

Flood Bay State Wayside Vulnerability Assessment

May 2022



Flood Bay State Wayside, Minnesota

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Minnesota Department of Natural Resources
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Minnesota's Lake Superior Coastal Program

and

Department of Commerce
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Office for Coastal Management

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EXECUTIVE SUMMARY

The Minnesota Department of Natural Resources (MN DNR), Minnesota Department of Transportation, and several coastal counties, cities, and towns manage public access sites along the coast of Lake Superior. These public access sites contain natural and built resources that are potentially vulnerable to lake level change and other natural hazards. To evaluate the vulnerability of these public access sites to natural hazards along the coast of Lake Superior, the MN DNR and the National Oceanic and Atmospheric Administration (NOAA) developed a vulnerability assessment protocol. The protocol standardizes the methodology and data utilized by site managers. The workflow and methods follow five main steps including exposure analysis, sensitivity analysis, potential impact analysis, adaptive capacity analysis, and vulnerability analysis.

This standardized protocol was utilized for a vulnerability assessment of the public access site assets at the Flood Bay State Wayside (FBSW) site near Two Harbors, Minnesota. The FBSW assessment identified four site assets including the parking lot, north beach, south beach, and wetlands. The exposure analysis for the FBSW indicated the parking lot has a low exposure while the north beach, south beach, and wetlands have a moderate exposure rank. The sensitivity analysis for the FBSW indicated the parking lot and north beach have a moderate sensitivity rank while the south beach and the wetlands have a low sensitivity rank.

The potential impact analysis for the FBSW identified the parking lot and north beach as having a moderate potential impact rank while the south beach and wetlands have a low potential impact rank.

Possible adaptive capacity measures were identified for the FBSW, including decommissioning and/or removal of the parking lot and living shoreline engineering designs for the north and south beach with an engineering downgrade on the north beach by removing the existing rip rap.

The identified adaptive capacity strategies ultimately decrease the vulnerability rank of the parking lot, north beach, and south beach to minimal. The wetlands remain at a low vulnerability rank because adaptive capacity strategies were deemed unnecessary for the naturally adaptive wetlands complex.

The vulnerability assessment for the FBSW site and reduction of the vulnerability rank of the assets is dependent upon implementing the highest impact adaptive capacity strategies. The assessment was also based on a desktop analysis that could be further enhanced by site manager knowledge of the assets. This assessment can also be re-evaluated by site managers as necessary when adaptive capacity strategies are implemented or for any new assets that might be identified or built on the site. As new datasets become available or old datasets are updated, this new information can be integrated into the assessment.

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1.0 INTRODUCTION

Public access sites along the Lake Superior coast are vulnerable to fluctuating lake levels and other natural hazards. Flood Bay State Wayside (FBSW) is no different. But how vulnerable is it?

To answer that question, the Minnesota Department of Natural Resources (MN DNR) and the National Oceanic and Atmospheric Administration’s Office for Coastal Management (NOAA OCM) followed a standardized process documented in “Vulnerability Assessment Protocol for Minnesota’s Public Access Sites” (MN DNR and NOAA OCM 2022a). The five steps in the process as outlined in Figure 1 are:

1. Exposure Analysis (see Section 9, Glossary, for a definition of exposure)
2. Sensitivity Analysis (see Section 9, Glossary, for a definition of sensitivity)
3. Potential Impact Analysis
4. Adaptive Capacity Analysis (optional analysis based on site and asset[s])
5. Vulnerability Analysis

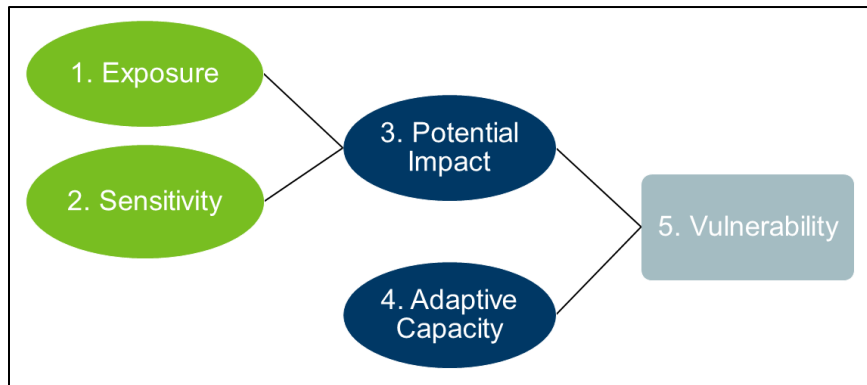


Figure 1. Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

This report documents the findings. It is one of five pilot sites chosen for protocol application. For information about other sites or the protocol itself, contact mlscp.dnr@state.mn.us.

