Hudson River Shoreline Stabilization Study

Albany, New York

Study

June 2021

Weston & Sampson℠

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EXECUTIVE SUMMARY

This study is intended to serve as a guiding document for the stabilization and restoration of the shoreline of the Hudson River in the City of Albany, New York. It will be used to prioritize and allocate resources for projects to protect the City's unique natural and built environment from future flooding and extreme weather events.

The Hudson River Shoreline Study (HRSS) was developed by the City of Albany with funding provided by the New York State Department of Environmental Protection Fund, Hudson River Estuary Program of the New York State Department of Environmental Conservation (NYSDEC). The City of Albany retained Weston & Sampson in December of 2019 to provide planning and conceptual design services for shoreline improvements and public access along the Hudson River waterfront. The project study area encompasses 4.6 linear miles of river frontage, from Island Creek Park on the southern border of the City to the northern border of the Village of Menands in the Riverfront Preserve. The project area is confined by Quay Street and Broadway to the west.

The HRSS provides the City with appropriate recommendations and potential stabilization systems to prevent hazardous flooding along the site area in the future. To accomplish these goals, the following tasks were performed:

- Assessment of the current conditions of the shoreline area.
- Evaluation of potential shoreline alternatives.
- Recommendations of potential stabilization systems.
- Determination of conceptual costs and exploration of possible funding sources to aid in implementation.
- Coordination with public officials and key stakeholders and public engagement services.

Stabilization systems were selected based on a careful analysis of the existing conditions of the shore, historic contextual factors, habitat features, public access, and adjacent land uses. Additional considerations included regulatory requirements, cost, ecological impacts (aquatic and terrestrial), and environmental justice.

This HRSS includes the following major sections:

- Project overview, which outlines the background and purpose of the HRSS, public involvement, and data used to develop the plan.
- Existing conditions, which document the history of the Albany shoreline, shoreline stabilization issues, and site factors related to the development of improvements along the riverfront.
- Shoreline types and stabilization recommendations for the three defining shoreline features of the Albany riverfront.
- Shoreline improvement strategies, which include riparian biodiversity, ground stability, erosion control, public access, and engineered approaches.
- Regulatory expectations, maintenance requirements, costs, and potential funding sources.

Reference materials, mapping, public survey data, and cost estimate documentation are provided in the appendices of the HRSS, which are intended for use by the City of Albany during implementation.

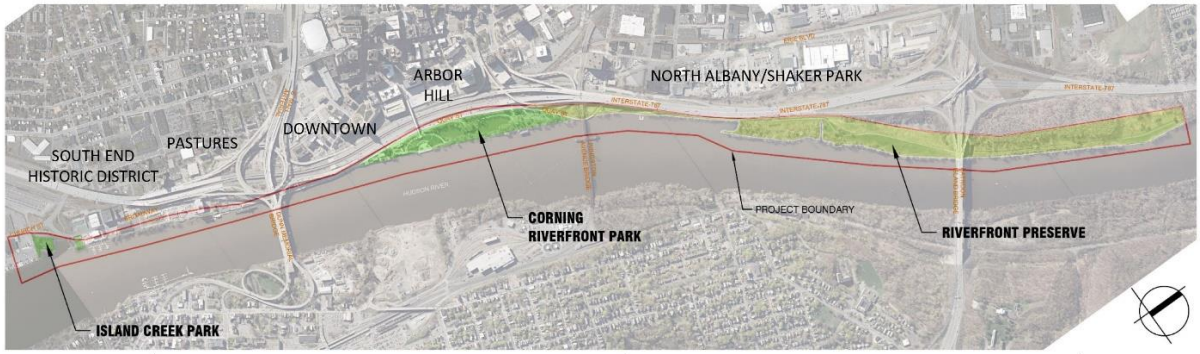

Figure 1: HRSS Study Area

OVERVIEW

This section includes a general overview of the project as well as a project background and context for this Shoreline Stabilization Study. This section also discusses visions and goals for the project and the methods of data collection.

1.1 Project Background & Study Area

The Hudson River Shoreline Study is a multi-disciplinary, inter-agency effort to simultaneously promote the riverfront as public resource while planning for measures to protect the City's parklands and urban infrastructure from the detrimental effects of climate change. Recognizing the tourism and investment potential of the area, Albany has invested in revitalization planning of the riverfront through previous studies and subsequent improvement projects. These planning and construction efforts, coupled with climate-change related weather disturbances, have necessitated the investigation of ways to protect the area from catastrophic impacts. The Port of Albany has suffered significant flooding in the last century from hurricanes and tropical storms. Flooding from extreme storms has already cost the region between $25 million and $1 billion between the years of 1960 and 2014 (NYSERDA, 2018). Low-lying areas are prone to flooding when rainstorms coincide with high tide. The City could expect tens of millions of dollars in future property damage if flooding and flood risks are not addressed along the Hudson River waterfront.

The HRSS is a strategy for restoring and enhancing Albany's riverfront. This endeavor provides a clear direction for future improvements along the shore, increases public access, enhances adjacent park areas, and informs planning decisions in the greater Hudson River corridor. The project advances Albany's 1991 Local Waterfront Revitalization Program, the 2013 Albany Climate Change Vulnerability Assessment and Adaptation Plan, and the Albany 2030 Comprehensive Plan. These plans promote redevelopment of the waterfront business district, which in turn will provide economic development benefits not only to the City, but to the entire region. Careful implementation of improvements will preserve and protect the waterfront, ensuring the financial investment in the riverfront are not lost.

The project study area encompasses 4.6 linear miles of river frontage along the Hudson River in the City of Albany. Beginning in the northern portion of the study area, the 85-acre Riverfront Preserve is comprised of woodlands, large expanses of open space, and the popular Mohawk-Hudson Bike Trail. Moving south, the 15-acre Corning Riverfront Park has tidal ponds, park lands, multi-use paths,

and a boat launch. This destination is a regional hub for festivals, concerts, passive recreation, fishing, and picnics. A 1,000-person amphitheater is found at Jennings Landing in the southern portion of the park, as well as a riverfront pump station (owned and operated by New York State). South of the park the Mohawk-Hudson Bike Trail extends along Quay Street before linking with the new South End connector at Church Street. A series of privately-owned commercial properties and City rights-of-way occupy approximately 11 acres of riverfront. Finally, the hidden gem of Island Creek Park is located on the southern border of the project area. This much-loved 3.5-acre park has a fishing pier, tidal flats, picnic areas, and lovely shade trees.

1.2 Context for Implementation

The Hudson River shoreline is a manmade environment in terms of infrastructure, soils and the inhabiting vegetation. The current alignment of the shoreline was influenced by maritime activities over the centuries. What used to be a sinuous span of tidal inlets, marsh, and islands was gradually straightened, filled, and hardened to accommodate anthropogenic[1] purposes.

A significant portion of the shoreline project area has naturalized over time as engineered stabilization infrastructure deteriorated and succumbed to hydrological pressures. Volunteer plants have established themselves along most of the shoreline, comprised of a mix of shrubs, trees, and sparse herbaceous cover. However, erosive flows, wave action, and ice damage have severely undercut parts of the shore. Some trees and shrubs lean toward the water; others have lost the battle with gravity and have toppled in. Runoff from increased stormwater volumes has also contributed to erosion along the shore, particularly in areas adjacent to buildings and parking lots.

Figure 2: Eroded shoreline conditions at Island Creek Park

[1] Defined as the influence of human beings on the natural world. Can also refer to environmental degradation resulting from human activities.

Engineered shorelines (concrete & steel bulkheads) occupy approximately 0.8 miles of the project area. These structures protect valuable urban infrastructure immediately adjacent to the shore, but do not provide habitat or biodiversity along the shore. In addition, engineered shorelines will need to be redesigned to accommodate anticipated sea level rise in the Hudson River and future severe storm scenarios.

1.3 Study Goals

The HRSS will help the City of Albany protect the riverfront from flooding while enhancing public access and enjoyment of the Hudson River waterfront. To accomplish this goal, the following parameters were developed to guide the study:

Critical Success Factors:	Performance Measures:
-Evaluation of climate change impacts	-Sea level rise and risk analysis
-Evaluation of the shoreline	-Shoreline condition site assessments
-Prioritization of projects	-Environmental justice considerations
-Equitable public access	-Public engagement
-Natural systems restoration	-Habitat assessment
-Public health & safety	-Formalized access and trail improvements

1.4 Data Collection

This section describes the data used to assess current site conditions. Base mapping and data were obtained from publicly available GIS data, Google Earth imaging, and past studies. Data was also collected in the field. Methods of field data collection are described below.

1.4.1 Geographic Information Systems Data & Google Earth.

The desktop evaluation was conducted using ArcGIS Desktop 10.5.1. Imagery was collected from Google Earth[2] and used to support a desktop review of field conditions. This data was supplemented with field review data to ensure accurate reporting and analysis of current field conditions.

1.4.2 Previous Studies & Reports

Past studies and reports were reviewed as part of the study area analysis. Data was obtained from sources, including the City of Albany, NYS DEC, other project stakeholders, and publicly available data online. The documents reviewed are included in the reference section at the conclusion of this report.

