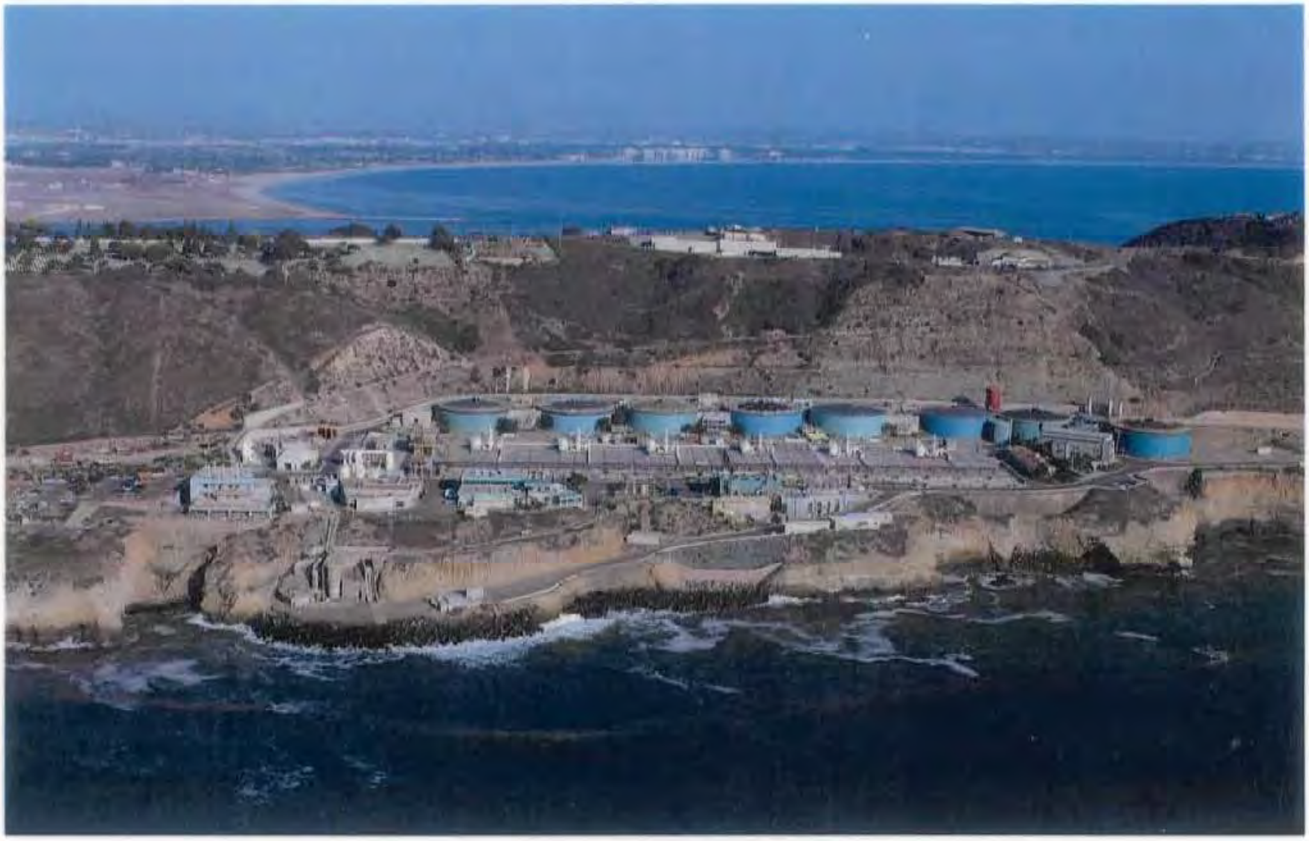
APPLICATION FOR RENEWAL OF
NPDES CA0107409 and
301(h) MODIFIED SECONDARY TREATMENT REQUIREMENTS
Point Loma Ocean Outfall



VOLUME VIII
APPENDICES M thru U

City of San Diego
Metropolitan Wastewater Department

November 2007

Application for Renewal of NPDES CA0107409

&

301(h) Modified Secondary Treatment Requirements for Biochemical Oxygen Demand and Total Suspended Solids

POINT LOMA OCEAN OUTFALL &

POINT LOMA WASTEWATER TREATMENT PLANT

Submitted under provisions of
Section 301(h) of the Clean Water Act

City of San Diego
Metropolitan Wastewater Department
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November 2007
(updated)

APPLICATION FOR RENEWAL OF NPDES CA0107409
&
301(h) MODIFIEDSECONDARY TREATMENT REQUIREMENTS

CITY OF SAN DIEGO
POINT LOMA OCEAN OUTFALL

November 2007
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VOLUME VIII

TECHNICAL APPENDICES M through U

Appendix M	**Re-Entrainment**
Appendix N	**Oceanography**
Appendix O	**Initial Dilution Simulation Models**
Appendix P	**Dissolved Oxygen Demand**
Appendix Q	**ROV Inspection of Discharge Zone**
Appendix R	**Analysis of Ammonia**
Appendix S	**2001 California Ocean Plan**
Appendix T	**2005 California Ocean Plan**
Appendix U	**Correspondence**

LIST OF VOLUMES

Appendix M

Re-entrainment

APPENDIX M

RE-ENTRAINMENT

ABSTRACT

INTRODUCTION

Wastewater is carried out of the discharge area, and replaced with new effluent free water, by ocean currents. The spatial dimensions of the wastefield, the strength of the ocean current, and the discharge rate are related to the dilution through the relationship:

$$S_a \cdot Q = H_w \cdot W_w \cdot V_a$$

where: S_a = flux-averaged initial dilution
Q = volumetric discharge rate of effluent (eg., m^3/sec)
H_w = depth of the water column occupied by wastewater (m)
W_w = "effective" width of the wastefield (m)
V_a = speed of the ocean current (m/sec)

At high current speeds, this relationship is satisfied by a decrease in the thickness and width of the wastefield, and by an increase in the initial dilution (e.g., proportional to $v_a^{1/2}$ for flow perpendicular to the diffuser- Roberts et al. 1989). At lower current speeds, for inviscid (frictionless) flow in density stratified water, the initial dilution becomes independent of current speed and the wastefield width increases (eg., due to the discharge-induced currents) to maintain the relationship. Over longer time- and length-scales, the effective width of the wastefield, and hence the dilution, can increase due to fluctuations in the component of the ocean flow perpendicular to the dominant direction of flow (eg., tidal and more slowly varying changes) and by lateral diffusion.

However, the actual dilution achieved by the outfall may be less than expected if previously discharged wastewater is re-entrained into the plume during the initial dilution process. This re-entrainment may occur under a number of circumstances. Over short time-scales, and in the immediate vicinity of the outfall the effects of viscosity can promote vertical mixing, re-entrainment, and the development of distortions in the local pressure and flow fields that result in "blocking". Longer periods of very weak currents can result in additional perturbations of the density structure of the ocean due to the entrainment of angular momentum. Even if the currents are relatively strong, re-entrainment may occur if reversals in the flow coincide with downward movements of previously formed segments of the wastefield (eg., due to downwelling and internal tides).

If all the conditions required for re-entrainment occur, the concentration of effluent in the wastefield will be increased, resulting in a reduction in the "effective" dilution. The magnitude of the effective initial dilution is related to the volumetric flux-averaged initial dilution and the concentration of ambient effluent in the entrained water by the equation:

$$C_w = \frac{(S_a - 1) \cdot C_a + 1 \cdot C_e}{S_a}$$

where:
C_w = concentration of effluent in the wastefield
C_a = concentration of effluent in the entrained receiving water
C_e = concentration of effluent (=1)
S_a = volumetric flux-averaged initial dilution

Under these circumstances, the "effective" initial dilution (i.e., the dilution achieved based on the concentration of effluent in the wastefield at the completion of the initial dilution process) is:

$$C_w = \frac{S_a \cdot C_a + 1 \cdot C_e}{S_a + 1} > \frac{S_a \cdot 0 + 1 \cdot C_e}{S_a + 1} = \frac{C_e}{S_a + 1} = C_w^o$$

where:
C_w = effluent concentration in the wastefield with re-entrainment
C_w^o = effluent concentration in the wastefield without re-entrainment
C_a = effluent concentration in the entrained ambient water
C_e = effluent concentration in the wastewater (= 1)
S_a = flux-averaged initial dilution

The State of California Ocean Plan places limits on the concentrations of a collection of trace constituents ("Table B" constituents) in the wastefield at the completion of the initial dilution process. These limits are based on their concentration in the effluent and monthly average values of the flux-averaged initial dilutions (see: Appendix O - Initial Dilution):

$$\frac{S_{avg} = \int_0^{30d} S_a(t') \cdot dt'}{30 \text{ day}}$$

where:
S_{avg} = 30-day average initial dilution
S_a = "instantaneous" flux-averaged initial-dilution at time, t'

If re-entrainment may occur (eg., due to current reversals), calculation of the individual effective dilutions making up the monthly-averaged value requires simultaneous information on the volumetric flux-averaged initial dilution and the concentration of previously discharged effluent in the ambient water entrained into the plume. Numerous methods have been developed for computing the volumetric flux-average initial dilutions (eg., Baumgartner et al, 1993--also see: Appendix O - Initial Dilution in this document). However, it is difficult to provide the detailed three-dimensional spatial and temporal descriptions of previously discharged wastewater in the receiving water environment that are required to describe the re-entrainment of effluent into the initial dilution plume. This is especially true in density-stratified coastal waters characterized by short coherence length-scales for cross-shore currents and internal wave activity, such as exist in the environment off Point Loma. For example, none of the simulation models suggested in the Amended 301(h) Technical Support Document are appropriate for this environment.

METHOD

In lieu of such a model, a simplified approach was adopted in order to obtain an estimate of the possible effects of effluent re-entrainment on the discharge from the Point Loma outfall. Since the California Ocean Plan uses a 30-day average initial dilution for the Table B constituents, our approach was to calculate the volume of effluent discharged during a 30-day period, and the volume of ocean water containing this effluent. Since the concentration of wastewater in the effluent is 1, the average concentration of effluent in this volume of ocean water is:

$$C_w^{avg} = \frac{V_e^{dschg}}{V_a^{eff}}$$

where: V_a^{eff} = volume of ambient water containing 30-days of discharged effluent

V_e^{dschg} = volume of effluent discharged during the 30-days $= Q \cdot T$

Q = volumetric discharge rate of effluent (eg., m^3/sec)

T = elapsed time (30 days $\approx 2.6 \times 10^6$ sec)

C_w^{avg} = average concentration of effluent in the volume V_a^{eff}

If one makes the (conservative) assumption that the receiving water in the entrainment region of the water column around the outfall diffuser always contains previously discharged effluent at this concentration, the effective initial dilution associated with the volumetric initial dilution S_a becomes:

$$S_e = \frac{S_a^*}{C_w^{avg}\left(S_a^* - 1\right) + 1}$$

where S_a = flux averaged initial dilution (as used in Appendix O).

$$(W_2)^2 = 2 \cdot \left(\sum_{i=n}^{N/2} \left(\frac{vx_i}{\varpi_i} \right)^2 + (n \cdot \Delta t)^2 \cdot \sum_{i=1}^{n-1} (vx_i)^2 \right)$$

Now suppose that there is a net flow, V_x^o. This produces a systematic shift in the center of mass of each wastefield segment by an amount equal to $V_x^o \cdot i\ \Delta t$. Thus the total (statistical) length of the region occupied by effluent discharged during the 30-day period is (see Figure M-1):

$$L_x = \sqrt{2} \cdot \sqrt{\frac{1}{2} \cdot (V_x^o \cdot \tau)^2 + VAR_x^{\bullet}}$$

The same approach can be applied to the cross-shore flows. However, since all the net flow was attributed to the longshore component, the width of the distribution in the cross-shore direction is limited to the standard deviation of the fluctuations in this direction:

$$L_y = 2 \cdot \sqrt{2 \cdot VAR_x^{\bullet}}$$

It is noted, however, that there will be lateral (oceanic) mixing even in the absence of measured fluctuations in the cross-shore component of the currents. The variance associated with this mixing (assuming a diffusion velocity representation) is:

$$VAR_{diff-vel} = \sigma^2_{diffuser} + (v_{diff} \cdot t)^2$$

where:

$\sigma_{diffuser}$ = variance associated with the initial width of the wastefield at the conclusion of the initial dilution

v_{diff} = diffusion velocity (eg., cm/sec)

t = elapsed time (sec)

It was shown in Appendix I that this representation provides a good description of the subsequent dilution of ammonia in the wastefield generated by the old Point Loma outfall for a diffusion velocity of 1 cm/sec. Similar values have been reported in measurements at a variety of other oceanographic sites (Okubo and Pritchard, 1969; Okubo, 1970).

If the lateral mixing is a process independent of the fluctuating currents in the cross-shore direction, the width of the distribution for the 30-days of discharged effluent would be:

$$L_y = 2 \cdot \sqrt{2 \cdot (VAR_{diff-vel} + VAR_y^{\bullet})}$$

However, the measured fluctuations in the cross-shore component of the ocean currents may be responsible for some of the lateral mixing. Therefore, the (conservative) assumption was adopted so that the lateral (cross-shore) width of the distribution was equal to the larger of the variances associated with lateral diffusion *or* the cross-shore current fluctuations:

$$L_y = 2 \cdot \sqrt{2 \cdot MAX(VAR_{diff-vel}, VAR_y^*)}$$

The area of the ellipse containing the discharged effluent is:

$$AREA = \pi \cdot \left(\frac{L_x}{2}\right)\left(\frac{L_y}{2}\right)$$

The thickness of the wastefield is estimated in a similar manner. Factors contributing to the effective thickness are:

1. Mean thickness of the wastefield.
2. Variation about the mean thickness.
3. Variation in the level of minimum dilution in the water column.
4. Vertical movements of isopycnal surfaces due to internal tides, internal waves, and up- and downwelling.
5. Vertical mixing.

Thus, the thickness of the uniform concentration layer containing the 30-days of discharged effluent is:

$$H_{eff} = 2\sqrt{2} \cdot \sqrt{\left(\frac{H_w}{2}\right)^2 + \sigma_w^2 + \sigma_h^2 + \sigma_I^2 + 2 \cdot \sigma_V^2}$$

where: H_w = mean thickness of the wastefield (m)

σ_w = standard deviation in the thickness of the wastefield (m)

σ_h = standard deviation in the height-of-rise to the level of minimum dilution (m)

σ_I = standard deviation of the vertical motion of the isopycnal surfaces (m)

σ_V = standard deviation of the vertical spreading associated with vertical mixing (m)

The standard deviation associated with vertical mixing is related to the vertical diffusivity by the equation:

$$\sigma_V^2 = 2 \cdot k_z \cdot \tau$$

where: k_z = vertical diffusivity (m^2/sec)

INPUT DATA

CURRENTS

Current meter data were from Mooring C5 during 1990 and 1991 (see: Appendix N - Physical Oceanographic Setting). These measurements were made in the vicinity of the new outfall diffusers, but prior to its construction. The mean height-of-rise to the level of minimum dilution for a discharge of 205 mgd is about 26.6m, thus the mean depth to the level of minimum dilution is about 67m. Currents were measured at depths of 20m, 40m, 60m, and 80m at C5. Therefore, the average effluent concentration was computed in the ambient water using the records collected depths of 60m and 80m. A linear interpolation was used to estimate the ambient effluent concentration at a depth of 67m.

Each cosine series representing a time-series of current measurements was constructed using a power-of-2 fast fourier transform. Because of this, none of the periods in the series precisely matched a period of 30 days. Therefore, the variances associated with the fluctuations in the longshore and cross-shore currents were computed for each time-series for durations that were shorter and longer than 30 days. The variance for a duration of 30-days was estimated by interpolation.

The measurements at the 60m and 80m depths were subdivided into seasons since the properties of the currents can change with season as well as depth. The months of January, February, and March were grouped together, since this period was the period of lowest predicted initial dilutions (see Appendix O - Initial Dilution). This group was given the seasonal label: "winter". Thus, the months of April, May, and June were designated as "spring"; July, August, and September, as "summer"; and October, November, and December, as "fall". The measurements at the 60m and 80m depths at mooring C5 for the spring and fall periods contained data gaps that were too long to be reliably estimated from the prior and following sections of the time-series. Therefore, the measurements collected at a depth of 60m at mooring C4 (lying inshore in 87m of water) were used for these two periods. The measurements at a depth of 77m at mooring C4 were too close to the bottom to be used as a reliable estimator of the currents at typical wastefield depths above the bottom. Thus only the concentration of effluent at a depth of 60m could be estimated for these two periods.

Although the net current was not always aligned with the longshore axis, it was assumed that the net flow was in this direction. Since it will be shown that the length of the ellipse (longshore axis) containing the discharged effluent is greater than its width (cross-shore), this assumption has the (conservative) effect of underestimating the area of the ellipse--and hence overestimating the ambient effluent concentration.

The net flows and variances associated with each current meter and season are summarized in Table M-1.

LATERAL DIFFUSION

In Appendix L (Dissolved Oxygen Deficit), it was shown that lateral mixing could be described with a diffusion velocity representation using a diffusion velocity of 0.01 m/sec (1 cm/sec). A diffusion velocity of 0.005 m/sec was used for the re-entrainment simulations. The motivation for this reduced velocity was that the inshore spreading of the wastefield resulting from oceanic mixing may be limited by the presence of the coastal boundary.

Table M-1
CURRENT VELOCITY INPUT DATA
(SPEEDS IN CM/SEC)

Mooring	Depth	Year	Season	Vnet	Std Dev Vx	Std Dev Vy	Days
5	60	1990	Winter	4.9	28.0	10.7	42.7
5	60	1990	Winter	4.9	17.4	8.2	21.3
5	80	1990	Winter	6.5	32.0	11.0	42.7
5	80	1990	Winter	6.5	17.7	6.3	21.3
5	60	1991	Winter	2.1	34.9	14.4	42.7
5	60	1991	Winter	2.1	27.6	10.6	21.3
5	80	1991	Winter	1.3	31.0	9.1	42.7
5	80	1991	Winter	1.3	18.7	3.1	21.3
4	60	1990	Spring	3.5	42.8	12.6	42.7
4	60	1990	Spring	3.5	20.0	5.2	21.3
5	60	1990	Summer	2.0	29.4	11.4	42.7
5	60	1990	Summer	2.0	20.9	6.3	21.3
5	80	1990	Summer	0.8	31.3	9.6	42.7
5	80	1990	Summer	0.8	20.4	7.1	21.3
4	60	1990	Summer	2.1	25.4	6.6	42.7
4	60	1990	Summer	2.1	17.2	4.5	21.3
4	60	1990	Fall	3.3	23.0	4.22	21.33
4	60	1990	Fall	3.3	5.1	1.99	7.11

EFFECTIVE WASTEFIELD THICKNESS

The mean height-of-rise of the wastefield was about 26.6m for a discharge of 205 mgd (Appendix Q - Fate of Suspended Solids). The California Ocean Plan requires that the initial dilutions be calculated without any enhancement from the currents (i.e., by setting the speed of the currents = 0 in the simulations). For weak currents, the mean initial thickness of the wastefield is about 10 percent greater than the height-of-rise to minimum dilution (Roberts et al., 1989), or about 29.4m.

The height-of-rise of the wastefield to the level of minimum dilution varies roughly uniformly between about 20.2m (10-percentile) and 33.4m (90-percentile), hence the standard deviation, σ_H, is about 3.3m. The corresponding standard deviation for variations in the thickness of the wastefield is 3.7m.

A vertical diffusivity of 0.125 x 10^{-4} m^2/sec (0.125 cm^2/sec) was assumed. This is one-eighth the value suggested in Appendix B of the Amended Technical Support Document. The diffusivity was reduced to reflect the presence of the ocean bottom below the wastefield, and increased density stratification above the wastefield. The standard deviation associated with vertical diffusion over a 30-day period, σ_V, is about 11.4m.

Isopycnal surfaces (as indicated by isotherms) undergo vertical motions as the result of internal tides and internal waves. These oscillations introduce wastewater into different density layers of the water column at semi-diurnal and diurnal frequencies. The horizontal length-scales corresponding to tidal excursions are on the order of a kilometer, or less. Therefore, the horizontal length-scales characterizing the packets of wastewater within the various density layers are on the order of 0.5 km, or less. Horizontal oceanic mixing rapidly spreads these relatively small-scale packets to fill in the gaps.

The strings of thermistors at moorings T2 through T5 measured internal tide associated root-mean-square (rms) vertical excursions of isotherms (contours of constant water temperature) of 4.2m during 1990, and 6.6m during 1991 (see: Appendix N - Physical Oceanographic Setting). These magnitudes were used for the standard deviations of the vertical motions of the isopycnal surfaces, σ_I. This is a conservative assumption since it ignores the effects of the vertical motions of comparable, or larger, magnitude that occurred over time-scales of days to weeks (eg., associated with up- and downwelling).

DISCHARGE FLUX

A flow of 205 mgd (maximum average flow during the waiver period) was used for the calculations. This corresponds to a flow of about 9 m^3/sec, or a volume of 1.3 x 10^8 m^3 over the 30-day period.

RESULTS

The average ambient water concentrations in the 30-day ellipse are summarized for each season and depth in Table M-2. As noted earlier, current meter data for the spring and fall seasons were only available for measurements made at a depth of 60m at mooring C4. To provide a comparison between the estimates based on the measurements at this mooring, and the measurements at mooring C5, the ambient background effluent concentrations were computed for the summer season using the data from moorings C4 and C5. This comparison showed that the ambient background concentration for the summer period, based on the current data recorded at mooring C4, was comparable with the concentration estimated from data collected at the same depth at mooring C5. This is not known if this same equivalence exists for the spring and fall seasons.

Table M-3 summaries the effect of re-entrainment on the volumetric initial dilutions. The median dilution values are based on the time-series data. The monthly initial dilutions are the California Ocean Plan initial dilutions based on the CTD data. The effects of re-entrainment on the monthly initial dilution values was estimated in the following manner:

1. The average height-of-rise to the level of minimum dilution above the diffuse port was subtracted from a water depth of 96m.

Table M-2
AMBIENT EFFLUENT CONCENTRATIONS

Mooring	Depth	Season	Year	Conc (205 mgd)	Conc (240 mgd)
5	60	Winter	1990	0.00022	0.00026
5	80	Winter	1990	0.00017	0.00020
5	60	Winter	1991	0.00032	0.00038
5	80	Winter	1991	0.00055	0.00064
4	60	Spring	1990	0.00029	0.00034
5	60	Summer	1990	0.00045	0.00053
5	80	Summer	1990	0.00038	0.00044
4	60	Summer	1990	0.00045	0.00053
4	60	Fall	1990	0.00031	0.00036

2. The background concentration at this depth was estimated by interpolation between the background concentrations at the 60m and 80m depths for the appropriate season.

3. The equation for the Se on page M-3 was used to compute the effective initial dilution for these conditions.

The background concentration for the median initial dilution was estimated in a similar manner using the 50-percentile height-of-rise to the level of minimum dilution, and the average of the seasonal background concentrations. Overall, the effect of re-entrainment was to reduce the volumetric initial dilutions by 8.4 to 8.7 percent. The largest reductions (12.1 percent) occurred for a flow of 205 mgd in the months of July and September. The smallest reduction (4 percent) was for a flow of 205 mgd in February, using the background concentrations based on the currents in 1990.

Table M-3
EFFECTIVE INITIAL DILUTIONS WITH RE-ENTRAINMENT

	Dilution			
	205 mgd		240 mgd	
	Volumetric	Effective	Volumetric	Effective
Median[1]	365:1	317:1	338:1	317:1
January[2,3]	214:1	206:1	292:1	195:1
January[2,4]	214:1	195:1	292:1	185:1
February[2,3]	204:1	196:1	224:1	215:1
February[2,4]	204:1	186:1	224:1	203:1
March[2,3]	264:1	251:1	263:1	250:1
March[2,4]	264:1	238:1	263:1	237:1
April[2]	313:1	280:1	284:1	257:1
May[2]	315:1	281:1	295:1	265:1
June[2]	354:1	313:1	324:1	290:1
July[2]	325:1	286:1	320:1	282:1
August[2]	317:1	286:1	294:1	262:1
September[2]	317:1	279:1	307:1	271:1
October[2]	287:1	264:1	281:1	259:1
November[2]	264:1	244:1	249:1	231:1
December[2]	217:1	203:1	206:1	194:1

[1] Time-series data (13757 cases) with actual currents.
[2] CTD data, currents set = 0.
[3] Current data from 1990.
[4] Current data from 1991.

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SEMPER VIGILANS

Appendix N

Oceanography

APPENDIX N

OCEANOGRAPHY

ABSTRACT

The Point Loma outfall discharges on the outer edge of the mainland shelf within the Southern California Bight. The bight is an area of complex bathymetry and circulation. The latter is primarily driven by the California Current at the surface, and the California Undercurrent at depth. The water column is density stratified by both temperature and salinity gradients throughout the year over the entrainment region of the water column during the initial dilution process. This density stratification changes over a wide range of time-scales due to internal waves, internal tides, up- and downwelling, and interannual variations. In contrast to the situation in the upper 30m of the water column, the greatest stratification occurs in the winter.

The wastefield typically forms at an average depth of about 70m. The annual net subsurface flow at this depth in the area is upcoast at about 3 cm/sec. Superimposed on the net flow are variations with time-scales ranging from hours to years. Interannual variability in the currents is comparable to the seasonal changes. The temporal characteristics of the fluctuations are different in the longshore and cross-shore directions. More than half the variance (ca. 45 - 99 cm^2/sec^2) in the longshore direction is associated with changes that occur more slowly than the tidal period; nearly all the variance (21- 81 cm^2/sec^2) in the cross-shore direction is associated with fluctuations of tidal, or shorter period. Transport over distances in excess of a few km is by the seasonal net flows (1-6 cm/sec) and the slowly varying changes in the currents (rms speeds of 7-10 cm/sec). The dominant direction of flow of these currents is along an axis with an alignment of 177-357 degrees (true) (i.e., essentially along the orientation of the local isobaths).

REGIONAL SETTING

SOUTHERN CALIFORNIA BIGHT

Bathymetry

The western coast of the United States makes an abrupt change in direction and bends to the east at Point Conception (Figure N-1). After proceeding east for about 100 km, it turns to the southeast to form the Southern California Bight (SC Bight). The landward boundary of this open embayment extends from Point Conception, California, to the vicinity of Cabo Colnett, Baja California, Mexico (SCCWRP, 1973). It includes the entire coast of southern California. The offshore boundary of the bight is defined by the inner boundary of the California Current.

The bathymetry within this embayment is unusual. Landward from the continental slope, it defines a series of coastal basins and troughs, submarine ridges and islands, a nearshore shelf and slope, and submarine canyons (Figure N-2). Because of this complexity, the region has been labeled a continental borderland (Shepard and Emery, 1941) in order to distinguish it from a normal continental shelf and slope.

The width of the borderland (e.g., from the coast to the 500m isobath at the upper edge of the continental slope) reaches a maximum of about 200km off Newport Beach, California. North of Point Conception and south of the border with Mexico, the width of the continental shelf is about 20 to 35 km. The area of the continental borderland inshore of the Continental slope is about 104,000 km^2 (Emery, 1960; NRC, 1990). Approximately 63 percent of this area is associated with basin and trough slopes; another 17 percent, with the basin and trough floors. Bank tops, islands, and island shelves contribute another 14 percent. The mainland shelf contributes the remaining 6 percent (ca. 6,500 km^2).

This bathymetry plays an important role in the flow of the ocean currents within the bight. Free circulation of ocean currents is limited to the upper 350m of the water column. Circulation within areas bounded by depths between 350m and about 1,000-1,500m is limited to semi-enclosed areas, generally open to the south, and within basins (Jackson, 1986). The San Diego Trough, lying offshore from Point Loma, forms the mouth to one of these embayments. Water depths in excess of 2,000m are excluded from the bight, with the exception of Velero, Outer, Animal, and Colnett Basins at the extreme southern end.

The mainland ("nearshore") shelf breaks in about 60-110m of water. Shelf widths range from less than 2 km (Pt. Dume, Palos Verdes, south of Newport Canyon) to 16-22 km (Ventura, Santa Monica Bay, San Pedro shelf, Santa Monica Bay, Pta. Descanso). The shelf is cut by submarine canyons, with sections disconnected by coastal promontories such as headlands and capes (Hickey, 1993).

Water Properties

The properties of the ocean water in the Southern California Bight represent a mixture of water of southern (Equatorial) water, Pacific Subartic water, and North Pacific Central water (Hickey, 1993). The Pacific Subartic water, which enters from the north, is characterized by low temperatures and salinity, and high dissolved oxygen and phosphate (Reid et al., 1958). North Pacific central water (entering from the west) is distinguished by warm temperatures, high salinity, and low dissolved oxygen and phosphate (Reid et al., 1958). Southern water, which enters from the south, has relatively high temperatures, salinity, and nutrients, but low dissolved oxygen (Pickard, 1964). North Pacific Central water does not normally directly enter the SC Bight, and the water in the bight can be considered to primarily be a mixture of Subartic and Southern water (Tibby, 1941). At depths of 200-400m, the water nearshore is estimated to be a mixture of about 30-40 percent northern water, and 60-70 percent southern water (Sverdrup and Fleming, 1941). A tongue of 80 percent southern water penetrates into the southern end of the SC Bight roughly midway between San Clemente Island and Tanner/Cortez Bank. The fraction of northern water generally increases with decreasing water depth, but salinities associated with a specific water temperature tend to increase with proximity to the coast, suggesting an increasing contribution of southern water (Jackson, 1986).

The California Cooperative Fisheries Investigation (CalCOFI) program has carried out measurements of the properties of the water off California and northern Baja California since 1956. Average values of water quality collected at Station 90.28 (offshore from Los Angeles) provide a summary of water characteristics in the inner portion of the bight. The water column is vertically stratified with regard to temperature, salinity, and density (Jackson, 1986). Salinities are relatively constant and independent of depth in the upper 50-60m of the water column (ca 33.5-33.6 ppt).

A strong summer pycnocline/thermocline develops during the summer over the entire SC Bight in response to seasonal warming. This stratification continues through the early fall. Near-surface temperature stratification is generally maintained even during the winter season (Hickey, 1993). Near the coast, minimum surface water temperatures average about 14-15°C, and occur between January and March. Surface water temperatures peak in the late summer (ca. September) at 18-20°C. During most of the year, a thermocline is present over the nearshore shelf at depths ranging from 3 to 25m, occasionally reaching to 40m. An upward slope in the density and temperature isopleths toward the coast is present in the in all seasons, but strongest (Hickey, 1993). Substantial interannual variations may occur in water temperatures--especially during periods of el Nino.

Average water temperatures at a depth of 100m seasonally vary between from a little more than 9°C to a little more than 10°C. In contrast to the surface waters, the lowest temperatures tend to occur during the late spring-early summer (May-July), and the maximum temperatures occur in the winter (January-March). Salinity gradients make an important contribution to density gradients in water with temperatures lower than 11-12°C (ca. > 50-60m depths), and hence at the entrainment depths for the discharge from the Point Loma outfall. Typical salinities vary between about 33.6 and 33.8 ppt, increasing with decreasing water temperature.

California Current

The major surface current in the area is the California Current. This is a broad (ca. 600 km wide), meandering, and diffuse southward flow along the west coast of the United States. It represents a continuation of the North Pacific Subartic Drift and is part of the eastern portion of the North Pacific gyre. It contains low temperature, low salinity water. Typical surface flow speeds are relative low (ca. 10-20 cm/sec), decreasing with depth to about 2 cm/sec at a depth of about 200m (Hickey, 1993). The maximum speeds are located about 300 km offshore and occur in the late summer (Hickey, 1993). Fluctuations in the current speed are comparable to the net speed (Jones, 1971). Normal transport rates have been variously estimated between 5.8 x 10^6 m^3/sec (January) to 7.8 x 10^6 m^3/sec (July) (Hickey, 1993), and 10 x 10^6 m^3/sec (Pavlov, 1966). By way of comparison, the effluent discharge rate from the Point Loma outfall is about 9 m^3/sec, the total mass emissions of treated municipal wastewater into the coastal waters of the SC Bight is on the order of 55 m^3/sec, and the average transport of the Mississippi River is about 1.81 x $10^5 m^3$/sec.

The California Current separates from the coast at the break near Point Conception, and continues its southward flow offshore from the Santa Rosa-Cortez ridge and the continental slope. At the southern end of the ridge, it bends to the east, flowing toward the coast in the general region of Cabo Colnett. The inner edge of this current defines the western and southern boundaries of the Southern California Bight.

Southern California Countercurrent

Currents within the Southern California Bight are complex. A seasonal surface counter-clockwise circulating gyre is often present between the coast and the California Current (Figure N-3). The inner, northward flowing, leg of this gyre is known as the Southern California Countercurrent. The path of this upcoast flow is largely blocked by the east-west trending northern Channel Islands at the northern end of the SC Bight. These islands (and connecting ridge) deflect the bulk of the water in the Countercurrent to the west, completing the gyre. However, a small part is often deflected to the right, resulting in a narrow (ca. 10-30 km wide), southward (unnamed) surface flow between the Countercurrent and the coast.

The Southern California Countercurrent is strongest in the summer and autumn, and weak (occasionally absent) in the winter and spring (SCCWRP, 1973). During the latter season, there may be a continuous equatorward surface current throughout the SC Bight. Current speeds in the Countercurrent are comparable to the California Current, with estimates ranging from 5-10 cm/sec (Jones, 1971) to 12-18 cm/sec (Sverdrup and Fleming, 1941). The transport is estimated to be only slightly less than the California Current (Jones,1971; Pavlova, 1966; Sverdrup and Fleming, 1941). Typical speeds of the nearshore surface flow are the order of 20 cm/sec, occasionally reaching a knot, or more.

Residence Time of Surface Water in the Southern California Bight

Typical travel times between Point Conception and the southern boundary of the gyre for water parcels lying along the inner edge of the California Current (and outer portion of the gyre) have been estimated at about 39 days from heating of the surface water (Sverdrup and Fleming, 1941) and about 25 days from the strength of the currents (Jones, 1971). Rough estimates of the residence time of surface water in the Southern California Bight as a whole have ranged from about one month (heating of the surface waters-Jones, 1971) to two to three months (currents-Jones, 1971; circulation model-SCCWRP, 1973; distribution of *Panulirus* larvae-Hendricks, 1979).

California Undercurrent

The circulation at depths in excess of 100m off southern California appears to be less complex than the surface circulations. The most distinctive characteristic is an upcoast subsurface flow (Jones, 1971) on the shoreward side of the California Current (Hickey, 1993). The undercurrent is narrower than the California Current, but appears to be present throughout the bight (Hickey, 1993). Measurements off Santa Monica Bay suggest that the core of the flow is over the mainland slope at a depth of about 100m, although other undetected cores may also exist within the bight (Hickey, 1989a). The core has been observed over the slope off northern Mexico at a depth of about 150m (Wooster and Jones, 1970). Typical speeds are 25 cm/sec, or less (Jones, 1971) although there may be pulses of flow exceeding 50 cm/sec (Hickey, 1993).

The seasonal maximum flow occurs in the late summer and early fall (Hickey, 1993), with a minimum in the spring. A second seasonal maximum in the early winter is present at most locations (Hickey, 1993). Free circulation of this undercurrent within the SC Bight is limited by the bathymetry to depths shallower than about 350m (Jackson, 1987). The spatial structure of the Undercurrent, and its relationship to the Southern California Countercurrent is the subject of on-going research (Hickey, 1993). Indirect (geostrophic) estimates of the combined transport of the Undercurrent and the Countercurrent based on hydrographic data collected by the California Cooperative Fisheries Investigation (CalCOFI) yield values of 0.8×10^6 m^3/sec in April to 1.8×10^6 m^3/sec (Hickey, 1993). These values are only about one-quarter to one-seventh the transport estimated for the SC Countercurrent alone by Pavlov (1966) and Sverdrup and Fleming (1941). Hickey (1993) however, notes that direct measurements indicate a poleward flow that is both stronger (ca. 15-20 cm/sec) and more continuous than indicated by the geostrophic data (ca. 5-10 cm/sec).

Nearshore Currents

The net flow of currents over the nearshore shelf varies above and below the thermocline. Mean transport by the surface currents is typically downcoast during all seasons, although weakest in the fall (e.g., Winant and Bratkovich, 1981). Net annual transport by the subpycnocline (subthermocline) currents is upcoast with speeds on the order of a few cm/sec (Hendricks, 1977, 1980, 1986, , 1990, 1992).

Both the net currents, and fluctuations in the currents, influence the transport of wastewater away from the discharge, and the replenishment of ambient ocean water. The distance that water is transported by variations in the flow depends on the duration of the flow in between reversals (e.g., "persistence"), as well as the speed of the currents. Variations in the currents of tidal and shorter period (i.e., in the tidal and supertidal frequency bands) in the midwaters of the water column are roughly comparable in the longshore and cross-shore directions, but are often enhanced in the near-bottom flows. Slowly varying fluctuations (subtidal frequency band) make an important contribution to the longshore flows, generally contributing more than one-half the total variance. In contrast, these slow varying changes are usually weak in the cross-shore direction. Transport length-scales associated with the supertidal fluctuations are limited to a few hundred meters, or less. Transport distances associated with the tidal period variations are on the order of a kilometer to a couple of kilometers, or roughly comparable to the length of the Point Loma outfall diffuser. Thus, transport of wastewater away from the vicinity of the diffuser is primarily associated with the net flow, and variations in the subtidal frequency band. Since the net flow and the slowly varying fluctuations are primarily associated with the longshore component of the currents, transport away from the outfall is predominantly in the longshore direction.

The correlation or coherence between variations in the currents at spatially separated locations depends on the magnitude of the separation, the frequency band of the fluctuations, the direction of the flow (longshore versus cross-shore component), and the bathymetric complexity of the area. The longest coherence length-scales are associated with the longshore component of fluctuations in the subtidal frequency band along sections of the coast with relatively simple (e.g., straight) bathymetry. Here currents may be coherent over longshore spatial separations on the order of 30 km (Hendricks, 1977; Winant, 1983). In contrast, cross-shore motions in the subtidal frequency band can be essentially uncorrelated over vertical separations of 20m, or less, and horizontal separations of less than a couple of kilometers.

Empirical orthogonal eigenfunction (EOF) analysis, which identifies dominant patterns of flow from an array of current measurements, indicates that for areas of simple bathymetry (e.g., off Point Loma), 90 percent or more of the variance associated with variations in the subtidal frequency band can be related to a single flow pattern (Hendricks, unpublished). In areas with an increased level of bathymetric complexity (e.g., within the bight lying downcoast from Point Loma), two flow patterns can be required to account for 80-90 percent of the variance (Hendricks and Christensen, 1987). Areas of even greater bathymetric complexity, such as within Santa Monica Bay, may not be adequately described in terms of a few simple flow patterns.

The properties of the near-bottom currents (e.g., with 5m of the bottom) on the mainland shelf can differ from those of the "midwater" currents due to friction with the bottom. The development of a boundary layer suppresses slowly-varying (subtidal frequency band) fluctuations in the near-bottom currents. On the other hand, fluctuations in the tidal and supertidal frequency bands may be enhanced--particularly in the cross-shore component of the flow. This combination enhances shear between flows at different depths. Monthly average near-bottom current speeds range from about 0.5 to 5 cm/sec (Hendricks, 1993). In contrast to the midwater currents, where the net flow is generally parallel to the local isobaths, the near-bottom net currents generally have an offshore component that is comparable in magnitude, or exceeds, the net longshore component (Hendricks, 1993). This offshore flow can have important consequences for the transport of resuspended sediments.

POINT LOMA SHELF AREA

BATHYMETRY

The mainland shelf off Point Loma is about 6.5 km wide. A narrow rocky shelf runs parallel to the coast, extending from the shoreline to water depths of 17 to 20m (Moore, 1957). The outer edge of a bed of *Macrocystis* and *Pelaqophycus* kelp marks the offshore edge of this rocky shelf. At its outer edge, the bottom drops sharply by about 3 to 18m, terminating in a relatively smooth, gently sloping plain (Moore, 1957). This plain extends seaward to a depth of about 90-95m., and with only minor variations in direction and width for at least 15 km to the north and south of the outfall. About 23 km north of the discharge, it is cut by Scripps Canyon; 17 to 24 km to the south are Coronado Canyon and the Coronado Islands.

At the outer edge of the mainland shelf, the bottom slopes sharply downward, descending into the Loma Sea Valley (Moore, 1957). The longshore and cross-shore bathymetry also becomes more complex. The axis of the Loma Sea Valley lies about 15 km offshore, with a depth of about 370m. Continuing offshore, the bottom rises sharply to a depth of about 145m over the Coronado Escarpment, a narrow (ca. 3 km wide) finger of the mainland shelf extending up from the south. The center of the escarpment lies about 2 km offshore from the axis of Loma Sea Valley. Offshore from the Coronado Escarpment, the bottom plunges to a depth of about 1200m in the San Diego Trough (ca. 23-38 km offshore from the coast). The north end of the Coronado Escarpment lies approximately offshore from the Point Loma outfall, then slopes downward to the north to intersect the mainland slope in about 800m of water about 20 km farther north.

At the south end of Point Loma the coast breaks abruptly to the east forming a bight. Immediately to the east of Point Loma, the coast is cut by the entrance to San Diego Bay.

The outer portion of the mainland shelf (e.g., water depths greater than 35-40m) is essentially a continuation of the mainland shelf off Point Loma. Bottom slopes are reduced inshore of this isobath, reflecting the increased width (ca. 16 km) of the shelf in the bight. Water depths inshore of an extension of the coastline off Point Loma are shallower than about 33-36m. The average depth of the top of the wastefield generated by the Point Loma discharge at the completion of the initial dilution process ranges from about 49m to 63m, and the minimum depth to the top during any month ranges from about 32m to 47m (Appendix O - Initial Dilution). Thus wastewater is normally excluded from entering the bight.

TEMPERATURE, SALINITY, AND DENSITY STRATIFICATION

Introduction

The density structure of the water column plays an important role in the discharge of wastewater. In combination with the ocean currents, the rate of discharge of effluent, and the design of the outfall diffuser it determines the magnitude of the initial dilution and the initial position of the wastefield in the water column. The magnitude of the density gradients, in combination with current shear in the water column, also determine the rate of vertical mixing. The latter, in turn, affects the properties of the ocean currents as well as the mixing of wastewater and ambient water, or the renewal of dissolved oxygen removed by the decomposition of organic materials in the effluent and natural waters.

The water column above the Point Loma outfall diffuser is density stratified by gradients in temperature and salinity. Salinity gradients are small for water temperatures above about 11-12°C, but make an important contribution to the density gradients for lower water temperatures. The strongest density gradients exist during the summer in the upper portion of the water column due to the formation of a seasonal thermocline at depths that range from a few meters to a few tens of meters (typically around 5-20m). Surface water temperatures during the summer may reach 18-23°C. Water temperatures are generally lowest in the late winter, when surface water temperatures can fall to about 12 to 14°C. The seasonal thermocline may disappear, and the density gradients may be minimal.

The situation is reversed in the lower portion of the water column (depths in excess of about 45m), where the strongest density gradients occur during the winter. Although the density gradients are weak in comparison with the gradients existing in the upper portion of the water column during the summer, they are sufficient to trap the wastefield at depths of 30m, or more, below the surface (see Appendix O).

The density of water is computed from the temperature and salinity of the water. Salinity, in turn, is computed from measurements of the conductivity and temperature of the water. The density structure of the water column in the vicinity of the Point Loma outfall has been examined using two sources of data. The first data set consists of hydrocast data collected with a CTD (conductivity-temperature-depth recorder). These measurements provide temperature and conductivity profiles of the water column. They are collected during the monthly hydrocast surveys that are a part of the monitoring program, as well as during special studies. The other source of data is time-series measurements of water temperature from thermistor moorings positioned at various locations (C1-C7, Figures N-4, N-5) along two transects off Point Loma, including in the vicinity of the outfall terminus. Simultaneous observations were made at each mooring at 30-minute intervals from March to October, 1990, and again from January to April, 1991 (deployment periods are listed in Sub-Appendix NS1). At mooring C5, in the vicinity of the present outfall diffuser, measurements were made at 5m depth increments between a depth of 44.5m and 93m.

The advantage of the CTD measurements is that both water temperature and conductivity are recorded, so that the salinity, and hence the density of the water can be computed directly. The disadvantage is that only one profile is collected per month, per hydrocast station. Since all the stations are typically sampled within 1-3 days of each other, variations in the density structure associated with short-term upwelling and downwelling, internal tides, and internal waves are not measured. Unless a large number of profiles are available, the density profiles determined from the CTD samples may not accurately reflect the receiving water conditions. The time-series measurements of water temperature avoid this potential undersampling (or "aliasing") problem, but introduce another problem--the lack of accompanying data on the distribution of salinity in the water column.

In order to estimate time-series of water column densities from the time-series of water column temperatures, it was necessary to assume that water salinities (and hence densities) are related to water temperature. Water masses are defined by unique temperature-salinity relationships. As noted previously, water at depths of 200-400m in the SC Bight can be represented as a mixture of Northern Pacific Subartic water and Equatorial water. Because the length-scales associated with variations in the ratio of this mixture, the time-scales associated with changes in the temperature-salinity relationship at a single location will be long.

An example of the change in the density-temperature relationship (via the salinity-temperature relationship) for three months in 1990 are illustrated in Figure N-6. The data was collected with a CTD during hydrocast surveys on calendar days 241 (August 29), 270 (September 27), and 304 (October 31). The data shown was collected at a single station (P5, Figure N-4) in the vicinity of the (now) extended Point Loma outfall. Changes in the density(sigma-t)-temperature relationship are visible, reflecting changes in the mixture of water masses, but the general shape of the relationship is preserved. This may not be as good an assumption in the surface waters, where heating by solar radiation, fresh water run-off, and wave-induced mixing may introduce changes over shorter time-scales. However, since the water at a depths of 60-100m is relatively insulated from changes in the surface waters by the presence of the thermocline, temporal changes in its salinity-temperature relationship are likely to approach those of deeper water, compared with the time-scales characterizing the surface water. Curves similar to that illustrated in Figure N-6, but using data from stations P1, P2, P4, P5, P7, P8, P9, P10 (Figure N4), were used to develop the analytical relationships between the water temperatures and the water density for the hydrocast surveys. An example, for calendar day 241, is illustrated in Figures N-7a (9-12°C) and N-7b (11-22°C).

Water Temperatures

Time-series measurements of water temperature were made at an array of moorings in the vicinity of the Point Loma outfall from March through September, 1990, and from January to March, 1991 (Figures N-4, N-5). One of the moorings (C5) was located close to the present location of the outfall diffuser. The time-series measurements of water temperature from this mooring provide the most complete description of water column thermal stratification over time-scales shorter than a year.

The magnitude of the initial dilution achieved by a discharge is inversely related to the strength of the density gradient of ambient water in the entrainment region of the water column. The average depth to the level of minimum dilution within the wastefield was predicted to be on the order of 67-70m (Appendix O - Initial Dilution). The mean depth of the discharge ports is about 93-94m. The density difference between ambient water at a depth of about 70m and at a depth of 93m provides an indication of this stratification. The probability distributions of this density difference are illustrated in Figures N-8 through N-17 for the months of January through March, 1991 and March through October, 1990. Water temperatures have been converted into water densities using temperature-density relationships determined from CTD data collected at monthly intervals during the same measurement period. Average and median values of the difference for each month are summarized in Table N-1.

The strongest stratification of the water column, as measured by the average and median differences in sigma-t between the 70m and 93m depths occurs in January, 1991. The distribution of density differences is summarized in Table N-2.

The water densities at 5m increments (i.e., at each thermistor depth) are listed in Table N-3 for each of the density profiles listed in Table N-2. The corresponding density profiles are illustrated in Figures N-18 and N-19. Density profiles collected with a CTD at a set of stations in the vicinity of the Point Loma outfall during a hydrocast survey on January 08, 1991 are illustrated in Figures N-20 through N-22.

Table N-1
DENSITY DIFFERENCE BETWEEN THE 70M AND 93M DEPTHS
(SIGMA-T UNITS)

Month	Average	Median
January	0.324	0.305
February	0.294	0.280
March	0.192	0.156
April	0.130	0.141
May	0.248	0.242
June	0.143	0.127
July	0.193	0.150
August	0.199	0.194
September	0.131	0.123
October	0.234	0 171

Table N-2
DISTRIBUTION OF DENSITY DIFFERENCE
BETWEEN 70M AND 93M FOR THE MONTH OF
MAXIMUM STRATIFICATION (JANUARY)

Percentile	Delta Sigma-T
10	0.154
30	0.229
50	0.305
70	0.394
90	0.544
Average	0.324

The next strongest average density stratification was in February 1991. The weakest average and median stratifications were associated with September 1990. The initial dilutions calculated from this time-series of temperature measurements (see: Appendix O - Initial Dilutions) had the lowest monthly average value in February and the highest monthly average value in September. A second set of CTD data was available from the monthly monitoring program carried out by the City of San Diego. Water column profiles were obtained during a total of 51 monthly hydrocast surveys carried out between 1991 and 1994. A total of 374 profiles are available from the stations in water depths comparable to the discharge depth during this period. These profiles were also used in the initial dilution calculations (but not illustrated here).

Table N-3
DENSITY PROFILES FOR JANUARY, 1991

Depth (m)	Percentile[2]					
	10	30	50	70	90	Average
44.5	25.010	25.042	25.018	25.100	24.876	24.906
49.5	25.064	25.062	25.023	25.177	24.892	24.925
54.5	25.130	25.086	25.034	25.230	24.920	24.963
59.5	25.184	25.122	25.110	25.273	25.000	25.037
64.5	25.250	25.163	25.096	25.300	25.080	25.054
69.5	25.282	25.219	25.137	25.362	25.106	25.071
74.5	25.282	25.261	25.163	25.479	25.103	25.103
79.5	25.343	25.325	25.250	25.507	25.154	25.154
84.5	25.373	25.381	25.290	25.584	25.238	25.194
89.5	25.381	25.427	25.335	25.658	25.601	25.325
93	25.436	25.448	25.442	25.756	25.651	25.395

[1] Derived from time series of temperature, calibrated using CTD data.

[2] Based on Sigma-t (70-93m) (see Table N-2).

Temporal Variations in the Density Structure

The temperature variations measured at mooring C5 (in the vicinity of the outfall diffuser) at the depth of 70m in the water column are illustrated in Figure N-23. Variations in the water temperature are evident in the time-series for a wide variety of time-scales. There is an overall increase of slightly more than 1°C in the water temperature at this depth over the seven months of data. This increase may be associated with warming of the surface waters by solar radiation and the downward diffusion of this energy, or with an overall downwelling of the water column.

At the other end of the frequency spectrum, fluctuations of semi-diurnal tidal periodicity (associated with internal tides) are evident throughout the entire period. Although typical temperature changes over a tidal cycle are on the order of a few tenth's of a degree, changes in excess of 1°C occasionally occur. In-between these two frequency extremes are fluctuations with periodicities ranging from about one to four weeks, and amplitudes ranging from about 0.25°C to more than 1°C. These changes are probably associated with episodes of up- and downwelling, although they could also result from the advection of water with a different density structure into the area.

