SECTION 8: Tidal Discharge From Talbert Marsh

8) Dilution and Dispersion of Tidal Discharge From Talbert Marsh

A) Initialization

The Talbert Marsh has a mean tidal prism of 3.0 x 10^5 m^3 (79.3 million gallons) and a storage volume of about 7.6 x $10^5 m^3$ (200 million gallons), see Liedersdorf, et al. (1992). It discharges into the ocean through a pair of short, non-surf zone piercing jetties immediately to the northwest of the Santa Ana River jetties (Figure 1.1). The jetties stop at about the mean tide line about 275 m seaward of the Pacific Coast Highway. During dry summer weather with low waves, a sand spit builds across the inlet in the interior region of the jetties, periodically closing the inlet and arresting tidal exchange between the marsh and the ocean. While the inlet is closed, the marsh continues to receive dry weather flows from the Talbert Channel, draining the City of Huntington Beach. The dry weather runoff progressively raises water levels in the marsh behind the barrier spit, creating a kind of perched pond. This runoff is typically laden with nutrients and bacteria which incubate in the marsh while the inlet remains closed.

The sand spit blocking the inlet is episodically breeched when large summer south swells from Mexican hurricanes and southern hemisphere storms erode the beach and overtop the barrier. Breeching initially cuts a pilot channel through the barrier sand spit, releasing the perched water behind the spit in a single flush of between 80 and 100 million gallons. The flush of marsh water is introduced directly into the surf zone along with the high bacteria levels that have incubated in the marsh waters during the period of inlet closure. Because the marsh waters are close to ambient seawater salinities, the contaminated water quickly infiltrates the surfzone and moves longshore with the littoral drift as shown schematically by the upper panel in Figure 8.1. Following spit breeching and the initial tidal flush

