US ARMY CORPS OF ENGINEERS
BAY MODEL 4th - 6th Grade TOUR

Hello Young Scientists!

Welcome to the United States Army Corps of Engineers Bay Model! What is the Bay Model, you ask? The building was used as a working laboratory from 1954 to the year 2000. The Model itself is a giant, indoor, concrete, hydrodynamic simulator. US Army Corps engineers and scientists used the Bay Model for many years to test several theories for collecting and storing fresh water, and to conduct a wide variety of environmental experiments. Today they use high-speed computers to do the job that the Bay Model once did as they continue their quest for viable solutions to keeping our waterways clean and healthy for all who depend on it.

In the process of studying the watershed flow patterns a growing knowledge of San Francisco Bay natural history and resources begins to emerge. Today, based on the information that's been collected, we have a much better understanding of the consequences of man's actions on neighboring plants, birds, fish, and wildlife.

However, as the human population of the Bay Area continues to grow, so does the demand on our fresh water supply. The increase of traffic on our waterways is another big concern. The Bay Model is now an excellent educational tool available for anyone who is interested in learning about the Bay Area watershed and it's unique environment.

Today, you are *all* scientists! And, we need *your* help! Our big question is: "What can we do, as individuals, to keep our bay environment clean and healthy so humans and wildlife can enjoy it together?" As young scientists, you need to understand what the problems are and discover solutions because someday the future of the entire watershed including the bay is going to be in your hands!

The exhibits, orientation film, and Bay Model will provide you with lots of useful material. Use your powers of observation. You have 1 hour to come up with new ideas to solve this question.

But, first you need to put your scientific minds to work. Let's explore our watershed and the unique ecosystems that depend on it. Let's see what it takes to protect and preserve our very special watery environment for future generations.

This activity is not meant to be a test. It is intended to help you to look for "clues". Your mission is to gather information, formulate questions, and make positive conclusions that will benefit an ecology that includes us all so we can all look forward to a brighter environmental future. I hope you find it both enlightening--and fun!

Sincerely,
Park Ranger Linda M. Holm

FOR YOUR CONVENIENCE:

The definitions of the CAPITALIZED words on the worksheet can be found in the Glossary of Terms located in the back of this worksheet

NAME: _____ Date: _____

Come on! Follow me! Let's go up the ramp to the upper level of the building. Go outside onto the deck overlooking Richardson Bay. Look around. What do you see? Birds? Boats? People? Docks? Piers? A big, giant pile of logs and DEBRIS? That pile of stuff looks very messy! Who is responsible for <u>most</u> of the mess? Nature____ or, People____

Manmade objects floating around in the Bay can do lots of damage to boats and wildlife. Our debris-collecting boats go out and pick up logs, abandoned boats, junked cars, shopping carts, appliances, etc, from the water and haul it back here out of harms way. After a few days of accumulation most of the stuff is trucked to a landfill where it is buried. None of it can be RECYCLED because of the TOXIC chemicals in the wood. Too bad! Recycling is a good thing! What a waste! Do you recycle at home? _____

<u>Factoid</u>: Did you know that 80% of the Earth's surface is water, but that only 1% of the Earth's surface is fresh water? We should never waste anything that we can't live without!!

And, did you know that the earth isn't making any new fresh water? The fresh water we have today is the same water the dinosaurs waded around in. No kidding! Our water just keeps going around and around. Should we take good care of the water we have? _____

Enter through the double doors and enter the round WATERSHED Exhibit room. Look closely at the mural. The painting on the wall tells a story about the HYDROLOGIC CYCLE also known as the "water cycle." Find the "button" and <u>gently</u> press it!

Where does our fresh water come from? Check the answer that best describes.
(A) Snow from the tops of mountains, rain, and condensation _____
(B) A giant squirt bottle in the sky _____
(C) RIVERS _____
(D) CREEKS _____
(E) A, C, and D _____

What is the name of the MOUNTAIN range that forms the eastern border of the SF Bay watershed? Check one:
(A) The Rocky Mountains _____
(B) The Coastal Range _____
(C) Big Rock Candy Mountain _____
(D) The Sierra Nevada Mountains _____

Now, in this round room, go on a quest to find three small red castles symbolizing the US Army Corps of Engineers. One of the panels will list the missions of the Corps. All the missions I have listed here are true except for one. Check the <u>one</u> that's <u>wrong</u>.
(A) Providing flood protection _____
(B) Managing recreation opportunities _____
(C) Overseeing navigation for commerce _____
(D) Providing fresh water storage _____
(E) Setting fashion trends with their new line of camouflage jammies at the GAP _____

Do you see the big water droplets on either side of the room? Turn them around. On the back they will tell you what the SALINE (salt) content of the water is and also what species live in that quality of water. As you go down the hall away from the Sierra Nevada Mountains you're heading towards the Pacific Ocean. You will find that the saline content in the big water drops increases and the SPECIES listed on the back will change. What is the name of the fish on the back of the droplet that you're looking at?

