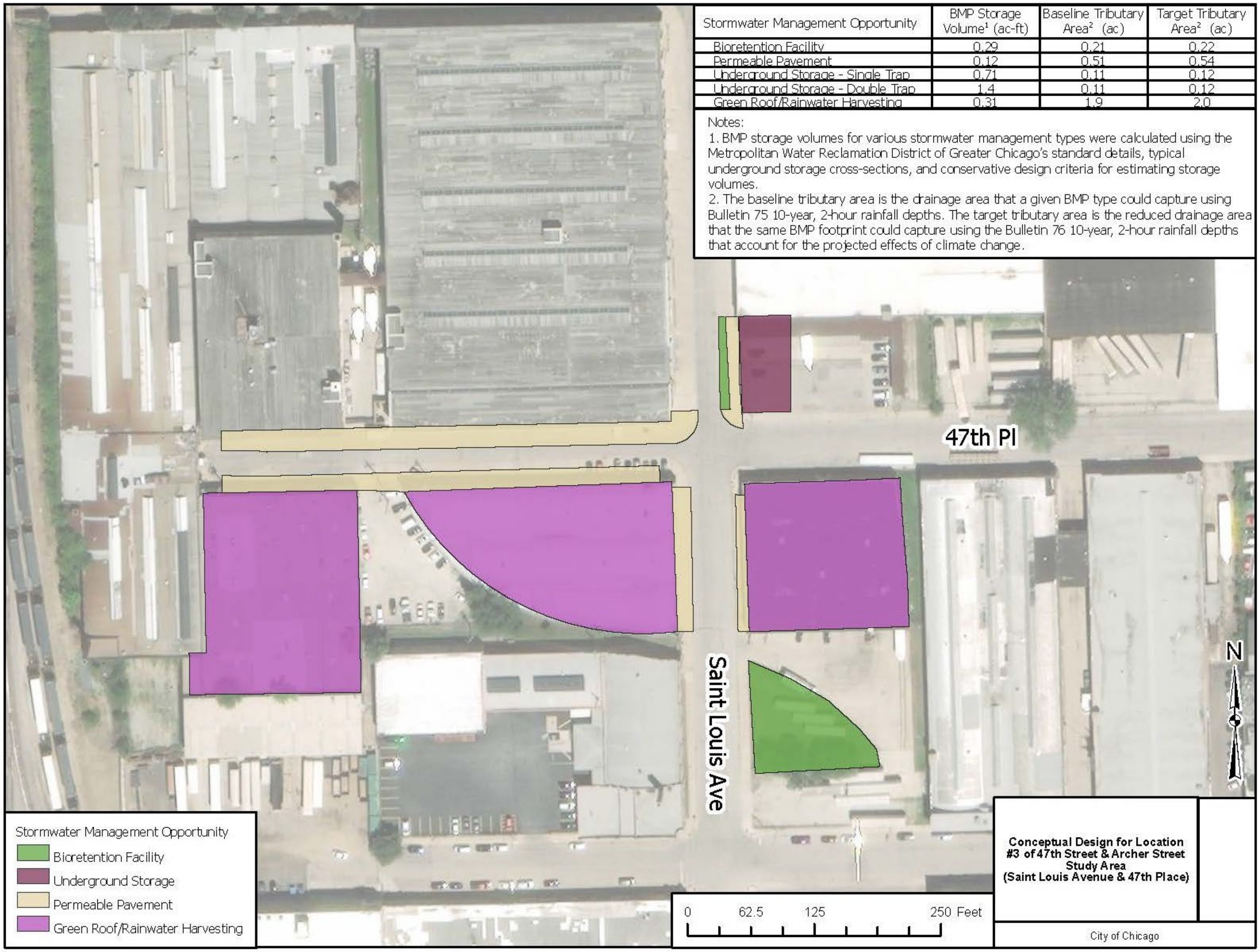
Figure 28: Conceptual design for location #2 of 47th Street and Archer Street study area (Drake Avenue and 47th Street)



Stormwater Management Opportunity	BMP Storage Volume[1] (ac-ft)	Baseline Tributary Area[2] (ac)	Target Tributary Area[2] (ac)
Bioretention Facility	0.50	0.36	0.39
Permeable Pavement	0.14	0.64	0.69
New Detention Basin	1.3	0.43	0.46
Depave	0.064	0.069	0.035

Notes:
1. BMP storage volumes for various stormwater management types were calculated using the Metropolitan Water Reclamation District of Greater Chicago's standard details, typical underground storage cross-sections, and conservative design criteria for estimating storage volumes.
2. The baseline tributary area is the drainage area that a given BMP type could capture using Bulletin 75 10-year, 2-hour rainfall depths. The target tributary area is the reduced drainage area that the same BMP footprint could capture using the Bulletin 76 10-year, 2-hour rainfall depths that account for the projected effects of climate change.

Figure 29: Conceptual design for location #3 of 47th Street and Archer Street study area (Saint Louis Ave and 47th Place)



Stormwater Management Opportunity	BMP Storage Volume[1] (ac-ft)	Baseline Tributary Area[2] (ac)	Target Tributary Area[2] (ac)
Bioretention Facility	0.29	0.21	0.22
Permeable Pavement	0.12	0.51	0.54
Underground Storage - Single Trap	0.71	0.11	0.12
Underground Storage - Double Trap	1.4	0.11	0.12
Green Roof/Rainwater Harvesting	0.31	1.9	2.0

Notes:
1. BMP storage volumes for various stormwater management types were calculated using the Metropolitan Water Reclamation District of Greater Chicago's standard details, typical underground storage cross-sections, and conservative design criteria for estimating storage volumes.
2. The baseline tributary area is the drainage area that a given BMP type could capture using Bulletin 75 10-year, 2-hour rainfall depths. The target tributary area is the reduced drainage area that the same BMP footprint could capture using the Bulletin 76 10-year, 2-hour rainfall depths that account for the projected effects of climate change.

Appendix F: Endnotes

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The Chicago Metropolitan Agency for Planning (CMAP) is our region's comprehensive planning organization. The agency and its partners developed and are now implementing ON TO 2050, a new long-range plan to help the seven counties and 284 communities of northeastern Illinois implement strategies that address transportation, housing, economic development, open space, the environment, and other quality-of-life issues.

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