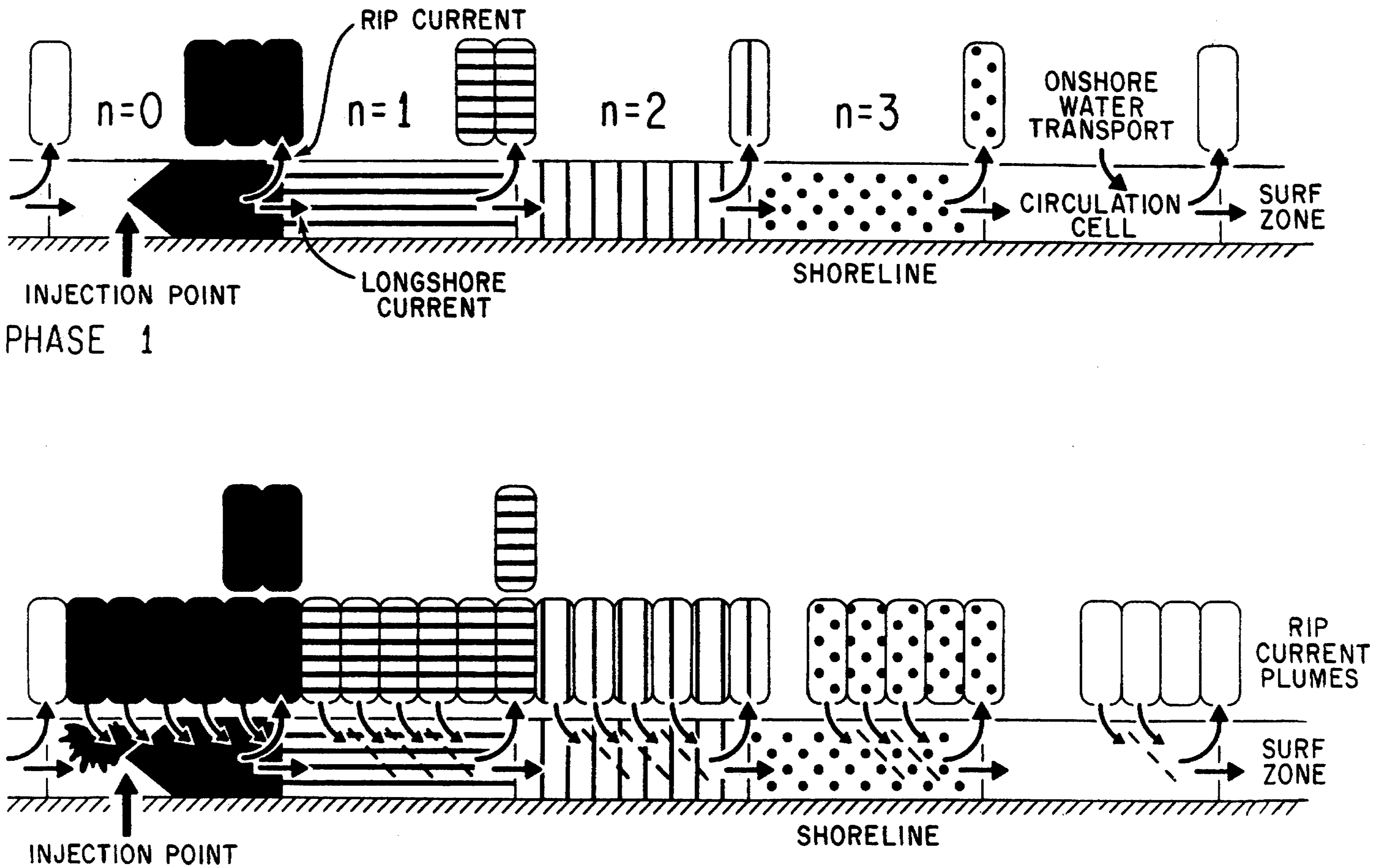

Figure 8.1. Schematic of dilution by rip cell mass transport of pollutants entering the surf zone from a shoreline source [after Inman et al., 1971].

of marsh water, bacteria remain largely confined near the shoreline by the rip current circulation cells. The rip current cells trap the contamination in re-circulation loops between the offshore rip heads and the surfzone as shown by lower panel in Figure 8.1. Each rip cell extends only a few surfzone widths seaward of the break point. Consequently, the contamination disperses primarily in the longshore direction and mixes seaward over distances of no more than 3 or 4 surfzone widths (Inman et al., 1971).

Orange County Sanitation District monitors bacteria levels in Talbert Marsh and adjacent beaches in Huntington and Newport Beach (OCSD, 2001). The maximum recorded total coliform counts in the marsh are on the order of 10^5 mpn/100 ml. We use this bacteria level in a worst case modeling scenario that will consider the release of 100 million gallons from the marsh in a single tidal flush during dry weather summer conditions. We further consider ocean conditions for a summer El Niño with large south swells and nearshore transport directed northwestward toward AES Huntington Beach. For this purpose we use the historic wave and currents conditions for the southern swell event of 7-10 August 1997 (Figures 3.12, 3.19, 3.20 in Section 3). We calculate the dispersion of the total coliform bacteria over a 3-day period assuming no mortality in the bacteria population, to give a worst case assessment of the possibility for being ingested by the AES infall. The bacteria are treated as a neutrally buoyant micron-sized particle in the subroutine **NULLPT** of the model (Figure 2.1 in Section 2).

B) Results

Figure 8.2 through Figure 8.4 give the depth averaged dilution factors for the marsh water over the effected coastline surrounding the Talbert Marsh during a 3 day period following the initial breech of the inlet barrier spit by the south swells

