



California State Assembly Select Committee
Sea Level Rise and the California Economy

Sea-Level Rise: a Slow-Moving Emergency



Select Committee Report of August 2014

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Cover photograph was taken by Douglas Moody, Point Blue Conservation Science, on December 13, 2012 and is courtesy of the California King Tides Initiative. The photograph shows flooding from king tides at the Highway 101-1 interchange in Mill Valley. Photographs like these of king tides offer a living record of the changes to our coasts and shorelines and help Californians visualize how sea-level rise will impact their lives.

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ACKNOWLEDGEMENTS

I want to thank Speaker Emeritus John A. Pérez who authorized the formation of the Assembly's Select Committee on Sea Level Rise and the California Economy. His foresight and leadership has helped to bring attention to a looming crisis in California.

I also want to thank my Assembly colleagues who joined me in a series of Select Committee hearings. They brought their commitment to protecting and improving California to our consideration of the issues we discussed.

Thank you's should also be given to the many experts and professionals who provided engaging testimony at our hearings.

Finally, I want to offer a special thank you to Ellen Hou. Ms. Hou serves as a Legislative Assistant in my Capitol Office. She took on the assignment of staffing the Select Committee and is to be commended for doing an outstanding job. Ms. Hou organized all of our hearings, managed logistics, and compiled this report. Thank you, Ellen.



Richard S. Gordon
Assemblymember, 24th Assembly District
Chair, Select Committee on Sea Level Rise and the California Economy

August 2014

INTRODUCTION

The sea is rising. The nation's longest continuously operating gauge of sea level, at Fort Point in San Francisco Bay, recorded a seven-inch rise in the sea level over the 20th century. As a result of climate change and global warming, sea-level rise is projected to accelerate during the next century. Even if greenhouse gas emissions are reduced, residual ocean warming will cause seas to continue to rise. A 2012 report from the National Research Council found that the average sea-level rise projections for California are an additional 6 inches by 2030, 12 inches by 2050, and 36 inches (3 feet) by 2100. As a result of these projections, sea-level rise has been called a slow-moving emergency. **The fact is that California is indeed facing an emergency.**

California has 840 miles of coastline ranking third among the 50 states behind Alaska and Florida for the most miles of coast. San Francisco Bay is highly developed along the shoreline and faces impacts from sea-level rise. Three quarters of California's 38 million people live near the coastline and the San Francisco Bay shoreline.

In addition to homes, existing critical infrastructure – such as roads, hospitals, schools, emergency facilities, wastewater treatment plants, and power plants – is vulnerable to sea-level rise. Several California airports are located in coastal zones and rising seas will also impact goods movement through California's ports. Sea-level rise also threatens public access to the coast and its recreational areas. Coastal waters, wetlands, estuaries, riparian areas, and beaches – which are important environmental and economic resources of California – are also at risk.

The Assembly Select Committee on Sea Level Rise and the California Economy was established in 2013 to thoroughly review the challenges ahead in addressing the expected impacts of sea-level rise on California and its economy. The Select Committee held four hearings throughout the state to examine sea-level rise's effect on various sectors and industries. Topics at the four hearings included projected impacts on: coastal agriculture, the fishing and aquaculture industry, tourism, ports, roads and bridges, and water and power infrastructure. The Committee also examined the existing authority granted to state agencies in regards to preparedness and response to anticipated sea-level rise.

This report summarizes the testimony at the hearings providing highlights as well as insightful images that put into perspective the risks California faces. The report also includes key findings and a set of recommendations that was written by committee staff and approved by the Chair. The findings and recommendations were not voted on by members of the Select Committee and may not reflect the view of each Select Committee member. This report is meant to inform and alarm so that California can be proactive in responding to the slow-moving emergency of sea-level rise.

KEY FINDINGS

The following are key findings that highlight the important takeaways from the Select Committee's four hearings.

- **Key segments of California's economy are at risk.** California's coastal agriculture, fishing, and tourist industries will be impacted. Airports, ports, and goods movement will be affected.
- **Infrastructure is at risk.** Critical infrastructure including 3,500 miles of roadways; about 280 miles of railroads; numerous schools, police and fire stations; and hospitals are located in the coastal zone. Key elements of California's wastewater treatment capacity and power generating capacity are located at current sea level.
- **True vulnerability is sea-level rise plus extreme storms and king tides.** King tides are especially high tides that occur several times each year. The combined effects of current sea-level rise combined with extreme storm events and king tides are already providing us with a preview of the new normal that can be expected as the seas continue to rise.
- **Sea-level rise will exacerbate the problem of saltwater intrusion.** Saltwater intrusion into coastal aquifers poses a high level of risk to agricultural communities along the California coast. Sea-level rise threatens water supply and water quality by aggravating saltwater intrusion in our freshwater sources like coastal aquifers, estuaries, and even the Delta.
- **Sea-level rise will accelerate coastal and beach erosion.** Erosion breaks down natural barriers such as cliffs, beaches, wetlands, and dunes – all of which act as buffers and protection for our coastal communities. Beach erosion in particular will negatively impact California's tourism industry. Erosion will also have significant impact on private property including homes and businesses.
- **Coordinated planning is required in order to adequately prepare.** Sea-level rise is an issue that crosses many sectors and jurisdictions; therefore, collaboration and coordination are needed to ensure effective planning. Key decisions will need to be reached relative to: where it would be appropriate to armor the coast, where adaptation is needed, and where retreat from the coastal zone should be encouraged.
- **Lack of funding is a barrier for taking action on sea-level rise.** Responding to sea-level rise will be costly. Currently, there is even insufficient funding to support local governments and others in assessing vulnerabilities, planning, and reducing risk. In fact, applicants to the Coastal Commission's Local Coastal Program Assistance Grant Program requested over five times the amount of available funding.

POLICY RECOMMENDATIONS

Educate the public about sea-level rise and its impacts. Education and raising awareness are key in order to have buy-in from communities to prioritize the issue now. Unfortunately, sea-level rise is often seen as a future problem; however, we need to reframe the discussion and inform the public that we are in the middle of an emergency – not at the beginning. The crisis is already here and action needs to be taken now.

Ensure there is a continued repository for science in the state in order to make educated policy decisions. Science plays a vital role in informing us about future conditions and helps frame decision-making and policy responses. The California Ocean Protection Council should be encouraged and incentivized to bring the best and most current science to the state.

Establish policy, guidelines, and guidance at the state level to inform planning decisions. The state should collaborate with local and regional government agencies to provide clear, consistent, and transparent standards and guidance, including uniform data that informs and supports local decision making processes. Current projections suggest that the planning horizon anticipate three feet of sea-level rise by 2100.

Be proactive in planning for sea-level rise. The severity of the impacts of sea-level rise will be linked to how quickly we take action. Preparing for sea-level rise will be expensive, but the price will be far lower than the alternative of waiting and reacting to these impacts as they occur. Planning should include consideration of both sea-level rise and extreme events.

Incentivize sea-level rise planning and adaptation through additional funding. Lack of funding is a barrier to taking action on sea-level rise. Therefore, additional funding to support current grant programs as well as the creation of new sources of funding will lead to increased actions to address the need. It is encouraging that the 2014-15 adopted budget includes funding for planning in the new California Climate Resilience Account. Future consideration should be given to a state revolving loan fund to assist communities with adaptation.

Encourage collaborative planning efforts. Coordination and collaboration especially regional planning is essential, as sea-level rise does not stay within jurisdictional boundaries. In fact, sea-level rise affects many sectors and agencies, which are often intertwined and dependent on each other.

Take action now to address sea-level rise, it is not too late. Sea-level rise has been called a slow-moving emergency. As a result, the future is not all doom and gloom since we have time on our side to prepare and plan for sea-level rise. Sea-level rise is not a surprise. We know it is happening and will only worsen. We must take advantage of the time we have to address this impending emergency now.

SUMMARY OF SELECT COMMITTEE HEARINGS

Overview and Impact of Sea Level Rise in California

Wednesday, May 15, 2013

9:30 a.m. – 12:30 p.m., Sacramento

The first Select Committee hearing brought in the Natural Resources Agency Secretary as well as scientists and academics who described the science behind why are seas rising and provided a broad overview of the threats and challenges facing California, setting the stage for the remaining hearings and discussion.

Overview of Sea Level Rise in California

John Laird, Secretary, Natural Resources Agency

Secretary Laird began by revealing that the public is aware of greenhouse gas (GHG) emissions and things that are related to it, but they have yet to develop a real comfort level with how the state is going to have to adapt to changes in the climate. Broad based education for the public is lacking.

The Natural Resources Agency is the state's lead on adaptation and is in the process of updating California's 2009 adaptation strategy, which includes oceans and coastal resources. It is clear that climate adaptation activities to date have been conducted without sufficient funding, mandate, staffing, or implementing authorities. Secretary Laird stated that the backdrop for today is that the state has much more science than in 2009 and science in many ways has started to settle the question of what might be used as a baseline for future sea-level rise. In fact, the National Research Council has projected sea level to rise in the range of 5 to 24 inches by 2050 and 17 to 66 inches by 2100. The median is somewhere around 14 inches by 2050 and somewhere around 41 or 42 inches by 2100. Secretary Laird pointed out that it is very important to look at the median because depending on the success of reducing GHG emissions, actual sea-level rise could be at the low end or high end of these projections.

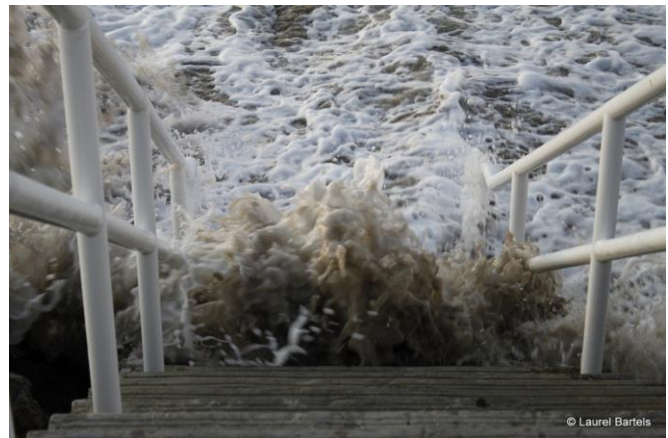
Secretary Laird also pointed out that the impacts California faces are not sea-level rise alone, but extreme storms as well. He provided the metaphor that the situation is not a bathtub where there is only gradual rise. Instead he asserted that it is the 2-year old child jumping into the bathtub, which is the extreme event. And it is the extreme event that will especially drive home what the sea-level rise is and what its effects are on the coast.

The severity of impacts will be linked to how quickly action is taken. Secretary Laird shared that this is an important point to dwell on because as with Hurricane Sandy, if \$15 billion of infrastructure improvements had been done prior to the storm, it would have mitigated most of the \$60 billion costs that accrued to taxpayers after the storm. He asserted that preparing for sea-level rise will be expensive, but the price will be far lower than the alternative of waiting and reacting to these impacts as they occur. These are major issues that have to be dealt with

and part of the work is educating the public. Secretary Laird concluded by stating that he looks forward to partnering with the Legislature in these efforts.

Cat Kuhlman, Executive Director, Ocean Protection Council

Ms. Kuhlman asserted that the sea is rising and is already causing impacts to the California coast and San Francisco Bay. As a result, sea-level rise poses a severe threat for the future. She shared that recently volunteers have been taking photographs (below are two examples) during king tides, which are extreme high tides that occur at predictable intervals during the year. These king tides document how California’s significant coastal resources are currently endangered and give an incredible preview of what will happen to communities as the sea rises. She stated that these images paint a visual picture of something that is otherwise hard to imagine about how California is going to be changing.



Ms. Kuhlman pointed out that climate change and sea-level rise have been strategic priorities for the Ocean Protection Council which was created by the Legislature to bring together the best science and policy for California’s decision makers both at the state and local level to protect coast and ocean resources. She asserted that science plays a vital role in informing the public about future conditions and helps to frame policy responses.

Ms. Kuhlman also shared that California is a leader in taking action to address sea-level rise. In fact, the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT) developed the State of California Sea-Level Rise Guidance Document which is intended to help state agencies incorporate future sea-level rise impacts into planning decisions. She stated that the policy recommendations laid out in this document were drafted by consensus with 16 state agencies¹ that have jurisdiction over coastal and ocean matters for California in

¹ The 16 state agencies included the Business, Transportation and Housing Agency, Coastal Commission, Department of Fish and Game, Department of Parks and Recreation, Department of Public Health, Department of Toxic Substances Control, Department of Transportation, Department of Water Resources, Environmental

addition to the Ocean Protection Council. She expressed that having guidance on the best available projections helps prevent confusion about which projections to use for decision-making.

Ms. Kuhlman advised that it is important to have accurate maps in addition to having good projections. She shared that the Ocean Protection Council's Coastal Mapping Program has produced detailed maps that can be used for evaluating future scenarios. In 2011, the Ocean Protection Council adopted a Sea-Level Rise Resolution stating that all state agencies and non-state entities implementing projects using state funds or on state lands should incorporate consideration of the risks posed by sea-level rise into all decisions. In terms of funding, she stated that the Ocean Protection Council provided \$2.5 million to fund projects in partnership with the Coastal Conservancy and the Coastal Commission. This funding will support sea-level rise analyses and projects that will result in updated Local Coastal Programs, which are key planning tools for addressing sea-level rise.

Furthermore, Ms. Kuhlman pointed out that many individual agencies are taking action to address sea-level rise, with projects such as:

- Caltrans – Transportation Hot Spot Map – recently completed;
- State Lands Commission – coordinating with leases and grantees about taking action on sea-level rise;
- San Francisco Bay Conservation and Development Commission (BCDC) – working with other regional governance entities on developing a Regional Adaptation Strategy for the Bay Area;
- Coastal Commission – developing guidance for addressing sea-level rise for permittees;
- Department of Public Health – awarded four-year funding to evaluate health impacts from climate change, including from sea-level rise; and
- Coastal Conservancy – developing strategies to address sea-level rise in wetland and other shoreline habitats in San Francisco Bay.

Ms. Kuhlman emphasized the need to use the state's coastal natural resources as part of the equation for solutions. In making these decisions, the importance of the natural world must be factored in. There is a growing body of research that shows the importance both from a resource perspective and an economic perspective that protecting and restoring ecosystems is both effective and cost effective. She asserted that this is another area where additional work and additional research is going to be pivotal for the state.

While the Ocean Protection Council has made preliminary investments in science, policy, and tools for decision makers, Ms. Kuhlman conveyed that California has a solid government infrastructure that has been and can be responsive. She asserted that California is in the lead compared to other states, but the sea is rising rapidly and there is a need to redouble efforts with both energy and courage. She also recommended that achieving a resilient coastline will require partnerships, not only the ones already created, but new and innovative partnerships, sound science that is responsive to decision makers at all levels of government. Most importantly, she stated that there is a need for creative incentives and requirements to evaluate all projects in light of climate change and sea-level rise. Ms. Kuhlman concluded that the Ocean Protection Council is committed to providing leadership and funding to prepare for sea-level rise. The Ocean Protection Council's goal is to work collaboratively with the Legislature, other state agencies, local agencies and interested partners to develop long range strategies that promote the resiliency of coastal communities, and restore and protect California's natural resources.

The Impact of Sea Level Rise: Threats and Issues Facing California and its Economy

Dr. Gary Griggs, Distinguished Professor of Earth Sciences and Director of the Institute of Marine Sciences, University of California Santa Cruz

Dr. Griggs observed that climate change and sea-level rise is nothing new, and has been known about for a long time. He shared that sea-level rise became known mid-way through the last century, where scientists learned that climate differed across the world, but also that climate has changed over time. As it gets warmer, ice melts and oceans expand. Scientists believe that ice melting accounts for about two-thirds of the rise in sea level. In addition, the density of the water as it gets warmer expands, which also raises sea level. Further, large-scale tectonics essentially what the land is doing, for example sinking, can also lead to sea-level rise.

Dr. Griggs stated that in the short-term, tsunamis can raise sea levels fifty feet or more over minutes in areas affected. Tides which go in and out every day also can change sea level in the short-term. Storm surges will do this as well and an El Niño can raise sea level for several months at a time. What the Select Committee is focused on is the long-term sea-level rise over millimeters per year. He conveyed that this seems minuscule, but the impact is much greater over the long-term. It is important to note that it is the short-term events which are going to be more problematic in the near future. As demonstrated by the three images on the following page, flooding from seawater is already a problem and this is without the expected projections of additional sea-level rise. Therefore, sea-level rise will only worsen and add to the problem.

Courtesy of Dr. Gary Griggs, Presentation to Select Committee



Dr. Griggs asserted that sea-level rise over the last several hundred years prior to about 1850 did not change a whole lot. When scientists started measuring with tide gauges, sea level rose at a rate of about 1.7 millimeters per year. He stated that in the last twenty or so years, scientists can now measure sea-level rise through satellites and it appears that the rate has nearly doubled. Sea-level rise will cause waves and run-up to reach higher elevations and extend farther inland. Shoreline flooding and coastal erosion will increase in magnitude and duration over the 21st century, increasing exposure of shoreline development to impacts of waves and high water. Dr. Griggs recommended looking at recent El Niños to know what to expect for the immediate future. He also shared sobering real world realities. Oakland International Airport begins to go underwater with 16 inches of sea-level rise. San Francisco International Airport begins to go underwater at 16 inches of sea-level rise at high tide. In closing, Dr. Griggs encouraged the Select Committee and the public to think about infrastructure of that sort to spur action on the issue as well as not forgetting the short-term events when looking at the total impact of sea-level rise to communities.

Dr. Patrick Barnard, Coastal Geologist, U.S. Geological Survey Pacific Coastal and Marine Center, Santa Cruz

Dr. Barnard continued the conversation by also discussing the complexity of the situation for California's coast in particular looking at the combined effects of sea-level rise and coastal storms.

Below are the kinds of effects that can be expected in coastal settings from projected climate trends such as increased sea-level rise:

- Accelerated beach erosion rates;
- Greater incidence of cliff failures;
- Landward translation of coastal flooding and inundation;
- More dangerous navigation conditions, particularly acute for our major harbors and ports in California;
- Beach/shore safety more often compromised; and
- Saltwater intrusion into coastal aquifers.

Below are photos of vulnerable coastal communities that are located right on the beach.



In addition, critical infrastructure along the coast that is “in the line of fire” include power plants and numerous wastewater treatment plants such as the Hyperion Wastewater Treatment Plant, Los Angeles’ oldest and largest wastewater treatment facility, shown below.



Furthermore sediment supply is another issue. Dr. Barnard expressed the importance and need for sand for beaches, since beaches act as a buffer as they are the first line of protection for coastal communities.

As mentioned previously, the problem is not just sea-level rise, but the combined effect of sea-level rise and extreme storm events. So instead of just a three meter bathtub based on sea-level rise and tide difference, an additional 5 meters or more resulting from an extreme storm would be added on top of a three meter rise. Dr. Barnard emphasized that this is what scientists have to model and understand because this will give a true sense of the vulnerability of the coast. Below are two images of Stinson Beach, one showing what the beach will look like with sea-level rise only and the other showing the combined effect. When the annual storm is added to the model, the flooding situation is much more severe and even shuts down the Highway 1 corridor.



Studies have shown that the frequency and intensity of events have increased off California's coast over the last half century or so and that the extreme waves are getting bigger and faster. Dr. Barnard urged that this is what especially needs to be worried about in terms of coastal impacts. He stated that today's 100-year coastal water level event in California is projected to

occur every one to five years by 2050, much more frequently, and will have the greatest impact on low-lying coastal areas such as Imperial Beach, Coronado, Mission Beach, Venice, Oxnard, and San Francisco Bay to name a few. Flooding events that are seen with king tides will also occur more frequently. Unfortunately, none of these projections incorporate shoreline change. As sea levels rise they tend to drive beaches further inland, which will increase communities' exposure.

In concluding, Dr. Barnard stated that sea-level rise compounds the problem. Process-based models need to take into account all aspects of future coastal water levels, especially due to extreme storms. He suggested that models should also include regional and local sea-level rise factors to reflect coastal vulnerability. Therefore, a statewide, systematic approach to assess the impact of climate change must include sea-level rise and storms.

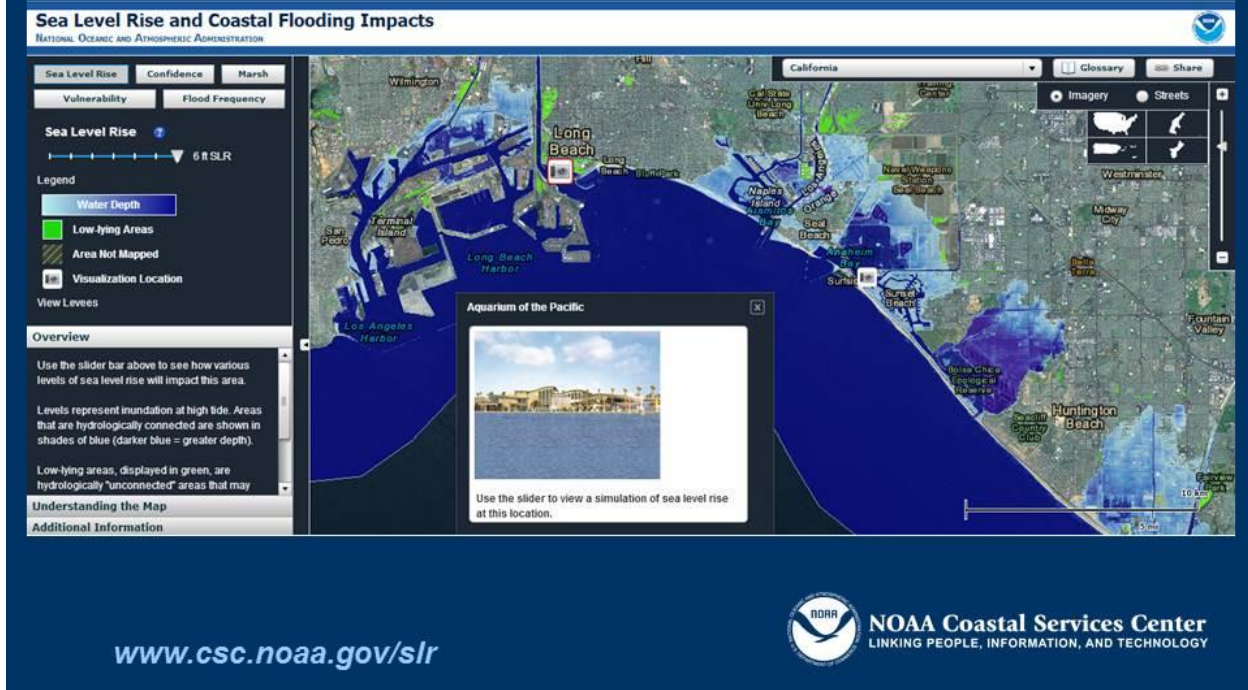
Becky Smyth, West Coast Director / Regional Division Chief, National Oceanic and Atmospheric Administration Coastal Services Center

Ms. Smyth's presentation took the next step and talked about how a decision maker in the state or local government gets information on sea-level rise in a useable format. She also spoke to what tools are available, what tools are still needed, and how the National Oceanic and Atmospheric Administration (NOAA) is starting to move forward on this.