1.4.3 Field Data Collection Methods

Initial field assessments were conducted in the spring and summer of 2020. Shoreline conditions and typical management areas were observed and recorded on foot and bicycle. Field data was recorded with a handheld GPS (Trimble Geo 7x Centimeter Edition) and a digital form. Extensive photographs were taken throughout the field assessment process. Field work photographs were provided to the City of Albany.

[2] Google Earth data was obtained from https://earth.google.com/web/.

1.4.4 Stakeholder & Public Engagement

The project team conducted one pop-up event, two virtual public meetings, an online public survey, and four meetings with a Project Advisory Committee (PAC) comprised of project stakeholders. This group includes the following participants:

Stakeholder	Title / Affiliation
Brad Glass	Director, Albany Department of Planning & Development
Jason West	Energy Manager, Mayor's Office of Energy and Sustainability
Joseph Coffey	Commissioner, Department of Water & Water Supply
Sergio Panunzio	Commissioner, Albany Department of General Services
Frank Zeoli	Deputy Commissioner, Department of General Services
Randy Milano	City Engineer, Albany Department of Engineering
Jay Lavigne	Forester, Division of Parks and Forestry
Gary Bohl	Asst. Director of Operations, Albany Dept. of General Services
Martin Daley	Water Quality Director, CDRPC
Dan Miller	Project Manager, Department of Environmental Conservation
Angelika Stewart	Environmental Analyst, NYS DEC

The public engagement presentations, pop up event, and online public survey resulted in the following major themes:

- Most people get to the waterfront in their cars.
- Biking, walking, running, and boating (kayak/rowing) are the primary activities people engage in along the waterfront.
- People are very concerned about the impacts of sea level rise and climate change, and feel they are sufficiently educated on the subject.
- Pedestrian and bicycle access, park space, and nature restoration are most important for the future of the riverfront.
- Restrooms, restaurants, and improved walking and bicycling facilities are desired amenities.
- Interstate 787 (I-787) is a physical barrier to the waterfront, which inhibits equitable riverfront access and environmental quality. People feel that the riverfront and environment should become an integral part of Albany's identity.

Public survey results can be found in Appendix A – Public Survey.

EXISTING CONDITIONS

Section 2 documents vegetation composition, existing plant communities, ecosystem services, and cultural influences affecting the landscape in the study area. This section also provides an overview of site factors known to exist in the study area based on field studies, GIS mapping, reports and other data as referenced in Appendix B – Project Drawings.

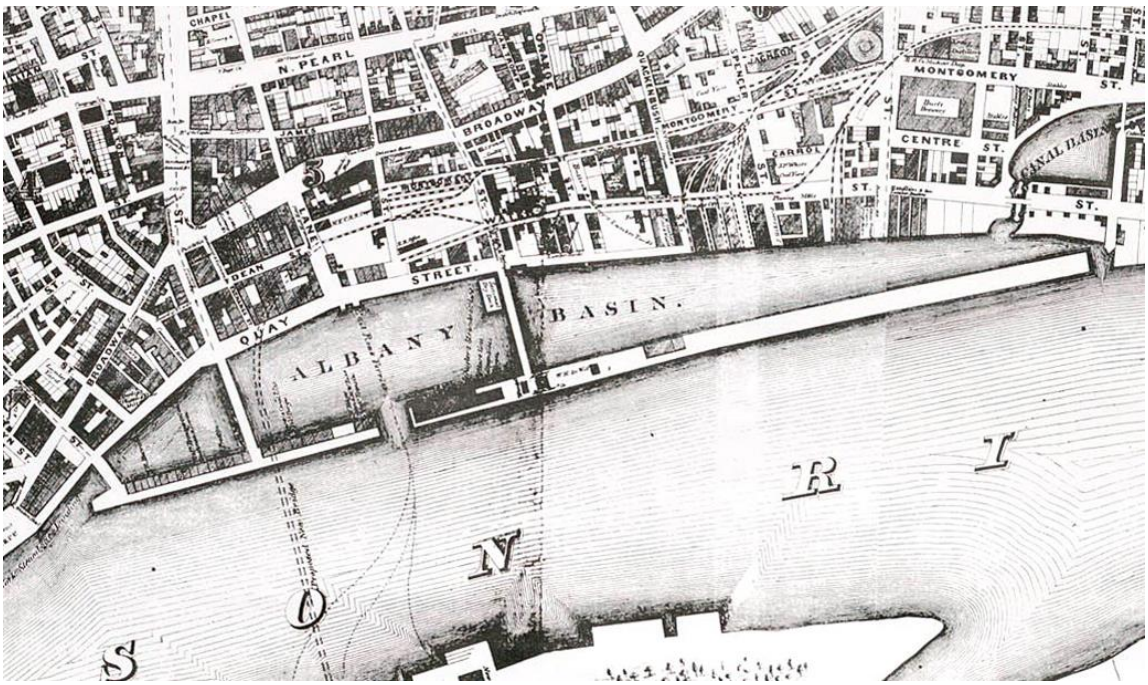

Figure 3: Map of the Albany Basin, 1857.

2.1 Historical Context

What is now known as the Albany riverfront was originally inhabited by the indigenous Algonquian peoples. Initial colonial development consisted of military and trading campaigns. Forts and settlement trading posts were initially occupied by fur traders. To encourage permanent settlement, the Dutch set up an investment system where large tracts of riverfront land were held by landowners called "patroons." Tenant farmers established homesteads and cultivated land, paying these patroons an annual land rent.[3] As the trading post expanded and prospered, people began to move north of the fort to a new settlement named Beverwyck.[4] The Dutch settlement surrendered to the British in 1664 and ownership to the territory was granted to King Charles II's brother James. Soon after, Beverwyck was renamed Albany[5].

2.2 Shoreline Stabilization Issues

Ground stability and erosion issues are present along the banks of the Hudson River. Shore instability along the Hudson River is generally due to one or more of the following factors:

[3] Anthony Opalka. (n.d.). *Albany: One of America's First Cities.* Retrieved June 19, 2020, from Albany Instititute of History & Art: https://www.albanyinstitute.org/albany-one-of-americas-first-cities.html

[4] Translates to beaver district

[5] Guide to Albany's Capital Region. (n.d.). Retrieved June 19, 2020, from Discover the History of Albany, New York: https://www.albany.com/about-albany/history/

- Bank undercutting due to waves.
- Bare soil conditions (no vegetation).
- Water encroachment behind shallow concrete revetments or riprap.
- Trees collapsing into the river.
- Walking paths down to the river, leaving the path bare of vegetation, compromising tree roots.

Areas of particular concern include:

- Tree decline, timber retaining structure failure, and erosion at Island Creek Park.
- Insufficient vegetative buffer and steeply sloped riprap edges at the Corning Riverfront Park.
- Development encroachment and insufficient shoreline buffer in commercial, privately owned properties in the southern section of the project area.
- Deteriorating bulkhead near the Corning Riverfront Park Boat Launch.
- Steep slopes with stressed trees along the Mohawk Hudson Bike Path in the southern portion of the Riverfront Preserve.

2.3 Site Factors

The following is a review of relevant site factors that will contribute to the success of shoreline stabilization improvements in the study area. Extensive site analysis mapping and documentation further describing these items can be found in Appendix B - Project Mapping and Appendix C – Site Documentation.

2.3.1 Soils & Topography

Several US Geologic Survey (USGS) soil classifications are found on the banks of the Hudson River. The four most common soil types are:

- Teel silt loam (Te): Typical profiles include silt loam and fine sandy loam found in floodplain conditions with moderately well-drained conditions.
- Udorthents (Uk), loamy-Urban land complex: Consist of loams that are considered moderately well-drained with potential for fill from previous land-alteration activities
- Udorthents (Ug), loamy: Consist of loams that are considered moderately well-drained.
- Urban Land (Ur): Consists mostly of sites for buildings, paved roads, and parking lots (USDA, 2020).

The topography in the study area varies. In general, there is a very gentle sloping of land from the outer perimeter of project area to the riverbank (< 5% slope). However, the majority of the riverbank itself is steep (>30% slope) and provides an abrupt change from the river to the upland area. The steepest sloped area is along the bike path just north of the Albany Rowing Club Boat Launch. From the water's edge to the top of bank, the slope of the bank itself is very steep (40-50%) with a wooded/high shrub riparian edge and abrupt transition to the water's edge. The shorelines at the Riverfront Preserve have more gradual (<20%) slopes that are thickly vegetated with trees and shrubby material. Approximately 0.8 miles of the project area shoreline is protected by concrete and steel bulkheads, which are vertical and do not have any living components in their construction.