These vertical movements of the surfaces of constant water temperature can have important consequences for the initial dilution process. Figure N-24 shows the time-series of the difference between the water temperature at the 70m (69.5m) and the 93m depth. Temperature differences range from less than 0.04°C to more than 1.8°C. A long-term trend over the seven months of data is lacking in the temperature difference time-series, indicating that the trend to increasing temperatures at the 70m depth also is present at the 93m depth. Fluctuations of tidal and intermediate frequencies are, however, present. These variations indicate that: (1) the vertical spacing between isotherms (contours of constant water temperature) dilate and contract within the water column, as well as moving up and down or, (2) there are significant changes with depth in the temperature gradients in this region of the water column. In either case, the changes in the strength of the temperature gradients in the entrainment region of the water column during the initial dilution process will result in substantial changes in the magnitude of the initial dilution over comparable time-scales.

Vertical Motions

The variations in water temperature shown in Figure N-23 cannot be used to estimate the magnitude of the vertical motions of the isotherms without information on the temperature gradients of the water column. The temperature data from the string of thermistors at the mooring has been used to examine these movements. Figure N-25 shows the magnitude of the vertical excursions of the 12.8°C isotherm for the same time as the temperature data shown in Figure N-23. Tidal fluctuations have been suppressed in this time-series by applying a 24 hour running-average on the original time-series. A downward trend in the depth of this isotherm over the seven months of data is evident, corresponding to the overall increase in water temperature previously illustrated at the 70m depth for the same period. The change in isotherm depth over the period is about 30m, corresponding to an average vertical speed of the isotherm of about 0.14 m/day.

Internal Tides

Figure N-26 shows the vertical displacements associated with the internal tides. Vertical displacements between the shallowest and deepest isotherm depths during a tidal period are commonly on the order of 5-10m, and occasionally reach 20-30m. These internal tide motions can be complex, exhibiting some characteristics of a cross-shelf internal seiche, as illustrated in Figure N-27.

Up- and Downwelling

Typical vertical displacements associated with the intermediate time-scales probably associated with up- and downwelling events are on the order of 15m to 30m. A short-duration, but large downward displacement of more than 50m is evident near calendar day 260 (mid-September), followed by an upward displacement of about 40m. These events occur at irregular intervals, and persist for varying lengths of time. There are about 13 occasions of upward displacements exceeding 10m over the 216 days of record, yielding an average interval between upwellings of slightly more than two weeks.

Figure N-28 shows the vertical movements of the 12.8°C isotherm from January to April, 1991 after removal of the tidal frequency fluctuations. There has been an overall downwelling of the 12.8°C isotherm from a depth of about 54m at the end of the previous record (calendar day 276, 1990) to a depth of about 84m at the start of this data period (calendar day 12, 1991). This is followed by an upward movement of the isotherm of about 70m over the next 79 days. This corresponds to an average vertical speed of almost 1m/day, or about almost seven times faster than the average downward speed during the preceding year. There are about eleven instances of upwelling with displacements in excess of 10m during the 79 days of data, yielding an average interval between the events of about one week. Vertical motions at the intermediate time-scales during this winter-early spring period are comparable to, or somewhat greater than, the displacements in the spring, summer, and early fall of 1990. Figure N-29 shows the variations for this period associated with the internal tides and internal waves.

CURRENTS

Introduction

Ocean currents play an important role in mitigating the effects of the discharge of wastewaters from an ocean outfall. They are characterized by properties that change with spatial position and time. In the immediate vicinity of the outfall (spatial-scales on the order of 1-2 km, and time-scales ranging from minutes to hours), the strength and direction of the flow influence the magnitude of the initial dilution, as well as the height-of-rise of the plume, and the spatial dimensions of the wastefield. Over long time-scales (days to weeks) and large spatial-scales (5-50 km), they determine the rate of flushing of wastewater out of the discharge area, and the renewal of effluent-free ambient water.

Although the ocean currents are three-dimensional, the vertical motions are small in comparison with the horizontal motions, and thus difficult to measure directly. For example, vertical displacements of 10m over a period of about 6 hours (e.g., semi-diurnal internal tidal oscillation) only correspond to vertical velocities of about 0.05 cm/sec (0.0005 m/sec). Therefore, the current meters used to record the ocean currents essentially only record the horizontal motions. The vertical motions must be inferred from the time-series measurements of water temperatures in the water column.

The two-dimensional measurements of ocean currents can be described either in terms of a speed and a direction of flow, or in terms of the velocity components along two independent spatial axes. Both representations have their merits. For example, the speed-direction representation is most convenient in assessing the short-term response of the initial dilution process to the ocean currents local to the vicinity of the diffuser. Since the temporal characteristics of the currents tend to vary between the "longshore" and "cross-shore" components of the flow, the use of velocity components is most convenient for assessing the transport of ocean water (and discharged wastewater) in the larger region around the outfall.

Historical Measurements

The Southern California Coastal Water Research Project (SCCWRP) has carried out measurements of the ocean currents off Point Loma at various times between 1974 and 1985. Virtually all of these measurements were made in water depths ranging between 28m and 60m, with the bulk of the measurements made at a depth of 40m at a station in 60m of water. Although the measurements were made in water depths shallower than the terminus of the present (extended) outfall, they have provided a number of useful insights into some general characteristics of the flows.

The net current , measured at the 40m depth in 60m of water over a 290 day period from January 11 to December 31, 1976 was upcoast at a speed of 3 cm/sec (Hendricks, 1977). Although the average currents over periods of two weeks varied substantially, there was an indication that the upcoast flow was strongest between summer and early winter, averaging 2 cm/sec during the first half of the record, and 4 cm/sec during the last half.

A current meter mooring was placed off Point Loma about 2 km north of the outfall, and drogues were deployed near the outfall, and also off Mission Beach, during a study in 1975 (Hendricks, 1975). Comparisons were made between the movements of the drogues, and the motions predicted from current meter data. The predicted longshore movements agreed well with the observed longshore movements of the drogues. On the other hand, there was little correlation between the predicted and observed cross-shore motions. In 1976, current meter moorings were placed along the 60m isobath off Point Loma (0 km), Mission Beach (6.5km), Pt. La Jolla (17km), Solana Beach (32km), and Encinitas (36.5km). Overall, the variations in the longshore component of the currents measured at Point Loma correlated well with the variations measured off Mission Beach and Point La Jolla--although on a couple of occasions, the peaks were shifted by a few days (Hendricks, 1977). Only major (large-amplitude) fluctuations observed off Encinitas were correlated with the fluctuations observed off Point Loma. No significant correlation was observed between the currents off Point Loma and Oceanside (ca. 50 km upcoast), during another study.

SCCWRP also carried out measurements at several stations along a cross-shore transect off Point Loma during the summer-fall of 1985, and in the winter of 1986-1987. Of particular interest in this data set, is the measurement of near-bottom currents at elevations of 1-2m above the bottom. The results are summarized in Table N-4.

A consistent offshore net flow was present during both seasons and at all water depths. There is an suggestion that the strength of this offshore component increases with water depth (r = 0.65-0.81, depending on the inclusion/exclusion of the observations at 60m).

Engineering-Science Measurements

Engineering-Science, Inc. carried out current measurements at the array of stations (C1-C7), shown in Figures N-4 and N-5, between January and September 1990, and January and April 1991 (deployment periods are listed in Sub-Appendix NS1). The measurements were made at intervals of 30 minutes. Each mooring along the main transect (C2-C5) at meter beginning at the 20m depth, repeated at 20m intervals to the bottom. At some moorings (e.g., C2, C4) the proximity of the bottom required that the lowermost current meter on the mooring be less than 20m below the meter above it. Although the beginning and ending dates can differ (as well as the servicing dates of the moorings), these current measurements were made simultaneously with the temperature measurements collected by the thermistor strings.

Table N-4
NEAR-BOTTOM CURRENTS (1-2 MAB)
(SCCWRP, UNPUBLISHED)

Water Depth at Mooring (m)	Beginning Calendar Day -Year	Ending Calendar Day -Year	Cross-shore (cm/sec) + Onshore	Longshore (cm/sec) +Upcoast
30mN	227-1985	248-1985	-0.5	2.2
30mS	227-1985	248-1985	-0.7	0.8
35m	343-1986	373-1986	-2.7	1.6
35m	008-1987	026-1987	-3.3	1.6
42m	164-1985	199-1985	-2.2	3.9
42m	199-1985	227-1985	-2.0	2.8
60m[1]	164-1985	199-1985	-0.6[1]	1.0[1]
60m[1]	199-1985	227-1985	-0.2[1]	-0.2[1]
65m	343-1986	373-1986	-2.5	1.0
77m	342-1986	008-1987	-2.6	1.3
77m	008-1987	043-1987	-3.0	1.1
100m	306-1986	342-1986	-5.2	0.2
100m	342-1986	008-1987	-4.7	-2.0

[1] - May be affected by the entrainment flow from the "old" outfall in operation at 60m.

Analysis of the initial dilution simulations (Appendix O - Initial Dilution) indicates that the level of minimum dilution typically falls between 66m and 77m. Therefore, the currents measured at the 60m and 80m depths at mooring C5 will best represent the flows affecting the initial dilution and the transport of wastewater. The properties of these currents will be the basis for the subsequent discussion.

The discussion is presented on a seasonal basis. The months of January-March were designated "winter"; April-June, "spring"; July-September, "summer", October-December, "fall". This particular choice was based on the characteristics of the receiving water environment and the discharge. On occasion, the current meters at the 60m and/or 80m depths failed to record an adequate data set for the period. The measurements at mooring C4, lying inshore of C5, were used for the analysis during these periods. A discussion of the properties of the currents as a group (e.g., inter-meter and inter-mooring correlations, current speeds at the other moorings, etc.) is contained in Hendricks (1990).

Current Speeds

The instantaneous (30-minute average) current speeds are important in estimating the actual initial dilutions achieved by the outfall-diffuser system. The distribution of these speeds for the winter of 1990 is illustrated in Figure N-30. The distributions for the winter of 1991, spring of 1990, summer 1990, and fall of 1990 are illustrated in Figures N-31 through N-34, respectively. The probability distributions of current speeds, in 1 cm/sec increments, are contained in Sub-Appendix NS2. Only a general summary of the distribution features are presented here.

The median speeds for all the seasons for the meters at moorings C4 and C5 are summarized in Table N-5. A comparison of the median speeds recorded in 1990 with those recorded in 1991 indicates that interannual variations are comparable with the seasonal changes.

Table N-5
MEDIAN CURRENT SPEEDS
(SPEED= M/SEC, DEPTH=M)

Mooring-Depth	Winter-90	Winter-91	Spring-90	Summer-90	Fall-90
C5-60	0.094	0.076	0.093	0.078	-
C4-60	0.094	0.084	0.089	0.076	0.081
C5-80	0.125	0.075	0.095	0.085	-
C4-77	0.094	0.100	0.084	0.082	0.076
C5-20	-	-	0.113	0.096	-
C4-20	0.149	-	0.127	0.097	-
C5-40	-	-	0.118	0.085	-
C4-40	0.125	-	0.088	0.077	-

Winter: January-March; Spring: April-June; Summer: July-September; Fall: October-December

The 10-percentile current speeds are summarized in Table N-6. Typical speeds at the 60m and 80m depths are on the order of 2 to 4 cm/sec, averaging 2.9 (±0.6) cm/sec.

The 90-percentile current speeds are summarized in Table N-7. At this level, there is less difference between the speeds at the 60m depths recorded in 1990 and 1991, but still a substantial interannual change at the 80m depth. Typical speeds range from about 16 to 20 cm/sec. The average 90-percentile speed at the 60m and 80m depths is 17.2 (±1.9) cm/sec.

The net current speeds for each season at the 60m and 80m depths are summarized in Table N-8. The strongest currents were measured during the winter of 1990; the weakest currents, in the summer. However, the currents measured during the winter of 1991 were almost as weak as measured in the summer. Thus interannual variability is comparable with the seasonal variability. The average net velocity over all seasons at the 60m depth was 3.4 (±1.1) cm/sec; at the 80m depth, 3.1 (±1.9) cm/sec. These speeds are comparable with the net speed of 3 cm/sec reported by Hendricks (1977) for 290 days of measurements in 1976.

Table N-6
10-PERCENTILE CURRENT SPEEDS
(SPEED=M/SEC, DEPTH=M)

Mooring-Depth	Winter-90	Winter-91	Spring-90	Summer-90	Fall-90
5-60	0.035	0.028	0.032	0.031	-
4-60	0.039	0.029	0.034	0.027	0.021
5-80	0.040	0.025	0.034	0.018	-
4-77	0.031	0.030	0.024	0.024	0.028
5-20	-	-	0.033	0.033	-
4-20	0.055	-	0.039	0.031	-
5-40	-	-	0.039	0.028	-
4-40	0.041	-	0.024	0.025	-

Table N-7
90-PERCENTILE CURRENT SPEEDS
(SPEED=M/SEC, DEPTH=M)

Mooring-Depth	Winter-90	Winter-91	Spring-90	Summer-90	Fall-90
5-60	0.185	0.158	0.192	0.168	-
4-60	0.175	0.158	0.169	0.158	0.152
5-80	0.209	0.157	0.183	0.177	-
4-77	0.214	0.190	0.160	0.159	0.148
5-20	-	-	0.241	0.197	-
4-20	0.284	-	0.265	0.213	-
5-40	-	-	0.219	0.181	-
4-40	0.172	-	0.189	0.171	-

Direction

Some caution is in order in interpreting the direction of the net flow. The speed and direction associated with a net flow can be converted into longshore and a cross-shore velocity components. Studies (Hendricks, 1977; Vinant, 1983) show that slowly changing fluctuations in the longshore direction tend to vary as a unit over the water column, and are correlated over longshore separations of 25-35 km. Thus, the longshore component of a net flow measured at the current meter mooring is likely to be representative of the net longshore flow over similar distances.

Table N-8
NET CURRENT SPEEDS BY SEASON

Season	Net Speed (cm/sec)			
	60m		80m	
	Speed	Direction	Speed	Direction
Winter - 1990	4.9	020	6.5	005
Winter - 1991	2.1	029	1.3	029
Spring	4.6	018	5.1	008
Summer	2.0	081	0.7	123
Fall[1]	3.3	033	2.6	004

[1] Depths of 60m and 77m in 81m of water (C4). The currents at the 77m depth may be affected by proximity to the bottom.

In general, the net flows show an onshore flow combined with a (stronger) upcoast flow. The magnitude of these cross-shore flows should, however, be viewed with some skepticism. Correlations distances for slowly varying cross-shore flows are short, with only small correlations observed over horizontal separations on the order of 1-2 km and over vertical separations of 20m (Hendricks, 1990). Variations in the cross-shore component of the currents, such as those in the tidal frequency band, may undergo one or more reversals in direction across the water column.

The current measurements were made at fixed depths in the water column. Density stratification of the water column suppresses transport across isothermal surfaces (surfaces of constant water temperature), so that currents are predominantly parallel to surfaces of constant water temperature. However, the isothermal surfaces at these depths undergo vertical excursions, and the spacings between them expand and contract, with the passage of internal waves and internal tides (see "Temporal Variations in the Density Structures" in this Appendix). These vertical motions can be in the opposite direction between the inner and outer areas of the shelf. Correlations may exist between the vertical displacements of the isotherms, the dilation and contraction of the vertical spacing, and the horizontal movements of the ocean currents. In that case, fictitious slowly-varying, or net, cross-shore flows may be generated in records of the currents recorded at a fixed depth. Clearly, the measured onshore flows can not persist for long, or over cross-shore distances, in excess of a few kilometers, without encountering the ocean bottom (i.e., the "effective" coastline).

The directional probability distributions are presented for 10-degree sectors in Sub-Appendix NS2. The principal value of "instantaneous" measurements of the direction of the current flow (the current meters do not average direction over the 30 minute interval) is in calculating initial dilutions. In this case, it is the joint probability distribution of current speed and direction that are useful. These distributions are presented for 1 cm/sec increments in current speed, and 10 degree directional sectors in Sub-Appendix N2. As will be shown later, transport of wastewater depends on the combination of the speed of the flow, its direction, and the persistence of the flow in a specific direction. The distributions of the direction of flow vary, depending on the time-scales of interest (which, in turn, depend on the transport length-scales of interest). Therefore, the distributions of instantaneous direction of flow have little value for the purpose of estimating transport.

As noted earlier, the height of rise to the level of minimum dilution averages about 23-24m above the diffuser ports, or a depth of about 70m. Therefore, only the measurements at the 80m depth will approximate the average direction of flow over the entrainment region of the water column. The directional distributions at this depth are presented in Table N-9 in 30 degree increments.

Table N-9
PROBABILITY DISTRIBUTION OF THE
INSTANTANEOUS DIRECTION OF FLOW AT 80m DEPTH
(30 DEGREE SECTORS, IN DEGREES-TRUE)

Sector	Winter-90	Winter-91	Spring-90	Summer-90	Fall-90
340-010	0.171	0.085	0.255	0.111	0.201
010-040	0.146	0.048	0.115	0.111	0.105
040-070	0.142	0.147	0.113	0.080	0.184
070-100	0.105	0.075	0.072	0.069	0.070
100-130	0.046	0.101	0.055	0.068	0.055
130-160	0.035	0.088	0.064	0.102	0.092
160-190	0.025	0.064	0.052	0.137	0.050
190-220	0.021	0.065	0.028	0.104	0.049
220-250	0.017	0.041	0.021	0.044	0.031
250-280	0.022	0.086	0.029	0.035	0.030
280-310	0.068	0.105	0.047	0.054	0.025
310-340	0.201	0.095	0.150	0.087	0.107

The distributions tend to be bimodal, with the highest probabilities corresponding to flow approximately up- and down-coast, or roughly paralleling the trend of the two diffuser legs. The most likely period of flow across the diffuser legs is during winter.

Temporal Properties of the Currents

The advective transport of ocean water and wastewater by the ocean currents depends on the strength and direction of the flow--and on the persistence of the flow in a specific direction. The presence of the coastal boundary inhibits sustained cross-shore flows, while these limitations are not present on flows parallel to the coast. Since the longer a flow continues in a specific direction the greater the transport distance, the coastal boundary tends to inhibit cross-shore flows that have long persistence. Thus it is natural to convert speed-direction measurements into velocity measurements, with the axes for the velocity components aligned approximately longshore and cross-shore. However, the actual alignment of these axes are often correlated with the trend of the isobaths (contours of constant depth) in the area--and hence may, or may not, be aligned with the actual coastline.

The method for selecting the alignment of the "longshore" and "cross-shore" axes will be described later. For the present, assume that this alignment has been determined, and that the two components of the velocity time-series are along these axes. The temporal properties of the time-series for the two velocity components can be examined by representing the time-series of observations by a series of sines or cosines functions--each with a different frequency (or periodicity) determined by the length of the time-series and the number of observations (Bracewell, 1978; Otnes and Enochson, 1978). The amplitude associated with each periodicity is a measure of strength of the variation at that periodicity. The sum of the squares of all the amplitudes is equal to the variance of the fluctuations about the net current.

An example of this decomposition is illustrated in Figure N-35. It represents the variations in the longshore components of the flows measured at the 60m and 80m depths during the winter of 1990. The vertical axis represents the cumulative variance, as the contributions with increasingly long periodicities are added to the sum. Thus the total variance contributed by all the fluctuations present during the 42.7 days of data in the time-series at the 60m depth is about 68.5 cm^2/sec^2. The two abrupt increases in the variance at periodicities of about 0.5 and 1 day correspond to variations of tidal periodicity. The oscillations of tidal period, combined with the fluctuations of even shorter periodicity, contribute about 30 cm^2/sec^2 to the variance. The remaining variance, ca. 38-39 cm^2/seo^2, or somewhat more than half the total, is associated with variations in the longshore current that change more slowly than the tidal oscillations. The temporal properties of the variations in the longshore flow at the 80m depth are similar to those at the 60m depth, but the variations are slightly stronger.

This distribution for the longshore component of the flow can be compared with the variations in the cross-shore component of the flow at the same depths and time period. The temporal dependence of these fluctuations is illustrated in Figure N-36. The total variance at the 60m depth is about 22 cm^2/sec^2; the total variance at the 80m depth is much larger, at 81 cm^2/sec^2. In contrast to the longshore flow, most of this variance is associated with fluctuations of tidal period, or shorter (ca. 73 percent to 91 percent at the 60m and 80m depths, respectively). The variance contributed by fluctuations that vary more slowly than the tidal oscillations is only about 6 to 7 cm^2/sec^2.

The corresponding plots for the spring, summer, and fall of 1990 are illustrated in Figures N-37 through N-42, respectively. Some seasonal differences are apparent by comparing the variance associated with three periodicity bands: (1) shorter than about 1 day, (2) periodicities between about 1 day and 1 week and, (3) periodicities longer than 1 week. The variances in the longshore flows associated with the three bands are summarized by season in Table N-10.

Table N-10
SEASONAL LONGSHORE VARIANCES BY PERIODICITY BAND (CM^2/SEC^2)

Season - Depth(m)	< 1.5 days	1.5 days - 1 week	1 week - 6 weeks
Winter - 60	31	9	27
Spring - 60	17	5	43
Summer - 60	25	16	41
Fall - 60	30	11	> 31
Winter - 80	35	14	28
Spring - 80	19	2	21
Summer - 80	25	16	42
Fall - 80	30	9	>11

Fluctuations with periodicities shorter than a week were weakest during the spring. The strongest fluctuations in the tidal (or shorter) frequency band occurred during the winter, with variances about twice those in the spring. Averaged over all four seasons, fluctuations at the 60m and 80m depths are of nearly equal strength in both the tidal (and shorter) band and in the intermediate band (1.5 days - 1 week). However, the average variance of the fluctuations associated with periodicities longer than 1 week are about 40 percent greater at the 60m depth than at a depth of 80m. This difference may be a consequence of friction with the bottom.

Most of the variance in the slowly varying flows is associated with periodicities longer than one week. The average variance of the fluctuations associated with periodicities longer than 1 week are about 40 percent greater at the 60m depth than at a depth of 80m. This difference may be a consequence of friction with the bottom. The flushing time of parcels of wastewater from an area extending 15 km up- and downcoast from the outfall (and 12 km cross-shore) is on the order of 4.5 days. Therefore, most of these very slowly varying components of the longshore flow will appear like net flows, of varying strength, to parcels of wastewater discharged from the outfall. Since the rms speeds associated with these fluctuations are usually greater than the net flow, the predominant direction of transport of wastewater will be along the direction of these oscillations (see "Dominant Direction of Flow" later in this appendix).

The corresponding breakdown for the cross-shore variances is contained in Table N-11. The cross-shore variations with tidal (and shorter) periodicities are enhanced at the 80m depth, relative to 60m during all four seasons, but most pronounced during the winter (4.5:1). The enhancement almost disappears in the fall. The variations in the other two bands are weak and nearly comparable at the 60m and 80m depths. However, a small reduction is present in the variance at the longest periodicities at the 80m depth.

Table N-11
SEASONAL CROSS-SHORE VARIANCES BY PERIODICITY BAND (CM^2/SEC^2)

Season - Depth(m)	< 1.5 days	1.5 days - 1 week	1 week - 6 weeks
Winter - 60	16	3	3
Spring - 60	27	1	3
Summer - 60	14	3	5
Fall - 60	37	3	> 1
Winter - 80	73	5	3
Spring - 80	50	1	2
Summer - 80	27	3	4
Fall - 80	40	2	> 0

Dominant Direction of Flow

The significance of the difference in temporal properties of the currents between the longshore and cross-shore flows is readily illustrated by the currents measured at the 80m depth during the winter of 1990. The total variance in the cross-shore direction (ca. 81 cm^2/sec^2) is slightly greater than the total variance in the longshore direction (ca. 76 cm^2/sec^2). However, nearly all the variance in the cross-shore direction is associated with fluctuations with tidal, or shorter, periodicities, while more than half the variance in the longshore direction is associated with fluctuations occurring more slowly than the tidal oscillations.

Two new time-series were constructed from the original time-series. First the net current velocity during the period of observation was removed from the time-series. The resulting time-series was then filtered with a 25-hour running average filter to produce a new time-series containing essentially only the fluctuations that vary more slowly than the tidal oscillations. This "low-pass" time-series was subtracted from the original time-series (but with the net velocity removed) to produce a "high-pass" time-series primarily consisting of fluctuations of tidal, or shorter, periodicities. The net velocity of both the low-pass and high-pass time-series was zero.

Next progressive vector diagrams (PVD's) were constructed from the two time-series. In this process, the velocity at each observation time is represented by an arrow whose length is proportional to the current speed, and the orientation of the arrow along the direction of flow.

The arrows are placed end-to-end, with the tail of the new arrow positioned at the head of the previous arrow. If the currents everywhere along the path "traveled" by the arrows are the same as at the current meter, the PVD represents the movement of a marker initially placed at the origin of the plot.

The motion of the marker due to the currents with fluctuations of tidal and shorter periodicity is illustrated in Figure N-43 (the net current and the slowly varying fluctuations have been removed). The movement of the marker is confined to an area extending about 1.6 km downcoast (to the left) and 2.3 km upcoast (right) from the point of release, and about 1.1 and 3.1 km offshore (up) and onshore (down), respectively. Thus the range of movements of the marker is bounded by a rectangle with dimensions of about 4 km on a side. Most of the time, the marker remains within an area of about 1.1 km (longshore) by 1.8 km (cross-shore).

The motion of the marker due to the currents with fluctuations longer than the tidal period is illustrated in Figure N-44 (the net current and the fluctuations of tidal and shorter periodicity have been removed). Here the longshore motions span a total length of about 75 km; the cross-shore motions, about 26 km. In the longshore direction, this is almost 20 times greater than motion associated with the tidal and shorter periodicities; in the cross-shore direction, it is more than 6 times greater (but, as noted earlier, cross-shore transport over distances in excess of a few km is suspect). Although the net flows are generally weaker than the rms speeds of the slowly varying fluctuations, they can result in substantial transport. The net longshore component of the current existing during the period illustrated in Figure N-44 was 6.5 cm/sec (the highest measured for any season and depth). This net flow would correspond to upcoast transport of 330 km over this 59 day period (however, any predicted excursions in excess of the correlation length of 25-35 km are likely to be wrong).

These slowly varying fluctuations are much more energetic in the longshore direction than they are in the cross-shore direction. Therefore the dominant direction of flow (from the standpoint of the advection of wastewater over distances in excess a few kilometers) will be in the longshore direction. Net currents velocities are often weaker than the variations in the flow. Therefore they are difficult to measure with precision. This is particularly true for the cross-shore flows. Since vertical mixing is weak, advective transport is primarily along surfaces of constant density (isopycnal surfaces). These surfaces move up and down along with the isotherms, while the current meters remain at fixed elevations of the ocean bottom. This can introduce biases in estimates of the net transport from current measurements if there is shear in the water column--a condition that characterizes the cross-shore component of the currents. Therefore, the alignment of the principal axis for the variations with periodicities longer than the tidal period provides one of the best estimates of the dominant direction of transport. These directions are summarized by season and depth in Table N-12.

The average alignment of the principal axes of variation of fluctuations with periodicities longer than the tidal period at the 60m and 80m depths are within 2 degrees of each other, and essentially parallel the alignment of the isobaths in the vicinity of the discharge.

Table N-12
RMS SPEED AND ALIGNMENT OF PRINCIPAL AXIS OF VARIATION
(SUBTIDAL FREQUENCY BAND)

	rms Speed (m/sec)		Direction (Degrees, True)	
Season	60m	80m	60m	80m
Winter-1990	0.073	0.065	358	348
Winter-1991	0.064	0.049	346	351
Spring	0.080	0.071	351	348
Summer	0.074	0.075	012	012
Fall[1]	0.058	0.040	001	003
Average	*0.070*	*0.060*	*358*	*356*

[1] Depths of 60m and 77m in 81m of water (C4). The currents at the 77m depth may be affected by proximity to the bottom

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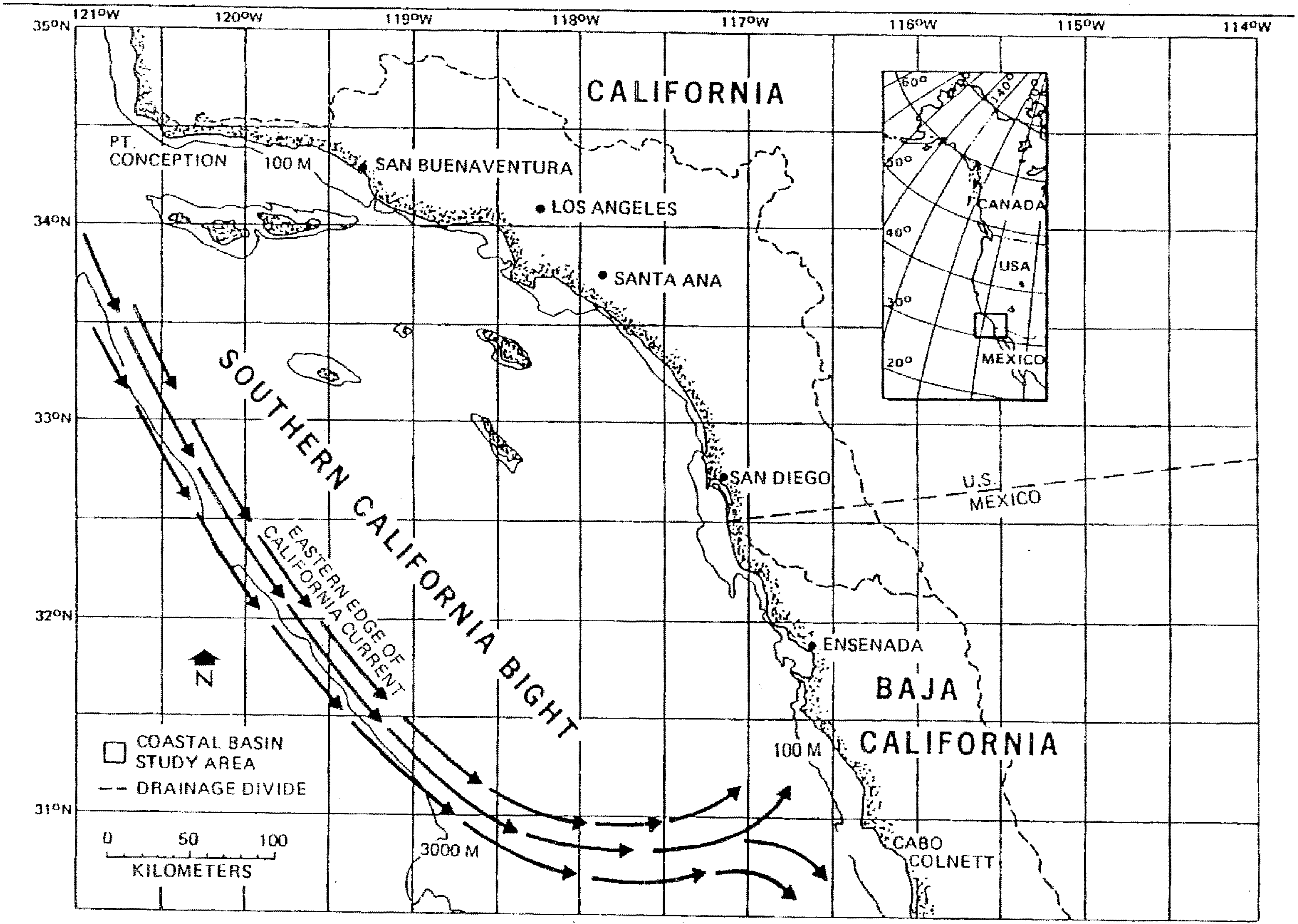
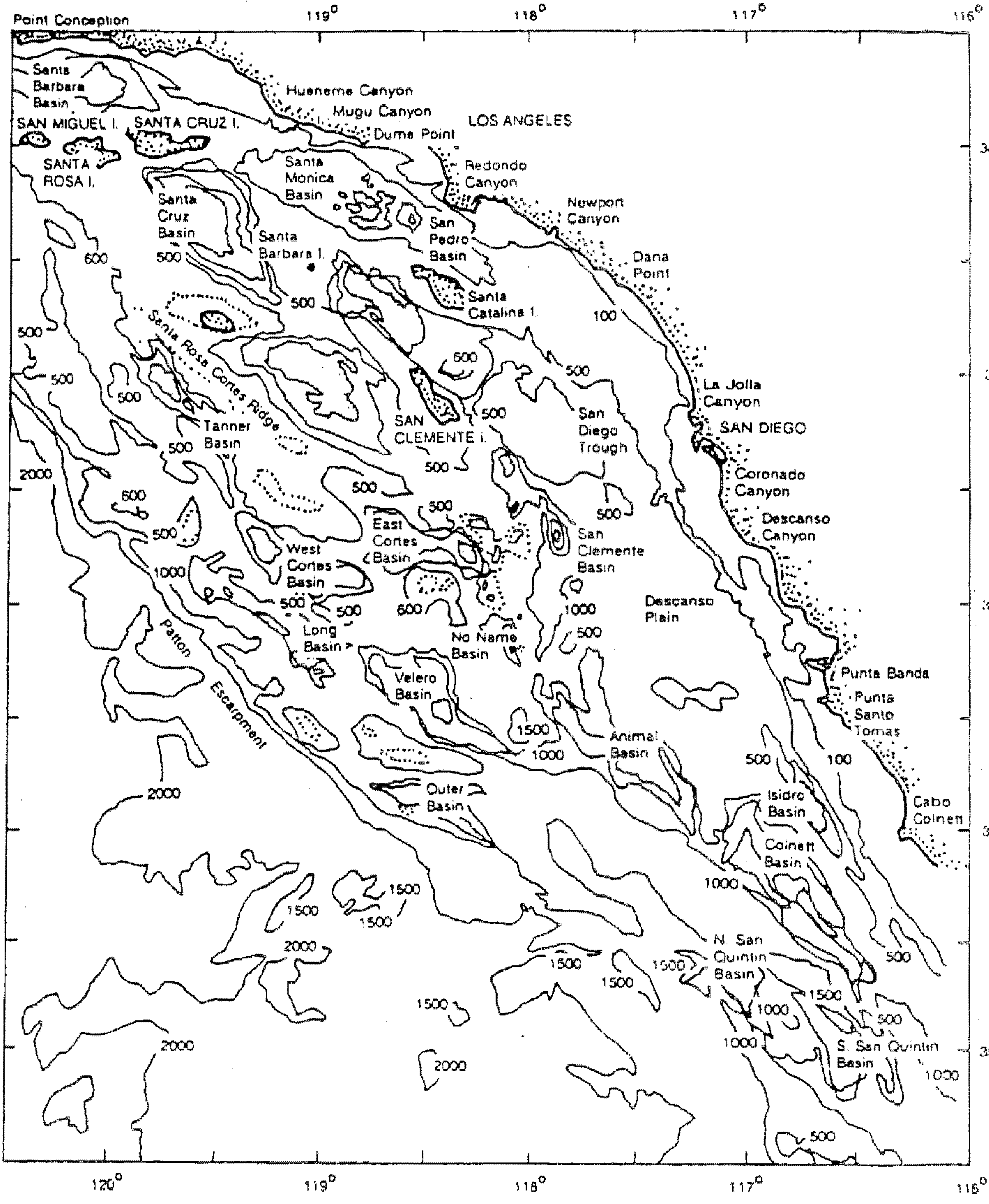
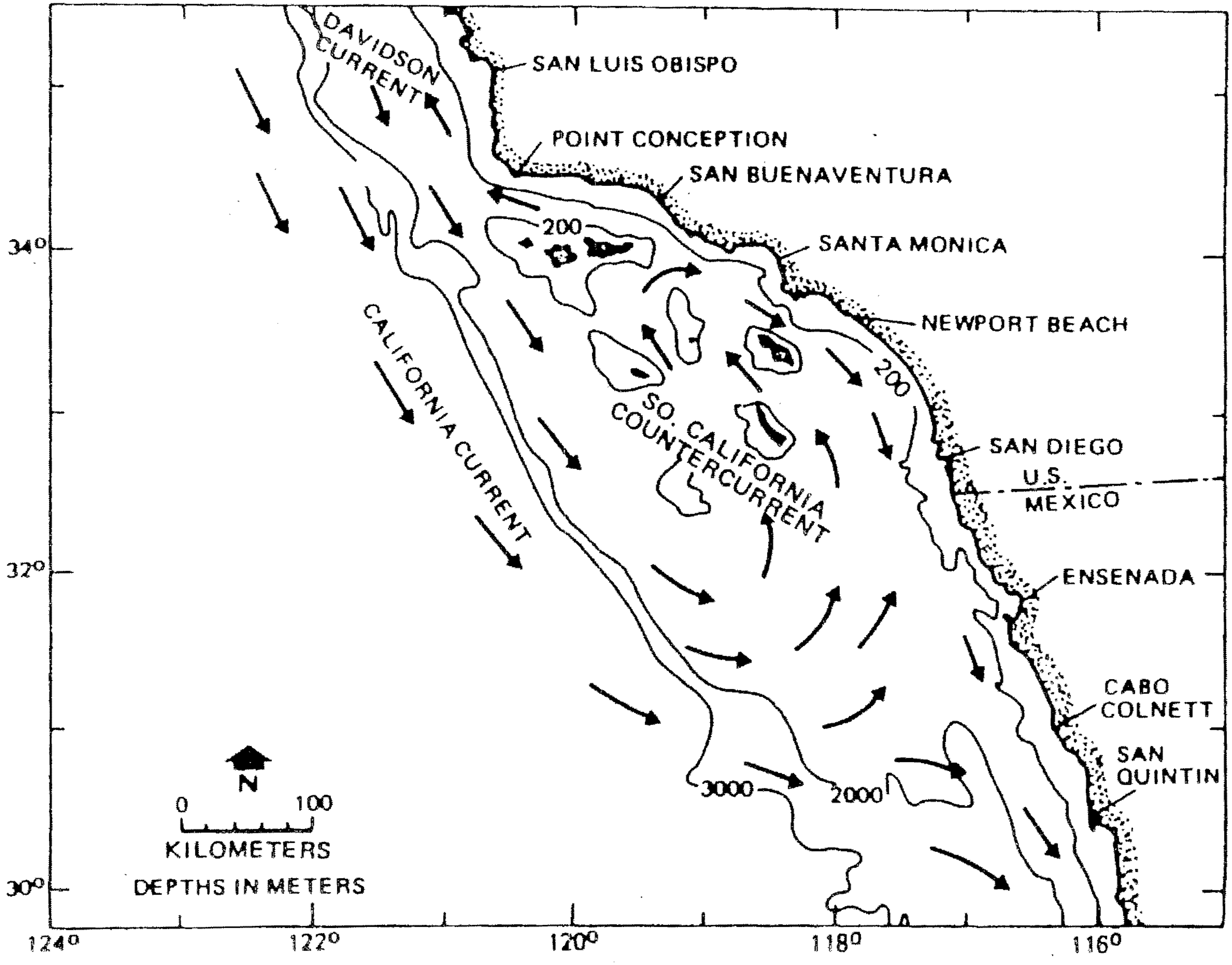


Source: SCCWRP 1973

SOUTHERN CALIFORNIA BIGHT

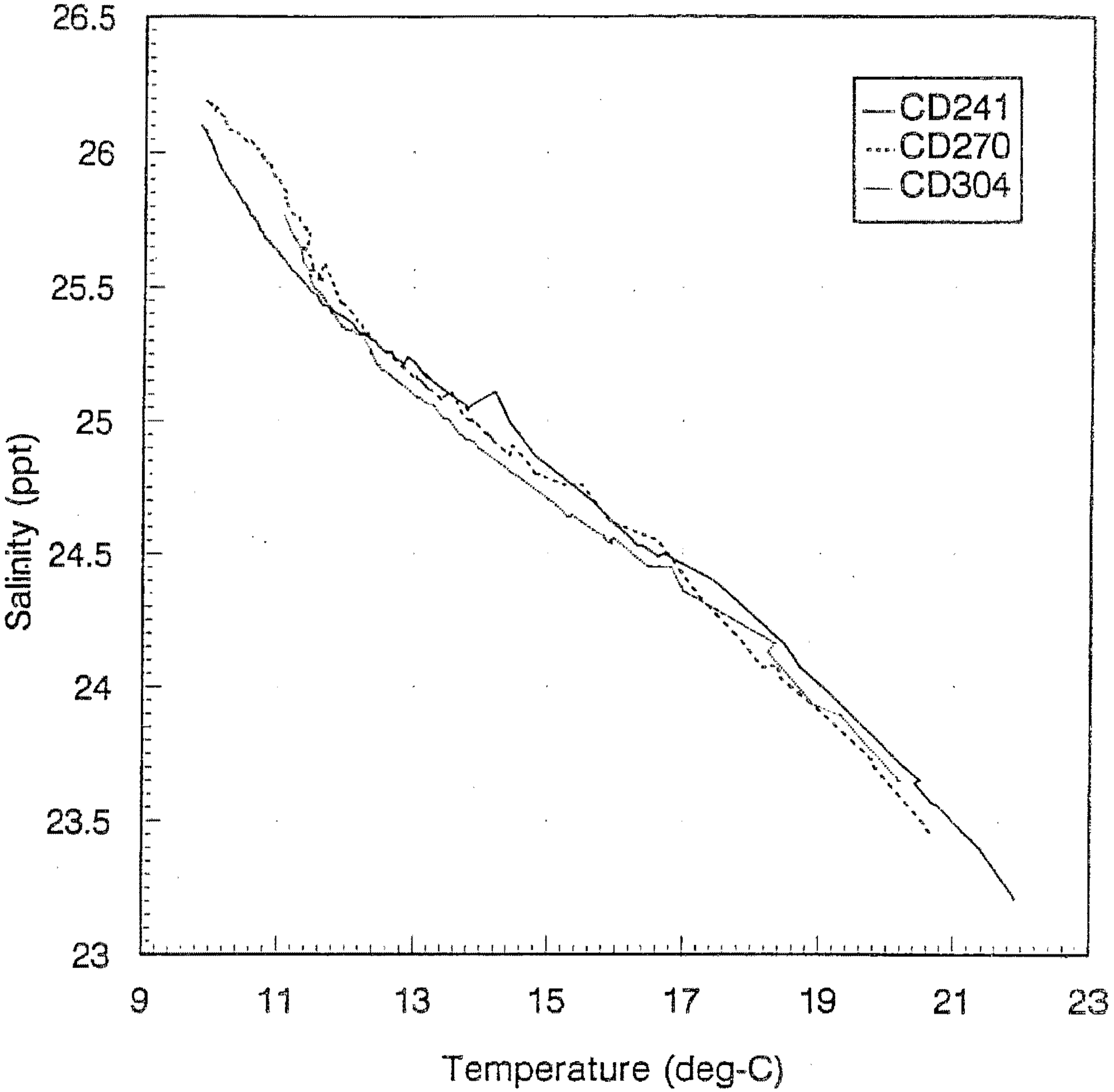


BATHYMETRY OF THE SOUTHERN CALIFORNIA BIGHT
(DEPTH IN FATHOMS; MOORE, 1969)

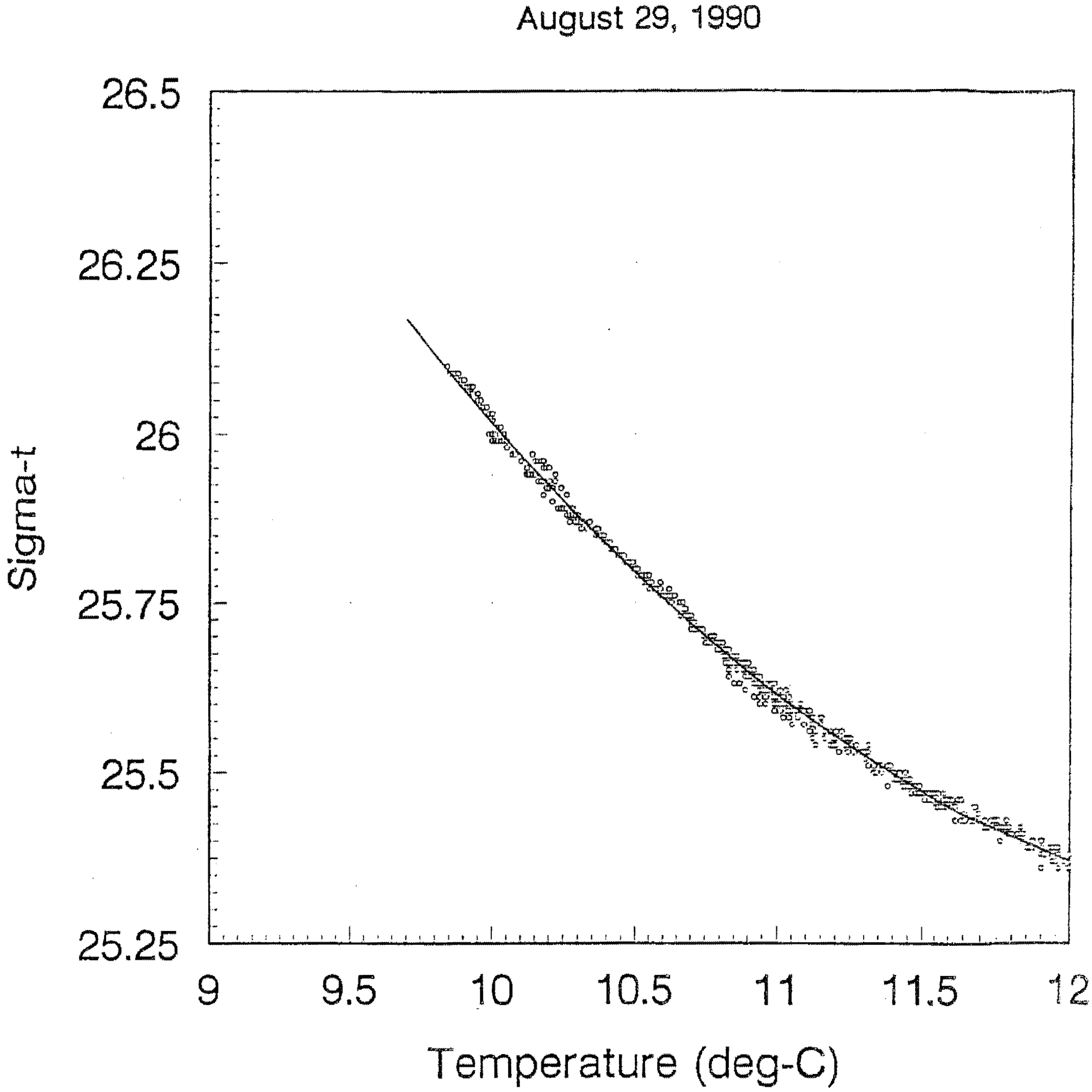


CURRENTS WITHIN THE SOUTHERN CALIFORNIA BIGHT

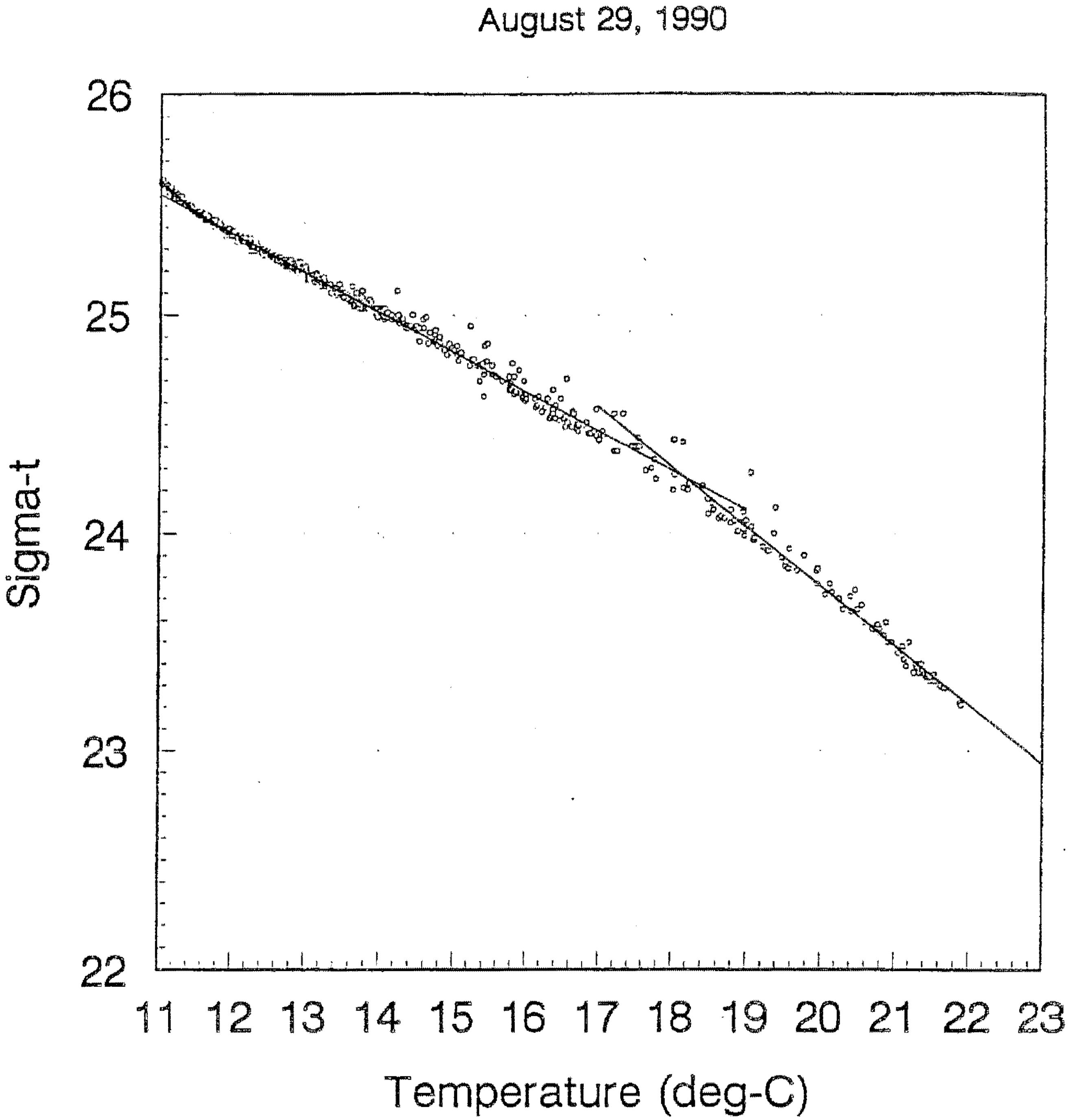
Figure N-3



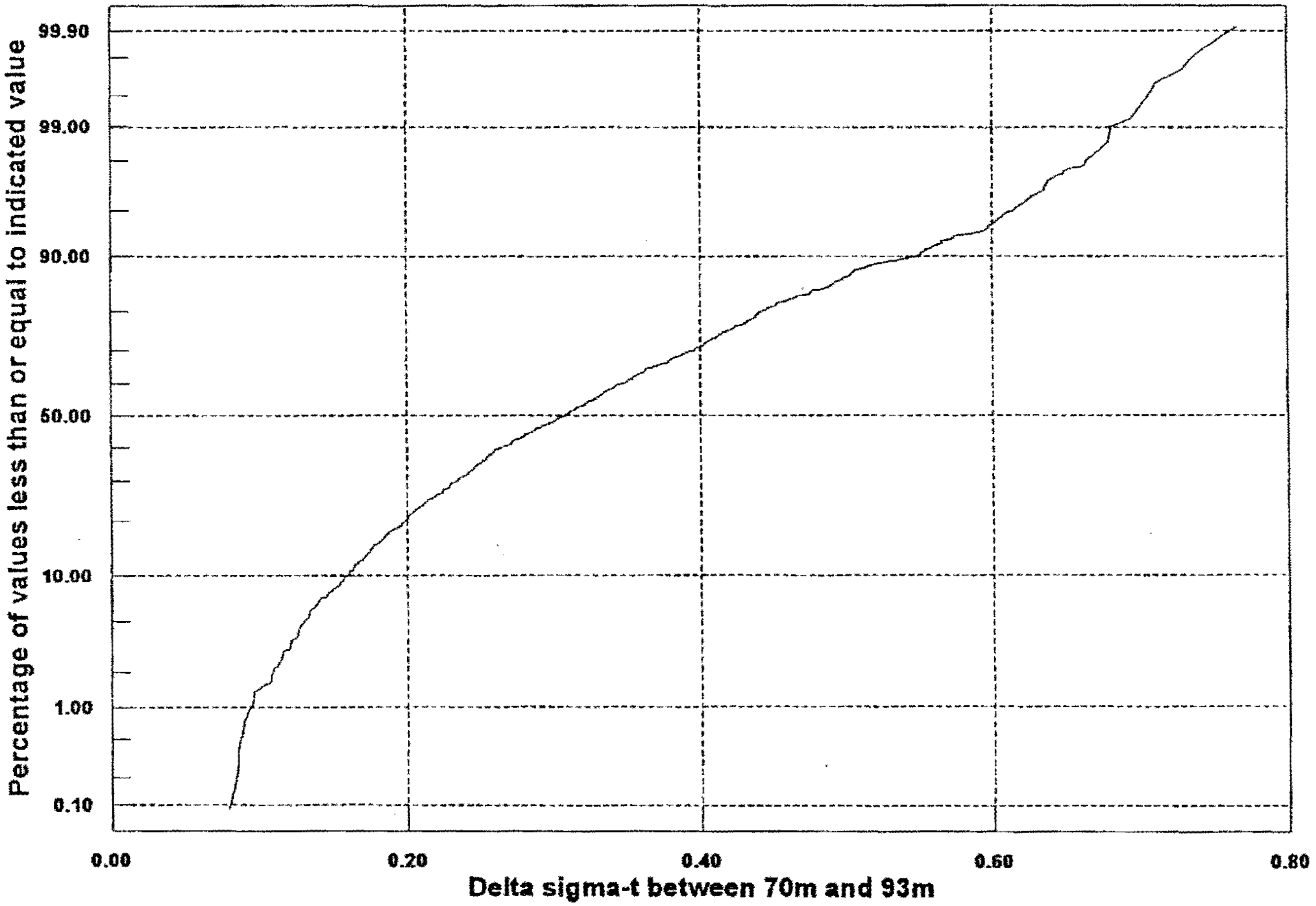
DENSITY/TEMPERATURE RELATIONSHIP FROM
CTD DATA COLLECTED AT STATION P5



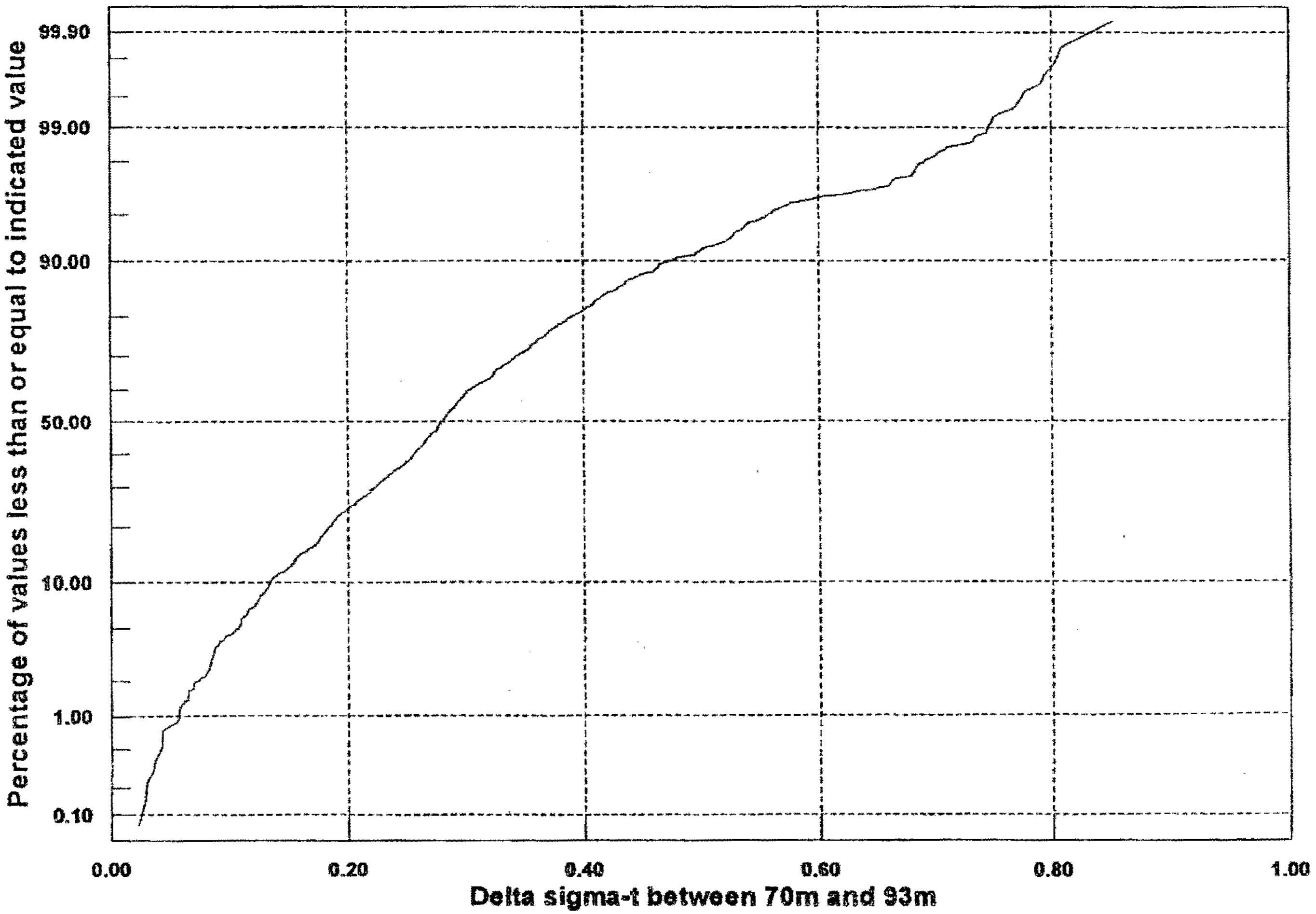
WATER TEMPERATURE VERSUS SIGMA-T
(CALENDER DAY 241; 9-12^{O}C)