Ms. Smyth stated that there are a lot of tools from the local, state, and national level that take all this information related to sea-level rise and start putting it into places that can help make decisions. She pointed out that these tools do not make decisions for policymakers or planners, instead they provide information in a way that decision makers can start assessing the tradeoffs and risks. Ms. Smyth explained that the different types of tools vary on what she called "The Simpsons" scale, from a tool that Homer Simpson would use which would be easy and simply visualizes the sea-level rise to more complex tools that Lisa Simpson would likely use.

One tool in Ventura that the Nature Conservancy is utilizing with many local, state, and federal partners is the Coastal Resilience tool, which looks at how natural systems can be used to help with adaptation as opposed to only relying on seawalls. Our Coast Our Future is a local Bay Area tool that is more sophisticated and looks at the full range of impacts and what that mean, in line with what Dr. Barnard was suggesting. In addition, the California Energy Commission funded research that is presented through Cal-Adapt which provides a sea-level rise threatened areas map in order to view areas along the coast that may be most at risk, providing a baseline look statewide.

Sea Level Rise and Coastal Flooding Impacts Viewer



Ms. Smyth also discussed NOAA's Sea Level Rise and Coastal Flooding Impacts Viewer (shown above). This is a screening tool that shows where the vulnerable areas are, with up to six feet of sea-level rise. Communities can utilize this tool to start looking at planning for three feet of sea-level rise for example and find out where their vulnerable areas are at this level of rise and then where more studies are needed. Included in this viewer is a visualization tool that can show the public how their region will be impacted by a specified amount of sea-level rise. There is also a social vulnerability screening tool.

She stated that California is fortunate in that people are already using this information to change the way that they are making decisions. For example, planning and permitting staff at San Francisco Bay Conservation and Development Commission (BCDC) used the Sea Level Rise Coastal Flooding Impacts Viewer and associated data for screening proposed projects. In addition, the Sea Level Rise and Coastal Flooding Impacts Viewer is included in grant criteria for project applications to the state's Local Coastal Program Sea-level Rise Grant Program.

Ms. Smyth concluded that NOAA has worked with an enormous number of state agencies and that California is a leader on this issue.

Dr. Peter Gleick, President, Pacific Institute

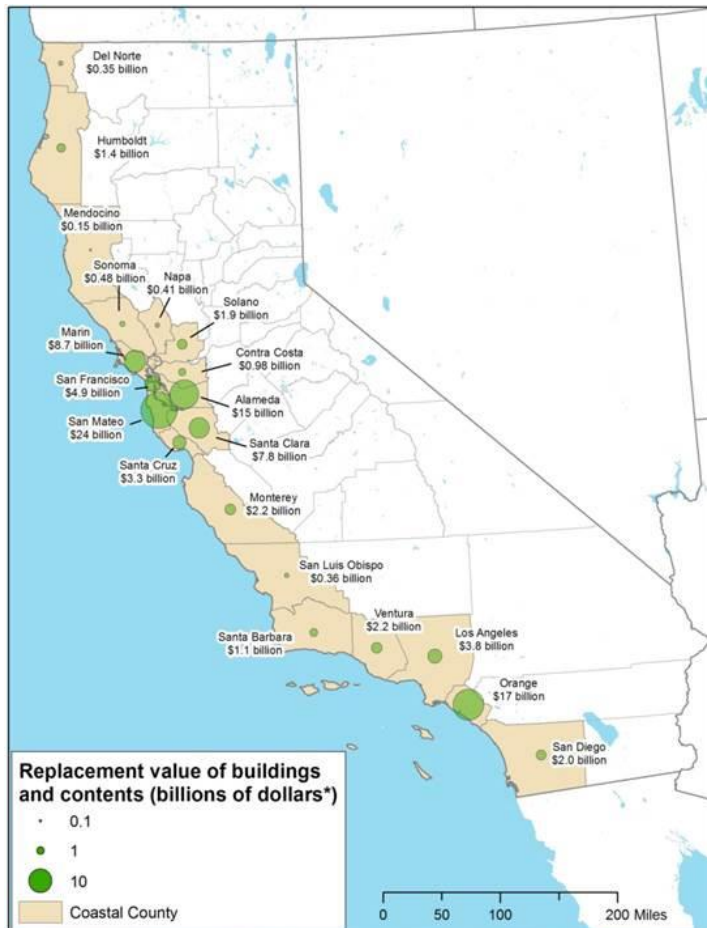
According to Dr. Gleick, climate change will inevitably change the character of the California coast at very high economic cost through increased flooding and erosion. As a result, large populations and infrastructure are at risk simply because of the way the state has developed. Dr. Gleick shared that the Pacific Institute, with support from the state, completed a detailed analysis of the current population, infrastructure, and property at risk from projected sea-level rise if no actions are taken to protect the coast. The Pacific Institute's report entitled *The Impacts of Sea-Level Rise on the California Coast* uses projections developed by the state from current best estimates, but does not reflect the worst-case sea-level rise that could occur. The report also evaluates the cost of building structural measures to protect high-valued locations, but Dr. Gleick pointed out that if development continues in threatened areas, all of these estimates will rise substantially.

Below are a few of the key findings from the report:

- sea level increases will put 480,000 people at risk of a 100-year flood event, given today's population (populations in San Mateo, Alameda, and Orange Counties are especially vulnerable);
- sections of the coast not vulnerable to flooding are often highly susceptible to erosion and the Pacific Institute estimated that a 1.4 meter sea-level rise will accelerate erosion, resulting in a loss of 41 square miles of California's coast by 2100;
- among those affected are large numbers of low-income people and communities of color;
- a wide range of critical infrastructure, such as roads, hospitals, schools, emergency facilities, wastewater treatment plants, power plants, and more will also be at increased risk of inundation in a 100-year flood event; and
- as a partial estimate of what is at risk, the study calculated that nearly \$100 billion (in year 2000 dollars) of property (measured as the current replacement value of buildings and contents) is at risk in the expanded flood zones as shown by the image on the next page.

Property at Risk

- \$100 billion dollars at *current* value and level of development.
- *Only* buildings and contents.



So, what can be done? Dr. Gleick provided the following recommendation to the Select Committee. He suggested that the state integrate climate change and sea-level rise into all coastal design and that new development needs to be limited in high risk areas. In addition, the remaining wetlands and nearby undeveloped areas need to be protected. Furthermore, there is a need to measure the social and environmental costs of adaptation strategies including environmental justice implications of the risks that are faced. Dr. Gleick also mentioned modernizing flood insurance maps and programs that need to be done at the federal level and the state level. Disaster planning is also key and has to take into account those who are the most vulnerable. Communities most vulnerable to harm have to be involved in decisions about future development such as preparation and adaptation strategies. Finally, Dr. Gleick asserted that adaptation planning needs to begin now in order to substantially reduce the risks that California faces. He concluded that if nothing is done, the infrastructure, buildings, and resources that are going to be at risk are going to have a larger impact and will be more expensive.

Preparing for the Effects of Global Warming: The American Public's Perspective on Sea Level Rise

Meg Caldwell, Executive Director, Center for Ocean Solutions, Stanford Woods Institute for the Environment

Climate change is a major priority for the state of California, and preparation for the unavoidable consequences of climate change is a priority for Governor Brown's administration. California state agencies, departments, commissions and councils have conducted numerous studies on the impacts of climate change and are poised to implement adaptation strategies and policies. Yet coastal managers throughout the state express concern about political will and public support for action, and note these to be barriers to successful implementation plans. However, a recent Stanford University poll suggests that the public strongly supports adaptation action and that these perceived barriers to progress may reflect a misunderstanding of the public's concerns. Ms. Caldwell presented the results of this survey which are the product of Stanford University's Center for Ocean Solutions and the Stanford Woods Institute for the Environment.

The following are the overarching findings of the poll:

- The California public believes that global warming will cause sea levels to rise (76%) and that global warming-induced sea-level rise will be a serious problem for the U.S. (79%).
- The California public overwhelmingly supports preparing now for the impacts of global warming (85%) rather than waiting (13%).
- The California public, more so than the general U.S. public, believes state government should take significant steps to lessen the consequences (59% of Californians vs. 53% of the national public) of sea-level rise.
- Californians are most supportive of adaptation strategies that include:
 - improving building standards for coastal development (62%),
 - limiting rebuilding of damaged structures (55%),
 - limiting new development in flood and inundation zones (53%), and
 - building sand dunes as a means of coastal protection (48%).
- The California public, more so than the U.S. public, believes that adaptation action will have a positive impact on the state's economy (52% vs. 38% for the U.S.) and jobs (60% vs. 42% for the U.S.).

Ms. Caldwell concluded that while previous work on climate adaptation has shown that there are many barriers that coastal practitioners face in successfully adapting to climate change (including lack of time, lack of capacity and money), one barrier frequently mentioned by coastal practitioners is lack of political will and public support. However, she pointed out that these results suggest that the American and Californian public firmly believes that climate

change is happening and it is causing sea levels to rise and storms to be worse and that these are bad. She further expressed that the public strongly supports preparing for these changes before damage is done and Californians believe preparation will help the California economy and jobs; they also support a leadership role for government in proactively addressing development in coastal hazard areas.

Impact of Sea Level Rise on California's Coastal Agriculture, Fishing and Aquaculture Industry, and Tourism
Wednesday, July 24, 2013
2:00 p.m. – 5:00 p.m., Half Moon Bay

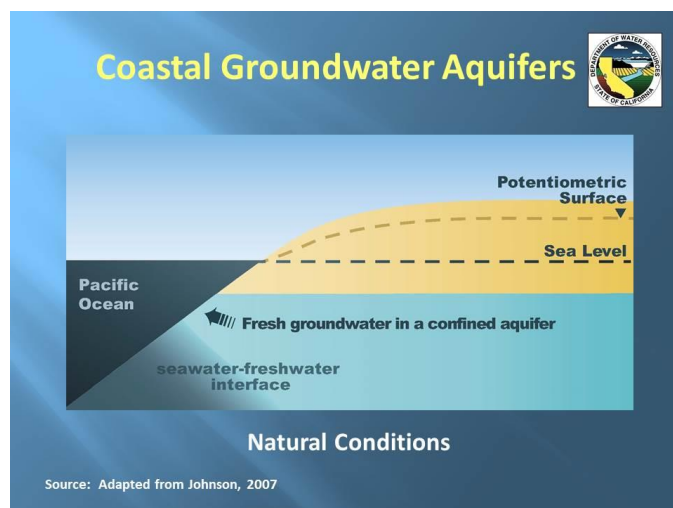
The second Select Committee hearing looked in-depth at three industries vital to California's economy that are affected by sea-level rise: coastal agriculture, fishing and aquaculture industry, and tourism. Representatives from each of these three industries discussed how they were being directly impacted.

Impact of Sea Level Rise on Coastal Agriculture

Mary Scruggs, Supervising Engineering Geologist, California Department of Water Resources

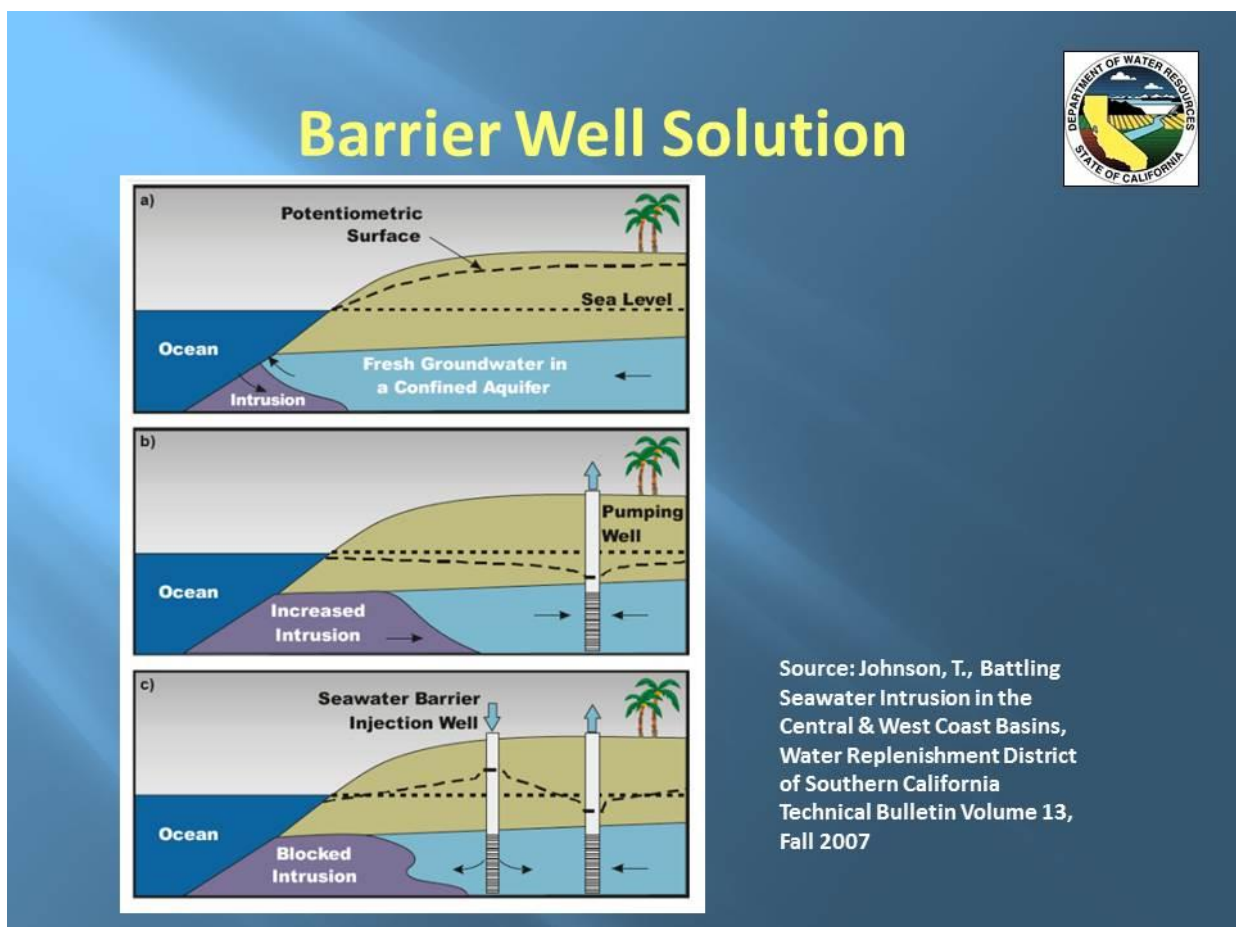
Ms. Scruggs provided an overview of groundwater and the issue of saltwater/seawater intrusion that sea-level rise exacerbates. Groundwater varies throughout the state and is managed at the local level in California. There are 515 alluvial basins and sub-basins in California. Groundwater provides 32 to 48 percent of the state's overall water supply based on numbers from 2005-2010. This is an enormous amount of the water use in the state.

Ms. Scruggs pointed out that seawater intrusion in California is not a new issue. Back in 1975, the Department of Water Resources published a bulletin, which identified areas that were impacted by seawater intrusion. She stated that seawater intrusion is the movement of ocean water into fresh groundwater, causing contamination of the groundwater by salt. It is a natural process that can be made worse by human activities and sea-level rise. Virtually all coastal aquifers around the world experience seawater intrusion to some degree due to the density differences between saltwater and freshwater. Saltwater is heavier and more dense so it is going to sink and freshwater is lighter so it is going to float more. The image below is of a confined aquifer and shows the mixing zone between the freshwater and seawater.



When a well is added and pumping occurs, seawater is pulled in towards the well. Therefore, seawater intrusion is induced by groundwater pumping. With sea-level rise in addition, there will be additional pressure which will exacerbate seawater intrusion due to the differences in density. Ms. Scruggs emphasized that whether there is groundwater pumping, sea-level rise, or both, seawater intrusion should be paid attention to because once the groundwater is contaminated with saltwater the aquifer is often lost. In coastal areas where groundwater is used for potable or agricultural purposes such as the Central and West Coast Basins in Los Angeles County, intrusion can be a serious problem resulting in the shutdown of wells or necessitating expensive desalination treatment.

So, what can be done to prevent saltwater from contaminating groundwater? There are several potential protective measures. Ms. Scruggs commented that it depends on the type of basin, the political dynamics of the area, the authority to take action, and the funding available. One option is reducing groundwater use through conservation and by limiting the groundwater pumping. Another option is developing new water supplies such as tertiary treated water for agricultural crops, expanding or rehabilitating of surface water reservoirs, and importing new surface water supplies. Also, on-site control can be implemented, such as refraining from pumping the well, moving the well further into the basin, or adding an injection well (shown below) to inject freshwater back into the ground to act as a barrier and block the intrusion.



In order to prevent and utilize the protective measures, Ms. Scruggs stated that monitoring is critical. A program initiated by the Legislature in 2009, is the California Statewide Groundwater Elevation Monitoring (CASGEM). It is a program that Department of Water Resources is responsible for and provides groundwater elevations and monitoring throughout the state.

Groundwater has ongoing challenges, especially funding, since programs are often not funded at the state or local level. Fortunately, CASGEM's funding was reauthorized in the 2014-2015 budget in order to continue the implementation of the program. This is definitely a start, but additional funding is still needed. Ms. Scruggs conveyed that authority is also a huge issue. Who has the authority to do it? There are overlapping jurisdictions. As a result, groundwater management varies from very well managed to not managed at all. The importance of the groundwater varies throughout the state too, so this is why lack of publicly available data continues to be a challenge. Fundamental data is needed such as assessments and monitoring because by the time a problem occurs such as saltwater having entered the groundwater, the aquifer is lost and it is too late. Proactive steps need to be taken. In addition, the increasing demand on groundwater is another challenge. Ms. Scruggs pointed out that as dry years continue, reliance on groundwater increases. Saltwater intrusion and how sea-level rise will exacerbate the problem and impact the water quality is a critical issue that the state is facing. In her closing, Ms. Scruggs emphasized that cooperation and integration is needed to meet these challenges moving forward.

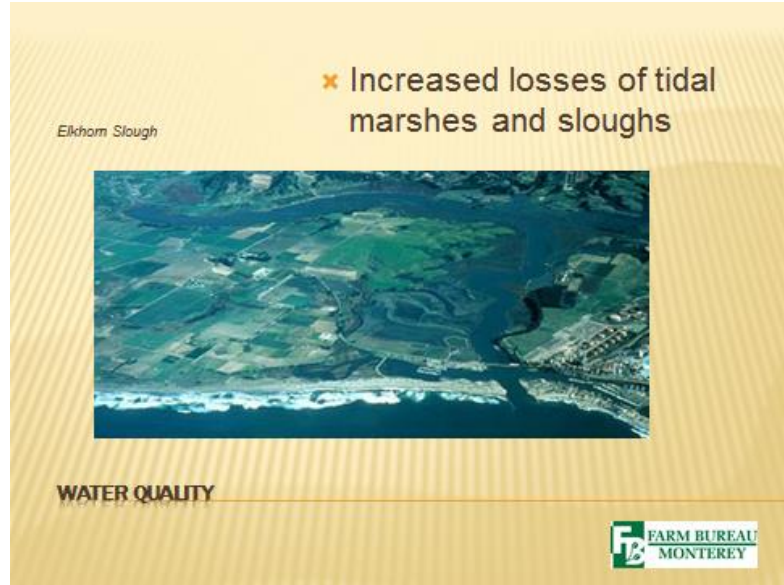
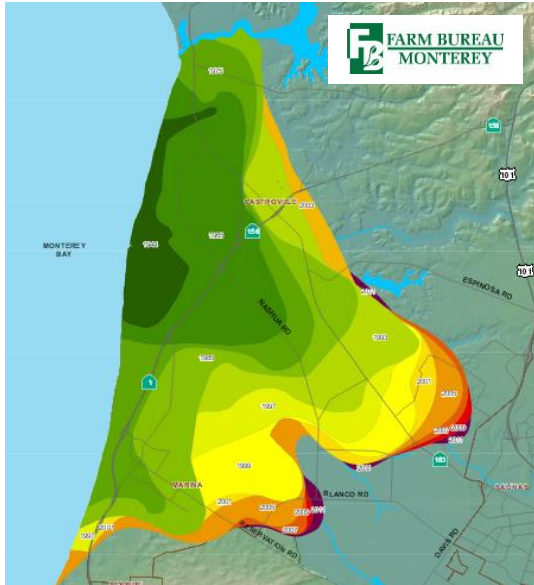
Norm Groot, Executive Director, Monterey County Farm Bureau

Mr. Groot began his presentation by referencing a 2011 survey that stated that the economic value of all agricultural production in Monterey County is \$8.2 billion. He also shared that the agricultural industry, which supports one of every three jobs in Monterey County, is over three times greater than the tourism industry in the County. Over 45,000 people in the county are employed in direct agricultural production and the agricultural sector in the county is the 4th largest in state and larger than 20 other states.

Monterey County has an estimated 22,000 acres of irrigated agriculture where much of the land is at current sea level elevations and are protected by sand dunes. Salt levels are already building in soils due to ocean proximity. As a result, Mr. Groot asserted that saltwater intrusion is one of the biggest issues right now. In Monterey County, saltwater intrusion was first determined in the 1940s due to over pumping of the Salinas River Groundwater Basin. Because of the intrusion, the grower community built and paid for numerous projects that are designed to halt and eventually reverse saltwater intrusion. About \$330 million was invested to date in net present value to actively try to solve the issue.