2.3.2 Land Use & Circulation

Land Use

Land use is defined by the New York Geographic Information Clearinghouse as activities, management strategies, and/or economic purposes placed upon the land by people or land managers (NY GIS, 2020). The most commonly occurring land uses within the study area are:

- Urban commercial use occurring predominantly just north of Island Creek Park, east of Quay Street. This use terminates after the Dutch Apple Cruise site at the intersection of Quay Street and Broadway.
- Passive and active recreation are found in Corning Riverfront Park and the Riverfront Preserve. This includes bike paths, passive open space use, playgrounds, and cultural event programming.
- Just north of Island Creek Park is the privately-owned Springer's Marina. Dutch Apple Cruises provides boat tours to the public at the intersection of Broadway and Quay Street. The USS Slater (a historic ship active in World War II) is docked at this location and available for tours. The Albany Rowing Center maintains a boat launch/dock in the northern portion of the Corning Riverfront Park. The launch and adjacent lands are owned by the City of Albany.
- Transportation is found along the I-787 corridor, Quay Street, Broadway and includes parking areas underneath the overpass.
- Non-forested wetlands are found in the Riverfront Preserve, particularly in the southern portion of the site.
- Forested wetlands are found in the Riverfront Preserve in the wooded corridors adjacent to the Hudson River.
- Forest areas occur along the Hudson River and intermittently along the western side of the Riverfront Preserve.
- Open lands are found at the Corning Riverfront Park and Riverfront Preserve.

Circulation

Historically, the Albany riverfront was dominated by transportation and industrial uses. However, opportunities for recreation emerged gradually as methods of transport for commercial and public transport changed over time. As with many American cities in the mid-twentieth century, as the popularity of trains declined, highways gradually infringed on the urban fabric of the city. Albany's waterfront is dominated by a network of roadways that move vehicles around and over the downtown district. Most prominent is the elevated highway, I-787, which provides a north-south connection through the City of Albany and neighboring municipalities. Today, while I-787 is an efficient route of vehicular travel through the greater region, its presence disconnects vehicular and pedestrian travel between the city and the waterfront.

Another physical barrier to the waterfront, the Canadian Pacific Railway, travels along I-787 through the study area.. From the southern portion of the study area near Church Street there are two at-grade parallel tracks that extend north. Starting around Arch Street, the tracks begin to elevate and meet the I-787 grade before Broadway and run parallel to and in between the north and southbound lanes. Just south of the Livingston Avenue Bridge, the tracks cross under the Route 9 and I-787 interchange and continue to the northwest. The freight carried on this important corridor varies and according to CDTC's I-787/Hudson Waterfront Corridor Study, materials "generally consist of oil, propane, chemicals, industrial supplies, heavy equipment, scrap and

mixed freight"[6]. The CSX rail line crosses the study area over the Livingston Avenue Bridge but does not impede access to the riverfront. This line enables east to west freight as well as Amtrack passenger service to the Albany-Rensselaer Station.

The waterfront can primarily be accessed on foot by Broadway, NY Route 5, the Hudson River Way pedestrian bridge, and Colonie Street. Connections are spaced ± ¼ to ¾ of a mile apart along the adjacent neighborhoods. The popular Mohawk-Hudson Bike-Hike Trail, mostly a paved multi-use trail with a few on-road bike route portions, extends from the Corning Preserve northwest along the Hudson River through the Riverfront Park and goes through Menands, Watervliet, Green Island, and Cohoes. Construction of the South End Connector was completed in 2020; connecting the Mohawk-Hudson Bike-Hike Trail near the USS Slater under and parallel to I- 787 to the Helderberg-Hudson Rail Trail, just west of the Port of Albany. Many people use the trail to walk, jog, and move from one end of the City to the other.

Figure 4: Bike path near the Hudson River Way pedestrian connection to the riverfront.

A variety of recreational and commercial vessels use the Hudson River corridor adjacent to the study area. Fishing boats, sailboats, and yachts travel up and down the river for short, local excursions or longer summer boating trips along the Hudson and other waterways. Dutch Apple Cruises, located just south of the Dunn Memorial Bridge, also offers scenic tours of the river. The Corning Riverfront Public Boat Launch is home to Albany Rowing Center and the City of Albany Boat Shed. The boat launch can be found right off the Mohawk-Hudson Bike Hike Trail near a parking lot off Colonie Street. Next to the boat launch is a ±120-feet long dock which is accessed by stairs. There are no amenities for transient boats at this site, but kayak rentals are available to the public.

[6] CHA Consulting, Inc. . (2018). *I-787/Hudson Waterfront Corridor Study.* Albany: CHA Consulting, Inc.

2.3.3 Ownership

Ownership within the study area varies between private, City and State-owned land. Island Creek Park, at the southern boundary of the study area, is owned by the City of Albany. Extending north to the Broadway I-787 underpass, parcels are mixed with privately-owned land and several narrow City-owned rights-of-way from Broadway to the river. City-owned parcels are frequently infringed upon, developed, and used by adjacent landowners. Uses on the privately-owned properties include maritime, transportation, office, and storage. Moving north, Jennings Landing and the Corning Preserve are maintained by the City of Albany. North of Livingston Avenue, the Riverfront Preserve is owned by New York State. This park extends beyond the project's limits at the northern border of the City of Albany and is bisected by the Mohawk-Hudson Bike Trail.

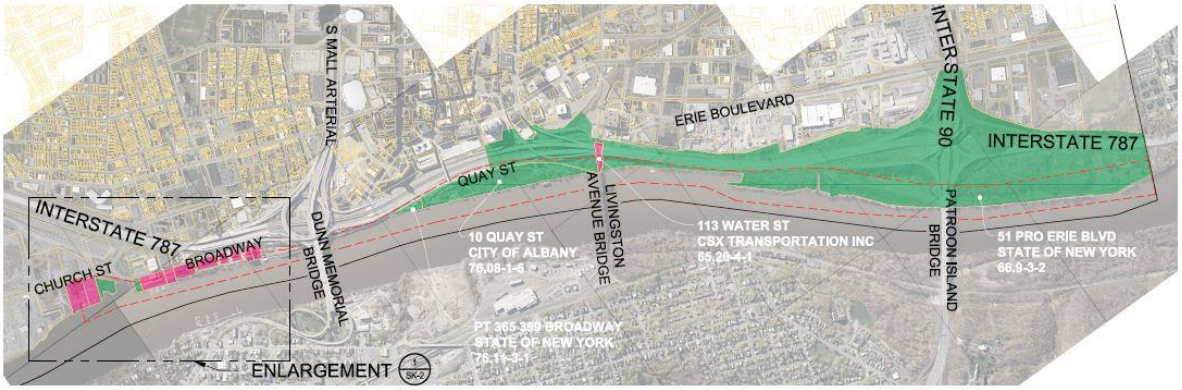

Figure 5: Ownership map. See Appendix B – Project Drawings for additional information.

2.3.4 Habitat & Wetland Resource Areas

The study area is entirely within the Hudson River Watershed, at the northern portion of the Hudson River Estuary. The landscape that is now the City of Albany was once drained by numerous tributaries, most of which have been filled in and diverted over time. These altered tributaries no longer provide the rich habitat value they once did, but do create wetland conditions in some locations. Wetlands, defined by saturated soils, high water tables, and plants adapted to wet locations, serve an essential role in the absorption and percolation of water into the ground. They are also critically important flood mitigation tools, and provide a wide variety of forage, shelter, and breeding sites for wildlife. The largest and most significant wetland landscape occurs in the Riverfront Preserve, encompassing almost 28 acres. In addition, two constructed freshwater tidal wetlands are located in the Corning Riverfront Park. These features were constructed to collect run-off from Interstate-787. Polluted waters, sediment accumulation, and goose feces contribute to frequent unpleasant odors. Living shoreline plantings would enhance the habitat potential of these pools and improve water quality.

While most of the corridor has been disturbed and is highly managed for human use, the Riverfront Preserve open space provides floodplain functions, vegetated buffers, and riparian[7] habitat connectivity. Riparian corridors are important areas for wildlife habitat because many species live both on land and in the water. Transition zones between the water and land are typically very diverse – these areas exist in a dynamic equilibrium governed by the changing currents of the river and flux of the shoreline over time. Shoreline vegetation provides forage and shelter for a wide range of aquatic and terrestrial species. Botanically diverse riparian edges provide seeds, nuts, buds, and fruits. Fisheries rely on shade and woody debris from shoreline trees and shrubs – healthy fish and their fry[8] in turn provide food for a variety of mammalian, amphibian, and avian species (Cohen, 2014).

Figure 6: Riparian water and land interface at the Riverfront Preserve.

Refer to Appendix C – Site Documentation for extensive information and mapping about habitat and wetland resources in the study area.

2.3.5 Vegetation

Existing vegetation in the study area is fairly robust given the active use of most sites and proximity to the heavily developed urban landscape. Existing shrub and herbaceous species are affected by erosion, improper management, and trampling. Most problematic is the overall lack of species diversity and rampant proliferation of non-native and invasive species, particularly along the river edge.

[7] Where the land connects to a stream or river. Riparian habitats are critical for wildlife and plants.
[8] Juvenile fish capable of feeding themselves.

Open views to the river are desired in many park locations, and for this reason, shoreline vegetation appears to be cut back along the shore, especially at the Corning Riverfront Park. This practice has resulted in a plant species mix adapted to disturbance, which includes a host of invasive and nuisance species.

Figure 7: Declining tree at Island Creek Park.