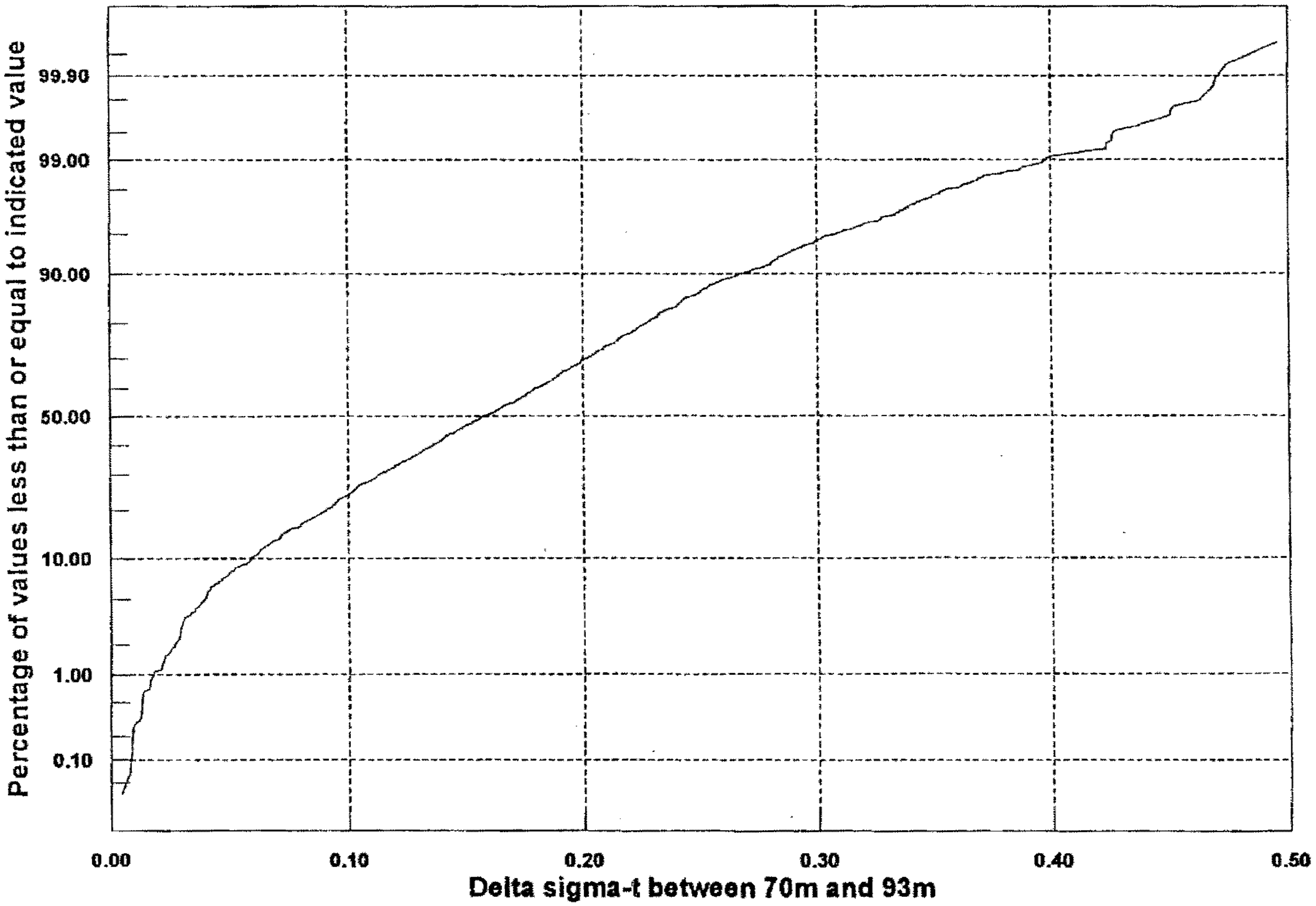
WATER TEMPERATURE VERSUS SIGMA-T
(CALENDER DAY 241; 11-22^{O}C)



PROBABILITY DISTRIBUTION OF DELTA SIGMA-T
BETWEEN 70 & 93M FOR JANUARY 1991

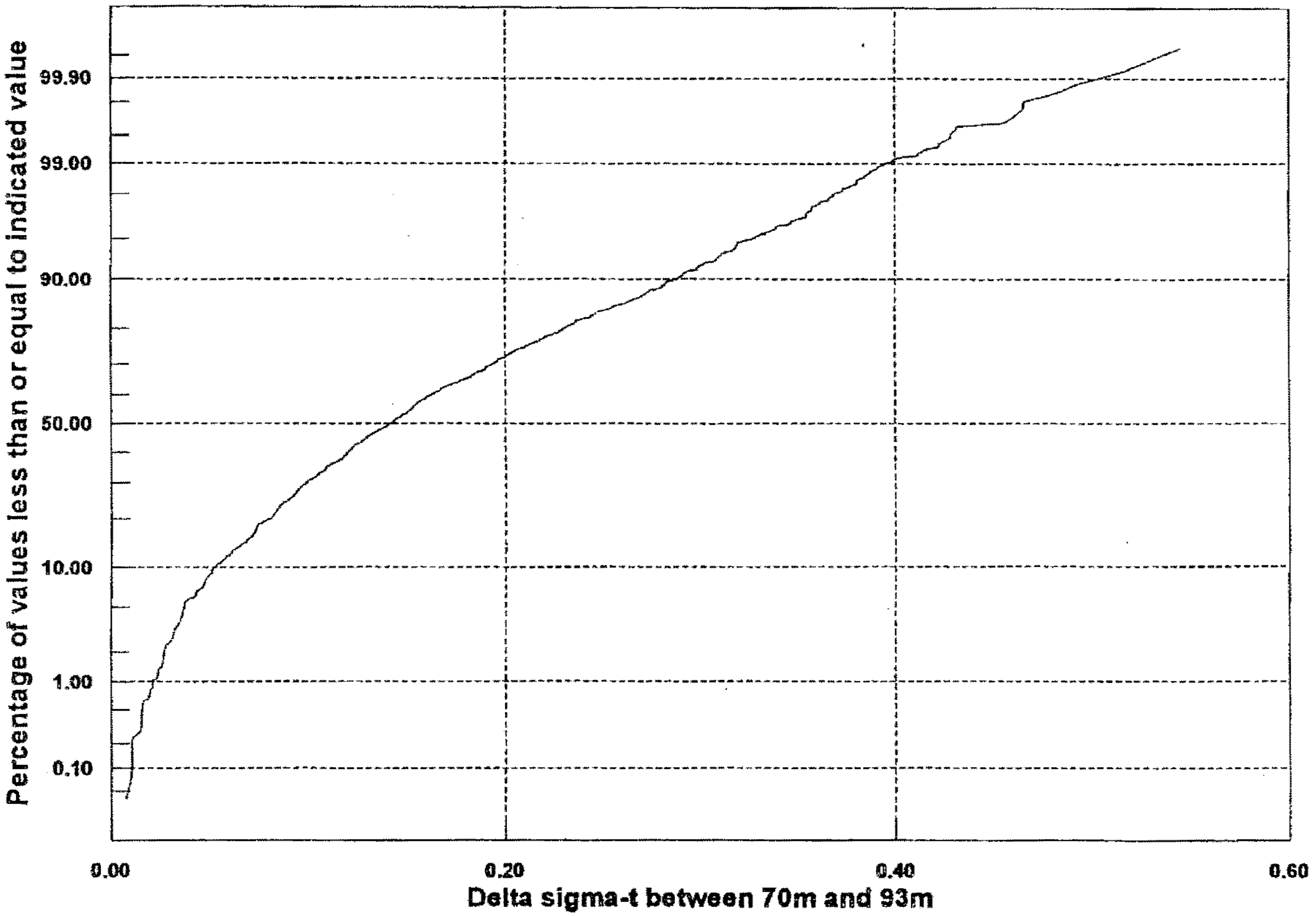


PROBABILITY DISTRIBUTION OF DELTA SIGMA-T
BETWEEN 70 & 93M FOR FEBRUARY 1991



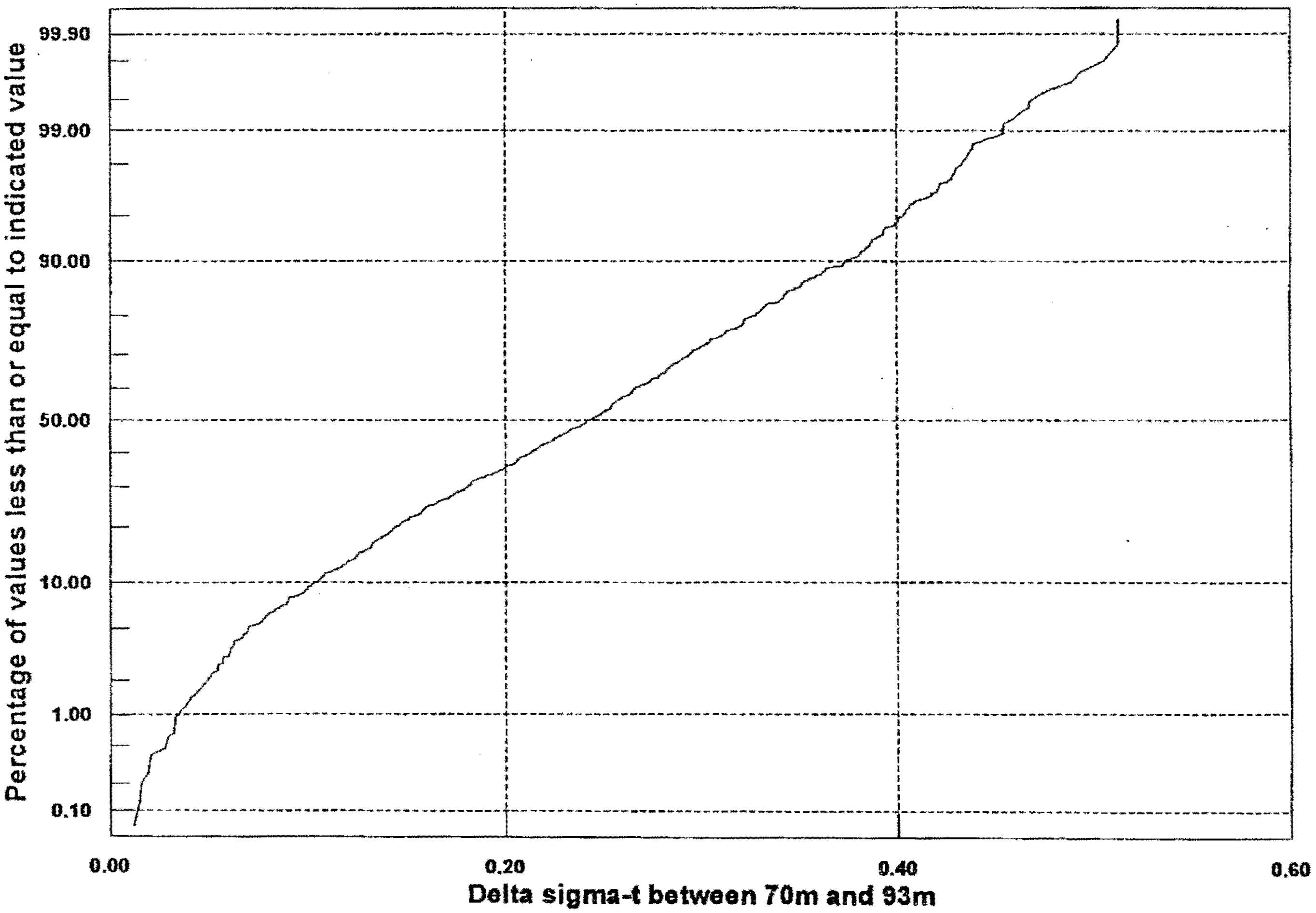
PROBABILITY DISTRIBUTION OF DELTA SIGMA-T
BETWEEN 70 & 93M FOR MARCH 1990 & 1991

Figure N-10



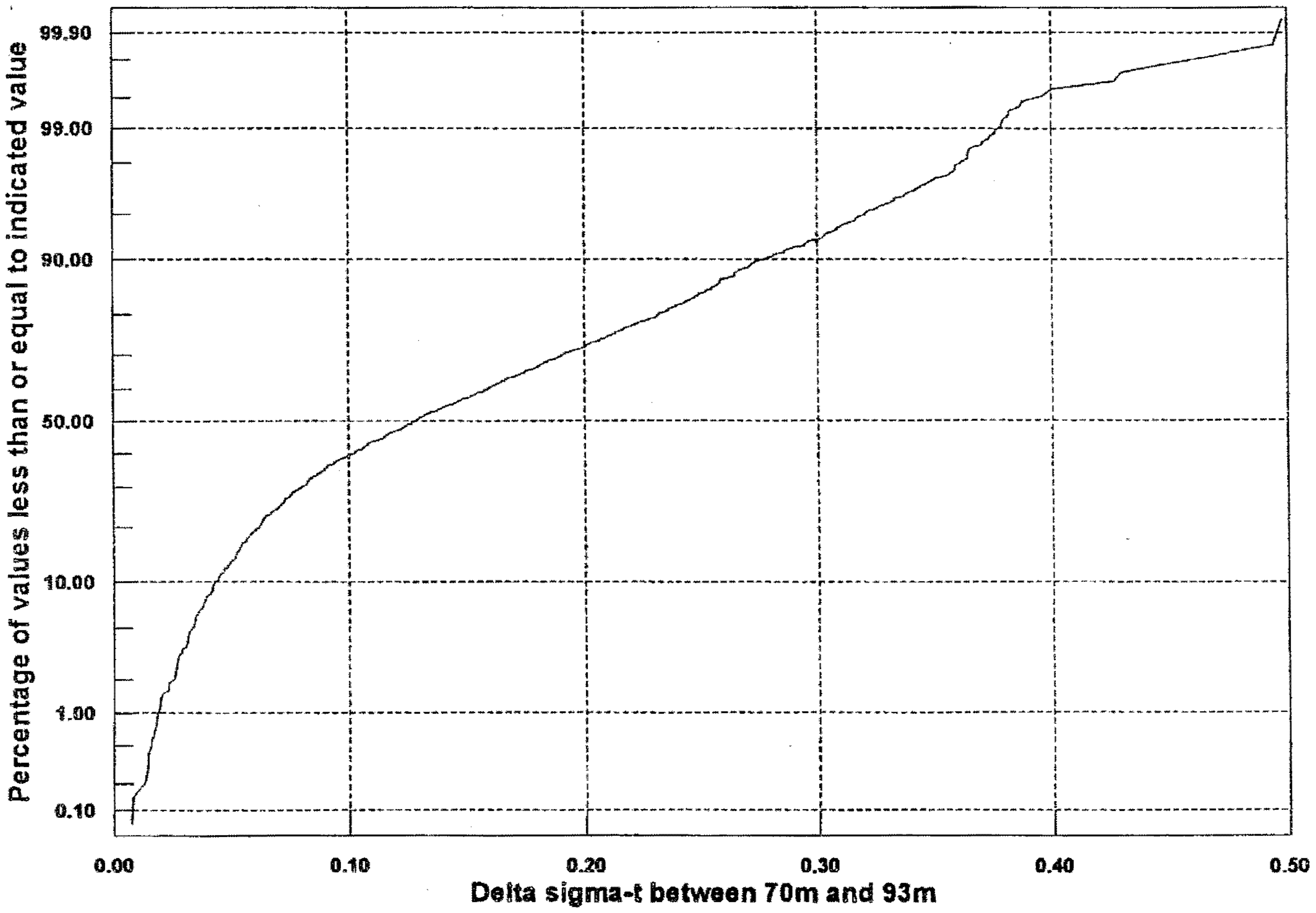
PROBABILITY DISTRIBUTION OF DELTA SIGMA- T
BETWEEN 70 & 93M FOR APRIL 1990

Figure N-11



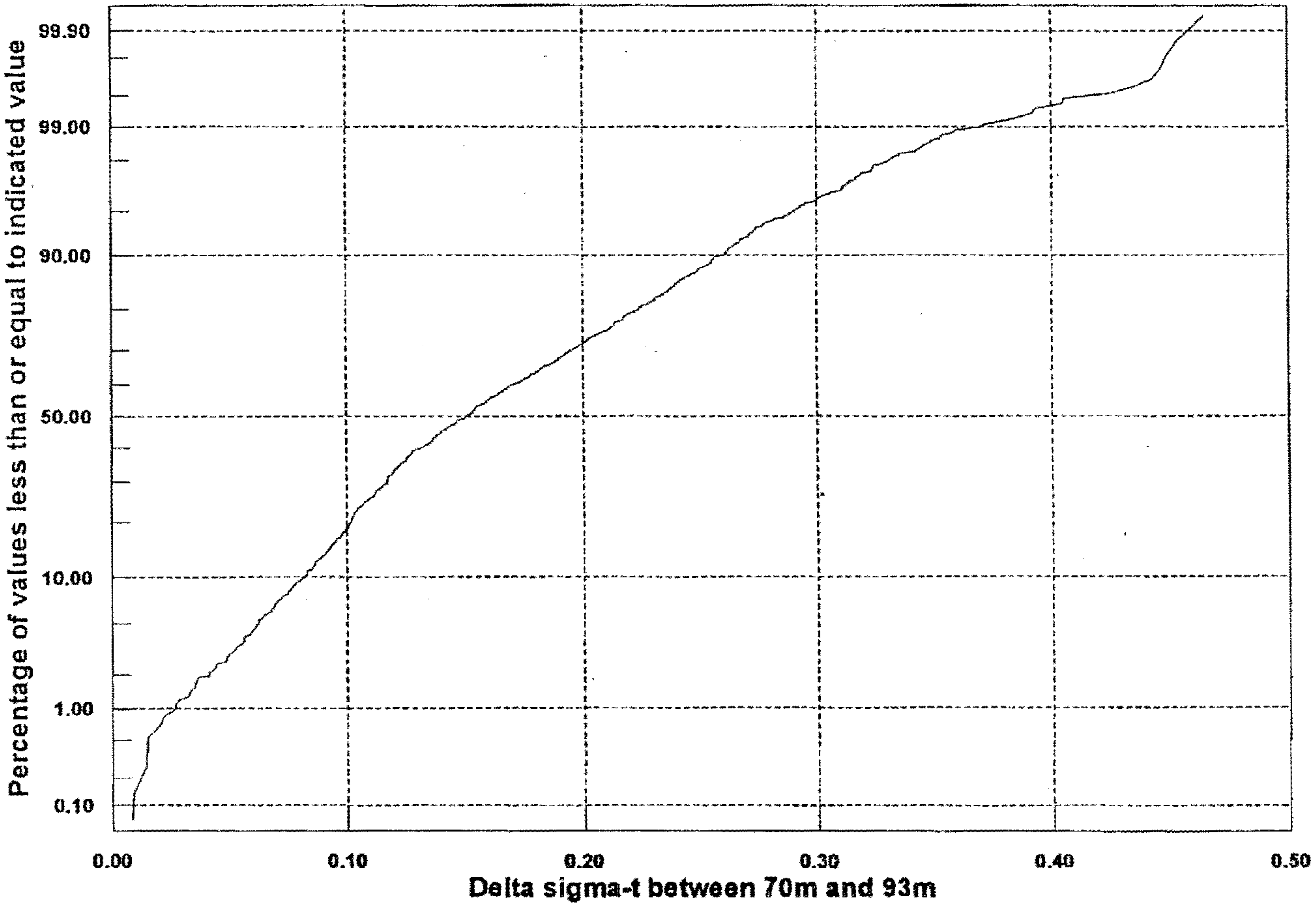
PROBABILITY DISTRIBUTION OF DELTA SIGMA-T
BETWEEN 73 & 93M FOR MAY 1990

Figure N-12



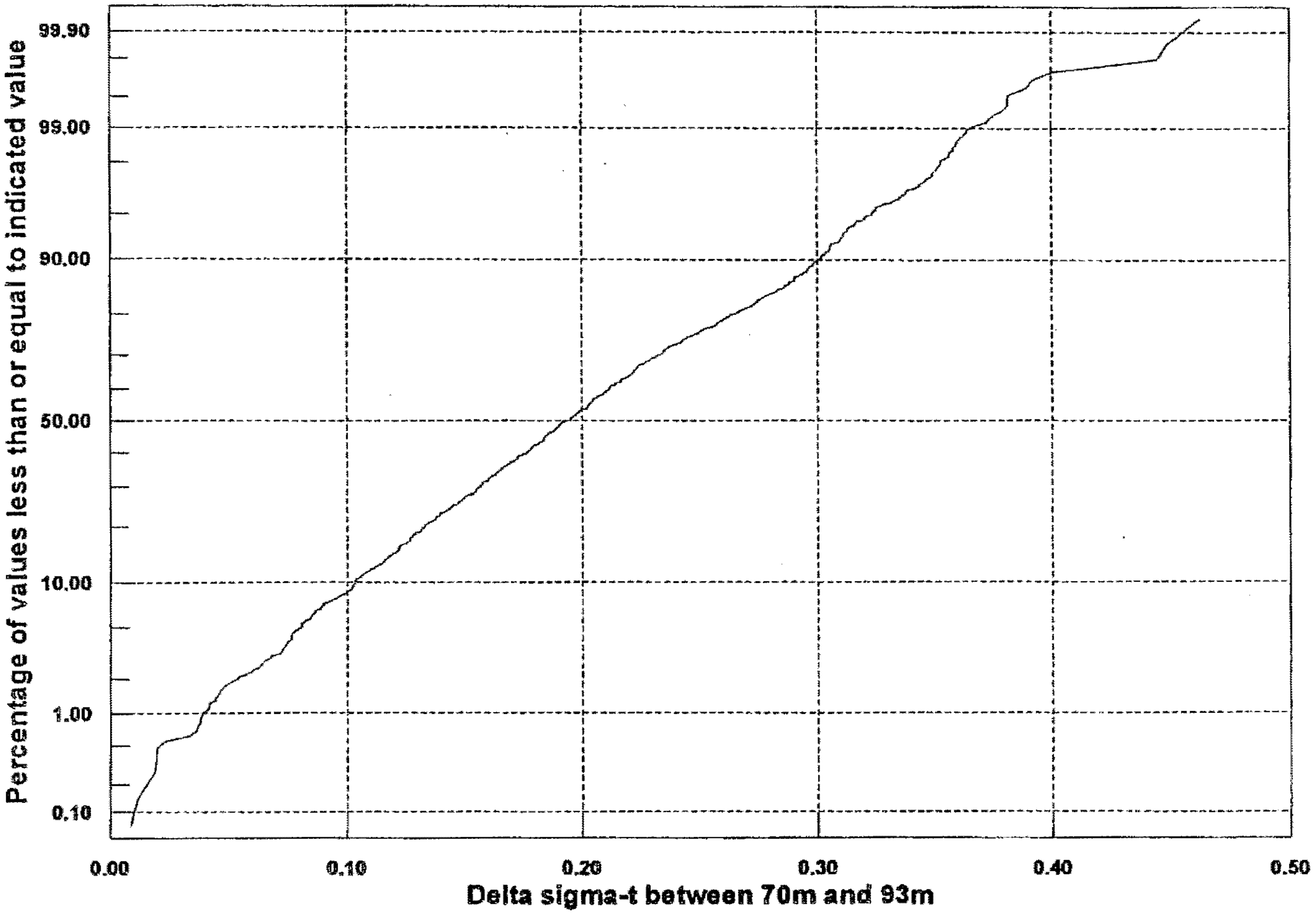
PROBABILITY DISTRIBUTION OF DELTA SIGMA-T
BETWEEN 70 & 93M FOR JUNE 1990

Figure N-1



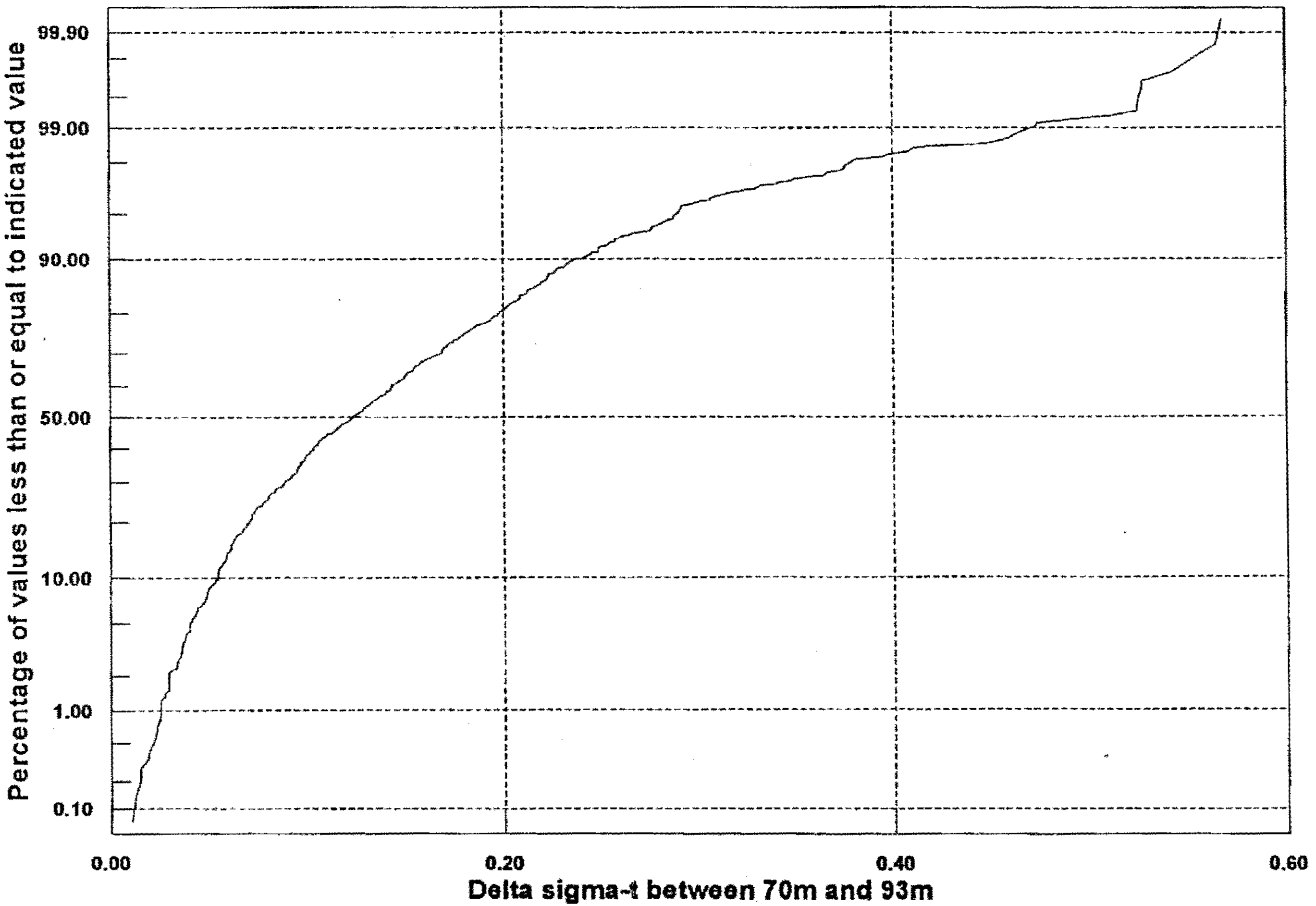
PROBABILITY DISTRIBUTION OF DELTA SIGMA-T
BETWEEN 70 & 93M FOR JULY 1990

Figure N-14



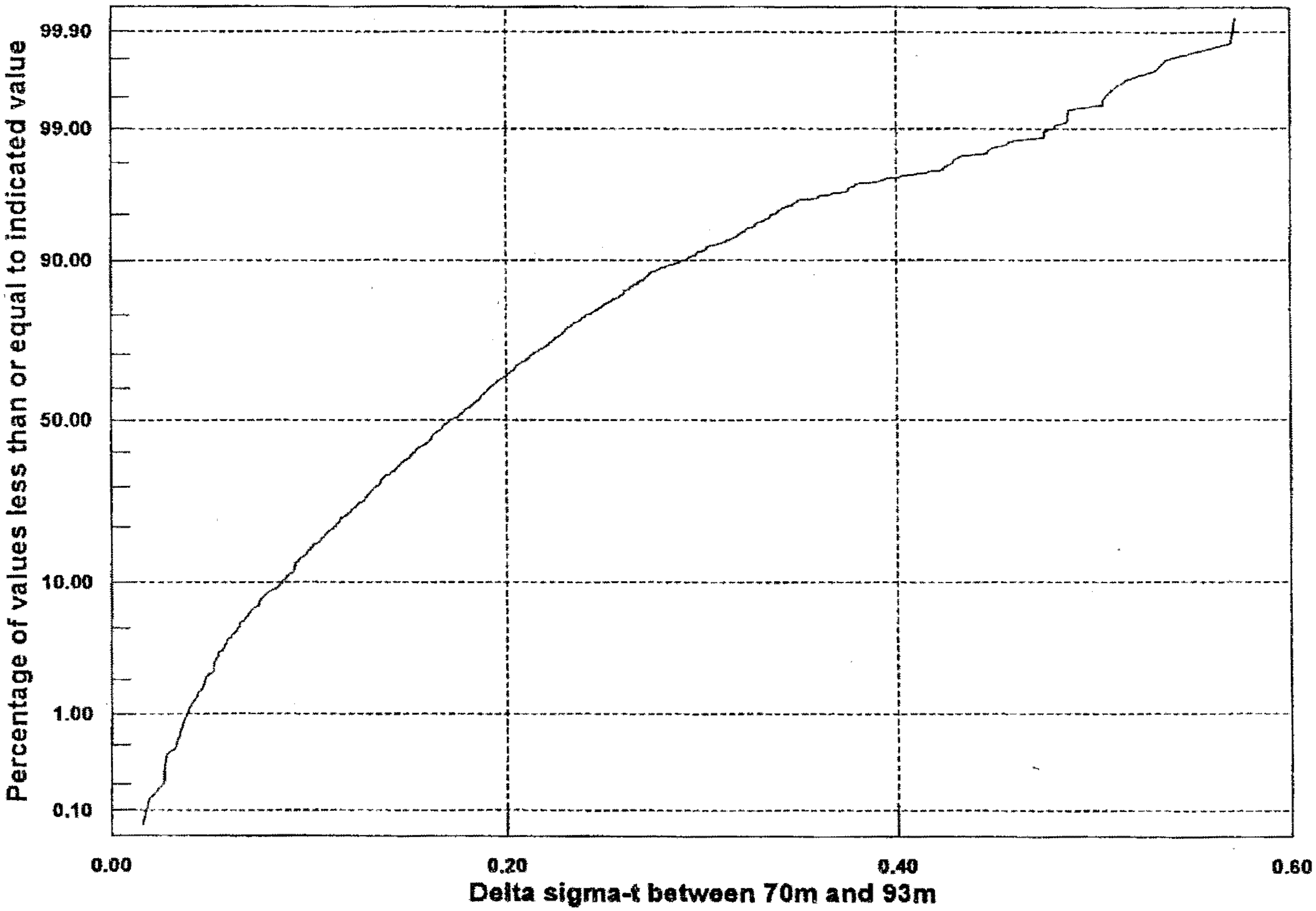
PROBABILITY DISTRIBUTION OF DELTA SIGMA-T
BETWEEN 70 & 93M FOR AUGUST 1990

Figure N-15



PROBABILITY DISTRIBUTION OF DELTA SIGMA-T
BETWEEN 70 & 93M FOR SEPTEMBER 1990

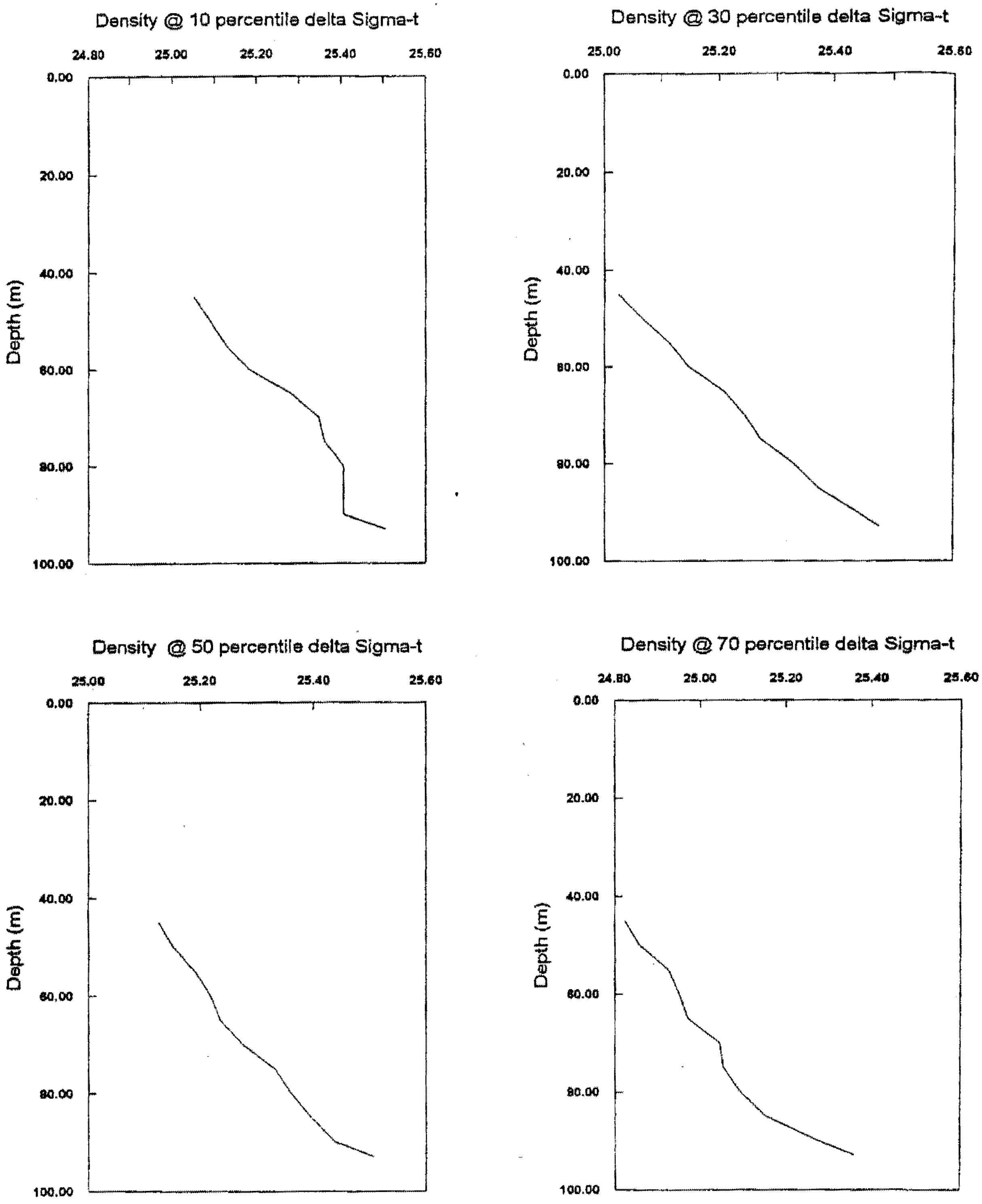
Figure N-16



PROBABILITY DISTRIBUTION OF DELTA SIGMA-T
BETWEEN 70 & 93M FOR OCTOBER 1990

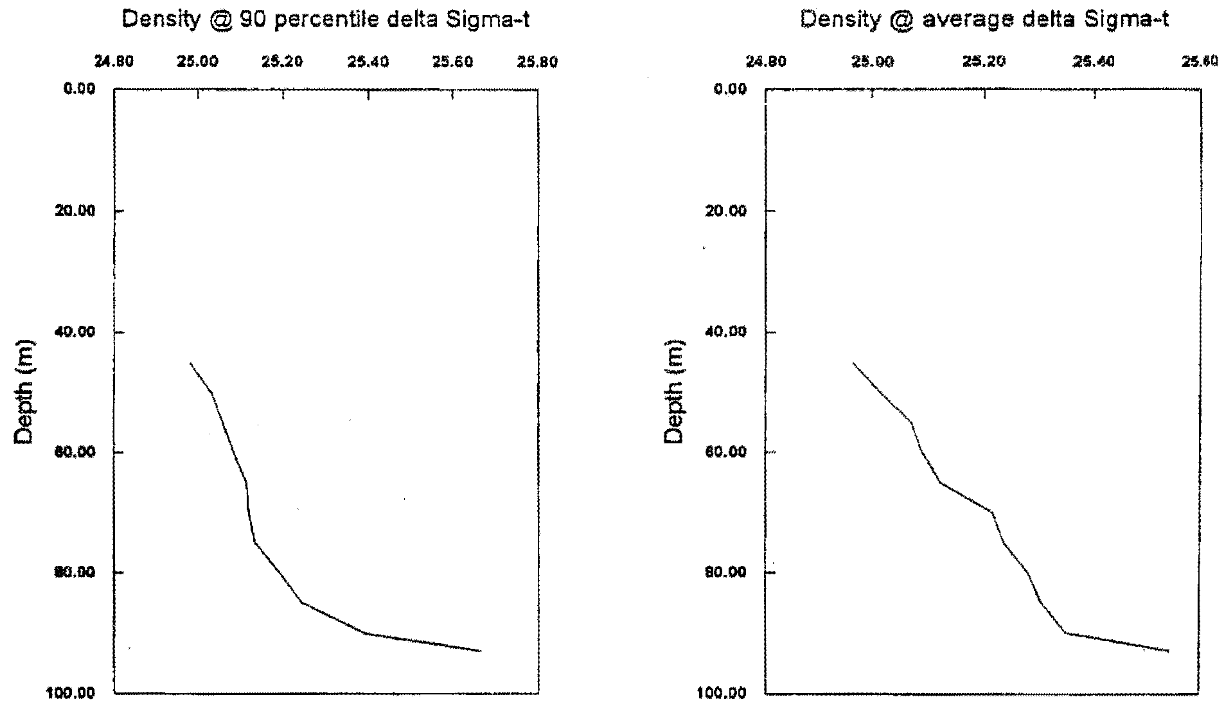
Figure N-1

Figure N-18



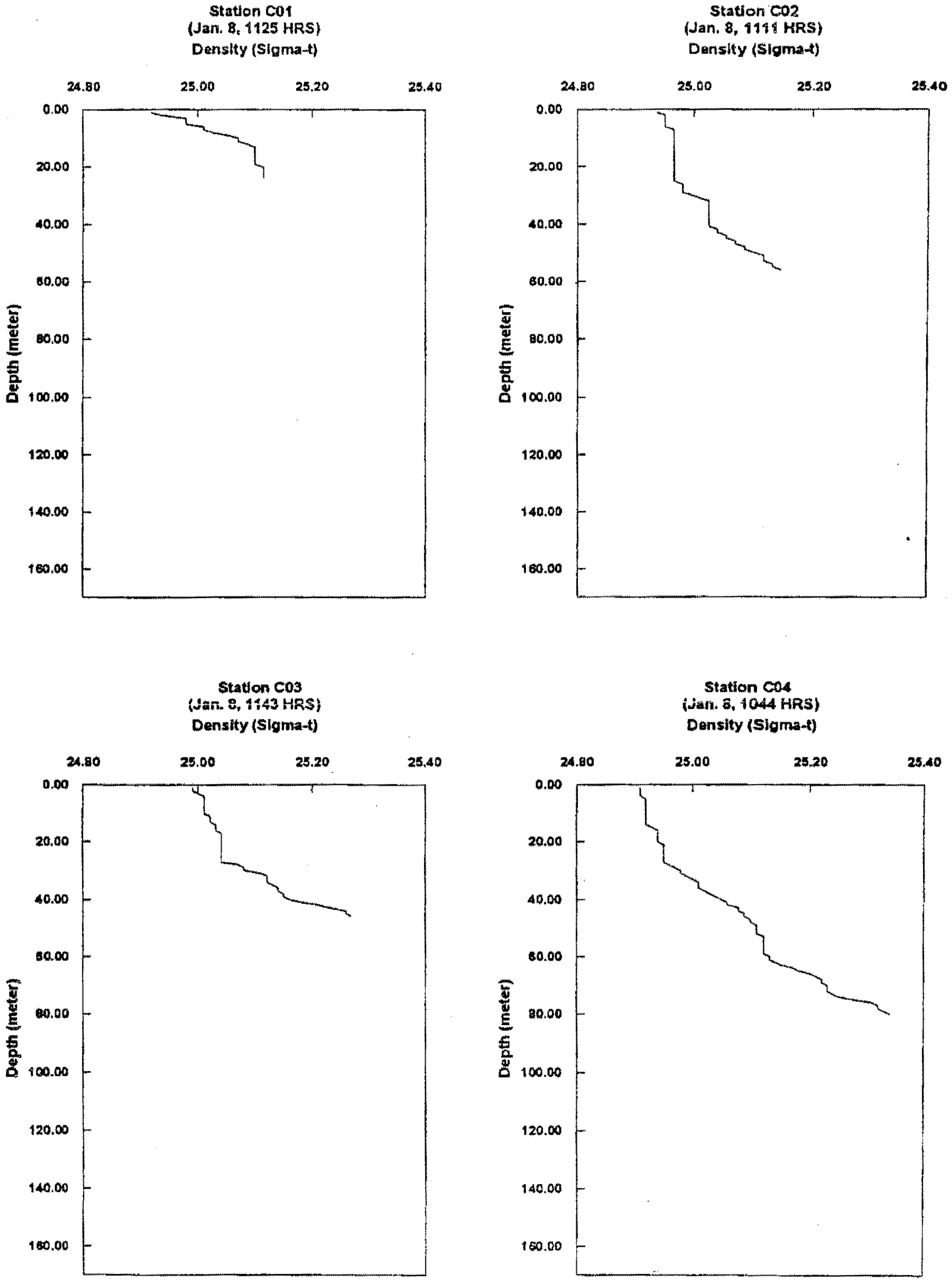
DENSITY (SIGMA-T) - DEPTH PROFILES FOR THE
MONTH OF MAXIMUM STRATIFICATION (JANUARY)
CONTINUOUS RECORDING DATA (1990)