The image on the left side of the next page shows a saltwater intrusion map from a 2011 survey by the Monterey County Water Resource Agency. The image illustrates the extent of saltwater intrusion at its farthest point, almost 10 miles inland, encroaching on city of Salinas.

Colors reflect periods of time of saltwater intrusion and in recent years the colors have gotten a lot smaller. Saltwater intrusion is slowing due to the projects that have been built to stop the intrusion and the growers hope to continue to see positive results.



Mr. Groot also pointed out that sea-level rise also affects increased losses of tidal marshes and sloughs. The image above on the right side of the page shows a slough adjacent to farmland which is vulnerable to flooding as sea levels rise.

Mr. Groot stressed that reductions in viable land within the coastal zone will curtail agricultural production of products such as artichokes, leafy greens and strawberries in Monterey County. In addition, the development of the Monterey County wine corridor will be impacted due to increased salinity in the soils and wells, as the land could become barren. Forced conversion to other uses will impact coastal zone areas with valuable farmland which will be lost when sand dune barriers collapse. In addition, costs to protect levees and coastal estuaries may be more than locals can afford. Further, water quality will change in the Delta region as sea levels change and fresh water can become more brackish and scarce. Mr. Groot is concerned that this will affect California's economy and environment. Locally in Monterey County, municipal water supplies that depend on local groundwater basins are also starting to see impacts and will incur additional costs for treating higher salinity levels.

In conclusion, Mr. Groot stated that saltwater intrusion into aquifers is slowing, but the pressures are going to mount as sea levels rise and lead to more groundwater contamination and soil salinity. The future of agriculture is at stake and deeply impacted by this issue.

Dr. Rosemary Knight, Professor of Geophysics, Stanford University

Saltwater intrusion poses a high level of risk to agricultural communities along the California coast, where there is a dependence on coastal aquifers for irrigation. Saltwater intrusion is driven by withdrawal of groundwater from aquifers, and by rising sea level. Dr. Knight revealed that while saltwater intrusion can occur gradually over decades, there is a critical point beyond which the dramatic change in salinity can be irreversible, resulting in the loss of a supply of freshwater. Thus, she asserted that there is a compelling need to map and monitor the freshwater/saltwater interface in coastal areas so that appropriate water management strategies can be put in place.

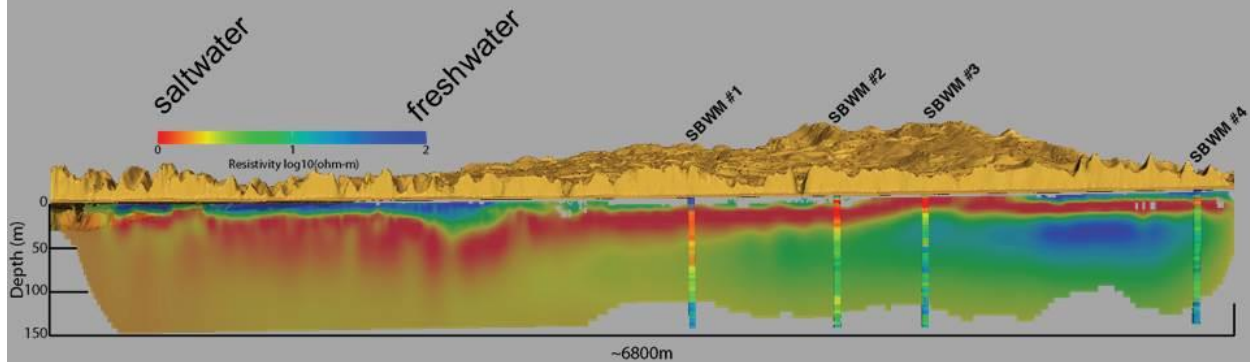
This is why the Center for Groundwater Evaluation and Management at Stanford University is using geophysics to image saltwater intrusion along the California coast. New and emerging technologies in this instance are being used as tools for groundwater management practices such as monitoring. The project that Dr. Knight undertook proposed the use of “sentinel geophysics” as a new approach to mapping and monitoring the freshwater/saltwater interface. Geophysical methods, which employ sensors on the ground surface (as shown below), can image the freshwater/saltwater interface hundreds of meters below the ground and so could be used as a long-term measurement system to understand and monitor saltwater intrusion.

Courtesy of Dr. Rosemary Knight, Presentation to Select Committee



Over the past two years Dr. Knight acquired a high-resolution large-scale geophysical image of saltwater intrusion along a seven kilometer segment of beach between Seaside, CA and Marina, CA. The data provided a 2D image (seen on the following page) of the electrical resistivity to a depth of approximately 150 meters. What is clearly seen in the image are regions of saltwater (warm colors, reds) and freshwater (cool colors, blue).

Electrical Resistivity Image



Shows the distribution of saltwater and freshwater to a depth of ~150 m.

Excellent agreement with measurements at the wells.

Reveals complex spatial distribution of saltwater.

Provides insights into dynamics of freshwater/saltwater interface.

Courtesy of Dr. Rosemary Knight, Presentation to Select Committee

The next steps for Dr. Knight are acquiring data for 40 kilometers along the coast of Monterey Bay in order to see to a depth of 300 meters. She would like to do similar measurements, but this time, fly a helicopter along the California coast using airborne electromagnetic survey to get similar images.

Dr. Knight asserted that the threat of saltwater intrusion requires a proactive, data-driven approach. At the small scale and large scale, data is needed to provide an improved understanding of the extent of, and controls on saltwater intrusion. A large-scale, big picture perspective is critically important as groundwater and seawater do not stop at jurisdictional boundaries. Long-term monitoring allows for adaptive groundwater management. Dr. Knight concluded that geophysical methods offer fantastic tools that can provide a cost effective means of undertaking this form of data-driven, science-based groundwater management.

Impact of Sea Level Rise on Fishing and Aquaculture Industry and the Effects of Ocean Acidification

Dr. Gretchen Hofmann, Professor of Marine Biology, University of California Santa Barbara

Dr. Hofmann stated that ocean acidification related to climate change is an economic and emerging issue for California. Ocean acidification is a carbon dioxide problem. 30 to 50 percent of atmospheric CO₂ is absorbed by the world's oceans. When greenhouse gases dissolve, it changes the pH of the ocean and makes the ocean more acidic. In fact since pre-industrial revolution global ocean pH has declined (become more acidic) by 0.1 pH, which can mean life or death for some of the ocean's organisms. As Dr. Hofmann reminded, big things can happen with just a small change in the number. Organisms that make calcium carbonate hard parts (shells and skeletons) are affected by the change in the ocean's chemistry, which decreases carbonate ions which are the building blocks for organisms' shells. With fewer building blocks, the harder it is to make a shell. Calcifying organisms such as the ones shown below are threatened by ocean acidification. Oysters and sea urchins have a large economic importance. Calcifying algae, an important part of the ecosystem, and coccolithophores, which make oxygen, are both affected.

Courtesy of Dr. Gretchen Hofmann, Presentation to Select Committee

Challenges to calcifying organisms

Those that make calcium carbonate hard parts



Oysters



Sea urchins



Calcifying algae



Uni

Dr. Hofmann asserted that the state stands to lose coastal ecosystems, cultural identity as Californians, food sources (aquaculture), and recreation in the form of fishing and clamming. In order to avoid emergency room science and address this issue, decision-making and science need to be combined. Three strategies that Dr. Hofmann suggested that can be done now are: (1) learn about the natural variability of pH in important coastal marine ecosystems through sensors in the water measuring pH along the California coast; (2) assess adaptive capacity of key organisms such oysters, sea urchin, or rock fish and look for genetic variation and their physiological resilience and tolerance; and (3) most importantly work collaboratively as a scientific community to address these challenges.

Zeke Grader, Executive Director, Pacific Coast Federation of Fishermen's Associations

The Pacific Coast Federation of Fisherman Association represents commercial fisherman along the coast, mostly owner operators, family fisherman, and small boat fisherman. Mr. Grader stated that commercial fishing is expected to be one of the industries to be affected first by climate change as well as being one of those to suffer the most severe impacts. Those anticipated impacts include: (1) ocean acidification and its effect on both shellfish and finfish populations, (2) a rise in sea temperature and changing currents affecting fishing patterns and fish migration, (3) more severe weather conditions affecting safety and days-at-sea fishing (expected to reduce annual productivity of fishing men and women), and (4) sea-level rise affecting the infrastructure that supports the commercial fishing fleet. Mr. Grader conveyed that fishermen are already witnessing far more extreme weather conditions in the Bering Sea and ocean acidification threatens the shellfish fishery of the Pacific Northwest.

Sea-level rise is expected to cause many facilities serving commercial fisheries – from ports, harbors, jetties and breakwaters, marinas, and a panoply of service facilities from fish processing plants, to boatyards, to ice and fuel docks (as well as the roads and access ways to them) to be more vulnerable to wave and surge conditions, if not completely inundated. Although California has taken some steps to begin to curb carbon emissions aimed at the causes of climate change, the state still must prepare to adapt for the inevitable change as a result of past and current carbon emissions into the atmosphere. For commercial fisheries this means identifying structures and facilities within the coastal zone most at risk from sea-level rise and begin preparations for their renovation or replacement to meet the anticipated rise in sea level.

For the physical impacts of sea-level rise, Mr. Grader recommended a three-pronged approach. First, complete a comprehensive assessment and inventory of current ports and what is likely going to be changed by sea-level rise projections and whether changes will be made for 50 years out and 100 years out. The second approach involves requiring planning to build, rebuild, strengthen, or replace structures and facilities within these ports so that planners are mindful and must consider what the sea level is going to be in the future in the next 25, 50 or 100 years. Finally, funding becomes a key question. Mr. Grader acknowledged that this is going to be expensive, so sources of funding will need to be identified to assist local governments and private businesses to adapt. He asserted that this is where the Legislature could play a big role. One possibility that Mr. Grader suggested is establishing something similar to what the Department of Boating and Waterways has which is a low-interest revolving loan program that could provide the funding that is needed to try and make it less of an economic hardship for those (local governments and private businesses) that are going to be affected. In his closing, Mr. Grader articulated that California needs to look at investing in how we adapt to climate change emphasizing the need for the continuation of scientific research and the development of technology.

Greg Dale, Southwest Operations Manager, Coast Seafoods Company

As a shellfish farmer in Humboldt Bay, Mr. Dale has been following sea-level rise and ocean acidification for some time. He admitted that it is frightening to think about. Mr. Dale sees the issue of sea-level rise as a planning exercise since sea-level rise is happening and will only worsen. In Humboldt Bay, Mr. Dale shared that they have 10 inches of geologic activity that adds to and would exacerbate sea-level rise. In addition, issues like subsidence and storm events such as king tides need to be considered when thinking about sea-level rise and what the impacts will be.

Failing infrastructure will also result from sea-level rise. In fact, Mr. Dale pointed to an instance during king tides where the sewer lines floated. If they are not a high pressure sewer line or they are not full of water, then they end up floating out of the ground. When this happened, Humboldt Bay was closed which also closed the area where shellfish are harvested. In addition, most wastewater treatment plants are at the bottom of the hill and not elevated so they are going to see these impacts of sea-level rise. Jetties and harbors and other structures are extremely expensive to engineer and develop. Mr. Dale shared that the jetty in Humboldt Bay is frequently overtopped by large storms, waves, and king tides. In addition, the local transportation infrastructure such as road systems and rail is affected by king tides more frequently as well. Mr. Dale stated that this presents many questions such as: should cities be protected by levees and pumping; should the area be built up; should infrastructure and cities be moved; and how much is this going to cost? This is why communities need to plan for future impacts.

Courtesy of Greg Dale, Presentation to Select Committee

Planning for rebuilding structures

Transportation

Jetties/Harbors

Will we build up?
Protect with Levees
and Pumping?
Move?
Economy?
Costs?
How much
is too much?

Docks/city buildings/streets

Mr. Dale conveyed that oyster farmers have similar concerns about water quality, infrastructure, near shore ecology and see the need for planning ahead. Humboldt County and the Harbor District are trying to address the levee system around Humboldt Bay. Many private levees being maintained by private landowners are getting very expensive to maintain. If there is one person that does not maintain the levee or barrier or protection, then any action taken to provide protection is a moot point. Another problem is that since the infrastructure is not in enough disrepair, it is difficult getting funds to fix these problems. The issues that the shellfish industry faces are not just infrastructure. A lot of their coastal dependent industrial sites have legacy contaminants on them. Those legacy contaminants today are not necessarily an issue because many of them have been identified and they are not mobilized or moving. However, as the water rises, a lot of those legacy contaminants are going to be mobilized and move into estuaries and near shore environments, which will affect the ecological processes and impact species living in these environments.

Bruce Steele, Commercial Fisherman

Sea-level rise is tied to ocean heating. Mr. Steele stated that most of sea-level rise so far is due to the expansion of seawater as it heats up plus some supply from glacier melting. However Mr. Steele also pointed out that moving into the future, sea-level rise is going to be dependent on the melting of the ice caps in Antarctica and Greenland.

Mr. Steele revealed that a projection of a five degree increase in average temperature by 2090 would make oceans in southern California similar to Hawaii today, approximately 80 degrees Fahrenheit. Heat spikes in ocean temperature, like during the 1997-1998 El Niño, would raise temperatures to greater than 80 degrees which would lead to mortality for some species such as purple sea urchins, which would greatly impact commercial fisherman.

As has been previously mentioned, it is the confluence of events – major storms, king tides, and sea-level rise – that will do most damage to California’s coastal harbors and communities including infrastructure that supports the fishing industry.

So, what can be done? Mr. Steele urged that the state needs to protect our estuary systems which are essential to fisheries. Bolsa Chica Ecological Reserve is a good example of a wetland that has been restored. He also recommended that planning for the future needs to begin now in addition to investing in science. Mr. Steele concluded that collaboration is essential. In fact, industry is working with scientists. A great example is the oyster industry working with scientists to deal with the issue of ocean acidification. More of this is needed in moving forward with issues related to climate change.

Impact of Sea Level Rise on Tourism

Jay Chamberlin, Chief of Natural Resources Division, California State Parks

114 State Parks out of 280 are located on California's coast, totaling about 340 linear miles of the coastline. Mr. Chamberlin stated that State Parks has a tremendous interest in the future and the impacts of sea-level rise. These 114 coastal park units include portions of State Parks, portions of State Wilderness areas, portions of State Reserves and of course State Beaches. The topic of tourism comes up. These units generate a tremendous amount of economic benefit for Californians. State Beaches alone generate more than 3 billion dollars of revenue to the state each year. More broadly looking at tourism especially in southern California, Mr. Chamberlin pointed out that the tourism industry is something of a 14 plus billion dollar industry annually. State Parks knows that about 41 million visitors go to state beaches alone each year.

State Parks is not simply in the recreation delivery business, but also in the education business. Mr. Chamberlin suggested that this is a tremendous opportunity to communicate with the people of California about the importance of sea-level rise. Another element of State Parks' mission is protecting the resources of the state. Some may not realize, but California holds some of the gems even of coastal ecosystems of the resources of the state. About a third of the remaining dune systems of the state are protected in the State Parks system alone along the coast. Those systems are especially important for protecting rare and endangered plants. But they are also really important for providing buffering for our communities. Dune systems are extremely significant in that regard. State Parks also have over 100 estuaries, which are important to fisheries of California as well as habitat for rare and endangered species. Additionally, the sandy beaches of the state, are significant from a rare endangered species point of view.

So what might the future hold for some of California's state parks systems? Using simplistic models and overlaying elevations of sea-level rise on top of current elevations shows a sobering view of the possible future of some of California's state parks. Many of the state beaches can be inundated and will be inundated under the projected scenarios of 2100. These simplistic models are much more useful as conversation starters and as potential examples of what could be. State Parks is using images like the one of Carmel River State Beach on the next page to put before their managers and help them understand that sea-level rise is coming. State Parks is attempting to help their field managers understand what the potential implications can be going forward.



California State Parks



Carmel SB

+ 55 inches SLR & 100-year storm event

Sea-level rise is one set of scenarios and of course there are also king tides and extreme events which are very much on the mind of State Parks and probably more so in the near term because of the impacts they have already felt. State Parks have significant infrastructure already impacted by sea-level rise or related phenomena at places like the Malibu Pier and MacKerricher State Park. Mr. Chamberlin recommended that the state needs to look broadly at all of the tools in their proverbial toolbox as planners and managers of coastal resources. State Parks has many previous investments that they have already made such as protecting dune systems. Mr. Chamberlin stated that State Parks is still asking themselves what can they do today to make those systems more resilient to climate change impacts.

In his conclusion, Mr. Chamberlin asserted that when looking forward into the future, State Parks is looking to building a robust set of approaches to protect those investments that they have already made and capitalize on their investments going forward.

Aaron McGregor, Associate Scientist, California Ocean Science Trust

Mr. McGregor discussed sea-level rise's impact on tourism and recreation which drive the beach economy in California. It is evident that sea-level rise will effect beach visitation and supporting spending and economic wellbeing. Mr. McGregor asserted that there will likely be some winners and losers at least in the economic category. Additionally, he acknowledged that sea-level rise impacts on the beach economy is one aspect of climate change and climate change is one of many things that coastal communities must consider when they plan for the future. He stated that how coastal communities consider how to manage their beach resources will likely reflect their local values as well as tradeoffs that result in other systems of the coast being altered.

Annually millions of visitors visit the beach and in the process spend money on items such as gas, food, lodging, and incidentals. It is estimated that of California residents only, there are about 15 million users and 150 plus million visits to beaches annually. This results in billions of dollars annually that flow into city, county, state, and federal economies. In addition, many local visitors to California beaches have the opportunity to enjoy the day at the beach for little or no cost. But, they still receive extensive economic benefit from their presence. This benefit is real and most often realized when beaches experience a change in quality or are permanently or temporary closed for an event like an oil spill. This demonstrates why beaches like the one shown below are important for the California economy.

Courtesy of Aaron McGregor, Presentation to Select Committee



The nexus Mr. McGregor wanted to establish between the physical and economic engines of the coast is that sea-level rise will change the character of our beaches. There are two dynamics that need to be discussed. The first is that gradually over time sea-level rise will result in beach inundation and secondly, storm events on top of rising seas will result in altered erosion patterns along the coast. As the profiles of our beaches change, this will result in

changes in beach width that will in turn affect the demand for beach going. As this demand changes so will the spending.

These fundamentals were best captured in a study² that was conducted for the state. The main goal of the study was to examine the effects of changing beach widths to sites in Los Angeles and Orange County. The key economic theory behind the study is that people will choose whether or not to go to the beach and what beach to visit depending on the option that provides them the greatest utility or value.

The study concluded that size (beach width) does matter and generally speaking narrower beaches in California have the most to lose with respect to their local economies. But, size is not all that matters. The study also demonstrated that beach width can have diminishing and even negative returns in certain contexts. People go to the beach not only because of the width, but depending on the activities they prefer. They also place a high value on other types of amenities such as water quality, the availability of lifeguards, parking, and a number of other different activities. So, the losses of beach width can be mitigated if beaches choose to strategically know their users and make investments in these other amenities that matter. The study focused on Los Angeles and Orange County beaches. There are dozens of beaches in these counties all with a high level of amenities. But when looking at other parts of the coast, such as central and northern California that have beaches that are fewer and farther apart, the impacts are likely to be much greater as there will be fewer substitutes and options for beach visitors.

Mr. McGregor concluded that the effects of climate change and sea-level rise in particular are uneven. As he mentioned, there will be winners and losers. However, sea-level rise is just one climate change impact. To get the true economic cost of adaptation decisions, Mr. McGregor suggested that other impacts need to be considered as well.

² Source: Pendleton et al. *Estimating the potential economic impacts of climate change on Southern California beaches*. November 2011.

http://geomorph.geology.ufl.edu/adamsp/Outgoing/Pubs/Pendleton_EtAl_2011_ClimChng.pdf

Impact of Sea Level Rise on California's Infrastructure

Friday, October 25, 2013

1:00 p.m. – 5:00 p.m., Long Beach

The Select Committee's third hearing focused on the impacts of sea-level rise to California's infrastructure, such as its effect on ports, airports, roads, bridges, as well as water and power infrastructure. Again, the Select Committee brought representatives from each of these affected industries to speak to the issues they are facing first-hand. This hearing was also a joint hearing with the Select Committee on Ports.

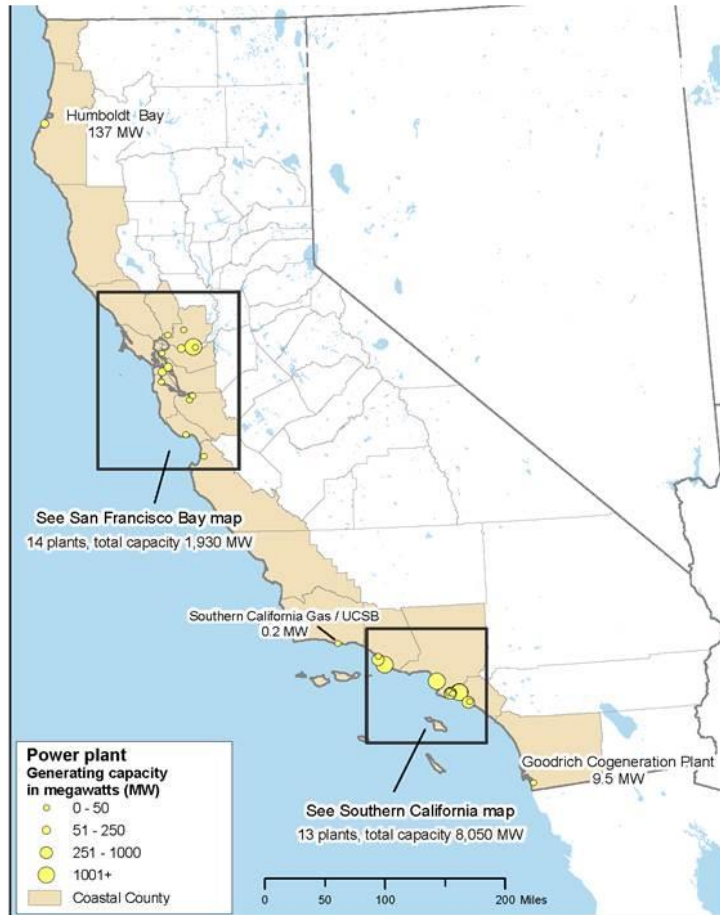
Sea Level Rise and California's Infrastructure

Heather Cooley, Water Program Co-Director, Pacific Institute

In 2008, the Pacific Institute conducted a statewide assessment of sea-level rise and its impacts on population, infrastructure, and on property. Ms. Cooley focused on some of the results of that analysis namely dealing with California's infrastructure.