The condition of trees in the study area varies widely due to the difference in site conditions and landscape management. In some instances, trees are simply declining due to age. As trees grow older, they are less able to compartmentalize injuries, resist decay, and retain branches. This appears to be the primary cause of the decline of *Populus deltoides* (cottonwood) trees at Island Creek Park. Alternately, trees in urban conditions are more likely to fail, especially if they are exposed to construction activities or are situated adjacent to impervious surfaces and polluted runoff, as is found at the Corning Riverfront Park tidal wetlands. Another characteristic to note is the presence of pests and disease among the riparian forest canopy. For example, many ash trees are experiencing the detrimental effects of the emerald ash borer.[9] In the Riverfront Preserve, invasive *Celastrus orbiculatus* (oriental bittersweet) vine is strangling large swaths of the forest.

2.3.6 Climate Change

Climate change has the potential to affect the riverfront and surrounding urban environment, which could have major implications for the City's management of existing parklands and redevelopment of districts within the floodplain. Below is a brief discussion of recent climate change, predicted change, and the implications for the project area.

Sea Level Rise (SLR)

New York State's coastlines have seen an average of 1.2 inches of sea level rise each decade since 1900 (NYS Energy Research & Development Authority, 2011). The Hudson River is a tidal river, which receives flows from the Atlantic Ocean at the New York harbor. Sea level rise includes

[9] A beetle native to north-eastern Asia that feed under the bark of ash trees, killing the tree.

both global-scale changes such as thermal expansion of seawater and the addition of water from melting land-based glacial ice sheets and more localized changes in land surface elevations such as land subsidence. The Hudson River is predicted to continue to rise in the Mid-Hudson Region, with projections listed at 5 to 27 inches by 2050 and high projections in 2100 listed as 71 inches (NYS DEC, 2021).

Large expanses of low-lying level terrain may factor into the severity of flooding in downtown Albany. In fact, the entirety of the project area is located within the Federal Emergency Management Agency (FEMA) floodplain Zone AE. This zone is included within the Special Flood Hazard Area (SFHA), which shows the extent of the 100-year flood, otherwise known as the 1% Annual Chance Flood. These 1% annual chance floods are extremely destructive because the precipitation, storm surge, and tidal flooding is significantly higher than other categories of floods. Zone AE also includes Base Flood Elevations (BFEs)[10] showing the anticipated height of the 1% Annual Chance Flood. The FEMA-defined BFE indicated for the project site is 22 feet NAVD88[11] (FEMA, 2021). In the event of a 1% annual chance flood event, a large portion of downtown Albany will be flooded. New York State (NYS) floodplain construction recommendations for new structures in Zone AE require building to the BFE plus an additional 2 feet of freeboard[12], resulting in an elevation of roughly El. 24 feet NAVD88 for the site, before considering sea level rise protections. Structures within the floodplain would therefore need to be built at least 24 feet above the ground to comply with FEMA regulations.

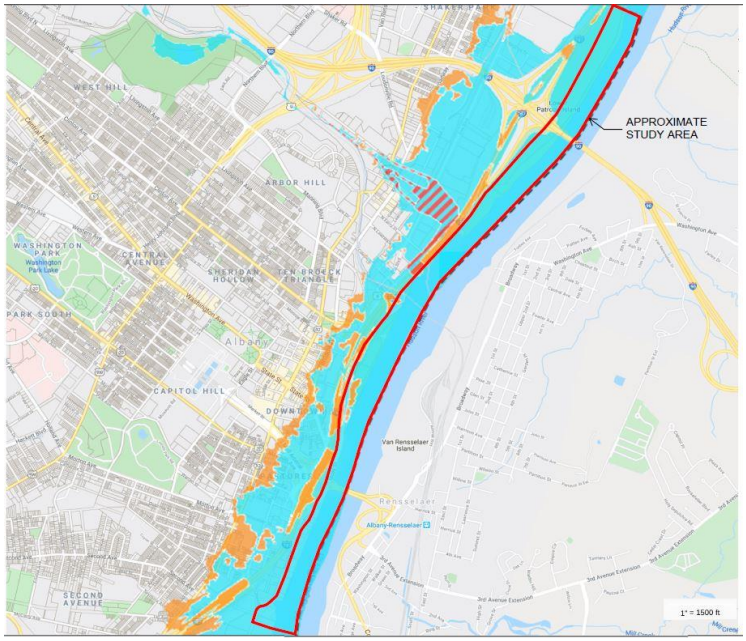

Figure 8: FEMA floodplain mapping in downtown Albany.

Flooding due to rising sea levels will impact properties, transportation networks, sewer outfalls, and other infrastructure and utilities. Rising sea levels will also impact areas of the parklands that

[10] The elevation of the water during the 1% annual chance flood event
[11] North American Vertical Datum of 1988 – a leveling network on the North American Continent used for survey and spatial mapping
[12] Used as a factor for safety when designing structures built within a floodplain; freeboard is typically calculated in feet above a known or projected flood level

provide habitat, as locations that were once tidal may become permanently submerged. It is therefore critically important to carefully evaluate sea level rise modeling regularly to determine how to best to protect the City's resources from climatic consequences.

Refer to Appendix B - Project Drawings for sea-level-rise and floodplain mapping for additional information.

Precipitation

Precipitation patterns have also changed with more extreme droughts and rainfall intensities. The amount of precipitation associated with a 24-hour storm having an average return period of 100-year has increased from approximately 6.7 inches in 1961 (U.S Department of Commerce, 1961) to 7.88 inches in 2015 (NOAA Atlas 14, Volume 10, 2015). Projections of climate-change related precipitation projections in the region indicate that by 2050, annual precipitation could increase by 3-12% per year with one additional 1 and 2-inch storms (NYS Energy Research & Development Authority, 2011).

Increased heavy precipitation events will make the likelihood of flooding, erosion, and infrastructure damage more likely. The project area has expansive impervious surfaces, including roadways, parking lots, buildings, and sidewalks. These types of land cover increase the velocity of stormwater as if flows over the landscape and does not permit the infiltration of stormwater into the ground. It is therefore important to consider how the City might incorporate green infrastructure and expanded open space into the long-range plan for the riverfront to reduce the impact of severe precipitation events.

For additional information about how future sea level rise in the Hudson River will affect the Albany shoreline, refer to FEMA and sea level rise mapping in Appendix B – Project Drawings.

2.3.7 Wave & Ice Dynamics

Urban development, engineered shoreline stabilization structures, dredging, and fill can change patterns of erosion and sediment deposition over time along a river corridor. Areas with lower flow velocities, shallow water depths, and inlet geometry will accumulate detached sediments as they travel downstream. Invasive aquatic vegetative species gradually increase the depth of organic materials in the riverbed and can also alter currents. When storms coincide with high tide in rivers, erosion can occur rapidly and change depositional patterns.

The Hudson River has long been a hub of maritime activity. Watercrafts generate waves (called wakes[13]) that can degrade the shore. Boats are not the only source of wave-action erosion; winds generate waves that have significant impacts to the composition and character of the shore. Wind-wave caused erosion is typically seen in areas with low-lying lands or long expanses of open water (Alden Research Laboratory, Inc., 2006). The way a wave affects the shoreline is dependent upon the geometry, water depth, and topography of that shore. The shallower the water and the more gradual the slope, the less momentum a wave will be able to gather before it reaches land. Conversely, walls and steeply angled slopes with deeper water depths experience the full force of waves. Due to location and prevailing wind direction, wind-wave action is not likely to be a significant factor in shoreline deterioration along the Albany waterfront.

[13] Boat wakes tend to be larger in height and shorter in duration than waves caused by the wind.

Ice is a factor in erosional processes as well. River currents, tides, temperature fluctuations, and winds all influence the movement of ice along the Hudson River. As the ice pushes up against the banks of the shore, sediments and riparian vegetation can be dislodged and carried into the river. In tidal flats, ice may disturb the substrate and damage aquatic vegetation. Ice jams[14] are another concern in the waters adjacent to the project area. Waters behind the jam can flood adjacent properties. When the ice begins to thaw when temperatures warm, sudden break ups of the jam may release elevated waters rapidly, precipitating dangerous flooding conditions.

Figure 9: Ice along the shores of the Hudson River

Localized ice jams have likely resulted in the deterioration of shoreline structures within the project area over the decades. Climatological conditions have been recorded by the US Coast Guard ice breakers in the Hudson River since 2004; however, shoreline improvements are site-specific and data on the impacts of ice on these systems is limited (NYSDEC , 2015). Cooperation with agencies (US Coast Guard, Hudson River Sustainable Shorelines, Hudson River National Estuarine Research Reserve, Stevens Institute of Technology) studying ice dynamics will yield valuable information to guide restoration activities along the Hudson River.

2.3.8 Water Quality

The New York State Department of Environmental Conservation (NYSDEC) has classified the regulated Hudson River as a Class C[15] waterbody (NYS DEC, 2021). The Hudson River continues to support unique ecological resources, despite considerable human disturbance over time. Ongoing threats to sensitive habitat include sedimentation, altered flows, temperature variations, and changing water depths (DOS Office of Planning and Development, 2012).

Runoff in urban areas flows over roadways, parking lots, maintained grass areas (with fertilizer, dog and geese feces) and picks up various pollutants, such as phosphorus, along the way. This pollutant-laden stormwater then enters the Hudson River and negatively affects water quality.