Figure N-



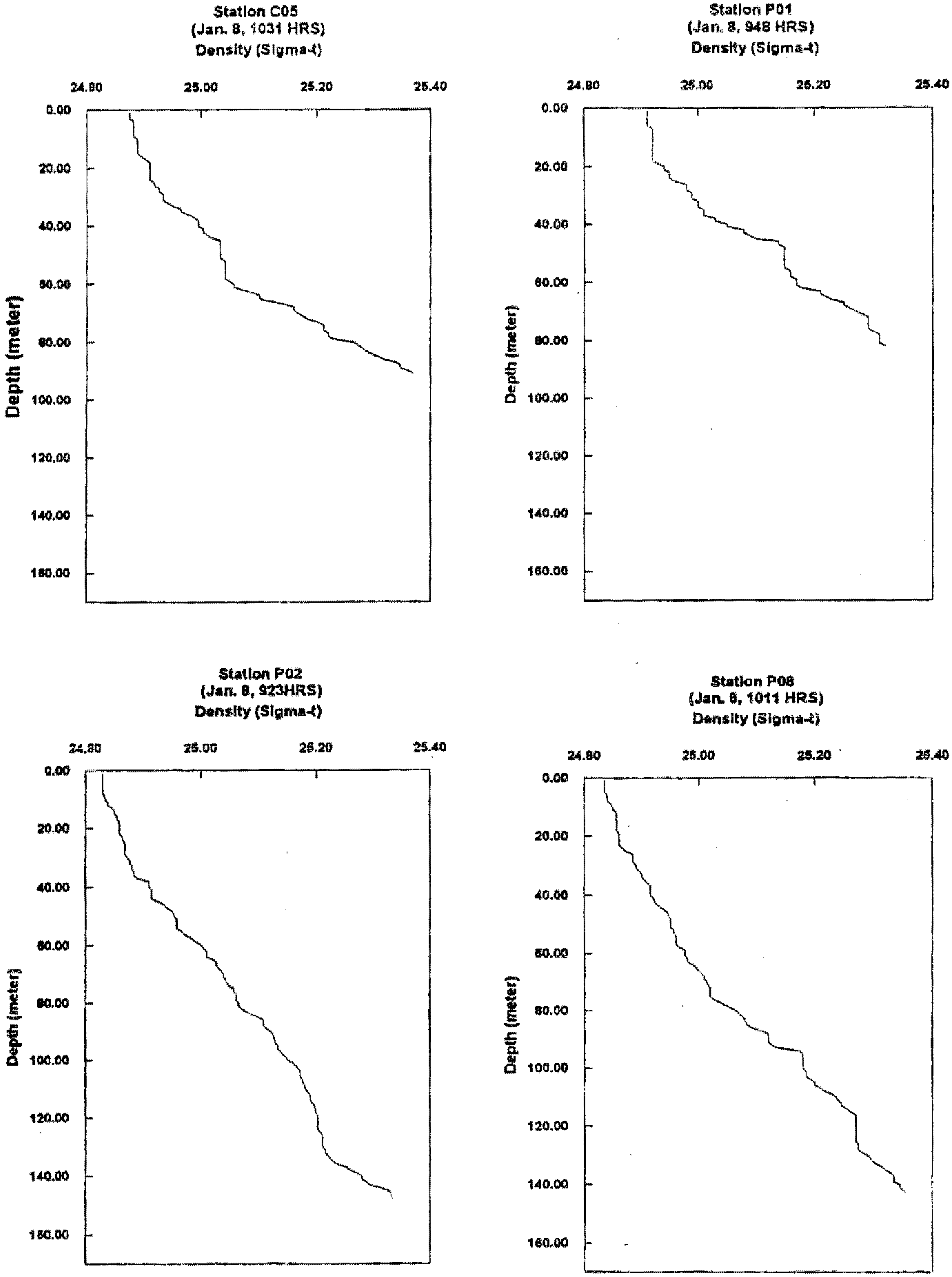
DENSITY (SIGMA-T) - DEPTH PROFILES FOR THE MONTH OF MAXIMUM STRATIFICATION (JANUARY) CONTINUOUS RECORDING DATA (1990)

Figure N-20



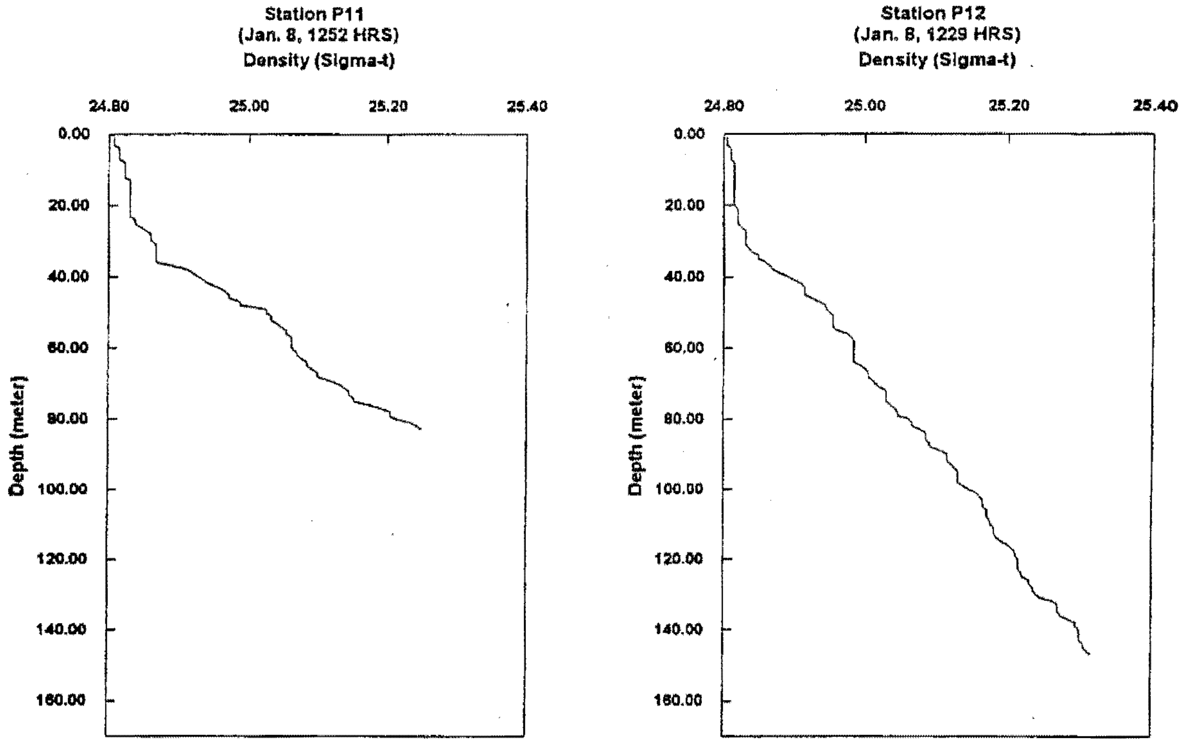
DENSITY (SIGMA-T) - DEPTH PROFILES FOR THE
MONTH OF MAXIMUM STRATIFICATION (JANUARY)
CTD DATA (1990)

Figure N-21

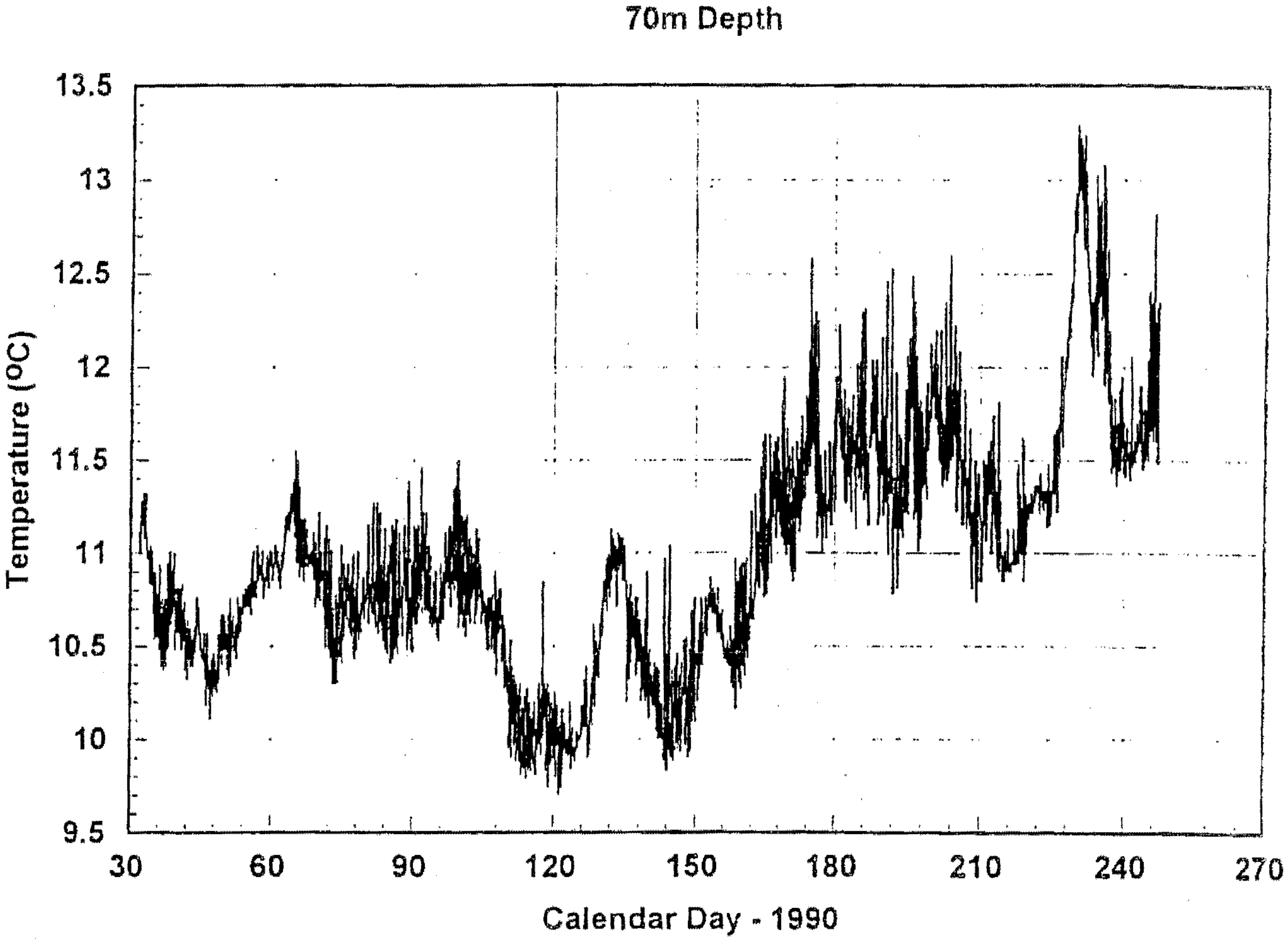


DENSITY (SIGMA-T) - DEPTH PROFILES FOR THE
MONTH OF MAXIMUM STRATIFICATION (JANUARY)
CTD DATA (1990)

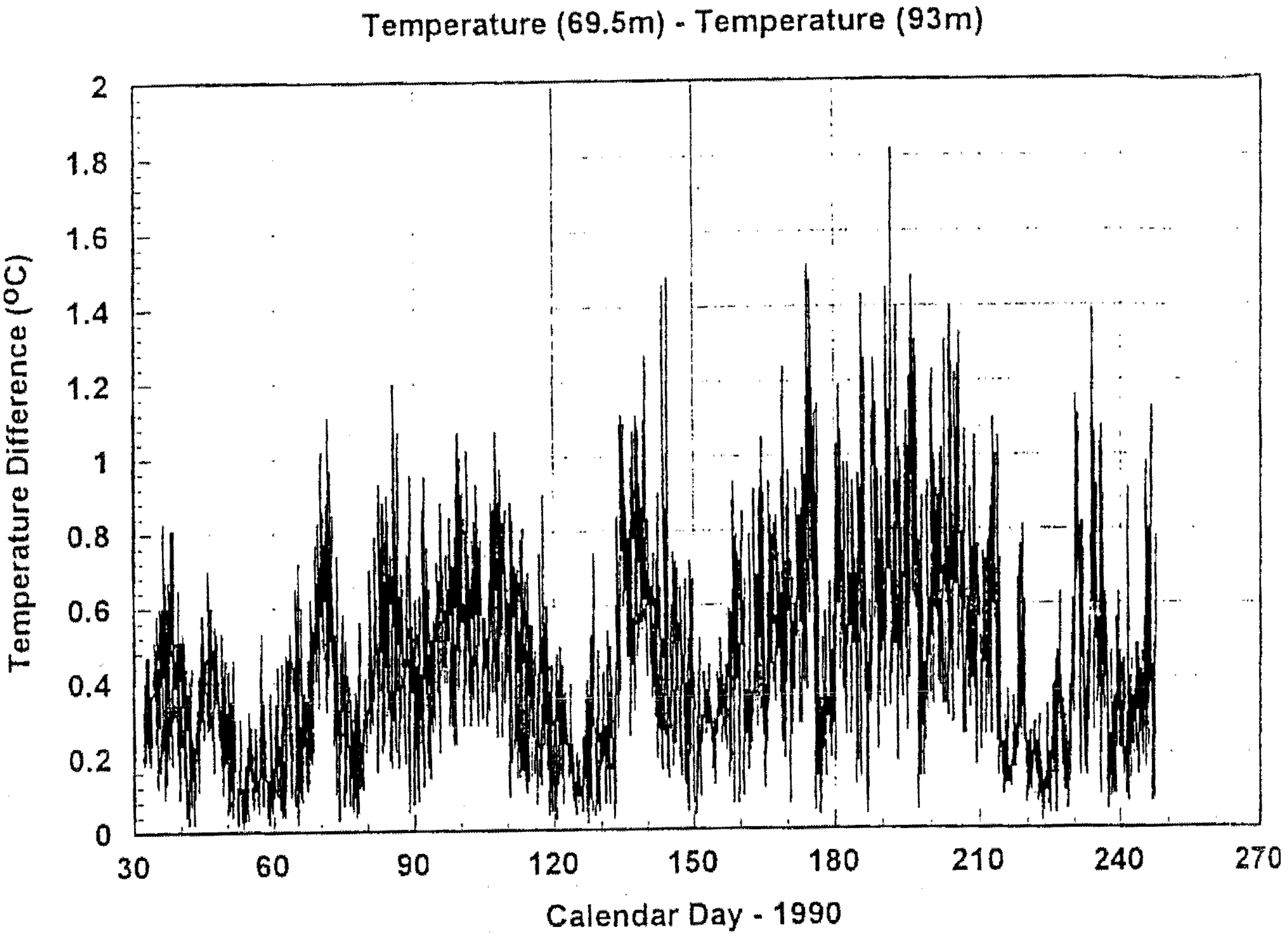
Figure N-2



DENSITY (SIGMA-T) - DEPTH PROFILES FOR THE MONTH OF MAXIMUM STRATIFICATION (JANUARY) CTD DATA (1990)

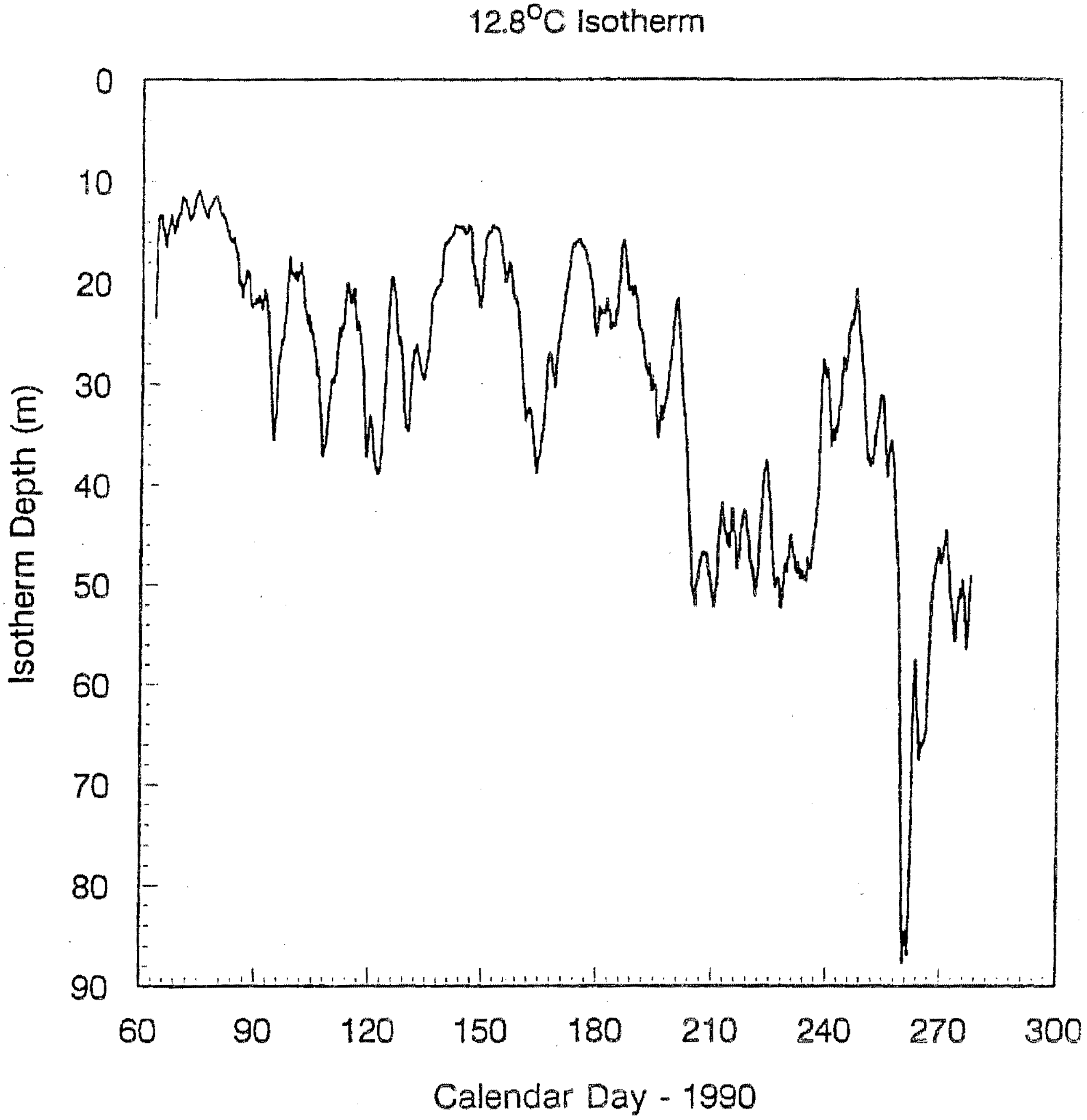


TEMPERATURE VARIATIONS MEASURED AT MOORING C5

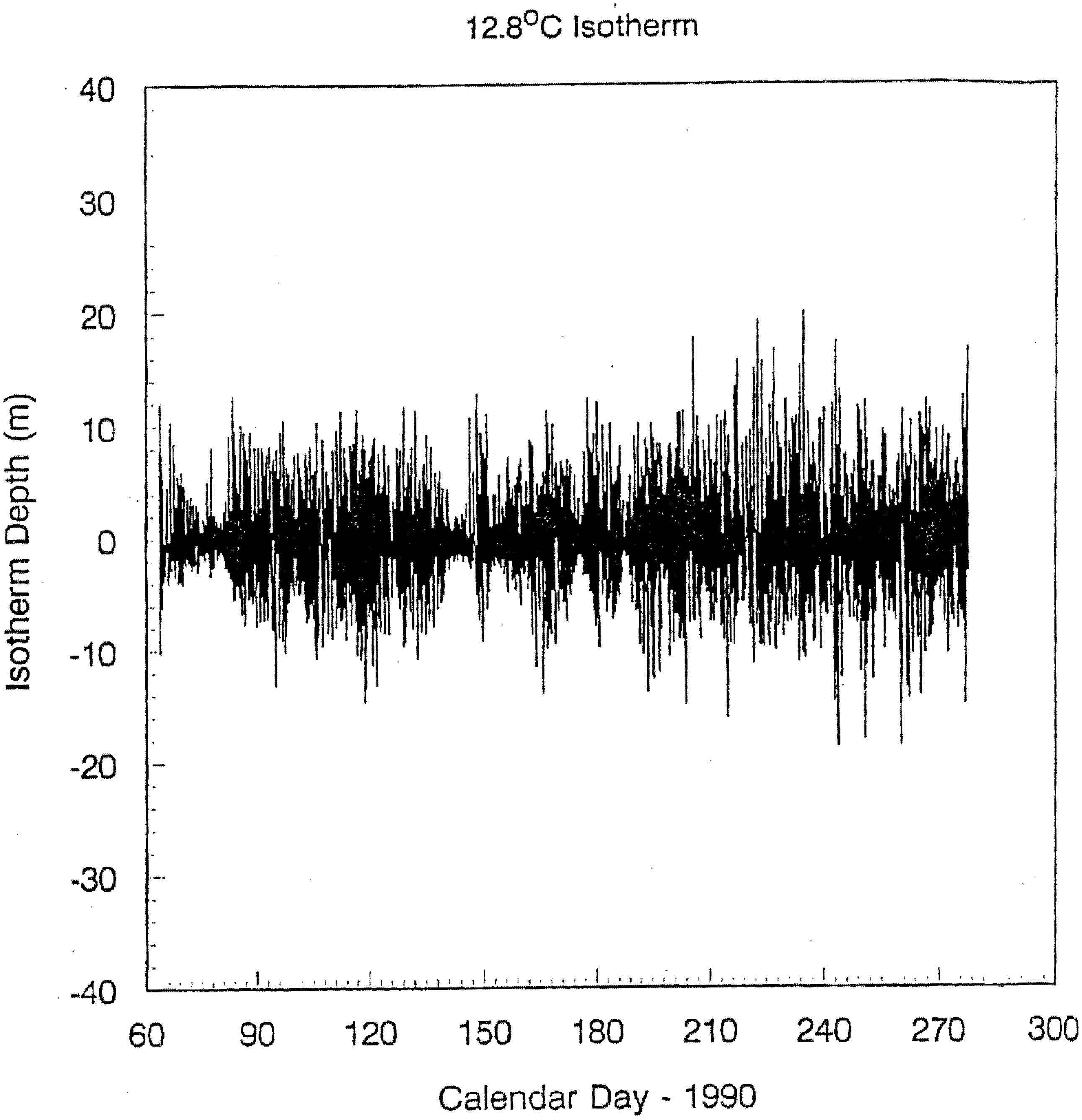


TIME-SERIES OF THE DIFFERENCE BETWEEN
THE WATER TEMPERATURE AT 69.5M AND 93M

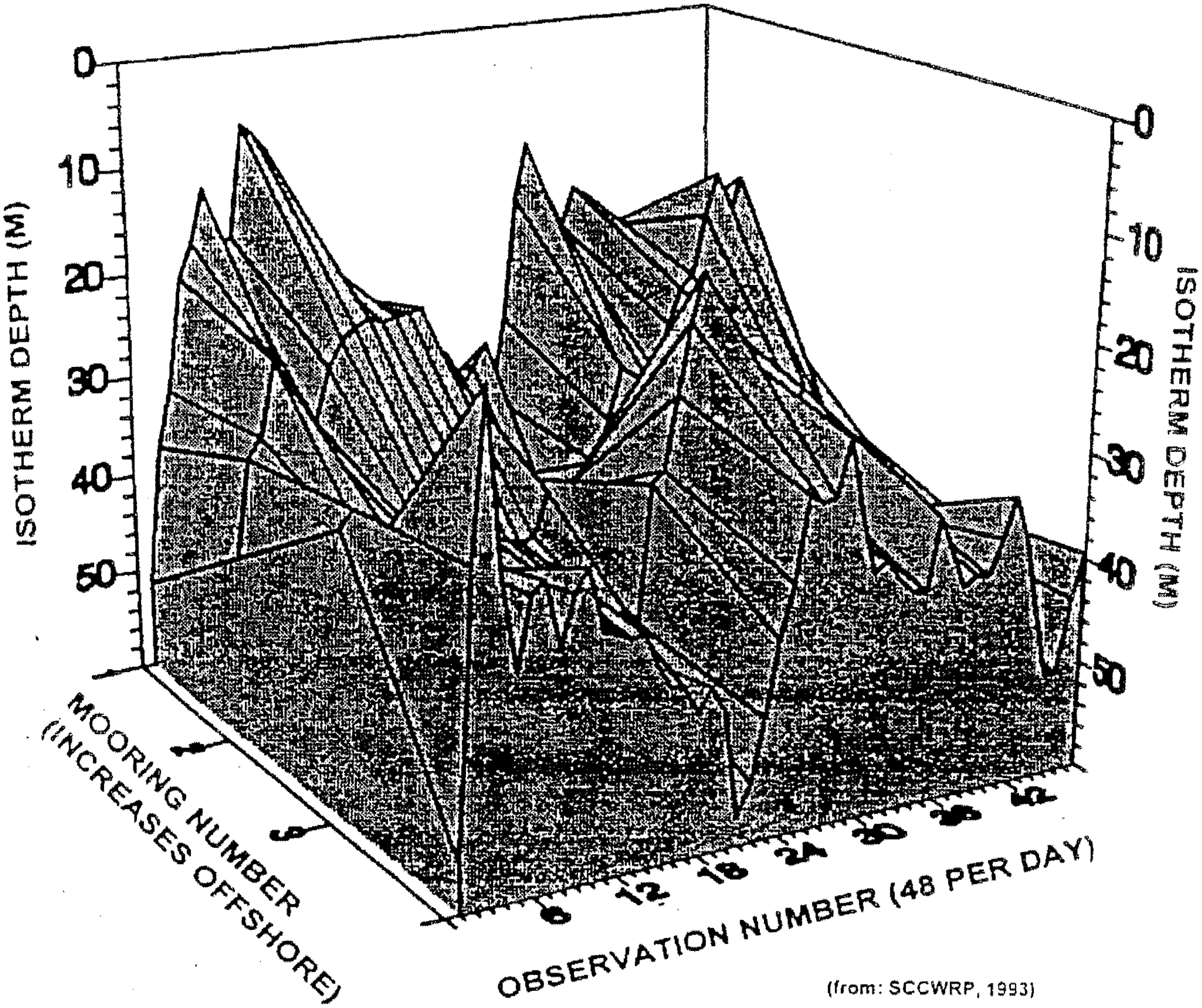
Figure IV-23



VERTICAL EXCURSION OF THE 12.8°C ISOTHERM



VERTICAL DISPLACEMENT ASSOCIATED WITH INTERNAL TIDES

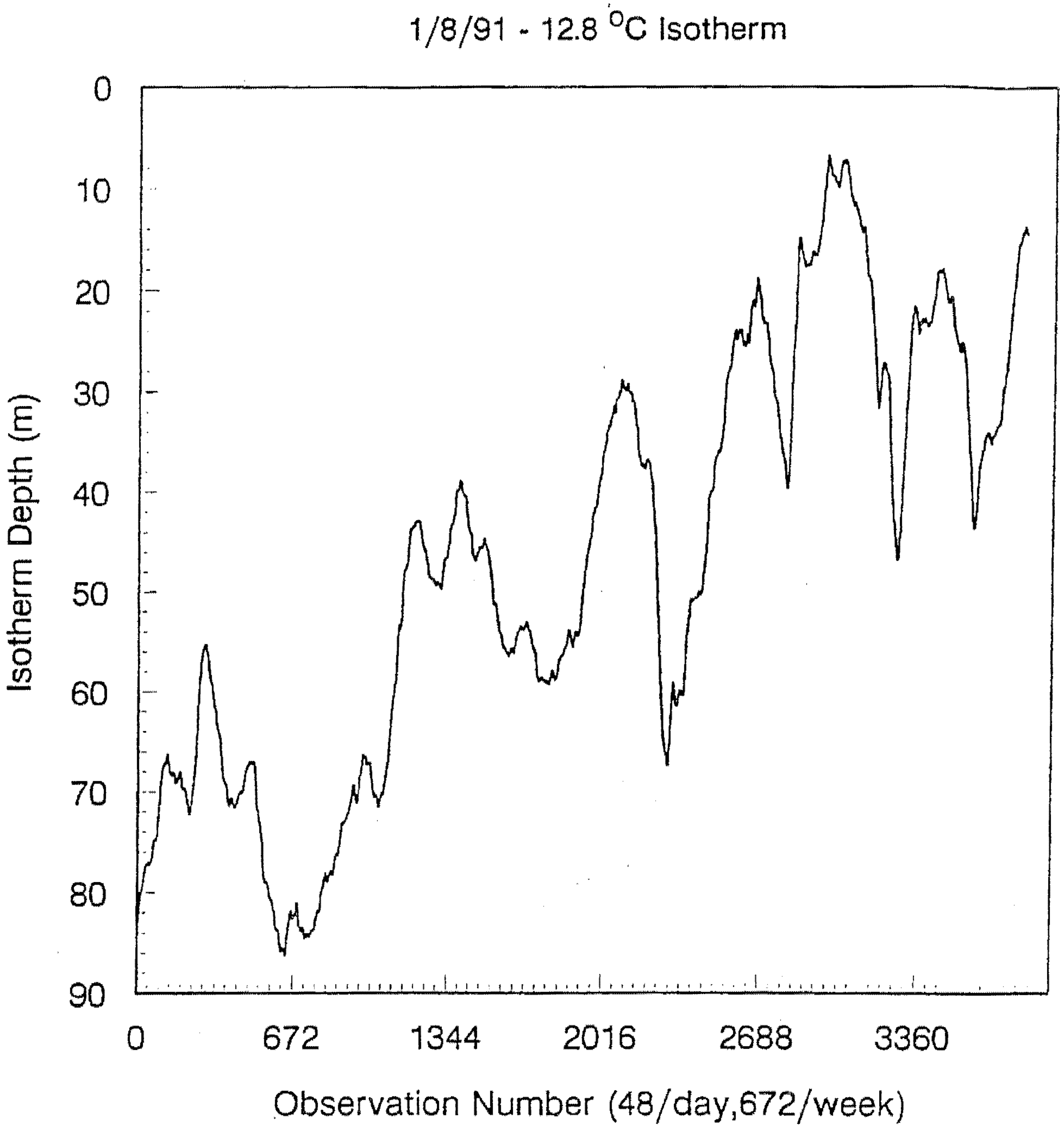


(from: SCCWRP, 1993)

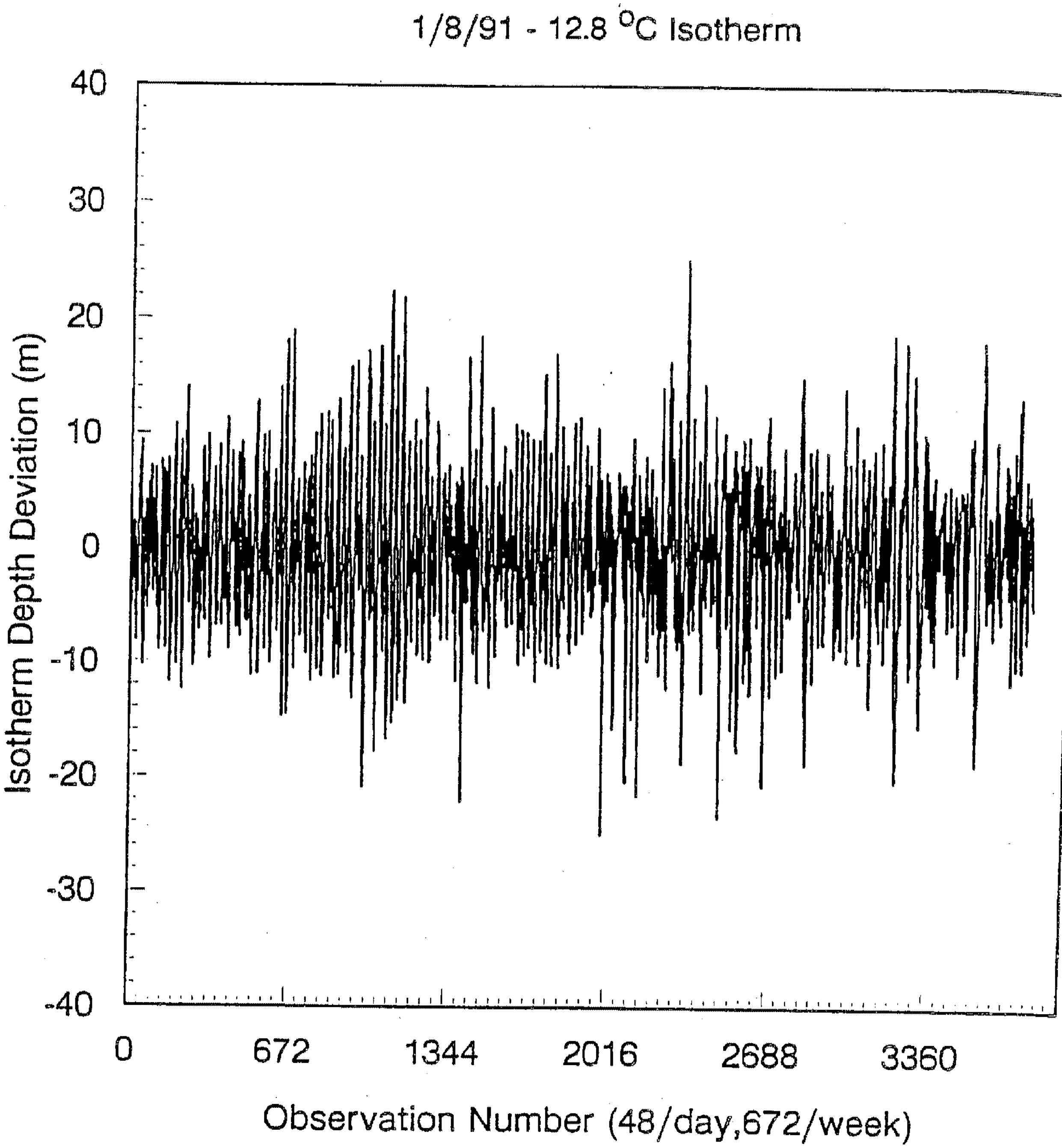
CROSS-SHORE DEPTH VARIATIONS OF THE 12.8^{O}C ISOTHERM AT MOORINGS C2, C3, AND C4 ON JUNE 25 & 26, 1990

(Each slice through the axis-labeled observation number is the depth at each of the moorings along the cross-shore transect. Planes parallel to the right-rear face of the box are slices in time - constant observation number)

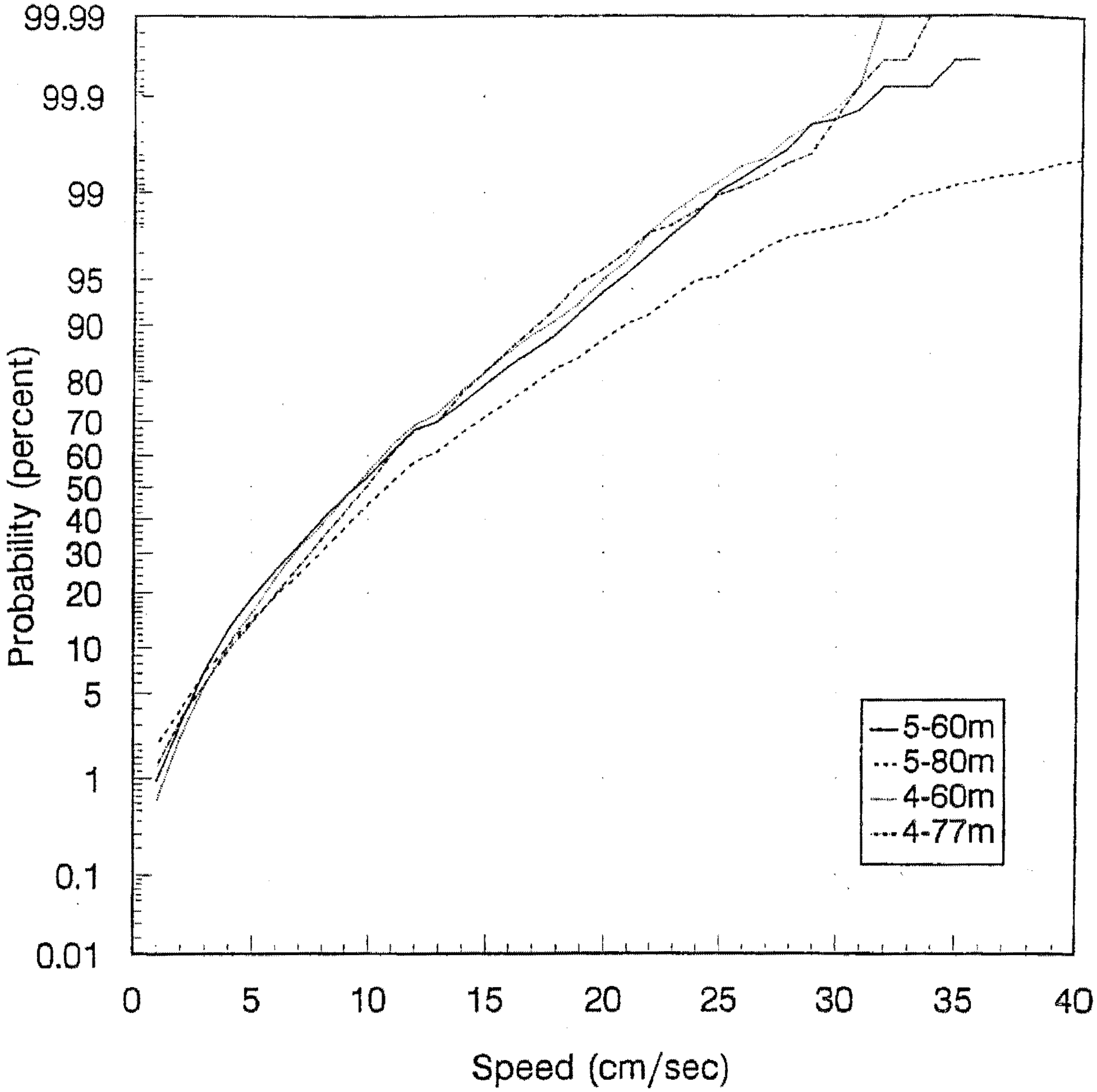
Figure N-28



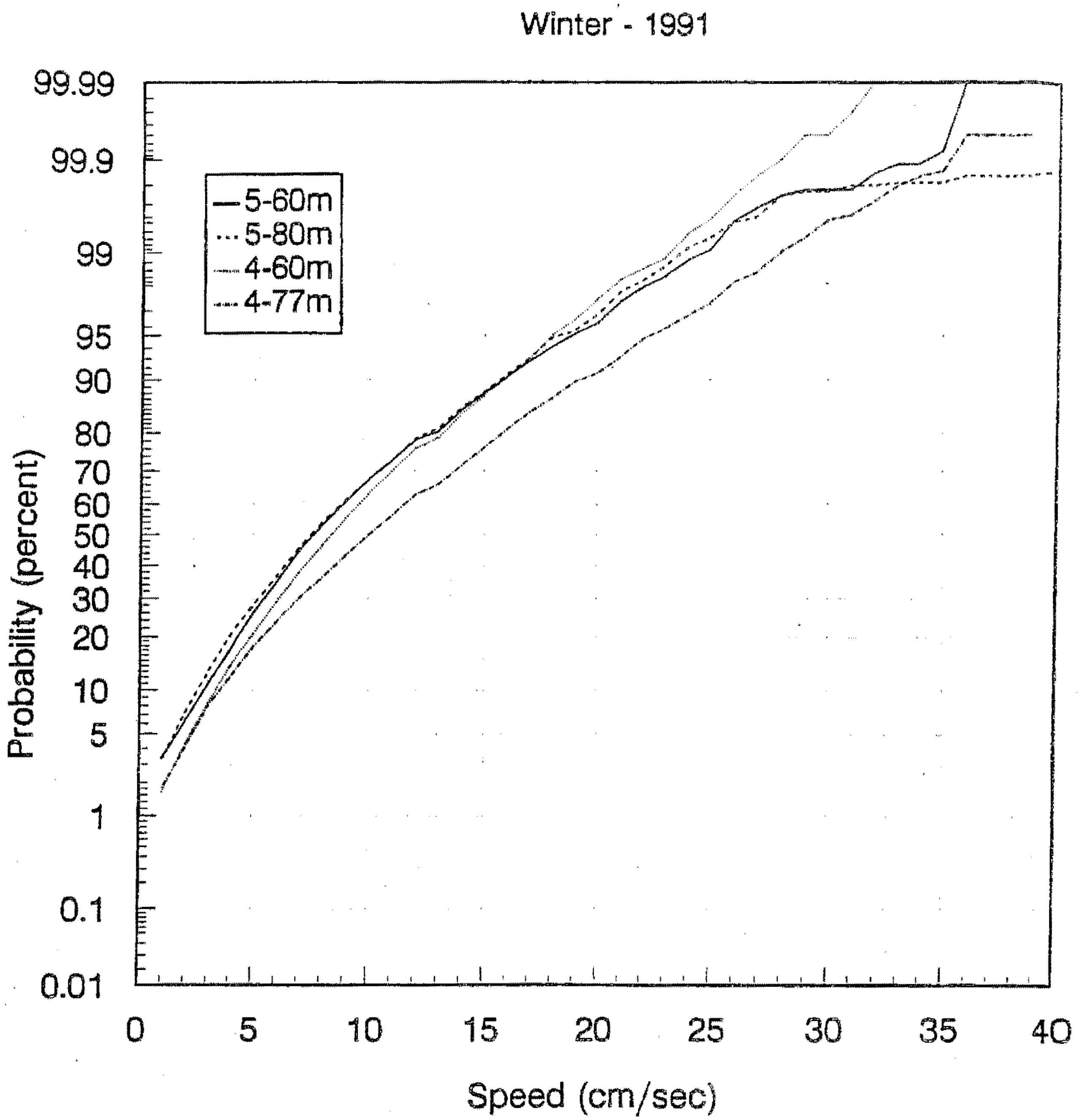
VERTICAL MOVEMENT OF THE 12.8°C ISOTHERM
FROM JANUARY THROUGH APRIL 1991, AFTER REMOVAL
OF THE TIDAL FREQUENCY FLUCTUATIONS



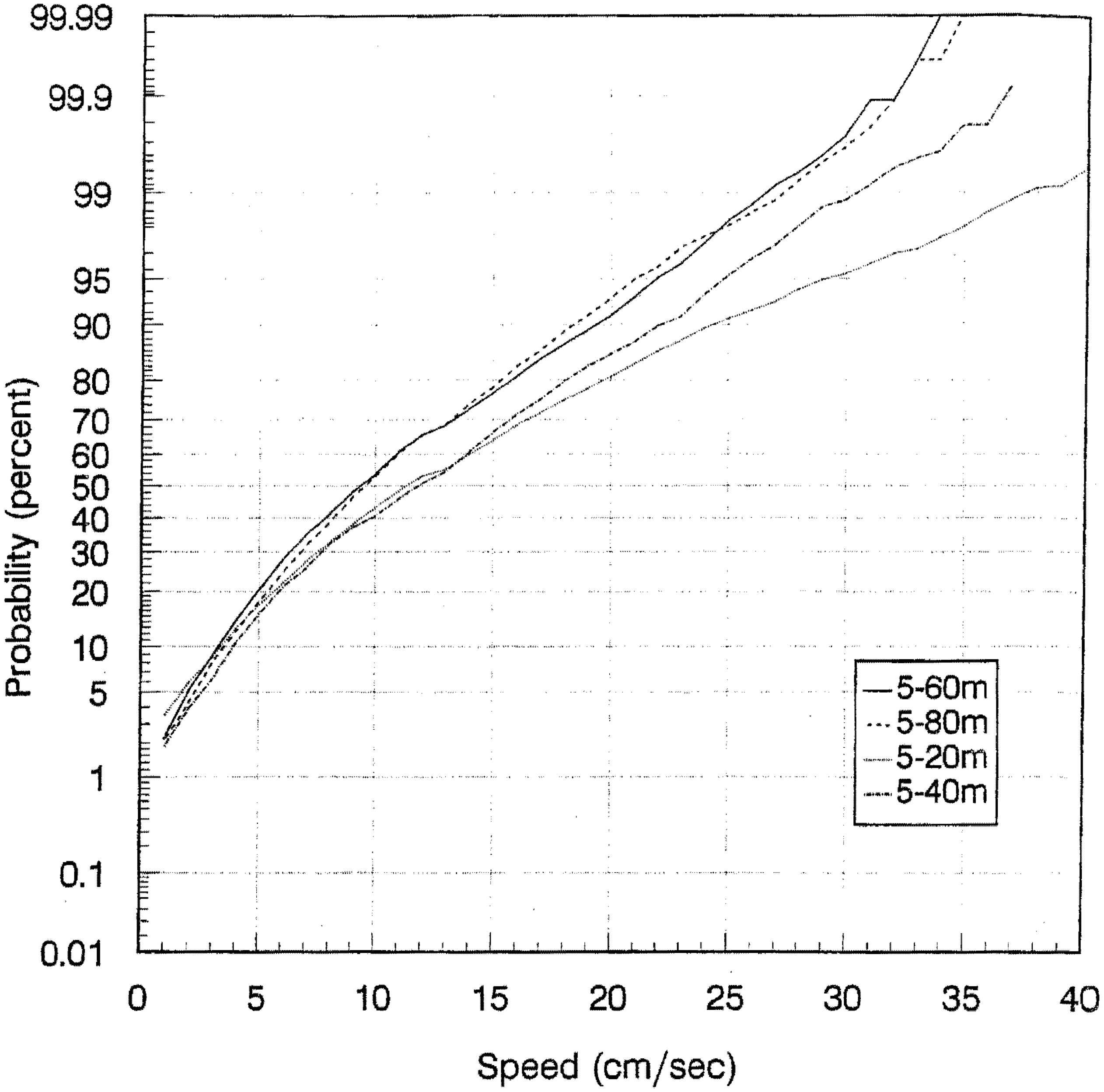
VARIATIONS IN VERTICAL MOTIONS ASSOCIATED WITH INTERNAL TIDES AND INTERNAL WAVES



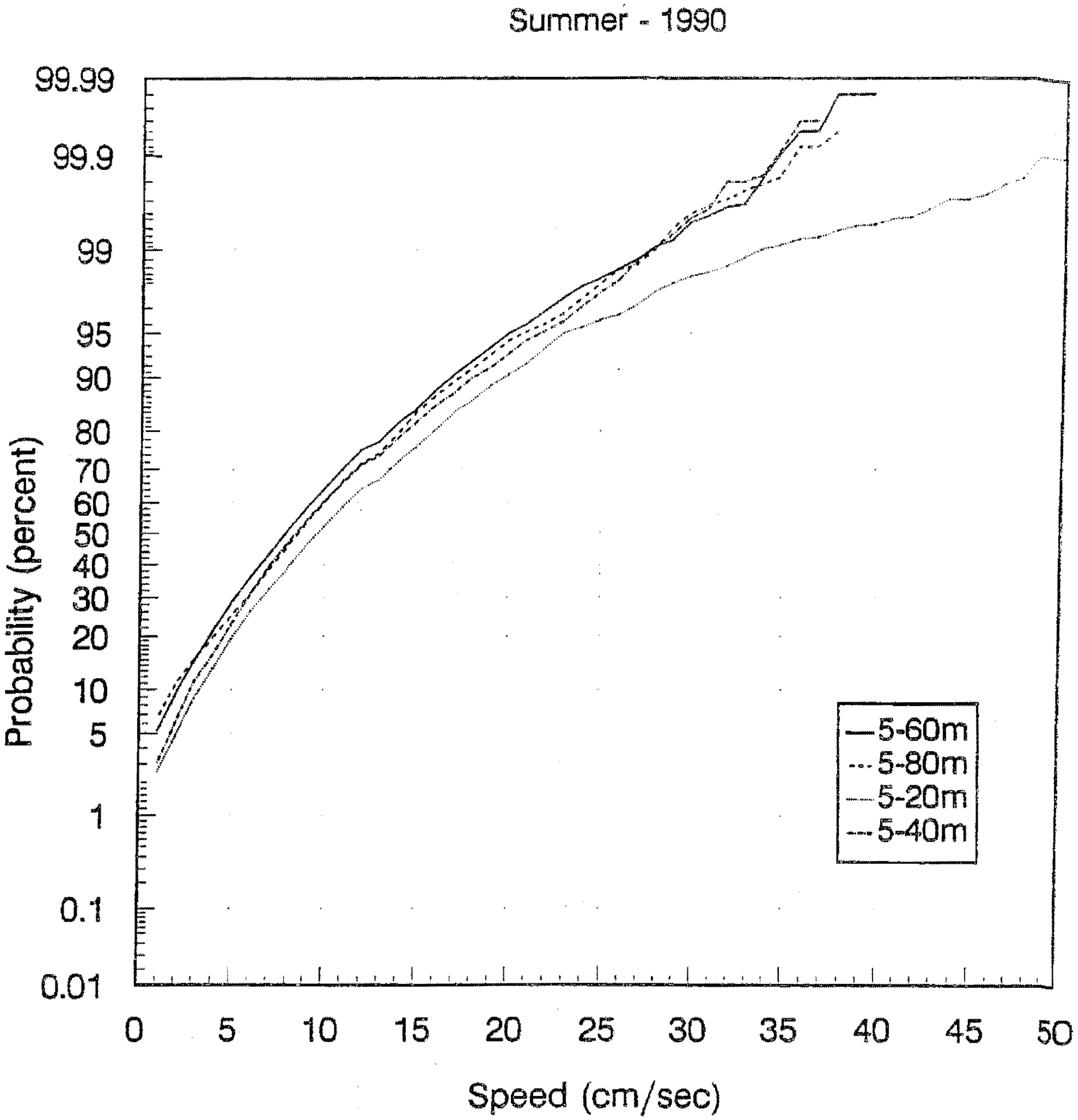
DISTRIBUTION OF CURRENT SPEED FOR THE WINTER 1990
(MOORING C5: 60M & 80M; MOORING C4: 60M & 77M)



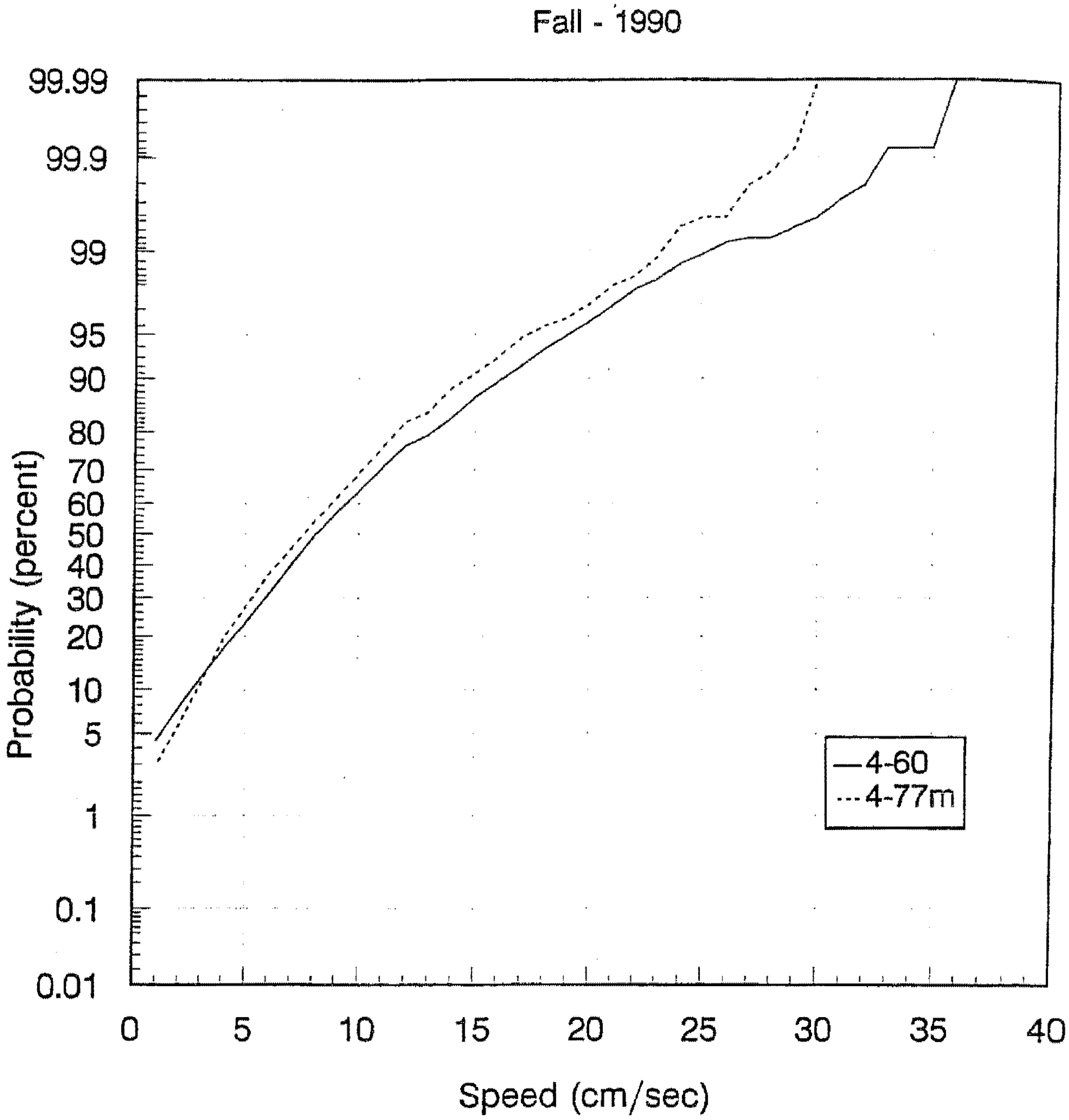
DISTRIBUTION OF CURRENT SPEED FOR THE WINTER 1991
(MOORING C5: 60M & 80M; MOORING C4: 60M & 77M)



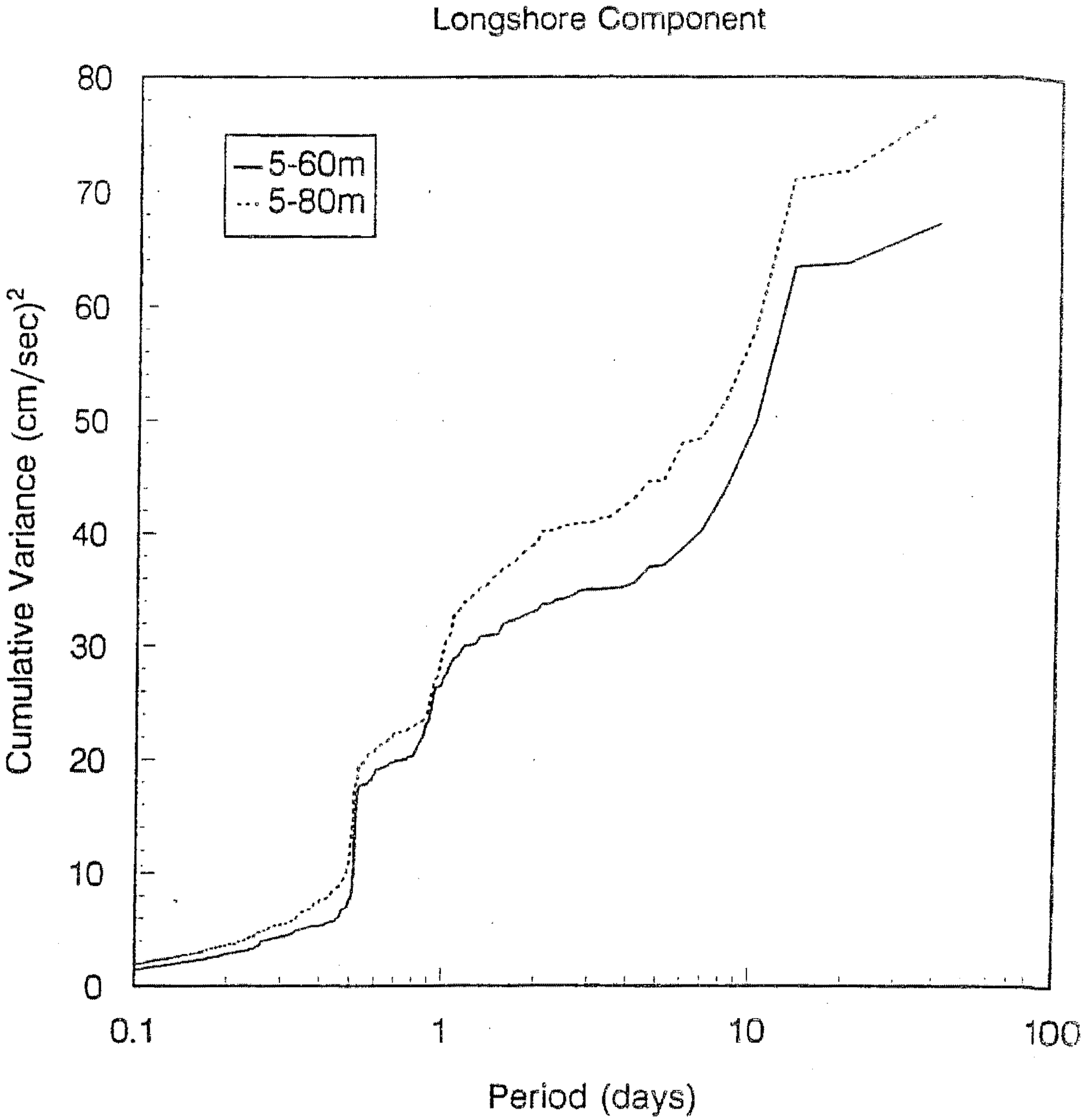
DISTRIBUTION OF CURRENT SPEED FOR THE SPRING 1990
(MOORING C5: 20M, 40M, 60M & 80M)



DISTRIBUTION OF CURRENT SPEED FOR THE SUMMER 1990
(MOORING C5: 20M, 40M, 60M & 80M)



DISTRIBUTION OF CURRENT SPEED FOR THE FALL 1990
(MOORING C4: 60M & 77M)



VARIATIONS IN THE LONGSHORE COMPONENTS OF FLOW
(MOORING C5: 60M & 80M; WINTER 1990)

THE CITY OF SAN DIEGO • STATE OF CALIFORNIA

SEMPER VIGILANS

Appendix O

Initial Dilution Simulation Models

APPENDIX O

INITIAL DILUTION SIMULATION MODEL(S)

ABSTRACT

The initial dilutions contained in this application were computed using the RSB-TSI initial dilution model. This model is based on the physical model initial dilution studies reported by Roberts et al. (1989a, 1989b, 1989c), and is a derivative of the "BASIC RSB" simulation model written by Roberts (Baumgartner et al., 1993). Both hydrocast data and time-series measurements of water column density structure and currents have been used to predict the initial dilutions achieved by the Point Loma extended outfall. For an annual average flow rate of 205 mgd (the maximum annual average flow during the waiver period), the median flux-averaged initial dilution is 365:1. If the dilution enhancing effects of currents are disregarded, the median initial dilution is predicted to decline to 300:1.

