Minnesota Point Scientific and Natural Area Vulnerability Assessment

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Minnesota Point SNA, Minnesota

Presented to

Minnesota Department of Natural Resources
Division of Ecological and Water Resources
Minnesota's Lake Superior Coastal Program

and

Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Service
Office for Coastal Management

Presented by

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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 Minnesota Point Scientific and Natural Area (MNP SNA) near Duluth, Minnesota. The MNP SNA assessment identifies five site assets including the Park Point Nature Trail (Trail), lakeside beach, bayside beach, lakeside dunes, and bayside dunes. The exposure analysis for the MNP SNA indicated the Trail and bayside dunes have a low exposure rank, the bayside beach had a moderate exposure rank, while the lakeside beach and lakeside dunes have a high exposure rank. The sensitivity analysis for the MNP SNA indicates all assets have a moderate sensitivity rank except for the lakeside beach, which had a high sensitivity rank.

The potential impact analysis for the MNP SNA identifies the lakeside beach had a high potential impact rank, the bayside beach and lakeside dunes had a moderate potential impact rank while the Trail and bayside dunes had a low potential impact rank.

Possible adaptive capacity measures were identified for the MNP SNA, including living shoreline engineering designs for the lakeside and bayside beach and lakeside and bayside dunes.

The identified adaptive capacity strategies ultimately decrease the vulnerability rank of the lakeside beach, bayside beach, and lakeside dunes to low. The Trail and bayside dunes remain at a low vulnerability rank because adaptive capacity strategies were deemed unnecessary for the Trail which is at a higher elevation than the other assets and the bayside beach has a decreased impact from climate change due to the location facing bayside in Superior Bay.

The vulnerability assessment for the MNP SNA 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. Minnesota Point Scientific and Natural Area (MNP SNA) 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
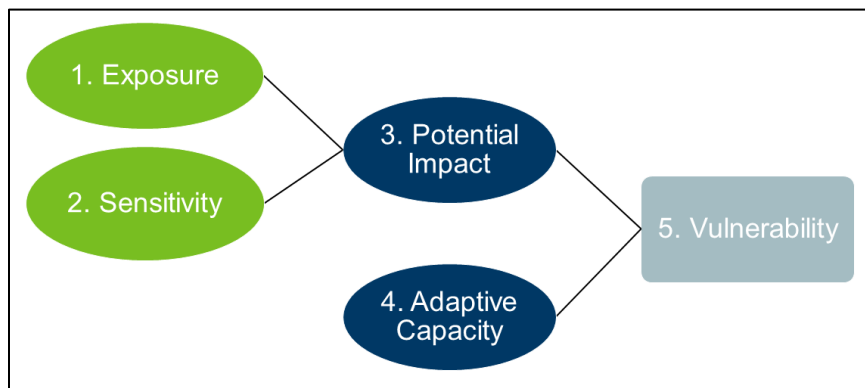
Figure 1. Vulnerability Analysis Process Adapted from Glick et al. (2011) and NPS (2016)

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

MNP SNA is an 18-acre site near the eastern tip of the 7-mile-long sandbar known as Minnesota Point near Duluth, Minnesota. The site was established in 2002 as a gift from Superior Power and Light through assistance from the Minnesota Land Trust and comprises two parcels that are surrounded by other public lands (Figure 2). The lakeside plot is exposed to the wind and waves of Lake Superior and the bayside plot spans the width of the point with the lakeside also being exposed to the wind and waves of Lake Superior while the bayside is more protected.

Figure 2.   Minnesota Point Scientific and Natural Area Location Map

The MNP SNA assessment identified five site assets (Figure 2) including the Park Point Nature Trail (Trail), lakeside beach, bayside beach, lakeside dunes, and bayside dunes (Table 1). The assets were mapped in ArcGIS utilizing a georeferenced PDF provided by the MN DNR available online at http://files.dnr.state.mn.us/destinations/snas/detail_maps/02000.pdf.