[14] Ice jams are blocks of ice that obstruct the flow of a river and occur during extremely cold weather
[15] Class C: best use of the waterbody is classified for fishing and non-contact actives

In the Capital District, the Cities of Albany, Watervliet, Cohoes, Rensselaer, and Troy, along with the Village of Green Island, have formed a team called the Albany Pool to work together to address Combined Sewer Overflows (CSOs). Federal policy adopted in 1994 requires that communities address discharges associated with CSOs. These communities developed a list of projects called the Albany Pool Long Term Control Plan (LTCP). These efforts have included the development of green-infrastructure projects that maximize stormwater infiltration in highly permeable soils. By keeping the rainfall runoff on-site, instead of conveying it to the existing combined sewer, the following benefits are achieved:

- Reduction of stormwater runoff flows that would otherwise contribute to a combined sewer overflow event, polluting the Hudson River.
- Increased rainfall filtering and groundwater recharge (more closely mimicking the natural hydrologic cycle).
- Improved aesthetics by planting perennials, shrubs, and trees as part of the green infrastructure practices (they remove nutrients and contaminants in the runoff).

Wherever possible, techniques should be used to improve water quality in the study area, utilizing best management practices and green infrastructure (rain gardens, sidewalk tree wells, permeable pavements) to capture flows before they reach the shoreline.

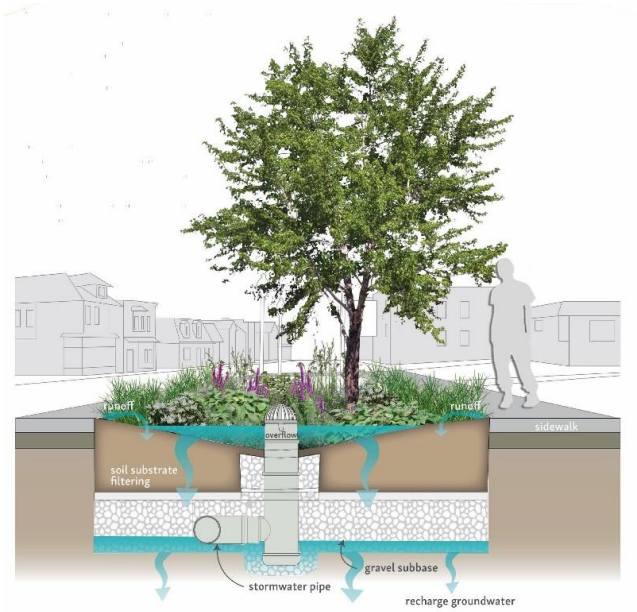

Figure 10: Rain garden section illustration showing green infrastructure developed for the Albany Pool.

SHORELINE TYPES & STABILIZATION RECOMMENDATIONS

Erosion is a natural process that occurs on the shores of rivers, streams, and lakes. In a natural setting, flooding, tidal action, ice, and waves work to change the character of the shore and the alignment of the water feature. Where there is no threat to public health and safety, this process can be allowed to unfold on the timeline prescribed by the weather and the geologic, aquatic, and landscape features of the water body. It is when the erosion of the shore creates hazards not only

to human health but to the infrastructure adjacent to the water body that interventions must be considered.

Incorporating climate resilience into design can help mitigate the impacts of sea level rise and storm-related flooding. Typically, to determine a design elevation for shoreline improvements, the FEMA base flood elevation (BFE) is added to 2' of freeboard[16] and anticipated sea level rise projections. Because the BFE is incredibly high throughout the project area, designing to an elevation based on this equation would require the City to construct shoreline improvements to an elevation of 26.25 NAVD88[17]. Bulkheads, walls, berms, and other shoreline improvements constructed at this height would prove to be an extraordinary visual barrier, difficult and costly to construct, and would not provide the public access and connection to the river that is a primary goal of this study.

This study therefore recommends designing shoreline stabilization applications to the more modest elevation of 10.3 NAVD88. This elevation seeks to incorporate a design life[18] of 35 years based on currently available data and utilizes the high-projection of 27" of 2050 anticipated sea-level rise. The elevation begins with the current common high tide level in Albany, El. 6.08, and adds the projected 27" of sea level rise as well as 2' of freeboard to comply with FEMA floodplain design standards. It is critical to also incorporate long-range planning for the acquisition of riverfront property to expand the network of parklands that can absorb anticipated flooding and protect urban infrastructure. The City may want to establish a task force to begin the conversation with potentially impacted and/or interested landowners within the floodplain to see if there is a way to elevate these structures to protect them from anticipated sea level rise-related flooding and damage.

The following section describes the existing conditions and proposed improvements of the three main types of shoreline stabilization measures found within the project area. Additional information about site conditions described during the field analysis portion of the study can be found in Appendix B – Project Drawings.

3.1 Engineered Shorelines

3.1.1 Existing Conditions

Bulkheads are a commonly used engineering practice to protect vulnerable shorelines and a working waterfront. The bulkheads along the Hudson River are vertical concrete and steel walls, often lined with a fence or guardrail along the top. These structures restrict access to the Hudson River; however, they provide open viewsheds of the water and the Rensselaer shoreline. Bulkheads are designed to withstand extreme flood events and to protect valuable urban infrastructure. Initial visual observations did not reveal signs of structural failure of the concrete bulkheads, but the Albany Rowing Club reported the steel bulkhead at the Corning Riverfront Park boat launch is deteriorating. The type of evaluations required to test the structural integrity of these systems is beyond the scope of this study. Bulkheads are found in the following locations in the project area:

[16] The elevation of a structure's lowest floor above predicted flood elevations as required by the National Flood Insurance Program.
[17] North American Vertical Datum of 1988, consisting of a leveling network across the North American continent. It is the official vertical datum of the National Spatial reference system.
[18] The life expectancy of a structure.

- Along the commercial corridor east of Quay Street and north of Island Creek Park (mixed shorelines are also found here).
- East of I-787 and Quay Street between Broadway and the pump station in the southern portion of the Corning Riverfront Park.
- At Jennings Landing in the Corning Riverfront Park.
- Along the access road at the Livingston Avenue Bridge.
- At the boat launch at the Corning Riverfront Park.

Locations of these types of shorelines and project images can be found in Appendix B – Project Area Mapping.

The Corning Riverfront Park Public Boat Launch is home to Albany Rowing Center and the City of Albany Boat Shed. The boat launch is located near a parking area at Colonie Street. Next to the boat launch is a ±120-feet long dock which is accessed by stairs. There are no amenities for transient boats at this site, but kayak rentals are available to the public.

There are few formalized fishing sites in the project area. People have been observed climbing down steep, eroded banks to fish off the riprap at the Corning Riverfront Park. Another popular fishing destination is located on top of a concrete retaining wall, at one of the few non-wooded areas along the shoreline at Riverfront Preserve, about a mile north of the Corning Riverfront Park Public Boat Launch. A large wooden fishing pier is heavily used at Island Creek Park in the southern section of the project area.

3.1.2 Proposed Improvements

Due to the proximity of urban infrastructure, buildings, and restricted available land, the bulkheads that currently exist in the project area will likely need to be replaced in kind, with engineering parameters designed to protect against future sea level rise and increasingly intense storms. If, in the future, the City acquires additional lands adjacent to the river within the project area, it is strongly recommended to convert such properties to open space with provisions for recreation and flood storage. If at some point the City decides to remove and re-engineer I-787, the riverfront could be expanded, and public access greatly improved to this extraordinary resource.

Floating wetlands are an innovative approach to reduce wave velocity, increase biodiversity, and improve water quality. These floating ecosystems can be installed at headwall locations to provide river surface vegetative buffer, whose underwater filaments provide shelter for a variety of aquatic organisms (Biomatrix Water, 2020). Available as modular structures, these products can be customized into a variety of shapes and sizes to fit the needs of any site. A wide range of plant material can be supported, from small perennials and grasses to large shrubs and trees. The structures are comprised of coir filled mats and can be biodegradable or contain non-biodegradable layers to provide more permanence. Root structures from wetland plantings extend into the water, providing a matrix which will support water quality and provide food and habitat for fish. They can be attached to bulkheads with a system that permits the structures to rise and fall with the tides, and breakwater systems can be installed against the flow to prevent ice damage. Additionally, they can be moved to the tidal wetlands during the winter to reduce the risk of ice injury.

Floating wetlands are not without precedent in the City of Albany. In July of 2018, the Radix Ecological Sustainability Center released a floating wetland island near Island Creek Park. The

project was funded by an Environmental Benefit Project Grant from the Albany Water Board. Research for the project was a collaborative effort between the Radix Center, the SUNY School of Public Health, Siena College, Skidmore College, and RPI. According to Scott Kellogg, director of the Radix Center:

> "The design, construction, and implementation of Radix's AFI was carried out in conjunction with the "Ecojustice Summer" program, a five-week summer youth employment immersion that combines community gardening with sustainability justice education and outdoor adventure. By including the youth, not only did the island function as a tangible model of participatory, problem-based, and experiential learning, it also spurred interest in the history and ecology of the river itself. In this sense it operated as an effective means for challenging ecological alienation among the youth who for many, despite having grown up in Albany, had never actually stood on the banks of the Hudson, let alone gone out into it on a boat (Kellogg, 2021)."

Floating wetlands may be considered for future restoration projects in locations with hard, engineered edges. These systems are a wonderful opportunity for environmental education, visual enhancement of the shoreline, water quality and improved biodiversity.

