

A Sea Level Rise Strategy for the San Francisco Bay Region

Revised September 2008

“The world we have created today, as a result of our thinking thus far, has problems that cannot be solved by thinking the way we thought when we created them.”

—Albert Einstein

Introduction

Over the past few years, the San Francisco Bay Conservation and Development Commission has become increasingly concerned that continued sea level rise from global warming will have profound impacts in the San Francisco Bay region, largely because over 200 square miles of low-lying filled land borders the Bay. Because BCDC was created largely to regulate Bay fill projects with the goal of preventing the Bay from becoming even smaller from unnecessary landfill projects, BCDC was not legally responsible for dealing with this dramatic change in climatic conditions that is making the Bay larger. Nor did BCDC have any explicit legal authority to address this problem. In light of this situation, in 2006 the Commission requested that the staff provide a broad outline of a comprehensive strategy for addressing climate change in the Bay region and identify any changes that would be needed in state law so that BCDC can play a productive role in implementing such a strategy.

In October 2007, the Commission’s staff released a report describing a comprehensive eight-year Bay Area regional strategy for controlling greenhouses and planning for the impacts of sea level rise. There was little enthusiasm for the initiative described in that report, probably because so many other climate change efforts are under way and because the Commission is not well-positioned to play a lead role in such a broad program. In response, the suggested strategy has been revised so that it focuses on the role BCDC can legitimately play in developing a plan to deal with sea level rise—i.e., a new type of Bay Plan. This effort could be accomplished in four years and could be folded into a broader regional strategy that addresses greenhouse gas reductions.



Meeting the Challenge

Background. San Francisco Bay is the largest estuary on the west coast of the North and South American continents. When the California Gold Rush began in 1849, the open waters and bordering wetlands of the Bay covered 787 square miles, and this magnificent natural harbor teemed with wildlife. But the Bay was shallow; two-thirds of it less than 12 feet deep. The unfortunate result was that as the new State of California began to grow, the Bay began to shrink. Shallow tidal areas were diked off from the open Bay to create salt ponds, farmland and duck hunting clubs. Municipalities used the Bay for garbage dumps. Siltation from hydraulic gold mining in the Sierra foothills washed into the Bay and filled wetlands. And numerous land reclamation operations were undertaken to create dry real estate where Bay waters once flowed.

By the middle of the 20th century, the Bay's open waters had been reduced to 548 square miles and nearly a third of the Bay—239 square miles—was gone. In 1959, the U.S. Army Corps of Engineers published a report which concluded that it was economically feasible to reclaim another 325 square miles—60 percent of the remaining Bay—by 2020. The Bay Area public rejected the notion that the Bay should be allowed to become little more than a wide river. Working together, in 1965, Bay Area citizens convinced the California Legislature to establish a new state agency—the San Francisco Bay Conservation and Development Commission (BCDC)—and to empower the agency to regulate new development in the Bay and along its shoreline so that any future fill placed in the Bay would be largely limited to water-oriented uses that could not be accommodated on existing land.

BCDC has been highly effective in achieving this public policy goal. By limiting the use and size of new landfills and requiring mitigation in the form of wetland creation, BCDC has reversed the shrinkage of the Bay; it is now nearly 19 square miles larger than it was in 1965. With BCDC's support, 26,000 acres of privately-owned salt ponds have been purchased by the public to improve their habitat value and convert some of the ponds to intertidal wetlands, resulting in a further expansion of the Bay.

Global Climate Change. In March 2006, the California Environmental Protection Agency published the *Climate Action Team Report to the Governor and the Legislature*, which evaluated three scenarios for reducing the amounts of greenhouse gases released into the atmosphere over the next century. Depending on whether and how much these emissions can be reduced, the report projects that by 2100 average temperatures in California will rise between 3 and 10.5 degrees Fahrenheit.

One of the most publicized impacts of global warming is a predicted acceleration of sea level rise. This acceleration would increase the historic rate of sea level rise, which has been measured in San Francisco Bay for over 140 years. Between 1900 and 2000, the level of the Bay increased by seven inches. Depending on which end of the range of projected temperature increases comes about, the California Climate Action Team found that water levels in San Francisco Bay could rise an additional five inches to three feet, or nearly one meter by the end of this century. More recent analyses indicate that sea level rise from warming oceans may be 1.4 meters (about 55 inches) over the next 100 years, or even higher depending upon the rate at which glaciers and other ice sheets on land melt.