1.1 Site Background

FBSW is located on State Highway 61 immediately northeast of the city of Two Harbors, Minnesota, in Lake County along the north shore of Lake Superior. The site was established in 1963 and features a long stretch of beach and a wetland complex with a small parking lot (Figure 2).



Figure 2. Flood Bay State Wayside Location Map

The FBSW assessment identified four site assets (Figure 2) including the parking lot, the north beach, the south beach, and the wetlands complex (Table 1). The parking lot asset includes the parking lot surface as well as the entrance road to the parking lot. The beach is separated into the north and south based on the presence of rip rap along the north end of the beach. The wetlands were identified using the National Wetlands Inventory (NWI) dataset. The wetlands asset is not separated by wetland types.

Table 1. Flood Bay State Wayside Site Assets

Asset	ID	Acres
Parking Lot	FB1	0.64
North Beach	FB2	1.1
South Beach	FB3	2.2
Wetlands	FB4	9.0

1.2 Methods

To assess vulnerability at FBSW, the site assessor used the following data sources (MN DNR and NOAA OCM 2022b):

- Geographic Information Systems (GIS) data compiled by MN DNR (MN DNR, NOAA OCM, and Tetra Tech, Inc. 2021), and
- Publicly available GIS data.

The assessor used the information from these sources to answer questions in the protocol's accompanying spreadsheet (Appendix A). There was no site visit, and the assessor had no prior knowledge of the site.

Further detail regarding how to analyze and gather data for the assessment is provided in a separate document utilizing FBSW as an example (MN DNR and NOAA OCM 2022c). The document provides step-by-step instructions on how to utilize ArcGIS or other software platforms to gather data for input to the spreadsheet.

2.0 EXPOSURE ANALYSIS

The exposure analysis for the FBSW assessment characterized exposure indicators for each of the assets including flooding, storm surge/seiche, lake level rise, historical flooding, erosion, geology, soils, and fish and wildlife habitat.

The flooding indicator analysis characterized:

- Federal Emergency Management Agency (FEMA) flood zones,
- Elevation data of the assets from 2012 light detection and ranging (LiDAR), and
- The elevation data compared to the 500-year flood elevation for Lake Superior.

The storm surge/seiche indicator analysis characterized:

- NOAA Cooperative Observer Program (CO-OP) water level data for comparison to the elevation of the asset,
- Lake Superior bathymetry slope data, and
- Fetch Exposure Index data.

The lake level rise indicator analysis characterized:

- NOAA CO-OP water level data historic minimum and historic maximums, and
- The difference in historic minimum and historic maximum in the NOAA CO-OP water level data compared to the elevation of the asset described above.

The historical flooding indicator analysis characterized:

- U.S. Geological Survey (USGS) stream gage and StreamStats data for streams at FBSW, and
- NOAA Advanced Hydrologic Prediction Service (AHPS) average annual precipitation data.

The erosion indicator analysis characterized:

- North Shore Erosion Mapping tool data from 2000, and
- Coastal Erosion Hazard Mapping (CEHM) data.

The geology indicator analysis characterized:

- Bedrock geology data from the Minnesota Geological Survey, and
- Surficial geology data from the Minnesota Geological Survey.

The soils indicator analysis characterized:

- The erosion factors data for Natural Resources Conservation Service (NRCS) mapped soils at FBSW, and
- North Shore Red Clay Soils data.

The fish and wildlife habitat indicator analysis characterized:

- Scientific and natural area data,

- State aquatic management area data,
- Native plant community data,
- Site of biodiversity significance data,
- NWI data, and
- Wildlife management area data.

