3.0 GEOLOGY, SEISMICITY, AND TSUNAMIS

3.1 BACKGROUND AND SETTING

3.1.1 Geology, Seismicity, and Ground Stability

The general geological setting for the Humboldt Bay area is described in subsection 4.2.2 in Chapter 4, Section II, Volume I of the Draft Management Plan.

The Humboldt Bay region occupies the western margin of the North American tectonic plate, which is moving westward, in opposition to the eastward-moving Gorda tectonic plate. The boundary between the plates is the geological fault known as the Cascadia Subduction Zone (CSZ), which is capable of producing significant earthquakes and significant tsunamis. South of Cape Mendocino the North American plate abuts the northward-moving Pacific tectonic plate. This plate boundary is the fault known as the San Andreas Fault, which also is capable of producing significant earthquakes. The boundary between the Pacific plate and the Gorda plate is a second transform fault called the Mendocino Fault, which also is capable of significant earthquakes.[1] The region in which the three tectonic plates meet is known as the Mendocino Triple Junction, which includes the region of Cape Mendocino and the Mattole River basin.

The relative regional motions of the tectonic plates have resulted in the landscape that includes the Humboldt Bay region. The regional convergence between the North American and Gorda plates has resulted in the elevation of the Coast Ranges (and in many geological features and phenomena that are not addressed here). The net relative effect of the motions of the three plates in the region of the triple junction has been to create a compressional force along the Humboldt County coast that roughly parallels the coastline at Humboldt Bay (i.e., compression in a northeast-trending direction).

The essential effect of this compressional force has been to create a series of "wrinkles" in the region's geology (often analogized to the wrinkles in a stiff rug pushed together from the two ends). The compression has elevated Table Bluff, Humboldt Hill, the Eureka terrace, and a number of other topographically high areas in the Humboldt Bay region, while causing intervening areas (e.g., the Eel River delta) to bend downward. The alternating series of elevated areas and intervening depressed areas that make up the Humboldt Bay regional geography originates from this essential source. The actions through which this landscape has been created are generally known as earthquakes.

The form of Humboldt Bay, with its enclosing sand spits, is a result of differing geomorphological processes. The actions of ocean waves on open coastal landforms and longshore transport result, in a general manner, in the formation of coastal barrier bars and spits across the mouths of coastal embayments. This process has resulted in the formation of barrier bars in the Eel River delta and in the coastal lagoons in Humboldt County, and the process has produced similar results in many other parts of the world.

1 There are significant faults within the North American and Gorda plates which may produce damaging earthquakes; however these faults are less directly related to the Humboldt Bay setting and are not described here.

There is no current evidence that these primary geological processes have ceased to operate, and it is anticipated in this Plan that they will continue to affect the Humboldt Bay region in the future.

While the potential consequences of the geological conditions in the Humboldt Bay region are significant for people in the region, the implications for the Management Plan are more limited, because the District does not have direct responsibility for land uses or other approvals that would significantly affect the exposure of people to risks from these sources. The primary considerations that the potential for seismic events and tsunamis raise for the Management Plan concern the potential effects of these events on harbor-related infrastructure such as docks and shoreline protection.

Major seismic events and tsunamis could result in a variety of effects on the Bay, including the direct destruction of shoreline facilities by shaking, lurching, or other loss of shoreline cohesion; erosion because of tsunami wave forces; potential undermining and an indirect failure because of liquefaction or wave scour; shoaling in bay channels as a consequence of tsunami-shifted sand; or an accumulation of water-borne debris in the Bay's channels.

Seismic-safety planning in the Humboldt Bay region has been refocused within the decade since a CSZ seismic event conclusively demonstrated that the CSZ was as active as other subduction zones. Prior to 1992, the most significant tsunami-related effects known within northern California were associated with the 1964 Crescent City tsunami, which resulted from a subduction-zone seismic event in Alaska, and it was not considered that such tsunami effects might occur from seismic events occurring in the vicinity of Humboldt Bay. Following the 1992 CSZ event near Cape Mendocino, the California Division of Mines and Geology (now the California Geological Survey) issued a report identifying a "design event" for the CSZ (Toppozada and others 1995) that would be expected to be associated with significant seismic-shaking impacts as well as major tsunami impacts. The potential effects in the Humboldt Bay region would not be unlike the effects of the December 2004 seismic event and tsunami in Indonesia. The potential for significantly damaging tsunami waves that would affect Entrance Bay and South Bay in such an event is high. [2]