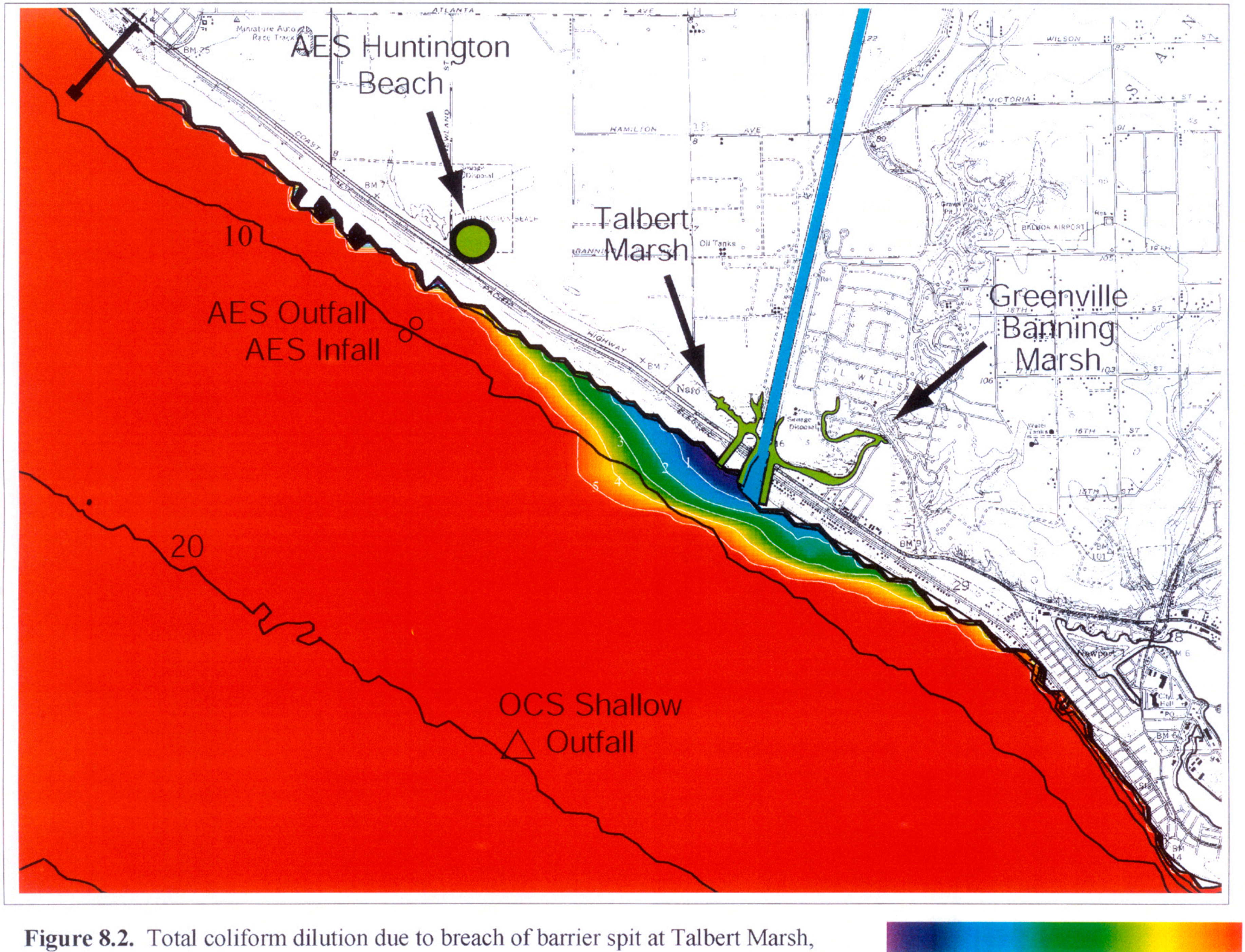

Figure 8.2. Total coliform dilution due to breach of barrier spit at Talbert Marsh, 7 August 1997, 04:10 PDT, ebb tide.