The results of the exposure analysis indicated the parking lot has a low exposure rank while north beach, south beach, and the wetlands have a moderate exposure rank (Table 2, Figure 3). Full results of the exposure analysis are available in the provided FBSW vulnerability assessment spreadsheet (Appendix A).

Table 2. Flood Bay State Wayside Exposure Analysis Results

Asset	ID	Exposure Score Sum	Exposure Score	Exposure Rank
Parking Lot	FB1	12	1.8	Low
North Beach	FB2	16	2.0	Moderate
South Beach	FB3	15	2.0	Moderate
Wetlands	FB4	17	2.3	Moderate

The parking lot exposure rank is lower than the north beach, south beach, and wetlands because the parking lot is at a higher elevation than the other assets and is therefore less exposed to high water or large waves as the low-lying assets are. The parking lot exposure analysis also included an “override.” While the parking lot is within a native plant community, wetland, and site of biodiversity significance, the parking lot is not fish and wildlife habitat itself. Therefore, the fish and wildlife habitat exposure indicator was set to zero for the parking lot asset.



Figure 3. Flood Bay State Wayside Exposure Analysis Results Map

3.0 SENSITIVITY ANALYSIS

The sensitivity analysis for the FBSW assessment characterized sensitivity indicators for each of the assets including flood damage potential, storm resistance and condition, historical damage, protective engineering, infrastructure, fish and wildlife habitat, climate, and water quality.

The flood damage potential indicator analysis characterized:

- FEMA flood zones,
- Elevation data of the assets from 2012 LiDAR,
- User input regarding whether the asset is currently elevated, and
- The elevation data compared to the 500-year flood elevation for Lake Superior.

The storm resistance and conditions indicator analysis characterized:

- User input regarding whether the asset has built resistivity to storms, and
- User input regarding whether the asset has natural resistivity to storms.

The historical damage indicator analysis characterized:

- User input regarding whether the asset has sustained damage in the past, and
- User input regarding the current maintenance level for the asset.

The protective engineering indicator analysis characterized:

- User input regarding whether the asset currently features protective engineering, and
- User input regarding the current condition of any protective engineering elements.

The fish and wildlife habitat indicator analysis characterized:

- Scientific and natural area data,
- State aquatic management area data,
- Native plant community data,
- Site of biodiversity significance data,
- NWI data, and
- Wildlife management area data.

The climate indicator analysis characterized:

- Increases or decreases in precipitation for the site compared to historic levels, and
- Increases or decreases in temperatures for the site compared to historic levels.

The water quality indicator analysis characterized:

- Invasive species (terrestrial and aquatic) data, and
- Buffer protection data for waterbodies on the site.

The results of the sensitivity analysis indicated the parking lot and north beach have a moderate sensitivity rank while the south beach and the wetlands have a low sensitivity rank (Table 3, Figure 4). Full results of the sensitivity analysis are available in the provided FBSW vulnerability assessment spreadsheet (Appendix A).

Table 3. Flood Bay State Wayside Sensitivity Analysis Results

Asset	ID	Sensitivity Score Sum	Sensitivity Score	Sensitivity Rank
Parking Lot	FB1	16	2.3	Moderate
North Beach	FB2	17	2.3	Moderate
South Beach	FB3	13	1.8	Low
Wetlands	FB4	12	1.3	Low

The parking lot and north beach scored higher in the sensitivity rank than the south beach and wetlands because the parking lot and north beach feature built environments (i.e., paved surface in the parking lot and rip rap protection on the north beach). These built assets are more sensitive to increased lake levels and increased erosion potential than the south beach and wetlands assets which have a natural resistivity and adaptability to potential impacts. Similar to the exposure analysis, the only “override” in the sensitivity analysis was for the parking lot asset. While the parking lot is within a native plant community, wetland, and site of biodiversity significance, the parking lot is not fish and wildlife habitat itself. Therefore, the fish and wildlife habitat sensitivity indicator was zero for this parking lot asset.