Soberingly, Ms. Cooley pointed out that even if greenhouse gas emissions were cut to zero today, sea levels will continue to rise for centuries due to a time lag effect. Thus a continued amount of sea-level rise is unavoidable. As a result, Ms. Cooley advised that climate response must be based on managing the unavoidable and avoiding the unmanageable. California can expect a range of impacts both in the natural and human environment as a result of sea-level rise. Specifically, Ms. Cooley shared that California can expect increased flooding, increased coastal erosion, altered sediment supply and movement, and saltwater intrusion in coastal aquifers and into estuaries.

The Pacific Institute's sea-level rise assessment focused on coastal flooding and erosion. The Pacific Institute used a sea-level rise projection of 55 inches because that was the estimate for California at the time. The Pacific Institute in their assessment evaluated the people, property, and infrastructure and ecosystems that would be a risk.



- 30 coastal power plants
- Generating capacity of 10,000 MW



A map above shows coastal power plants that will be vulnerable to sea-level rise of 55 inches. They are located on the coast because that is where the demand is, but also because many of these power plants are using or were using seawater for cooling. However, because of their location on the coast, they are vulnerable to sea-level rise. There are 30 power plants located along the coast and the combined generating capacity of these power plants that are at risk is approximately 10,000 megawatts hours. This demonstrates that sea-level rise would have a huge impact on the state's energy infrastructure.





- 28 wastewater treatment plants
- Combined capacity of 530 million gallons per day



In addition to power plants, the map above shows wastewater treatment plants along the coast that are also at risk. Wastewater treatment plants are often situated at the lowest part of a service area or a water utility in order to take advantage of gravity to get waste to the treatment plant and then discharge it. However, again because of their location, they are vulnerable to sea-level rise. The Pacific Institute identified 28 wastewater treatment plants along the California coast. These have a combined capacity of around 530 million gallons per day. 21 of them are clustered within the San Francisco Bay alone. Possible impacts to these facilities would be flooding of the facilities, submerging outfall potentially causing backflow or overflow, increased pumping costs, and seawater intrusion in the treatment works.

In addition, our airports are vulnerable and in particular San Francisco International Airport which is located right next to the San Francisco Bay. This is a similar story with the Oakland International Airport (shown on the next page), another very low-lying airport.

Oakland International Airport

 Sixteen Inch Sea Level Rise
and
 Fifty-five Inch Sea Level Rise



There is a range of other infrastructure at risk. The Pacific Institute identified 3,500 miles of roadways at risk of flooding. About 280 miles of railroads, 140 schools, 34 police and fire stations, 55 healthcare facilities, parks, ports, bridge access and all types of California infrastructure are vulnerable to sea-level rise. Therefore, Ms. Cooley urged that planning must begin now to ensure that these facilities are able to continue operating in the future.

Ms. Cooley concluded that the state needs to continue to improve the science on risks and enhance our understanding. In addition, she advised that we need to be focusing on mitigation to reduce the severity of the problem, hence avoiding the unmanageable. Further, enhancing state and local capacity to manage unavoidable impacts is necessary. She mentioned that shining a light about what is going on and what more needs to be done in regards to sea-level rise is critical. Finally, she recommended that building public understanding was needed because California still has a long way to go in terms of increasing awareness around these issues.

Impact of Sea Level Rise on California's Ports

Richard Cameron, Acting Managing Director of Environmental Affairs & Planning, Port of Long Beach



The Port of Long Beach over the last 10 to 15 years has changed its culture in terms of initially being reactive to now being more proactive and having a vision for the future. Mr. Cameron declared that the port, knowing that sea-level rise and climate change is going to be a challenge, started to move forward and embark on a planning effort to address these challenges.

It has been the case that the port's planning horizon has been 20-40 years. However, talking about the impacts of sea-level rise and climate change, the planning horizon becomes much longer for example 80 to 100 years. Therefore, the port realizes that even in their current development plans, they needed to consider those factors of sea-level rise in the design. Currently, the port is incorporating sea-level rise in their designs of a major redevelopment of a marine terminal because the port does not want the situation of having to rebuild their wharfs in 15 years to adapt to an impact of significant sea-level rise. The Port of Long Beach is a

great example of an entity that has started well in advance in starting to address sea-level rise in their development.

Specifically, the Port of Long Beach is embarking on creating a Climate Change Adaptation and Coastal Resiliency Strategic Plan, which will be a three-year process. The port through their Climate Change Adaptation and Coastal Resiliency Strategic Plan will be going through asset inventories, looking at the effects of sea-level rise, and assessing the Long Beach breakwater. Next, the port will be examining what areas of the port are most vulnerable and how do they assess those in terms of priorities. Some of the actions that may come out of this plan are going to be focused on changing and adapting what the port needs to do in terms of standards. The following are the objectives of the port's Climate Change Adaptation and Coastal Resiliency Strategic Plan:

- 1) Incorporate port policy-making, planning, infrastructure design, construction, maintenance, and operational activities;
- 2) Assess climate change risks;
- 3) Ensure resilience and business continuity of port operations and its transportation system;
- 4) Develop strategy to protect the built environment within the Harbor District;
- 5) Promote outreach and education; and
- 6) Provide methodology for climate change adaptation and coastal resiliency planning to other seaports

Mr. Cameron concluded that a plan or strategy should not be so much about evading sea-level rise, but being prepared for it and being resilient. Their goal is to keep the port and its customers up and running as the Port of Long Beach is a vital economic driver of the state as well as the nation.

Antonio Gioiello, Chief Harbor Engineer, Port of Los Angeles

Mr. Gioiello spoke about the port's experience in looking at the issue of sea-level rise and specifically discussed the port's collaboration with the RAND Corporation. In 2012, RAND prepared a white paper entitled *Characterizing Uncertain Sea Level Rise Projections to Support Investment Decisions*. The paper examined how to characterize deeply uncertain climate change projections to support such decision by examining a question facing the Port of Los Angeles: how to address the potential for presumably low probability but large impact levels of extreme sea-level rise in its investment plans. This study used a robust decision making analysis to address two questions: (1) under what future conditions would a Port of Los Angeles decision to harden its facilities against extreme sea-level rise at the next upgrade pass a cost-benefit test, and (2) does current science and other available information suggest such conditions are sufficiently likely to justify such an investment?

The goals of this collaboration through the white paper were to help the port develop an initial analysis of potential vulnerabilities and response to future sea-level rise; demonstrate applicability of robust decision methods to infrastructure planning under uncertainty; and evaluate effectiveness of these new methods compared to other approaches.

Below are the potential threats to the Port of Los Angeles due to climate change.



Many Expected Changes Pose Risks for the Port of Los Angeles

Climate Change Manifestations	Threats for the Port of Los Angeles
Sea level rise with added storm surge	Chronic flooding or inundation of connecting highway, rail Chronic flooding of open storage areas Reduced bridge clearance Liquefaction of substrate soils Dispersion of buried contaminants
More frequent, more intense, and longer lasting storms (greater precipitation, surge, waves, and wind)	Ship/wharf collisions Containers and other cargo from open storage physically dislodged Wharf or pier structures damaged Terminal buildings damaged or destroyed Specialized terminal equipment damaged or destroyed Pavement and foundations damaged or undermined Flooding of connecting highway, rail Stormwater system capacity overwhelmed Increased storm-related Port closures Increased underwater debris buildup, blockages or loss of markers hindering channel navigation Increased dredging requirements
More intense river runoff and flooding	Increased dredging requirements Increased flooding of adjacent low-lying areas
Potential opening of Arctic shipping routes	Changed shipping patterns leading to loss of business for Port

An important disclaimer and caveat that Mr. Gioiello discussed at the hearing is that even with sea-level rise projections there is still many unknowns and are likely to change as new evidence becomes available. In summary, the robust decision making approach used in the study could prove useful for many decisions related to sea-level rise and would be a model to help the port make decisions. The main thing that the port will be doing in the next several years is come up with a monitoring program. The port looked at the projections, but they do not know what the accelerations of the sea-level rise will be. The approach that the port will be taking for the next several years is to keep monitoring and building towards design guidelines to include some mitigations for the future.

Richard Sinkoff, Director of Environmental Programs & Planning, Port of Oakland

Richard Sinkoff, Director of Environmental Programs and Planning at the Port of Oakland, discussed raising awareness of sea-level rise and assessing the scale of the threat of sea-level rise to California seaports. In addition, Mr. Sinkoff presented the specific impacts to the Port of Oakland as well as the port's response to these challenges.

Below is an image of the Port of Oakland and some facts about the port that demonstrate its economic impact to not only the state, but also the nation.

Port of Oakland 101





The map illustrates the Port of Oakland's operations across four main divisions: Aviation (blue), Commercial Real Estate (orange), Maritime (purple), and Parks and Open Space (green). Key locations include Oakland, Alameda, San Leandro, and San Francisco Bay. Landmarks such as the Oakland International Airport, Oakland Army Base, and various parks are marked. A legend at the bottom identifies the color-coded areas.

- 5th highest volume container port in U.S.
- 3rd busiest container port on U.S. West Coast
- Also owns and operates Oakland International Airport
- 12th busiest cargo airport in the U.S.
- 33rd busiest passenger airport in the U.S.
- 20 miles of waterfront (maritime, aviation and real estate), utilities, public parks and habitat

A study³ was done at Stanford University that looked broadly at whether seaport and aviation managers are prepared for sea-level rise and essentially there were two major findings. One is that many are concerned, but under-informed and another is that the planning horizon for port infrastructure is often not in line with climate change trajectory. In other words, sea-level rise may happen quicker than the life cycle of port facilities.

³ Source: Becker, Austin; "Port Perceptions of Sea Level Rise – An Overview" (World Ocean Council, Sustainable Ocean Summit 2013)

Mr. Sinkoff further discussed that specifically the port's wharves, marine terminals, and railyards are vulnerable to flooding due to sea-level rise. In addition, state tidelands and habitat conservation areas that the port is managing are vulnerable as well. The port's efforts right now are mostly focused on the planning. The port is working with regional agencies in the Bay Area such as the Joint Policy Committee which is doing a resiliency study that involves the San Francisco Bay Conservation and Development Commission; the Association of Bay Area Governments; the Metropolitan Transportation Commission; and the Bay Area Air Quality Management District. The port is also conducting a sub-regional multi-hazard assessment of the port's vulnerable Oakland International Airport, which includes an integrated look at sea-level rise but also earthquake, flooding, and other hazards. The point is that there needs to be a more integrated approach to understanding the risks as they are all interrelated. The port is currently undergoing a project to raise the levee at the South Field of the Oakland International Airport. The project was initiated to protect the major passenger terminal and added a foot of height to the engineering to address the projected sea-level rise. Despite this project, there is still a lot of work to be done.

The port also has several projects underway that continue to deal with the greenhouse gas emissions side of the equation. Like many of the southern California ports, the Port of Oakland has a comprehensive air quality management program. In addition, the port is trying to shift their renewable energy resources procurement to meet the state standards, but also to address a more sustainable model for energy at the port.

Lastly, Mr. Sinkoff described the following policy considerations beginning first with the need for better data on the height of sea-level rise in addition we need better standardized specifications. Further, Mr. Sinkoff suggested there is a need for improved coordination among public and private entities; a need for a blend of regulations and incentives for adaptation strategies (especially a need for funding these studies); a need for a paradigm shift in bay fill to promote "living shorelines"; and a need to work with hydrology because there are ways where natural hydrological systems can actually help in this matter, so it is a combination of engineering and natural coastal systems. Mr. Sinkoff concluded his presentation by stating acknowledge the problem, take action, and figure out ways to adapt.

Kristin Decas, Executive Director, Port of Hueneme

Ms. Decas spoke to how the Port of Hueneme is addressing sea-level rise. The Port of Hueneme created in 1937 by the State Legislature, is a Special District of the state of California governed by five elected harbor commissioners. The port plays a vital role as a U.S. Port of Entry and is one of California's 11 strategic ports as shown on the following page.



Ms. Decas relayed that the port understands that it must be actively engaged on the issues surrounding climate change and sea-level rise since it will directly impact the future of infrastructure and operations. Emerging regulations and technical guidance are providing criteria to evaluate their harbor complex for varying scenarios of sea-level rise. The port developed an environmental framework that includes a strategic action plan dedicated to climate change. The first step of this plan is to conduct a baseline inventory to identify the short and long-term direct and indirect effects of sea-level rise. The findings of this assessment will allow the port to effectively begin incorporating changes to policy and contracting by incorporating considerations for sea-level rise in facility design and maintenance.

Given that the port is just launching the implementation of their strategic action plan on climate change, the port does not have hard evidence of associated impacts. However, there is the concern of how climate change may directly impact trade export activity and their regional economy since sea-level rise has the potential to significantly affect local beneficial groundwater resources in Ventura County and its robust agricultural production which represents an important export commodity.

In addition erosion is of particular concern to the port and surrounding areas because it breaks down natural barriers such as cliffs, beaches, wetlands, and dunes which provide protection to shore side structures. The Port of Hueneme operates at less than three meters above sea level which puts it at relatively high risk of damage should heavy flooding or wave activity occur. The port has already seen water breach the sea wall and deposit rocks and sediment on port property.

As a result, port infrastructure is a major concern. A port-wide conditions study will help determine the remaining life of certain infrastructure along with the cost/benefit analysis and whether maintenance, retrofits or new-builds are needed moving forward. The port also foresees indirect effects such as coastal storm surges and changes in runoff from watersheds affecting operations. Consistent with the findings of the port's initial climate change assessment, climate adaptation and sea-level rise can best be considered in the design and implementation of new equipment and infrastructure.

The port is responding to sea-level challenges through port policy, partnerships, and the implementation of projects that reduce greenhouse gasses. In 2012, the port's Board of Commissioners updated the port's environmental policy statement which led to the adoption of a Climate Change Adaptation Plan as an element of the port's Environmental Management Framework. The Climate Change Adaptation Plan seeks to identify measures, both short- and long-term, which the port can implement to improve its understanding, planning, administration, partnerships, and technical approach to anticipated effects of climate change.

The Climate Adaptation Plan is focused on two main objectives:

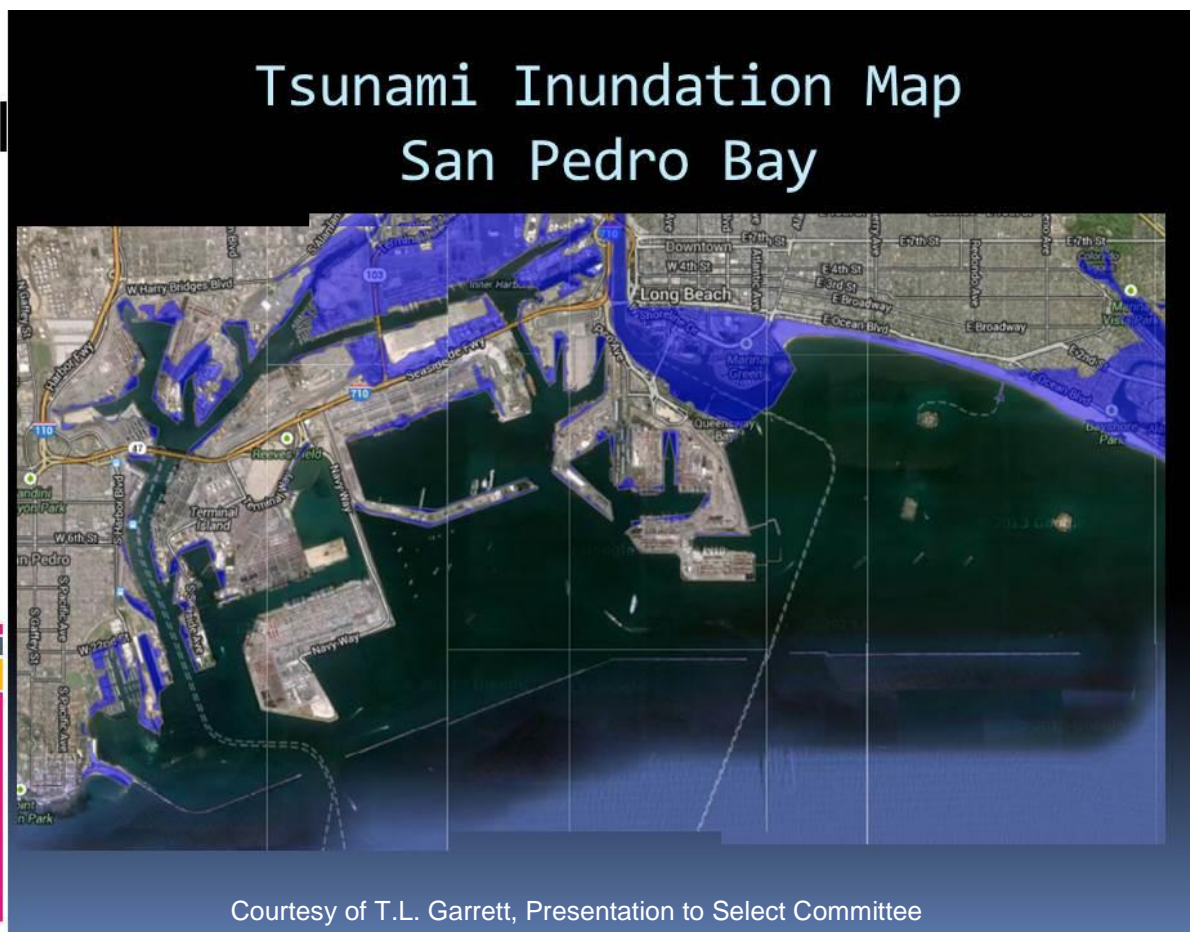
- 1) Tracking new and emerging studies that may provide better regional and local resolution of predicted potential impacts, and
- 2) Identifying strategies that can be implemented by the port to reduce operational and environmental impacts.

The port has also identified regional partners and is looking to actively engage those working to address the potential impacts of climate change and sea-level rise, including the United States Navy. The port has identified the U.S. Navy as a partner in developing and evaluating harbor specific data and information that can be used to support changes in policies and strategies allowing for continued operations of the harbor that accommodate anticipated sea-level rise. Additionally, the port has been tracking funding opportunities provided by the state and the Ocean Protection Council to support more detailed sea-level rise assessments. Further, the collaboration provided by Ventura County Coastal Resilience brings together state and national resources managers, regulatory agencies, and local level perspectives. In terms of what is needed to better respond, Ms. Decas stated that the port seeks clear guidance and information from state leaders and regulatory partners in order to adequately plan and develop their facilities to accommodate sea-level rise and other impacts from climate change.

T.L. Garrett, Vice President, Pacific Merchant Shipping Association

The Pacific Merchant Shipping Association is a trade association that represents terminal operators and ocean carriers that call on the West Coast of the United States. It is clear that preparation for sea-level rise needs to start sooner rather than later, especially because Mr. Garrett pointed out that sea-level rise is on top of surges, storms, and tsunamis. Like most people, Mr. Garrett had more questions than he had answers. Key questions he raised are: should more essential services (electrical generation, water, emergency services) be dedicated to the California port complexes to ensure uninterrupted operations in response to increasing sea-level rise that will intensify the effect of surges, storms, and even tsunamis, and then importantly when locating these services in the port, can they be protected?

To illustrate the effects of a tsunami on San Pedro Bay, below is a map of the Ports of Los Angeles and Long Beach from the Science Applications for Risk Reduction (SAFRR) report, which was led by the U.S. Geological Survey (USGS) and the California Geological Survey (CGS).



This is a worst-case scenario. The inundation map assumed a 9.1 earthquake in Alaska setting off a tsunami that reaches the California Coast, specifically San Pedro Bay. It was

estimated that the statewide cost would be \$8 billion from a tsunami of this magnitude, that the ports could potentially be shut for several days due to inundation and currents. The estimated cost of the San Pedro Bay port interruption would be somewhere between \$200 million and \$4.3 billion depending on the implementation of the recommended repairs estimated to cost \$100 million. It was also estimated that one in three recreational vessels/boats in coastal harbor and ports would be extensively damaged or sunk as a result of such an event. Interestingly, the report looked at the event occurring at high tide and as a result, the effects of the event would be much greater during high tide which speaks directly to sea-level rise.

Again, this is a worse case, but it surely must inform future decisions. Mr. Garrett suggested additional study is needed. The above scenario is an Alaska generated tsunami. It might be useful to do an additional study on the impacts of a California coastal event, or another event along the Pacific Rim. Further, after Hurricane Sandy the increased effects of storms and surge on coastal areas and ports must be considered. Mr. Garrett recommended that there are lessons that can be learned on coastal protection from the Fukushima Tsunami or Hurricane Sandy that could be applicable to our consideration of sea-level rise on California's coast. Of course, there is also the key question of where will the money come from to complete improvements that are going to be necessary to deal with this issue?

In discussing priorities and concerns, Mr. Garrett stated that safety will always be the number one priority. Safe transit to the berth, safe and stable berthing of the vessel while being worked, safe access by road and rail, and safe transit for public, workers, commuters, recreational users, and tourists, that regularly use the port complexes. Along with safe operations, security is essential to protect the vital national interests provided by the ports and maritime industry. Another priority is uninterrupted cargo movement. In addition to the economic importance of the ports, they provide a vital response capability in the event of a disaster. Further, vessel protection from surges, storms, and tsunamis and protecting supporting infrastructure such as power, road, and rail must be additional priorities. Finally, emergency response should be a priority. Large portions of the ports are isolated and if a significant event occurs, there needs to be adequate emergency services. Those services must also be protected to be of any use.

Impact of Sea Level Rise on California's Transportation Infrastructure: Airports, Highways and Roads, and Bridges

Paul Manasjan, Environmental Affairs Director, San Diego International Airport

Mr. Manasjan spoke about how the San Diego International Airport would be affected by sea-level rise. San Diego International Airport is the 3rd largest airport in the state of California. The airport services over 17 million passengers a year and contributes over \$10 billion to the local economy. The airport does all of this on 661 acres and is located in the northern portion

of San Diego Bay. The airport is right on the bay as evidenced by the image below with the airport highlighted in red.



