Student Name:_____ Independent Site: _____

Partner's Name:_____ Partners Site: _____

Key

Part 1: Physical Investigation

Station 1: Waves

Create a hypothesis that predicts how waves will impact erosion.

Design an experiment to test your hypothesis. Sketch the experiment below.

Did your experiment support your initial hypothesis?

Explain the results.

Station 2: Coastal Geology

Create a hypothesis that predicts how beach morphology will impact erosion.

Design an experiment to test your hypothesis. Sketch the experiment below.

Did your experiment support your initial hypothesis?

Explain the results.

Station 3: Slope and Sea Level Rise

Create a hypothesis that predicts how coastal slope and SLR will impact erosion.

Design an experiment to test your hypothesis. Sketch the experiment below.

Did your experiment support your initial hypothesis?

Explain the results.

Part 2: Field Investigation

Use the online data site to complete the table on the following page. Use the link below to the right to access the data. You should use a large screen to interact with the data site.

(https://experience.arcgis.com/experience/8a56c883113d4c15be67d10d13c70c15)

Table 1: Shoreline Evaluation Criteria						
Variable	*High Stability*	*Stable*	*Slightly at Risk*	*Vulnerable*	*High Risk*	*Notes*
Geomorphology	Rocky Beaches, High Bedrock Cliffs	Medium Cliffs	Low Cliffs or Cobble Beaches	Estuary or Protected Beaches	Barrier Beaches, Sand Beaches, Salt Marsh, or Mud Flats	Classify the site visually.
Offshore Slope	>0.04	0.03-0.04	0.02-0.03	0.01-0.02	<0.01	The slope from the waterline seaward 300 meters. Use the topographic profile to calculate this parameter.
Maximum beach Elevation (meters)	>7	5-7	3-5	1-3	<1	Use the topographic profile to measure this parameter.
Relative Sea Level Rise (mm/yr)	<2	2.0-3.0	3.0-4.0	4.0-5.0	>5.0	SLR data has been calculated by NOAA.
Significant Wave Height (m)	<0.55	0.55-0.85	0.85-1.00	1.00-1.25	>1.25	Wave height is measured by the National Data Buoy Center.

Complete the table below.

Table 2: Shoreline Data						
	Class Example: Virginia Beach		*Your Site: Cedar Island or Savage Neck* *Circle the location*		*Partner Site: Cedar Island or Savage Neck* *Circle the location*	
Variable	*Description or Value*	*Vulnerability*	*Description or Value*	*Vulnerability*	*Description or Value*	*Vulnerability*
Geomorphology	Sand Beach	High Risk	Barrier Island	High Risk	Estuary Beach	*Vulnerable*
Offshore Slope	(0-(-6.1))/300= 0.020	*Slightly at Risk or Vulnerable*	(0-(-1.4))/300= 0.005	High Risk	(0-(-1.5))/300= 0.005	High Risk
Maximum beach Elevation (meters)	4.6 meters	*Slightly at Risk*	1.7 meters	*Vulnerable*	13.3 meters	*High Stability*
Relative Sea Level Rise (mm/yr)	6.22 mm/year Chesapeake Channel, VA	High Risk	6.22 mm/year Chesapeake Channel, VA	High Risk	4.03 mm/yr Kiptopeke, VA	*Vulnerable*
Significant Wave Height (m)	0.99 m Station 44099	*Slightly at Risk*	Station 44089 1.02 meters	*Vulnerable*	Station 44072 0.38 meters	*High Stability*

Review the data you have collected and recorded in table 2. Create a hypothesis that predicts which of these locations is the most vulnerable to future shoreline erosion. Explain which of the variables cause the beach to be more vulnerable than the other sites.

*Students will likely predict that **Cedar Island** is most vulnerable because it is a **barrier island** with a **low elevation and offshore slope**, a **high rate of sea level rise**, and **large waves** compared to the other sites. However, if their predictions vary, they do not need to be corrected here. The students will be able to self-correct on the next page.*

Part 3: Validation

You will now return to the data to test your hypothesis. The data sets provided include orthophotos from 2002 and 2021. The change in shoreline location between the 2 photos can be measured and then the erosion rate can be calculated. The erosion rate is the distance divided by the time.

$$\text{Shoreline Change Rate} = \frac{\text{change in shoreline location (meters)}}{\text{Time (years)}}$$

The change in location should be measured in meters. The time in this example will always be 19 years (2021-2002=19 years). On the photo, the shoreline is identified as the wet/dry line, not the waterline. The wet/dry line is used rather than the waterline because the waterline will fluctuate each time a wave breaks on the shore. Erosion should be noted with a negative rate while accretion (beach growth) should be recorded as a positive rate. Calculate the rate of shoreline change and record it in the table below. For partial credit, show your work.

Table 3: Shoreline Change

	Virginia Beach	*Cedar Island*	*Savage Neck*
Shoreline Change (m/yr)	20 m/19 yrs= -1.05 m/yr	240 m/19 yrs= -12.63 m/yr	12.8 m/19 yrs= -0.67 m/yr

Review your hypothesis and the rate of shoreline change. Is the erosion rate the highest at the site you predicted to be the least stable?

(Yes) No

In the future sea level rise is expected to accelerate because of warming temperatures and ice melting. Which type of beach do you expect to be most impacted by accelerating sea level rise? You should discuss the impact of specific variables in your response. Is there a correlation between potential inundation caused by sea level rise and proximity to an offshore subduction zone?

Beaches with a flatter slope will experience more shoreline retreat due to sea level rise.
Continental Margins, with an offshore subduction zone generally have steeper slopes so they will be more resilient to inundation due to sea level rise.

Sketch a beach that is highly vulnerable to erosion and flooding and another that is more stable. Annotate both sketches to highlight the differences.

Unstable Beach

Stable Beach

Shoreline Stability Review Sheet

Use the online data site to complete the table below for Assateague. Compare this site to the 3 you studied in class. Use this data to answer the questions

Use the link below to access the data. You should use a large screen to interact with the data site. (https://experience.arcgis.com/experience/8a56c883113d4c15be67d10d13c70c15)

	Assateague	
Variable	*Description*	*Vulnerability*
Geomorphology	Barrier Island	High Risk
Offshore Slope (%)	(0-(-4.2))/300= 0.014	Vulnerable
Maximum beach Elevation (meters)	4.3 m	Slightly at Risk
Relative Sea Level Rise (mm/yr)	5.28 mm/yr Ocean City	High Risk
Shoreline Change (m/yr)	4 m/19 yrs= -0.21 m/yr Minimal change	Slightly at Risk
Significant Wave Height (m)	Station 44089 1.02 m	Vulnerable

1. Compare Assateague to Cedar Island. The erosion rate at Cedar Island is greater than Assateague. Example why this might be.

   Cedar has a lower elevation, a flatter coastal slope, and greater SLR. The waves and morphology are the same at both locations so those answers would be incorrect.

2. All the sites you have looked at (Cedar, Assateague, Savage and VA Beach) are along the coast of Virginis and therefore have many similarities. Which site is least like the others? Why do you think that is?

   Savage Neck because it is inside of the Chesapeake Bay.

3. Which parameters make Assateague most vulnerable to erosion?

   Morphology, SLR, Wave height

Examine the sketch to the right. Annotate the drawings to describe features that make the site more resilient or vulnerable to shoreline erosion.

Site 1 has flatter slope and lower elevation making it more vulnerable to shoreline erosion.

Site 2 has larger waves making it more vulnerable to erosion.

Sea Level rise cannot be observed.