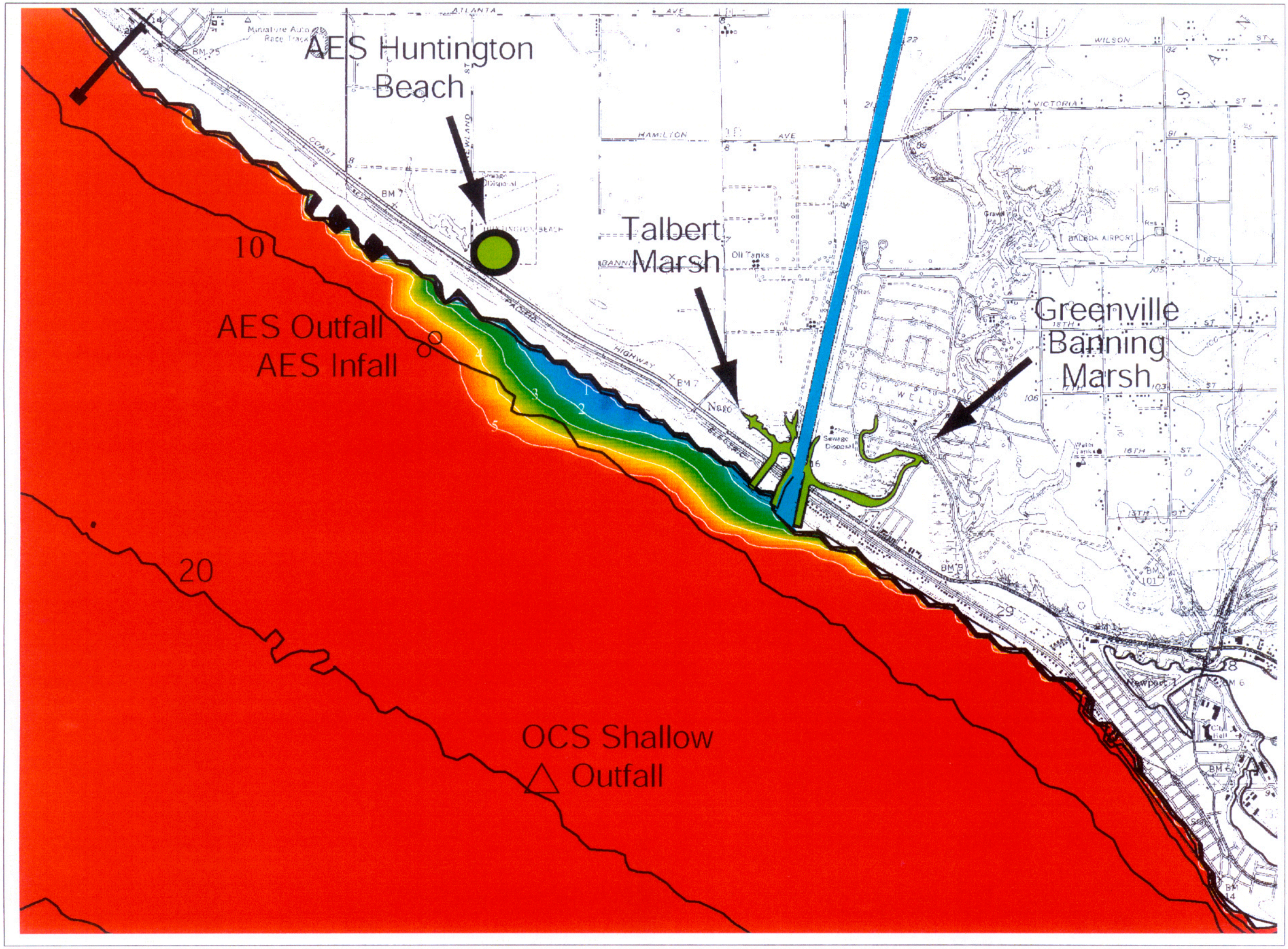

Figure 8.3. Total coliform dilution from Talbert Marsh tidal flush, 8 August 1997, 10:20 PDT.