Reconstruction of the Corning Riverfront Boat Launch is recommended to ensure the launch is safe for visitors and accommodating for a variety of boating activities. Further evaluation of the boat ramp will be required to ensure the launch is stable motor craft. An accessible soft launch for kayaks and canoes will provide expanded opportunities for recreation in the Hudson River. The bulkhead will require further evaluation for upgrades to expand opportunities for recreation.

Figure 11: Existing Corning Riverfront Park boat launch.

Formalized fishing piers and overlooks will not only provide a safe place to fish, but socialization opportunities and vistas of the Hudson River. In addition to formal fishing access, informal river access points are recommended for those who do not wish to be in a group. Fishing sites also provide the chance to install interpretive signage about unique ecological and historic features of the Hudson River and Albany's maritime legacy.

3.2 Mixed Shorelines

3.2.1 Existing Conditions

Mixed shorelines include concrete revetments, riprap, deteriorated timber cribbing, and destabilized previously hardened shores. Characteristics of the areas adjacent to this type of shore include impermeable surfaces, tree plantings, herbaceous and shrubby plants, and lawn. There is potential for invasive species when these stabilization types are not maintained. Open viewsheds to the water and Rensselaer shoreline do occur within this type, but where the vegetation has not been pruned these views may be blocked.

Trees in the mixed shoreline condition are subject to difficult site constraints when they grow adjacent to infrastructure on the upland side of the river corridor. Mature trees show signs of decline (such as crown dieback, bark damage, and root girdling), and frequently succumb to scorch and dehydration. Construction of pathways, bridge restoration, and excessive foot traffic all contribute to root damage and compaction.

Mixed shorelines are found in the following project area locations:

- Along the commercial corridor east of Quay Street and north of Island Creek Park (bulkhead shoreline structures are also found here).
- Along the shore of the Corning Riverfront Park.

Locations of these types of shorelines and project images can be found in Appendix B – Project Area Mapping.

3.2.2 Proposed Improvements

It is critical to establish an adequate vegetative between intensive land use areas and the water's edge. Restoration of the shoreline and expanded areas of shoreline stabilization plantings are needed where inadequate vegetative buffers exist, and the slopes are too steep to adequately support a healthy vegetative riparian corridor. Where possible, regrading of existing steep slopes to accommodate a wider vegetative buffer is highly recommended. Shallower slopes expand the area over which floodwaters must travel, and vegetation establishment will be more successful where the slope is shallow enough to secure the roots. Where there is insufficient area to regrade the slope, a tiered system of vegetated riprap or vegetated timber cribbing is recommended. Low-lying native species may be established where viewsheds are desired; however, intermittent stands of trees should also be considered to shade out invasive species and to provide stable

Figure 12: Island Creek Park mixed shoreline improvement concept rendering.

shoreline conditions.

Relevant sites:

- Island Creek Park deteriorated timber bulkhead shoreline
- Corning Riverfront Park riprap shoreline
- Riverfront Preserve at existing tributary locations

<u>Tidal Pools</u>

A primary cause for concern at the tidal pools in the Corning Riverfront Park is increased runoff due to compaction of soils, impervious surfaces, improper conveyance of stormwater, and insufficient vegetated buffers along the shore. Erosion control matting, live staking with buffer plantings, contour wattling, and other green infrastructure strategies are methods used to intercept and promote infiltration of stormwater. Finally, limited no-mow zones may be an effective

way to increase the width of the vegetative buffer without expensive, labor-intensive planting. No-mow zones allow uplands to return via succession but must be monitored for invasive plants during establishment.

Shorelines adjacent to roadways and multi-use paths

To prevent further erosion and minimize pollution from adjacent roadways, replanting of vigorous native shrubs and trees adapted to salt and urban conditions is recommended. Invasive species are a concern in this area, but they also serve to stabilize the shore, especially in areas where pollution, poor soils, and steep slopes are present. Invasive plant removal strategies must be accompanied by immediate replanting to maintain the integrity of the river edge.

Tiered vegetated cribbing is another viable option in this condition. Where slopes are too steep to adequately maintain vegetation, a living engineered structure may be installed to increase the depth and width of the shore. This strategy will provide additional space for appropriate native plantings and increase flood resilience. This intensive measure should be considered to protect the critical infrastructure just above the river's edge.

Relevant sites:

- Corning Riverfront Park tidal pools – construction activities damaged existing trees and the vegetative layer
- East of I-787 between the Corning Riverfront Park and the Riverfront Preserve

3.3 Wooded Shorelines

3.3.1 Existing Conditions

Wooded shorelines include sites with deteriorated riprap and natural shoreline conditions. Adjacent landscapes are varied: in some areas dense woodland canopy and understory vegetation prevails, while at other locations the predominant condition is maintained open lawn. Dense vegetation limits the viewshed potential to the Hudson River.

Riparian wooded banks are the most stable of existing shoreline conditions in the study area, especially when the slope is average and adequate width exists between the river edge and upland developed settings. Exceptions include areas where trees have collapsed into the river, creating an unstable edge. Collapsed trees do, however, provide valuable aquatic habitat in shallow riverine environments. Wooded shorelines tend to have a good number of native trees in the canopy; however, oriental bittersweet vines, pests, and other invasive species are rampant in the woodland and contribute to the decline of many species.

Wooded shorelines are found along the entire length of the shoreline at the Riverfront Preserve. Locations of this types of shorelines and project images can be found in Appendix B – Project Area Mapping.

3.3.2 Proposed Improvements

Many trees along the wooded shoreline are in fair condition and a fair degree of diversity exists in the more heavily wooded riparian zones. A healthy riparian corridor has space for root growth,

species diversity, symbiotic mycorrhizal[19] relationships, recycling of nutrients, and shade. In areas where insufficient space is available for the riparian forest, trees are exposed to erosional factors and eventual collapse into the river. Sporadic loss of trees in this condition is part of the natural cycle of riverine shoreline conditions and should only be considered a detriment if the fallen trees pose a threat to public safety.

In areas where an increased width of the riparian woodland buffer is desired, additional plantings may be installed in a phased method. The extensive root systems of trees are a critical component of slope stabilization and added layer of mixed overstory and understory plantings will attract a wider range of birds and other wildlife. Tree canopy shading may also inhibit invasive encroachment in the shrub layer. Each year a row of trees, shrubs, and herbaceous native plants can be installed behind the existing woodland corridor. Over time, the width and resiliency of the vegetative buffer will gradually increase. Plant species must be carefully chosen to accomplish objectives specific to each site. If adequate room is present at the restoration site, a layer of shade tolerant herbaceous material may be planted between the shrub layer and adjacent upland landscape.

Figure 13: Riverfront Preserve riparian buffer restoration rendering

Meadows are highly recommended in the expansive lawn areas of the Riverfront Preserve. Meadows can be established in select locations where minimal passive recreation exists to reduce maintenance and provide valuable habitat. Meadows are characterized by grasses and other herbaceous plant material that provide resources for numerous species of pollinators, birds, and mammals. Taller grasses provide cover and camouflage for birds and provide visual interest across the landscape. These landscapes provide important ecological benefits, runoff reduction and sediment filtration functions. Design, installation, and ongoing management of meadows is important to ensure the success of these native grasslands. Once established, long-term maintenance costs (mowing, fertilizers, pesticides, and watering) can be reduced by 80 – 90% (Pratchett & Weaner, 2015).

[19] Mycorhizzae - a symbiotic relationship occurring in the root zone between a vascular plant and fungi

Urban agriculture is another excellent potential use for open lawn areas in the Riverfront Preserve. Community gardens strengthen social bonds and provide life-long education about food production and sustainability. River bottoms have long been used for agriculture; soils in these areas are rich with nutrients washed over the land during floods.

The creation of tidal inlets along the shore is recommended to restore a measure of sinuosity of the shoreline. A curvilinear shoreline with constructed tidal zones would be more resilient to flooding and would provide much greater opportunities for aquatic and terrestrial biodiversity. These inlets can be constructed at a depth appropriate for fish spawning and could even include stepped depths along the shores for different types of wetland-adapted plants. The inlets have been proposed in locations where the shoreline topography would naturally facilitate the construction of an inlet.

Finally, vegetated berms are recommended to protect the Riverfront Preserve from sea level rise and increasingly severe flood scenarios. Sloped berms planted with herbaceous and shrubby vegetation can reduce the energy of waves as they connect to the shore. Waves will break along the berm as they become shallow against the slope. Maintenance of the berms long term is required for the structures to remain effective. Trees and large shrubs can compromise the integrity of the berm, and wildlife may burrow into the slopes, undermining the system.

3.4 Riparian Biodiversity

The natural cycle of growth and decay can be a boon for a host of organisms. Fallen trees in the waterway can support a variety of life, providing shelter for spawning fish and feeding sites for aquatic invertebrates. If the presence of these snags[20] does not pose a hazard to recreational river users they should be allowed to decompose in place. An additional benefit to leaving collapsed trees in place in the river is the natural restoration of the shore behind the snag. Undercutting was observed in a few locations during field work – these areas could be restored by selectively allowing dead trees to remain in place in the water. Over time, sediment will accumulate behind the structure of the tree. This sediment can be allowed to naturally revegetate, or a more active approach may be used to re-establish native vegetation and a desired gradual slope at the bank.