The geological and seismic setting of the Humboldt Bay area is characterized in substantial conceptual detail in a geological investigation prepared by PG&E (2002) for the Humboldt Bay Power Plant. The regional geology is also characterized generally in the context of California geology in the excellent treatment by Harden (2004). Generally, the Humboldt Bay region reflects a combination of sediment deposition in a Tertiary ocean basin (Harden 2004:300-303), faulting (Harden 2004:366-371), and regional uplift and coastal emergence (Harden 2004:415). All of these factors are associated with the tectonic dynamics of crustal plates in the region that is now California (Harden 2004:282), although the complete geological history of northwestern California is not yet established.

For planning purposes, the most significant geological concern generally is faulting and earthquakes. The seismic setting for the Humboldt Bay Management Plan includes the potential for seismic shaking from several earthquake sources: (i) intraplate earthquakes

2 See the webpage of the Redwood Coast Tsunami Work Group for more information, at URL: http://sorrel.humboldt.edu/~geodept/earthquakes/rctwg/toc (viewed January 2005).

(primarily along transform faults) in the Gorda Plate, (ii) Mendocino Fault system transform earthquakes, (iii) San Andreas Fault system transform earthquakes, (iv) intraplate earthquakes (primarily along thrust faults) in the North American Plate, and (v) Cascadia Subduction Zone (CSZ) great thrust earthquakes. The potential for damaging groundshaking varies according to the source of the shaking. Historical earthquakes in the Humboldt Bay region have not included many CSZ events, and policy guidance from the California Geological Survey is currently still being developed with respect to reliable, specific predictions about CSZ effects in the region.

The energy released in an earthquake is used to calculate a "magnitude" for the event (e.g., a Richter Magnitude). The magnitude, once established, is a fixed characteristic of an earthquake.[3] Mathematical relationships of fault length and other characteristics can be used to predict magnitude ranges for future earthquakes on existing faults. However, the perceived effects of an earthquake depend on distance from the location of the earthquake, sediment type and degree of consolidation, and other factors. The same earthquake (with a fixed magnitude) may be perceived as stronger or weaker at different locations; a scale called (generally) an "intensity scale" can be used to reflect locally perceived intensity.[4]

Summarizing current understanding about faults, earthquakes, and the groundshaking that will result, Table 3-1 (modified from Dengler and others 1992) lists the potential effects of events resulting from the five most likely sources of earthquakes in the Humboldt Bay region. Energy magnitudes are expressed as the range of magnitudes that could result from earthquakes along the identified faults. The intensity ranges are the peak intensities expected for earthquakes from each source; these peaks might not necessarily result from earthquakes with the greatest magnitudes. See Dengler and others (1992) for additional information.

A further clarification regarding the potential effects from a Cascadia Subduction Zone earthquake was included in the "planning study" for a potential CSZ "scenario earthquake" in the Humboldt Bay area (Toppozada and others 1995). In general, the anticipated energy magnitude is 8.4, from an earthquake along the CSZ fault which dips shallowly to the northeast approximately 12 miles below Eureka. Potentially damaging ground shaking in the project area will last for a minimum of 60 seconds. The projected earthquake intensity (i.e., the "experienced" strength of the earthquake) would be associated with a potential for significant damage and disruption in the project area.

The California Geological Survey classifies faults as "active" if there is evidence of fault movement during Holocene time (within the last 11,000 years). Faults are considered "potentially active" if there is evidence of movement more than 11,000 but less than 1.8 million years before the present. All of the sources of seismic ground motion listed in Table 3-1 are considered to be "active."

3 For example, the energy magnitude for the 25 April 1992 CSZ earthquake was 7.1, with two smaller earthquakes (not CSZ earthquakes) that same day of magnitude 6.6.

4 For example, the intensity of the April 1992 CSZ earthquake was VIII in the Petrolia area, VII in Rio Dell, and V in Eureka.

Table 3-1. Potential Source Areas of Damaging Earthquakes in the Plan Area.