The airport was built completely on fill and is entirely within the tidal zone. The airport is also home to the endangered California Least Tern, which nests right next to their runway and taxiways.

The airport's stormwater drainage system has 14 outfalls to the bay, so stormwater is a major issue for the airport. There is some relationship if you look at a whole systems approach to it, mitigating sea-level rise impacts and also mitigating their stormwater discharges.

The airport already experiences some flooding in its northern region. Since the entire airport boundary is within the tidal zone, the tide goes up everyday underneath their property through the storm drain system. Mr. Manasjan stated that about 2/3 mile away from the shoreline, the airport staff is seeing eel grass from the bay in their stormwater catch basins, which has been transported by the tide. When there is a high tide plus a storm event, the storm drain system fills up with the bay water and so there is no where for the surface water to go. As a result of

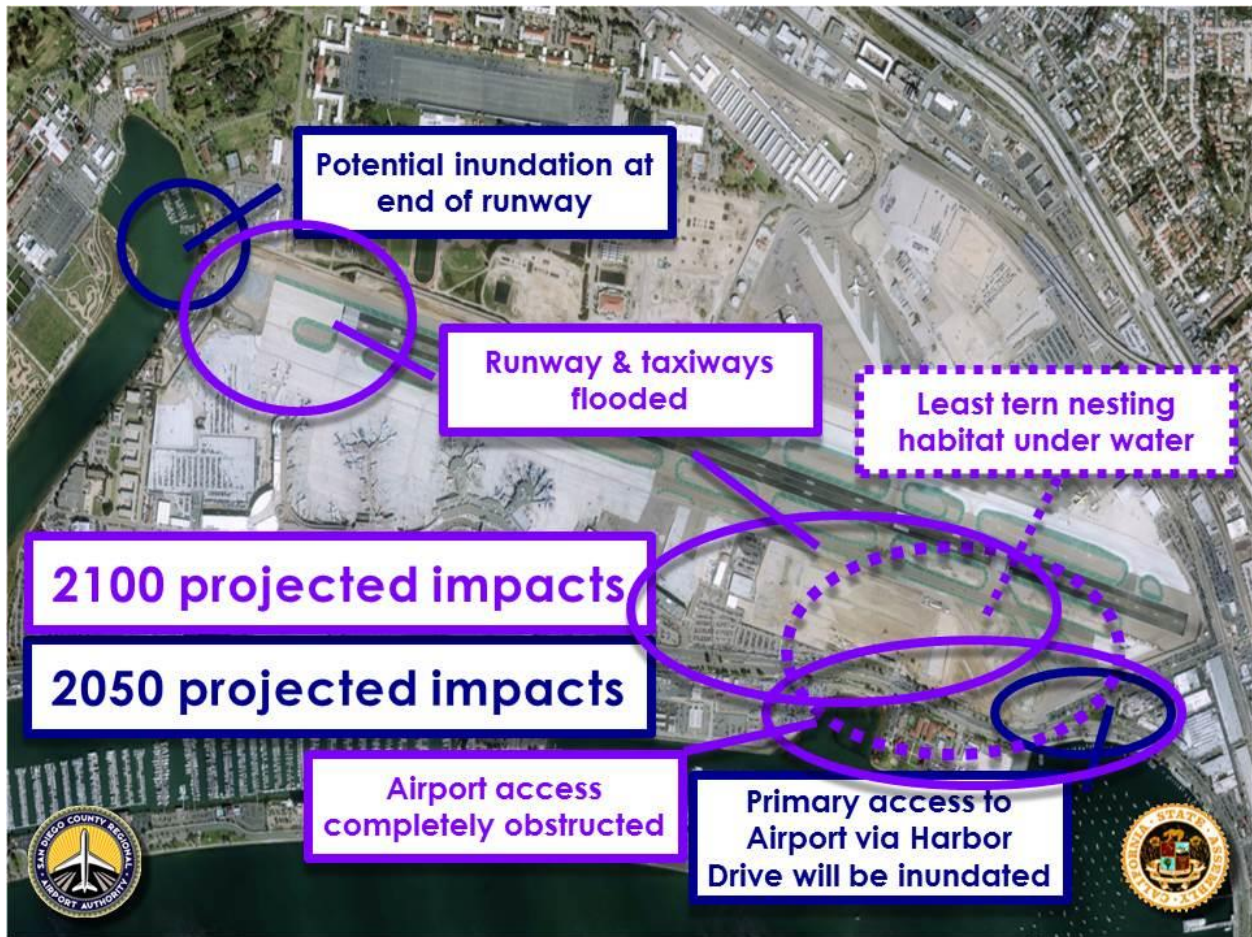
this, the airport experiences flooding in low areas. Fortunately, it has not impacted the runways or taxiways yet. But Mr. Manasjan stated that the airport believes it will eventually.

Good news that Mr. Manasjan shared is that there has been activity in the San Diego area to address the impacts of climate change. The San Diego Foundation realizing the vulnerability of the area's infrastructure along the bay and impacts to the community came out with a report focused on 2050 and looks specifically at the impacts of climate change on San Diego. People often think about the sea-level rise issues, but there are many more issues that the airport is concerned about when it comes to climate change including extreme heat events, impacts to water supply, water shortage, impacts to energy usage, public health effects, and fires which affect their activity at the airport.

In addition, a lot of climate science has been coming out of San Diego through work being done at local universities in regards to research relating to sea-level rise. There have been inundation studies done collectively and that information was taken into an effort to look at what is the impact of sea-level rise to the entire bay. This was an effort that was funded by the San Diego Foundation, ICLEI Local Governments for Sustainability administered it, and the Tijuana River Coastal Training Program helped with stakeholder engagement. The five cities around the bay, the Port of San Diego, and the airport participated in this effort, clearly a collective effort. The study itself was a comprehensive regional assessment of climate change impacts to the bay. The study also looked at various strategies for adaptation that could be utilized by those various municipalities around the bay. The study specifically looked at two time periods, 2050 and 2100. The study also differentiated between only sea-level rise impacts, which would be inundation, and sea-level rise combined with tidal surges and a storm event, which would lead to additional flooding.

Mr. Manasjan stated that the sea-level rise adaptation strategy for San Diego Bay was recognized nationally and is a prime example of what collaboration should be. The Steering Committee and Stakeholder Working Group assembled and established a process for adaptation strategy.

The airport faces various vulnerabilities. Storm drains will be inundated, primary access to the airport via Harbor Drive will be inundated, runway and taxiways will be inundated, and Least Tern nesting habitat will be underwater as shown in the map on the next page, which was included in the adaptation strategy report.



It is important to note that this map only shows inundations due to sea-level rise alone. It does not include storm events, which would exacerbate the problems. This demonstrates the potential and future impacts to the airport's terminal infrastructure and especially impacts to their runways, which would make it impossible for the airport to operate.

The adaptation strategies that came out of the bay report include hard structure such as seawalls, revetment, bulkhead, sea dike; soft structures such as beach nourishment, wetlands, green infrastructure; withdrawal such as buffers, setback and zoning, managed retreat; and accommodation such as raised ground level, raised foundations, floodable development, and floating structures. So, what is the airport doing now to address these impacts? Mr. Manasjan declared that the airport is taking a whole systems approach to how water comes on to their property and leaves their property. Specifically, the airport is looking at maximizing on-site retention of stormwater through pervious pavement with subsurface infiltration chambers such as in their parking lots, bio-retention swales, and rainwater capture and reuse cisterns. Another adaptation strategy that the airport is examining within the storm drain system itself is backflow prevention devices. Also at the end of the stormwater outflows there will be flapper gates installed.

The airport is in the process now of preparing a comprehensive strategic stormwater drainage master plan by looking at how the airport can maximize their opportunities for infiltration, but also collection and reuse of that stormwater as well. Next year, the airport hopes to conduct a more detailed site-specific airport infrastructure vulnerability assessment. Additionally, the airport recently joined the San Diego Regional Climate Collaborative because collaboration is essential in the work they are doing to address sea-level rise. Mr. Manasjan illustrated that if the city streets that access the airport are flooded, the airport has no control of that. So, if the city does nothing, the airport cannot operate. Therefore, collaboration is essential in the process. Mr. Manasjan concluded that the airport will be expanding opportunities for regional collaborations on climate resilience and will be identifying potential funding sources for studies and adaptation strategies.

Joe Birrer, Principal Engineer, San Francisco International Airport

Mr. Birrer spoke about the geography of San Francisco International Airport, its economic importance, and how SFO is addressing sea-level rise through their adaptation plan. San Francisco International Airport is on San Francisco Bay and is owned by the City and County of San Francisco, but uniquely resides in San Mateo County. The bay front perimeter at the airport is approximately 8 miles and the airport is built on fill over bay mud, so subsidence is an issue for the airport as well. Below is a good representation of the airport’s location on the bay and geography.



The majority of the airfield and terminal areas lie at an elevation of approximately 6 to 10 feet. The image below puts the issue into perspective in that it will not take much in the area of sea-level rise to adversely affect the airport. Therefore, as the image says status quo is not an option. The airport realizes it must address sea-level rise and they are looking into it and trying to work proactively.



Status Quo is not an Option!



It is important to protect the airport because it is a huge economic engine for the San Francisco Bay region. In 2012, the airport directly accounted for over \$5 billion to the local economy and supported 33,000 jobs. Businesses at SFO generated \$2.5 billion in state and local tax revenues. Off-site businesses directly dependent on the airport contributed over \$31 billion to the Bay Area economy and supported 153,000 jobs. The airport served 44 million passengers in fiscal year 2012-2013, which is a record for the airport. These statistics demonstrate how important airports such as SFO are to communities and their economy and why airport infrastructure needs to be protected from sea-level rise.

The airport has been proactive in sustainability and mitigating their environmental impact, but even with that, the airport is still vulnerable to sea-level rise. The airport would like to take the same proactive approach to this problem.

Below is a map from the San Francisco Bay Conservation and Development Commission (BCDC) showing areas vulnerable to 16 inches and 55 inches of sea-level rise, including the airport shown in the circle which according to the projections would be underwater.



Even at 16 inches of sea-level rise it is not just the airport that is inundated, but it is also Highway 101, portions of the airport's neighboring cities, Caltrain, even potentially BART is affected. It will not take much to affect many different pieces of infrastructure in and around the airport.

If focusing specifically on the airport, not only is sea-level rise a looming problem for the airport, but also the airport is also very focused now on addressing the short-term potential flooding.

Being on the San Francisco Bay, the airport has protections in place. There are different types of seawalls that surround the airport as shown on the following page.



The image of the concrete seawall in particular illustrates the vulnerability of the airport due to the current water levels in the bay.

So, what is the airport doing about this? SFO has a Shoreline Protection Feasibility Study that started in January 2013 and is a two-year study. In this study, the airport is looking at determining the deficiencies of their seawalls and levee systems, assessing their interior drainage system and developing their adaptation plans going forward. The airport would also like to get recommendations from the study on the types of projects the airport needs to bring forward and implement to protect themselves against sea-level rise. Knowing that the airport is vulnerable, they have started to engage with other stakeholders such as the City and County of San Francisco, Army Corps of Engineers, San Mateo County Board of Supervisors, BCDC, State Coastal Conservancy, Caltrans, Federal Aviation Administration, U.S. Coast Guard, and business community in order to work collaboratively to address sea-level rise in the region.

So what is needed to move this issue forward? The development of policies and guidelines would be beneficial. Identifying lead agencies at the state to help airports move projects through when they do come up and start going on them. Further, of course funding opportunities whether through the state or federal government will be important to identify. Legislation that could facilitate collaborative approach among local and regional communities would be important in order to establish a balanced approach to address sea-level rise. Of course it will be very difficult to go forward without the support of the community so any educational or outreach programs that can help the community understand this issue, its scope, and cost will be imperative. Lastly, sea-level rise cannot be addressed in isolation. It will affect all of us whether it is the state, counties, or agencies like the airport. It really is going to need to be solved at a regional level. The airport could build a seawall to protect itself to the year 2100 and beyond, but if their neighbors are not equally protecting themselves, the airport would be flooded from its north and south boundaries. So, only by working with their neighbors and having a coherent and cohesive plan can they solve the issue for the airport. The final point Mr. Birrer wanted to express is to recognize that airports are going to have unique shoreline protection requirements. Wetland type projects or projects that would bring wildlife especially birds closer to airports are extremely dangerous to aircrafts and the flying public. To airports, the safety of the travelling public is going to be paramount. So, the projects that airports put forward to address sea-level rise may not look like other projects that

are being implemented around the bay. This is going to be important for people to understand that one size does not fit all in terms of planning for sea-level rise.

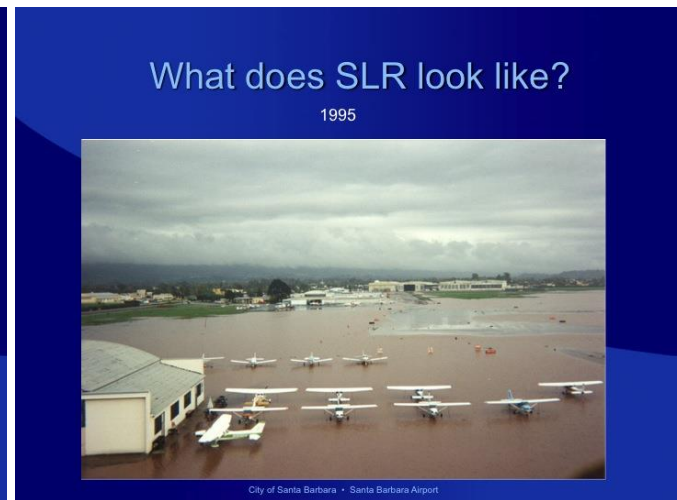
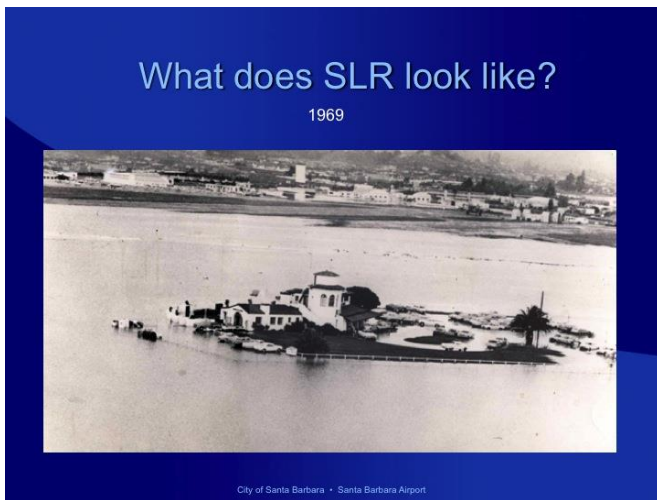
Andrew Bermond, Project Planner, Santa Barbara Municipal Airport

Mr. Bermond spoke about sea-level rise issues that are anticipated to impact the airport as well as unique situations at the airport that are offering a sea-level rise preview. The Santa Barbara Airport is located on the south coast of Santa Barbara County and is a city department. This is the largest airport on the central coast of California and has approximately 750,000 passengers a year. The airport also has 450 of their 1,200 acres of property designated as the Goleta Slough Ecological Reserve, which is primarily tidal wetland and surrounds roughly half of their airfield, which is shown below in green.



Mr. Bermond discussed the risk of sea-level rise for their airport, which is not rising tides coming in from the beach. It is flooding of stormwater that will stay around longer, cover larger areas, so that places that are rarely flooded will be flooded more often. The airport already sees a little of this happening when there are major storms and high tide events. As has

happened every twenty years or so the airport ends up underwater. Below are images of flooding at the airport.



History keeps repeating itself and these pictures are going to show up more often as a result of sea-level rise. Sea-level rise will result in more flooding that is more severe, which will result in habitat change or habitat loss. Therefore more urgently and immediately, the airport is seeing a change in bird behavior which leads to an increase in bird strike hazards. Not all birds are created equal at airports and the most dangerous are large migrating waterfowl such as ducks and geese that will be attracted to deeper waters which sea-level rise and extreme storms bring. To address this, the airport has an aggressive bird strike monitoring and reporting program. They still have relatively fewer bird strikes than other airports in the state, but Mr. Bermond believes that this is largely attributed to the airport's tidal wetland restoration project, which removed barriers to tidal flows into what used to be seasonal wetlands. The airport found through a three year study in partnership, with the Federal Aviation Administration, Coastal Conservancy, and Coastal Commission that by making this habitat change, the airport was changing the bird type such as local shore birds that was using the wetlands and they were therefore improving safety because these birds were less likely to incur on runways.

Part of the problem in addressing sea-level rise and adaptation strategies is that there is a very complex regulatory framework and as a result a difficult permit path for adaptation. There are a number of agencies from the federal, state, and local level that are involved and every one of them has the ability to either deny or issue special conditions. Under the adaptation strategy that the airport has outlined, the airport would be subject to the California Environmental Quality Act, they would have to get landowner permission from the State Lands Commission, they would need a coastal development permit, a streambed alteration agreement, and more. Mr. Bermond asserted that it is a convoluted process and promotes inaction because it is much simpler to wait for the emergency to arise and address it with some rapid and low cost engineering solution rather than adopting a large-scale management strategy.

The airport has been working collaboratively for a couple decades with the Goleta Slough Management Committee to address environmental issues and in the past two years the Committee has taken sea-level rise as a big threat to the Goleta Slough. The concern is habitat change and loss as well as long-term threats to infrastructure including runways and taxiways, access roads, and wastewater treatment facilities. The airport and others on this Committee are trying to get ahead of this threat and identify what needs to be abandoned, what needs to be moved, and what strategies are needed for proactive management to maximize resource and infrastructure protection.

Garth Hopkins, Office Chief for the Office of Regional and Interagency Planning, California Department of Transportation

Mr. Hopkins discussed the impacts of sea-level rise to California's transportation infrastructure such as highways, roads, and bridges. California's transportation system is a complex multi-modal system and the highway system is just one element of the statewide transportation network.

Caltrans is the owner and operator of the largest and most complex highway system in the country. Caltrans is responsible for maintaining over 50,000 lane miles of roadway, 12,000 bridges, 250,000 acres of roadside including 25,000 landscaped acres, 88 rest stops, 340 park and ride lots, and more than 400 maintenance yards with a fleet of more than 14,000 pieces of equipment. In 2012, there was approximately 180 billion miles of travel on the State Highway System. Caltrans works with local transportation agencies and other stakeholders such as the coastal commission to ensure the road network is safe and efficient.

California has the longest coastline in the nation – equivalent to 11 east coast states from New Hampshire to Georgia. There are thousands of miles of roadway along the coast – including the State Highway System and local streets and roads. In addition to roads, there is other infrastructure such as bridges and tunnels. In order to protect expensive real estate and other infrastructure, over one third of the southern California coast is armored.

Under current sea levels, approximately 1,900 miles (State Highway System and local streets) are at risk of a 100 year flood event and 4.5 feet of sea-level rise would put about 430 miles of highways at risk of flood.⁴

⁴ Source: Pacific Institute. *The Impacts of Sea-Level Rise on the California Coast*. May 2009. <http://www.pacinst.org/wp-content/uploads/2013/02/report16.pdf>

Courtesy of Garth Hopkins, Presentation to Select Committee



Mr. Hopkins stated that the State Highway System currently experiences flooding. Portions of the State Highway System are inundated during large storms, and extreme events such as king tides in San Francisco, which are the highest tides of the year and occur during winter storms.

Flooding can cause temporary shut down of facilities, but can cause permanent damage to some infrastructure such as corrosion on metal signs, posts and culverts and pavement deterioration.

Courtesy of Garth Hopkins, Presentation to Select Committee



Mendocino County flood from storm surge



Coastal flood from king tide event in Marin County

In addition, transportation routes along coastal bluffs are vulnerable to erosion. As sea levels rise, waves will break closer to the shoreline accelerating the erosion of beaches, dunes and cliffs. Erosion rates vary based on coastal geology, and the degree of coastal armoring. The 2012 National Research Council report on sea-level rise for California, Oregon and Washington stated that with a one meter rise in sea level, the central and northern California

coast would lose 31 square miles or 20,000 acres of land to erosion by 2100. Mr. Hopkins revealed that billions of dollars have been spent protecting and relocating portions of Highway 1 from landslides and erosion. Caltrans protects infrastructure using retaining walls, shoreline armoring, soil nailing, and reinforcing embankments. Extreme cases may require relocation.

Courtesy of Garth Hopkins, Presentation to Select Committee



Retaining wall supporting Highway 1 in Monterey County



Coastal erosion along Highway 1 in Marin County

Bridge scour, which is the removal of sediment from bridge piers and abutments, has also become an issue. The sediment acts as a supporting material, helping to keep the structure properly “connected” to the ground to keep it well supported. Bridge scour occurs when water moves swiftly past bridge infrastructure. Scour is one of the three main causes of bridge failure. It is the most common cause of highway bridge failure, responsible for 60% of all bridge failures in the U.S. As sea levels rise, coastal bridges will need to withstand more and larger wave action, potentially accelerating bridge scour. In the future, design standards will likely need to change to recognize this impact of sea-level rise as there will be more scour situations.