_____

Look down! The carpet tells a story about our two main TRIBUTARIES. You're following the flow of the Sacramento River on your right (if you're facing the theater) and San Joaquin River on your left. Slowly, splash your way down the long narrow room. Take your time! Be sure to study the mural. Look at all the wildlife that live near or in the water. Can you see the many different ways that people depend on this water too? _____

Do you know that <u>two-thirds</u> of all the fruits and veggies grown in the US come from California? It takes a whole lot of water to irrigate 4.5 million acres of farmland. Do you see all the birds in the sky? The sky, right over our heads, is part of a big bird highway called the "PACIFIC FLYWAY." Our wetlands are resting and nesting places for millions of birds and almost three hundred different species of birds! Do you think it's because of all the birds flying overhead that caused rangers to want to wear big hats for protection when they go outside? Yes _____ or, No _____.

Look to your right. Do you know that the Bay Area has been the ancestral home for humans for thousands of years? Do you see a little model of a boat? What plant material did the Bay Area Native Americans (Miwok and Ohlone) use to make their boats?

_____

Now, hunt for the words "Beginning of a Big Change." Oh my! It says that most of the original DELTA wetlands have been replaced! Too bad!!! Do you know that the wetlands act much like our own kidneys? They filter out impurities. This process produces fresh clean water that trickles down into our AQUIFERS, which is another pl ace that we can tap into for fresh clean drinking water. Today, however, just a small part of our wetlands are left. What happened to them? Name just <u>two</u> of the many things that have replaced our wetlands?

1. _____

2. _____

Do you think it's important to protect and preserve the wetlands that we have left?
Yes _____ No _____ or, I don't know yet _____

OK, now continue your journey down the hall…study the mural and find your way to the "ESTUARY." Choose the answer that best defines an estuary. Check <u>one</u>.

(A) An AQUATIC HABITAT for many species where fresh water mixes with salt water?
_____
(B) A place where people remove drinking water from the rivers through large straws?
_____
(C) A place that doesn't have very many plants or animals living there? _____
(D) A place where people mix freeze-dried, vacuum-sealed packages of eggnog with salty water? _____

****<u>ATTENTION! SCIENTISTS!</u> <u>Please stay with your class</u> and don't get too close to the Theater doors! A motion detector activates the movie, and if you get too close you will start the movie before your class gets a chance to enter, sit down, and get comfortable. The movie lasts 9 minutes. Now, continue your scientific journey down the Carpet River. You are slowly working your way towards the <u>Pacific</u> Ocean.**

Now, hunt for the words, "It's an Invasion!"

INVASIVE SPECIES cause billions of dollars in damages nationwide every year. They normally don't have any natural enemies in their new environments so they can multiply with ease. They cause considerable damage to the native ECOSYSTEMS. Invasive species include <u>all living things</u> that are not native to a specific area. Wind and seed distribution are two ways that invasive plant species can travel. Do you have any plants in your backyard that are not native to California? _____

Non-native, or invasive, species compete with native species for food and living space. True _____ or, False _____

Competition for food and living space makes it harder for the native species to survive. True _____ or, False _____

Name <u>two</u> bay invaders: _____and _____

Name <u>one</u> thing that you and your family can do to help native species survive.

_____

List <u>three</u> animals whose homes are hidden "Under The Bay." _____,

_____ and _____.

Now, find the panel that reads, "Where Salt and Fresh Water Meet." There are species that need fresh water for their survival. Others need salt water. But, did you know there are many species that must have <u>both</u> fresh and salt water in order to survive? Where the fresh water and salt water <u>mix</u> together is called BRACKISH. The Dungeness Crab, Pacific Herring, and the Leopard Shark are just a few species that need brackish water. This is why estuaries are so very important and why they need special care. Without them, many species would die. That would be very sad!!! Do you think they need protecting? _____

Check the name of the zone where fresh and salt water come together?
(A) The blended zone _____
(B) The stirred not shaken zone _____
(C) The mixing zone (that includes something called the NULL zone) _____

Each of these animals requires a different environment. Draw lines connecting each animal with the kinds of aquatic habitat it needs.

Dungeness Crab	
Duck	**SALTY**
Pelican	
Salmon	**BRACKISH**
Tule Reeds	
Whale	**FRESH**

Did you know that water moves fastest where land becomes the narrowest? Guess what? This is where water is also the deepest!
The water in SF Bay is <u>deepest</u> under what bridge? _____

How many feet deep is the water under that bridge? _____ft.