NAME	LOCATION AND STYLE OF FAULTING	MAGNITUDES OF DAMAGING EARTHQUAKES	PEAK INTENSITIES	RECURRENCE
Gorda Plate Example: 11/8/80 (surface wave magnitude 7.2)	primarily offshore; strike-slip faulting	5 to 7.5 (historic)	VII to VIII (historic)	5.5 years for intensities ≥VII (combined Mendocino Fault and Gorda Plate sources)
Special notes: accounts for majority of historic seismicity, most probable source of damage in the near future; primary impact to coastal communities of Humboldt County.				
Mendocino Fault Example: 6/25/68 (local magnitude 5.9)	offshore west of Cape Mendocino; primarily strike-slip faulting	5 to 7.5? (historic)	VII to VIII (historic)	5.5 years for intensities ≥VII (combined Mendocino Fault and Gorda Plate sources)
Special notes: second most common source of historic earthquakes, primarily impacting communities near Cape Mendocino and those in the Eel River Valley and Humboldt Bay areas.				
San Andreas Transform System Example: 4/18/06 (magnitude 8.3)	onshore and near-shore, south of triple junction; primarily strike-slip	5.0 to 8.3 (historic)	VII to IX (historic) in southern Humboldt County	of 1906 San Andreas-type earthquakes, 200 to 400 years
Special notes: less probable but potentially more damaging than Gorda Plate or Mendocino Fault earthquakes; primary impact in southern Humboldt County and Humboldt Bay areas.				
North American Plate no historic large thrust earthquakes	onshore and shallow; primarily thrust-faulting	6.5 to 8+ (expected)	≥IX for thrust events (expected)	for thrust events, hundreds of years
Special notes: less probable in near future than Gorda Plate or Mendocino Fault earthquakes; much greater impact; possible tsunami.				
Cascadia Subduction Zone no historic great subduction zone earthquakes. April 25, 1992 M = 7.1 involved slip at the southern end of the zone	onshore and offshore; rupture length 125 miles (200 km) or more; thrust-faulting	7.1 (historic); southern segment *ca.* 8.5; whole zone *ca.* 9 to 9.5 (expected)	in Humboldt and Del Norte counties; ≥X (expected)	300 to 500 years
Special notes: less probable in near future than Gorda Plate or Mendocino Fault earthquakes; most damaging of all potential sources; likely to generate a tsunami.				

Source: Modified from Dengler and others 1992.

Additional sources of potential damage associated with geotechnical conditions in the Humboldt Bay region include seismically induced or related land movements of several sorts: (1) liquefaction, (2) lurching, (3) landsliding, and (4) differential settlement or differential movement.

- *Liquefaction* is an effect that results in saturated granular soils (particularly rounded sandy and silty materials) subjected to strong seismic motion. The loss of cohesion reduces the ability of the material to support surface structures. There is ample evidence of liquefaction that has been associated with many of the major earthquakes in the Humboldt Bay region, and ground surface failures have affected structures near the margins of Humboldt Bay.
- *Lurching* is related to the sideways movement of an unconfined surface soil layer toward the unsupported side-surface, such as a streambank, road cut, or levee. The movement may occur as a response to seismic shaking, but the effect may be exacerbated if there are saturated, granular layers underlying the unconfined material and liquefaction provides a sliding surface.
- *Landslides* are mass movements of earth in sloped areas. Generally the lands that are subject to District regulation are unlikely to be subject to failure because of landsliding, since these lands do not include steep slopes.
- *Seismically induced differential land movement* may include differential settlement or differential movement in contrasting geological materials. The potential for materials of differing composition to move differently when subjected to seismic shaking (either co-seismically or as a consequence of differential settlement) can be associated with shearing movements that could rupture buried pipelines and other utilities. Previous seismic events have resulted in (probably abrupt) subsidence in bay-margin sediments, and there is historical evidence of damage to pipelines in the Humboldt Bay region associated with seismic events.