The lowest monthly average initial dilution in the absence of currents (as required by the California Ocean Plan to comply with Table B requirements) was predicted to be 204:1 from the hydrocast data and 238:1 from the time-series data.

The design maximum annual average flow capacity for the outfall as presently configured is 240 mgd. At this flow rate, the median initial dilution falls to 338:1, or about seven percent less than for the 205 mgd flow rate during the waiver period. The lowest monthly average initial dilution in the absence of currents was predicted to be 202:1 from the hydrocast data, and 227:1 from the time-series data.

INTRODUCTION

INITIAL DILUTION PROCESS

The Point Loma ocean outfall discharges warm, low salinity wastewater effluent into southern California coastal ocean waters at a depth of about 93 meters. The discharge is a source of both kinetic energy (associated with the momentum of the jet of water from the diffuser port) and potential energy (due to buoyancy of the effluent in sea water). Shear driven by the energy input results in the entrainment of ambient ocean water into the wastewater plume. For typical municipal wastewater discharges, the bulk of this entrainment is driven by the buoyancy of the effluent, with the initial jet mixing playing a secondary role. The reduction in the concentration of effluent within the plume as the result of this mixing is known as *initial dilution*.

In the absence of ocean currents, the initial jet-induced mixing from a port discharging horizontally is followed by a buoyancy-driven transition to a nearly vertical buoyant rising plume. If the receiving water is not density stratified (or if the stratification is very weak), the plume will rise to the surface and the effluent sea water mixture will spread out to form a horizontal wastefield. In general, any additional mixing subsequent to this transition from a plume to a wastefield is slow compared with the mixing into the rising plume. The initial dilution process is considered to be complete when the buoyant rise of the plume ceases.

If the water column is density stratified, the deep ambient water entrained into the plume will be denser than the ambient water entrained into the plume at shallower depths. For sufficiently strong stratification, enough dense ambient water can be entrained into the plume during its rise so that at some depth the density of the water in the plume becomes equal to the density of the surrounding ambient water. In that case, a submerged horizontal wastefield is formed instead of a surface wastefield.

The magnitude of the initial dilution depends on the design of the outfall and the characteristics of the receiving water environment. Increasing the density difference between the discharged effluent and the receiving water increases the buoyant energy and hence the mixing. Increasing the interface area between the plume and surrounding receiving water (e.g., by increasing the length of the diffuser and the number of ports, and reducing port diameters) promotes entrainment and increases the initial dilution. Conversely, an increase in the discharge rate requires an increased entrainment across the interface to achieve the same dilution, hence the initial dilution may be reduced. Increased density stratification of the water column reduces the height of rise of the plume, reducing the interface area and the initial dilution.

The situation becomes more complicated in the presence of ocean currents. The flow of ambient water past the diffuser changes the current shear and also generates a pressure difference between the upstream and downstream faces of the plumes from the diffuser. This causes the plume to "bend over" in the downstream direction. This has two potentially important consequences: (1) the entrainment length is increased and (2) vertical mixing (across the plume) can become important. Since the density of the rising plume is less than the surrounding water, the upper interface between the plume and the receiving water is gravitationally unstable, and vertical mixing is enhanced (conversely, vertical mixing is suppressed on the lower interface). At low speeds, these current-induced effects are small. However, there is a threshold speed at which they become important, resulting in an increase in initial dilution compared with the dilution of the same discharge in the absence of a current. The magnitude of this threshold speed depends on the design of the diffuser, discharge rate of effluent, effluent-receiving water density difference, the speed of the current, and the current direction relative to the alignment of the diffuser.

It is difficult and expensive to directly measure the magnitude of the initial dilution achieved by an ocean outfall. This is especially true if the discharge rate is large or the wastefield is trapped well below the surface--both characterize the Point Loma discharge. A number of numerical models have been developed to relate the characteristics of the initial dilution process to the diffuser design, discharge rate, effluent density, and the properties of the receiving water environment (e.g., density, density gradient, ocean currents). The numerical models have been developed from a mixture of theoretical principals, heuristic methods, and physical model studies of the initial dilution process. The hydrodynamics of the entrainment process in a density stratified, moving ocean are complex and the characteristics of the receiving water change with time, depth, and position. Thus, a large number of parameters are required to completely describe the initial dilution process. Every simulation model has some limitations in its range of application. Therefore, the model that is most appropriate for the discharge and receiving water conditions existing at the study site should be selected for the simulations.

INITIAL DILUTION DEFINITIONS

A number of definitions of dilution, initial dilution, etc. are commonly used. For example, the EPA defines "dilution", S, as the reciprocal of the volume concentration (fraction) of effluent, C_e, in the plume ($S = 1/C_e$). Thus, pure effluent has both a concentration and a dilution of unity. In contrast, the State of California Ocean Plan defines "dilution" as the volume of diluting ocean water mixed with a unit volume of discharged effluent. In this definition, the concentration of pure effluent is unity; the corresponding dilution is zero; and the concentration of effluent is related to the dilution through the equation:

$$Ce = {}^{1}\!/_{(1+S)}$$

As will be shown, the initial dilutions resulting from the extended Point Loma outfall are in excess of 100:1 at all times. For this outfall, the two definitions of dilution differ by less than one percent. This difference is less than the typical 10-15 percent uncertainties in the simulation model predictions (Roberts et al., 1989a). Hence, for all practical purposes in the present case, the two definitions can be used interchangeably.

Terms like "initial dilution", "minimum dilution", "minimum initial dilution", "average initial dilution", and "minimum average initial dilution" are frequently used in environmental regulations to describe model predictions and the results of laboratory and field studies. Unfortunately, a specific term may refer to different things in various references. All of the terms usually refer to the dilution after some type of averaging, but the type of averaging is not always clearly expressed. In this application, references to *concentration* mean the concentration of effluent, averaged over a sufficiently long period of time so that fluctuations associated with turbulent mixing are averaged out. Typical averaging times for a sample collected at some point within the plume are on the order of minutes to tens of minutes. *Dilution* means inverse of the concentration and *minimum dilution* means the dilution associated with the highest concentration within the plume/wastefield at the completion of the initial dilution process.

Initial dilution and *average initial dilution* are often used to refer to several different types of averaging schemes. In this appendix, references to *initial dilution* refer to the flux-averaged dilution, S_{fa}. The flux-averaged dilution is related to the flux-averaged concentration across a section of the wastefield. The latter is computed by weighting the concentration of effluent at some location, z, within the wastefield, C(z), by the discharge-induced velocity of flow, v(z) at that elevation:

$$1/S_{fa} = C_{fa} = \frac{\int_{z_1}^{z_2} C(z)v(z)dz}{\int_{z_1}^{z_2} v(z)dz}$$

The flux-averaged initial dilution is equivalent to the volumetric dilution, (i.e., the total volume of ambient water to the volume of effluent in the wastefield). The volumetric initial dilution is often required to demonstrate regulatory limitations on contaminant concentrations in receiving waters. For example, the receiving water concentrations of "Table B" constituents in the State of California Ocean Plan (1990) are computed using a volumetric (i.e., flux-averaged) initial dilution.

Minimum initial dilution means the smallest flux-averaged initial dilution value among a set of flux-averaged initial dilution values. This differs from the definition of minimum initial dilution in the California Ocean Plan.

Average initial dilution, S_a, is most commonly used to refer to the average of a set of individual initial dilution values. The averaging is usually carried out for some period of time, such as the "monthly average initial dilution". Note, however, that both the term "average initial dilution" and the notation, S_a, are used in Roberts et al. (1989a) to denote the spatially-averaged dilution across the plume/wastefield:

$$1/S_{sa} = C_{sa} = \frac{\int_{h_l}^{h_u} C(z)dz}{\int_{h_l}^{h_u} dz}$$

The lower and upper bounds of the wastefield, h_l and h_u, are not well defined. For practical purposes, they are often selected to correspond to the upper and lower edges of the wastefield, where the effluent concentrations are equal to five percent of the maximum concentration (Roberts et al., 1989a).

In the present application, use of the term *average initial dilution* is limited to the temporal average of a set of initial dilutions. Any references to the spatially-averaged initial dilution are specifically referred to as the *spatially-averaged initial dilution*, and denoted by S_{sa}.

The term *minimum average initial dilution* is used to mean the smallest value among a set of average initial dilutions. For example, a set of initial dilutions might be computed for a number of cases within each month, producing a set of monthly average initial dilutions. The minimum average initial dilution would be the monthly average initial dilution with the smallest value in this set.

The most realistic simulation model estimates of the concentrations and dilutions achieved at the end of the initial dilution process are obtained using simultaneous measurements of the density structure of the water column and the ocean currents within the entrainment region of the plume. However, this information is frequently not available, and the data consists of measurements of the density structure and ocean currents taken at different times. In this case, any correlations between the strength and direction of the currents and the density stratification of the water column are not known. Perhaps because of this, the State of California Ocean Plan (1990) takes a conservative approach in estimating initial dilutions by requiring that "...Dilution estimates shall be based on observed waste flow characteristics, observed receiving water density structure, and the assumption that no currents of sufficient strength to influence the initial dilution process, flow across the discharge structure." The resulting initial dilutions are commonly referred to as "no current" initial dilutions. Initial dilutions meeting this criteria are obtained in the RSB numerical model simulations by setting the ambient current speed to be zero (or sufficiently small so that they lie below the threshold value for enhanced dilution).

In order to distinguish the initial dilution values associated with the artificial requirement of zero currents from the set of initial dilution values associated with the actual currents, we prefix references to initial dilutions obtained by setting the current speed to zero as *regulatory initial dilutions*. Thus, based on our earlier definitions, the initial dilution required by the California Ocean Plan for meeting Table B concentration standards is referred to in this appendix as the *regulatory minimum average initial dilution* instead of the terms "minimum probable initial dilution", "minimum initial dilution", and "lowest average initial dilution" used in the Plan.

RSB INITIAL DILUTION SIMULATION MODELS

The initial dilutions contained in this application were computed using the RSB-TSI initial dilution model. This model is based on the physical model initial dilution studies reported by Roberts et al. (1989a, 1989b, 1989c), and is a derivative of the "BASIC RSB" simulation model written by Roberts (Baumgartner et al., 1993). Another version of the RSB model ("EPA-RSB") is available in the EPA PLUMES initial dilution simulation package (Baumgartner et al., 1993, 1994). The principal changes in the EPA-RSB model from the BASIC RSB model are:

1. A change in the programming language from BASIC to PASCAL.

2. Adaptation of the BASIC RSB computational kernel to the PLUMES package interface and file structure.

3. Termination of the iterative scheme used within the kernel to obtain a solution if the number of iterations exceeds some specified number of iterations.

An initial dilution simulation model, based on the RSB model, was selected for the simulations because:

1. The RSB model (as well as the UM model) is recommended for multiport outfalls discharging buoyant sewage wastes into stratified saline waters (see: Table VI, Baumgartner et al., 1993). As stated therein: "In general, we believe RSB...is applicable to any case that matches closely the experimental conditions used in its development, which were limited to multiport discharges." As will be shown later, the range of parameter values in the simulations for the extended Point Loma outfall fall within the range of values examined in the development of the model. The principal difference between the model study and the Point Loma conditions is that the density gradient generally varies with depth in the ocean, while a constant density gradient was examined in the laboratory model studies. Roberts allowed for the case of a variable density gradient in the BASIC RSB model, and each of the two derivatives of this model that were used to compute the initial dilutions utilize his approach. As will be discussed later, the effect of his approximation is to tend to underestimate the initial dilution and the height-of-rise of the plume in the water column.

2. Although both the UM and RSB models are appropriate for multiport discharges in the presence of currents, only RSB model (and its derivatives) can provide estimates of the initial dilution and a spatial description of the wastefield when the flow is within forty-five degrees of the alignment of the diffuser. This "along diffuser" flow dominates at the Point Loma discharge, resulting in our selection of the RSB model.

RSB-TSI INITIAL DILUTION MODEL

The RSB-TSI simulation model was chosen for the simulations over the BASIC- and EPA-RSB models based on the volume of input data available for the simulations.

The oceanographic data available for the Point Loma initial dilution simulations fell into two types. The first type consisted of water column density stratification data collected during hydrocast surveys with a CTD (conductivity, temperature, depth recorder). These data are available at roughly monthly intervals from special studies (predesign and predischarge) made in the vicinity of the extended Point Loma outfall between February 1990 and October 1993 and from monthly monitoring data collected after commencement of the discharge (November 1993) to the present (October 1994). The second type of oceanographic data consists of about 287 days (ca., 13,760 observations) of simultaneous measurements of water column temperatures and currents at a station close to the terminus of the extended Point Loma outfall collected between March 1990 and April 1991.

The EPA-RSB and the BASIC-RSB initial dilution models were not used for the simulations for a number of reasons:

1. The large number of observations available for the simulations are not efficiently stored in the file structure used in the BASIC RSB model (e.g., > 13 Mb is required to store the input files). The file structure used by the EPA-RSB model is in an undocumented binary format. In addition, oceanographic density data was available at nineteen to twenty depths in the water column. This exceeds the storage allotted in the EPA-RSB model.

2. Both the BASIC- and EPA-RSB models use an iterative approach to arrive at a solution to the initial dilution equations. We found that for the receiving water density structure existing off Point Loma, this method could put the program into an infinite loop (BASIC RSB) model, or result in inaccuracies in the simulation output (EPA-RSB).

3. Neither the BASIC-RSB nor the EPA-RSB model provides for the automatic processing of an extensive set of simulation cases.

4. The format of the output generated by the RSB-TSI model could be tailored to fit our needs in subsequent simulations that build on the results of the initial dilution calculations.

The RSB-TSI model is based on the computational kernel in the BASIC RSB model. Initially, after adapting the input and output file structure to our needs, this kernel, as supplied and without modification, was to be used. This kernel uses an interactive method to obtain a solution to the initial dilution process (for each set of discharge and receiving water condition). The steps in this process are:

1. A trial height-of-rise to the top of the wastefield (above the diffuser port) is chosen. In the BASIC RSB model, this initial trial value is set equal to the depth of the diffuser port below the sea surface.

2. The average density gradient of the receiving waters between the diffuser port and the trial height-of-rise is computed.

3. This "constant" density gradient is combined with the discharge characteristics (e.g., flow rate, effluent density), diffuser characteristics (port diameter, port spacing, number of ports), and ocean current strength and direction of flow (relative to the diffuser) to predict a height-or-rise to the top of the wastefield.

4. The magnitudes of the trial and the predicted heights-of-rise are compared.

5. If the trial and the predicted heights are within one percent of each other, a solution has been obtained and the height-of-rise to the top of the wastefield is known. The rest of the initial dilution characteristics (e.g., magnitude of the "minimum" initial dilution, wastefield thickness, height-or-rise to level of minimum dilution, and downstream distance to completion of the initial dilution process) are then computed.

6. If the two heights-of-rise are not the same, a solution has not been obtained and another iteration is executed. A new trial height-of-rise is computed for this iteration and steps 2 through 6 are repeated.

This approach was not practical for the oceanographic conditions found off Point Loma. The computer would "lock-up" while computing the initial dilutions for some of the observations in the data set. Examination of the execution of the program revealed that the program was caught in an infinite loop in which a sequence of trial and predicted heights-of-rise were repeated over and over without any convergence to the solution. The EPA-RSB model (Baumgartner et al., 1993, 1994) avoids this "lock-up" problem by terminating the iteration process if the solution fails to converge. After exiting the iterative loop, the tentative solution is output with a warning that the results are suspect. Our analysis showed that the trial and predicted heights-of-rise generated by the 2nd edition version of the model (Baumgartner et al., 1993) could change radically between sequential iteration steps with corresponding consequences on the initial dilution.

Baumgartner et al. (1994) noted that the iteration technique was changed between the 2nd and 3rd editions to "...converge faster and more regularly." It also issues a warning if convergence is not attained. The modifications are not described, so the effects of the change could not be examined in detail. Various methods of selecting an updated trial solution in the BASIC-RSB iterations were tried (e.g., different weightings, randomizing part of the weightings, "intelligent" weightings depending on a history of previous iteration steps, etc.). All of these modifications changed the details of the iteration process, but none of them guaranteed an acceptable solution for all of our oceanographic data. When the solution failed to converge, averaging the height-of-rise values comprising the repeating sequence was also tried, but the averaging did not provide the best possible estimate. Eventually it was concluded that our desired accuracy and convergence criteria could not be achieved using any of our modifications to the iterative process.

As a result, a different solution method, as well as a different file structure, was used in the RSB-TSI initial dilution simulation program. The principal changes in the RSB-TSI model from the BASIC RSB model are:

1. A change in the programming language from BASIC to FORTRAN.

2. Replacement of the BASIC RSB input data and file structure by a file structure designed to interface with the time-series of oceanographic data (temperature and currents). The output file structure was also adapted to provide output data specific to the application of the modeling results.

3. A change in the method of solution within the computational kernel. The iterative approach used in the BASIC and EPA-RSB models was replaced by an incremental method.

4. Animation was added to the program output in order to illustrate characteristics of each initial dilution (magnitude, spatial dimensions), the convergence to the height-of-rise solution, the current strength and direction (relative to the diffuser), temperature stratification of the water column, and a set of bar graphs indicating the magnitudes of various parameters that describe the hydrodynamical characteristics of the initial dilution process.

The incremental solution method is analogous to the iterative solution approach, except that:

1. The initial trial value is selected to be a small distance above the diffuser port (3m in the Point Loma simulations).

2. A solution is achieved when the difference between the trial and predicted heights-of-rise is less than some specified distance (10 cm in the Point Loma simulations).

3. If a solution is not achieved, the new trial value is set equal to the previous trial value plus the test distance specified in step 2 (i.e., 10 cm at Point Loma). This is in contrast to the iterative approach, which computes a new trial value from a weighted combination of the previous trial value and the associated predicted value.

4. This process is repeated until a solution is achieved, or until the trial height-of-rise is equal to the depth from the diffuser port to the sea surface. If a solution still has not been obtained in the latter case, the solution height-of-rise is set equal to the average of the trial and predicted values that had the smallest difference. The difference between the trial and predicted heights-of-rise is stored in one of the output files ("detailed" output) for each observation, hence these cases can be removed from the output data, if desired.

In cases where the iterative approach converges to a solution, the predictions from the BASIC RSB model and the RSB-TSI model are essentially the same. However, small differences can exist in the predicted heights-of-rise since the BASIC-RSB model solution (and, it is assumed, the EPA-RSB model) requires that the trial and predicted values differ by less than 1 percent, while the RSB-TSI model requires that the two values differ by less than a specified distance. This distance was 10 cm for the Point Loma simulations, so the RSB-TSI convergence requirement is more restrictive when the height-of-rise to the top of the wastefield exceeds 10 meters (> 99 percent of the cases). A comparison between the heights-of-rise and initial dilutions predicted by the BASIC RSB model and the RSB-TSI model for a set of identical input conditions is presented later in this appendix.

CONSERVATIVE ASSUMPTIONS

A number of assumptions have been made in the BASIC RSB and RSB-TSI initial dilution models. Overall, the assumptions should tend to underestimate the initial dilutions actually achieved by the discharge. Three of these assumptions are:

1. On the average, the density gradient in the receiving waters below the seasonal thermocline increases with decreasing depth in the water column. The BASIC RSB, EPA RSB, and RSB-TSI models all assume that the density gradient is constant ("linear density profile") over the rise height to the top of the wastefield. Baumgartner et al. (1993) concluded from examining studies reported in Roberts (1993) that: "... this (linearization) is a conservative assumption, as linear stratifications lead to less rapid spreading, thinner wastefield, less subsequent mixing, and, therefore, less dilution than in a wastefield at the same rise height in a non-linear stratification." The ratios of the predicted to the measured minimum initial dilution reported by Roberts (1993) for four discharge scenarios (3 discharge rates, 1 case with and without ambient currents), varied from 0.82 to 0.96 (average: 0.86 ± 0.07).

2. The RSB physical model studies examined initial dilution for flow perpendicular, parallel, and at a 45-degree angle to a linear diffuser. The extended Point Loma outfall terminates in a diffuser consisting of two legs forming a wide "V" (a

"bent" line source). Ocean currents will generally flow across the two legs at different angles. This difference in angles has no effect on the initial dilutions if the Froude number is less than 0.1. At higher Froude numbers, all other conditions being equal, the diffuser leg oriented with the smallest angle to the flow will have the lowest initial dilutions. In the RSB-TSI model, a user selectable option forces the simulation to select the diffuser leg with either the: (1) smallest or, (2) largest angle to the flow (the actual leg will change from case to case as the direction of the flow changes). The initial dilutions in this application were generated for the leg with the smallest angle, thus the predicted initial dilutions will tend to underestimate the dilution for the combination of the two legs.

3. The flux-averaged initial dilution is difficult to measure directly. Based on estimates of entrainment flows measured outside the plume in laboratory studies, Roberts (1989) concluded that the flux-averaged initial dilution is approximately 1.15 times greater than the minimum initial dilution. This factor is incorporated into the RSB models to estimate the flux-averaged initial dilution. For a buoyancy-dominated line discharge, the data reported by Roberts et al. (1989a), and the assumption that the level of minimum dilution (or maximum effluent concentration within the wastefield) corresponds to the level of density equilibrium with the receiving water, our theoretical calculations predict a factor of 1.21. This factor is predicted to decline as the ambient flow increases, but the change cannot be accurately estimated (our equilibrium assumption is expected to break down). Since the California Ocean Plan requires that the regulatory minimum initial dilutions be computed assuming no ambient currents, the "actual" regulatory initial dilutions could be about five percent (1.21/1.15) greater than we predicted.

SIMULATION DATA

The input data required for the initial dilution simulations consists of three types: (1) data values or parameters that remain constant, (2) values that show more or less regular cycles and, (3) values that are not cyclic--although fluctuations associated with a number of time-scales may be evident.

TYPE 1 DATA (CONSTANTS)

The first type of data includes the characteristics of the diffuser. Examples are: the number of ports, port configuration, port diameter(s), port spacing, port depth(s) below the surface, alignment of the diffuser leg(s), and the annual average discharge rate. The values of these parameters that were used for the initial dilution simulations are summarized in Table O-1.

Table O-1
CONSTANT DATA VALUES

Parameter	Value
Number of Ports	416
Port Configuration	Paired on opposite side of diffuser
Port spacing	7.33 m
Nominal port diameter	0.108 m
Nominal port depth	93.7 m
Diffuser alignment (deg. true)	190°, 345°
Annual avg. discharge rate (waiver)	8.98 m^3/sec (205 mgd)
Annual avg. discharge rate (max. design)	10.51 m^3/sec (240 mgd)

The discharge rate of 240 mgd corresponds to the maximum annual average design flow of the outfall; the discharge rate of 205 mgd to the maximum annual average flow during the waiver period.

TYPE 2 DATA (CYCLIC VARIATIONS)

Examples of the second type of data include diurnal and seasonal variations in the discharge rate the effluent density. The daily hydrographs used in the simulations are presented in Table O-3; the annual hydrographs and the monthly variations in effluent density are listed in Table O-2.

TYPE 3 DATA (OCEANOGRAPHIC MEASUREMENTS)

Oceanographic data about the density structure of the water column and the ocean currents falls into the third data category. Two types of information on the density stratification of the water column were available for the Point Loma initial dilution simulations.

Hydrocast Data

Hydrocast data was collected at approximately monthly intervals during the predesign and predischarge phases of the outfall construction, and as part of the routine monthly monitoring program following commencement of the discharge in November 1993.

Table O-2
ANNUAL HYDROGRAPH AND EFFLUENT DENSITY

Month	Relative Flow (205 and 240 mgd) (Annual Average)	Effluent Density (sigma-t)
January	1.139	-1.878
February	1.076	-2.022
March	1.061	-2.313
April	0.976	-2.692
May	0.950	-2.989
June	0.958	-3.279
July	0.966	-3.578
August	0.984	-3.648
September	0.980	-3.097
October	0.990	-2.910
November	0.969	-2.228
December	0.951	-2.767

The advantage of the hydrocast data set is that density profiles are available for every month of the year, and over a period of four years. The disadvantage is that the density profiles are subject to aliasing by internal wave and internal tide activity, and by up- and downwelling events. The aliasing effects on the monthly average initial dilutions are reduced if the number of profiles is large. A summary of the number of hydrocast surveys available for each month of the year is contained in Table O-4.

Water column profiles of temperature and conductivity were collected with a CTD (conductivity-temperature-depth recorder) during the hydrocast surveys. Salinity profiles were computed from the water conductivity and temperature. The equation of state of sea water was then used with the salinity and temperature profiles to obtain density profiles. For the initial dilution calculations, the density was computed at depth increments of 5m between the surface and a depth of 95m. Each density profile obtained from the hydrocast surveys was used in the RSB-TSI initial dilution model to compute a value of initial dilution (for zero current speed) using the appropriate average discharge. The resulting set of dilution values for the various profiles in each month was averaged to obtain the monthly average initial dilutions for the (assumed) case of zero current speed. The regulatory minimum average initial dilution required by the California Ocean Plan (for calculation of Table B concentrations) was chosen as the lowest value in this set of regulatory monthly average initial dilutions.

Time-Series Temperature Data

The second type of density stratification information was collected by using strings of thermistors at four moorings positioned along a cross-shore transect off Point Loma between March and September 1990, and between January and April 1991. The data was collected as part of predesign studies for the extended outfall. The properties of the temperature structure of the water column measured by the thermistor strings is discussed in detail in Appendix N - Physical Oceanographic Setting.

The terminus of the outfall diffuser was constructed close to the location of mooring T5 (Figure O-1) in 95m of water. Temperature data was collected at half-hour intervals. The string consisted of eleven thermistors, spaced at 5m intervals (except for the bottom pair, which had a spacing of 1.5m). The uppermost thermistor in the string was at a depth of 44.5m; the lowermost thermistor, 93.0m. The advantage of this data set is that the sampling interval was sufficiently short so that the major fluctuations in the temperature structure of the water column are resolved and aliasing effects are minimal. The disadvantage is that data are available for less than ten months of one year.

The initial dilution simulations only require information on the density stratification of the water column between the diffuser port and the top of the wastefield. Prior to carrying out the initial dilution simulations, the distribution of depths to the top of the wastefield could only be estimated from past experience. In order to provide some estimate of the density structure of the water column above the uppermost thermistor, a time-series of water temperatures was synthesized for this portion of the water column using data obtained from the thermistor strings on the moorings in shallower water. Mooring T4 contributed measurements at depths of 30.5, 35.5, and 40.5m; mooring T3, depths of 18.3, 23.3, and 28.3m; and mooring T2, 15.5m. Surface water temperatures measured at approximately monthly intervals during the hydrocast surveys, were interpolated to provide a time-series of estimated surface (0.0m) water temperatures.

Table O-3

DAILY FLOW HYDROGRAPH (FLOW RELATIVE TO MONTHLY AVERAGES)

Time	205 mgd Ave. Flow	240 mgd Ave. Flow
00:00 - 00:30	1.073	0.917
00:30 - 01:00	1.073	0.917
01:00 - 01:30	1.073	0.917
01:30 - 0200	1.073	0.917
02:00 - 02:30	0.756	0.646
02:30 - 03:00	0.756	0.646
03:00 - 03:30	0.756	0.646
03:30 - 04:00	0.756	0.646
04:00 - 04:30	0.756	0.646
04:30 - 05:00	0.463	0.646
05:00 - 05:30	0.463	0.646
05:30 - 06:00	0.463	0.375
06:00 - 06:30	0.463	0.375
06:30 - 07:00	0.463	0.375
07:00 - 07:30	0.463	0.646
07:30 - 08:00	0.463	0.646
08:00 - 08:30	0.756	0.646
08:30 - 09:00	0.756	0.912
09:00 - 09:30	0.915	0.912
09:30 - 10:00	1.073	0.912
10:00 - 10:30	1.073	1.167
10:30 - 11:00	1.390	1.167
11:00 - 11:30	1.390	1.167
11:30 - 12:00	1.390	1.354
12:00 - 12:30	1.390	1.354
12:30 - 13:00	1.390	1.354
13:00 - 13:30	1.390	1.530
13:30 - 14:00	1.390	1.521
14:00 - 14:30	1.390	1.521
14:30 - 15:00	1.390	1.521
15:00 - 15:30	1.073	1.354
15:30 - 16:00	1.073	1.354
16:00 - 16:30	1.073	1.354
16:30 - 17:00	1.073	1.354
17:00 - 17:30	1.073	1.354
17:30 - 18:00	1.073	1.167
18:00 - 18:30	1.073	1.167
18:30 - 19:00	1.073	1.167
19:00 - 19:30	1.073	1.167
19:30 - 20:00	1.073	1.167
20:00 - 20:30	1.073	1.167
20:30 - 21:00	1.073	1.167
21:00 - 21:30	1.073	0.917
21:30 - 22:00	1.073	0.917
22:00 - 22:30	1.073	0.917
22:30 - 23:00	1.073	0.917
23:00 - 23:30	1.073	0.917
23:30 - 00:00	1.073	0.917

Table O-4
AVAILABLE MONTHLY HYDROCAST DATA

Month	Year 90	91	92	93	94	Total No. Profiles
January	0	0	9	9	9	27
February	4	2	9	9	9	33
March	4	2	9	9	9	33
April	4	2	9	8	9	32
May	3	0	9	9	9	30
June	4	0	9	7	9	29
July	4	9	9	9	9	40
August	4	9	9	9	9	40
September	4	8	9	9	9	39
October	4	9	9	9	9	40
November	0	9	8	1	0	18
December	0	9	4	0	0	13

The depth to an isotherm surface (surface of constant temperature) changes with the passage of internal tides and internal waves over time on the order of tens of minutes to hours. These effects propagate through the study area, thus, there can be shifts in the phase of the oscillations among the thermistor moorings in the cross-shore transect. These phase shifts can introduce some artifacts in the synthesized temperature profile at depths shallower than 44.5m (the uppermost thermistor depth at mooring 5). On occasion, the shifts were sufficient to produce temperature (and hence density) inversions. In order to reduce the effect of these artifacts, a smoothing function was applied to the temperature data in order to remove these inversions. Any artifacts introduced by the synthesized temperatures for the upper portion of the water column are considered minimal. For most of the initial dilution simulations, the top of the wastefield was found to lie at, or below, the uppermost thermistor in the mooring 5 thermistor string.

Maximum heights-of-rise are associated with the maximum average annual discharge rate (240 mgd) and the regulatory condition of no ocean currents. For the simulations associated with these worst-case conditions, the top of the wastefield was predicted to rise above a depth of 44.5m less than 12 percent of the time (in only 2 percent of the simulations was the top of the wastefield predicted to rise above a depth of 40.5m--the depth of the upper thermistor at mooring T4, the next closest thermistor mooring). Since RSB-TSI starts the initial dilution calculation near the discharge port, and works its way up the water column, if the predicted height of rise is less than 44.5m, the actual height of rise is guaranteed to be above that depth--no matter what artifacts or errors are contained in the synthesized temperature profile region of the water column. Large heights-of-rise are often associated with large initial dilutions. Therefore, artifacts in the initial dilution associated with artifacts in the synthesized temperature profiles affect only the largest predicted initial dilutions.

Water temperatures recorded by the thermistors were converted into water densities using CTD data collected monthly at a set of stations in the vicinity of the mooring and the slowly varying temperature-salinity relationship of the local water mass. Water temperature and conductivity is converted into water salinity, and then water density, as described earlier. Then the water density is plotted versus the water temperature. Examples for the months of March and October, 1990 are illustrated on Figures O-2a,b, respectively. A set of first and second order polynomials was used to analytically describe the water density as a function of temperature (indicated by the line segments in Figures O-2a,b). These analytical relationships are used by the RSB-TSI initial dilution model to estimate the density structure of the water column from the thermistor measurements of water temperature.

Time-Series Ocean Current Data

Ocean currents belong to the third type of input data. Currents were measured at five stations along the cross-shore transect containing the thermistor moorings (moorings C1 through C5 on Figure O-1). The properties of these currents are discussed in Appendix N - Physical Oceanographic Setting.

Currents were recorded concurrently with water temperature measurements between March and September 1990, and again between January and April 1991 at mooring C5, located adjacent to the thermistor mooring T5. Currents were measured at depths of 20m, 40m, 60m, and 80m at half-hour intervals. Initial dilutions carried out during the predesign phase indicated that a typical height-of-rise to the level of minimum dilution was on the order of 25m, corresponding to a wastefield depth of about 68m. Thus, the entrainment region of the water column during the initial dilution process is typically between 93m and 68m, for an average depth of 80.5m. Therefore, the current measurements from a depth of 80m were used for the initial dilution simulations.

The mooring C5 meter at the 80m depth failed to record data on one occasion, from April 19 to May 21 1990. Current measurements made either at the 60m depth at mooring C5, or from mooring C4, lying ca. 1.5 km inshore (and adjacent to thermistor mooring T4), were used to provide current data for these periods. Current measurements were made at mooring C4 at depths of 20m, 40m, 60m, and 77m. Comparisons were carried out to examine the statistical properties (distribution of speeds, net speed, net direction of flow, etc.) of the currents at each depth at mooring C4, and the 60m and 80m depths at mooring C5. The currents at the 60m depth at mooring C4 were found to most closely correspond to the currents at the 80m depth at mooring C5. Therefore, measurements from this meter were used for the initial dilution calculations when currents were not recorded at the 80m depth at mooring C5.

RESULTS

APPLICABILITY OF THE RSB MODEL

As noted earlier, Baumgartner et al. (1993, 1994) endorse the use of the RSB model provided that the parameters characterizing the discharge to be simulated are within the range of values examined during the Roberts et al. (1989a,b,c) physical model studies. The primary characteristics of the discharge conditions in the physical model studies are summarized by three dimensionless parameters (Roberts, 1989a). These are:

1. Ratio of the port spacing to a characteristic buoyancy length-scale, L_{SB}.

2. Ratio of a characteristic momentum length-scale to the characteristic buoyancy length-scale, L_{MB}.

3. A Froude number ("Roberts Froude number") involving the speed of the ambient currents past the diffuser, F_R.

The ratio of the port spacing to the buoyancy length-scale, L_{SB}, varied from 0.31 to 1.92. Dilution values are independent of this ratio for values < 0.3 (Roberts et al., 1989a), where the discharge essentially becomes a line source. Figure O-3 shows the distribution of L_{SB} values for the simulations for a discharge of 240 mgd and the measured currents (a normal, or Gaussian, distribution of values would lie on a straight line on this probability plot). Only about one percent of the cases simulated have a ratio of less than 0.3 (i.e., the buoyancy length-scale is so large that the discharge acts like a line source). However, all of the cases simulated have ratios less than 1.92--the maximum value in the physical model studies. Thus, use of the RSB model for the Point Loma simulations is appropriate from the standpoint of this parameter.

The ratio of the momentum length-scale to the buoyancy length-scale, L_{MB}, is a measure of the relative importance of the energy associated with the jet momentum to the energy associated with the effluent buoyancy. The range of values examined in the physical model studies was from 0.078 to 0.5. Dilution becomes independent of this ratio for values less than 0.1 (Roberts et al., 1989a). The distribution of L_{MB} values for the Point Loma simulations at a discharge rate of 240 mgd is shown on Figure O-4. The ratios for all the cases were less than 0.35 (smaller discharge rates would result in smaller L_{MB} ratios). About one-half the cases had ratios below 0.1; the dilutions for these cases are equivalent to a discharge with negligible jet momentum.

The Roberts Froude number is related to the ratio of the energy associated with the flow past the diffuser and the energy associated with the buoyancy of the discharge. The values examined in the Roberts et al. (1989a,c) studies ranged from 0.0 to 100. There was no significant effect on the currents for Froude numbers less than 0.1, and the effects were minor for flow parallel to the diffuser for Froude numbers less than about 1.0. Froude numbers for the Point Loma outfall simulations are summarized on Figure O-5. About 30 percent of the values were less than 0.1, hence about one-third of the time there was no significant effect of the currents on the magnitude of the initial dilution. Roughly another one-third of the cases had a Froude number in excess of 1. For these cases, the dilution was enhanced by the currents independent of whether the flow was along or perpendicular to the diffuser. The maximum Froude number was 60--well within the range of values examined during the physical model studies.

These comparisons indicate that the RSB simulation model is appropriate for the discharge and receiving water conditions existing at the Point Loma outfall area.

COMPARISON OF RSB-TSI AND BASIC-RSB PREDICTIONS

Simulations were carried out using both the BASIC RSB and RSB-TSI simulation models for ten randomly selected water column stratifications and current conditions. The purpose of this comparison was to validate the predictions generated by the RSB-TSI model. The observations for the comparisons were selected from the time-series data in the following manner:

1. One observation was randomly selected from each group of 130 observations within the total set of 13,757 observations. This produced a set consisting of 100 observations.
2. Ten observations were randomly selected from this group of 100.

In addition, one simulation was carried out for a case where the solution from the RSB-TSI model had a minimum difference between the trial and predicted height-of-rise of 25 cm (versus the "solution found" criteria of 10 cm). The results of the comparison are summarized in Table O-5.

Table O-5
COMPARISON OF RSB-BASIC AND RSB-TSI PREDICTIONS (ANNUAL AVERAGE FLOW = 240 MGD)

		Average Initial Dilution			Ht.-of-Rise to Top of Field (m)		
Date	Obs. No.	Rsb-Bas	Rsb-Tsi	% Diff.	Rsb-Bas	Rsb-Tsi	% Diff.
03/06/90	107	388	392	+1.03	35.3	35.9	+1.8
03/28/90	1,165	815	811	-0.49	36.8	36.8	0.0
04/03/90	1,483	362	362	0.00	41.2	41.2	+0.1
04/07/90	1,677	387	386	-0.26	45.6	45.8	+0.5
04/08/90	1,707	275	278	+1.09	48.8	48.8	-0.1
04/14/90	1,987	554	552	-0.36	25.9	25.8	-0.3
09/22/90	9,741	431	431	0.00	39.9	40.0	+0.3
01/19/91	10,299	224	223	-0.45	27.8	27.3	-1.7
02/08/91	11,246	197	196	-0.51	29.2	28.7	-1.7
03/06/91	12,501	483	481	-0.41	39.0	39.1	+0.2
	Average	*411.6*	*411.2*	*-0.10*	*36.95*	*36.95*	*0.0*
3/06/91	12,526[1]	No soln.	462	-	No soln.	49.42	-

[1] Selected observation (not part of the random cases)

The initial dilutions and heights-of-rise to the top of the wastefield predicted by the RSB-TSI initial dilution model are comparable to those predicted by the BASIC RSB model. Differences in initial dilution values are less than 1 percent in 8 of the 10 cases, and heights-of-rise differ by less than 1 percent in 7 out of the 10 cases. The averages of the initial dilutions predicted by the two RSB models differ by one-tenth of one percent, and the averages of the heights-of-rise are identical. The range of Roberts Froude numbers (F_R) among the 10 cases varied from 0.02 to 15.8 (70 percent are greater than 0.1, consistent with the distribution of Froude numbers among the 13,757 observations). The angle of the flow relative to the diffuser varied from 6^0 to 55^0 (with $F_R = 0.44$ in the latter case).

The least difference between the RSB-TSI trial height-of-rise and the predicted height-of-rise for observation 12,526 (see last row in Table O-5) was 25 cm, corresponding to a difference of 0.5 percent. The BASIC RSB model would not provide a solution to this case (the computer "hung") -- even though the solution criteria in this model only require agreement between the trial and predicted values of 1.0 percent.

Although the test cases in Table O-5 represent a random selection from among the 13,757 observations in the time-series, they do not include representatives from each of the seasons spanned by the data. Therefore, a second stratified random sampling was carried out. In this sampling, the time-series was partitioned into ten sequential groups, each consisting of 1375 observations (28.65 days). An observation was then randomly selected from each of the groups. The results are summarized in Table O-6.

Table O-6
COMPARISON OF RSB-BASIC AND RSB-TSI PREDICTIONS
(ANNUAL AVERAGE FLOW = 205 MGD)

		Average Initial Dilution			Ht.-of-Rise to Top of WFLD (M)		
Date	Obs. No.	Rsb-Bas	Rsb-Tsi	% Diff.	Rsb-Bas	Rsb-Tsi	% DIFF.
03/28/90	1,164	942	944	+0.21	41.4	41.4	-0.0
04/03/90	1,463	412	411	-0.24	40.8	40.8	+0.0
05/10/90	3,221	353	352	-0.28	35.6	35.6	+0.0
06/16/90	5,012	229	229	-0.00	30.0	30.1	+0.4
06/30/90	5,670	362	364	+0.55	36.6	36.6	+0.1
07/25/90	6,903	490	492	+0.41	42.8	42.7	-0.2
09/04/90	8,858	371	364	-1.91	51.1	50.6	-0.9
01/29/91	10,784	337	335	-0.60	32.3	31.7	-1.8
02/09/91	11,311	279	279	-0.00	37.4	37.1	-0.8
03/05/91	12,480	291	290	-0.34	35.9	36.0	+0.2
	Average	*406.6*	*406.0*	*-0.15*	*38.39*	*38.26*	*-0.34*

As might be expected, the results are comparable to the previous comparison. Differences between the predicted flux-averaged dilutions and also the height-of-rise to the top of the wastefield are less than one percent in nine out of the ten cases. The average difference between the two predicted initial dilutions is 0.15 percent; and the average difference between the heights-of-rise is 0.34 percent (in both cases the RSB-TSI predictions are lower).

These results demonstrate that the predictions from the RSB-TSI model are comparable to those generated by the BASIC RSB model, and that the RSB-TSI model is capable of providing adequate predictions for cases where the BASIC RSB model fails.

TIME-SERIES INITIAL DILUTIONS

Initial dilutions in the presence of currents were computed only for the time-series of simultaneously measured water column temperatures and ocean currents. These measurements were available for the period from March 3 (Calendar Day 063) to September 29, 1990 (CD270),

Comparison of Initial Dilutions for 205 mgd and 240 mgd

The probability distribution of initial dilutions for an annual average discharge of 205 mgd is compared with the distribution for a discharge of 240 mgd in Figure O-12. Overall, the initial dilutions associated with the 205 mgd discharge (solid line) are about seven percent higher than those associated with a discharge of 240 mgd (dashed line). This is slightly higher than the five percent increase expected for a buoyant plume from a line source in receiving waters with a constant density gradient--but an increase is in agreement with expectations for a buoyancy dominated discharge. Dilutions for some individual observations may, however, be greater for a discharge of 240 mgd than for 205 mgd, depending on the stratification of the water column.

Diurnal Variations in the Initial Dilution

The magnitude of the initial dilution depends on the density stratification of the receiving water, the strength and direction of the ocean currents, and the discharge rate. Surface and internal tides of semidiurnal and diurnal frequency change the density stratification of the water column and the ocean currents over the course of a day. Similarly, the volumetric discharge has a diurnal cycle. The magnitude of the initial dilution will normally be affected by phasing of these fluctuations relative to one another, and may be either enhanced or diminished.

The interplay between the semidiurnal and diurnal tidal period changes in the currents and in the water column stratification, and the diurnal changes in the discharge rate are evident on Figures O-13a,b. The Figure contains the predicted initial dilutions for the period from calendar day 35 to calendar day 40 (February 4 to 9) in 1991 for various discharge and receiving water conditions. Figure O-13 illustrates the dilutions in the presence of the measured currents and without currents. The solid line represents the most "realistic" estimate, since it includes the variations in the stratification of the water column, currents, and discharge rate. A semidiurnal (two cycles per day) fluctuation is evident in the magnitude of the initial dilution. However, the two peaks within a day are often of different magnitude, corresponding to the diurnal fluctuations in the receiving waters and the discharge rate.

The effect of the varying discharge rate is evident by comparing the initial dilutions predicted for a constant discharge rate (dashed line) with those with the sequence of initial dilutions with the varying discharge rate. At times, the magnitude of the initial dilution may be either enhanced or diminished--depending on the phase of the receiving water and discharge rate fluctuations. In some cases, the difference is as much as 60 to 70 percent during this period.

Figure O-13b shows the initial dilutions for the same set of conditions, but with the ocean currents set equal to zero. Therefore, the dashed line in Figure O-13b illustrates the variations in the initial dilution that result solely from changes in the density stratification of the water column. Semidiurnal period density fluctuations are sufficient to change initial dilutions by as much as 80 percent over the course of one-half a period (ca. 6 hours).