Table 1.   Minnesota Point Scientific and Natural Area Site Assets

Asset	ID	Measurement
Park Point Nature Trail	MP1	1,248 feet
Lakeside Beach	MP2	1.33 acres
Bayside Beach	MP3	0.66 acres
Lakeside Dunes	MP4	1.87 acres
Bayside Dunes	MP5	0.57 acres

1.2   Methods

To assess vulnerability at MNP SNA, 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 Flood Bay State Wayside 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 MNP SNA 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 MNP SNA, 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 mapped soils at MNP SNA, 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,

- National Wetland Inventory (NWI) data, and

- Wildlife management area data.

The results of the exposure analysis indicated the Trail and bayside dunes have a low exposure rank, the bayside beach has a moderate exposure rank, while the lakeside beach and lakeside dunes have a high exposure rank (Table 2, Figure 3). Full results of the exposure analysis are available in the provided MNP SNA vulnerability assessment spreadsheet (Appendix A).

Table 2.   Minnesota Point Scientific and Natural Area Exposure Analysis Results

Asset	ID	Exposure Score Sum	Exposure Score	Exposure Rank
Park Point Nature Trail	MP1	11	1.3	Low
Lakeside Beach	MP2	22	3.0	High
Bayside Beach	MP3	18	2.4	Moderate
Lakeside Dunes	MP4	20	3.0	High
Bayside Dunes	MP5	14	1.6	Low

The lakeside beach and lakeside dunes scored higher than the bayside beach and bayside dunes because of the exposure to waves, wind, and erosion from Lake Superior. The assessor used an "override" for the lakeside beach and lakeside dunes to increase the storm surge/seiche indicator to capture the exposure to the waves, wind, and erosion from Lake Superior for these lakeside-facing assets. The assessor also used an override on the historical flooding indicator and the erosion indicator based on input from MN DNR on recent erosion and flooding issues that have been encountered at the site. The Trail exposure analysis also included an override because, while the Trail is located within fish and wildlife habitat polygons, the Trail itself is not fish and wildlife habitat. Therefore, the fish and wildlife habitat exposure indicator was zero for the Trail asset.

Figure 3.   Minnesota Point Scientific and Natural Area Exposure Analysis Results Map

3.0   SENSITIVITY ANALYSIS

The sensitivity analysis for the MNP SNA 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 all assets had a moderate sensitivity rank except for the lakeside beach which had a high sensitivity rank (Table 3, Figure 4). Full results of the sensitivity analysis are available in the provided MNP SNA vulnerability assessment spreadsheet (Appendix A).

Table 3.   **Minnesota Point Scientific and Natural Area Sensitivity Analysis Results**

Asset	ID	Sensitivity Score Sum	Sensitivity Score	Sensitivity Rank
Park Point Nature Trail	MP1	15	2.0	Moderate
Lakeside Beach	MP2	21	3.0	High
Bayside Beach	MP3	19	2.5	Moderate
Lakeside Dunes	MP4	19	2.8	Moderate
Bayside Dunes	MP5	15	2.3	Moderate