3.1.2 Tsunami

The Humboldt Bay region is subject to tsunamis, more commonly known as "tidal waves" or seismic sea waves, generated by submarine landslides, earthquakes, or other events that alter the elevation of a large area of ocean floor. These waves are capable of causing major property damage and loss of life upon arrival at shorelines adjoining the affected water body. Tsunami risk in the Humboldt Bay area differs for tsunamis generated by distant earthquakes and tsunamis resulting from certain local earthquakes. Tsunami run-up elevations for distant earthquakes (i.e., for earthquakes not within the Cascadia Subduction Zone; see below) were calculated for ocean-exposed locations by Houston and Garcia (1978), including normal tidal cycle elevations. On ocean beaches the predicted run-up elevations for tsunamis from distant earthquakes were approximately 3.3 to 3.6 meters (10 to 11 feet) for a tsunami event expected approximately once per century and about 6.4 meters (about 21 feet) for an event with a once-in-500-years frequency.

The April 1992 CSZ earthquake modified shoreline elevations near the Mattole River and generated a tsunami that reached the Humboldt Bay area approximately 20 minutes after the onset of the event (Oppenheimer and others 1993). This indicates that a major event within the Cascadia Subduction Zone could generate a large tsunami with an arrival time in the Humboldt Bay area of 20 minutes or less (perhaps in as little as five minutes). Studies summarized in Toppozada and others (1995) concluded that the "scenario

earthquake" would likely produce locally generated tsunami waves with a height of approximately 10 meters (about 33 feet) in water offshore about 150 feet deep. As these waves approached the shore, they would be expected to increase in relative height; that is, the waves at the beach shoreline west of Humboldt Bay would exceed 10 meters (about 33 feet) in height above the pre-wave water level.

The tsunami waves from this "design" CSZ event would be expected to cross the low dunes of the peninsulas west of Humboldt Bay, particularly the area of the Samoa Peninsula south of the Samoa townsite and the South Spit, producing a "high velocity wave hazard" for the peninsula and the eastern shoreline of the bay between King Salmon and the mouth of Elk River.[5] The landforms on the peninsula likely would absorb some of the waves' energy, however, and the higher dune elevations north of Samoa could reduce wave overwash. The effect and height of the waves would be reduced significantly on the east side of Humboldt Bay and on the islands in the bay, but the waves would carry debris that could be associated with substantial damage even some distance from the waterfront on the east side of the bay. Tsunami events from a major CSZ earthquake likely would also inundate the diked former tidelands behind levees in most of the Humboldt Bay basin. Many of the "predictions" of this technical report are echoed and confirmed by the detailed investigations reflected in PG&E (2002). In response to the enhanced knowledge about tsunami risk on the Pacific Coast, and particularly the risk in the Pacific Northwest, an earthquake warning system has been implemented in California, in which the District is a participant. Should an earthquake warning be issued that affects the Humboldt Bay region, the District is responsible for evacuating Woodley Island.

The December 2004 Indonesian earthquake and the resulting tsunami provided additional stimulation for emergency planners to consider tsunami risks in California. According to a recently released report of the California Seismic Safety Commission,[6] California is not adequately prepared for the probable effects of tsunami events that could occur in the state. Many of the considerations and recommendations in the Commission's report are germane for the Humboldt Bay region, although they are beyond the scope of this EIR document. In a general sense, both the level of planning for a Cascadia Subduction Zone-related tsunami and the degree of preparedness of most individual Californians are judged by the Commission not to be adequate for avoiding significant infrastructural and financial impacts on either a statewide or a local scale.

3.1.3 Other Flooding Concerns Relevant for the Management Plan

The subject of a "100-year flood" is generally understood in the context of flood in river or stream channels, and such an event is approximately defined as a high-water event that statistically would be expected to occur once per century if hydrological records for a

5 See URL: http://www.humboldt.edu/~geodept/earthquakes/rctwg/toc.html, the webpage of the Redwood Coast Tsunami Work Group (viewed October 2005).