Comparison of the initial dilutions for a constant discharge rate (dashed lines - Figure O-13) illustrates the importance of the tidal period current fluctuations. During this time period, the difference between the highs and the lows is greater in the presence of the currents than in their absence. This suggests that the semidiurnal tidal period variations in the density stratification and in the currents are phased to enhance the variations in the initial dilution.

These variations indicate that care must be exercised in computing regulatory minimum average initial dilutions based on hydrocast data. Since each station is only sampled once during each hydrocast survey, the sample represents only one of the possible stratifications of the water column that may exist over the course of a diurnal tidal cycle. Therefore, the initial dilution predictions may be aliased by the tidal fluctuations unless a sufficient number of density profiles are collected so that the set is representative of the range of stratifications existing during each monthly period. Another factor to consider is that during monitoring surveys, hydrocast data are often collected at the same station at roughly the same time of the day, and at roughly the same time within a month, over the course of a number of years. This has the potential to introduce biases into the initial dilution predictions since there are rough correlations between the timing of the tidal fluctuations between years.

CALIFORNIA OCEAN PLAN INITIAL DILUTIONS

The California Ocean Plan requires that the initial dilutions calculated to show compliance with "Table B" concentrations (effluent constituent concentrations after initial dilution) be computed with currents sufficiently weak so that the initial dilutions are not enhanced by the flows. Because of concerns about the number of independent CTD profiles that were available for the initial dilution calculations, we calculated regulatory initial dilutions based on both the CTD and the time-series data (by setting the ambient current speed equal to zero).

The CTD casts were divided into twelve sets, each corresponding to one month of the year. The years for which CTD data was available is summarized in Table O-4. More than one profile is available for each month of each year. However, these data correspond to profiles collected on the same day, or separated by two days, at multiple hydrocast stations near the outfall. For example, the 9 profiles available for the month of January in 1992 were all collected on the same day. The purpose of using data from more than one hydrocast station is to average out the effects of the density variations associated with internal waves and tides (the data are collected over a period of several hours). Individual profiles within each monthly set was used to calculate a value of the initial dilution (for zero current) for the average monthly flow (annual average flow times month factor shown in Table O-2).

240 mgd - Maximum Annual Average Design Flow of Present Outfall Configuration

The regulatory initial dilutions for a discharge of 240 mgd are summarized by month in Table O-9. The regulatory average initial dilution is the average of all the values during the month. Values range from lows of 202 to 206:1 in the winter (January, December), to highs of 320 to 324:1 in early summer (June, July). The value of 202:1 corresponds to the regulatory minimum average initial dilution used in the California Ocean Plan for computing Table B concentrations.

Regulatory monthly average initial dilutions were also estimated using the 30-day running average initial dilutions computed from the time-series measurements for no currents. The monthly average corresponds to the 30-day running average beginning on the calendar day corresponding to the first day of each month (for example, the February monthly average would correspond to calendar day 032). The resulting regulatory monthly average initial dilutions for the time-series from 1990 and 1991 are summarized in Table O-10.

Note that calendar days in Table O-10 that are surrounded by parenthesis () indicate that the listed 30-day average corresponds to the 30-day average beginning on that day, and thus are only approximate estimates of the value for the month (data was not available to compute the 30-day average for the correct beginning day).

Table O-9
30-DAY AVERAGE DILUTIONS
(HYDROCAST DATA - NO CURRENTS)
(ANNUAL AVERAGE FLOW = 240 MGD)

Month	Dilution Avg.
Jan.	202
Feb.	224
Mar.	263
April	284
May	295
June	324
July	320
Aug.	294
Sept.	307
Oct.	281
Nov.	249
Dec.	206

Table O-10
30-DAY AVERAGE DILUTIONS
(TIME-SERIES DATA - NO CURRENTS)
(ANNUAL AVERAGE FLOW = 240 MGD)

Month	Beginning Calendar Day	TS-1990	Dilutions TS-1991	CTD(1990-94)
January	1	No Data	227 (CD11)	202
February	32	No Data	227	224
March	60	317 (CD63)	267	263
April	91	285	No Data	284
May	121	260	No Data	295
June	152	304	No Data	324
July	182	341	No Data	320
August	213	294	No Data	294
September	244	359 (CD239)	No Data	307
October	274	No Data	No Data	281
November	305	No Data	No Data	249
December	335	No Data	No Data	206

The regulatory monthly average initial dilutions predicted from the time-series range from lows of 227:1 in the winter (January, February) to a high of 359:1 in early fall (September). The value of 227:1 corresponds to the regulatory minimum monthly average initial dilution based on the time-series data. This is about twelve percent higher than the regulatory minimum monthly average initial dilution based on the CTD data.

Overall, the regulatory 30-day average initial dilutions predicted from the time-series are remarkably similar to the values predicted using the CTD data--especially considering the potential effects of internal wave aliasing and interannual variability. For example, the time-series measurements were made in 1990 and early 1991, while the hydrocast data are weighted towards measurements from the years 1992 to 1994. The average of all the regulatory monthly initial dilutions based on the time-series data is 288:1. This is about four percent greater than the regulatory monthly average initial dilution of 276:1 predicted from the CTD data. The variability of the regulatory monthly average initial dilutions within the year is illustrated on Figure O-14.

Initial dilutions predicted from the time-series data range from a low of 227 (January-February) to a high of 359 (September), compared with the range of 202-324 predicted from the hydrocast data. The average of all the time-series based initial dilutions is 287:1, or about three percent greater than the average of 279:1 for all the hydrocast-based initial dilutions during the same months.

205 mgd - Maximum Annual Average Flow During Waiver Period

The minimum initial dilution for a discharge of 205 mgd is summarized by month in Table O-11. Values range from a low of 204 in February to 354 in June.

The 30-day average regulatory initial dilutions for the time-series in 1990 and 1991 are summarized in Table O-12.

The winter lows in the regulatory monthly average initial dilutions predicted from the time-series data range from 238-241 (January-February); the early autumn highs reach 384 (September). Again this compares favorably with the range of 204 to 354 predicted from the hydrocast data. The average of all the time-series based regulatory monthly average initial dilutions is 305:1. This is about four percent greater than the average of 292:1 based on the hydrocast data for the same months. The distribution of regulatory monthly average initial dilutions within the year is illustrated in Figure O-15.

During the waiver application period, the regulatory minimum monthly average initial dilution required by the California Ocean Plan for the Table B concentrations based on the time-series based data is 238:1. The corresponding value for the hydrocast data is 204:1.

Table O-11
30-DAY AVERAGE DILUTIONS
(HYDROCAST DATA - NO CURRENTS)
(ANNUAL AVERAGE FLOW = 205 MGD)

Month	Dilution Avg.
Jan.	214
Feb.	204
Mar.	264
April	313
May	315
June	354
July	325
Aug.	325
Sept.	317
Oct.	287
Nov.	264
Dec.	217

Table O-12
30-DAY AVERAGE DILUTIONS
(TIME-SERIES DATA - NO CURRENTS)
(ANNUAL AVERAGE FLOW = 205 MGD)

Month	Beginning Calendar Day	TS-1990	Dilutions TS-1991	CTD(1990-94)
January	1	No Data	238 (CD11)	214
February	32	No Data	241	204
March	60	337 (CD63)	287	264
April	91	300	No Data	313
May	121	275	No Data	315
June	152	324	No Data	354
July	182	359	No Data	325
August	213	310	No Data	325
September	244	384 (CD239)	No Data	317
October	274	No Data	No Data	287
November	305	No Data	No Data	264
December	335	No Data	No Data	217

Height-of-Rise

The height-of-rise to the level of minimum dilution, bottom of the wastefield, and top of the wastefield varies over the same time-scales characterizing the variations in the magnitudes of the initial dilutions (e.g., hours to years). The monhtly averages for an annual average flow of 205 mgd, based on the time-series data from 1990 and 1991, are illustrated in Figures O-16. Also shown is the maximum height-of-rise to the top of the wastefield during each month.

For annual average flows of 205 mgd and 240 mgd, the height-of-rise to the level of minimum dilution varies from about 20m to 31m, corresponding to depths of 62 to 74m below the surface. In general, the months with the highest heights-of-rise also tend to have the highest initial dilutions. The average height-of-rise to the top of the wastefield at the completion of the initial dilution process varies from about 30m to 40m, corresponding to depths of about 54m to 64m. The maximum height-of-rise to the top of the wastefield during a month varies from about 50m to 64m, corresponding to depths of about 30m to 44m. The water depth at the outer edge of the kelp bed lying inshore from the outfall is about 16-17m; the water depth at the outer edge of the San Diego bight (i.e., along an extension of the Point Loma coastline) lying downcoast, is about 40-45m.

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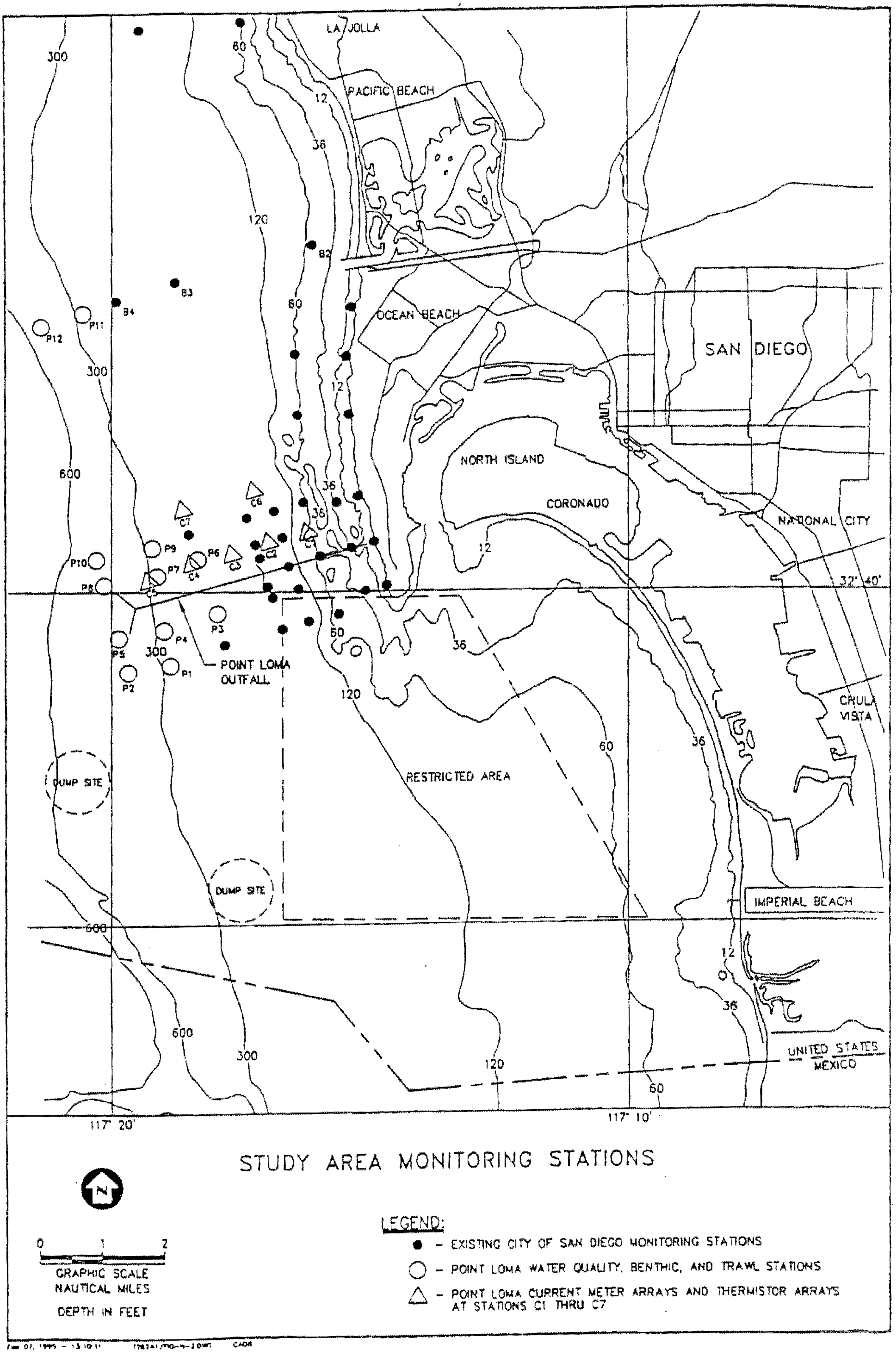
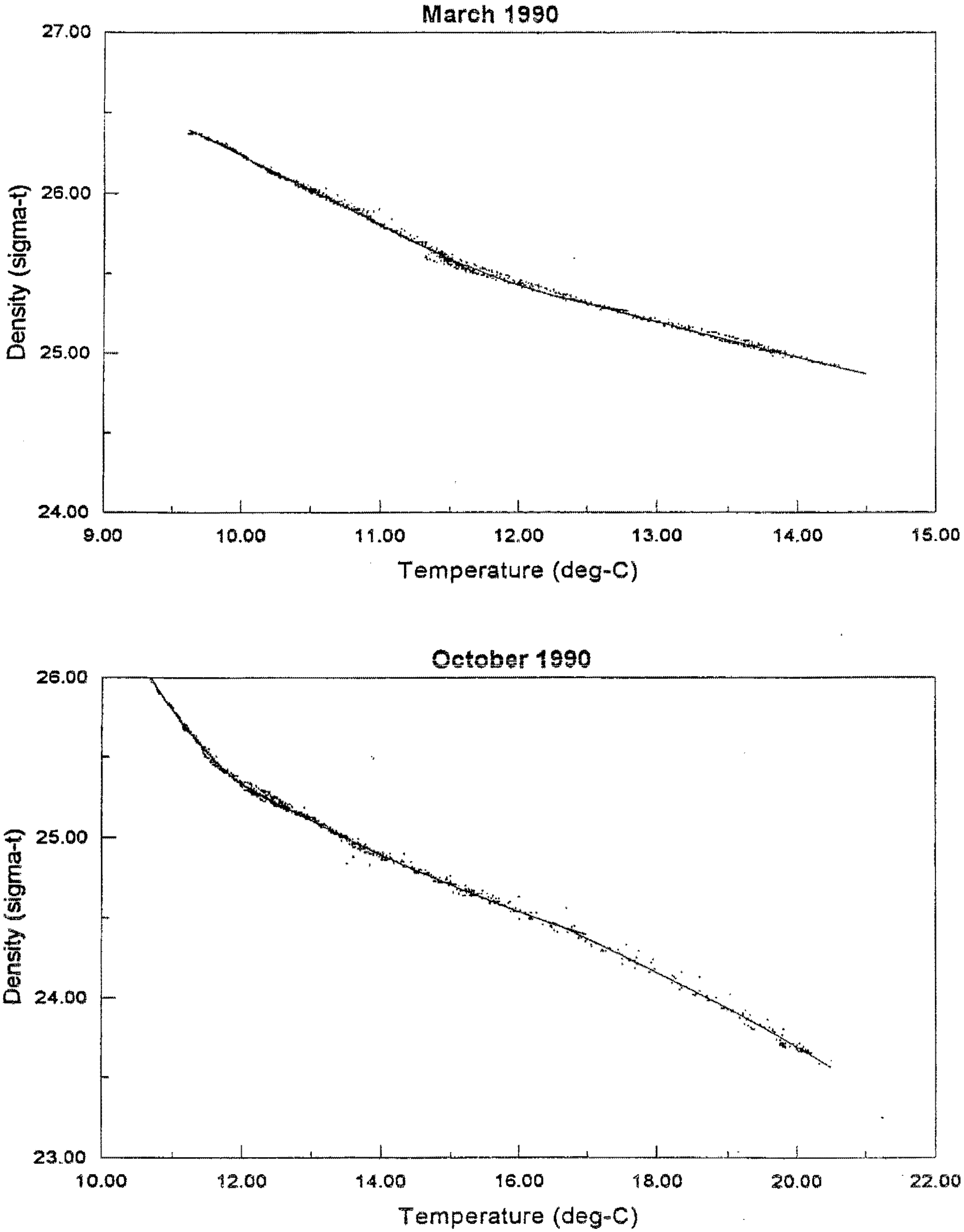
Figure O-1

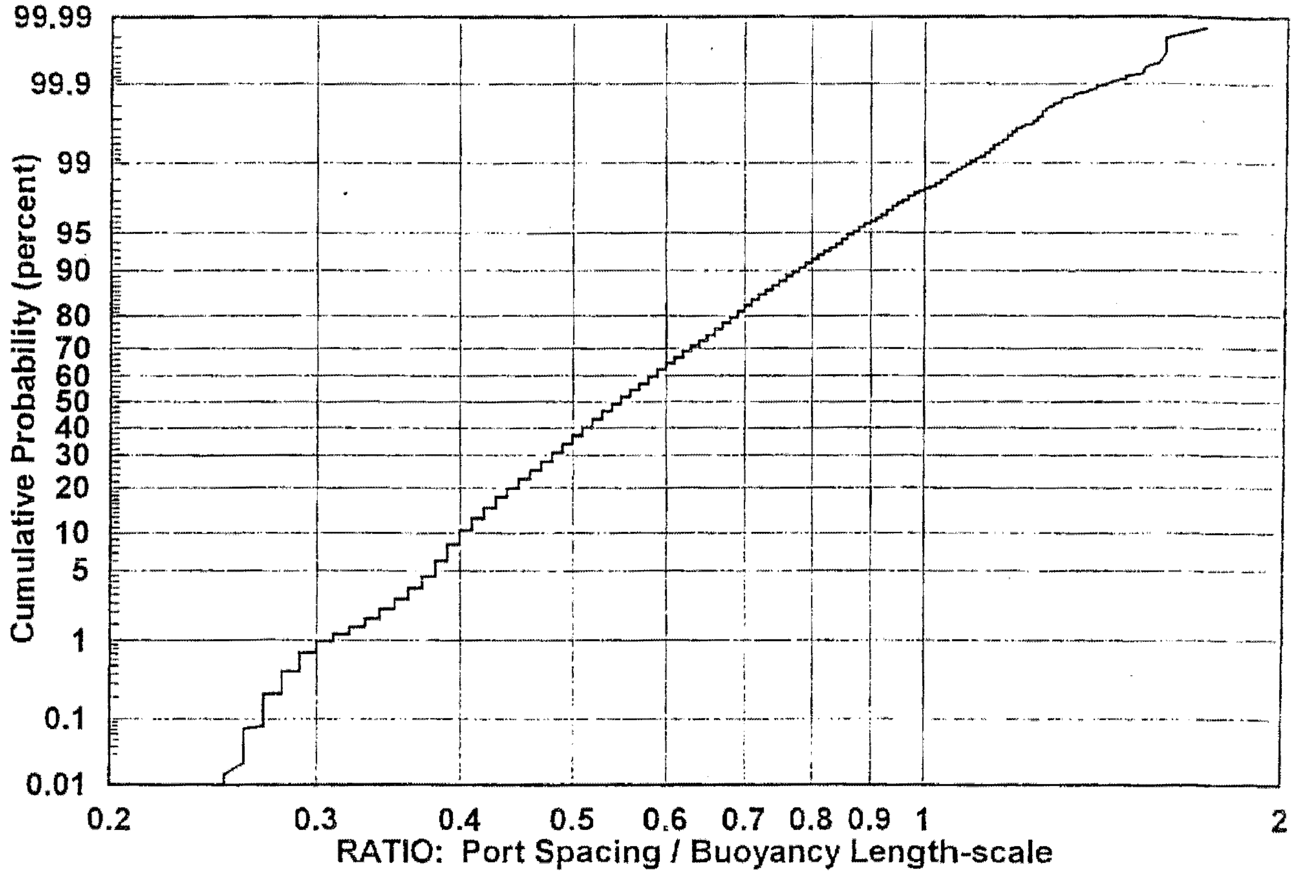


STUDY AREA MONITORING STATIONS

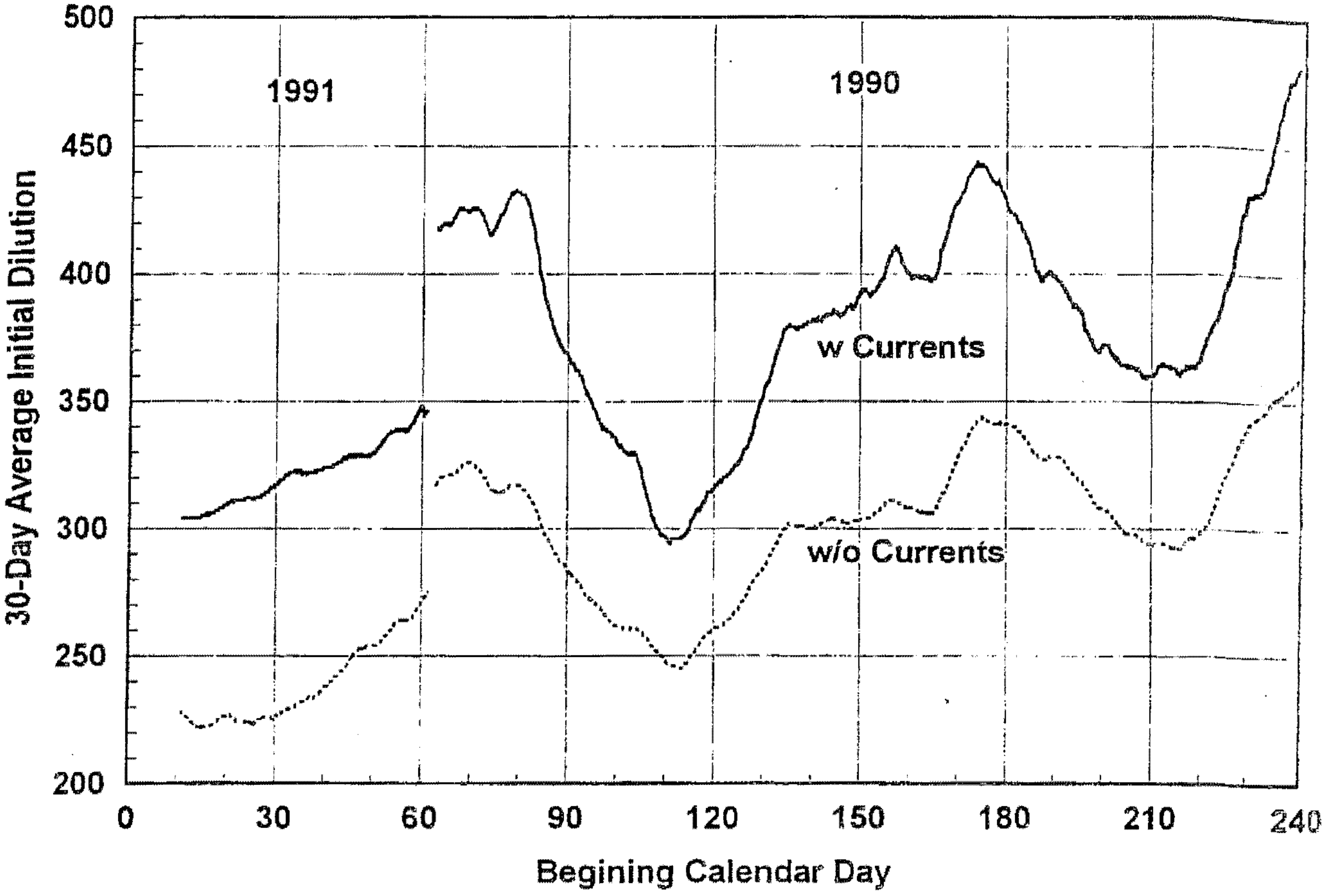
Figure O-2a h.



WATER TEMPERATURE VERSUS WATER DENSITY

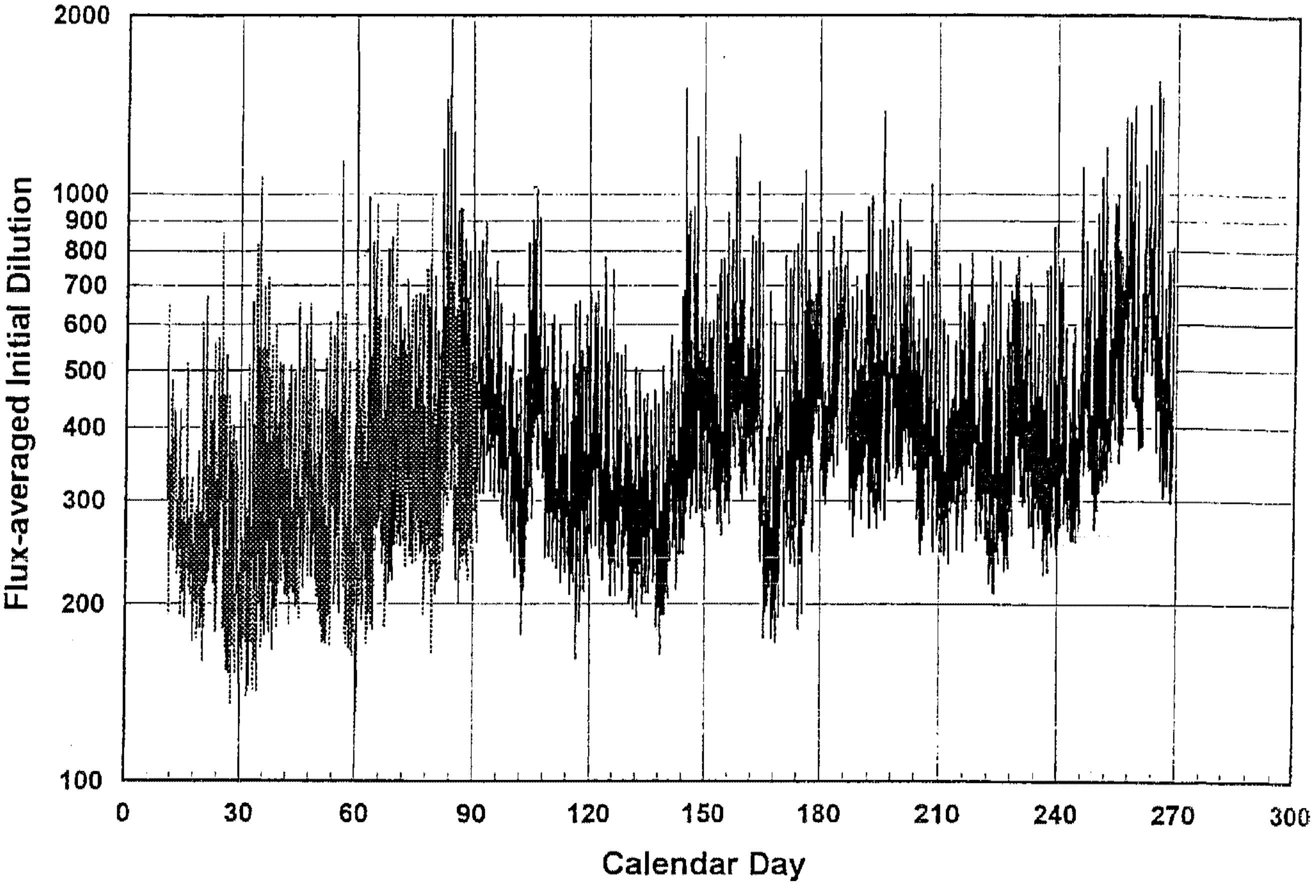


DISTRIBUTION OF THE RATIO OF PORT SPACING
TO THE BUOYANCY LENGTH-SCALE VALUES FOR THE
SIMULATIONS FOR A 240 MGD DISCHARGE



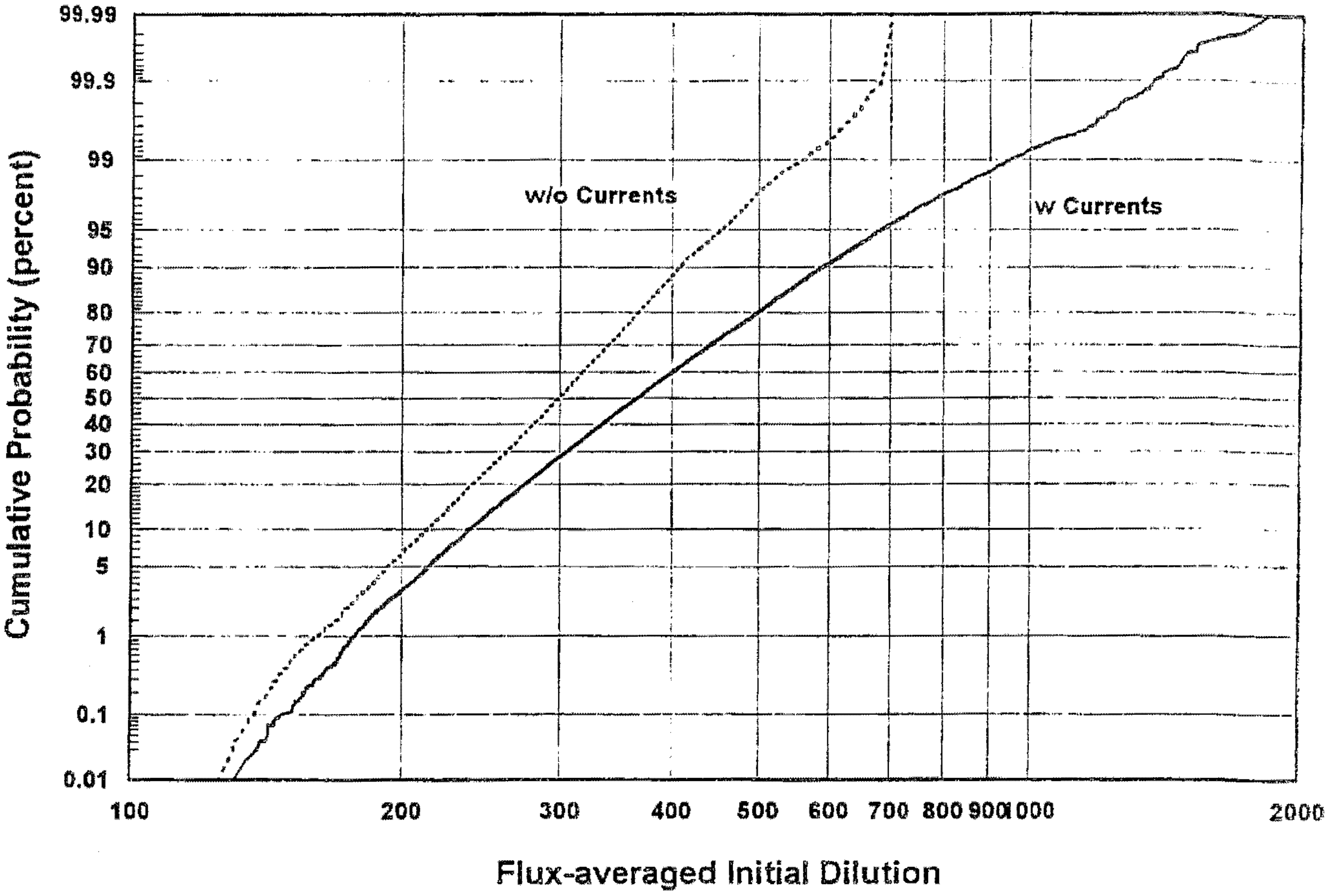
RUNNING 30-DAY AVERAGE OF INITIAL DILUTION, 1990-1991
(240 MGD DISCHARGE; WITH AND WITHOUT CURRENTS)

Figure O-9

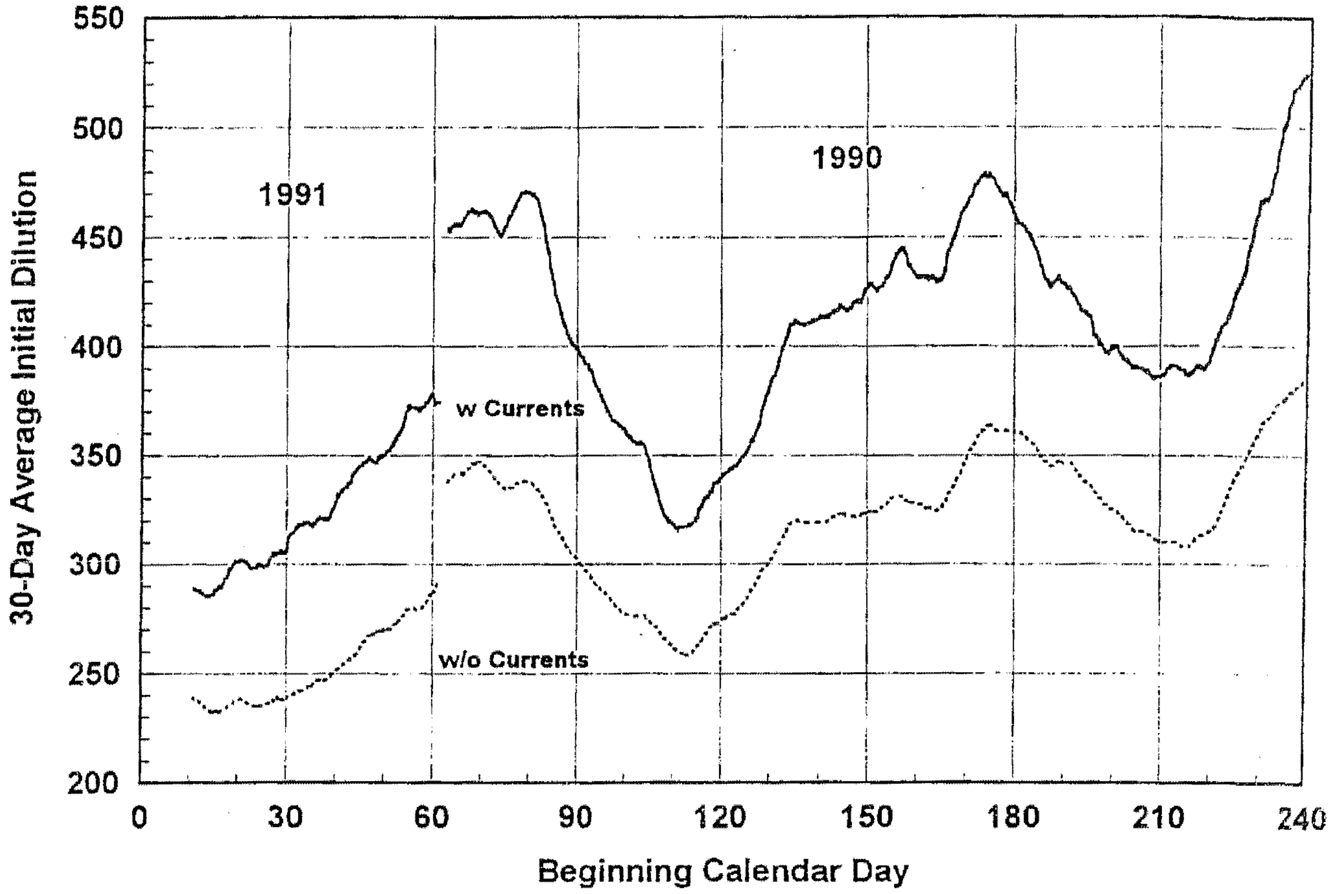


TIME-SERIES OF FLUX-AVERAGED INITIAL DILUTION VALUES
(205 MGD DISCHARGE; WITH CURRENTS)

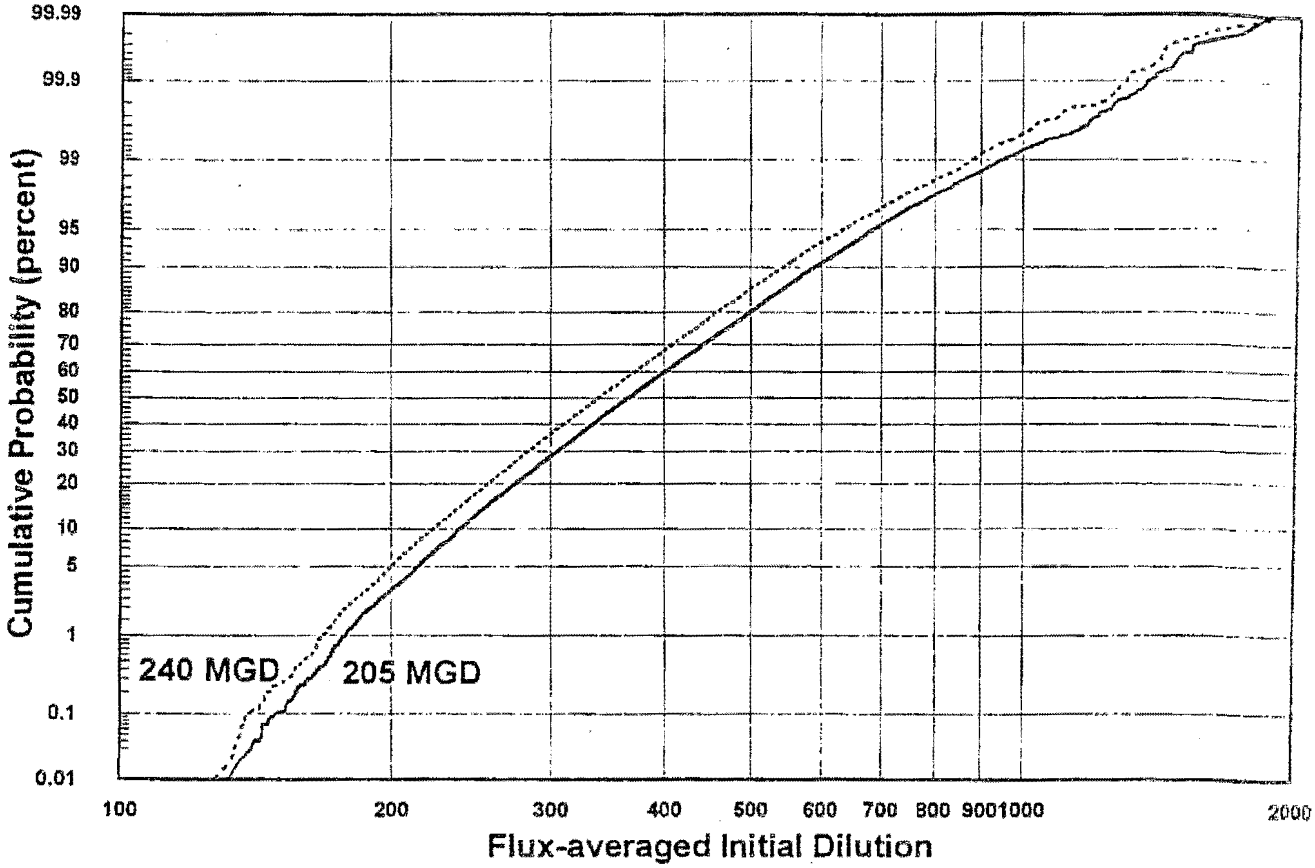
Figure O-10



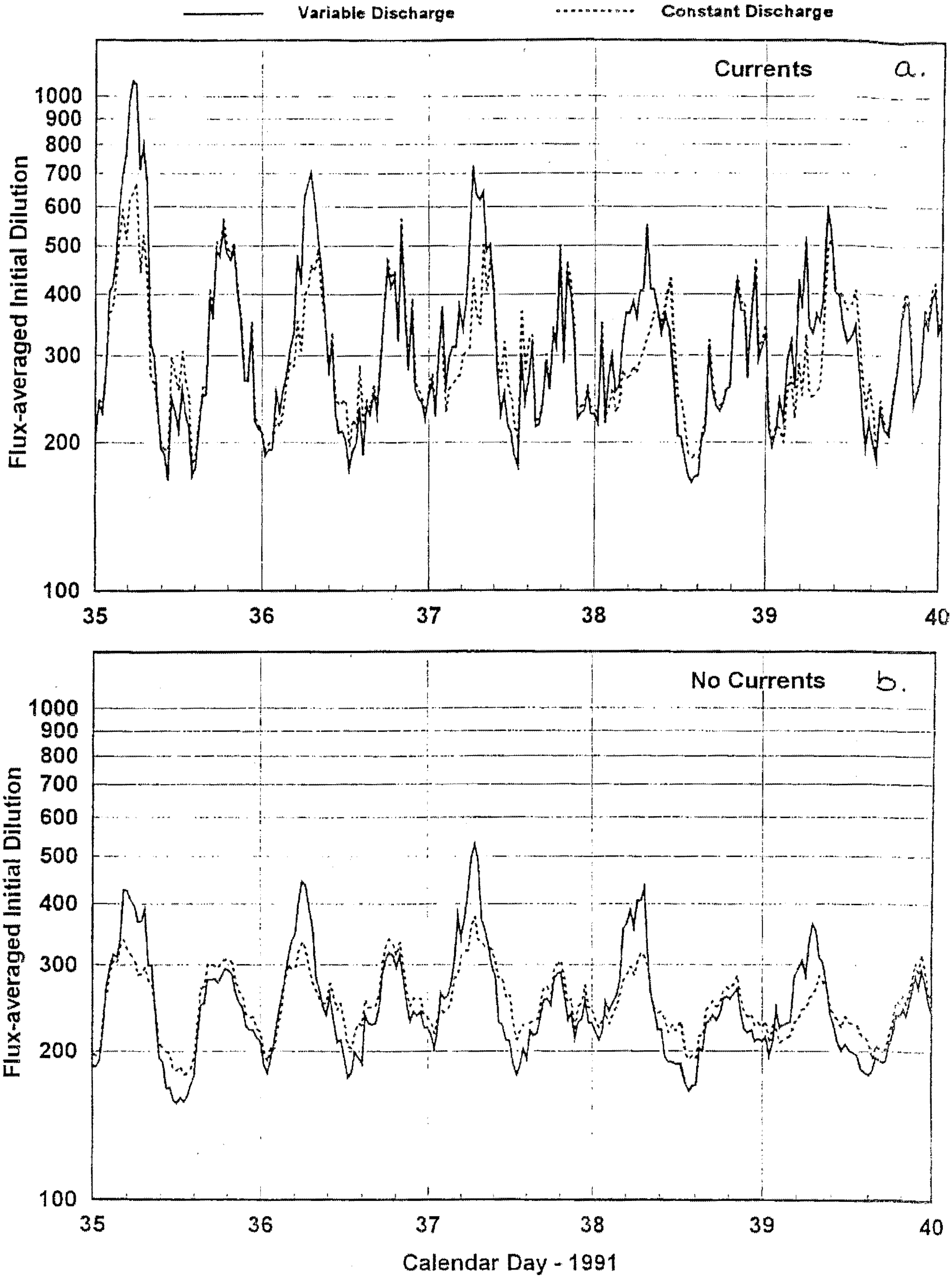
PROBABILITY DISTRIBUTION OF FLUX-AVERAGED
INITIAL DILUTION MAGNITUDES
(205 MGD DISCHARGE; WITH AND WITHOUT CURRENTS)



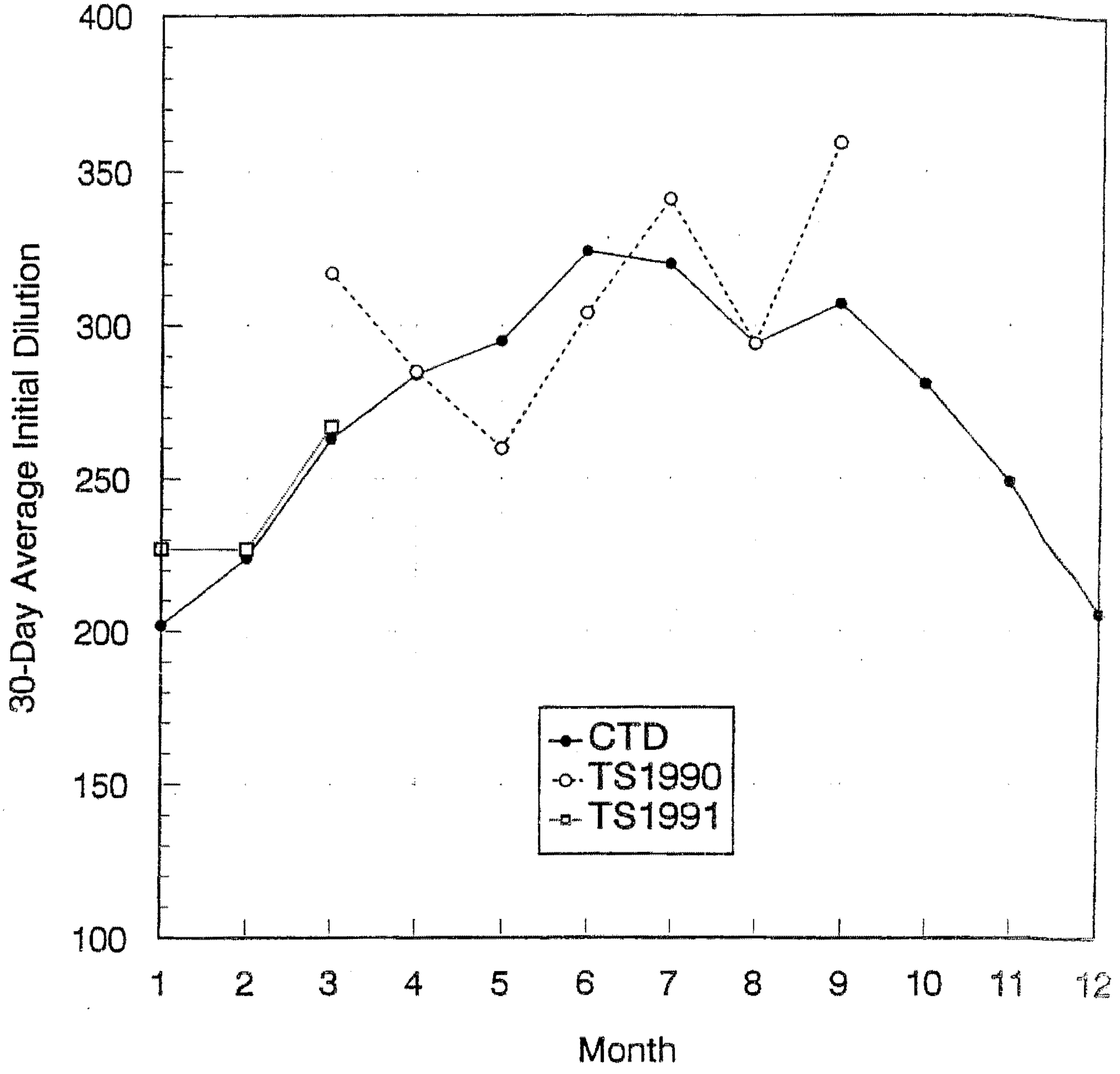
RUNNING 30-DAY AVERAGE OF INITIAL DILUTION, 1990-1991
(205 MGD DISCHARGE; WITH AND WITHOUT CURRENTS)



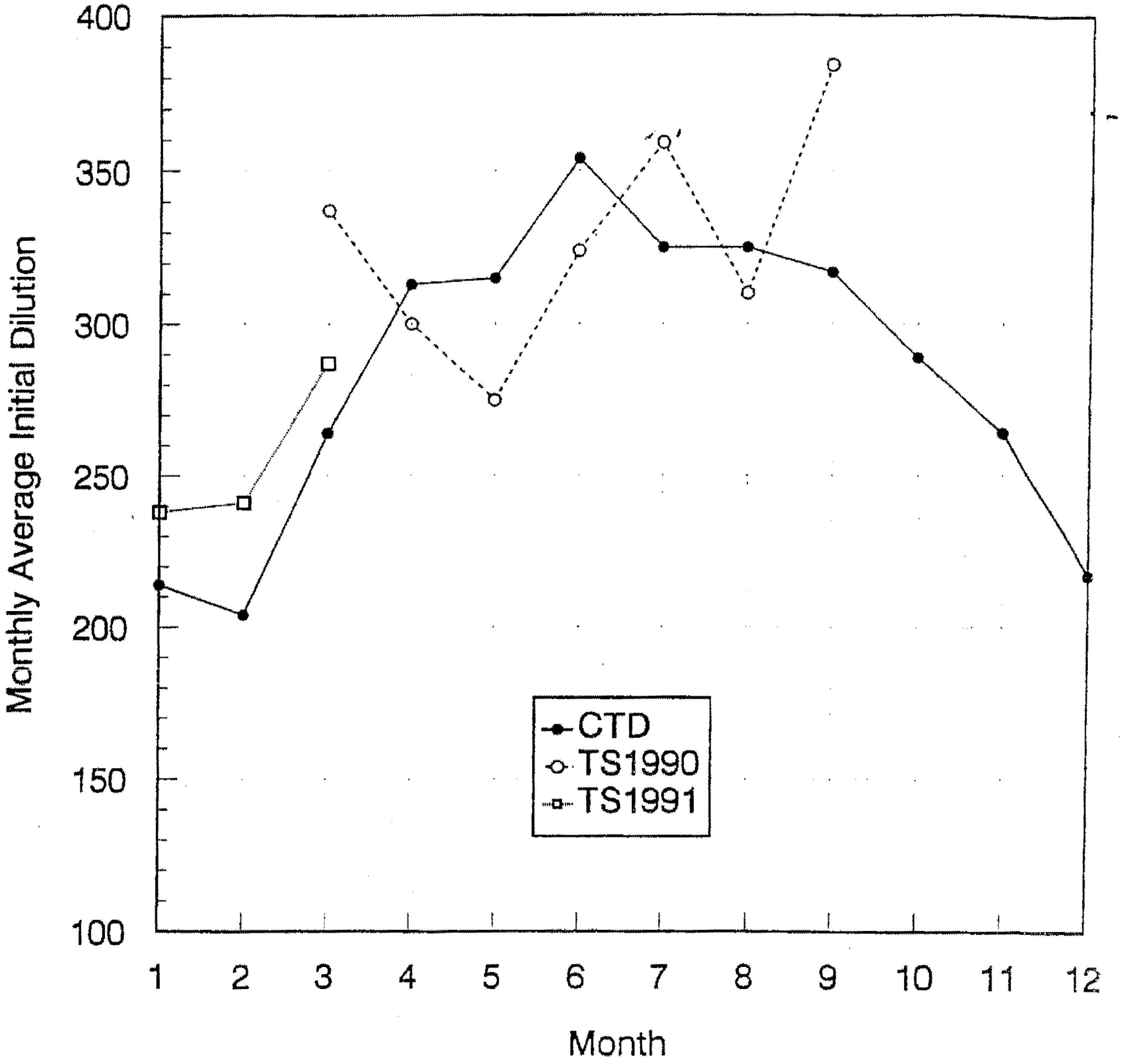
PROBABILITY DISTRIBUTION OF FLUX-AVERAGED INITIAL DILUTION FOR ANNUAL AVERAGE DISCHARGES OF 205 MGD AND 240 MGD
(WITH CURRENTS)



TIME-SERIES OF FLUX-AVERAGED INITIAL DILUTION
VARIABLE DISCHARGE VERSUS CONSTANT DISCHARGE
(WITH AND WITHOUT CURRENTS)

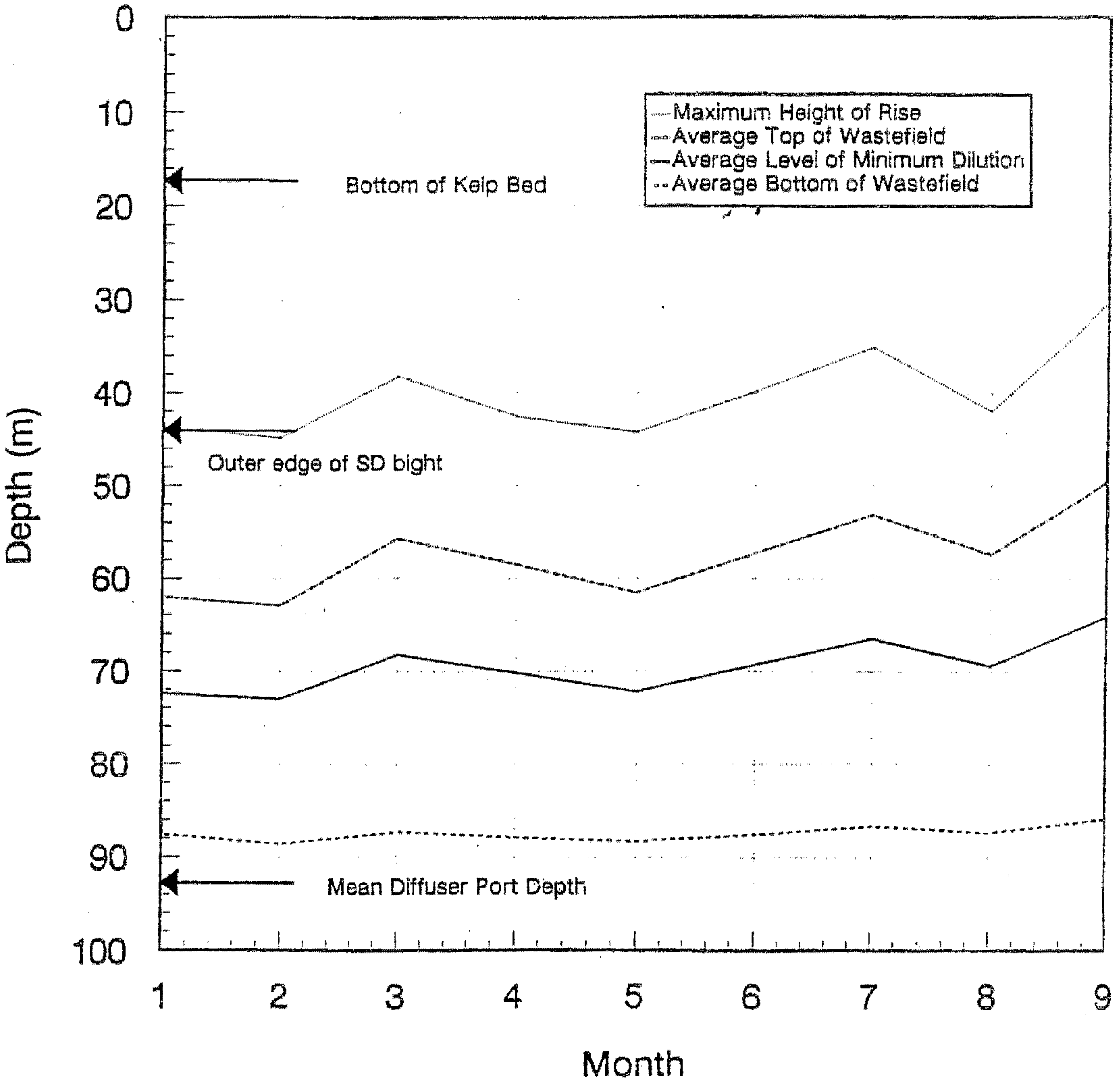


VARIABILITY OF 30-DAY AVERAGE INITIAL DILUTION
WITHIN THE YEAR
(240 MGD DISCHARGE; WITHOUT CURRENTS)



VARIABILITY OF MONTHLY DAY AVERAGE INITIAL DILUTION
WITHIN THE YEAR
(205 MGD DISCHARGE; WITHOUT CURRENTS)

Figure C-10



MONTHLY AVERAGE DEPTH OF THE WASTEFIELD AT COMPLETION OF THE INITIAL DILUTION PROCESS (205 MGD)

THE CITY OF SAN DIEGO · STATE OF CALIFORNIA ·

SEMPER VIGILANS

Appendix P

Dissolved Oxygen Demand

APPENDIX P

DISSOLVED OXYGEN DEMAND

Table of Contents

List of Figures

List of Tables

APPENDIX P
DISSOLVED OXYGEN DEMAND

ABSTRACT

This appendix presents calculations of the dissolved oxygen deficit due to Immediate Dissolved Oxygen Demand (IDOD) and the farfield Biological Oxygen Demand (BOD) due to the release of oxygen demanding waste materials from the Point Loma Ocean Outfall (PLOO). In assessing dissolved oxygen (DO) issues, methods used for calculating IDOD and BOD are presented, along with corresponding input data.