Using GIS data, BCDC has prepared illustrative maps showing that a one-meter rise in the level of the Bay could flood over 200 square miles of land and development around the Bay. Using financial support from Caltrans and the California Energy Commission, the Pacific Institute is working in partnership with BCDC to determine the value of the development threat-

ened with inundation. Initial estimates indicate that over \$100 billion worth of public and private development could be at risk.

Impacts from sea level rise are most likely to occur in concert with other forces that already contribute to coastal flooding. When superimposed on higher sea levels, these conditions will combine to create short-term extremely high water levels that can inflict damage to areas that were not previously at risk. For example, computer models indicate that a one-foot rise in sea level will increase the likelihood that the most extreme storm surge event, which now occurs once a century, will occur once every ten years. While storm impacts cannot be mapped as easily as sea level rise can, it is likely that larger areas will flood during future storm events.

The Challenge. To prevent San Francisco Bay from continuing to get smaller, the Legislature created BCDC and empowered it to exercise regulatory control over development in the Bay. After four decades of existence, BCDC has been accomplishing the public policy goal set out by the Legislature. However, the greatest threat to the Bay Area over the next century is not that the Bay will get smaller, but that global climate change will make the Bay larger.

The primary responsibility for regulating development in areas likely to be flooded by sea level rise and storm surges rests largely with the nine counties and 52 cities and towns fronting on the Bay. BCDC has no authority to either regulate new development in flood-prone areas or to require flood protection measures to protect any such development in low-lying areas. BCDC does have the authority to protect valuable tidal marsh habitat in the Bay, but as sea levels rise, marshes must migrate upland or be inundated. BCDC does not have authority to ensure that upland areas are available for marsh migration. Further, BCDC has no legal responsibility for reducing greenhouse gas emissions to slow the rate of sea level rise.

Fortunately, the Bay Area Air Quality Management District (BAAQMD), which has the primary legal responsibility for dealing with air pollution in the region, has initiated an aggressive program to reduce greenhouse gas emissions. About half of the carbon dioxide emissions in the region are generated by the transportation sector, primarily by cars and light trucks on the region's highways. Reducing these emissions requires some combination of building new vehicles that are much cleaner and reducing reliance on the private automobile as the primary mode of transportation in the region. To help achieve the latter goal, the Metropolitan Transportation Commission (MTC), the region's transportation planning and financial authority, and the Association of Bay Area Governments (ABAG), the regional council of local governments, are working together on a program called FOCUS, which is aimed at assuring that future growth in the region is more compact, more centered on transit corridors and more sustainable. MTC and ABAG have also joined with the air district to address climate change through a coordinating council called the Joint Policy Committee (JPC). BCDC joined the JPC in a non-voting capacity in 2007, and state legislation was passed in 2008 that allows BCDC to become a voting member of the JPC and directs the Commission to address climate change and sea level rise in its planning activities.

This partnership of four regional agencies is encouraging and essential. But cooperation alone has its limitations. None of the four agencies has the authority to prohibit development in flood-prone areas, and none has the authority to require that levees be constructed to protect low-lying areas. The BAAQMD does not have the authority to regulate emissions from vehicles. That responsibility rests with the California Air Resources Board, which is in the process of formulating a sweeping strategy for cutting greenhouse gases as called for in the California Global Warming Solutions Act of 2006 (AB 32).

BCDC is the only agency in the Bay Area regional partnership with any direct authority to regulate land use, but BCDC's jurisdiction extends only over the Bay and a narrow strip along the immediate shoreline where the Commission's authority is quite limited. The 110 local governments in the Bay Area have the most comprehensive authority over land use. Therefore, to deal most effectively with sea level rise in the Bay Area, a new partnership must be forged which draws on the best capabilities of local governments, federal, state and regional agencies, private enterprise and non-governmental organizations. This new partnership can be built upon the existing close relationships BCDC enjoys with its sister regional agencies, ABAG, MTC, and BAAQMD; state agencies, such as the Coastal Conservancy, the Ocean Protection Council, the Coastal Commission, and the California Resources Agency; federal agencies, including the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the U.S. Geological Survey and other organizations, such as the San Francisco Estuary Project.

Meeting the Challenge with a New Type of Bay Plan. A bold, new plan for the Bay is needed to meet the challenges of sea level rise head-on. The goal of the plan should not be to restore the Bay to historic conditions because climate-induced changes will not allow a return to past conditions. Instead, the plan should be a vision for resilient communities and adaptable natural areas around a dynamic and changing Bay that will have different sea level elevations, salinity levels, species and chemistry than the Bay has today. A new pattern of development will be needed to respond to these changing conditions. Because the rate of sea level rise and other impacts of climate change are still uncertain, the plan should embrace a pro-active adaptive management strategy that can respond to changes that will come about in the future as a result of climate change.