Figure 4. Flood Bay State Wayside Sensitivity Analysis Results Map

4.0 POTENTIAL IMPACT ANALYSIS

The potential impact analysis for the FBSW assessment characterized the results of the exposure and sensitivity analyses. The potential impact to the assets was calculated by averaging the exposure and sensitivity scores from the previous analyses. The results of the potential impact analysis indicated the parking lot and north beach have a moderate potential impact rank while the south beach and the wetlands have a low potential impact rank (Table 4, Figure 5). Full results of the potential impact analysis are available in the provided FBSW vulnerability assessment spreadsheet (Appendix A).

Table 4. Flood Bay State Wayside Potential Impact Results

Asset	ID	Exposure Score	Exposure Rank	Sensitivity Score	Sensitivity Rank	Potential Impact Score	Potential Impact Rank
Parking Lot	FB1	1.8	Low	2.3	Moderate	2.0	Moderate
North Beach	FB2	2.0	Moderate	2.3	Moderate	2.1	Moderate
South Beach	FB3	2.0	Moderate	1.8	Low	1.9	Low
Wetlands	FB4	2.3	Moderate	1.3	Low	1.8	Low

At this point, the potential impact analysis can be used to characterize the vulnerability of the assets identified at FBSW. The following section (Section 5) presents potential adaptive capacity strategies to lower the vulnerability of the assets at FBSW. Adaptive capacity strategies identified in this document are conceptual and can be updated or removed as deemed necessary by the FBSW site manager.



Figure 5. Flood Bay State Wayside Potential Impact Results Map

5.0 ADAPTIVE CAPACITY ANALYSIS

Based on the potential impact analysis previously described adaptive capacity strategies for FBSW assets are identified below. Table 5 describes the general adaptive capacity strategy identified for each asset and provides more specific examples of the strategies.

Table 5. Flood Bay State Wayside Adaptive Capacity Options

Asset	ID	Adaptive Capacity Strategy	Adaptive Capacity Strategy Example
Parking Lot	FB1	Decommission and Remove	Move parking lot away from shoreline
North Beach	FB2	Protect/Engineer; Storm Resistant Design; Engineering Downgrade	Living shoreline design and removal of rip rap
South Beach	FB3	Protect/Engineer; Storm Resistant Design	Living shoreline design
Wetlands	FB4	None	N/A

Moving the parking lot may seem like an expensive and drastic strategy but the savings on future maintenance needs as erosion continues due to climate change could make the strategy a solid, long-term solution for the FBSW site. Designing a living shoreline approach and removing the rip rap on the north beach would increase the natural resistivity to potential impacts for the asset. The same approach could be applied to the south beach asset. No adaptive capacity strategies were identified for the wetlands because the wetlands are naturally able to adapt to a changing climate unlike the more heavily engineered assets (i.e., parking lot and beaches).

6.0 VULNERABILITY ANALYSIS

This final vulnerability analysis for the FBSW site sums the potential impacts and subtracts the adaptive capacity scores. Based on the final vulnerability score for each asset, the asset was assigned to one of four categories: high vulnerability, moderate vulnerability, low vulnerability, or minimal vulnerability. By utilizing the adaptive capacity strategies described previously, the vulnerability of the parking lot, north beach, and south beach can be reduced to minimal (Table 6, Figure 6). The wetlands do not have any adaptive capacity strategies identified because the asset is already buffered against impacts from climate change with a natural adaptive capacity.

Table 6. Flood Bay State Wayside Vulnerability Score and Rank

Asset	ID	Potential Impact Score	Potential Impact Rank	Adaptive Capacity Score	Vulnerability Score	Vulnerability Rank
Parking Lot	FB1	2.0	Moderate	2.0	0.0	Minimal
North Beach	FB2	2.1	Moderate	2.1	0.0	Minimal
South Beach	FB3	1.9	Low	1.9	0.0	Minimal
Wetlands	FB4	1.8	Low	0.0	1.8	Low



Figure 6. Flood Bay State Wayside Vulnerability Rank Map

7.0 DISCUSSION

While Table 6 above shows the potential reduction of vulnerability of assets at FBSW, this reduction is dependent upon implementing the highest impact adaptive capacity strategies identified in Table 5. Site managers at FBSW may not have the ability to fund these options or may not be able to implement these actions in a timely fashion. This vulnerability assessment has also been performed as a desktop analysis without a visit to the site itself. Site managers should utilize the best available knowledge of the site and the knowledge of what adaptive strategies are most readily available or feasible in order to fully assess the vulnerability of the assets. As new datasets become available or old datasets are updated, it may behoove the site manager or others interested in the site to integrate it into the assessment. Furthermore, if adaptive capacity strategies are implemented on certain assets (i.e., on the parking lot but not on north beach), the vulnerability assessment can be redone to update the vulnerability rank of the assets or of any new assets that might be identified or built at the site.