The original version of this appendix was presented in the City's 1995 301(h) waiver application. Effluent quality of the Point Loma Wastewater Treatment Plant (Point Loma WTP) has improved significantly since the original version of this appendix was prepared, but receiving water conditions addressed in the City's original 1995 301(h) application (including initial dilution, receiving water BOD, and receiving water dissolved oxygen) remain valid. Dissolved oxygen (DO) depressions presented in the City's 1995 301(h) application thus become even more conservative, as current day (year 2006) BOD concentrations of 102 mg/l are approximately 10 percent less than the 114 mg/l Point Loma WTP BOD values used in the original 1995 DO deficit computations.

The section on IDOD uses actual ambient dissolved oxygen and temperature data, and the calculated initial dilution and height-of-rise-to-the-trapping-level values to determine the dissolved oxygen depression due to the IDOD. Results of this analysis showed that the IDOD does not depress the ambient dissolved oxygen more than 0.8 percent.

Effluent BOD can exert oxygen demand through IDOD, carbonaceous BOD, and nitrogenous BOD. Two means were used to assess PLOO outfall effects on receiving water DO. First, procedures established in the EPA Amended 301(h) Technical Support Document (ATSD) were used to calculate DO depression. Using the ATSD procedures, total DO depression caused by IDOD and BOD is conservatively estimated at 2.8 percent. Second, a time-history analysis is used to calculate theoretical initial dilution values required to depress receiving water DO concentrations by 10 percent. For critical PLOO conditions, an initial dilution of approximately 100:1 would be required

to cause a 10 percent DO depression. As documented in Appendix O, minimum PLOO initial dilutions at a 240 mgd flow greatly exceed this 100:1 value. Initial dilutions for the Point Loma outfall are far in excess to the minimum dilutions required to prevent a 10 percent depression of receiving water DO.

P.1 INTRODUCTION

California Ocean Plan. The State of California Ocean Plan (2005) requires that: "The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding waste materials." Mathematically, this is expressed as:

$$\frac{\Delta DO(z_m)}{DO_a(z_m)} \leq 0.10$$

where: $\Delta DO(z_m)$ = dissolved oxygen depression due to the oxygen demand of discharged waste at the depth, z_m, and

$DO_a(z_m)$ = concentration of dissolved oxygen in the ambient water at the depth z_m.

The oxygen depressions associated with the oxygen demand of the wastewater are proportional to the concentrations of the effluent IDOD, the effluent BOD in the wastefield, and the difference between the DO concentration in the ambient receiving water and in the effluent. The magnitudes of the depressions associated with each of these factors are proportional to their respective concentrations in the plume/wastefield. The latter are inversely proportional to the volumetric initial dilution, S_a:

$$\frac{\Delta DO}{DO_a} \propto \left\{\frac{IDOD, BOD}{DO_a \times S_a}\right\}$$

Dissolved Oxygen - Critical Period. As part of pre-construction studies of ocean conditions for the PLOO outfall extension, time-series of initial dilutions were calculated from corresponding time-series measurements of the ocean currents and the density stratification of the water column (see Appendix O - Initial Dilution). Minimum DO concentrations monitored over several years were superimposed on computed initial dilutions during critical periods to create a paired DO/stratification data base. Using a conservative approach, the period of most critical dissolved oxygen depression was estimated by assuming that the minimum ambient dissolved oxygen measured in a specific month from several years of data collected from hydrographic surveys, may occur simultaneously with the minimum initial dilution for that month. This is a very conservative assumption since it is unlikely that both extremes will occur simultaneously. (Available hydrographic data and initial dilution simulations suggest that the two quantities are negatively correlated, i.e., warm water temperatures are associated with low initial dilutions but higher ambient dissolved oxygen concentrations.).

The City of San Diego monitoring data, collected in the vicinity of the Point Loma outfall between 1991 and 1994, were used to identify the minimum dissolved oxygen concentrations for each month.

DO concentrations at a depth of 82m (270 feet) were used since this depth approximately corresponds to the layer of minimum dilution within the wastefield (i.e., the "centerline" of the wastefield for the smallest initial dilutions). Normalized values (based on the minimum value) of the product of the minimum initial dilution and the minimum DO for each month, are shown in Table P-1. As shown in Table P-1, the critical period for DO depression is January through April. (Subsequent DO monitoring by the City continue to show that the January through April months have the lowest DO concentrations at depth. (See Figure II.B-1 in the Large Applicant Questionnaire, Volume II.)

Table P-1
Ranking of Months for Critical DO Period

Month	Relative Value[1]	Rank
January	1.159	4
February	1.000	1
March	1.004	2
April	1.021	3
May	1.214	6
June	1.171	5
July	1.988	8
August	1.223	7
September	2.057	9

[1] $(DO_{min} \times Sa_{min}) / (DO_{min\text{-}Feb} \times Sa_{min\text{-}Feb})$

P.2 IMMEDIATE DISSOLVED OXYGEN DEMAND (IDOD)

The dissolved oxygen calculation was carried out using the method described on pages B-14 to B-18 in the ATSD. The dissolved oxygen concentration following initial dilution can be predicted using the following equation (Equation B-6 from the ATSD):

$$\Delta DO\% = DO_a + \frac{DO_e + IDOD + DO_a}{S_a}$$

where: DO_f = Final dissolved oxygen concentration of receiving water (mg/L) at the plume trapping level,

DO_a	=	Affected ambient dissolved oxygen concentration (mg/L) immediately up current of the diffuser averaged over the tidal cycle (12.5 hours) and from the diffuser port depth to the trapping level,
DO_e	=	Effluent dissolved oxygen (mg/L),
$IDOD$	=	Immediate dissolved oxygen demand (mg/L),
S_a	=	Flux averaged initial dilution, and
DO_p	=	Ambient dissolved oxygen (mg/L) at diffuser port depth (93m).

The percent depression of dissolved oxygen due to wastewater is given by Equation B-9 of the ATSD, as follows:

$$\Delta DO\% = 100 \cdot \frac{DO_t - DO_e + IDOD}{DO_t \cdot S_a}$$

where: DO_t = Ambient dissolved oxygen concentration (mg/L) at the trapping level

The IDOD is a difficult value to measure because the chemical test often gives unreliable answers; so much so, that Standard Methods has eliminated it since the 14th edition. Based on Point Loma's travel times and BOD_5 values, the ATSD (Table B-3) recommends use of IDOD values of 3 to 4 mg/L. Testing performed on the PLOO effluent during 1994 yielded IDOD values ranging from 0.45 to 1.74 mg/L, and no IDOD testing has occurred since that date. (See response to Large Applicant Questionnaire Section II.B.4(b) in Volume II.) To be conservative, the 4 mg/L EPA-recommended value is used in the DO depression calculations in lieu of the lower IDOD values measured in 1994.

Final dissolved oxygen (DO_f) concentrations were calculated using data collected by Engineering-Science (CTD data), for sampling period events using data from 1990-1991. These data remain valid, and are appropriate for use in assessing DO depression because the data were collected before the extended PLOO was constructed (thus observed ambient DO concentrations are not influenced by effluent).

To ensure that dissolved oxygen values for the lowest initial dilution periods were properly correlated with depth, temperatures recorded at both the port and calculated trapping level were noted. These temperatures were then referenced using the CTD data to get the dissolved oxygen at those depth positions and points in time. Because of internal tides, the DO as measured by the depth can vary rapidly in time, and comparing DO directly to the depth of the trapping level would lead to erroneous results. On the other hand, since temperature and DO do not vary rapidly in time, referencing DO to temperature is preferred.

Table P-2 presents the correlated initial dilution, DO, and temperature data used in the DO depression computation. Using Table P-2, given water temperatures for the port and trapping level on a given calendar day, one can reference these to DO values at the two levels. The ambient dissolved oxygen (DO_a) becomes the DO, "...averaged...from the diffuser port depth to the trapping level", as suggested in the ATSD. The ATSD lists two additional requirements in the definition of DO_a. The first requirement, that the "...dissolved oxygen concentration [be measured] immediately up current of the diffuser..," is met because the CTD data measurements were taken before the outfall was extended. The second, where the DO is "... averaged over the tidal cycle (12.5 hours)...," is met by tagging the DO with temperature, as discussed above, to remove the variability with depth.

Table P-2
Summary of Initial Dilution
240 mgd PLOO Discharge

Date		Initial Dilution S_a	Temperature (°C)		DO (mg/L)	
			At Port	At Trapping Level	At Port	At Trapping Level
1990	Mar. 7	287	10.39	10.85	4.23	5.37
	Apr. 17	253	10.48	10.87	4.30	4.78
	May 23	230	9.72	10.24	3.65	4.47
	Jun. 20	355	9.51	10.03	5.23	5.60
	Jul. 25	238	10.90	12.21	4.35	5.20
	Aug. 29	416	10.67	11.07	5.60	6.08
	Sept. 27	409	11.32	11.55	3.99	4.68
1991	Jan. 26	275	12.20	13.14	6.60	7.15
	Feb. 7	212	10.87	11.49	4.60	5.83
	Mar. 7	260	10.23	10.68	4.15	5.00
	Apr. 7	258	9.97	10.53	3.63	5.18

Using the above data as input, Table P-3 (page P-6) presents computed DO following initial dilution for the 1990-1991 (pre-discharge) database. As shown in Table P-3, the largest DO change occurs under the February 7, 1991 conditions, where DO is reduced from 5.22 mg/L to 5.17 mg/L. The maximum observed percentage DO depression (0.8%) occurs for the February 7 and May 23 data points.

P.3 FAR-FIELD DISSOLVED OXYGEN DEMAND

Background. The preceding section discussed the reduction in the concentration of dissolved oxygen in the wastefield due to: (1) the chemical oxidation of reduced compounds in the effluent at the time of discharge and, (2) the difference in dissolved oxygen concentrations in the effluent and the ambient receiving water. These depressions occur during the time the initial dilution process takes place.

Organic materials in the effluent contain carbon and nitrogen that can serve as a source of energy and nutrients for bacteria. Over time, bacteria can convert this material into bacterial cells, consuming additional dissolved oxygen in the process. The amount of oxygen consumed in this process, per unit volume of effluent, is referred to as biological oxygen demand (BOD). The BOD includes both carbon-associated BOD (CBOD) and nitrogen-associated BOD (NBOD). The rates of oxygen consumption differ for CBOD and NBOD demands.

Table P-3
Dissolved Oxygen Immediately Following Initial Dilution
240 mgd PLOO Discharge

Date		Initial Dilution S_a	DO (mg/L)				ΔDO (%)
			DO_p	DO_t	DO_a	DO_f	
1990	Mar. 7	287	4.23	5.37	4.80	4.77	0.6
	Apr. 17	253	4.30	4.78	4.54	4.50	0.7
	May 23	230	3.65	4.47	4.06	4.03	0.8
	Jun. 20	355	5.23	5.60	5.42	5.39	0.5
	Jul. 25	238	4.35	5.20	4.78	4.79	0.7
	Aug. 29	416	5.60	6.08	5.84	5.81	0.4
	Sept. 27	409	3.99	4.68	4.33	4.31	0.5
1991	Jan. 26	275	6.60	7.15	6.88	6.84	0.6
	Feb. 7	212	4.60	5.83	5.22	5.17	0.8
	Mar. 7	260	4.15	5.00	4.58	4.54	0.7
	Apr. 7	258	3.63	5.18	4.41	4.37	0.7

[1] Calculations based on IDOD = 4.0 mg/L and DO_e = 0.0 mg/L

The rate of consumption of each type of BOD, and the corresponding rate of demand of dissolved oxygen, can be represented by a first-order rate equation:

$$\frac{d(C_{BOD})}{dt} = -k \cdot C_{BOD} = \frac{d(DO)}{dt}$$

where: C_{BOD} = concentration of either type of BOD (mg/L)
k = first-order decay rate for the corresponding material (e.g., day^{-1})

While the depressions associated with the IDOD and the difference between the DO concentrations in the ambient water and the effluent are established by the time the initial dilution process is finished, the reduction associated with the BOD occurs as the wastefield is carried away by the ocean currents.

The magnitude of the reduction depends on the BOD demand of the effluent, the rate at which this demand occurs, and the amount of dissolved oxygen available in the wastefield. The rate of oxygen demand varies with water temperature through the decay rate, k (which increases with increasing temperature), and the concentration of BOD. The latter declines with the passage of time, as the materials associated with the BOD are converted into bacterial cells. Meanwhile, the amount of dissolved oxygen available in the wastefield increases with the passage of time due to mixing of the wastefield with the surrounding ambient water. As a result of these competing processes, the dissolved oxygen reduction reaches a maximum at some time after completion of the initial dilution process.

Methodology. The time-dependent dissolved oxygen deficiency in the wastefield due to oxygen demanding wastewater materials, ΔDO_w, is:

$$\Delta DO_w = DO_w(t) - DO_t = -\left\{\frac{\Delta O_2^{eff} + \Delta O_2^{IDOD} + \Delta O_2^{BOD}(t)}{D_s(t)}\right\}$$

where: $DO_w(t)$ = dissolved oxygen concentration in the wastefield at the Time, t (mg/L)

DO_t = dissolved oxygen concentration in the ambient surrounding water at the wastefield depth (mg/L)

ΔO_2^{Eff} = dissolved oxygen reduction due to the difference between the DO concentration in the effluent and the DO concentration in the ambient water [= $(DO_e-DO_t)/S_a$]

ΔO_2^{IDOD} = dissolved oxygen demand due to effluent IDOD (mg/L)

$\Delta O_2^{BOD}(t)$ = dissolved oxygen demand at time, t, due to the effluent BOD (mg/L)

$D_s(t)$ = subsequent dilution of the wastefield due to oceanic mixing

The above equation does not include the effects of the entrainment of deeper, colder, ambient water, with lower DO values, into the plume. These effects are excluded from the requirements of the California Ocean Plan. In keeping with the example in the section on IDOD (equation B-9, Appendix B, ATSD), the calculations are carried out as though the concentration of ambient DO entrained into the plume during initial dilution is the same as at the trapping level (i.e., $DO_a = DO_t$).

The quantities ΔO_2^{Eff} and ΔO_2^{IDOD} were calculated in the preceding section for an annual average discharge rate of 240 mgd. In combination, they varied from about 0.03 to 0.06 mg/L at the completion of the initial dilution process (for the lowest monthly initial dilution and the lowest monthly ambient dissolved oxygen concentrations).

The oxygen consumption associated with the BOD of the wastewater in the wastefield, $\Delta O_2^{BOD}(t)$ is obtained by integration of the rate equation for oxygen consumption (presented above) for the carbon- and nitrogen-associated BOD:

$$\Delta O_2^{BOD} = \Delta CBOD_L \cdot (1 - e^{-k_c t}) + \Delta NBOD_L \cdot (1 - e^{-k_N t})$$

where: $\Delta CBOD_L$ = carbon-associated BOD concentration (above ambient) at completion of the initial dilution (mg/L)

$\Delta NBOD_L$ = nitrogen-associated BOD concentration (above ambient) at completion of the initial dilution (mg/L)

k_C = decay rate for carbon-associated BOD (day-1)

k_N = nitrification rate coefficient (day-1)

t = elapsed time since completion of initial dilution (days)

A solution to the equation for ΔDO_w requires information on the parameters, IDOD, $\Delta CBOD_L$, $\Delta NBOD_L$, k_C, k_N, and the time-dependent subsequent dilution, $D_s(t)$. Conservative estimates for each of these parameters are presented below.

Initial Dilution. The concentration of CBOD and NBOD in the wastefield, and the magnitude of the DO reduction associated with the instantaneous oxygen demand (IDOD), are related to the concentration of CBOD, NBOD, and IDOD in the effluent and the flux-averaged initial dilution. The results of simulations of the initial dilution achieved by the Point Loma diffuser system are discussed in detail in Appendix O. The lowest initial dilutions were associated with the period from January through March, and the highest initial dilutions occurred in the late summer to early fall.

A total of 13,757 simultaneous measurements of ocean currents and density structure of the water column (through the water temperatures) were made between January and March, 1991, and March and September, 1990. Although ambient currents were recorded simultaneously with the density structure information, the current speed was set equal to zero in calculating the initial dilutions (as required by the California Ocean Plan). The initial dilutions calculated from this data set were used for the IDOD calculations above. The 30-day average monthly initial dilutions for an annual average discharge rate 240 mgd are summarized in Table P-4 (page P-9).

The number of density profiles used in this initial dilution simulation is roughly two orders of magnitude (or more) greater than the number often available for initial dilution calculations. Therefore, the probability of the present data set containing rarely occurring instances of high stratification (resulting in low initial dilutions) is significantly greater. A five percentile initial dilution value of 200:1 (see Table O-7 in Appendix O) for the 240 mgd PLOO discharge is close to the 204:1 minimum California regulatory initial dilution assigned in Order No. R9-2002-0025.

Table P-4
Regulatory 30-Day Average Initial Dilutions - Zero Ocean Currents
240 mgd PLOO Discharge

Data Set	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
TS[1] (1990-91)	227	227	267	285	260	304	341	294	359
CTD[2] (1990-1994)	202	224	263	284	295	324	320	294	307

1 Data obtained from time-series measurements.
2 Data obtained from hydrocasts.

Effluent Biological Oxygen Demand (BOD). Point Loma WTP effluent BOD concentrations during 2006 averaged 102 mg/l. To be conservative, a higher effluent BOD concentration of 121 mg/l was used in the DO depression computations.

Initial Effluent CBOD and NBOD Concentrations in the Wastefield. BOD measurements are normally measured as the oxygen consumed over a period of five days (BOD_5). To estimate CBOD and NBOD, thirteen days of measurements of BOD_5 and $CBOD_5$ (i.e., with nitrification inhibited) were conducted on the Point Loma WTP effluent between June 1 and July 27, 1992. This data were used to estimate the ratio of nitrogen-associated BOD_5 ($NBOD_5 = BOD_5 - CBOD_5$) to total BOD_5. Observed ratios ranged from 2.2 percent to 27.6 percent (median: 11 percent; average: 12.4 ± 8.8 percent).

The decay rate (see discussion on page P-10) for carbon (k_C) exceeds the nitrification rate (k_N). At the same time, the ratio of ultimate CBOD ($CBOD_L$) to $CBOD_5$ is greater than the ratio of ultimate NBOD ($NBOD_L$) to $NBOD_5$. Therefore, the greatest oxygen demand, per unit BOD_5, will occur for the lowest ratio of $NBOD_5$ to BOD_5.

To conservatively estimate the maximum possible oxygen demand, it was assumed that the $CBOD_5$ is 97.8 percent of the total BOD_5 of the effluent, and the $NBOD_5$ is 2.2 percent of the total BOD_5. Thus the maximum $CBOD_5$ is estimated to be 118.3 mg/l (121 x 0.978), and the corresponding $NBOD_5$ is estimated to be 2.7 mg/l.

The next step is to convert the 5-day BOD values into the corresponding ultimate BOD concentrations (i.e., at the completion of the conversion process to bacterial cells). Thomann and Mueller (1987) estimated the ratio of the ultimate carbon-associated BOD ($CBOD_L$) to $CBOD_5$ for primary effluent to be 2.84. This conversion factor was used for the calculations, yielding an ultimate CBOD of 336 mg/l (118.3 x 2.84). Thomas and Mueller also estimated the corresponding ratio for nitrogen-based BOD to be 2.54. Hence, an ultimate NBOD ($NBOD_L$) of 6.8 mg/l (2.7 x 2.54) was used in the calculations.

BOD Decay Rates. The decay rate for CBOD (k_C) can be estimated from the equation (from: Equation B-13, Appendix B, ATSD):

$$k_c = 0.23\ \Theta_c^{(T-20)}$$

where: T = wastefield temperature in degrees Celsius
Θ_c = temperature correction factor

Fair et al. (1968) suggest Θ_C values of 1.15, 1.11, and 1.047 for temperatures of 5, 10, and 20 degrees Celsius, respectively. These three pairs of values were represented by a second-order polynomial to estimate the decay coefficient at intermediate water temperatures. At a water temperature of 12.5°C, the value for Θ_C is estimated to be 1.092. The corresponding value for the decay coefficient, k_C, is then 0.119 day^{-1}, or 0.00495 hr^{-1}.

The corresponding equation for NBOD (from: Equation B-15, Appendix B, ATSD) is:

$$k_n = 0.1\ \Theta_N^{(T-20)}$$

A value of $\Theta_N = 1.08$ is valid for temperatures between 10 and 30 °C (Appendix B, ATSD). At a temperature of 12.5 degrees, the nitrification rate becomes 0.0561 day^{-1}, or 0.00234 hr^{-1}.

Water Temperature. As noted earlier, the lowest initial dilutions in the DO/initial dilution database period occurred during January to March, 1991 (3858 cases). This subset was then sorted by the magnitude of the dilution for the calculation of the decay rates (decay rates are temperature dependent). A second subset was created from this sorted subset, by selecting only the cases with values within 20 percent of the lowest initial dilution.

The average ambient water temperature at the wastefield depth for this set of low initial dilutions was 11.70 °C. The highest temperature was 12.57 °C; the lowest temperature, 10.81°C. A temperature of 12.5 °C was used to compute the rate constants for the oxygen depressions associated with effluent BOD. This is a conservative assumption, since the water temperature at any depth in the wastefield will be lower than the ambient water temperature at the same depth outside the wastefield.

Ambient BOD. The BOD of the ambient waters is so low that the measured values are within the range of error of the measurement. For the purposes of the dissolved oxygen reduction calculations, we assumed it to be zero (this demand is normally satisfied by vertical diffusion of oxygen in the water column). Therefore, the $\Delta CBOD_L$ and $\Delta NBOD_L$ in the preceding equation can be considered to be equal to the effluent $CBOD_L$ and $NBOD_L$ after initial dilution.

Dissolved Oxygen at the Completion of Initial Dilution. The oxygen demand due to the instantaneous dissolved oxygen (IDOD) of the effluent and the entrainment of ambient receiving water during the initial dilution process was discussed in the preceding section of this appendix. These values were used as the dissolved oxygen initial conditions in the calculation of the temporal evolution of dissolved oxygen in the wastefield with the passage of time.

Subsequent Dilution. Horizontal mixing (e.g., along surfaces of constant water density) takes place in the ocean due to turbulent diffusion (from the combination of molecular diffusion and shear in the currents). The process is commonly referred to as "dispersion". Current shear is associated with eddies present in the flow field. The most effective mixing of a patch of water with the water surrounding it is associated with the set of eddies with dimensions that range up to the size of the patch. These eddies tend to break down the original patch into ever smaller patches, until the relatively weak process of molecular diffusion becomes effective. On the other hand, eddies with dimensions larger than the patch tend to advect it as a unit rather than producing mixing. The end result is that if turbulent eddies covering a wide range of dimensions are present in the ocean, the "eddy diffusivity" describing the mixing will increase as the dimension of the dispersed patch grows. Thus the range of eddy dimensions ("length-scales") present in the ocean, and the distribution of kinetic energy among eddies of various length-scales, will determine the characteristics of the eddy diffusivity.

The square-root of the spatial variance (i.e., the standard deviation, σ) of a patch along an axis is often used as a measure of its "dimension" along that axis. If all the eddies present in the area of the patch have dimensions that are smaller than the dimension of the patch, the eddy diffusivity will remain constant in magnitude as the patch dimensions increase. For a patch with initial variance $\sigma^2(0)$ the variance of the patch grows linearly with time:

$$\sigma^2(t) = \sigma^2(0) = 2K_H \cdot t$$

where: $\sigma^2(t)$ = variance (e.g., m^2) of the patch at the time t (e.g., sec)
K_H = horizontal eddy diffusivity (e.g., m^2/sec)

Diffusion characterized by a constant diffusivity is often referred to as "Fickian" diffusion (it is characteristic of molecular diffusion). However, in the ocean the "diffusivity" associated with the current eddies greatly exceeds that associated with molecular diffusion.

If the range of eddy dimensions is always greater than the dimensions of the patch (at any time during the period of interest), and if the energy input supporting the eddies is supplied to the eddies with the largest dimensions, the rate of growth of the patch dimensions will be proportional to the three-halves power of the time (the variance increases as the cube of the time). This leads to an eddy diffusivity that is proportional to the four-thirds power of the dimensions of the patch, giving rise to the so-called "four-thirds" law for eddy diffusion.

Eddies associated with conditions that lie between these two extremes, or different assumptions about the dynamics of the mixing process, can give rise to other patch growth rates. Okubo and Pritchard (1969) and Okubo (1970) note that in coastal waters, the dimensions of a patch are frequently observed to grow linearly with time. Okubo (1970) observed that this apparent growth rate may be associated with the input of energy into eddies at specific length-scales (e.g., corresponding to the dimensions of the tidal ellipse, etc.).

A linear growth rate in the patch dimensions, and a quadratic growth rate in time of its variance, can be quantified dimensionally by the introduction of a "diffusion velocity" (v_d). For a "point" patch, the variance grows as:

$$\sigma^2(t) = (v_d \cdot t)^2$$

Measurements at a wide range of locations indicate diffusion velocities are typically on the order of 1 cm/sec (Okubo and Pritchard, 1969). In general, the patches of interest will not start out at time t=0 as point patches. For example, immediately following the initial dilution process the wastefield will have some width (and corresponding variance $\sigma(0)^2$). Since the initial dilution process is independent of the oceanic mixing process, the initial and subsequent variances are statistically independent. Therefore, for a representation of diffusion velocity, they can be added to get the variance at the beginning of the wastefield (e.g. time t = 0) as follows:

$$\sigma^2(t) = \sigma^2(0) + (v_d \cdot t)^2$$

A two dimensional patch (e.g., an ellipse) will spread in two dimensions. These are often taken as the "spreading" in the "along-current" and "cross-current" directions, since the apparent eddy diffusivities are frequently different in the two directions. The along-current diffusivity is enhanced by the presence of current shear with water depth and vertical mixing. (Okubo and Pritchard, 1969) For a continuous discharge, however, it is the cross-current eddy diffusivity that produces most of the reduction in the concentration of wastewater in the wastefield (although the along-current diffusivity may be greater, the along-current gradients in wastewater concentration are small).

If mixing only occurs along surfaces of constant water density (i.e., vertical mixing is negligible), and if the normalized distribution of some tracer (e.g., wastewater) within a patch remains the same (e.g., a Gaussian distribution). The ratio of the concentrations of the tracer within the patch at two different times is equal to the inverse of the ratio of the "dimensions" of the patch at these times, as follows:

$$\frac{c(t)}{c(0)} = \frac{1}{Dilution} = \frac{\sigma(0)}{\sigma(t)}$$

where: $c(t)$ = concentration of the tracer at time t

Horizontal eddy diffusivity was estimated on the basis of plume tracking studies completed by Hendricks and Harding (1974) using measurements of ammonia. These measurements were made as part of a study of phytoplankton response to wastewater nutrients. At the beginning of the study, a parachute drogue was deployed at the approximate depth of the wastefield immediately downcurrent from the original Point Loma outfall (in 60m of water). Two auxiliary drogues were placed 300m away from this primary drogue perpendicular to the direction of flow. Measurements of ammonia, nitrite, nitrate, and chlorophyll-a were made at approximately 6m intervals between the surface and a depth of 51m in the water column. These profiles were measured adjacent to the primary drogue, and each of the secondary drogues, at 5 hour intervals over a period of 40 hours. It was assumed that the effects of vertical mixing were negligible, and the reduction in ammonia concentration was due to horizontal mixing.

Figure P-1 (page p-14) presents observed reductions in the peak ammonia concentration in the wastefield plume over this period (from Hendricks and Harding, 1974). The wastefield starts out at time t=0 with an initial variance, $\sigma^2(0)$. The variance describing the cross-wastefield distribution of ammonia in the wastefield is:

$$\sigma^2(0) = \int_0^L p(y) \cdot y^2 \cdot dy$$

where:
y = the cross-wastefield position, relative to its centerline
$p(y)$ = normalized concentration distribution of wastewater within the plume
L = half-width of the plume

The initial standard deviation of the distribution of wastewater across the wastefield depends on the strength and direction of the currents, the discharge rate, diffuser leg lengths, and the downstream distance to the initial profile (t=0). It was estimated to be 349m based on the relative concentrations at the center drogue and side drogues (at t=5 hr), and the decline in the peak concentration between the first two samplings (t=0, t=5 hr).

The predicted rate of decrease in the peak concentration of ammonia in the wastefield for this initial standard deviation and a diffusion velocity of 1 cm/sec (0.01 m/sec) is shown in Figure P-1 (page P-14). The predicted decrease in peak ammonia concentration is a good approximation to the observed decrease, indicating that a diffusion velocity representation with a diffusion velocity of 1 cm/sec is appropriate for describing the cross-wastefield dispersion in this area.

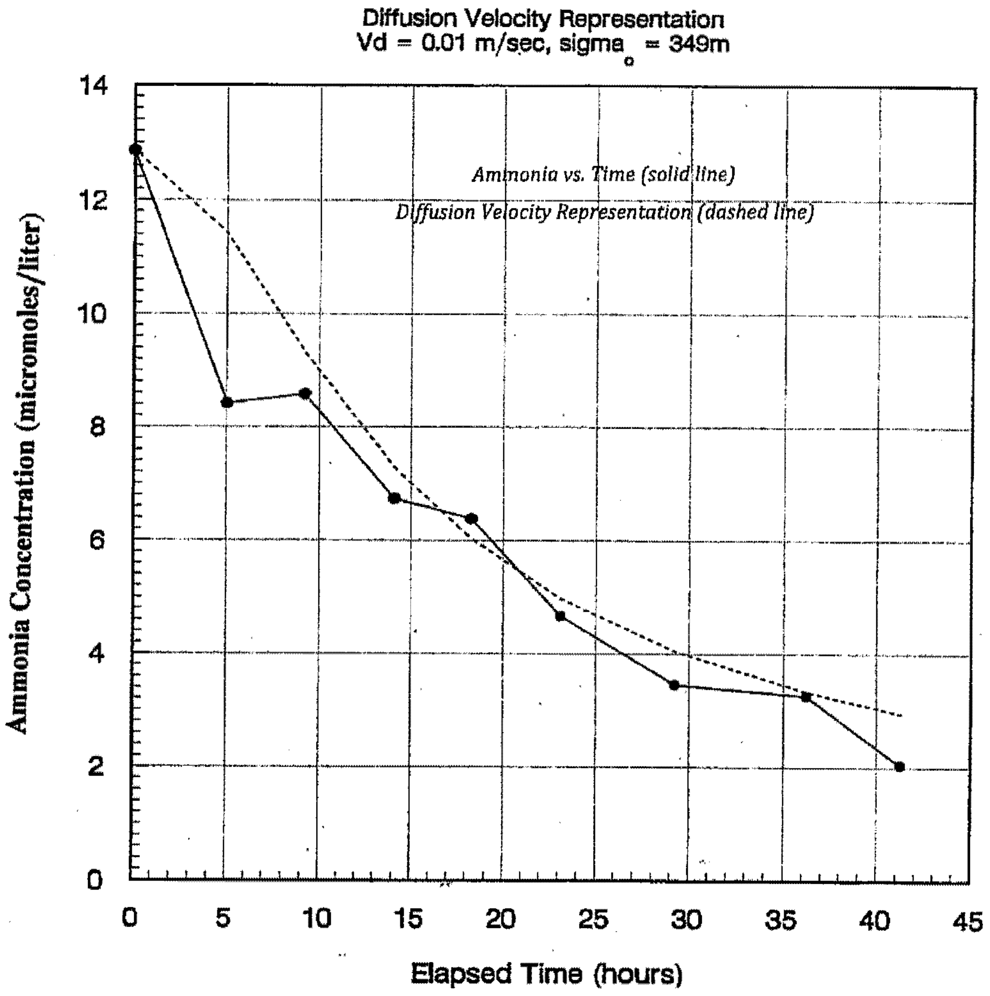


Figure P-1 Diffusion Velocity Characteristics

The 1994 ATSD recommends that: "if the applicant can show that the 4/3 law (or some other relationship) is applicable to the discharge site, then that relationship should be used." A diffusion velocity based representation, with a diffusion velocity of 1 cm/sec was used, to estimate the subsequent dilutions associated with oceanic mixing in the Point Loma area since:

- Coastal dispersion is frequently observed to result in a patch whose variance increases with the square of time (Okubo, 1970).
- Diffusion velocities at a variety of coastal locations have been observed to be on the order of 1 cm/sec (Okubo and Pritchard, 1969).
- The dispersion of ammonia in a subsurface wastefield in the Point Loma area is well represented by a diffusion velocity based representation with a diffusion velocity of 1 cm/sec.

The initial width of the wastefield from the present (extended) outfall will be larger than from the previous outfall, since the length of the diffuser has been increased from about 810m to about 1525m.

The subsequent dilutions used in the farfield DO depression calculations are based on an initial standard deviation of 658m (versus the 349m standard deviation for the ammonia distribution in the study at the old outfall). This value was selected based on the greatest dimension of the ZID (~1,720m) as per the legend for Equation B-17 in Appendix B of the ATSD. To this was added the effects of the spreading as the initial "top-hat" profile is transformed into a normal distribution.

Table P-5 presents subsequent dilutions through 96 hours of elapsed time, based on an initial standard deviation of 658m. For comparison, Table P-5 also presents EPA-computed subsequent dilution estimates for 5,000 foot-wide (1,424m) wastefield that are based on the following two methods:

- Case 1 - diffusivity (K_H) is a constant, and
- Case 2 - the "4/3's Law" (e.g. diffusivity is a function of distance to the 4/3 power).

Table P-5
Subsequent Dilution
(Diffusion Velocity = 1 cm/sec; Initial Standard Deviation - 658 m)

Elapsed Time (hrs)	Subsequent Dilution Ratio		
	Computed Subsequent Dilution (D)	EPA Value for Constant Diffusivity[1] K_H	EPA Value for 4/3's Law[2]
0	1.00 : 1	1.0 : 1	1.0 : 1
4	1.02 : 1	1.1 : 1	1.2 : 1
12	1.20 : 1	1.6 : 1	2.3 : 1
18	1.40 : 1	-	-
24	1.65 : 1	2.1 : 1	4.4 : 1
30	1.92 : 1	-	-
36	2.21 : 1	-	-
42	2.51 : 1	-	-
48	2.81 : 1	2.8 : 1	10.0 : 1
72	4.06 : 1	3.4 : 1	17.0 : 1
96	5.35 : 1	3.9 : 1	24.0 : 1

1 EPA-computed subsequent dilution values for a constant diffusivity, per Table B-5 of Appendix B of the ATSD (EPA, 1994).

2 EPA-computed subsequent dilution values where diffusivity varies to the 4/3's power with distance. Values from Table B-5, Appendix B of the ATSD (EPA 1994).

Results. Table P-6 presents farfield DO depressions using the data set previously presented in Table P-3. Within Table P-6, farfield *ΔDO(%)* is computed to include DO depression from the effluent DO, the IDOD, the NBOD, and the CBOD. The calculations are based on the following:

$$\Delta DO(\%) = 100 \cdot \frac{\Delta DO}{DO_f}$$

Where: ΔDO = the farfield DO depression

DO_f = the minimum level of DO in the wastefield as the result of the DO and IDOD in the effluent, DO uptake by the BOD exertion, and subsequent oceanic mixing with the surrounding higher DO water.

Input values from May 23, 1990 results in the highest DO drawdown (2.8 percent) for a PLOO flow of 240 mgd.

The predicted depression curve of the dissolved oxygen concentration, showing a peak DO depression of 2.4 percent, in the wastefield, for February, is illustrated in Figure P-2 (page P-17). The maximum reduction associated with the combination of effluent IDOD and BOD occurs about 34 hours after the wastewater release.

Table P-6
Farfield Dissolved Oxygen Depression Due to Discharged Wastewater
240 mgd PLOO Discharge

Date		S_a	DO (mg/L)		Farfield ΔDO (%)	Elapsed Time[1] to ΔDO (hrs)	Subsequent Dilution[1]
			DO_t	ΔDO			
1990	Mar. 7	287	5.37	0.10	1.9	34.5	2.14
	Apr. 17	253	4.78	0.11	2.4	35.5	2.18
	May 23	230	4.47	0.13	2.8	35.5	2.18
	Jun. 20	355	5.60	0.08	1.5	34.5	2.14
	Jul. 25	238	5.20	0.12	2.4	35.0	2.16
	Aug. 29	416	6.08	0.07	1.2	34.0	2.11
	Sept. 27	409	4.68	0.07	1.5	35.5	2.18
1991	Jan. 26	275	7.15	0.11	1.5	32.0	2.02
	Feb. 7	212	5.83	0.14	2.4	34.0	2.11
	Mar. 7	260	5.00	0.11	2.2	35.0	2.16
	Apr. 7	258	5.18	0.11	2.2	35.0	2.16

[1] At time of maximum DO depression.

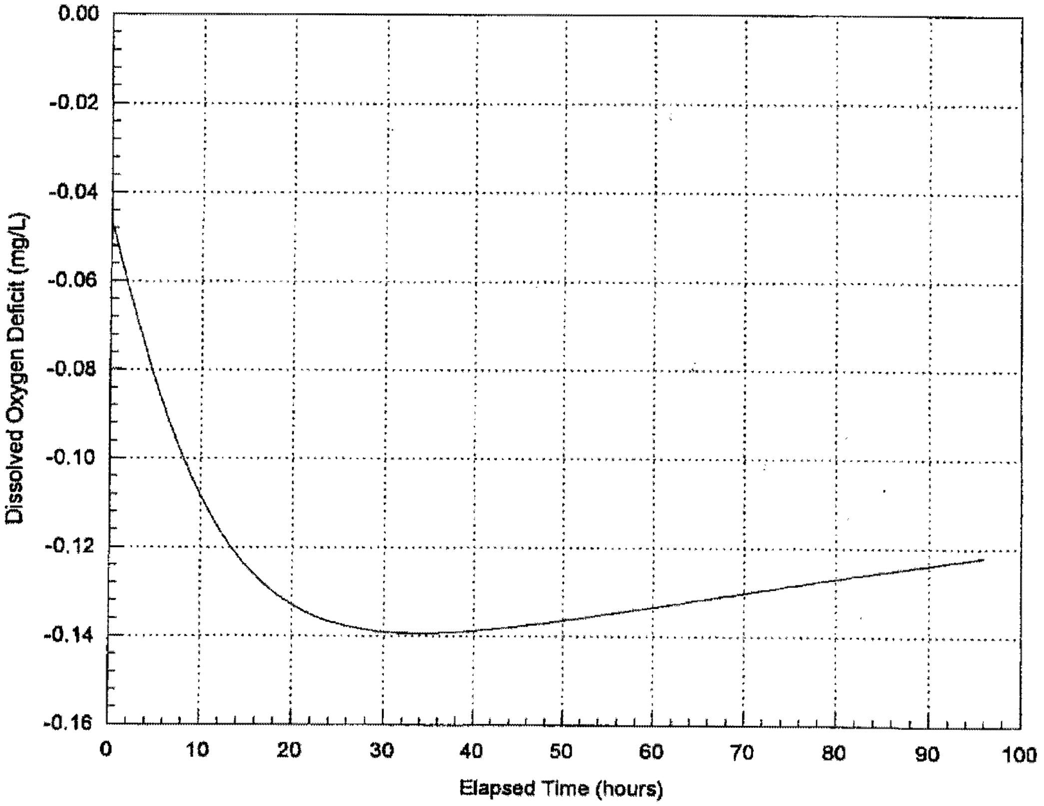


Figure P-2 Computed DO Depression vs. Time
Critical DO Depression Conditions (February 7, 1991)

P.4 ALTERNATIVE APPROACH

In order to demonstrate that there is always enough initial dilution, we have calculated the minimum dilution required to meet the Ocean Plan standards for DO. To find the minimum allowable initial dilution for each month, a hypothetical case assuming a peak dissolved oxygen depression of 10 percent was used in conjunction with the historical low reading of DO in the ambient water at the wastefield depth.

Table P-7 (page P-18) summarizes the lowest allowable initial dilutions for each of the input data points (e.g. January, February, etc.) that could cause receiving water DO concentrations to be depressed by 10 percent at a PLOO flow of 240 mgd. Actual minimum PLOO initial dilutions are significantly in excess of these computed "threshold" dilutions required to cause a 10 percent DO reduction.

Table P-7
Initial Dilutions Required to Cause DO Levels to be Depressed by 10 Percent

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.
DO_t	3.80	3.60	3.50	2.82	3.25	2.99	3.88	2.66	3.98
S_a(min)	76	80	82	100	88	95	74	106	72

[1] Calculations based on a hypothetical 10 percent depression of DO_t and no any plume calculations.

P.5 DISCUSSION

The regulatory initial dilution values attainable by the PLOO discharge are presented in Table P-4. These values are in excess of the minimum dilutions allowable in Table P-6. This demonstrates that the PLOO is well within the Ocean Plan maximum DO depression limit of 10 percent. Moreover, these projected depressions are based on the following compounding conservative assumptions:

- the lowest historical dissolved oxygen for the month,
- a Point Loma effluent BOD_5 concentration of 121 mg/l was used in the calculation, a value approximately 20 percent higher than the current (year 2006) average effluent BOD concentration of 102 mg/l.
- The nitrogen-BOD/total BOD ratio used in the calculation is at the lower limit of its range. (The average and median ratios were substantially larger than used in the simulations: approximately 12 percent versus 2.2 percent.)
- a DO of 0.0 mg/l was assumed for the effluent in lieu of the higher values typical in the PLOO effluent,
- an IDOD value of 4 mg/l was conservatively used based on EPA suggested values, in lieu of actual measured Point Loma WTP IDOD values which ranged from 0.45 to 1.74 mg/l.
- maximum ambient water temperatures were used in computing decay rates (assuming the higher temperatures increase the decay rate and hence the DO reduction).

It is unlikely that all these conditions will exist at the same time. Because the initial dilution levels achieved by this outfall far exceed the values shown in Table P-6, it is overwhelmingly evident that the farfield DO depression due to the discharge meets that Ocean Plan standards at all times with a substantial margin of safety.

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Appendix Q

ROV Inspection of Discharge Zone

ROV Photo Surveys, Pt Loma Outfall Area

(5 November 2007)

Four transcects, 3 near the outfall and one station to the North

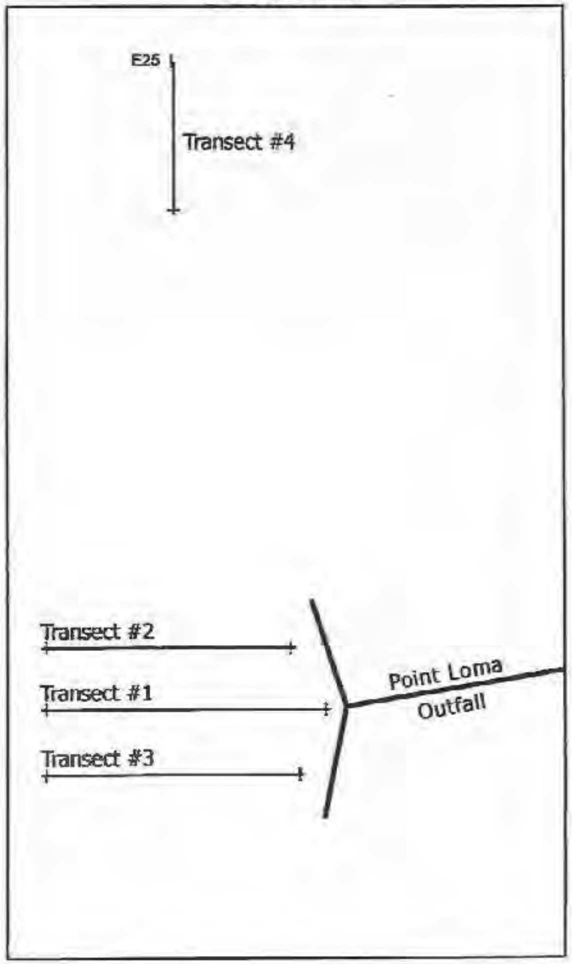
- 3 transects near the outfall; 1 transect near station E25;
- Distances = estimates based upon sonar returns;
- Images = video screen captures.

1. Transect #1: Center of outfall "wye" westward
   - Transition from bedding rock to soft bottom began ~600 ft west of Mixing Box;
   - There was some form of bedding rock along the entire distance.
2. Transect #2: North diffuser leg westward
   - Transect ~500 ft north of center "wye" from diffuser leg to ~300 ft west;
   - Bedding rock began ~100 ft from diffuser leg.
3. Transect #3; South diffuser leg eastward
   - Transect ~500 ft south of center "wye" from diffuser leg to ~300 ft east;
   - Bedding rock began ~100 ft from diffuser leg.
4. Transect # 4: Station E25
   - Transect near E25 running somewhat along a north to south heading;
   - Distances between images difficult to estimate, but 50 ft is probably close.

Results of visual Inspection

1. Bottom visual characteristics show outfall biota similar to reference transect
2. Bedding rock deposited for outfall foundation still visible after 14 years of discharge confirms that sediment is not building up.