This new plan should draw from the lessons learned during the formulation and implementation of BCDC's existing, highly effective *San Francisco Bay Plan*, particularly the Bay Plan's goal of fostering both conservation and development. The new plan should rely on ecosystem-based adaptive management principles to ensure that future development, shoreline retreat, flood protection and habitat enhancement strategies are coordinated to achieve a vibrant, healthy Bay co-existing with sustainable communities along the shoreline.

The first step in preparing this plan should be to determine more precisely which shoreline areas are vulnerable to flooding and storm surge from sea level rise. With this information in hand, the value of both built and natural resources that will be impacted can be determined. Next, the flood-prone areas that are already occupied by development that is too valuable not to protect should be identified. Using this information, a regional flood protection strategy can be prepared to describe all the dikes, levees and other protective devices that need to be built.

The next areas that should be identified are: flood-prone areas where it may be more cost-effective to remove existing development than to protect low economic value structures; low-lying areas that are planned for development that has not yet been built where it may be more cost-effective to abandon these plans than to try to protect the new development from flooding; and undeveloped upland areas where marshes can migrate when sea levels rise. Making these choices will be difficult, particularly if the areas contain significant environmental, aesthetic, social, cultural or historic resources or where the removal would raise environmental justice issues.

Another probable impact of climate change is that more precipitation in the Sierra Nevada will fall as rain rather than snow, and the snow pack will melt earlier in the spring. In turn, this will reduce late spring and summer runoff into the Delta, allowing salt water to extend farther

into the Delta than it does now. Sea level rise and higher flood flows resulting from climate change, as well as earthquake risk, will also increase the probability of catastrophic levee failure. These conditions could result in the Delta becoming a more estuarine ecosystem. Therefore, the Bay Area's planning should be closely coordinated with the planning for the Delta.

Tidal wetlands must play a key role in any regional climate change strategy because wetlands play two roles. They are both adaptive to climate change by buffering shorelines from storm surge, and tidal wetlands help mitigate the impacts of climate change by sequestering carbon. Hundreds of millions of dollars have already been invested in wetland restoration projects in the Bay Area, and billions of dollars of more investments in habitat enhancements are planned. Unfortunately, inundation of tidal marshes would be devastating to the San Francisco Bay ecosystem, and the extent and location of wetlands and other habitats likely will shift as a result climate change. However, there is limited space along the shoreline available for marsh migration. Much of the shoreline is either developed or migration is precluded by topography. Pulling existing development back from the Bay's shoreline and foregoing planned development of low-lying areas can provide an opportunity to build on past investments and allow for migration of tidal wetlands. Therefore, development of upland areas that are suitable for marsh migration could pose a long-term threat to ecological sustainability in the Bay.

This new plan for the Bay should be prepared by a partnership of government agencies that takes full advantage of the unique strengths, expertise and experiences of BCDC, MTC, ABAG and the BAAQMD, in cooperation with federal and state agencies, local governments, the business community, academic institutions, and other organizations, with the JPC providing the overarching coordination of the planning process.

State Legislation. To develop and begin implementing a comprehensive regional strategy to address sea level rise in the Bay Area, state law should be enacted to require and authorize the following to be accomplished over a four-year period. Although this schedule is ambitious, any delay will simply allow the problems the region is facing to become acute crises.

- **Sea Level Rise Maps.** Within one year, BCDC should be required to prepare detailed maps that depict the areas that are most likely to be inundated around San Francisco Bay and the Suisun Marsh as a result of projected sea level rise and storm activity within the next 50 years and within the next 100 years. The maps should reflect scientific consensus on the highest rates of sea level rise expected within the scenario that reflects current global emission trends.¹
- **BCDC's Jurisdiction.** Two revisions should be made to BCDC's regulatory and planning jurisdiction: (1) the Commission's regulatory authority over the shoreline area extending 100-feet inland from the Bay should be expanded to allow BCDC to decide if and under what conditions new shoreline development should be authorized while the plan is being prepared; and (2) BCDC's permit and planning jurisdiction should be expanded eastward so that it includes all of the Bay and waterfront areas along the Bay/ Delta

¹ It is particularly difficult to develop a thoughtful strategy for dealing with sea level rise in the Bay when the temperature increase scenarios used by the California Climate Change Center yield possible increases in water level in San Francisco Bay over the next 100 years that have a tenfold difference between the lowest and highest potential increases. The uncertainties inherent in planning for the future can be reduced by half by developing a strategy with a 50-year time horizon and updating the strategy every ten years to incorporate emerging information. A 50-year planning horizon is short enough to offer more certainty, yet long enough to amortize most capital investments made in accordance with the strategy.

shoreline of Solano County and Contra Costa County to enable BCDC to more effectively participate in the formulation and implementation of regional public policy decisions that have been endorsed by the Joint Policy Committee.