8.0 REFERENCES

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9.0 GLOSSARY

Exposure. The nature and degree to which a system is exposed to direct climate change impacts (Glick et al. 2011). For example, an asset that is sited well above a beach or riverbank will be less exposed to variations than an asset that is sited near the elevation of the lake or river.

Sensitivity. The degree to which a system is affected, either adversely or beneficially, when exposed to climate variations (Glick et al. 2011). For example, an asset with natural resistivity to climate change impacts like a wetland or unobstructed beach will be less sensitive to changes in lake level or storm damage than an asset with built features like a beach with rip rap or a parking lot that do not have natural resistivity to changes.

APPENDIX A: FLOOD BAY STATE WAYSIDE VULNERABILITY ASSESSMENT SPREADSHEET

Step 1. Exposure DATA			Flooding Indicator			Storm Surge/Seiche Indicator				Lake Level Rise	
ID	Asset	Site	FEMA Flood Data	LiDAR Elevation Data	Flood Elevation Data	NOAA CO-OP Data	Slope Data	Fetch Exposure Index Data	Elevation Data	NOAA CO-OP Data	Elevation Data
FB1	Parking Lot	Flood Bay Wayside	N/A	614.2	5.8	601.5	2.71	188650	12.7	4.594	8.1
FB2	North Beach	Flood Bay Wayside	N/A	608.1	-0.3	601.5	2.71	188650	6.6	4.594	2.0
FB3	South Beach	Flood Bay Wayside	N/A	608.2	-0.2	601.5	2.71	188650	6.7	4.594	2.2
FB4	Wetlands	Flood Bay Wayside	N/A	607.3	-1.1	601.5	2.71	188650	5.8	4.594	1.2

Step 1. Exposure DATA			Historical Flooding Indicator		Erosion Indicator		Geology Indicator		Soils Indicator	
ID	Asset	Site	USGS Stream Gage Data	NOAA AHPS Data	Erosion Data	CEHM Data	Bedrock Geology Data	Surficial Geology Data	gSSURGO Data	North Shore Red Clay Soils Data
FB1	Parking Lot	Flood Bay Wayside	237	31	High	Unknown	Basalt/Rhyolite	Clayey Sediment	0.43	0-8%
FB2	North Beach	Flood Bay Wayside	237	31	High	Unknown	Basalt/Rhyolite	Clayey Sediment	0	8-15%
FB3	South Beach	Flood Bay Wayside	842	31	High	Unknown	Basalt/Rhyolite	Clayey Sediment	0	N/A
FB4	Wetlands	Flood Bay Wayside	842	31	Unknown	Unknown	Basalt/Rhyolite	Clayey Sediment	0.43	0-8%

Step 1. Exposure DATA			Fish and Wildlife Habitat Indicator					
ID	Asset	Site	Scientific and Natural Areas?	State Aquatic Management Areas?	Native Plant Communities?	Site of Biodiversity Significance?	National Wetland Inventory?	Wildlife Management Area?
FB1	Parking Lot	Flood Bay Wayside	No	No	Yes	Yes	Yes	No
FB2	North Beach	Flood Bay Wayside	No	No	Yes	Yes	Yes	No
FB3	South Beach	Flood Bay Wayside	No	No	Yes	Yes	Yes	No
FB4	Wetlands	Flood Bay Wayside	No	No	Yes	Yes	Yes	No