6 "The Tsunami Threat to California: Findings and Recommendations of Tsunami Hazards and Risks 2005." See URL: http://www.seismic.ca.gov/(viewed December 2005).

century were available for assessment.[7] Such stream-related flood events do not have any appreciable effect on the water surface elevation in Humboldt Bay, and a flood flow in any of the Bay's tributaries would not noticeably affect the water surface elevation in Humboldt Bay, no matter how large or intense the flow event may be.[8]

A concern for the Humboldt Bay Management Plan is that the water surface elevation attained by a flood flow can be increased if the flow is constrained from occupying the floodplain of the stream or river. Essentially this result occurs because the flood behaves like a wave moving downstream through the stream system. The flood wave is composed of a mass of water that must be accommodated with the stream channel and its floodplain. If the "space" within the stream's floodplain that would be occupied by the water in the larger part of the flood wave is not available to contain the water because the floodplain has been separated from the stream by levees, then the surface elevation of the flood wave rises even higher in the constrained channel. Thus the height or intensity of flood events in the tributary streams to Humboldt Bay may be increased by the presence of the levees that separate the diked former tidelands, which are the "floodplains" of the streams as they approach the bay, from the streams.

The local intensity of flood waves may also be exacerbated by development or other land uses in the bay's watershed that increase runoff intensity and shorten its delivery period to the streams; see Chapter 5.0 for additional consideration of the hydrological changes associated with development.

While the water surface elevation in the bay is essentially unaffected by flood waves in tributary streams, the relationship is not true in the reverse direction. The surface elevation of water in the bay responds to tidal elevation and to several meteorological factors. When the bay's surface elevation is lower than the surface elevation of a flood entering the bay from a tributary, the flood flows freely into the bay. When the bay's surface elevation is higher than the surface elevation of the flood flow, the flood flow stops flowing and the stream "backs up," causing the flood surface elevation to increase upstream. This effect is generally not very important except for lands that are close in elevation to the height of the flood wave, such as the levees near the bay and some low-lying lands near tributary mouths. However, with an increased sea level the potential that the effects of the bay acting as a "hydraulic dam" for tributary flows may be a more significant concern in the future (see Chapter 5.0).

3.2 ISSUES TO BE ADDRESSED AND THRESHOLDS OF SIGNIFICANCE

The primary issues identified in the Initial Study process that are related to geological concerns arise in two separate but related sections of the Environmental Checklist (see

7 Such lengthy hydrological data records are seldom available in the western United States, and the magnitudes of "100-year floods" are subject to revision, generally upwards, as the lengths of periods of existing records increase.

8 As noted above, the water surface elevation in Humboldt Bay could be affected by tsunamis, which may be assessed statistically for their intensity just as flow events can, and the general relationship is that water surfaces in the bay may raised to higher elevations by tsunamis that occur less frequently. That it, the general relationship between tsunami "intensity" and recurrence interval is similar to that for flow events, with less-frequent events being larger.

Appendix A). The first set of issues are geological in nature (Section VI), and include the following: item VI (a)(i) addresses the possible exposure of people or property to hazards because of the rupture of known earthquake faults; item VI (a)(ii) addresses the exposure of people or property to hazards because of strong ground shaking; and item VI (a)(iii) addresses the exposure of people or property to hazards because of seismically related ground failure, including liquefaction. The second set of issues arises from the flooding-related concerns covered in Section VIII, including the following: item VIII (h) addresses the placement of structures within a "100-year flood hazard area," a context that includes the waters of Humboldt Bay; item VIII (i) addresses risks to people or property because of flooding; and item VIII (j) explicitly addresses flooding risk because of tsunami events.

Generally there were no responses to the Notice of Preparation that raised additional issues with respect to geological, seismic, tsunami, or other flood-related concerns.

Thresholds of significance for these concerns in a programmatic environmental document crafted for a management plan are not easily drawn. This EIR adopts the "threshold of significance" convention throughout the EIR that the potential environmental effect of the plan would be significant if the proposed policies in the plan increase the potential for occurrence of a possible environmental effect (impact) beyond the degree that would exist if the policies recommended in the plan were not carried out. The assessment of the effect of the plan for each particular issue requires a judgement regarding the likelihood that the plan will lead to actions that will create or exacerbate adverse conditions that would not occur without the plan. If a reasonable argument is possible that the Plan's policies would exacerbate a possible adverse condition, or create a new adverse condition that does not occur at the present time, then the effect of the Plan is judged to be environmentally significant

3.3 Environmental Effects of Proposed Plan and Plan Alternatives

3.3.1 "No Project" (Existing Master Plan)

The 1975 Humboldt Bay Master Plan acknowledged the risk of major seismic events in the Humboldt Bay region, but erroneously indicated only a modest risk to harbor-related structures. The Master Plan also erroneously indicated a low risk of tsunami inundation and tsunami-related damage in the Humboldt Bay vicinity, indicating that there was a potential that rapid currents associated with tsunami events could affect docks and shoreline structures. The Humboldt Bay Master Plan did not incorporate guidance for any of the issues addressed in this chapter.