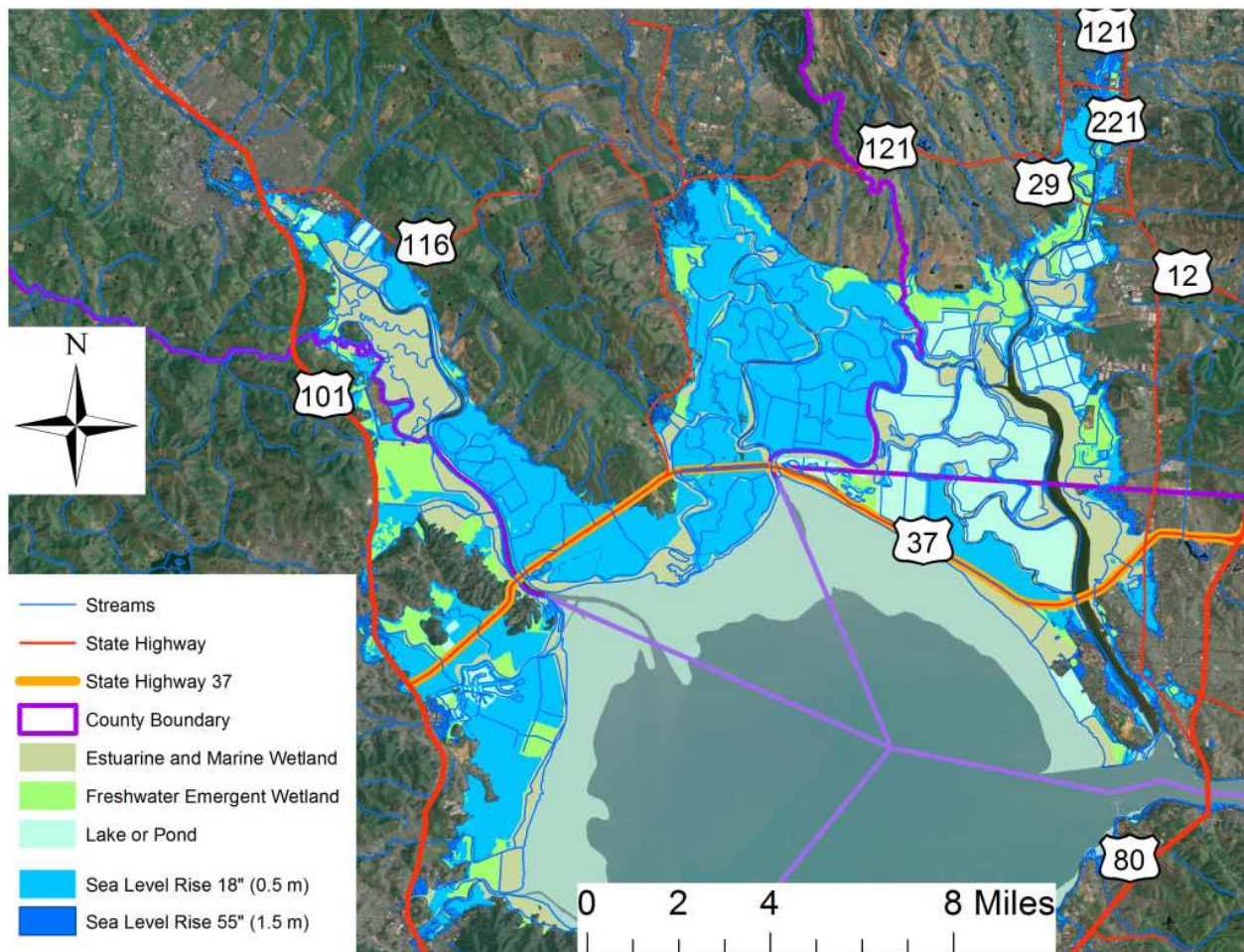


Courtesy of Garth Hopkins, Presentation to Select Committee



Mr. Hopkins also shared how Caltrans is specifically addressing this critical issue. Caltrans' Divisions of Transportation Planning, Design and Environmental Analysis developed guidance for incorporating sea-level rise into the early engineering of projects. The document will be updated to become guidance for Caltrans staff on considering and incorporating sea-level rise into design and planning. In addition, Caltrans District 4 and regional partners are working with UC Davis to conduct a study of State Route 37, which is vulnerable to sea-level rise. It is a 21 mile route along the northern shore of San Pablo Bay that connects I-80 to Route 101. It is a key regional connector highway for the North Bay area, and is a designated emergency response route. Increasing traffic demands often create long bottlenecks which greatly reduces the level of service. It spans the northern shore of the San Pablo Bay, and is extremely vulnerable to sea-level rise. The study is examining alternatives to either relocate or elevate the road to increase capacity and potentially include transit options. Difficulties in determining the best alternative includes environmental considerations and transportation options. The land around the route is a vital marshland with high environmental sensitivity – contains threatened species and environments. The current study is scheduled for completion in mid-2014. Below is a map that shows State Route 37 and its vulnerability to sea-level rise.

Courtesy of Garth Hopkins, Presentation to Select Committee



Caltrans is also working to identify where the State Highway System is vulnerable to impacts from climate change, including sea-level rise. In District 1 (Del Norte, Humboldt, Mendocino, and Lake Counties) a vulnerability assessment is currently underway which has received funding from the Federal Highway Administration and Caltrans. The vulnerability assessment is looking at all potential impacts from climate change. Portions of the State Highway System in District 1 are highly vulnerable to sea-level rise, those areas will be identified and adaptation options will be studied. In District 4 (San Francisco Bay Area), a vulnerability assessment through BCDC's Adapting to Rising Tides project is also underway to identify how climate change may impact Bay Area communities. This is the second phase of the Adapting to Rising Tides project, also received funding from Federal Highway Administration and Caltrans. Both will be complete by late 2014. Caltrans headquarters will be conducting vulnerability assessments in other areas to get a statewide understanding of where the State Highway System is vulnerable to climate change and extreme events.

There are numerous sea-level rise projections in use. Mr. Hopkins asserted that to successfully plan and design projects to consider sea-level rise, a common set of projections needs to be agreed upon by all federal, state and local agencies. This will ensure consistency among agencies and help streamline regulatory/permitting processes. Mr. Hopkins concluded by suggesting that the Coastal and Ocean Resources Working Group for the Climate Action Team (CO-CAT) may be the appropriate group to make the sea-level rise projection determination.

Impact of Sea Level Rise on California's Water and Power Infrastructure: Stormwater Facilities, Wastewater Treatment Facilities, and Power Plant Facilities

Shahram Kharaghani, Watershed Protection Program Manager, City of Los Angeles Bureau of Sanitation

Mr. Kharaghani provided background on the Los Angeles flood control system and described the expected impact of sea-level rise to this system focusing on stormwater infrastructure. The Los Angeles flood control system consists of over 1,000 miles of storm drain pipes, 35 miles of open channels, 39,451 catch basins, 63 debris basins, and 18 stormwater pump plants. This infrastructure was created in the 1960s and 1970s and the population over the decades has grown substantially since; however, the backbone of this system is still in the same place that we were in the 1960s and 1970s.

The flood control system is vulnerable to flooding and inundation and sea-level rise would exacerbate flooding in low lying areas that are at or near sea level. Specifically, wastewater and storm water collection systems are sensitive to inflow from high tides, storm-related floods, and groundwater, which reduce their conveyance capacity. In addition, wastewater treatment plants and pumping plants are vulnerable to flooding and inundation because their electrical equipment and process operations can be damaged. Sea-level rise would only worsen the

problem. In fact, there is flooding occurring now. In January 2010, Harbor Boulevard between 5th Street and 6th Street in San Pedro flooded, as shown by the image below.



Courtesy of Shahram Kharaghani, Presentation to Select Committee

Most storm drain systems for cities and other jurisdictions discharge stormwater in the ocean, where the pipes are above the ocean level. However, during the day this photograph was taken, there was a severe storm and there was a high tide which acts like a wall and blocks the flow of stormwater into the ocean. As a result, the pipes backed up and flooding occurred. Imagine the problems that a permanent high tide such as sea-level rise will present for this area as well as the economic costs of addressing flooding. Mr. Kharaghani mentioned that this is more of what can be expected if no appropriate planning is done.

Mr. Kharaghani stated that the Bureau of Sanitation has undertaken some efforts to make their assets more resilient to sea-level rise, and especially storm-related flooding. Two years ago, a microburst storm event caused sewage to back-up into homes in a handful of locations. This became the impetus to examine how the impacts of sea-level rise could impact the Venice Pumping Plant and sewer drains in San Pedro. The Bureau of Sanitation is planning to expand this vulnerability study to other sites to better understand what can be expected and how to prepare. In addition, the City of Los Angeles has incorporated sea-level rise in their planning documents and design for a proactive approach.

However, the challenge then becomes whether there is funding to actually implement the planning that has been done. Mr. Kharaghani urged that a stable funding source is needed in order to address sea-level rise and be proactive. He hopes that in the future a regional or municipal assessed stormwater fee could be the answer, but admitted that the two-thirds vote requirement established by Proposition 218 of 1996 is a major challenge, which he suggested should be reexamined.

Kevin Hardy, General Manager, Encina Wastewater Authority

In addition, to his work at the Encina Wastewater Authority, Mr. Hardy is also Second Vice President of the California Association of Sanitation Agencies (CASA), a statewide organization representing 106 local public agencies that provide wastewater collection, treatment, resource recovery and water recycling services to more than 25 million Californians. Mr. Hardy relayed that CASA members are actively engaged in a number of California's initiatives designed to mitigate climate change impacts by 2020 and address sea-level rise on wastewater treatment facilities.



Courtesy of Kevin Hardy, Presentation to Select Committee

Public wastewater agencies can play an important role in crafting and delivering climate change solutions while simultaneously accomplishing their core mission of protecting public health and the environment. Mr. Hardy stated that CASA believes their member agencies will experience the first significant infrastructure impacts of climate change. Wastewater treatment facilities will be among the hardest hit by climate change, in part, because treatment plants are generally located at the low point in each watershed to make efficient use of gravity for conveyance purposes. This means that in coastal areas, wastewater facilities are often located along the coast or within an estuary – and like the Encina Water Pollution Control

Facility that Mr. Hardy manages in Carlsbad, have an ocean outfall with a direct hydraulic connection to the facility. Even in the case of inland locations, plants and the outfalls are often found within river valleys and floodplains. As the sea level rises and storm surges increase in coastal areas, facility outfall elevations may need to be increased or may require pumping in order to discharge. Inundation of facilities, including higher coastal groundwater levels causes more inflow of brackish or salty water that in turn requires higher volumes or treatment levels and makes water recycling more energy intensive. In addition, extreme storms can result in water inflow that exceeds the current capacity of much of the wastewater infrastructure, meaning that wastewater agencies will need to invest significantly in upgrading systems to prevent sewage overflows and potential impacts to public health. Increased inland flooding events will put critical infrastructure and service at risk of failure meaning flood protection adaptation measures such as levees and seawalls will be needed. Thus, wastewater agencies will acutely experience the effects of sea-level rise and storm events attributable to climate change.

Climate change will pose unique challenges to California's and the nation's water, wastewater and stormwater utilities. Mr. Hardy stated that wastewater utilities across California and the U.S. can expect:

- Sea-level rise and storm surge impacts,
- Increased service disruptions from flooding,
- Increased extreme precipitation events,
- Increased treatment requirements,
- Higher energy demand,
- Increased emergency response and recovery, and
- Declining safe and reliable water supplies.

In addition, Mr. Hardy discussed some of the adaptation strategies that wastewater facilities will likely use to address these challenges which included the following:

- Elevating pumping stations, building levees and, in some circumstances, relocating treatment facilities to avoid rising sea levels from rendering the wastewater plant inoperable.
- Increased mitigation of brackish groundwater infiltration into the collection systems where influenced by rising sea levels.
- Increased focus on integrated watershed planning and use of the full toolbox of management techniques to manage systems holistically. This may include use of both green and gray infrastructure, real time management and optimization techniques, and other processes to manage wet weather flows, as well as more efficient treatment technologies.
- Increasing the treatment of wastewater, including cooling of the effluent, to address likely increased surface water temperatures of receiving bodies whose ecological health will be compromised under changed climate conditions.

- Relying more heavily on reuse technologies so that wastewater can help compensate for the decrease in drinking water availability. In California, we have seen a dramatic increase in the interest to develop such projects to respond to the drought and ensure a safe and reliable water supply.

CASA also believes that climate change presents them with unique opportunities. As wastewater agencies consider ways to confront this threat, their agencies are finding new ways to build upon the innovative energy savings developed over the past few decades. In addition to a focus on the impacts on infrastructure and operations of wastewater treatment systems related to sea-level rise, renewable energy production should also be addressed. Public wastewater agencies have the ability to develop and expand the utilization of alternative, renewable energy technologies and are in an excellent position to help reduce greenhouse gas emissions.

Mr. Hardy concluded by saying that California is a leader in the campaign to address climate change, and wastewater treatment plants can serve as very proactive partners in achieving state mandates adopted for this purpose. However, legislative and regulatory support is needed as well as increased funding opportunities to assist wastewater agencies in these efforts while they fulfill their primary mission to protect human health and the environment.

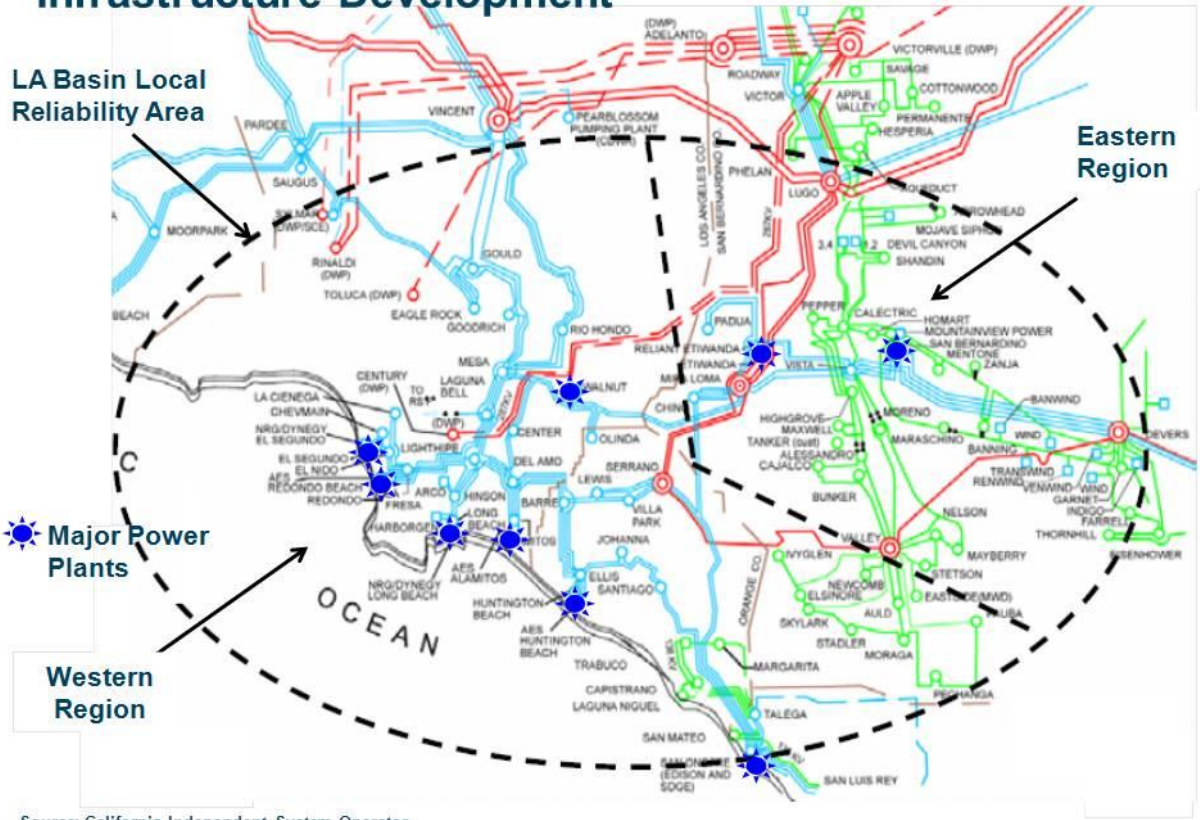
Stephen O'Kane, Manager of Sustainability and Regulatory Compliance, AES Southland

AES is a global power and utility provider in 21 countries serving millions of customers. When power plant operators look at adaptation and sea-level rise, it is a little more immediate as AES is currently in the process of redeveloping some very old, but very important pieces of infrastructure to the California power grid. AES has facilities in southern California in Huntington Beach, Long Beach, and Redondo Beach. The AES Long Beach power plant is now the largest power generating facility in southern California. All of AES' facilities are located on the coast originally to take advantage of the efficiency of ocean water for cooling and Mr. O'Kane asserts that power plants now need to remain on the coast for an entirely different reason. Over 15 million people and over 3 million businesses in southern California are dependent on electricity. So, it is critical that the infrastructure is kept in place. As AES looks at developing their sites, they do have to consider what the effect of the environment is on their facilities and what the future will look like.

There is a tremendous load of people who need electricity in southern California. Going forward Mr. O'Kane believes that if we want to meet our 2050 climate change goals, the only way is through aggressive electrification of the rest of our economy, such as at ports facilities and through the transportation network. This means increasing the demand and load near the coast. On the following page is a picture of the western Los Angeles reliability area for the independent system operator. The light blue lines are the 230 kilovolt transmission lines and the red lines are the 500 kilovolt longer range transmission lines that move power around the

western Los Angeles Basin. The blue dots are the major utility scale power plants that are located within this basin.

Consideration of Sea Level Rise Already Affects Infrastructure Development



Again, Mr. O’Kane pointed out that these power plants are concentrated along the coast. Some may say that the easiest thing to do in order to mitigate for sea level changes is to move the power plants. However, Mr. O’Kane believes this is not the appropriate approach. He asserted that if we remove power plants or power lines that infrastructure is gone forever and may increase the risk for the businesses and economy that depend on the power in those areas. As a result, power plants would be in less effective locations having to generate more fuel and produce more power in order to serve the same number of people and businesses. Mr. O’Kane believes this issue has to be looked at holistically.

For AES it is reasonably easier to address sea-level rise since their facilities are small sites compared to ports and airports. For example, the AES Long Beach Power Plant, the largest in southern California, is only on 63 acres. From an engineering perspective, even at the outset of the 100 year prediction, it would not be difficult for AES to maintain and protect that site saving the infrastructure due to a number of factors. Currently, AES’ lowest facility is 14 feet above sea level and by the end of that facility’s life there may be a 2 or 3 feet sea-level rise. This is something that AES can manage. In addition, there is a relatively short planning

horizon for power plants since their facilities only have a 30 to 40 year time horizon. Therefore, in 2050 notwithstanding sea-level rise, the power plants will still be looking to rebuild.

Nevertheless, there are challenges for power plants in addressing sea-level rise in the future. Mr. O’Kane pointed out that no standard, code, or consensus exists for design requirements. In this absence, design and construction will be based on risk assessments and he stated that the final arbitrator on risk is the financial markets who will either be willing to provide the capital for development or not, using risk analysis to see if there is a return on their investment. Having the money to actually pay for projects to address this issue is the most pressing challenge.

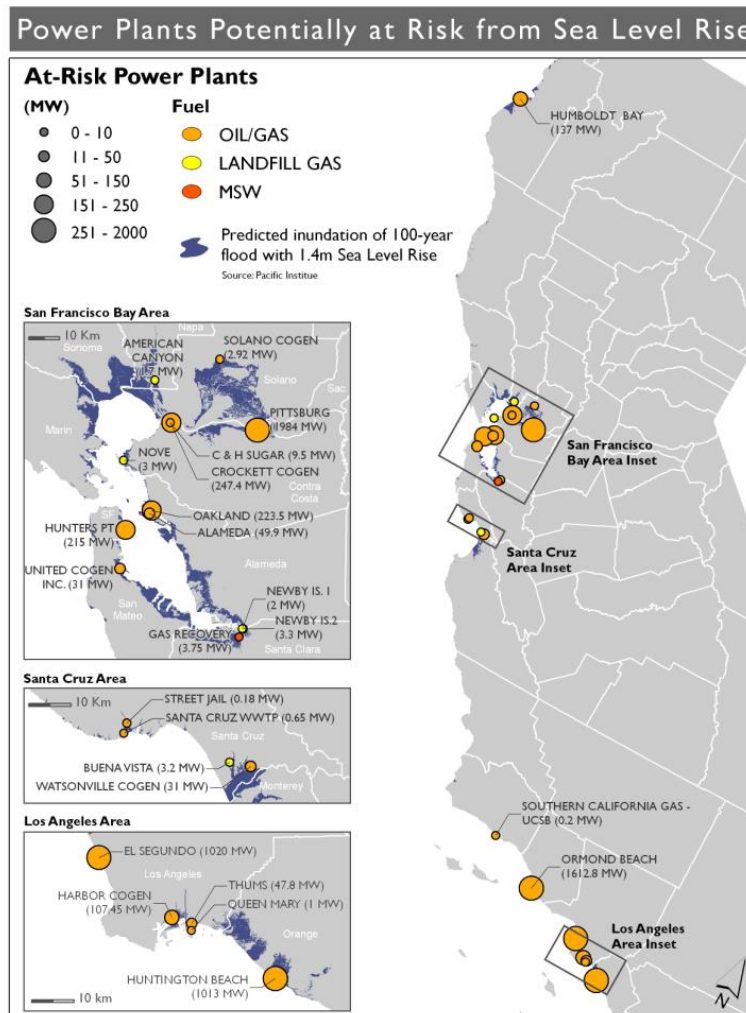
Since AES cannot foresee the future, they plan for multiple scenarios. In terms of design options for the near term to mitigate for some of the risks, AES does not want to be dependent on any of the variables that are changing. Therefore, AES has eliminated the use of ocean water in their design going forward. The other major plan of action to address future sea-level rise is making sure the major component of technology that the power plant is looking to implement is not at risk, so moving the maintenance and parts off site makes sense. Also when planning for an unknown future, civil works and site layout should allow for mitigation and adaptation options such as dikes, levees, seawalls which may need to be added. Mr. O’Kane in his closing stressed that as power plants move forward on developing sites to ensure safe reliable sustainable energy for the future, a key aspect is never giving up on options.

Roger Johnson, Deputy Director for the Siting, Transmission and Environmental Protection Division, California Energy Commission

Roger Johnson is the Deputy Director for Siting, Transmission and Environmental Protection at the California Energy Commission. He addressed sea-level rise and its potential effect on coastal power plants in California. The Energy Commission is the state’s authority for permitting large thermal power plants. These include gas fired power plants, geothermal power plants, and solar thermal power plants. The Commission was designed to provide statewide consistency for permitting these large power plants. The Commission also has authority for permitting all related facilities associated with those power plants such as transmission lines, water supply systems, natural gas pipelines, waste disposal facilities, and access roads. The Commission oversees the construction, operation, and closure of power plants.