Step 1. Exposure Data Scores			Flooding Indicator						Storm Surge/Seiche Indicator						
ID	Asset	Site	FEMA Flood Score	LIDAR Elevation Score	Flood Elevation Score	Flooding Score	Override?	Flooding Score Final	NOAA CO-OP Score	Slope Score	Fetch Exposure Index Score	Elevation Score	Storm Surge/Seiche Score	Override?	Storm Surge/Seiche Score Final
FB1	Parking Lot	Flood Bay Wayside	0	1	1	1		1	1	1	1	1	1		1
FB2	North Beach	Flood Bay Wayside	0	3	4	2		2	1	1	1	3	2		2
FB3	South Beach	Flood Bay Wayside	0	2	4	2		2	1	1	1	2	1		1
FB4	Wetlands	Flood Bay Wayside	0	4	4	3		3	1	1	1	4	2		2

Step 1. Exposure Data Scores			Lake Level Rise Indicator					Historical Flooding Indicator					Erosion Indicator				
ID	Asset	Site	NOAA CO-OP Score	Elevation Score	Lake Level Rise Score	Override?	Lake Level Rise Score Final	USGS Stream Gage Score	NOAA AHPs Score	Historical Flooding Score	Override?	Historical Flooding Score Final	Erosion Score	CEHM Score	Erosion Score	Override?	Erosion Score Final
FB1	Parking Lot	Flood Bay Wayside	4	1	3		3	1	3	2		2	4	0	2		2
FB2	North Beach	Flood Bay Wayside	4	3	4		4	1	3	2		2	4	0	2		2
FB3	South Beach	Flood Bay Wayside	4	2	3		3	3	3	3		3	4	0	2		2
FB4	Wetlands	Flood Bay Wayside	4	4	4		4	3	3	3		3	0	0	0		0

Step 1. Exposure Data Scores			Geology Indicator					Soils Indicator				
ID	Asset	Site	USGS Bedrock Geology Score	USGS Surficial Geology Score	Geology Score	Override?	Geology Score Final	gSSURGO Score	North Shore Red Clay Soils Score	Soils Score	Override?	Soils Score Final
FB1	Parking Lot	Flood Bay Wayside	2	1	2		2	3	1	2		2
FB2	North Beach	Flood Bay Wayside	2	1	2		2	0	2	1		1
FB3	South Beach	Flood Bay Wayside	2	1	2		2	0	0	0		0
FB4	Wetlands	Flood Bay Wayside	2	1	2		2	3	1	2		2

Step 1. Exposure Data Scores			Fish and Wildlife Habitat Indicator									Exposure Score Sum	Exposure Score	Exposure Rank
ID	Asset	Site	Scientific and Natural Areas Score	State Aquatic Management Areas Score	Native Plant Communities Score	Site of Biodiversity Significance Score	National Wetland Inventory Score	Wildlife Management Area Score	Fish and Wildlife Habitat Score	Override?	Fish and Wildlife Habitat Score Final			
FB1	Parking Lot	Flood Bay Wayside	1	1	4	4	4	1	3	0	0	12	1.8	Low
FB2	North Beach	Flood Bay Wayside	1	1	4	4	4	1	3		3	16	2.0	Moderate
FB3	South Beach	Flood Bay Wayside	1	1	4	4	4	1	3		3	15	2.0	Moderate
FB4	Wetlands	Flood Bay Wayside	1	1	4	4	4	1	3		3	17	2.3	Moderate

Step 2. Sensitivity DATA			Flood Damage Potential Indicator				Storm Resistance and Condition Indicator	
ID	Asset	Site	FEMA Flood Data	LiDAR Elevation Data	Asset Elevated?	500 Year Flood Potential?	Built Resistivity?	Natural Resistivity?
FB1	Parking Lot	Flood Bay Wayside	N/A	614.2	No	No	Yes	No
FB2	North Beach	Flood Bay Wayside	N/A	608.1	N/A	Yes	Yes	Yes
FB3	South Beach	Flood Bay Wayside	N/A	608.2	N/A	Yes	N/A	Yes
FB4	Wetlands	Flood Bay Wayside	N/A	607.3	N/A	Yes	N/A	Yes