Except for the lakeside beach, all assets fell into the moderate sensitivity rank. Because these assets are all at similar elevations and because they are natural environments, they have similar natural resistivity to climate impacts. The lakeside beach was ranked as a high sensitivity because of the known impacts from climate change that have been well-documented by MN DNR at the site. In that regard, the assessor utilized an override for the flood damage potential indicator, historical damage indicator, and protective engineering indicator for the lakeside beach and lakeside dunes. Like the exposure analysis, an override in the sensitivity analysis was utilized for the Trail. While the Trail is located within fish and wildlife habitat polygons, the Trail is not fish and wildlife habitat itself. Therefore, the fish and wildlife habitat sensitivity indicator was zero for the Trail asset.
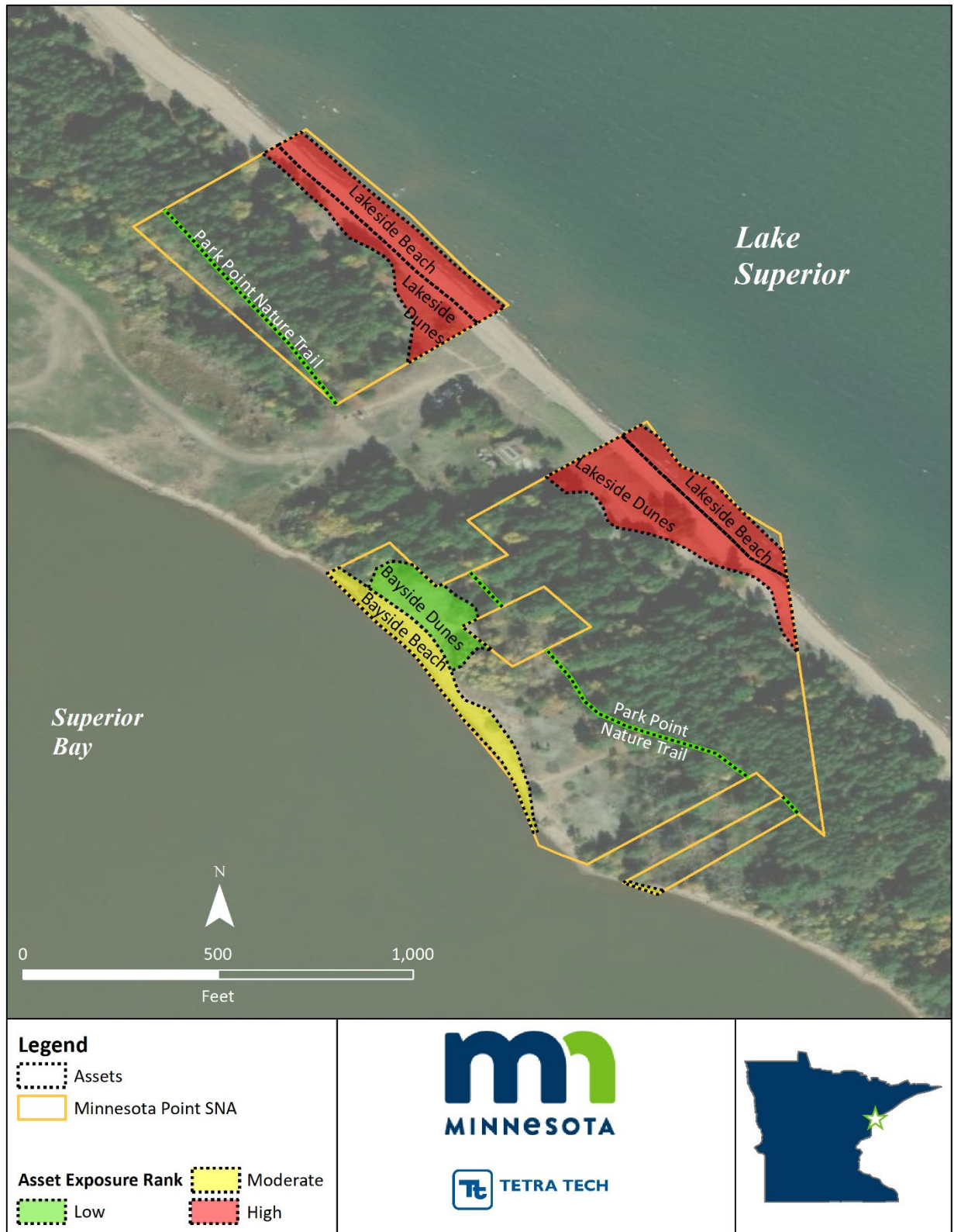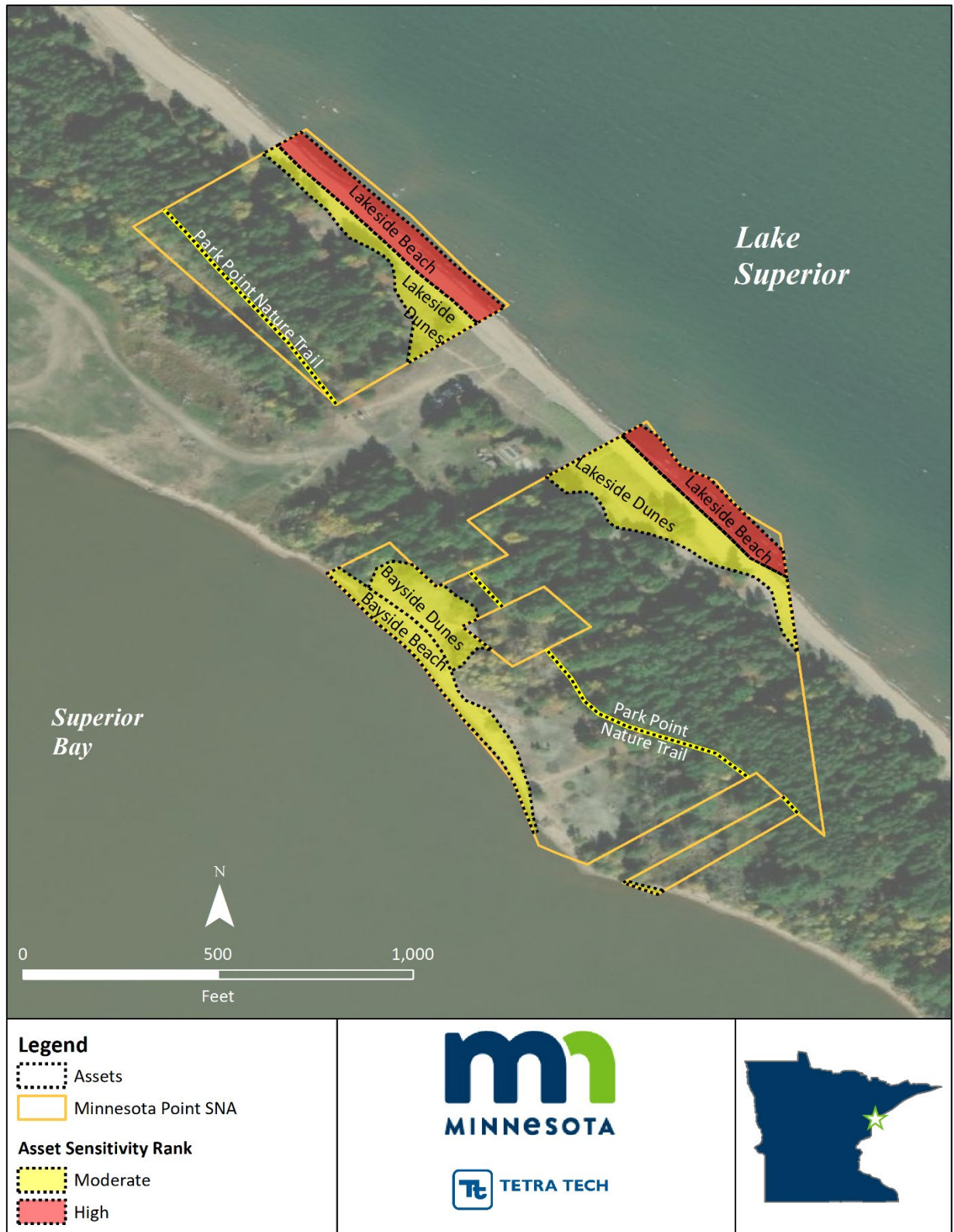
Figure 4. **Minnesota Point Scientific and Natural Area Sensitivity Analysis Results Map**