Deadwood[21] and snags provide a crucial role in any healthy ecosystem. Deadwood provides habitat for detritivores and decaying organisms, while snags provide habitat for a variety of species, depending on the height of the snag (French, 2018). Even snags as low as 5 -15 feet can provide nesting habitat. Trunk hollows can be made from tree stumps rather than completely removing every dead or damaged tree on the site. Identify suitable trees and prune back the canopy as necessary. If possible, retain any existing hollows, and create new holes and cavities where feasible. This can be done in branches, trunks, and stumps.

Numerous strategies can be implemented to protect and enhance wildlife habitat along the Hudson River. Mowing/cutting times should consider the lifecycles of the animals and insects that depend on the plants for forage and shelter. Pruning after flower and seed cycles allows for the replenishment of the seed bank in the soil, and opportunities for feeding on nectar and fruits. Localized noise disturbances can have detrimental effects on wildlife, particularly during the breeding season. Routine management practices should be avoided during nesting and peak activity periods, to reduce disruptions and damage to breeding sites.

[20] Snag – decaying or dead standing tree
[21] Deadwood – a dead branch or other part of a tree

PUBLIC ACCESS

Albany's riverfront can be designed to promote and celebrate social diversity. It is important to always seek to expand inclusivity by providing spaces that engage a range of ethnic, cultural, and socioeconomic groups reflected in the demographics of the City itself. Riverfront parks should be a haven for people to enjoy interacting with their friends and family, while having the opportunity to engage with people from different backgrounds. Spaces should be flexible – providing recreational opportunities desired by the community while maintaining open spaces that can evolve over time.

As the City moves forward with the design of shoreline improvements, the concerns and visions received through the public engagement process of this study should be considered. Often, riverfront projects take many years to fully implement. It is therefore relevant to plan to engage the community further as designs develop.

4.1 Pathway Improvement

Expansion of pedestrian and bicycle connections from adjacent neighborhoods will provide access for a wider demographic of park-goers, reduce traffic, and reduce the need for parking. Where possible, safe sidewalks and multi-use paths should be installed adjacent to road connections, linking the circulation network to the riverfront.

To prevent further erosion along the banks and protect environmental resources, several measures can be implemented to promote proper path and park design. These include proper buffer plantings to prevent off-path access, specific call outs for access to fishing and boating, and proper signage to prevent intrusion into sensitive areas.

Pathway design within the study area is contextual. In some locations (Corning Riverfront Park, Riverfront Preserve) the relocation of the multi-use path to allow for an expanded vegetated buffer is appropriate. Some sites may be more appropriate for a smaller-width stone-dust path leading to the shore or designated overlooks. In all cases, constructing inclusive, accessible path systems is a top priority. Improvements should be welcoming to as wide a demographic as possible. A comprehensive lighting strategy along pathways will increase the usability of these systems and will increase the safety of visitors at the riverfront.

Figure 14: Pathway along I-787 at the Riverfront Preserve - the slope to the river is very steep

4.2 River Access

It is important to provide formalized locations for river access at regular intervals and at popular locations. These access points can be designed to accommodate heavy foot traffic, soft launches, or fishing. Structured river access can be accomplished with the installation of wood deck overlooks or hard scape areas with a small natural retaining wall along the shore. Inclusion of built river access will prevent erosion issues resulting from informal entry points. Property owners along the waterfront can partner with redevelopment efforts to provide easements for river access to allow the public to engage with the waterfront along the length of the Hudson River.

Providing structured access routes to shoreline restoration areas will increase efficacy of monitoring and management and will provide the public with recreational and educational opportunities. Increased access can be problematic if natural resource areas are not fully understood. The most efficient means of protection is often education. People are more likely to protect rather than disturb sensitive resource areas if they understand the value of these habitats. A thoughtfully designed interpretive signage program highlighting important ecological resources can be installed at active and established restoration locations.

Finally, the construction of the Albany Skyway will undoubtedly bring many more visitors to the waterfront and will bolster economic and recreational opportunities in the area. Improved walking and bicycle access to this unique amenity will expand its use. Additionally, the proximity of the Skyway to the Corning Riverfront boat launch increases the likelihood that more people will know of the boating opportunities. The boat launch and surrounding infrastructure should therefore be improved to accommodate increased traffic and use. The feasibility of constructing a boathouse with public facilities (restrooms, and amenities) at the boat launch in the northern section of the Corning Riverfront Park should also be reviewed.

4.3 Aesthetics

Project area aesthetics vary depending on location and land use. Public engagement revealed that most participants preferred either naturalized parklands or formalized landscape aesthetics. Albany has a strong sense of history, which is evident in the architecture in the neighborhoods and business districts adjacent to the project area. Continued use of these design elements in recently revitalized areas will serve to unify the visual identity of the Albany riverfront. Establishing a uniform, consistent style of riverfront amenities will promote a sense of visual continuity and structural cohesion in the project area. Expansion of the riparian buffer will enhance the natural appearance of the shoreline, and a cohesive program of parkland maintenance and landscape improvements will achieve the desired appearance of a thriving, well-loved park system.

Figure 15: Landscaping at the Corning Riverfront Park

Chain-link fences, weathered storage buildings, and asphalt sidewalks are common visual elements as the corridor transitions from parklands to commercial to residential and industrial activities. Many of these waterfront buildings are merely functional and not designed to be visually pleasing. Where possible, partnerships with private landowners to improve the aesthetic appeal of these properties will help to knit together the visual identity of the riverfront.

Existing stabilization systems are composed of materials that reflect the history and heritage of the City's waterfront. Common themes include weathered wood, stone, iron, and relics of an era where boating and trade were the primary economic engine of the region. Many of these elements are buried under years of shoreline collapse and vegetation encroachment. Where possible, it is recommended to utilize these elements to underscore the history of the riverfront. Reuse of materials where safe and appropriate will create a site vernacular unique to the Albany riverfront.

LOGISTICS

5.1 Anticipated Regulatory Requirements

The following is a list of anticipated permits required to implement the recommendations for shoreline stabilization in the study area. Additional permits may be required as information is revealed during the design development phase and extensive site analysis is performed.

NYS Department of Environmental Conservation
Protection of Waters (ECL Article 15, Title 5)
Freshwater Wetlands (ECL Article 24)
State Environmental Quality Review Act (SEQR)

US Army Corps of Engineers
Section 408 – Permit for the alteration or use of a Civil Works Project

US Environmental Protection Agency
National Environmental Policy Act (NEPA)
Section 401 – Water Quality Certification
Section 404 – Permit for discharge of dredge or fill

US Fish and Wildlife Service/NOAA Fisheries
Endangered Species Act Formal Consultation & Biological Opinion
Fish and Wildlife Coordination Act (FWCA) Report

State Historic Preservation Office
Determination of Significance

Department of State
Coastal Zone Management Act Determination of Consistency

5.2 Shoreline Maintenance & Monitoring

Management of the Hudson River shoreline involves a network of City staff, non-profit and volunteer groups. All entities will ideally work towards the same overall goals in a coordinated manner. In each management area, the entity responsible for a particular management activity must be identified. An ongoing management framework should seek to:

- Be realistic about what the City staff can take on, with current machinery, tools and staff resources available.
- Strategize capital investments to maximize impact of available funding.
- Strategize non-profit, NGO, and volunteer group efforts to maximize implementation of long-term goals.

Management activities along the Albany shoreline shall be guided by this plan and organized by the City of Albany. Most routine, weekly/monthly practices are best completed by City staff. In addition, recurring periodic maintenance activities, such as shoreline vegetation cutting or yearly meadow mowing can also be completed by City staff. When more detailed periodic maintenance activities, like invasive species removal or one-time project-based work is required, these activities are best taken on by either a nonprofit group (with volunteers) or City-hired contractors. The challenge with City-hired contractors is that the funding and procurement process may not best correlate with when

the work should occur in the field for ecological objectives. For this reason, non-profit groups may be best suited for some of the more detailed periodic maintenance and project-based work tied to living shorelines.

To promote the success of the selected stabilization improvements, the following monitoring measures (at minimum) should be taken:

Follow-up Inspections

All disturbed areas will be monitored to determine the success of the utilized erosion control. Inspections will occur after the first and second growing seasons to monitor revegetation in certain locations throughout the project area. Success will be measured by the density and cover of non-invasive vegetation and how it compares to the surrounding undisturbed areas. Photographs of the areas where erosion controls were utilized shall be taken annually in the spring. A visual assessment of the control success can be achieved by comparing the photos from subsequent years.

Pre-and Post-Storm Event Inspections

Best practice standards recommend inspection of all erosion controls to ensure they have been properly installed and are secure before all major storm events. A major storm is defined as a storm predicted by the National Office of Atmospheric Administration (NOAA) Weather Service with warnings of flooding, severe thunderstorms, or similarly sever weather conditions or effects. For the purposes of this monitoring plan, inspections are recommended for storms producing more than 0.5 inches of rainfall. After the storm event, the erosion controls shall be inspected to ensure the structural integrity of the Best Management Practice (BMP) is intact and to determine if sediment needs to be removed from the BMP.