Step 2. Sensitivity DATA			Historical Damage Indicator		Protective Engineering Indicator		Infrastructure Indicator	
ID	Asset	Site	Historical Damage?	Current Maintenance Level Data	Protective Engineering?	Engineered Element Condition Data	Critical Infrastructure Present?	Infrastructure Protected?
FB1	Parking Lot	Flood Bay Wayside	Yes	Good	Yes	Good	Yes	Yes
FB2	North Beach	Flood Bay Wayside	Yes	Moderate	Yes	Moderate	No	N/A
FB3	South Beach	Flood Bay Wayside	N/A	None	No	None	No	N/A
FB4	Wetlands	Flood Bay Wayside	N/A	None	N/A	None	No	N/A

Step 2. Sensitivity DATA			Fish and Wildlife Habitat Indicator					
ID	Asset	Site	Scientific and Natural Areas?	State Aquatic Management Areas?	Native Plant Communities?	Site of Biodiversity Significance?	National Wetland Inventory?	Wildlife Management Area?
FB1	Parking Lot	Flood Bay Wayside	No	No	No	Yes	Yes	No
FB2	North Beach	Flood Bay Wayside	No	No	Yes	Yes	Yes	No
FB3	South Beach	Flood Bay Wayside	No	No	Yes	Yes	Yes	No
FB4	Wetlands	Flood Bay Wayside	No	No	Yes	Yes	Yes	No

Step 2. Sensitivity DATA			Climate Indicator		Water Quality Indicator	
ID	Asset	Site	Precipitation Change Data	Temperature Change Data	Invasive Species?	Buffer Protection Data
FB1	Parking Lot	Flood Bay Wayside	0.32	0.2	Yes	None
FB2	North Beach	Flood Bay Wayside	0.32	0.2	Yes	50 Foot Buffer
FB3	South Beach	Flood Bay Wayside	0.32	0.2	Yes	50 Foot Buffer
FB4	Wetlands	Flood Bay Wayside	0.32	0.2	Yes	50 Foot Buffer

Step 2. Sensitivity Data Scores			Flood Damage Potential Indicator							Storm Resistance and Condition Indicator				
ID	Asset	Site	FEMA Flood Score	LiDAR Elevation Score	Asset Structure Elevation Score	500 Year Flood Score	Flood Damage Potential Score	Override?	Flood Damage Potential Score Final	Built Resistivity Score	Natural Resistivity Score	Storm Resistance and Condition Score	Override?	Storm Resistance and Condition Score Final
FB1	Parking Lot	Flood Bay Wayside	0	1	4	1	2		2	1	4	3		3
FB2	North Beach	Flood Bay Wayside	0	3	0	4	2		2	1	1	1		1
FB3	South Beach	Flood Bay Wayside	0	2	0	4	2		2	0	1	1		1
FB4	Wetlands	Flood Bay Wayside	0	4	0	4	2		2	0	1	1		1

Step 2. Sensitivity Data Scores			Historical Damage Indicator					Protective Engineering Indicator				
ID	Asset	Site	Historical Damage Score	Current Maintenance Level Score	Historical Damage Score	Override?	Historical Damage Score Final	Protective Engineering Score	Engineered Element Condition Score	Protective Engineering Score	Override?	Protective Engineering Score Final
FB1	Parking Lot	Flood Bay Wayside	4	2	3		3	1	2	2		2
FB2	North Beach	Flood Bay Wayside	4	3	4		4	1	3	2		2
FB3	South Beach	Flood Bay Wayside	0	0	0		0	4	0	2		2
FB4	Wetlands	Flood Bay Wayside	0	0	0		0	0	0	0		0

Step 2. Sensitivity Data Scores			Infrastructure Indicator					Fish and Wildlife Habitat Indicator								
ID	Asset	Site	Critical Infrastructure Present Score	Infrastructure Protection Score	Infrastructure Score	Override?	Infrastructure Score Final	Scientific and Natural Areas Score	State Aquatic Management Areas Score	Native Plant Communities Score	Site of Biodiversity Significance Score	National Wetland Inventory Score	Wildlife Management Area Score	Fish and Wildlife Habitat Score	Override?	Fish and Wildlife Habitat Score Final
FB1	Parking Lot	Flood Bay Wayside	4	1	3		3	4	4	4	1	1	4	3	0	0
FB2	North Beach	Flood Bay Wayside	0	0	0		0	4	4	1	1	1	4	3		3
FB3	South Beach	Flood Bay Wayside	0	0	0		0	4	4	1	1	1	4	3		3
FB4	Wetlands	Flood Bay Wayside	0	0	0		0	4	4	1	1	1	4	3		3