The District's existing ordinances are also largely silent regarding these issues. The majority of the management requirements for earthquakes and/or tsunamis established for the Humboldt Bay region are those resulting from agencies that have statutory and regulatory authority over these subjects. For seismic concerns per se, the most significant agency is the California Geological Survey (formerly the Division of Mines and Geology), the state agency most directly responsible for carrying out the requirements of the Alquist-Priolo Earthquake Fault Zoning Act and other state laws.[9] Additional

9 See URL: http://www.consrv.ca.gov/CGS/rghm/ap/index.htm (viewed December 2005).

responsibility for addressing seismic, tsunami, and flood hazards is shared among the Humboldt County Office of Emergency Services,[10] the California Office of Emergency Services,[11] and the Federal Emergency Management Agency.[12] Currently the District cooperates with these agencies in developing and carrying out emergency management programs that affect Humboldt Bay. If the HBMP were not adopted and implemented, this working relationship would continue unchanged.

3.3.2 Proposed Management Plan

Implementing the Draft Humboldt Bay Management Plan could lead to potential actions that could affect, or be affected by, geological or seismic safety or stability, or that could affect, or be affected, by tsunami or meteorological flooding risk. The policies would produce these effects indirectly, as a consequence of implementing actions or activities that could occur in carrying out some of the policies. The following policies in the Draft Plan may be associated with these stability and safety-related seismic and tsunami concerns because of their potential for exposing people or structures to seismically related failures or to possible tsunami or meteorological flood-related inundation.

Harbor Policies:

- HLU-6: Develop "specific plans" for District-owned parcels
- HSM-1: Develop an inventory of shipping terminal facilities necessary to carry out adopted harbor-related planning policies for Humboldt Bay
- HSM-2: Develop standards for new and existing Humboldt Bay shoreline protection
- HSM-3: Develop appropriate, consistent shoreline protection guidelines for commercial, industrial, and residential development around Humboldt Bay
- HWM-2: Dredging may be authorized to meet Plan purposes
- HWM-3: Re-deposition of dredged materials within Humboldt Bay may be authorized to meet Plan purposes
- HWM-4: Placement of fill within Humboldt Bay may be authorized to meet Plan purposes
- HWM-7: Evaluate channel maintenance alternatives for the community of King Salmon

The Draft Management Plan is intended to provide a "self-mitigating" programmatic management program for Humboldt Bay. In general, the goal in such an approach is to assure that policies that could result in adverse effects are accompanied by other policies that moderate or prevent possible adverse effects. The Plan's success in avoiding impacts depends entirely on the full implementation of all of the Plan's policies.

3.3.2.1 Seismicity and Ground Stability

The Draft Management Plan has a (relatively minor) potential for exposing people and property to the effects of seismic shaking and related geological instability concerns.

10 See URL: http://www.co.humboldt.ca.us/sheriff/OES/ (viewed December 2005).

11 See URL: http://www.oes.ca.gov/Operational/OESHome.nsf/1?OpenForm (viewed December 2005).

12 See URL: http://www.fema.gov/regions/ix/index.shtm (viewed December 2005).

While the District does not explicitly regulate concerns of these types for the majority of the lands near Humboldt Bay, the District is responsible for crafting and implementing policies that address shorelines and potential fill areas in the bay. Structures constructed on fill in or adjacent to the bay (e.g., docks and/or levees) would be subject to intense shaking during earthquakes, which could be associated with damage resulting from the shaking itself, or as a consequence of lurching or liquefaction. Structures located on lands owned by the District would be subject to the same potential effects, and the District would arguably bear a greater degree of authority for regulating the design or construction of these uses than of similar uses elsewhere in the Bay. This EIR finds that the potential effects related to seismically related shaking or ground failure would be environmentally significant.