Mr. Johnson relayed that no California power plants are currently affected by sea-level rise. However, this does not mean that power plants are not at risk from sea-level rise. The NRG Long Beach power plant in the Port of Long Beach is located on land that is below sea level due to subsidence from past oil field extractions, but the project is protected by a dike. Recent planning studies suggest 25 power plants and 86 substations are at risk of flooding or compromised operation due to a 100-year flood with a 1.4 meter sea-level rise. Therefore,

much can be done to minimize or eliminate the risks. Below is a map showing California's power plants that are potentially at risk from sea-level rise courtesy of the Pacific Institute.



Source: Pacific Institute

So, how is the California Energy Commission preparing for future sea-level rise in the siting and the California Environmental Quality Act process? The Engineering Office of the Commission prepares assessments of site vulnerability to sea-level rise during siting and amendment proceedings. Consistent with other environmental impacts, sea-level rise is evaluated for the “reasonably foreseeable” life of the project, usually 30 years. Staff utilizes the latest projections about sea-level rise to assess whether or not the proposed project has adequate separation from groundwater or surface water features, which are the most direct threats from sea-level rise.

Power plant vulnerability relative to sea-level rise is related to 100-year flooding scenarios predicted by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate maps (FIRM). Current projections that show power plants at risk are based on a sea-level rise scenario of 1.4 meters in 100 years plus FEMA flood inundation depth. The Commission is not

aware of any plants that have needed to, or are proposing any risk reduction measures at this time. Although in the future, some owners may choose engineered solutions to increase their flood protection. A response from an individual power plant may depend on how or if FIRM maps change.

So what is needed to better respond? Mr. Johnson stated that all the current projections for sea-level rise in California are for planning purposes. Site specific assessments are now being performed by Commission staff during active proceedings, but not necessarily for all existing power plants that are not amending their project or site. This would appear to be a gap. Perhaps the Commission could look at doing additional site specific assessments.

How State Agencies are Addressing Sea Level Rise in California
Thursday, January 16, 2014
9:00 a.m. – 12:30 p.m., Sacramento

The Select Committee's fourth and final hearing brought the discussion back to the State Capitol. After hearing from affected industries, we turned our attention to how the state is addressing sea-level rise and what role the Legislature could play in responding to this challenge.

San Francisco Bay Conservation and Development Commission

R. Zachary Wasserman, Chair, San Francisco Bay Conservation and Development Commission (BCDC)

Four years ago, as part of its efforts to address rising sea levels, BCDC released its USGS-generated "inundation maps" that caused both great interest and much consternation. They showed the results of rising sea level in the bay, both within BCDC's jurisdiction and farther inland. BCDC recognized then, and certainly continues to recognize now, that California needs to plan for a rising bay to protect the long-term safety, wellbeing, and vitality of the Bay Area's communities, natural resources, and economy.

Chair Wasserman discussed two projects underway at BCDC that demonstrate the agency's attempt to help the Bay Area adapt to a rising sea level. The first is the Adapting to Rising Tides (ART) Pilot Project. BCDC is working in partnership with National Oceanic and Atmospheric Administration (NOAA) and with assistance from ICLEI Local Governments for Sustainability, Metropolitan Transportation Commission, and the Caltrans on the project. ART is a community-based collaborative planning effort that addresses two questions:

- 1) How will climate change impacts of rising sea level and storm events affect the future of Bay Area communities, infrastructure, ecosystems and economy; and,
- 2) What strategies can BCDC and its stakeholders pursue, both locally and regionally, to reduce and manage these risks?

ART is being conducted in a portion of the Alameda County shoreline, from Emeryville to Union City. ART has assessed the subregion's vulnerability and its risks, and has evaluated the vulnerability of the assets in the subregion, including transportation, community land use, parks and recreation, contaminated lands, structural and non-structural shorelines, the Port of Oakland, Oakland International Airport, stormwater/wastewater, hazardous waste sites and pipelines. Also, ART developed a portfolio of possible adaptation responses to address the subregion's vulnerabilities. ART is using four lenses through which to analyze communities' resiliency and ability to adapt: society and equity; economy; environment; and governance.

Secondly, BCDC and the Association of Bay Area Governments (ABAG) are leading the development of a collaborative regional planning and implementation program called “Resilient Shorelines” to address sea-level rise and storms, as well as earthquakes. Further, BCDC is starting to work formally with the State Coastal Conservancy to expand their cooperation, collaboration, and partnerships, as both agencies are conducting projects together and separately that promote regional resilience. The projects in the Resilient Shorelines program will help local and regional governments build the capacity to be active and successful participants so that local and regional strategies to address multiple hazards to the built environment and natural resources can be formulated and implemented from the bottom up. Some of the strategies will be integrated into the 2017 Bay Area Sustainable Communities Strategy to be adopted by the Joint Policy Committee.

From BCDC’s experience examining the issue of sea-level rise, Chair Wasserman offered the following conclusions and recommendations to the Select Committee. The State should collaborate with local and regional government agencies to provide clear, consistent, and transparent standards and guidance, including agreed upon uniform data that informs and supports local decision-making processes. Land use decisions should continue to be made on the local level. The State should also support a wide variety of on-the-ground, community-based, and scalable resilience programs that exemplify best practices, provide necessary and useful policy information for a region’s resilience, measure and monitor results, and are applicable to a wide variety of locales. Lastly, all levels of government must engage the public in constructive discussions to answer jurisdictional and policy issues. To solve the challenges and implement the recommendations of BCDC, Chair Wasserman asserted that the state needs an integrated, crosscutting, agency-wide policy development and implementation strategy, with funding to implement that strategy.

Natural Resources Agency

John Laird, Secretary, Natural Resources Agency

Secretary Laird testified before the Select Committee at the first hearing. There have been some developments since he testified, but as he stated, the basic problem is still present, if not more dramatic.

Rising sea level and the impact of erosion are severe. Of our 38 million people in California, three quarters of the population live in close proximity to the coast where sea-level rise is very much an issue. Among those are significant numbers of low-income people and communities of color who are especially vulnerable and might not have the same ability to respond.

There is critical infrastructure, such as roads, hospitals, schools, emergency facilities, wastewater treatment plants, power plants that are at increased risk of inundation, as are vast

areas of wetlands and other natural ecosystems. State-of-the-art modeling shows that a single extreme winter storm in California could cost on the order of \$725 billion – with total direct property losses of nearly \$400 billion. Sea-level rise threatens water supply by exacerbating saltwater intrusion in our freshwater sources like the Delta. It is estimated that \$900 billion of assets in California are at risk due to water dependency.

A great point that Secretary Laird made in his opening is that individuals often view sea-level rise as a future problem. However, he said that looking back, there has already been seven inches of sea-level rise over the 20th century. This demonstrates that California is in the middle of the problem and is not just looking at this prospectively. The crisis is already here and action needs to be taken now.

Secretary Laird shared that in December 2013, the Natural Resources Agency released a public review draft of the Safeguarding California Plan for ways to reduce climate risk, provide guidance, and take action. This plan is a policy guidance document for state decision makers and includes a chapter on Ocean and Coastal Ecosystems and Resources, which discusses risks from sea-level rise and recommendations for action still needed. The Safeguarding California Plan is a multi-sectoral plan meant to work in conjunction with sector specific implementation efforts such as Ocean Protection Council's sea-level rise resolution and sea-level rise guidance document. The Safeguarding California Plan recommends careful consideration of new development in areas vulnerable to flooding, inundation, and sea-level rise to minimize the adverse effects of sea-level rise and storms.

In addition, Secretary Laird said that the administration released the draft of the Bay Delta Conservation Plan which seeks to avoid water supply disruption and protect water quality by modernizing and updating California's water delivery facilities. He emphasized that the rising sea level will impact the Delta in two important ways: 1) increase the risk of overtopping and other forms of levee failure and 2) increased saline/brackish tidal pressure, which if not counteracted by increases in freshwater outflows will lead to increased saltwater intrusion and higher salinity levels in the Delta.

Even Governor Brown is involved in these issues as he has been appointed to President Obama's Task Force on Climate Preparedness and Resilience. The Natural Resources Agency, along with other state agencies and departments, are helping to staff this effort to provide recommendations to the task force and the federal government to encourage actions and support efforts to preparing for climate risks including sea-level rise.

In terms of other work the administration is doing to specifically address sea-level rise, the Ocean Protection Council in 2011 collaborated with a dozen other partners to implement a Coastal Climate Needs Assessment. The survey showed that the top two barriers for taking action on sea-level rise are lack of funding and lack of staff. As a result, the Natural Resources Agency has developed partnerships to address these barriers to support local

governments in assessing vulnerabilities and developing plans to reduce risk. To lessen these barriers, two coordinated grant programs were implemented. The Coastal Commission's Local Coastal Program (LCP) Assistance Grant Program and the Ocean Protection Council's Local Coastal Program (LCP) Sea-Level Rise Grant Program. The 2013 Budget Act approved an appropriation of \$1 million to the Coastal Commission to provide these grants which are the first LCP planning grants available since fiscal year 2000-2001. The Ocean Protection Council authorized \$2.5 million for their grant program. A second round of these grants has already been announced for another \$1 million from the Coastal Commission and another \$1.2 million from the Ocean Protection Council.

As demonstrated by these grant programs, local governments in all regions of the state are interested in taking action to reduce risk from sea-level rise. In fact many local governments are in the phase of conducting vulnerability assessments for sea-level rise, while others are working on developing land-use policies to address the issue. However, there is not enough state funding appropriated to support local governments in assessing vulnerabilities and reducing risk – applicants to the Coastal Commission's grant round requested over five times the amount of available funding. This still remains a challenge.

Secretary Laird asserted that public awareness and education needs to be a focus in order to tackle the issue of sea-level rise. The Natural Resources Agency, along with other government agencies and non-profit partners, are helping to raise awareness about sea-level rise and its accompanying risks through the California King Tides Initiative for example. The initiative asks the public to take pictures of king tides to show potential effects of future sea-level rise. The photographs provide coastal managers important information on the most vulnerable areas and provide a glimpse into the impacts of rising seas.

Secretary Laird concluded that sea-level rise is a slow-moving train wreck, but reminded nonetheless that it is still a train wreck. Just because sea-level rise will have more dramatic impacts in 50 years, does not mean that planners should wait until 50 years to address the problem. The Natural Resources Agency through their Safeguarding California Plan, through the work of the Ocean Protection Council, and through the King Tides Initiative are trying to provide guidance to the public and raise awareness that sea-level rise with all its impacts is coming and people must take action.

California Coastal Commission

Dr. Charles Lester, Executive Director of the California Coastal Commission

Dr. Lester discussed the Commission's work related to preparing for sea-level rise. Since 1972 California's coastal program has a tremendous record of protecting the values of the coast, including providing thousands of public accessways to and along the shoreline, preserving and restoring thousands of acres of marine, wetland, and terrestrial habitats, and

keeping hundreds of miles of rural agricultural and scenic coastlines nearly the same as they were 40 years ago.

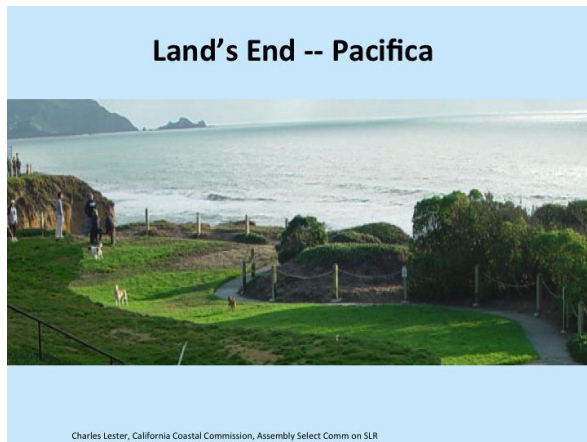
The success of the coastal program has been built on a strong and vital partnership between the state and local governments and active public participation. The Commission has 76 local governments (61 coastal cities and 15 coastal counties) in the coastal zone and in recognition of this the Commission established the Local Coastal Program (LCP) to implement statewide interests at the local level – 85% of coastal zone governed by an LCP developed by local governments in partnership with the Commission.

Finally, coastal management and land use planning is inherently dynamic. Change is constant, there is inherent uncertainty in many areas, and thus, constant management effort is needed. California must change, adapt, and update land use plans and development rules to address changing conditions such as sea-level rise.

Since its inception the Commission has addressed coastal hazards and new development by attempting to set back development sufficiently to be “safe” for its economic life. Coastal erosion can also be episodic, not incremental, creating emergency situations if planning is not done. Setbacks due to inadequate planning also lead to seawall and other shoreline structure developments that have adverse impacts on public access, recreation, and other coastal resources.

Dr. Lester gave the Lands End apartment complex as a good example. The Lands End apartments were built just before the Commission began regulating coastal development. At that time the apartments were set back from the bluff edge 150 feet based on an assumed 75 year life and 2 feet of erosion a year. The buildings were actually endangered less than 40 years later. The Lands End Apartments in Pacifica lost over 90 feet of bluff land in places over several months in 2009-2010, illustrating the sometimes “episodic” nature of bluff erosion, and placing the buildings in an emergency situation. In August, 2013, the Commission gave its final approval to the large emergency seawall to protect the buildings. On the next page you can view two sets of comparison images of the bluff, before and after the erosion.

Before:



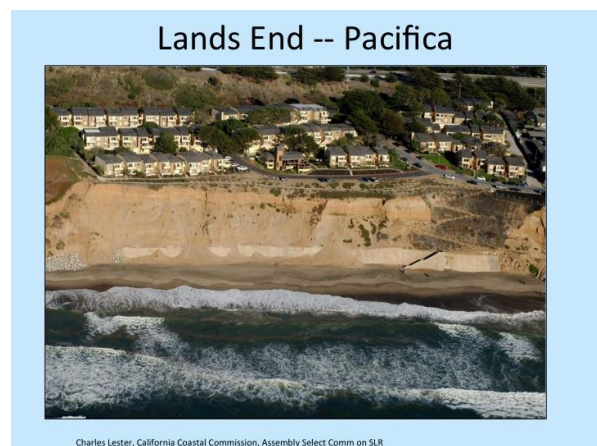
After:



Before:



After:



To further guard against inherent uncertainties, Dr. Lester stated that the Commission has also applied a strong regulatory program to require that property owners assume the risks of developing in inherently hazardous locations. The challenge squarely in front the state is how to address accelerating sea-level rise in already urbanized or developed areas, in a way to protect private property interests and public trust resources.

Port Hueneme is another example that illustrates the tension between emergency response and proactive planning. \$2 million was approved by the Legislature to pay for the emergency revetment placed to protect coastal road, infrastructure and public access, due to the cessation of historic beach replenishment from the adjacent harbor dredging. The Commission is also working actively with Caltrans to plan for and relocate Highway One in numerous locations along the coast, as well as integrate the consideration of sea-level rise into major public highway projects, such as the I-5 expansion in San Diego.

Sea-level rise will significantly exacerbate coastal hazards, including accelerating bluff and shoreline erosion, and exacerbating storm conditions, wave attack and coastal flooding. The best available science establishes that sea levels will be rising, though there is some

uncertainty as to exactly how much. No matter what is done with greenhouse gas emissions, sea level will continue to rise for hundreds of years. Thus, adapting in some way to this geophysical reality cannot be avoided.

Dr. Lester shared that the Commission adopted a Strategic Plan in April of 2013 that includes a Multi-Pronged Strategy to Address Climate Change. The Commission is also currently in the development of comprehensive Sea-Level Rise Guidance for local governments and development applicants. The draft Sea-Level Rise Policy Guidance was out for public review on October 15, 2013. The guidance includes direction to:

- Use best available science to identify locally-relevant sea-level rise
- Assess local risks and impacts
- Analyze planning scenarios and development constraints
- Identify adaptation measures
- Update LCPs/design projects to address hazards (be adaptive) and protect other coastal resources
- Monitor and revise

The central piece of the Commission's coastal adaptation strategy is to enhance the LCP planning program. The primary goal is to update LCPs with new policies and land use planning to provide for intelligent adaptation to sea-level rise and other climate changes. Most LCPs were approved in the 1980s and are significantly out of date. In addition to the Commission's Strategic Plan, both the 2009 California Adaptation Strategy and the recently released draft Safeguarding California Plan recognize the importance of updating LCPs to address climate change.

However, the planning capacity of the Commission and local governments is significantly constrained. Increased investment, like the budget augmentation that the Commission received last year for the LCP program, will need to be sustained. In addition, more local assistance funds will be needed to support local government. On January 8, 2014, the Commission awarded \$1 million in LCP assistance grants to 11 local jurisdictions, but 28 applications requesting \$5.2 million had been submitted, illustrating the clear need for additional planning resources. The Commission will be allocating an additional \$1 million later this year.

In summary, Dr. Lester shared that the Commission's overarching strategy for coastal adaptation planning and responding to sea-level rise is centered on the existing LCP program and update of local community plans to provide for intelligent adaptation to coastal hazards while protecting coastal resources. The Strategy requires investment in vulnerability assessments to inform LCP updates, and on-going intergovernmental coordination across five primary sectors: public access and recreation, sensitive resources, urban development, critical industrial infrastructure, and transportation infrastructure. New agencies or programs are not required;

rather, the state should invest in existing programs and institutions to achieve its coastal adaptation objectives.

Dr. Lester concluded by stating that people will adapt to a changing climate and environment. The important questions are: how and when? Comprehensive planning and investment in adaptation strategies will lead to more sustainable adaptation that both provides for a strong economy and a healthy environment.

California State Lands Commission

Jennifer Lucchesi, Executive Officer, California State Lands Commission

Ms. Lucchesi discussed her agency's experience with addressing sea-level rise. As background, the State Lands Commission serves the people of California by managing and protecting over 4 million acres of sovereign land, including the beds of California's navigable rivers, lakes and streams, and the state's tide and submerged lands. The Commission's jurisdiction extends along the state's over 1,100 miles of coastline and offshore islands from the ordinary high water mark to three nautical miles offshore. The Commission also exercises residual oversight authority over sovereign public trust lands granted in trust by the Legislature to approximately 80 local jurisdictions.

There are a tremendous amount of State owned land and resources under the Commission's jurisdiction that will be impacted by rising sea levels. Increased storm intensity and sea-level rise may put existing structures at risk and may lead to the loss of sandy beaches in some areas along the coast, while some areas may see an increase in the amount of sand deposited on the beach. One significant impact of sea-level rise as it relates to the Commission's jurisdiction will be to property boundaries from the resultant changes in the elevation of the mean high tide line. Because the boundaries of these lands are typically based upon this mean high tide line, sea-level rise can impact boundaries between state-owned sovereign land and private uplands.

Ms. Lucchesi shared that the Commission's efforts to address sea-level rise go back to 2009 when the Commission considered and approved "A Report on Sea Level Rise Preparedness," which was prepared to address concerns expressed by the Commission about sea-level rise and its implications for California's economic and social future. The Report included the results of a survey conducted by staff to assess the extent to which the Commission's grantees and lessees had considered the potential impacts of sea-level rise on their public trust lands. Of the 140 surveys sent out, only 40 responses were received. Based on the answers provided, it became apparent to Commission staff that the majority of the respondents had not yet begun to comprehensively consider the impacts of sea-level rise. As a follow-up in July 2010, Commission staff resurveyed 110 major lessees and grantees. Twenty seven

responses were received, 13 of which were first time responders. Of the 27 responses, 13 said that they had considered no action to address sea-level rise.

In addition to addressing the survey responses, the 2009 Report offered recommendations to better assess the impacts of sea-level rise on existing facilities, as well as future development proposals that may be considered by the Commission. One of the recommendations that the Commission implemented, was revising its surface leasing application to require applicants proposing new development to address whether any feature of the project would be subject to sea-level rise or other effects associated with climate change over the life of the project; and if so, the applicant must include an explanation of proposed adaptation strategies. This revision to the leasing application is shown below.

California State Lands Commission

“A Report on Sea Level Rise Preparedness”: One Year Later

• **Surface Leasing Application**

e. If the project involves development, in an area subject to tidal action, provide a risk analysis, implications of failure, and adaptation strategies for addressing projected sea level rise of 16 inches by year 2050 and 55 inches by year 2100, relative to the projected life expectancy of the project. Adaptation strategies may include alternate project designs to prevent impacts.

f. What engineering standards are being relied on to address potential impacts from sea level rise on proposed or existing facilities throughout the life of the project?

Part II, Section B, Subsection 1 ←

California State Lands Commission
Land Management Division Page 7 of 16 Revised: 10/12/11

Part III, Section B →

Will the project involve:	Yes	Maybe	No
1. A change in existing features of any bays, tidelands, beaches, lakes, or hills, or substantial alteration of ground contours?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. A change in scenic views from existing residential areas or public lands or roads?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. A change in pattern, scale or character of the land use at or in the general area of the project?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Impacts to plants or animals?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The potential introduction or spread of non-native species?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Any feature subject to sea level rise or other effects associated with climate change over the life of the project? If so, please explain in detail and address any planned adaptation strategies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Generation of solid or liquid waste or litter?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

California State Lands Commission
Land Management Division Page 12 of 16 Revised: 10/12/11

Courtesy of Jennifer Lucchesi, Presentation to Select Committee

In addition to these internal efforts, Ms. Lucchesi stated that the Commission is an active participant in addressing sea-level rise in many external ways. For example, the Commission actively participates on the state’s Coastal and Oceans Climate Action Team which is working together with a multitude of stakeholders to educate and advise policymakers on mechanisms to prepare and plan for climate change and sea-level rise. The Commission has also worked

hard to address the impacts of sea-level rise on granted public trust lands, which includes tidal and submerged lands underlying the state's ports, harbors, and marinas.

Facilities and coastal access within the Commission's jurisdiction are especially vulnerable to incremental sea-level rise and storm surges with extreme high tides. Other climate change and sea-level rise related impacts affecting the Commission's administration of its jurisdiction include a potential increase in the number of applications the Commission receives to build seawalls or other protective structures.

Ms. Lucchesi conveyed that the Commission will also have to address the impacts of sea-level rise on property it manages pursuant to other agreements. An example is the historic Bolsa Chica Lowlands Restoration Project in Orange County that involves four state agencies, four federal agencies, and the Ports of Los Angeles and Long Beach. The \$151 million Restoration Project was completed in 2006, and resulted in the successful restoration of hundreds of acres of coastal wetlands on land also owned by the Commission. The Restoration Project was designed long before the current sea-level rise projections were in place. The Commission, however, as the landowner and financial trustee for the Restoration Project, will play a leading role in the long-term preservation of the habitat created by the Restoration Project, including protection from sea-level rise. In addition, as sea levels continue to rise the Commission's staff anticipates receiving more applications for large scale beach nourishment projects to address erosion.