5.3 Prioritization & Funding

Prioritization

A multi-faceted shoreline stabilization plan requires many different levels of phasing throughout project development and construction. Several factors influence project phases, including but not limited to complexity of shoreline improvements, property acquisitions, level of regulatory permitting required, difficulty of construction, and most importantly, the amount of available funding.

If feasible, for cost and time savings, it is recommended that each project be implemented in one phase. However, in most cases, a single phase is not possible due to funding constraints or the approval processes required for various sections of the project. As a result, a framework of three phases of implementation is recommended per project. If it is determined that some of these phases can be combined, it would result in more cost- and time-effective implementation.

Shoreline stabilization phasing recommendations are primarily organized by severity of existing erosion, followed closely by the project's benefit to users and momentum to continue future project phases, anticipate approvals, and to identify potential funding. Each phase is intended to generate interest in expanded/improved riverfront amenities, increase monetary and social investment in Albany's waterfront, and to create a sustainable shoreline for future generations. Finally, where possible, phases should be combined with other improvements to leverage and enable efficiency of implementation.

Prior to the implementation of a project, a Feasibility Analysis should be completed specific to the project area and recommended improvement strategies to identify potential site constraints. The Feasibility Analysis should clearly define the project intent; include a site-specific survey of topography, shoreline conditions, and site elements; confirm necessary permits; develop an implementation schedule and public outreach strategy; and refine the project budget/cost estimate. Utilizing the refined cost estimate and additional information revealed from land surveys, the City can seek out and procure funding from grants, partnerships, etc. A detailed overview of funding strategies is included at the end of this section.

Overall, the project team recommends the implementation of the projects identified in this study in the following order:

Tier 1 Projects – High Priority

- Island Creek Park Shoreline & Park Improvements
- Corning Riverfront Park Shoreline Improvements
- Corning Riverfront Park Boat Launch Reconstruction

Tier 2 Projects – Mid Priority

- Riverfront Preserve Woodland Riparian Buffer Expansion & Meadow Development
- Floating Wetland Establishment

Tier 3 Projects – Low Priority

- Bulkhead and Engineered Shoreline Reconstruction & Improvements

Island Creek Park is identified as a high priority tier 1 project because the park's existing shoreline infrastructure is deteriorating rapidly and the trees adjacent to the shore are subject to collapse into the river. The deterioration of the shoreline significantly impacts surrounding park spaces and presents a potential safety hazard. The park is a cherished resource and is heavily used for fishing and passive recreation. Since the recommended shoreline improvements are comprised of mixed structural elements with living shoreline systems that can be designed for public access, the aesthetic, ecological, and community benefit of the project will be substantial. Finally, this park is listed as an environmental justice area by the New York State DEC and is adjacent to historically underserved neighborhoods (NYS DEC, 2021).

The shoreline of the Corning Riverfront Park is eroding rapidly and there is little to no stabilization system in place. These shores are often immediately adjacent to park trails and infrastructure. Each storm event sloughs more sediment into the waterway, quickly reducing the available land. Ultimately, the reconstruction of the shore becomes more expensive and labor intensive the longer this pattern continues. The popularity of the Corning Riverfront Park with its varied amenities, as well as the ongoing investment into the park, makes this worthwhile project to consider immediately. Opportunities for passive recreation, fishing, and long-term flood protection abound in this project site. Additionally, the heavily used boat launch in the park requires attention to ensure safe launching is provided for visitors and the site is welcoming to all who pass through. There exists ample community support and desire to improve this recreational destination. This enthusiasm should be capitalized upon to garner support and funding for improvements to the launch and surrounding shoreline amenities.

Figure 16: Fishing at the Corning Riverfront Park

Riparian buffer, meadow establishment, and floating wetlands are all relatively inexpensive shoreline improvements that can be implemented gradually with private/public partnerships and existing City staff resources. Expansion of the woodland area in the riverfront preserve can be accomplished with planting strategies, while maintaining regard for the need for more extensive inlet construction and berm establishment over time. Meadows can be planted in select locations with a few years of post-construction maintenance. Floating wetlands can be purchased and placed in key locations with interpretive signage, informing the public about their purpose. These restoration efforts will be immediately visible, and with the proper outreach, can be excellent catalysts for future projects.

Engineered shorelines require multi-disciplinary collaboration to ensure the design and construction of these structures can withstand increasingly severe storms, flooding, and climatic pressures. Engineered stabilization systems will be necessary in locations adjacent to City infrastructure and residential areas prone to flooding. Careful analysis of the integrity of current structures will be necessary to prioritize what can be fixed versus what must be completely replaced. Design of

engineered shorelines must consider future sea level rise to ensure the City's investment will meet emerging flood resiliency standards.

Depending on the desires of the City, it may be most advantageous to prioritize one project over another and deviate from the recommendations of this plan. This may be especially true if funding sources emerge that will facilitate the development of a specific project. If the project aligns with the goals of the City and improves the overall flood resilience of the riverfront, priorities can be reconsidered and adapted. It is important to recognize that climate change, while not immediately visible along the waterfront in Albany, will be a destabilizing force in the decades to come. Valuable infrastructure, natural resources, and indispensable public space is threatened with flooding and the loss of riparian biodiversity, resulting pests and invasive species proliferation. It is therefore crucial to use this report as a starting point for the City to begin a dialogue with leaders, stakeholders, and residents about a strategy for adaptation in a changing world. Investment now in the protection and enhancement of the riverfront will pay dividends in the future when the effects of global warming become impossible to ignore.

Funding

Park improvements promote and support a community's economic development, crime prevention, and community health. This study is unique in that the improvements to the shoreline are designed to prevent the flooding and degradation of these park resources as well. Moreover, shoreline stabilization and flood mitigation are critical for the protection of adjacent urban infrastructure, neighborhoods, and City resources. The City should seek to leverage partnerships wherever possible to help fund these critical projects. The City will also need to work diligently to continue to control expenses and improve revenues to implement the projects over the long-term.

Revenue enhancement is one key component of financially sustainable implementation plan. The City should continue to pursue funding strategies that include:

- Exploring alternative funding sources that strategically align with targeted improvements.
- Expanding alternative funding for strategic initiatives through grants.
- Exploring additional Community Partnerships.
- Exploring additional opportunities for (and use of) sponsorships.

Below is a list of potential funding sources that may assist with the implementation of the recommendations:

- Office of Parks, Recreation and Historic Preservation Outdoor Recreation, Acquisition, Development and Planning grants.
- Hudson River Valley Greenway water trail and community grant programs.
- NYS Parks program grants.
- NYS Department of State Waterfront Resilience and Local Waterfront Revitalization Program grant programs.
- Hudson River Foundation Hudson River Improvement Fund grants.
- Transportation Alternatives Programs (TA Funds): TA funds can be used to increase bicycle and pedestrian mobility. These funds will cover a maximum of 80 percent of the project with the remaining portions most likely coming from the project sponsoring organization. TA funds are distributed in New York State through a competitive grant program.

- The Outdoor Recreation Legacy Partnership Program (ORLP) offers grants to improve local parks and outdoor recreation areas. The program is funded through the Land and Water Conservation Fund (LWCF).
- A new online tool developed by a partnership between the Alliance for Biking and Walking and the League of American Bicyclists helps find potential federal funding sources for alternative transportation projects. The site can be reached at http://bit.ly/11xhEtr.
- Public-Private Fundraising: The City could work with non-public entities or the general public to raise funds through private fundraising or grant sources available only to the non-public entities to match public funds for riverfront improvements. It could be possible to provide some memorial that acknowledges the contribution.
- Donations: The City could work to acquire donated funds or materials and services from local companies or residents to support restoration projects. Acknowledgement of supporting companies or individuals could be included along the riverfront as desired.

The Feasibility Analysis completed for the specific projects identified above will aid in determining which funding strategies and sources will be most applicable for each project.

5.4 Next Steps

With the assistance of residents, businesses, City staff and state officials, the City can undertake the following steps. The steps do not need to be in the order listed here, but this order is recommended to ensure adequate funding and permitting is established to help the projects progress smoothly:

- Prepare a Feasibility Analysis for the specific project and project area that the City is currently pursuing, including the preparation of site surveys and geotechnical investigations where stabilization measures are proposed.
- Conduct shear stress and velocity analysis along the Hudson to determine which stabilization solutions will work for each site.
- Collect additional data about ice damming and monitor damage caused by ice along the shore to contribute to the base of knowledge about the effects of ice on the riverfront.
- Conduct a Phase 1A Archaeological Assessment in the study area to determine where sensitive pre-historic and historic resources may be sited (this may be completed as one comprehensive assessment of the entire shoreline or broken up and included as part of the Feasibility Analysis for each project).

The Hudson River shoreline in the City of Albany is varied and represents a change not only of use and function but of values over the course of history. The riverfront seen today is a patchwork of efforts to create a waterfront more natural and accessible to the public, and to create a place of pride for the inhabitants of the City. While not perfect, the shoreline represents a work in progress – one that has great potential to improve the quality of the environment while providing expanded and enjoyable access to residents and visitors alike.

Figure 17: Corning Riverfront Park shoreline stabilization rendering

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