4.0   POTENTIAL IMPACT ANALYSIS

The potential impact analysis for the MNP SNA 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 lakeside beach has a high potential impact rank, the bayside beach and lakeside dunes have a moderate potential impact rank, while the Trail and bayside dunes have a low potential impact rank (Table 4, Figure 5). Full results of the potential impact analysis are available in the provided MNP SNA vulnerability assessment spreadsheet (Appendix A).

Table 4.   Minnesota Point Scientific and Natural Area Potential Impact Results

Asset	ID	Exposure Score	Exposure Rank	Sensitivity Score	Sensitivity Rank	Potential Impact Score	Potential Impact Rank
Park Point Nature Trail	MP1	1.3	Low	2.0	Moderate	1.6	Low
Lakeside Beach	MP2	3.0	High	3.0	High	3.0	High
Bayside Beach	MP3	2.4	Moderate	2.5	Moderate	2.4	Moderate
Lakeside Dunes	MP4	3.0	High	2.8	Moderate	2.9	Moderate
Bayside Dunes	MP5	1.6	Low	2.3	Moderate	1.9	Low

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

Figure 5.   Minnesota Point Scientific and Natural Area Potential Impact Results Map

5.0   ADAPTIVE CAPACITY ANALYSIS

Based on the potential impact analysis previously described, adaptive capacity strategies for MNP SNA 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.   Minnesota Point Scientific and Natural Area Adaptive Capacity Options

Asset	ID	Adaptive Capacity Strategy	Adaptive Capacity Strategy Example
Park Point Nature Trail	MP1	None	N/A
Lakeside Beach	MP2	Protect/Engineer; Storm Resistant Design	Living Shoreline Design
Bayside Beach	MP3	Protect/Engineer; Storm Resistant Design	Living Shoreline Design
Lakeside Dunes	MP4	Protect/Engineer; Storm Resistant Design	Living Shoreline Design
Bayside Dunes	MP5	None	N/A

While the lakeside beach, bayside beach, and lakeside dunes assets are generally resistant to climate impacts because of natural resistivity, a living shoreline approach to further protecting and enhancing these assets could be undertaken. No adaptive capacity strategies were identified for the Trail or the bayside dunes assets because the trail is at a higher elevation and generally less affected by climate impacts while the bayside dunes are also elevated and on the less exposed side of the site.

6.0   VULNERABILITY ANALYSIS

This final vulnerability analysis for the MNP SNA 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 lakeside beach, bayside beach, and lakeside dunes can be reduced to low (Table 6, Figure 6). The Trail does not have any adaptive capacity strategies identified because the asset is already buffered against impacts from climate change by being elevated, and the bayside dunes do not have any strategies identified because the asset is already buffered against impacts from climate change by facing bayside away from the higher impact storms and erosive forces of Lake Superior and having natural resistivity to potential climate impacts.

Table 6.   Minnesota Point Scientific and Natural Area Vulnerability Score and Rank

Asset	ID	Potential Impact Score	Potential Impact Rank	Adaptive Capacity Score	Vulnerability Score	Vulnerability Rank
Park Point Nature Trail	MP1	1.6	Low	0.4	1.3	Low
Lakeside Beach	MP2	3.0	High	1.5	1.5	Low
Bayside Beach	MP3	2.4	Moderate	1.5	0.9	Low
Lakeside Dunes	MP4	2.9	Moderate	1.5	1.4	Low
Bayside Dunes	MP5	1.9	Low	0.0	1.8	Low

Figure 6. **Minnesota Point Scientific and Natural Area Vulnerability Rank Map**

7.0   DISCUSSION

While Table 6 above shows the potential reduction of vulnerability of assets at MNP SNA, this reduction is dependent upon implementing the highest impact adaptive capacity strategies identified in Table 5. Site managers at MNP SNA 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, 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: MINNESOTA POINT SCIENTIFIC AND NATURAL AREA VULNERABILITY ASSESSMENT SPREADSHEET

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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
MP1	Park Point Nature Trail	Minnesota Point SNA	Zone C	607.3	2.5	601.5	1.05	81857	5.8	4.594	1.2
MP2	Lakeside Beach	Minnesota Point SNA	Zone A	605.8	1.0	601.5	0.91	159117	4.3	4.594	-0.3
MP3	Bayside Beach	Minnesota Point SNA	Zone A	605.4	0.6	601.5	1.20	4597	3.9	4.594	-0.7
MP4	Lakeside Dunes	Minnesota Point SNA	Zone AH	612.3	7.5	601.5	0.91	159117	10.8	4.594	6.2
MP5	Bayside Dunes	Minnesota Point SNA	Zone AH	608.5	3.7	601.5	1.20	4597	7.0	4.594	2.4