Can you guess what species depends on the bridge for their daily migration? _____

Can you find the whale on the mural? This whale is a gray whale. See? No dorsal fin! Only a dorsal ridge. That's the series of little bumps on its back. Look for the sea lion, the turtle, and other marine life that share the Bay! Look for the big container ship. I wonder where it's coming from? What do you think it's carrying?

Now enter the theater as a group, get comfortable, and watch the orientation movie. Pay attention, because some of the upcoming questions will be answered in it!

What species did the most damage to the Bay? Check <u>one:</u>
Man _____
Birds _____
Tule Elk _____
Aliens from Mars _____

The overall depth of the Bay can best be described as: Check <u>one:</u>
Deep _____
Shallow _____
I don't know…I fell asleep in the theater _____

For those of you who stayed awake, how long (or should I say…how short) is a Bay Model day? Let's see if you remember! Check <u>one:</u> 14.9 minutes _____ or, 24 hours _____

Did you know that the Bay Model, just like the real Bay, will experience two high tides (flood tides) and two low tides (ebb tides) each day, also known as a tidal cycle? A lunar day (24 hours and 50 minutes) is used to calculate the TIDES. The moon's gravitational pull on the Earth's liquid is stronger than that of the sun because the moon is closer to the earth. The moon is 240,000 miles away. The sun is 93 million miles away. Next time you jump in your car look to see how many miles are on the odometer. Do you think your car has driven the distance of the moon yet? _____

Exit the theater to get an aerial view of the Bay Model. This is what the San Francisco Bay looks like from an altitude of 12,000 ft. Observe! From here you can see all the different bays that make up the San Francisco Bay! Can you see the Golden Gate Bridge? _____

Each bay has it's own individual characteristics. Suisun Bay has the freshest water. South Bay has the saltiest water. All of them are very important in their own special way. It's a good idea to get acquainted with each of the bays. Just like the human body, the SF Bay has a circulatory system! Fresh water inflow and tidal action will determine which bays have the best circulation!

Draw a picture of a landmark that you recognize and name it!

This is a picture of: _____

Oh, by the way…if you guessed 14.9 minutes as the length of a Bay Model day, please give yourself a gentle pat on the head for paying attention in the theater!

Did you know that out there in the SF Bay is a manmade island!!! Yep! It was built for the location of the Worlds Fair in 1939! The two stone elephants that grace downtown Sausalito are relics from that big exposition too. Can you guess the name of the manmade island?
(A) Manhattan Island _____
(B) Skull Island _____
(C) Treasure Island _____
(D) Isle of Califia _____

Look way across the model! Do you see the painting on the far wall? See the ship, the big whale, and the dolphins swimming? That represents the ocean. In fact, that large swimming pool looking part of the Bay Model also represents an ocean. Can you tell me the name of that ocean?
(A) Atlantic _____
(B) Pacific _____
(C) Indian _____
(C) Bigwet _____

Oh, by the way, did you guess Treasure Island as the manmade island in the Bay? If you did, give yourself another nice gentle pat on the head!!!

See all the little copper tabs sticking up out of the water? There are 250,000 of them! They were strategically placed to create water currents in the Model that imitate the currents in the real Bay. Building models can be a lot of fun. Have you ever built a model? _____

Well, by now you probably have all kinds of intelligent ideas as to what we can do to keep our bay environment healthy and clean. Someday when you're all grown up you will be making lots of good decisions that will improve the Bay Area quality of life so that all living things can enjoy it together.

To find out where to go next you need to decipher this cryptic code:
DESLI ERLU

_____ _____

*****HINT!!! This oversized replica represents an instrument that the engineers and scientists used for the purpose of mathematics before calculators and computers were invented. If you can't figure it out, you may ask your teacher. If your teacher doesn't know…you have a very young teacher.**

This big mathematical tool really works! Look down at the panel that says "Technology Changes the Model." Follow the instructions to Step 1, 2 and 3, and do the math! Pretty cool, huh? It actually works quite well! Is a calculator easier to use? Yes _____
No _____ or, I don't know _____. Now, continue to the right and find John Reber.

Back in the 1940s, John Reber thought the fresh water flowing from the watershed to the ocean was a waste of fresh water. He wanted to see two huge, shallow reservoirs created by building two dams: One by the Bay Bridge, and the other where the Richmond-San Rafael Bridge is today. He thought his proposed idea would come in handy so people would have more fresh water to use. True _____ or, False _____

So, did you find the SLIDE RULE yet? Look around! It's mounted on the wall!

Mr. Reber didn't know a whole lot about the Bay environment or he wouldn't have proposed such a thing. The US Army Corps built the Bay Model to test his THEORY *before* building the dams to see if his proposed idea would work or not. The results of the testing showed that too much water would evaporate to make building the dams worthwhile. Further research disclosed lots of information about ECOSYSTEMS that hadn't been known before.