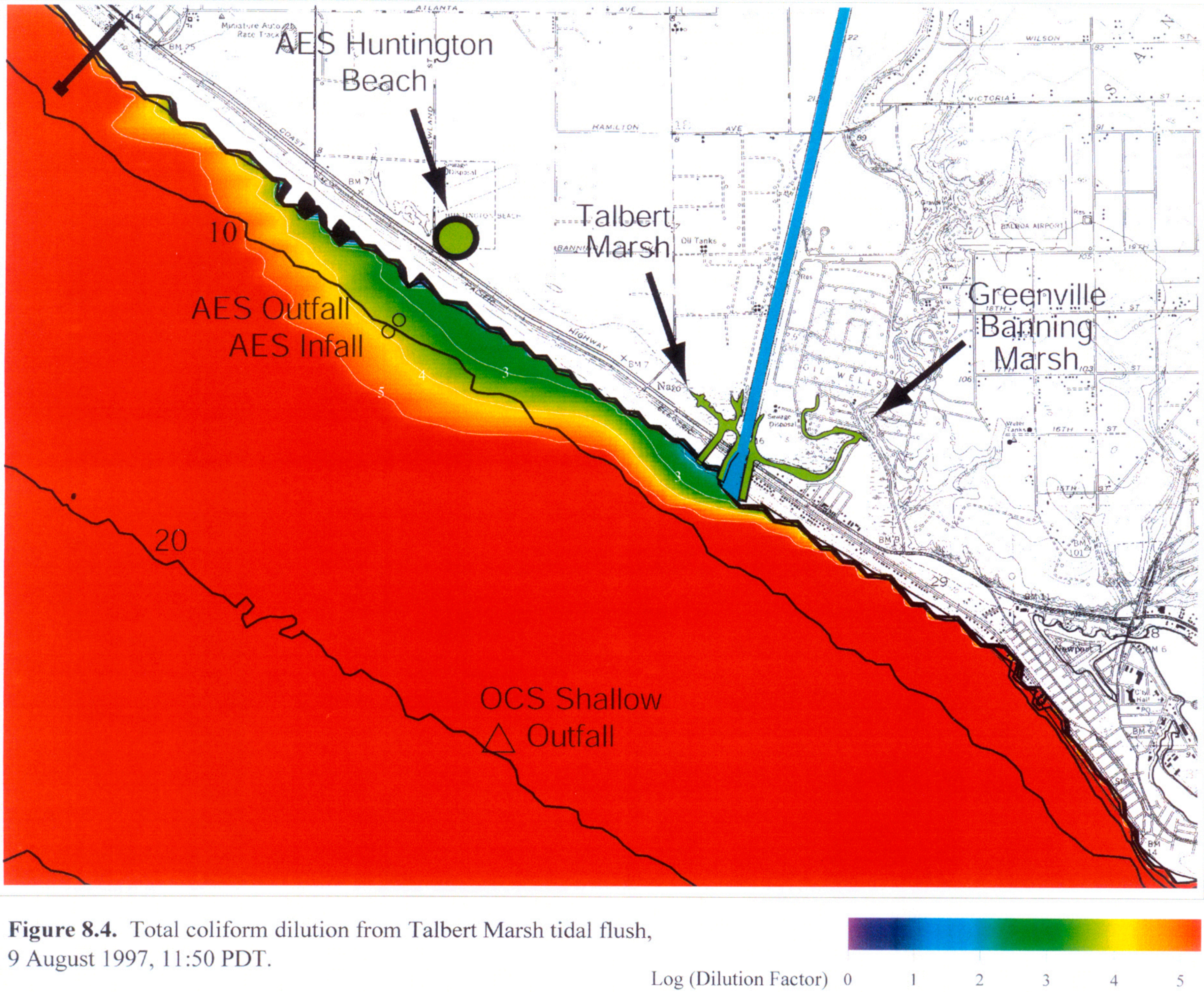

Figure 8.4. Total coliform dilution from Talbert Marsh tidal flush, 9 August 1997, 11:50 PDT.

of 7 August 1997 (Figure 3.12 in Section 3). The marsh water disperses progressively upcoast over the following 3 days as the discharge moves with the north-westward flowing littoral drift induced by the south swells. We find at the offshore location of the AES infall that the contaminated marsh water is diluted by at least 20,000 to 1 over this period. These high dilution factors are a consequence of three factors: 1) the infall is located offshore where deeper water depths afford large dilution volumes, 2) the infall is at a sufficiently large distance from the marsh source, and 3) the onshore fluxes of wave energy and re-circulation by rip cells keep the marsh water confined to the shallow water of the surf zone where dilution volumes remain low. Because the marsh discharges directly into the surf zone, the latter factor explains why coliform counts remain highest in the shallowest water nearshore.

The corresponding total coliform counts caused by the release of 100 million gallons of marsh water having total coliforms of 10^5 mpn/100 is shown in Figure 8.5 thru Figure 8.7. We find that total coliforms released by the marsh reach counts a maximum of 8 mpn/100 ml at the AES Huntington Beach infall during the 3 day period after the initial breeching of the inlet. However in the inshore domain, total coliform counts can range from 10^2 to 10^4 along the shoreline between the generating station and the Talbert Channel. This inshore patch of high coliform counts moves progressively north-westward with the most persistent hotspot in the dispersion occurring at the OCSD sample station #9N near the AES powerplant. The high total coliform counts decay rapidly in the downcoast direction (toward Newport) due to the net transport in the nearshore being directed north-westward during summer El Niño conditions (Figure 3.19 in Section 3). The results in Figures 8.5-8.7 are consistent with total coliform counts