The District bears no direct authority to enforce seismic safety standards for most occupiable structures or for most fills in upland areas adjacent to the bay, which are regulated under building and/or grading ordinances of the upland land uses authorities (the county and the cities). Structures proposed to be located on new fill within the bay would be subject to the same regulations, even if the filling activities required approval by the District. Structures proposed to be located on District-owned parcels would also be subject to regulation by other agencies. Virtually the only structures that would be regulated directly by the District under the Draft Plan would be those covered directly by the policies identified above; i.e., those related to shoreline structures and shipping-related facilities near the bay's margins or its channels.

The options that are available to the District for addressing stability-related impacts in the topical areas in which the District has direct jurisdiction (e.g., shoreline structures) are therefore limited to: (1) requiring compliance with adopted building and grading requirements in state or local laws, or (2) requiring that uses approved by the District exceed the standards in state or local laws. The Draft Management Plan does not explicitly address this topic. However, Policy HSM-2 directs the District to develop, in coordination with relevant governments, a set of "appropriate standards and guidelines for shoreline areas" in the bay. This policy direction will allow the District, in consultation with relevant state and local agencies, to accommodate suitable seismic safety and stability elements into the standards and guidelines developed under the policy. This EIR finds that a modification to policy HSM-3 will address seismic and ground stability concerns in these areas of District jurisdiction (Section 3.4). In addition, a new policy is recommended below that directs the District to consult directly with the state and local agencies charged with managing emergency response in California to assure that District implementation programs address state standards in these areas. This EIR finds that these policy measures adequately address the District's obligations under CEQA, because these measures constitute the entire feasible response that is available to the District.

This EIR also finds that it is unknown whether the factors that may be included in the design standards developed pursuant to the policy will remove all potential failure risk, and notes that such a conclusion is virtually impossible to reach owing to the inherent uncertainty about seismic and stability concerns.

3.3.2.2 Tsunami

The potential effects of tsunami waves on structures near Humboldt Bay are considered in this EIR to place such structures at significant risk of destruction, and people and

property associated with these structures may be damaged or destroyed. In addition, the damage to of destruction of these structures could directly interfere with potential emergency response efforts that involved ocean vessels. This EIR identifies both of these potential effects as environmentally significant.

An additional effect of such tsunami-related impacts would likely include a short-term to long-term adverse effect on economic activity with the Humboldt Bay region, a socioeconomic effect that is not strictly germane for this EIR, but one that is likely to be of concern for decision-makers in the region.

As with seismic concerns covered above, the District lacks direct authority to address these tsunami-related concerns. This EIR recommends that an additional policy be added to the harbor section of the Draft Plan to direct the District's staff and decision-makers to consult with the Office of Emergency Services and other federal, state, and local agencies that manage emergency responses in California to assure close District coordination with these agencies in focusing the District's resources in responding to tsunami events. This additional policy addresses the District's CEQA obligations for the adoption of the Humboldt Bay Management Plan, because there are no additional feasible mitigation measures that the District could adopted.

As noted in the previous subsection, it is unknown whether these measures could remove all potential tsunami-related risks in Humboldt Bay, and this EIR does not speculate regarding that possibility.

3.3.2.3 Other Flooding Concerns

The Draft Management Plan includes no policies that explicitly address upland or bay-margin flooding or the land uses that could be affected by such flooding. The Draft Plan does not have apparent effects on the flooding risks in these areas. The areas that are subject to District jurisdiction are simply too low in the watershed to increase or exacerbate the intensity or magnitude of these events.

However, lands subject to District jurisdiction could contribute to ameliorating these events. Policy CAE-3 in the Draft Management Plan directs the District to work in collaboration with other agencies to develop and implement a wetland restoration and enhancement plan for the Humboldt Bay ecosystem complex. An element of this plan could include the restoration of corridors of diked former tidelands along the major streams that are tributary to Humboldt Bay (Jacoby Creek, Freshwater Creek/Eureka Slough, Elk River, and Salmon Creek). A restoration of marginal floodplain corridors along the channels of these waterways would increase the "out-of-channel" floodwater storage available during long-return-interval meteorological floods. Because such a focus could be developed under the existing policy, no additional policy changes would be necessary to enact such a measure. This topic is considered further in Chapter 5.0.