Step 2. Sensitivity Data Scores			Climate Indicator					Water Quality Indicator					Sensitivity Score Sum	Sensitivity Score	Sensitivity Rank
ID	Asset	Site	Precipitation Change Score	Temperature Change Score	Climate Score	Override?	Climate Score Final	Invasive Species Score	Buffer Protection Score	Water Quality Score	Override?	Water Quality Score Final			
FB1	Parking Lot	Flood Bay Wayside	4	2	3		3	4	0	2		2	16	2.3	Moderate
FB2	North Beach	Flood Bay Wayside	4	2	3		3	4	3	3.5		4	17	2.3	Moderate
FB3	South Beach	Flood Bay Wayside	4	2	3		3	4	3	3.5		4	13	1.8	Low
FB4	Wetlands	Flood Bay Wayside	4	2	3		3	4	3	3.5		4	12	1.3	Low

Step 3. Potential Impact								
ID	Asset	Site	Exposure Score	Exposure Rank	Sensitivity Score	Sensitivity Rank	Potential Impact Score	Potential Impact Rank
FB1	Parking Lot	Flood Bay Wayside	1.8	Low	2.3	Moderate	2.0	Moderate
FB2	North Beach	Flood Bay Wayside	2.0	Moderate	2.3	Moderate	2.1	Moderate
FB3	South Beach	Flood Bay Wayside	2.0	Moderate	1.8	Low	1.9	Low
FB4	Wetlands	Flood Bay Wayside	2.3	Moderate	1.3	Low	1.8	Low

Step 4. Adaptive Capacity DATA			1. Decommission and Remove	2. Elevate	3. Relocate	4. Protect/Engineer	5. Storm Resistant Design	6. Engineering Downgrade
FB1	Parking Lot	Flood Bay Wayside	Yes	N/A	N/A	N/A	N/A	N/A
FB2	North Beach	Flood Bay Wayside	N/A	Elevate Above	N/A	Living Shoreline	Yes	Yes
FB3	South Beach	Flood Bay Wayside	N/A	N/A	N/A	Living Shoreline	Yes	N/A
FB4	Wetlands	Flood Bay Wayside	N/A	N/A	N/A	N/A	N/A	N/A

Step 4. Adapt. Capacity Scores												
ID	Asset	Site	1. Decommission and Remove	2. Elevate	3. Relocate	4. Protect/Engineer	5. Storm Resistant Design	6. Engineering Downgrade	Exposure Adaptive Capacity Score	Sensitivity Adaptive Capacity Score	Adaptive Capacity Score Sum	Adaptive Capacity Score
FB1	Parking Lot	Flood Bay Wayside	4	0	0	0	0	0	0	0	4	4.0
FB2	North Beach	Flood Bay Wayside	0	4	0	4	4	4	2	4	6	3.0
FB3	South Beach	Flood Bay Wayside	0	0	0	4	4	0	2	2	4	2.0
FB4	Wetlands	Flood Bay Wayside	0	0	0	0	0	0	0	0	0	0.0

Step 5. Vulnerability Analysis			Exposure Score	Exposure Rank	Sensitivity Score	Sensitivity Rank	Potential Impact Score	Potential Impact Rank	Adaptive Capacity Score	Vulnerability Score	Vulnerability Rank
FB1	Parking Lot	Flood Bay Wayside	1.8	Low	2.3	Moderate	2.0	Moderate	2.0	0.0	Minimal
FB2	North Beach	Flood Bay Wayside	2.0	Moderate	2.3	Moderate	2.1	Moderate	2.1	0.0	Minimal
FB3	South Beach	Flood Bay Wayside	2.0	Moderate	1.8	Low	1.9	Low	1.9	0.0	Minimal
FB4	Wetlands	Flood Bay Wayside	2.3	Moderate	1.3	Low	1.8	Low	0.0	1.8	Low