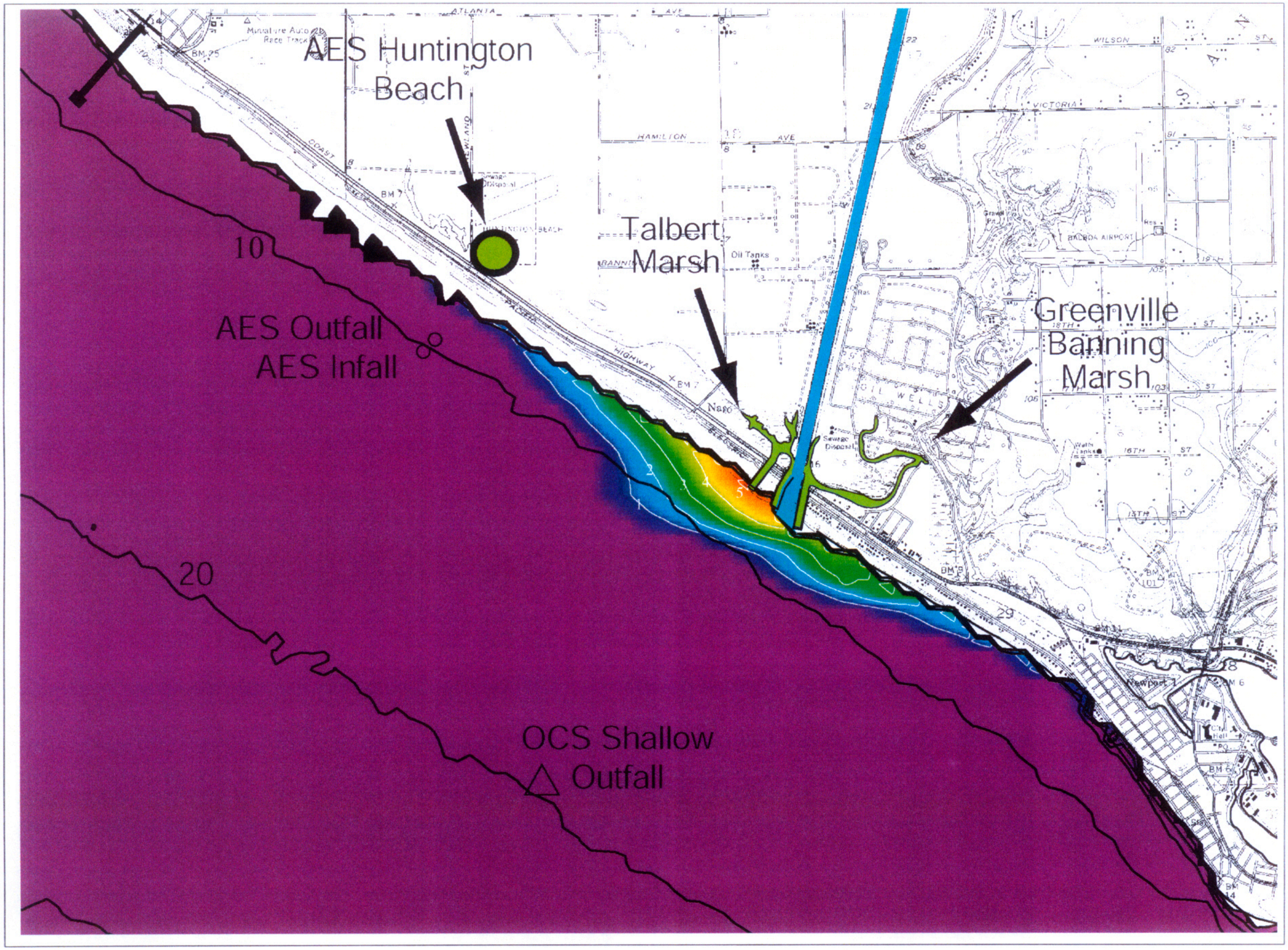

Figure 8.5. Total coliform dispersion due to breach of barrier spit at Talbert Marsh, 7 August 1997, 04:10 PDT, ebb tide.