The Bay Model was constructed for what purpose? Check <u>one</u>:

(A) A museum? ____

(B) A working laboratory to test the "Reber Plan?" ____

(C) A place to count the 1000s of yellow rubber duckies -- that escaped from a container ship and are floating around in the Pacific -- in the event that they found their way into San Francisco Bay? _____

Now turn around. Do you see the big, circular concrete exhibit under the banner that says "Why Was The Model Built? It's called a TACTILE sculpture. This is what the Bay Model feels like. Touch it. The different colors represent the different ways that land is used around the Bay. Draw a line to match the color on the left with the appropriate land use.

Gray	**Transportation routes or roads**
Dark Green	**Cities, towns, urban areas**
Blue	**Industrial areas or airports**
Red	**Marshlands, or Parks**
Dark Brown	**Upland areas or hills**
Beige or Light Tan	**Water**

What process makes it possible for big ships to enter a shallow port??? _____

Notice the channels that Army Corps boats carved out in the SF Bay floor so that big giant container ships - carrying products that we like to buy (like sneakers, computers, cameras, toys, clothing, cars, rubber duckies, and many other items) from far away places like China and Japan -- can enter our shallow harbors and offload their freight?

Did you guess DREDGING? If you did, you are correct!!!! Careful laboratory testing is conducted because salt water from the ocean can follow these newly dredged channels causing salinity levels to increase in water that isn't supposed to be that salty. This extra salt can cause harmful effects to the BENTHOS and other life forms in the Bay! It's very hard to balance the needs of man with the needs of the bay creatures. Sometimes we need to compromise. But, sometimes compromising isn't the solution either. So, there are times when we have no alternative but to change our way of doing things. And, that's why we need your help in resolving some of these issues. Will you help us? _____

It used to be that NATURE got all the water. Today, as you can see, there are many more demands and uses for fresh water than in the past. And, many of these demands can cause our fresh water to become polluted too. Much of our fresh water is diverted away from the estuaries for IRRIGATION, and creatures that live in the estuaries today are living in constant drought conditions because of this. We need to think of new ways to conserve fresh water so there's plenty for all. What <u>one</u> specie do you think causes the most pollution? _____. Do you think educating the public will help? _____

Now -- when your class, teachers and parents are all together – you may slowly walk down the spiraling ramp to the lower level. When you reach the bottom of the ramp, turn directly to your left and walk over to the edge of the Bay Model. <u>No running or pushing please! We don't want any of our scientists to get hurt!!</u>

You should now be overlooking the PORT of Oakland. Do you see the CHANNELS that were carved into the Bay Model? That's just what it looks like if you could see below the water of the real Bay. You can see how shallow the bay really is. Do you think the Bay Model is helpful for learning about our watershed and the San Francisco Bay? _____

If you make your way around to the left, you will come to the DELTA area that looks like a collection of islands. It represents about 500,000 acres. Just think! It used to be miles and miles of wetlands but today it's mostly farmland. It also includes about 1,100 miles of waterways called LEVEES and SLOUGHS. Notice that the land is below water level. What do you think would happen to the land if one of the levees broke? Check one:
(A) The land would flood _____
(B) The sky would fall _____
(C) The Jolly Green Giant would rise up from the land of peas and fix it. _____

We just covered approximately 200 miles of land from the Sierra Nevada Mountains to the Pacific Ocean in about one hour. That's our entire watershed. Do you really feel like a scientist now? Yes _____ or, No _____. I hope you answered "Yes" because you are!!!

If time allows, please visit our many other exhibits. Kindly treat our exhibits with the utmost care. Over by the Carquinez Strait you will find a navigation map. The little tiny numbers indicate the depth of the bay in feet. The Carquinez Strait is the second deepest part of the bay. Are you surprised to see how shallow some areas are? Yes _____
No _____. See if you can find the "Keeping It Clean" exhibit on your way out! It's cool!

Now, young scientists, here's your chance to make a difference. Let us know what conclusions you've formulated that will keep our waterways healthy and clean. This part can be done either here or back in your classroom. If you finish the comment form before leaving today, please carefully tear it off and hand it to a ranger! Thank you. I hope you enjoyed your visit! And, I hope you will come back and visit us again!

NAME: _____ AGE: _____

SCHOOL: _____ CITY: _____

Using some of the words from your glossary, write your ideas, theories, suggestions, questions, and solutions (use the back if you need to) with any other comments you may have here:

When you're all done, please send them to me: Bay Model Visitor Center, 2100 Bridgeway, Sausalito, CA 94965-1764. ATTN: Education Coordinator. Or, fax: 415-332-0761. Thank you so very much! Please come back and see us again!

- END-