3.4 POLICY CONSIDERATIONS FOR MITIGATING POTENTIALLY SIGNIFICANT EFFECTS

The policies recommended in the Draft Humboldt Bay Management Plan largely address the potential environmental consequences of the Plan. In order to fully address indirect environmental concerns related to seismic stability, ground failure, and tsunami risk, this

EIR finds that a modification should be made in one existing policy and one new policy should be added. This EIR also finds that incorporating these modifications into the Draft Plan would reduce the potential environmental concerns to levels that comply with CEQA's requirements that the District adopt feasible mitigation measures. Whether it is possible to remove all seismic and tsunami risks associated with Humboldt Bay is an exercise in speculation, but seems unlikely.

An additional policy modification would also address an additional risk of flooding related to meteorological events. This measure is not, however, clearly associated with a potential adverse effect of the Draft Plan, and it constitutes a Plan-related environmental enhancement for the watershed.

3.4.1 Seismic Effects, Ground-Stability, and Tsunami Consultation

This EIR recommends that the following additional Policy HSM-8 be added to Section 3.3 of Chapter 3.0, Section III, of the Draft Plan (added text underlined).

HSM-8: Develop coordinated plan for addressing seismic effects, land stability, and tsunami response plan for Humboldt Bay

Policy: The District shall work collaboratively with the California Office of Emergency Services, other appropriate local, state, and federal agencies, and other interested parties to identify roles and responsibilities that are appropriate for the District in responding to seismic events, tsunamis, or other major sources of damage to infrastructure or regions of Humboldt Bay that are subject to District jurisdiction. The District shall develop suitable emergency response plans for all District-owned properties or facilities that address such events, and shall assure that persons who visit District-owned sites are apprised of the elements of these plans.

3.4.2 Shoreline Stability

This EIR recommends that Policy HSM-3 be amended to read as follows (added text underlined).

HSM-3: Develop appropriate, consistent shoreline protection guidelines for commercial, industrial, and residential development around Humboldt Bay

Policy: The District shall work collaboratively with the City of Arcata, the City of Eureka, the County of Humboldt, relevant state and federal agencies, and other interested parties to identify appropriate guidelines for shoreline protection that meets the requirements of the local, state, and federal agencies. The District shall incorporate standards and guidelines that address potential seismic effects and land-stability hazards, including effects that are related to tsunami events, that may affect shoreline stability and bay-margin land uses in the Humboldt Bay region.

3.4.3 Floodway Enhancement

This EIR recommends that Policy CAE-3 be amended to read as follows (added text underlined; note that this recommendation is also included in Chapter 5.0 of this EIR):

CAE-3: Work cooperatively to develop and implement a restoration and enhancement plan for Humboldt Bay's aquatic ecosystems

Policy: The District, in consultation with the Department of Fish and Game, the Coastal Commission, the U. S. Fish and Wildlife Service, the U. S. Army Corps of Engineers, other

affected state and federal agencies, Humboldt County, the City of Eureka, the City of Arcata, affected landowners, and other interested parties, shall prepare or cause to be prepared a management, and enhancement plan for wetlands and other aquatic ecosystem elements occurring in Humboldt Bay, consistent with the provisions of this Management Plan. The objectives of the plan shall include:

a. to enhance the biological productivity of wetlands
b. to minimize or eliminate conflicts between aquatic ecosystems and developed uses
c. to provide stable boundaries and buffers between developed areas and habitat areas
d. where feasible, to provide guidance for avoiding impacts and to inform mitigation planning for future development proposals that may include aquatic ecosystem areas
e. <u>to accommodate a coordinated response to possible sea surface elevation increases in ways that allow for the enhancement of wetland and the protection of valuable human improvements in the Humboldt Bay watershed</u>
f. <u>to incorporate the enhancement of diked former tidelands, where feasible, into the management of major hydrological events like floods in ways that are compatible with both adjacent land uses and wetland ecosystem functions</u>

The plan shall include an element that ranks various restoration or enhancement options for aquatic ecosystems in a Humboldt Bay-wide sense. The District shall consider the priorities in this plan in establishing mitigation requirements for proposals subject to the District's jurisdiction. The District shall adopt findings with respect to the requirements of this plan when approving District operational programs or when approving any applications for approvals submitted to the District.

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