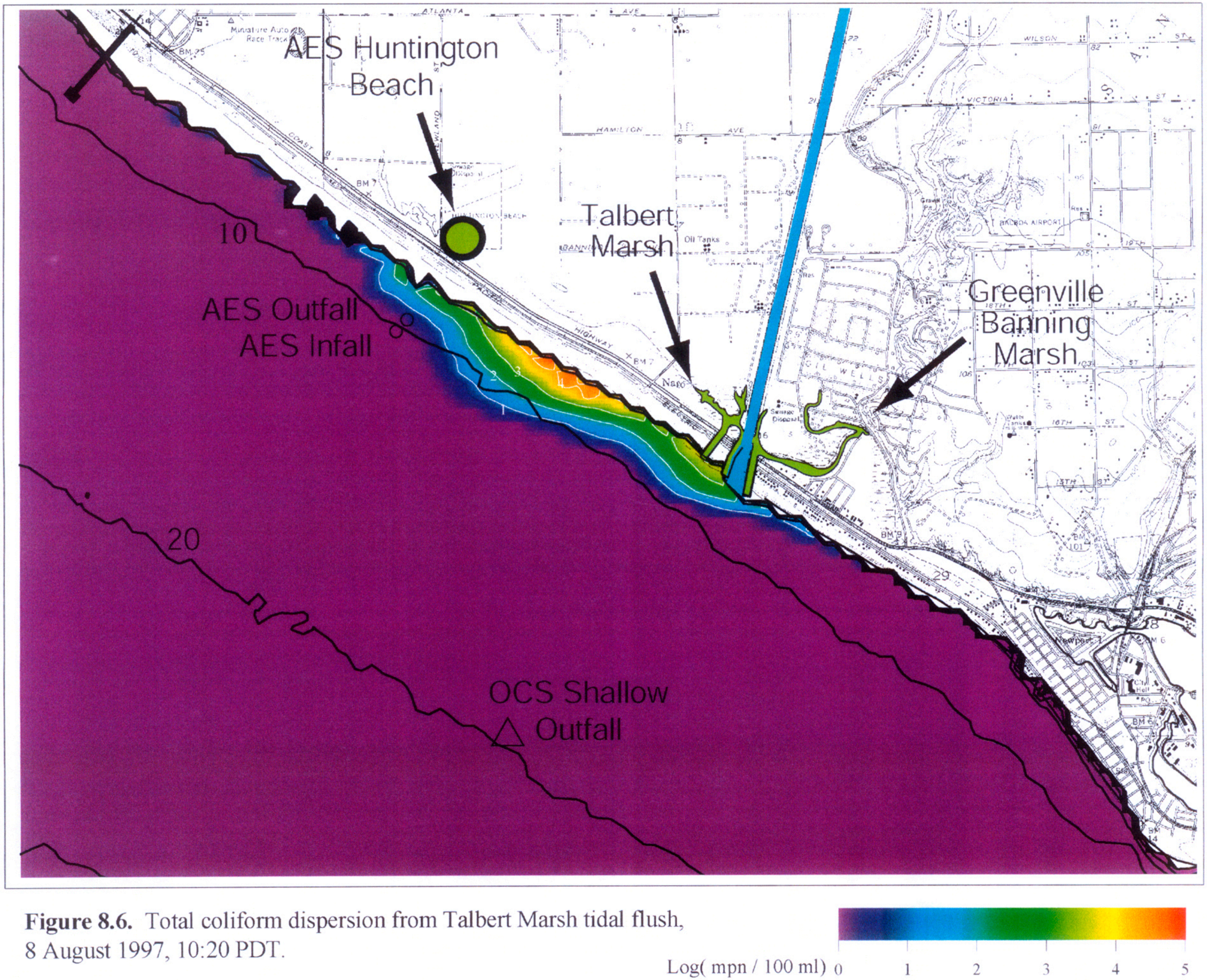

Figure 8.6. Total coliform dispersion from Talbert Marsh tidal flush, 8 August 1997, 10:20 PDT.