- **Socio-economic and Ecological Determination.** Within two years, BCDC should be required to determine:
 - (a) The social and economic value of all existing and permitted built resources² within the area expected to be impacted by sea level rise;
 - (b) The cost of protecting these resources from inundation through the construction of seismically-safe levees or sea walls, raising the elevation of infrastructure or implementing ecologically-sustainable shoreline protection strategies;
 - (c) The economic and ecological value of all natural resources expected to be impacted by sea level rise;
 - (d) The cost of acquiring any upland areas needed to allow wetlands to migrate as sea levels rise or otherwise mitigating the impacts of sea level rise on wetlands and other important habitats; and
 - (e) The cost of removing or relocating the resources that are projected to be inundated in those areas where BCDC has determined that the cost of protection exceeds the value of the resources.
- **Sea Level Rise Adaptation Plan.** Within four years, BCDC should be required to prepare an adaptation plan that includes a strategy for adapting to sea level rise in San Francisco Bay and the Suisun Marsh over the next 50 years. The plan should take full advantage of ecosystem-based management principles to ensure that future development, shoreline retreat, flood protection and wetland enhancement strategies will be coordinated to achieve a vibrant, healthy Bay that co-exists with sustainable communities around the Bay. The plan should determine the measures needed to adapt to projected sea level rise by identifying:
 - (a) The most significant structural, environmental, aesthetic, social, cultural and historic resources that must be protected from inundation;
 - (b) Those areas that are inappropriate for protection from inundation;
 - (c) Those areas that are most suitable for wetland restoration, habitat enhancement and other opportunities that would enhance the biological productivity of the Bay;
 - (d) Undeveloped uplands that are suitable for marsh migration; and
 - (e) Strategies and techniques that will make future conservation and development projects more resilient to climate change.

The primary goals of the plan should be for the region to adapt to sea level rise in a manner that enhances the biological productivity of the San Francisco Bay estuary,

² The built resources to be identified should include the complete range of all built infrastructure, including buildings, road and rail networks, airports, waste treatment facilities, parks, utilities and any other public or private physical structures, facilities or improvements that could be damaged or suffer a loss in economic value if exposed to inundation or would result in costs to society if flooded, such as landfills and contaminated lands.

advances continued economic prosperity in the Bay Area, and addresses environmental justice issues. In addition to using socio-economic cost-benefit analyses to produce the information need for the plan, BCDC should be required to fully coordinate its planning for the Bay and the Suisun Marsh with the planning for the Sacramento-San Joaquin River Delta by the Department of Water Resources and whatever entity emerges as the primary Delta planning authority. The Suisun Marsh Charter Group should be required to address the impacts of climate change, potential catastrophic levee failure and salinity increases in its planning, and such planning should be incorporated into the plans prepared for San Francisco Bay by BCDC and for the Delta by its respective planning authority. The plan should also include recommendations on any further changes to law, authority or investments needed to implement the plan.

- **Regional Coordination.** To ensure that BCDC takes full advantage of the expertise, resources and perspective of all affected members of the Bay Area community, the Commission should be required to actively engage the following constituencies in its evaluation and planning activities: members of the public, the private sector, educational and research institutions, environmental and community organizations, local governments, regional agencies and organizations, and state and federal agencies.
- **Joint Policy Committee Oversight.** To ensure that BCDC's analyses and planning policies are fully integrated with the region's plans and programs dealing with transportation, air quality, housing, employment, seismic hazards, water quality and general land use, the sea level rise maps, socio-economic and ecological determination and sea level rise adaptation plan described above should be reviewed by the regional Joint Policy Committee prior to final adoption by BCDC.

For further information or to comment on this proposal, please contact BCDC's Executive Director, Will Travis, (415/ 352-3653 travis@bcdc.ca.gov) or BCDC's Deputy Director for Climate Change, Steve Goldbeck (415/ 352-3611 steveg@bcdc.ca.gov).

“There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things. Because the innovator has for enemies all those who have done well under the old order of things, and lukewarm defenders in those who may do well under the new.”

–Niccolo Machiavelli