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
MP1	Park Point Nature Trail	Minnesota Point SNA		30.5	Unknown	Unknown	Basalt/Rhyolite	Fill	0.15	N/A
MP2	Lakeside Beach	Minnesota Point SNA		30.5	Unknown	Unknown	Basalt/Rhyolite	Fill	0.15	N/A
MP3	Bayside Beach	Minnesota Point SNA		30.5	Unknown	Unknown	Basalt/Rhyolite	Fill	0.15	N/A
MP4	Lakeside Dunes	Minnesota Point SNA		30.5	Unknown	Unknown	Basalt/Rhyolite	Fill	0.15	N/A
MP5	Bayside Dunes	Minnesota Point SNA		30.5	Unknown	Unknown	Basalt/Rhyolite	Fill	0.15	N/A

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 Signficance?	National Wetland Inventory?	Wildlife Management Area?
MP1	Park Point Nature Trail	Minnesota Point SNA	Yes	No	Yes	Yes	No	No
MP2	Lakeside Beach	Minnesota Point SNA	Yes	No	Yes	Yes	No	No
MP3	Bayside Beach	Minnesota Point SNA	Yes	No	Yes	Yes	No	No
MP4	Lakeside Dunes	Minnesota Point SNA	Yes	No	Yes	Yes	Yes	No
MP5	Bayside Dunes	Minnesota Point SNA	Yes	No	Yes	Yes	No	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
MP1	Park Point Nature Trail	Minnesota Point SNA	1	3	1	2		**2**	1	0	0	3	1		1
MP2	Lakeside Beach	Minnesota Point SNA	3	4	1	3		**3**	1	0	1	4	2	3	3
MP3	Bayside Beach	Minnesota Point SNA	3	5	1	3		**3**	1	1	0	5	2		2
MP4	Lakeside Dunes	Minnesota Point SNA	2	1	1	1		**1**	1	0	1	1	1	3	3
MP5	Bayside Dunes	Minnesota Point SNA	2	2	1	2		**2**	1	1	0	2	1		1

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
MP1	Park Point Nature Trail	Minnesota Point SNA	4	3	4		**4**	0	3	2		**2**	0	0	0		**0**
MP2	Lakeside Beach	Minnesota Point SNA	4	4	4		**4**	0	3	2	3	**3**	0	0	0	3	**3**
MP3	Bayside Beach	Minnesota Point SNA	4	5	5		**5**	0	3	2		**2**	0	0	0		**0**
MP4	Lakeside Dunes	Minnesota Point SNA	4	1	3		**3**	0	3	2	3	**3**	0	0	0	3	**3**
MP5	Bayside Dunes	Minnesota Point SNA	4	2	3		**3**	0	3	2		**2**	0	0	0		**0**

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
MP1	Park Point Nature Trail	Minnesota Point SNA	2	4	3		**3**	1	0	1		**1**
MP2	Lakeside Beach	Minnesota Point SNA	2	4	3		**3**	1	0	1		**1**
MP3	Bayside Beach	Minnesota Point SNA	2	4	3		**3**	1	0	1		**1**
MP4	Lakeside Dunes	Minnesota Point SNA	2	4	3		**3**	1	0	1		**1**
MP5	Bayside Dunes	Minnesota Point SNA	2	4	3		**3**	1	0	1		**1**

Fish and Wildlife Habitat Indicator

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	Exposure Score Sum	Exposure Score	Exposure Rank
MP1	Park Point Nature Trail	Minnesota Point SNA	4	1	4	4	1	1	3	0	**0**	11	1.3	Low
MP2	Lakeside Beach	Minnesota Point SNA	4	1	4	4	1	1	3		**3**	22	3.0	High
MP3	Bayside Beach	Minnesota Point SNA	4	1	4	4	1	1	3		**3**	18	2.4	Moderate
MP4	Lakeside Dunes	Minnesota Point SNA	4	1	4	4	4	1	3		**3**	20	3.0	High
MP5	Bayside Dunes	Minnesota Point SNA	4	1	4	4	1	1	3		**3**	14	1.6	Low