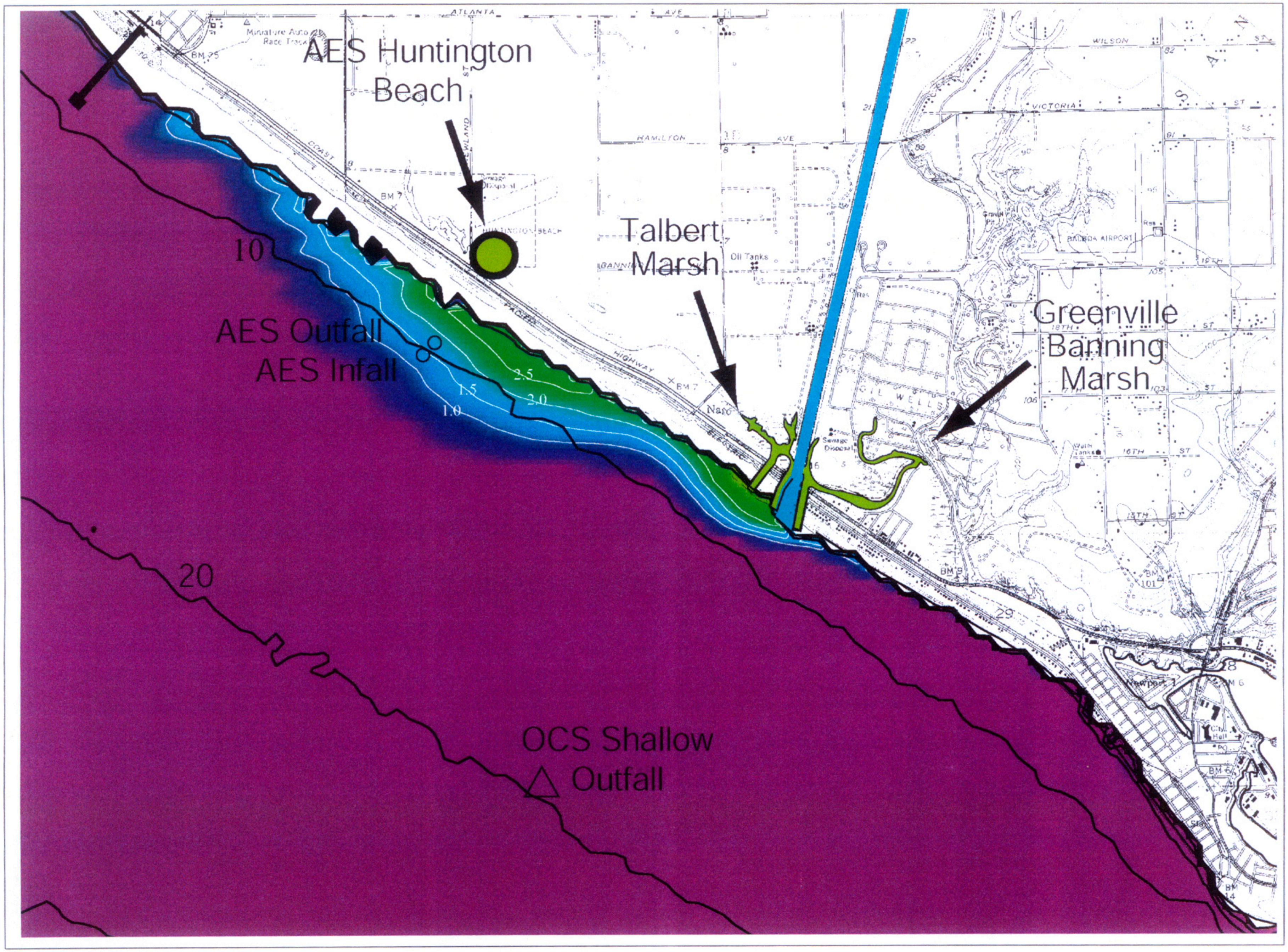

Figure 8.7. Total coliform dispersion from Talbert Marsh tidal flush, 9 August 1997, 11:50 PDT.

measured along these beaches during summer months by Orange County Sanitation District (OCSD, 2001). These findings have more recently been confirmed by high sample rate field measurements of dye and indicator bacteria released at the Talbert Channel and Santa Ana River jetties (Grant, et.al., in press).

Figures 8.5 thru 8.7 show that high coliform counts in the shallow wading depths of the surf zone do not imply high coliform counts in the offshore waters around the infall and discharge of the AES Huntington Beach generating station. It must be emphasized that the AES outfall is not in the surfzone. The water depth around the outfall is about -28 ft MSL, which could only be the surfzone if the waves were 36 ft high. Plant-induced currents decay rapidly with distance and are too weak to push water all the way to the shoreline. This does not mean that there is absolutely no exchange of water by other (natural) processes, in particular: wind drift, wave and tidal current mixing, rip cell circulation, mass transport in the wave boundary layers and shoaling internal waves. However, none of these processes are very effective shoreward transport mechanisms. The reasons for this are that the on/off-shore directed fluxes from these processes are discontinuous between the surfzone and the offshore and all shoreward directed motion has to stop at the beach. There is no current system that provides an uninterrupted pathway between the shoreline and the offshore area around the AES outfall. The onshore directed mass transport of the wave boundary layers is weak (second order) and is arrested near the break point by the action of wave breaking and by opposing under-tow currents in the surfzone; while the rip-cell currents extend only a few surfzone widths beyond the wave breakpoint. The AES outfall is well seaward of the surfzone and mixing or wind drift are the only persistent process that can bridge the gap in the discontinuous on/off-shore current pathways. Shoaling internal waves that reach the surfzone are episodic and relatively rare, and when they do occur, the longshore current typically flows downcoast (toward the southeast) transporting AES discharge away from the chronic hot spots at 9N. As a result the exchange of water between the AES outfall and the shoreline is small (but not zero) and the dilution that occurs during that exchange is rather substantial. The recently completed CEC study (KOMEX, 2003; Jones and Major, 2003) found that dye discharged from the AES outfall is diluted by a minimum of 36 to 1 at the shoreline. Minimum dilution of AES discharge calculated by the hydrodynamic model study (low flow case in Section 4) was found to be 32 to 1 at the shoreline (see Figures 4.6 & 4.8). Thus the model results derived two years before the KOMEX field study appear to be well confirmed. Both studies conclude that even for worst case scenarios, the dilution associated with the AES outfall is sufficiently large that it can not account for the high bacteria levels measured at the shoreline. Moreover, typical shoreline dilutions of AES effluent average 190 to 1, (Figure 4.8 and Table 6, Section 4), making the generating station effects on surf zone pollution even more unlikely.