In her close, Ms. Lucchessi suggested that the Legislature continue thinking about how to identify and prioritize sea-level rise planning goals, including providing agencies with the funding and resources necessary to address sea-level rise. The Commission also suggested that the Legislature begin thinking about how to provide guidance to mitigate potential public access conflicts and that guidance from the Legislature should reflect the importance of public access and the special/unique characteristics of public trust lands. Finally, she recommended that state and local governments should continue to coordinate their planning efforts and establish goals that are consistent and complementary to ensure effective planning for sea-level rise.

California State Coastal Conservancy

Nadine Peterson, Deputy Executive Officer, California State Coastal Conservancy

The Coastal Conservancy is the non-regulatory arm of the state's coastal management program. Their geographic boundaries include the entire coastline and its watersheds, the San Francisco Bay 9-county region, and the near-shore ocean area. The Conservancy's authority was expanded through SB 1066 in 2012. This legislation provided the Conservancy with explicit authority to help communities address climate change impacts and reduce greenhouse gas emissions while prioritizing expenditures on projects that maximize public

benefits. Ms. Peterson stated that the Conservancy's work on climate change is focused within four categories: policy and guidance; developing basic data including research, modeling, and decision-support tools; supporting local and regional resiliency planning; and implementing pilot and other projects that improve resiliency.

The Conservancy's climate work fits within the overall statewide policy context of the Natural Resources Agency's "Draft Safeguarding California Plan" and the Office of Planning and Research's "Draft Environmental Goals and Policy Report," which promote integration of climate resiliency measures into all policies, escalation of efforts to safeguard the state's natural systems and critical infrastructure, and building sustainable regions that support healthy livable communities.

Ms. Peterson shared that the Conservancy prioritizes project funding decisions based on a number of its adopted policies, project selection criteria, strategic plan, and on requirements specific to funding sources. These are updated as needed to respond to emerging issues and state policies. In response to the Governor's 2008 Executive Order and subsequent work by CO-CAT and the Ocean Protection Council, the Conservancy adopted its own Climate Change Policy and Project Selection Criteria, which requires consideration of a range of sea-level rise scenarios, and to the extent possible, projects must reduce risks and increase resiliency to sea-level rise.

The Conservancy has also provided funding for development of several regional sea-level rise assessments. Each has a different set of regional and site-specific characteristics that must be factored in to effectively plan for future conditions.

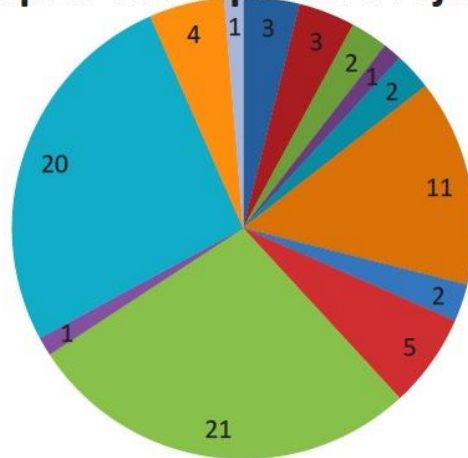
The most successful adaptation planning work is collaborative, and involves local stakeholders working hand in hand with policy makers, planners and experts. Many tools are now available that allow stakeholders to visualize modeling results for multiple scenarios of sea-level rise, and to assess and compare the benefits and costs of alternatives adaptation measures. Humboldt Bay is one example of where the Conservancy has supported sea-level rise planning with community involvement.

Preparing for sea-level rise is expensive, but not preparing for it will be more expensive. Over the last year, small amounts of funding have been approved to help some communities plan for sea-level rise. The Conservancy is partnering with the Ocean Protection Council and Coastal Commission to help work on grants to fund local communities Local Coastal Program (LCP) updates. In addition, the Conservancy ran its own Climate Ready Grant Program. These grants were available to local governments and non-profit organizations throughout the coastal and San Francisco Bay Area. Originally, a total of \$1.5 million was available for awards through this competitive grant program. However, the Conservancy received 76 proposals, totaling just over \$13 million in requests. 21 of the proposals requested assistance

in addressing sea-level rise and extreme weather and tidal events as shown in the pie chart below.

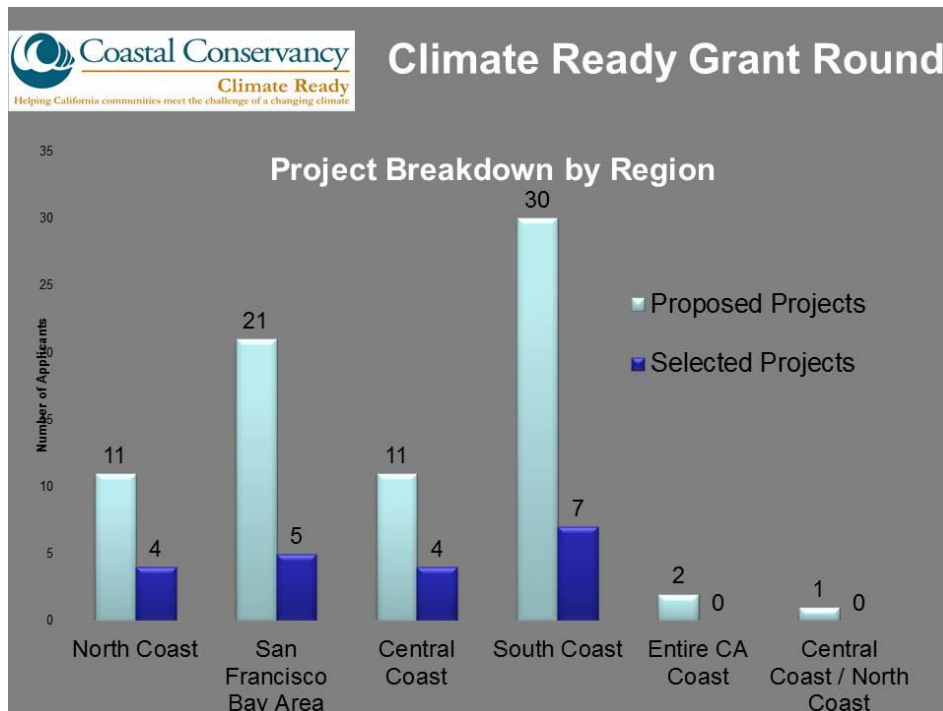


Topics of Proposed Projects



- Agriculture
- Carbon Sequestration
- Education/Outreach
- Fire Intensity
- GHG Reduction
- Green Infrastructure
- Living Shorelines
- Restoration
- Sea Level Rise
- Seawater Intrusion
- Vulnerability Assessment
- Water Recharge
- Wildlife Corridors

At the end of the selection process, the Conservancy identified the 20 highest ranked projects and on January 23, 2014 the Board approved funding these projects, which totaled just over \$3 million. The chart below shows the number of Climate Ready Grant proposals requested and selected for each region.



In addition, the Conservancy identified the following legislative actions that they recommend to further support effective preparation for sea-level rise.

- 1) Direct state agencies to develop and utilize coastal climate smart goals and principles and a shared definition of climate resiliency. Examples of climate smart principles include prioritizing solutions that rely on natural infrastructure.
- 2) Direct coastal zone management agencies to identify the work that is needed to complete coastal adaptation and resilience plans for the entire coast and bay.
- 3) Create a Coastal Zone Management Resiliency Account to allow funds to be deposited from various new and existing sources for the specific purpose of supporting SLR resiliency.
- 4) Require LCPs to address climate change, including sea-level rise and extreme events.
- 5) Support beneficial re-use of sediment by adopting a resolution requesting the federal government to mandate that funding be spent on harbor maintenance projects and allowing beneficial re-use to be an eligible expenditure.

To effectively prepare for rising seas and extreme events, Ms. Peterson suggested that California must make it a priority to fund needed technical and planning work, staff resources, and construction and implementation of on-the-ground resiliency projects. Sea-level rise is going to happen. It will cost money to protect our communities, recreational amenities, and natural resources, but not doing so will result in tremendous losses of life, property, recreational resources, and natural resources.

CONCLUSION

This report is the product of the work of the Assembly Select Committee on Sea Level Rise and the California Economy and shows what the Select Committee has done to address and especially inform the Legislature and the public about the expected impacts of sea-level rise.

Our first hearing brought in scientists and academics who described the science behind why seas are rising and provided a broad overview of the threats and challenges facing California, setting the stage for our remaining hearings. Our second hearing looked in-depth at industries vital to California's economy that are affected by sea-level rise, such as coastal agriculture, fishing and aquaculture industry, and tourism. Our third hearing focused on the impacts of sea-level rise to California's infrastructure, such as its effect on ports, airports, roads, bridges, as well as water and power infrastructure. After hearing directly from affected industries, our fourth hearing turned our attention to how the state is addressing sea-level rise and what role the Legislature could play in responding to this challenge. Agendas, presentation materials, and videos of the four hearings as well as an electronic copy of this report can be found on the Select Committee's website at <http://sealevelrise.assembly.ca.gov/> or by contacting committee staff.

This report is meant to provide the highlights from our four hearings, which informs why sea-level rise is happening and what the impacts will be. This report then goes further and attempts to answer the question "so what can we do about it" by providing policy recommendations that could be implemented through legislation, the budget, and by the administration.

While the Select Committee examined many issues related to sea-level rise and affected entities, there is still much more that can and should be investigated. For example, the impacts to public health have been mentioned briefly, but could be examined further. In addition, the role of the federal government and its agencies should be looked into especially since collaboration among all levels of government is crucial to adequately respond to the impacts of sea-level rise. Further, the issue of flood insurance could encompass an entire hearing. These are just a few examples of additional topics that should be explored.

Sea-level rise is a critical threat to Californians and our state's economy. This has been called a slow-moving emergency, but it is an emergency nonetheless. Therefore, action must be taken now in order to best prepare and adapt for the future. There is a lot of work to be done as we face many impacts from sea-level rise; however, we have time on our side, so let us begin.

ACTIONS TAKEN FROM POLICY RECOMMENDATIONS

From the Select Committee's policy recommendations the following legislation has been introduced in the 2014 Legislative Session:

- AB 2516 (Gordon, Achadjian, Lowenthal, Muratsuchi, Skinner, and Ting) would establish an online statewide Planning for Sea Level Rise Database overseen by the Natural Resources Agency and the Ocean Protection Council. The database would serve as a single source of information that portrays where California is in terms of preparing for, and adapting to sea-level rise. A statewide database would allow coastal zone management agencies and other involved state entities to coordinate and continue a discussion of sea-level rise preparedness. In addition, the database could be utilized as an educational vehicle for state agencies to engage the public about what is currently being done and what could be done to address this threat.
- ACR 160 (Gordon, Achadjian, Lowenthal, Muratsuchi, Skinner, and Ting) would encourage state agencies and non-state partners to consider establishing coastal climate adaptation goals and planning principles to help prepare for the impacts sea-level rise. The resolution would also encourage state agencies to communicate with the public and other entities regarding the risks of sea-level rise and the development and implementation of adaptive and protective measures to address those risks.

From the Select Committee's policy recommendations the following budget actions have been supported and are included in the 2014-15 adopted budget:

- The creation of the California Climate Resilience Account which will be spent by the state's Coastal Zone Management Agencies for coastal zone management activities related to addressing the risks and impacts of climate change, sea-level rise, and associated extreme events to coastal and bay communities and natural resources. Additionally, the budget appropriates \$2.5 million into this Account for planning and implementation activities to address the risks and impacts of climate change and sea-level rise, which will include local assistance grants.
- Additional funding to the California Coastal Commission to work in partnership with local governments to accelerate the completion and updates of Local Coastal Programs (LCPs). This LCP work will include critical climate change adaptation planning and methods to address projected accelerated sea-level rise consistent with the objectives in the Administration's draft Safeguarding California Plan.

APPENDIX 1: SELECT COMMITTEE WORKPLAN



Assembly Select Committee on Sea Level Rise and the California Economy

Richard S. Gordon, Chair

Mission Statement:

The Select Committee on Sea Level Rise and the California Economy has been established to thoroughly review the challenges ahead in addressing the expected impacts of climate change on the California Economy. The Select Committee will examine in research and hearings the impact of sea-level rise on coastal agriculture, parks and other state lands, the fishing industry, and ports and infrastructure, as well as examine the existing authority granted to state entities such as the Coastal Commission, the State Lands Commission, the San Francisco Bay Conservation and Development Commission, and the Coastal Conservancy.

Deliverables:

The Select Committee will develop a report to the Assembly on key issues facing California, strategic potential legislative responses, and possible recommendations for future budget action.

Process:

Staff of the Select Committee will meet with key stakeholders and review reports and existing research in order to create an Assembly database on key issues.

The Committee will hold the following four public hearings.

Hearing Schedule:

Date	Location	Issues and Potential Witnesses
May 15, 2013	Sacramento	Overview and Impact of Sea Level Rise in California <ul style="list-style-type: none">• Threats and issues facing California and its economy Natural Resources Agency Ocean Protection Council Academics

<p>July 24, 2013</p>	<p>Half Moon Bay</p>	<p>Agriculture, the Fishing and Aquaculture Industry, and Tourism</p> <p>Ocean Science and Ocean Acidification Farm Bureau Fishing and Aquaculture Industry State Parks</p>
<p>October 25, 2013</p>	<p>Long Beach</p>	<p>Infrastructure: Ports, Airports, Bridges, Roads and Highways, Water, and Power</p> <p>Port of Long Beach / Port of Los Angeles Port of Oakland San Francisco Airport / San Diego Airport Caltrans</p>
<p>January 16, 2014</p>	<p>Sacramento</p>	<p>How State Agencies are Addressing Sea Level Rise</p> <ul style="list-style-type: none"> • Are agencies prepared to respond? • What work is being done to address this challenge? • How can the Legislature help agencies better respond to this threat? <p>BCDC Natural Resources Agency Coastal Commission State Lands Commission Coastal Conservancy</p>

APPENDIX 2: SELECT COMMITTEE HEARING AGENDAS

Members
Katcho Achadjian
Toni Atkins
Steven Bradford
Rocky Chávez
Jeff Gorell
Bonnie Lowenthal
Al Muratsuchi
Nancy Skinner
Philip Y. Ting



Assembly California Legislature

ASSEMBLY SELECT COMMITTEE ON SEA LEVEL RISE AND THE CALIFORNIA ECONOMY

RICHARD S. GORDON, CHAIR
ASSEMBLYMEMBER, TWENTY-FOURTH DISTRICT

Overview and Impact of Sea Level Rise in California
Wednesday, May 15, 2013
9:30 a.m. – 12:30 p.m., State Capitol, Room 444

AGENDA

- 9:30 a.m. Welcome and Opening Remarks
- Chairman Rich Gordon
 - Members of the Select Committee
- 9:45 a.m. Overview of Sea Level Rise in California
- John Laird, Secretary, Natural Resources Agency
 - Cat Kuhlman, Executive Director, Ocean Protection Council
- 10:15 a.m. The Impact of Sea Level Rise: Threats and Issues facing California and its Economy
- Dr. Gary Griggs, Distinguished Professor of Earth Sciences and Director of the Institute of Marine Sciences, University of California Santa Cruz
 - Dr. Patrick Barnard, Coastal Geologist, U.S. Geological Survey Pacific Coastal and Marine Center, Santa Cruz
 - Becky Smyth, West Coast Director / Regional Division Chief, National Oceanic and Atmospheric Administration Coastal Services Center
 - Dr. Peter Gleick, President, The Pacific Institute
- 11:35 a.m. Preparing for the Effects of Global Warming: The American Public's Perspective on Sea Level Rise
- Meg Caldwell, Executive Director, Center for Ocean Solutions, Stanford Woods Institute for the Environment
- 12:00 p.m. Public Comment
- 12:15 p.m. Closing Comments and Next Steps for the Select Committee
- Chairman Rich Gordon

Members
Katcho Achadjian
Toni Atkins
Steven Bradford
Rocky Chávez
Jeff Gorell
Bonnie Lowenthal
Al Muratsuchi
Nancy Skinner
Philip Y. Ting



**Assembly
California Legislature**

**ASSEMBLY SELECT COMMITTEE ON
SEA LEVEL RISE AND THE CALIFORNIA ECONOMY**

RICHARD S. GORDON, CHAIR
ASSEMBLYMEMBER, TWENTY-FOURTH DISTRICT

Impact of Sea Level Rise on California's Coastal Agriculture, Fishing and Aquaculture Industry, and Tourism
Wednesday, July 24, 2013
Half Moon Bay Department Operations Center
537 Kelly Avenue
Half Moon Bay
2:00 p.m. – 5:00 p.m.

AGENDA

- 2:00 p.m. Welcome and Opening Remarks
- Chairman Rich Gordon
 - Members of the Select Committee
- 2:15 p.m. Impact of Sea Level Rise on Coastal Agriculture
- Mary Scruggs, Supervising Engineering Geologist, California Department of Water Resources
 - Norm Groot, Executive Director, Monterey County Farm Bureau
 - Dr. Rosemary Knight, Professor of Geophysics, Stanford University
- 3:00 p.m. Impact of Sea Level Rise on Fishing and Aquaculture Industry and the Effects of Ocean Acidification
- Dr. Gretchen Hofmann, Professor of Marine Biology, University of California Santa Barbara
 - Zeke Grader, Executive Director, Pacific Coast Federation of Fishermen's Associations
 - Greg Dale, Southwest Operations Manager, Coast Seafoods Company
 - Bruce Steele, Commercial Fisherman
- 4:00 p.m. Impact of Sea Level Rise on Tourism
- Jay Chamberlin, Chief of Natural Resources Division, California State Parks
 - Aaron McGregor, Associate Scientist, California Ocean Science Trust
- 4:35 p.m. Public Comment
- 4:50 p.m. Closing Comments
- Chairman Rich Gordon

Sea Level Rise Members

Katcho Achadjian
Toni Atkins
Steven Bradford
Rocky Chávez
Jeff Gorell
Bonnie Lowenthal
Al Muratsuchi
Nancy Skinner
Philip Y. Ting

Ports Members

Toni Atkins
Rob Bonta
Wesley Chesbro
Ken Cooley
Susan Talamantes Eggman
Jeff Gorell
Isadore Hall, III
Al Muratsuchi
Brian Nestande
Nancy Skinner



**Assembly
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JOINT HEARING

SELECT COMMITTEE ON SEA LEVEL RISE AND THE CALIFORNIA ECONOMY

AND SELECT COMMITTEE ON PORTS

RICHARD S. GORDON, BONNIE LOWENTHAL, CHAIRS

Impact of Sea Level Rise on California's Infrastructure

Friday, October 25, 2013

Aquarium of the Pacific

100 Aquarium Way, Long Beach

1:00 p.m. – 5:00 p.m.

AGENDA

- 1:00 p.m. Welcome and Opening Remarks
- Chair Rich Gordon, Chair Bonnie Lowenthal
 - Members of the Select Committees
- 1:20 p.m. Sea Level Rise and California's Infrastructure
- Heather Cooley, Water Program Co-Director, Pacific Institute
- 1:35 p.m. Impact of Sea Level Rise on California's Ports
- Richard Cameron, Acting Managing Director of Environmental Affairs & Planning, Port of Long Beach
 - Antonio Gioiello, Chief Harbor Engineer, Port of Los Angeles
 - Richard Sinkoff, Director of Environmental Programs & Planning, Port of Oakland
 - Kristin Decas, Executive Director, Port of Hueneme
 - T.L. Garrett, Vice President, Pacific Merchant Shipping Association
- 2:40 p.m. Impact of Sea Level Rise on California's Transportation Infrastructure: Airports, Highways and Roads, and Bridges
- Paul Manasjan, Environmental Affairs Director, San Diego International Airport
 - Joe Birrer, Principal Engineer, San Francisco International Airport
 - Andrew Bermond, Project Planner, Santa Barbara Municipal Airport
 - Garth Hopkins, Office Chief for the Office of Regional and Interagency Planning, California Department of Transportation
- 3:40 p.m. Impact of Sea Level Rise on California's Water and Power Infrastructure: Stormwater Facilities, Wastewater Treatment Facilities, and Power Plant Facilities
- Shahram Kharaghani, Watershed Protection Program Manager, City of Los Angeles Bureau of Sanitation
 - Kevin Hardy, General Manager, Encina Wastewater Authority
 - Stephen O'Kane, Manager of Sustainability and Regulatory Compliance, AES Southland
 - Roger Johnson, Deputy Director for the Siting, Transmission and Environmental Protection Division, California Energy Commission
- 4:35 p.m. Public Comment
- 4:50 p.m. Closing Comments
- Chair Rich Gordon, Chair Bonnie Lowenthal

Members
Katcho Achadjian
Toni Atkins
Steven Bradford
Rocky Chávez
Jeff Gorell
Bonnie Lowenthal
Al Muratsuchi
Nancy Skinner
Philip Y. Ting



**Assembly
California Legislature**

**ASSEMBLY SELECT COMMITTEE ON
SEA LEVEL RISE AND THE CALIFORNIA ECONOMY**

RICHARD S. GORDON, CHAIR
ASSEMBLY MEMBER, TWENTY-FOURTH DISTRICT

How State Agencies are Addressing Sea Level Rise in California
Thursday, January 16, 2014
State Capitol, Room 126
9:00 a.m. – 12:30 p.m.

AGENDA

- 9:00 a.m. Welcome and Opening Remarks
- Chairman Rich Gordon
 - Members of the Select Committee
- 9:15 a.m. San Francisco Bay Conservation and Development Commission
- R. Zachary Wasserman, Chair, San Francisco Bay Conservation and Development Commission
- 9:50 a.m. Natural Resources Agency
- John Laird, Secretary, Natural Resources Agency
- 10:25 a.m. Coastal Commission
- Dr. Charles Lester, Executive Director, California Coastal Commission
- 11:00 a.m. State Lands Commission
- Jennifer Lucchesi, Executive Officer, California State Lands Commission
- 11:35 a.m. Coastal Conservancy
- Nadine Peterson, Deputy Executive Officer, California State Coastal Conservancy
- 12:10 p.m. Public Comment
- 12:25 p.m. Closing Comments
- Chairman Rich Gordon