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?
MP1	Park Point Nature Trail	Minnesota Point SNA	Zone C	607.3	No	No	No	No
MP2	Lakeside Beach	Minnesota Point SNA	Zone A	605.8	N/A	No	No	Yes
MP3	Bayside Beach	Minnesota Point SNA	Zone A	605.4	N/A	No	No	Yes
MP4	Lakeside Dunes	Minnesota Point SNA	Zone AH	612.3	N/A	No	No	Yes
MP5	Bayside Dunes	Minnesota Point SNA	Zone AH	608.5	N/A	No	No	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?
MP1	Park Point Nature Trail	Minnesota Point SNA	No	Good	No	None	No	N/A
MP2	Lakeside Beach	Minnesota Point SNA	Yes	None	No	None	No	N/A
MP3	Bayside Beach	Minnesota Point SNA	Yes	None	No	None	No	N/A
MP4	Lakeside Dunes	Minnesota Point SNA	No	None	No	None	No	N/A
MP5	Bayside Dunes	Minnesota Point SNA	No	None	No	None	No	N/A

Step 2. Sensitivity DATA			Fish and Wildlife Habitat Indicator						Climate Indicator		Water Quality Indicator	
ID	Asset	Site	Scientific and Natural Areas?	State Aquatic Management Areas?	Native Plant Communities?	Site of Biodiversity Signficance?	National Wetland Inventory?	Wildlife Management Area?	Precipitation Change Data	Temperature Change Data	Invasive Species?	Buffer Protection Data
MP1	Park Point Nature Trail	Minnesota Point SNA	Yes	No	Yes	Yes	No	No	0.19	0.29	Yes	None
MP2	Lakeside Beach	Minnesota Point SNA	Yes	No	Yes	Yes	No	No	0.19	0.29	Yes	50 Foot Buffer
MP3	Bayside Beach	Minnesota Point SNA	Yes	No	Yes	Yes	No	No	0.19	0.29	Yes	50 Foot Buffer
MP4	Lakeside Dunes	Minnesota Point SNA	Yes	No	Yes	Yes	Yes	No	0.19	0.29	Yes	None
MP5	Bayside Dunes	Minnesota Point SNA	Yes	No	Yes	Yes	No	No	0.19	0.29	Yes	None

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Step 2. Sensitivity Data Scores

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
MP1	Park Point Nature Trail	Minnesota Point SNA	1	3	4	1	2		2	4	4	4		4
MP2	Lakeside Beach	Minnesota Point SNA	3	4	0	1	2	3	3	4	1	3		3
MP3	Bayside Beach	Minnesota Point SNA	3	5	0	1	2		2	4	1	3		3
MP4	Lakeside Dunes	Minnesota Point SNA	2	1	0	1	1	3	3	4	1	3		3
MP5	Bayside Dunes	Minnesota Point SNA	2	2	0	1	1		1	4	1	3		3

Step 2. Sensitivity Data Scores

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
MP1	Park Point Nature Trail	Minnesota Point SNA	1	2	1.5		2	4	0	2		2
MP2	Lakeside Beach	Minnesota Point SNA	4	0	2	3	3	4	0	2	3	3
MP3	Bayside Beach	Minnesota Point SNA	4	0	2		2	4	0	2	3	3
MP4	Lakeside Dunes	Minnesota Point SNA	1	0	0.5	3	3	4	0	2	3	3
MP5	Bayside Dunes	Minnesota Point SNA	1	0	0.5		1	4	0	2	3	3

Step 2. Sensitivity Data Scores

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
MP1	Park Point Nature Trail	Minnesota Point SNA	0	0	0		0	1	4	1	1	4	4	3	0	0
MP2	Lakeside Beach	Minnesota Point SNA	0	0	0		0	1	4	1	1	4	4	3		3
MP3	Bayside Beach	Minnesota Point SNA	0	0	0		0	1	4	1	1	4	4	3		3
MP4	Lakeside Dunes	Minnesota Point SNA	0	0	0		0	1	4	1	1	1	4	2		2
MP5	Bayside Dunes	Minnesota Point SNA	0	0	0		0	1	4	1	1	4	4	3		3

Step 2. Sensitivity Data Scores

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	Sensitivity Score Sum	Sensitivity Score	Sensitivity Rank
MP1	Park Point Nature Trail	Minnesota Point SNA	2	4	3		3	4	0	2		2	15	2.0	Moderate
MP2	Lakeside Beach	Minnesota Point SNA	2	4	3		3	4	3	3.5		4	21	3.0	High
MP3	Bayside Beach	Minnesota Point SNA	2	4	3		3	4	3	3.5		4	19	2.5	Moderate
MP4	Lakeside Dunes	Minnesota Point SNA	2	4	3		3	4	0	2		2	19	2.8	Moderate
MP5	Bayside Dunes	Minnesota Point SNA	2	4	3		3	4	0	2		2	15	2.3	Moderate

Step 3. Potential Impact								
ID	Asset	Site	Exposure Score	Exposure Rank	Sensitivity Score	Sensitivity Rank	Potential Impact Score	Potential Impact Rank
MP1	Park Point Nature Trail	Minnesota Point SNA	1.3	Low	2.0	Moderate	1.6	Low
MP2	Lakeside Beach	Minnesota Point SNA	3.0	High	3.0	High	3.0	High
MP3	Bayside Beach	Minnesota Point SNA	2.4	Moderate	2.5	Moderate	2.4	Moderate
MP4	Lakeside Dunes	Minnesota Point SNA	3.0	High	2.8	Moderate	2.9	Moderate
MP5	Bayside Dunes	Minnesota Point SNA	1.6	Low	2.3	Moderate	1.9	Low

Step 4. Adaptive Capacity DATA								
ID	Asset	Site	1. Decommission and Remove	2. Elevate	3. Relocate	4. Protect/Engineer	5. Storm Resistant Design	6. Engineering Downgrade
MP1	Park Point Nature Trail	Minnesota Point SNA	No	No Elevating	No Relocating	N/A	N/A	N/A
MP2	Lakeside Beach	Minnesota Point SNA	N/A	N/A	N/A	Living Shoreline	N/A	N/A
MP3	Bayside Beach	Minnesota Point SNA	N/A	N/A	N/A	Living Shoreline	N/A	N/A
MP4	Lakeside Dunes	Minnesota Point SNA	N/A	N/A	N/A	Living Shoreline	N/A	N/A
MP5	Bayside Dunes	Minnesota Point SNA	N/A	N/A	N/A	N/A	N/A	N/A

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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
MP1	Park Point Nature Trail	Minnesota Point SNA	1	1	1	0	0	0	1	0	1	0.4
MP2	Lakeside Beach	Minnesota Point SNA	0	0	0	4	0	0	2	1	3	1.5
MP3	Bayside Beach	Minnesota Point SNA	0	0	0	4	0	0	2	1	3	1.5
MP4	Lakeside Dunes	Minnesota Point SNA	0	0	0	4	0	0	2	1	3	1.5
MP5	Bayside Dunes	Minnesota Point SNA	0	0	0	0	0	0	0	0	0	0.0

Step 5. Vulnerability Analysis										
ID	Asset	Site	Exposure Score	Exposure Rank	Sensitivity Score	Sensitivity Rank	Potential Impact Score	Potential Impact Rank	Adaptive Capacity Score	Vulnerability Score	Vulnerability Rank
MP1	Park Point Nature Trail	Minnesota Point SNA	1.3	Low	2.0	Moderate	1.6	Low	0.4	1.3	Low
MP2	Lakeside Beach	Minnesota Point SNA	3.0	High	3.0	High	3.0	High	1.5	1.5	Low
MP3	Bayside Beach	Minnesota Point SNA	2.4	Moderate	2.5	Moderate	2.4	Moderate	1.5	0.9	Low
MP4	Lakeside Dunes	Minnesota Point SNA	3.0	High	2.8	Moderate	2.9	Moderate	1.5	1.4	Low
MP5	Bayside Dunes	Minnesota Point SNA	1.6	Low	2.3	Moderate	1.9	Low	0.0	1.9	Low