Transect Diagram
Not to scale



PLOO "Center of Wye" Transect

Seafloor just west of mixing box

PLOO “Center of Wye” Transect

Seafloor ~100 ft west of mixing box

PLOO "Center of Wye" Transect

Seafloor ~135 ft west of mixing box

PLOO "Center of Wye" Transect

Seafloor ~180 ft west of mixing box

PLOO "Center of Wye" Transect

Seafloor ~300 ft west of mixing box

PLOO “Center of Wye” Transect

Seafloor ~400 ft west of mixing box

PLOO "Center of Wye" Transect

Seafloor ~500 ft west of mixing box

PLOO "Center of Wye" Transect

Seafloor ~600 ft west of mixing box

PLOO "North Diffuser Leg" Transect

(~500 ft north of mixing box)

Seafloor just west of diffuser leg

PLOO "North Diffuser Leg" Transect

(~500 ft north of mixing box)

Seafloor ~75 ft west of diffuser leg

PLOO "North Diffuser Leg" Transect

(~500 ft north of mixing box)

Seafloor ~120 ft west of diffuser leg

PLOO "North Diffuser Leg" Transect

(~500 ft north of mixing box)

Seafloor ~225 ft west of diffuser leg

PLOO "North Diffuser Leg" Transect

(~500 ft north of mixing box)

Seafloor ~300 ft west of diffuser leg

PLOO "South Diffuser Leg" Transect

(~500 ft south of mixing box)

Seafloor just east of diffuser leg

PLOO "South Diffuser Leg" Transect

(~500 ft south of mixing box)

Seafloor ~120 ft east of diffuser leg

PLOO "South Diffuser Leg" Transect

(~500 ft south of mixing box)

Seafloor ~150 ft east of diffuser leg

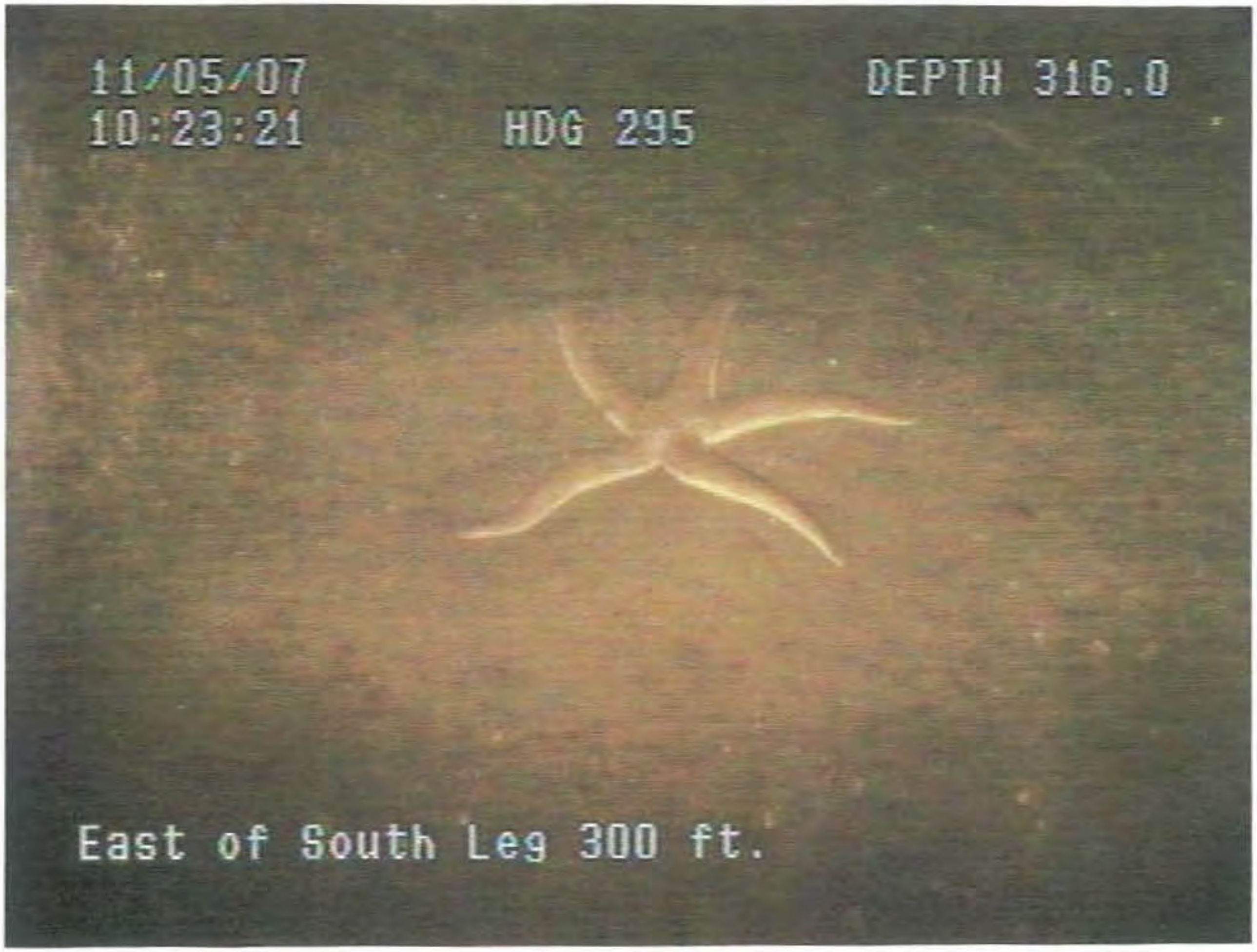
PLOO "South Diffuser Leg" Transect

(~500 ft south of mixing box)

Seafloor ~225 ft east of diffuser leg

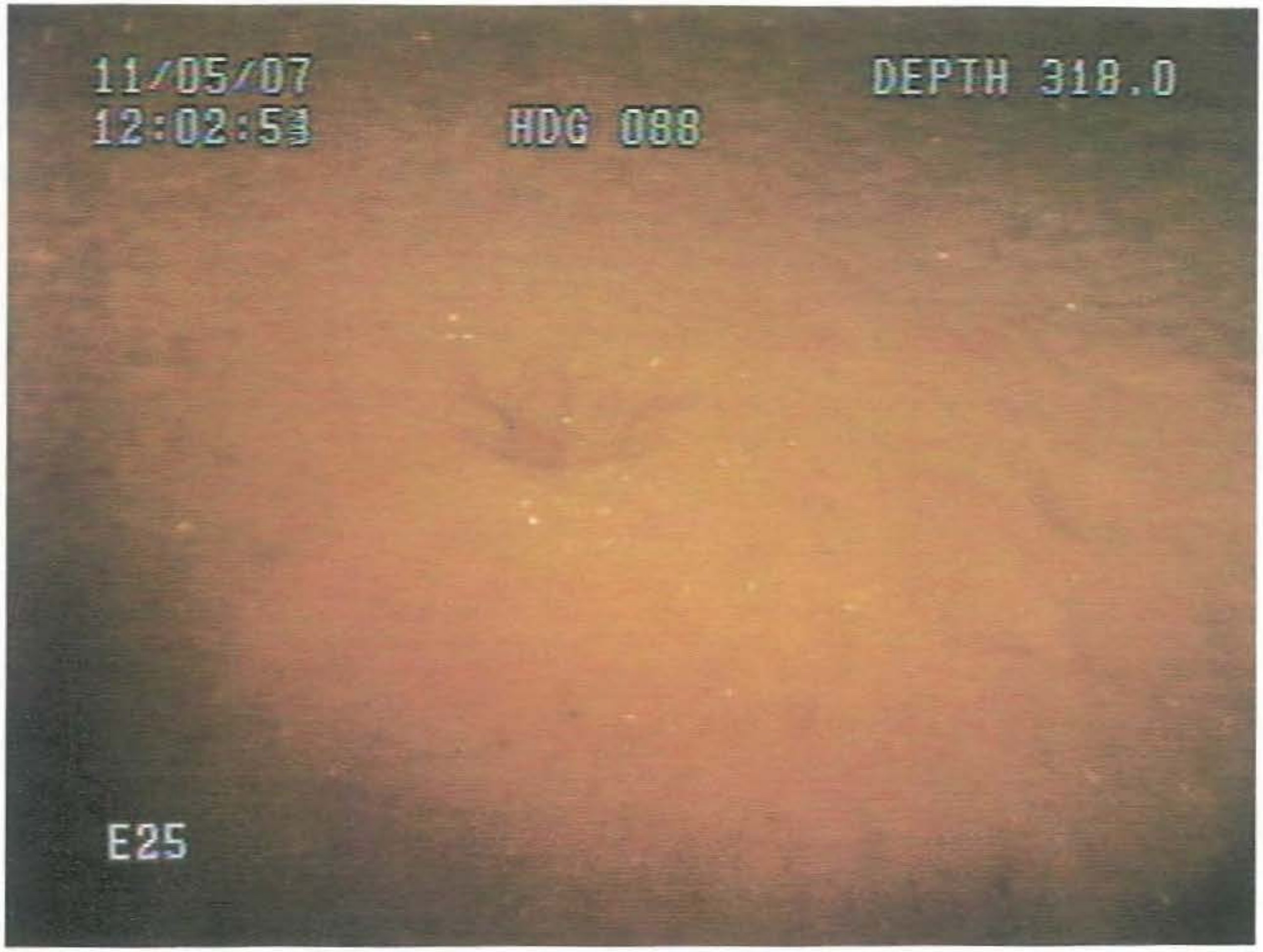
PLOO “South Diffuser Leg” Transect

(~500 ft south of mixing box)



Seafloor ~300 ft east of diffuser leg

PLOO Station E25 Transect



Seafloor on N-S heading near station E25
(successive images estimated 50 ft apart)

PLOO Station E25 Transect

Seafloor on N-S heading near station E25
(successive images estimated 50 ft apart)

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Appendix R

Analysis of Ammonia

APPENDIX R

ANALYSIS OF AMMONIA

Table of Contents

List of Tables

APPENDIX R

ANALYSIS OF AMMONIA

ABSTRACT

This appendix estimates receiving water ammonia-nitrogen concentrations for discharge of treated wastewater from the Point Loma Wastewater Treatment Plant (Point Loma WTP) to the ocean via the Point Loma Ocean Outfall (PLOO). Receiving water ammonia concentrations are computed on the basis of Point Loma WTP effluent ammonia concentrations and PLOO initial dilution rates assigned in the Point Loma WTP NPDES permit (Regional Board Order No. R9-2002-0025, NPDES CA0107409).

A maximum day receiving water ammonia concentration of 0.18 mg/l is projected upon completion of initial dilution. A maximum month receiving water ammonia-nitrogen concentration of 0.16 mg/l is projected. These projected receiving water concentrations are significantly below standards established in the California Ocean Plan. The concentrations are also significantly below federal water quality criteria for ammonia-nitrogen in saltwater.

PLOO mass emissions of ammonia-nitrogen are less than mass emission benchmark values established in Order No. R9-2002-0025.

R.1 INTRODUCTION

Ammonia is a common constituent of wastewater formed by the biological degradation of proteins and urea. It typically occurs in primary and secondary treated wastewater at concentrations on the order of 25-35 mg/l (as total ammonia-nitrogen - NH_4^+-N and NH^3-N). (Secondary treatment employing a nitrification process can reduce effluent ammonia concentrations from these levels.) Ammonia can also be contributed by industry, through the use of ammonia as a means of neutralizing low pH industrial discharges.

Ambient or background levels of ammonia in seawater in Southern California have been shown to range from zero to 0.014 mg/l as ammonium (NH_4^+) (Eppley, et al., 1979). Ammonia is an essential macronutrient, but in higher concentrations, ammonia can be toxic. Ammonia is readily nitrified in oxygenated waters, and is not bioaccumulated, bioconcentrated, or biomagnified.

R.2 AMMONIA SPECIATION

The speciation of total ammonia between its ionized (NH_4^+) and un-ionized (NH_3) forms is a major factor to be considered in analyzing the potential effects of ammonia discharge on the marine environment. For clarity, the term "ionized ammonia" is used herein to describe the compound NH_4^+, and the term un-ionized ammonia is used to describe NH_3. Ammonia is considerably more toxic to aquatic organisms in its un-ionized (NH_3) form. Because NH_3 is lipid soluble and uncharged, it rapidly permeates cell membranes, particularly the gills of fish. Equilibrium between ammonia species is governed by the following expression:

$$NH_4^- + OH^- \leftrightarrow NH_3 + H_2O$$

The effects of pH, temperature, and salinity (ionic strength) on this relationship are well studied documented in chemistry and solubility textbooks. At a given ammonia concentration, the un-ionized concentration or percentage that has dissociated will decrease with decreasing pH, decreasing temperature and increasing salinity. Since the salinity and pH are relatively constant in seawater, temperature becomes an important consideration in defining the un-ionized fraction of ammonia.

Although total ammonia concentration ($NH_3 + NH_4^+$) can be determined analytically in a number of ways, there exists no direct method for measuring NH_3. As a result, un-ionized ammonia concentrations are normally calculated from simultaneous measurements of total ammonia, pH, temperature, and salinity. Numerous researchers have addressed ammonia equilibrium and solubility relations in seawater. Research addressing salinity, pH, and temperature effects on ammonia equilibrium in seawater has, in part, included:

1. Whitfield (1974) reported on a precise and detailed evaluation of the effects of pH, temperature, and salinity on the speciation of ammonia.
2. Bower and Bidwell (1978) tabulated the ammonium dissociation constant (pK_a) versus temperature and pH for various salinities on the basis of Whitfield's results.

3. Johannson and Wedborg (1979) assessed the ammonium dissociation constant (pK_a) versus pH for a range of seawater concentrations.
4. Skarheim (1973) tabulated values for the un-ionized fraction of total ammonia under equilibrium conditions corresponding to a range of environmental circumstances.

Over the range of values of pH, temperature, and ionic strength normally encountered in natural aquatic environs, equilibrium considerations dictate that ammonium ion (NH_4^+) will be the dominant ammonia species present in terms of concentration. Although un-ionized ammonia is favored by high pH, high temperature, and low ionic strength, relative dominance of NH_4^+ is a virtual certainty in well buffered, constant salinity systems (such as open seawater) in which wastewater constituents are rapidly dispersed. For salinity concentrations of 30 grams per kilogram, un-ionized ammonia typically constitutes less than 4 percent of the total ammonia. (Un-ionized ammonia comprises even less of the total ammonia in Point Loma seawater, which typically has a salinity ranging from 33 to 35 g/kg.)

R.3 FEDERAL WATER QUALITY CRITERIA

EPA published federal water quality criteria in *2002 National Recommended Water Quality Criteria* (EPA-822-R-02-047) and in *2003 Revised Human Health Water Quality Criteria* (RPA-822-F-03-012). EPA maintains a list of updated federal water quality criteria at: http://www.epa.gov/waterscience/criteria/wqcriteria.html. EPA saltwater ammonia criteria are set forth in *Ambient Water Quality Criteria for Ammonia (Saltwater)*, (U.S. EPA 440/5-88-004, 1989). Recognizing the pH- and temperature-dependent effects on ammonia speciation, EPA ammonia criteria for saltwater are pH, salinity, and temperature dependent.

Table R-1 (page R-4) summarizes receiving water pH and temperature in the immediate vicinity of the PLOO diffuser (Stations F29, F30, and F31). As shown in the table, pH values typically range from 8.0 to 8.2 pH units at subsurface depths (10-20 m) and from 7.6 to 7.9 in deep waters (greater than 88 meters). Receiving water temperature varies with season, but can range from roughly 10 to 15 °C in subsurface waters.

Table R-2 (page R-4) presents pH- and temperature-dependent EPA criteria for total ammonia in salt water for the range of pH and temperature expected in the PLOO discharge zone. On the basis of the PLOO receiving water data, a pH of 8.2 and water temperature of 15 °C represents the most critical expected receiving water conditions. At this pH and temperature, the corresponding ammonia-nitrogen receiving water criteria are 6.7 mg/l (maximum) and 1.0 mg/l (30-day average).

Table R-1
Temperature and pH in the PLOO Discharge Zone, 1995-2006[1]

Data Period	Season	pH		Temperature °C	
		10-20 m Depth	Depths > 88m	10-20 m Depth	Depths > 88 m
2006	January	8.1	7.8	15.0	10.2
	April	8.1	7.7	13.1	9.5
	July	8.1	7.8	14.5	10.5
	October	8.2	7.9	15.3	11.0
1995-2005	January	8.1	7.8	10.2	11.4
	April	8.0	7.7	9.5	9.8
	July	8.0	7.6	10.5	10.2
	October	8.1	7.8	11.0	11.6

1 Data from City of San Diego annual receiving water report (City of San Diego, 2006).

Table R-2
EPA Ambient Saltwater Criteria for Ammonia-Nitrogen[1]
(Criteria for Salinity of 30g salt /kg water)

Period	pH	Ammonia Concentration Criteria[1,2] (mg/l NH_3-N)		
		10° C	15° C	20° C.
Maximum Value	7.6	37	25	21
	7.8	23	16	11
	8.0	15	10	7.3
	8.2	9.6	6.7	4.6
30-Day Average Value	7.6	5.6	3.7	3.1
	7.8	3.4	2.4	1.7
	8.0	2.2	1.6	1.1
	8.2	1.4	1.0	0.69

1 From U.S. Environmental Protection Agency, *Ambient Water Quality Criteria for Ammonia (Saltwater)*, 1989. Criteria are listed for the range of pH and temperatures common to the Point Loma extended outfall waste field. Ammonia criteria become more relaxed with increasing salinity. The typical ocean salinity near San Diego is approximately 33 to 35 g/kg, so the above values based on a 30 g/kg salinity are conservative.

2 The above water quality criteria are not enforceable standards, but are presented by EPA as guidance to States and Tribes in developing enforceable water quality standards.

R.4 CALIFORNIA OCEAN PLAN STANDARDS

Ammonia discharges in California are regulated under provisions of the *California Ocean Plan* (Ocean Plan). The Ocean Plan was most recently updated in 2005. Ocean Plan standards for ammonia are presented in Table R-3.

Table R-3
California Ocean Plan Standards for Ammonia-Nitrogen

Period	Ocean Plan Concentration Standard for Total Ammonia Nitrogen Receiving Waters
6-Month Average	0.6 mg/l
Daily Maximum	2.4 mg/l
Instantaneous Maximum	6.0 mg/l

R.5 COMPLIANCE WITH STANDARDS AND CRITERIA

PLOO Effluent Quality. Table R-4 (page R-6) presents monthly average effluent concentrations for total ammonia-nitrogen in the Point Loma effluent during 2006. Point Loma WTP effluent ammonia-nitrogen during 2006 averaged 30.7 mg/l, and ranged from a daily maximum of 36.7 mg/l to a daily minimum of 28.0 during the year.

Projected Receiving Water Quality. The effluent total ammonia-nitrogen concentrations presented in Table R-4 can be combined with projected initial dilutions from the PLOO to estimate receiving water ammonia-nitrogen concentrations at the edge of the zone of initial dilution (ZID) upon completion of initial dilution.

Order No. R9-2002-0025 assigns a minimum month initial dilution of 204:1 to the PLOO. Using this minimum month initial dilution, Table R-5 (page R-6) presents estimated receiving water ammonia-nitrogen concentrations in the ZID for maximum day and maximum month conditions. As shown in Table R-5, a maximum day ammonia-nitrogen receiving water concentration of 0.18 mg/l is projected upon completion of initial dilution. A maximum month ammonia-nitrogen receiving water concentration of 0.16 mg/l is projected. It should be noted that these projected maximum day and maximum month receiving water concentrations are conservative, and are based on the simultaneous occurrence of (1) critical initial dilution, and (2) maximum Point Loma WTP effluent concentrations.

Table R-4
Point Loma WTP Influent and Effluent Ammonia-Nitrogen Concentrations During 2006

Month	Point Loma WTP Effluent Ammonia-Nitrogen Concentration (mg/l as N)		
	Monthly Average	Maximum Day	Minimum Day
Jan	29.5	30.5	28.3
Feb	32.3	36.7	29.7
Mar	31.1	32.5	29.4
Apr	30.4	31.9	28.8
May	30.3	31.1	29.1
Jun	29.3	30.5	28.3
Jul	30.1	30.5	28.8
Aug	30.5	31.4	30.2
Sep	30.4	31.4	29.7
Oct	30.6	32.8	28.0
Nov	30.9	31.4	30.2
Dec	32.6	33.9	31.1
Average	30.7	---	---
Minimum Value	29.5	---	28.0
Maximum Value	32.6	36.7	---

1 Data from annual and monthly monitoring reports submitted by the City to the Regional Board during 2006.

Table R-5
Projected Ammonia-Nitrogen Receiving Water Concentrations Upon Completion of Initial Dilution

Parameter	Units	Maximum Month	Maximum Day
Point Loma Effluent Ammonia-Nitrogen Concentration	mg/l (as N)	32.6[1]	36.7[1]
Initial Dilution at 240 mgd flow[1]	--	204:1[2]	204:1[2]
Projected Receiving Water Ammonia-Nitrogen Concentration	mg/l (as N)	0.16[3]	0.18[3]
Ocean Plan Ammonia-Nitrogen Standard	mg/l (as N)	0.60[4]	2.4[5]

1 Maximum day and maximum monthly average value from Table R-4 on page R-5.

2 Minimum month initial dilution assigned in Order No. R9-2002-0025 for purposes of determining compliance with criteria for the protection of aquatic life.

3 Computed receiving water concentration at the edge of the ZID upon completion of initial dilution.

4 The Ocean Plan does not have a maximum month standard for ammonia. The listed value is the 6-month average value.

5 The Ocean Plan establishes a daily maximum ammonia-nitrogen receiving water standard (to be achieved upon completion of initial dilution) of 2.4 mg/l, and a maximum instantaneous ammonia-nitrogen receiving water standard of 6.0 mg/l. (See Table R-3 on page R-5.)

Ocean Plan Compliance. As shown in Table R-5, the maximum day total ammonia-nitrogen concentration in the Point Loma ZID of 0.18 mg/ is more than an order of magnitude less than the 2.4 mg/l Ocean Plan daily maximum standard.

The projected maximum month ammonia-nitrogen receiving water concentration of 0.16 mg/l is approximately a factor of four less than the Ocean Plan six-month average receiving water standard for ammonia-nitrogen of 0.6 mg/l. This factor of four compliance margin is significant; as shown in Table R-4, monthly average Point Loma WTP effluent concentrations of ammonia typically vary 10 percent or less from the mean.

In summary, receiving water within the Point Loma ZID is projected to contain concentrations of ammonia significantly below the Ocean Plan standards. Ammonia concentrations will further be reduced after initial dilution, due to the following:

1. dilution and dispersion as the plume is advectively transported by ambient currents,
2. oxidation (via nitrification) of ammonia to nitrite and/or nitrate, and
3. biological assimilation by marine algae (phytoplankton).

Conformance with Federal Water Quality Criteria. As shown in Table R-2 (page R-4), federal water quality criteria for ammonia-nitrogen are dependent on salinity, pH, and temperature. The maximum day projected PLOO receiving water concentration of 0.18 mg/l is significantly below corresponding federal water quality criteria for all anticipated ranges of receiving water temperature and salinity.

PLOO receiving water data (see Table R-1 on page R-4) indicate that a receiving water pH of 8.2 and temperature of 15 °C represent "worst case" conditions for un-ionized ammonia dissociation. Under these pH and temperature conditions, the corresponding 30-day average ammonia-nitrogen criterion is 1.0 mg/l. The projected PLOO maximum month receiving water ammonia-nitrogen concentration of 0.16 mg/l is approximately a factor of six less than this criterion.

The PLOO discharge is projected to comply with federal water quality criteria for ammonia in saltwater by a significant margin in all anticipated receiving water pH, salinity, and temperature conditions.

R.6 AMMONIA MASS EMISSIONS

Table R-6 summarizes PLOO mass emissions during 2002-2006. As shown in Table R-6, PLOO total ammonia-nitrogen mass emissions averaged 6,740 metric tons per year during 2002-2006.

Order No. R9-2002-2025 establishes non-enforceable mass emission benchmarks based on PLOO mass emissions that occurred during 1990-1995. Order No. R9-2002-2025 establishes a total ammonia benchmark of 8,018 metric tons per year. Mass emissions of ammonia in the PLOO discharge have been consistently less than this benchmark level, indicating that current mass emissions have not increased from the 1990-1995 reference period.

Table R-6
PLOO Ammonia-Nitrogen Mass Emissions

Year	Ammonia-Nitrogen Mass Emissions	
	Metric tons/year	lbs/day
2002	6,487	41,360
2003	6,495	39,240
2004	6,579	39,740
2005	6,956	42,020
2006	7,202	43,510
Average 2002-2006	6,740	40,740
Mass Emission Benchmark of Order No. R9-2002-0025	8,018	48,440

1 Mass emission standard for ammonia-nitrogen within Order No. R9-2002-0025 (NPDES CA0107409).

R.7 CONCLUSIONS

The discharge of ammonia-nitrogen from the PLOO does not result in toxic concentrations of un-ionized ammonia in the receiving waters. Maximum computed receiving water concentrations of ammonia-nitrogen are projected to be less than applicable Ocean Plan standards by approximately a factor of four, and less than applicable federal water quality criteria by a factor of six. PLOO mass emissions of ammonia-nitrogen remain below benchmark mass emission levels established in Order No. R9-2002-0025.

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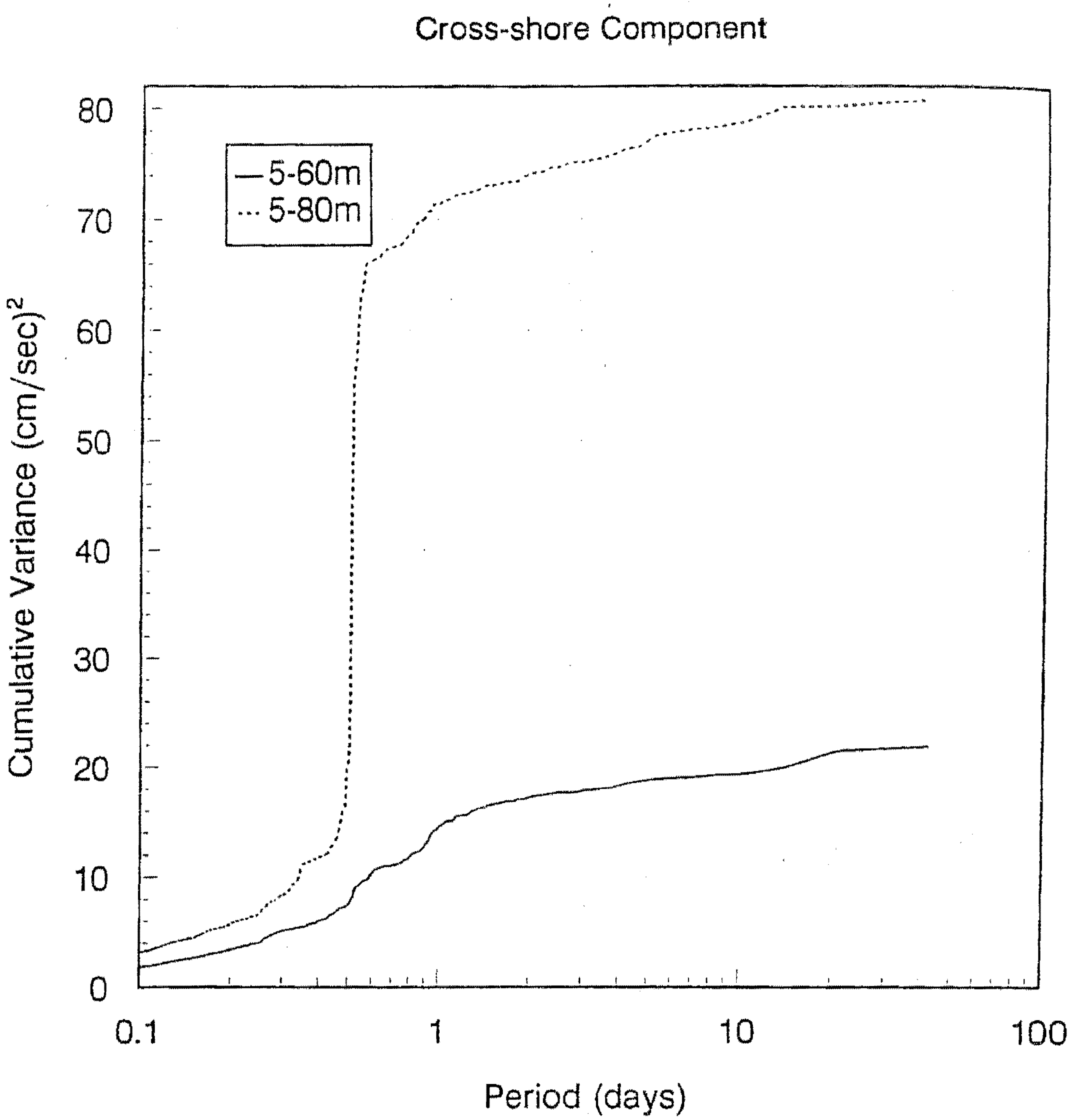
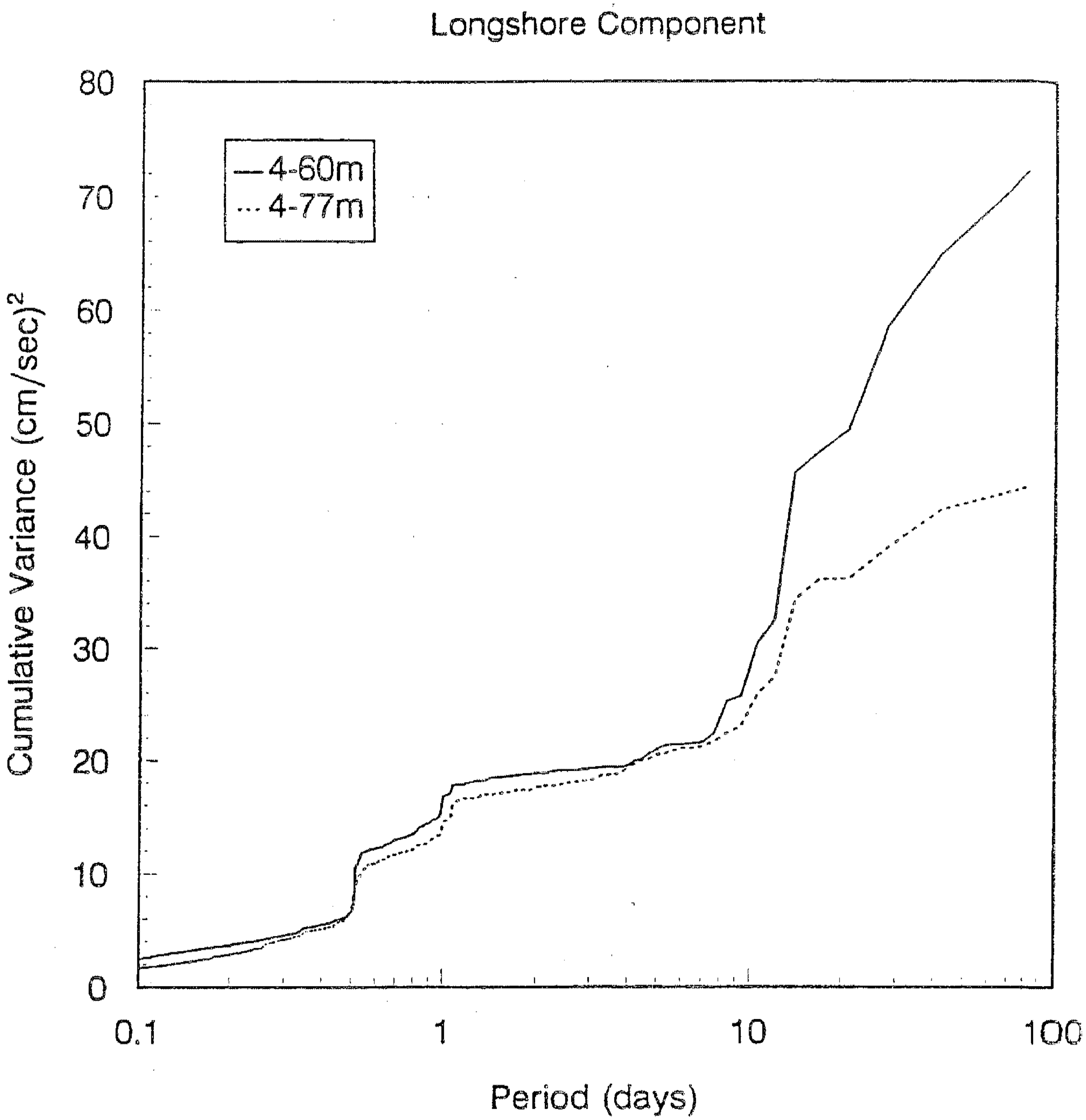
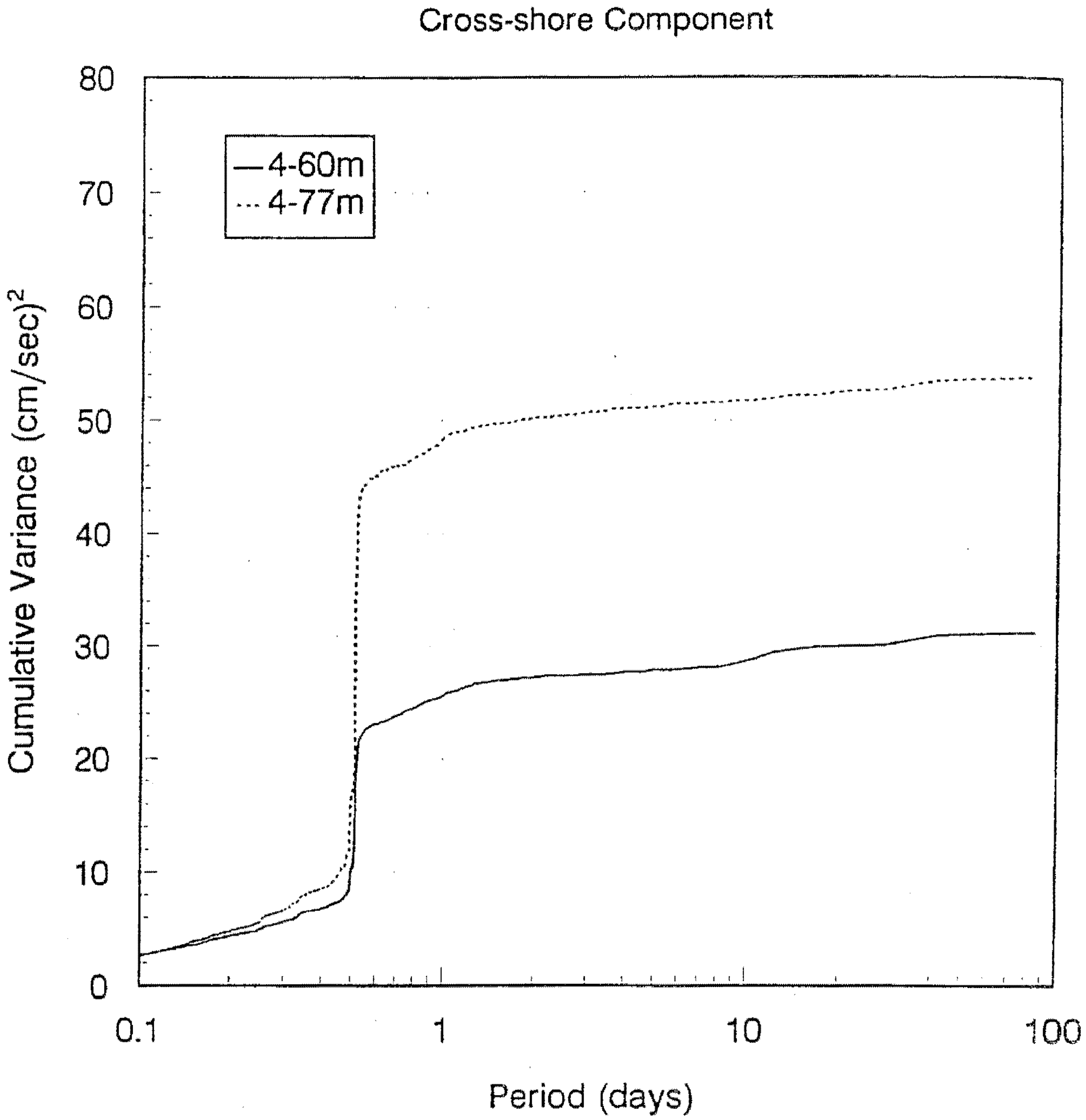
Figure IV-30



VARIATIONS IN THE CROSS-SHORE COMPONENTS OF FLOW
(MOORING C5: 60M & 80M; WINTER 1990)



VARIATIONS IN THE LONGSHORE COMPONENTS OF FLOW
(MOORING C4: 60M & 77M; SPRING 1990)



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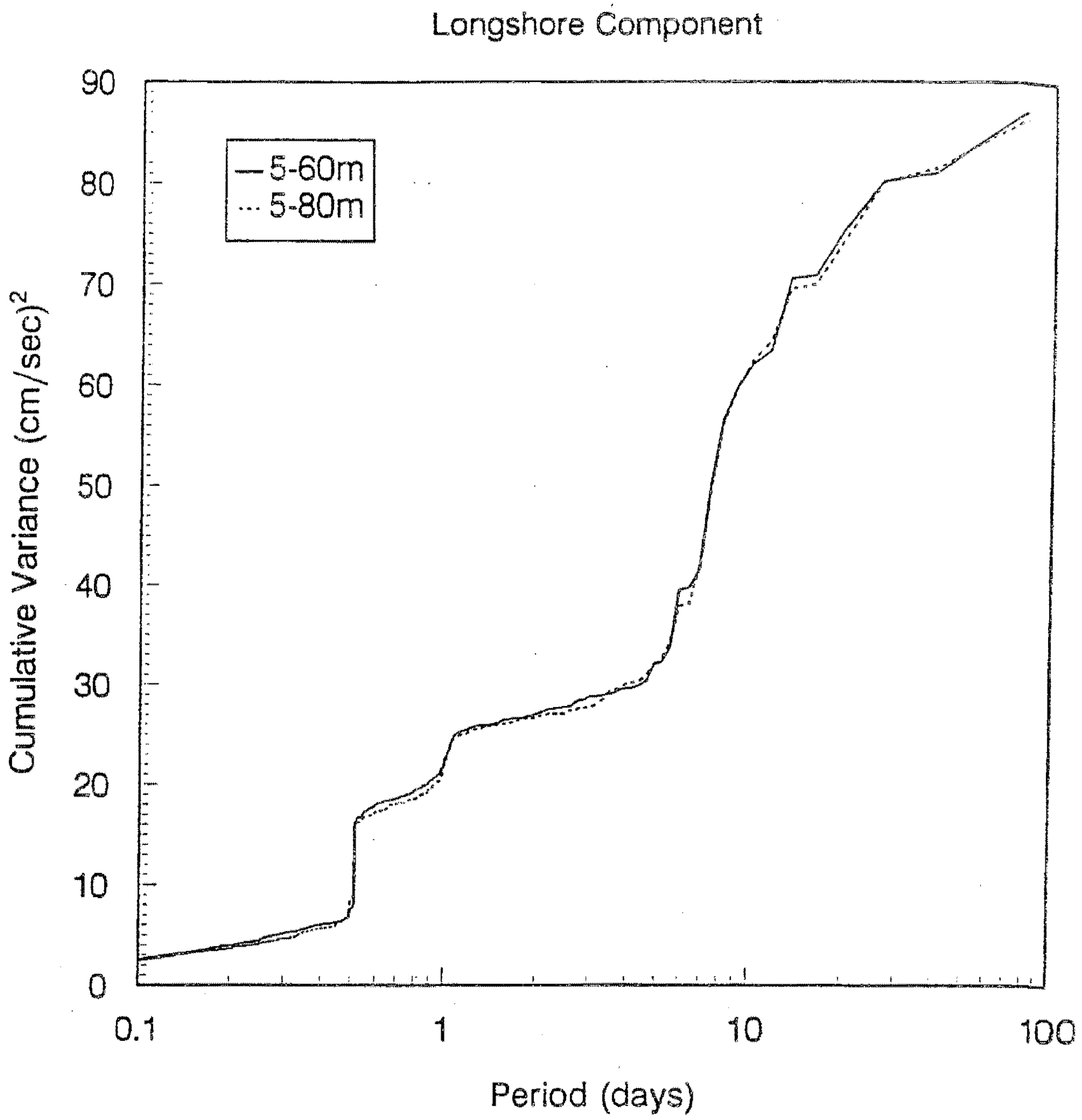

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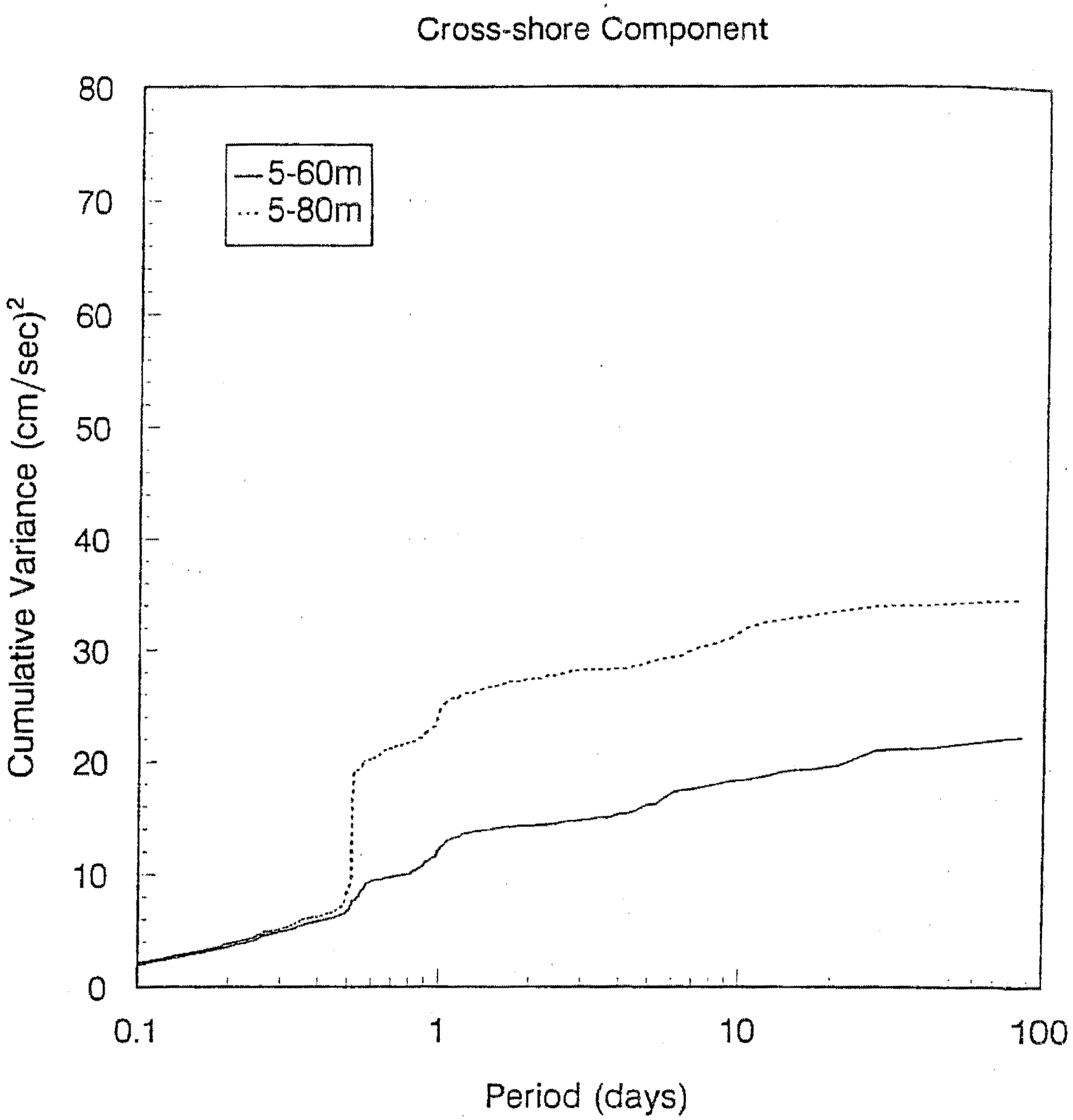
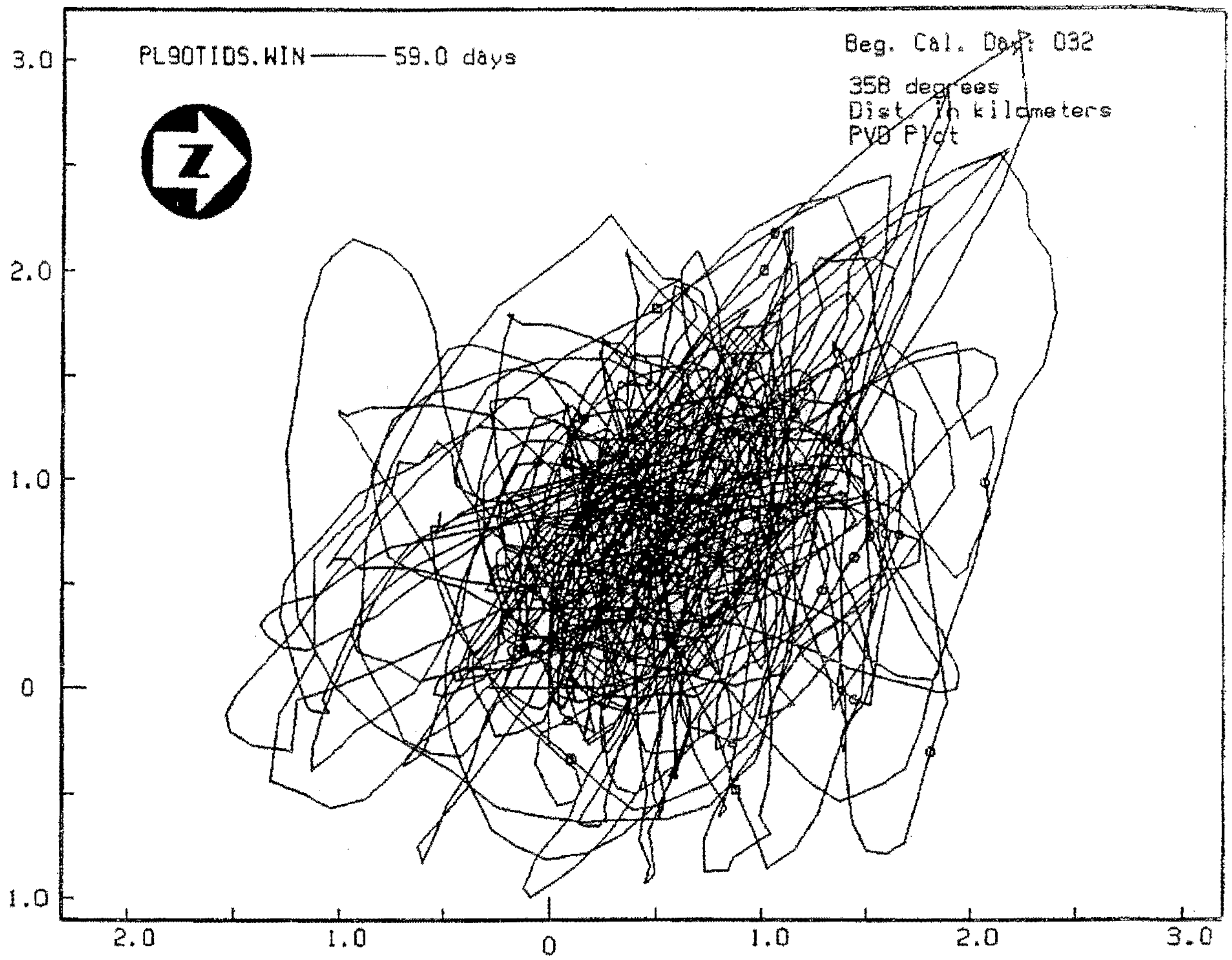
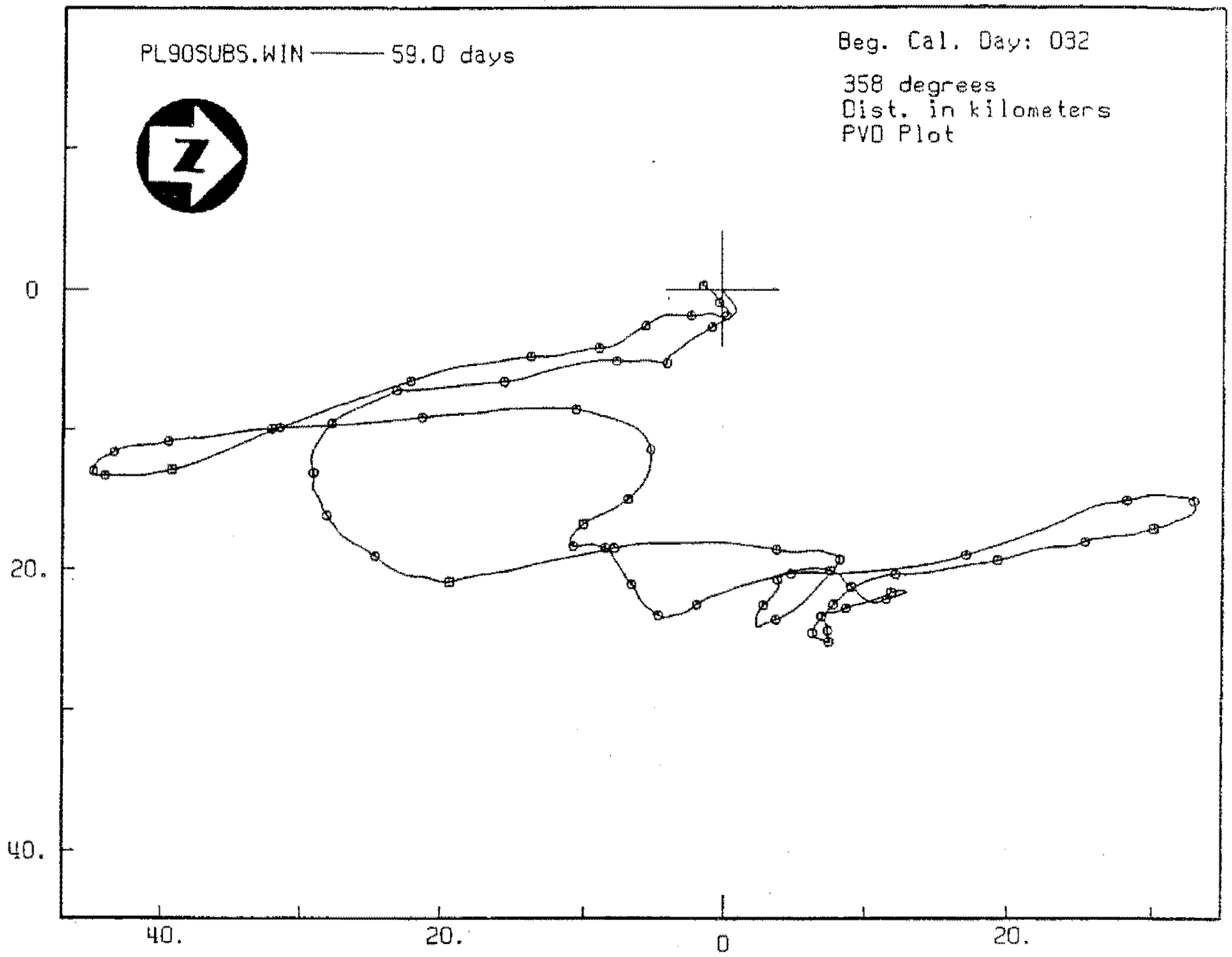


VARIATIONS IN THE CROSS-SHORE COMPONENTS OF FLOW
(MOORING C5: 60M & 80M; SUMMER 1990)

Figure N-43



CURRENT TRAJECTORY FOR TIDAL AND SUPERTIDAL
FREQUENCY BAND FLUCTUATIONS
(NET CURRENT AND SUBTIDAL FREQUENCY
FLUCTUATIONS HAVE BEEN REMOVED)



CURRENT TRAJECTORY FOR SUBTIDAL
FREQUENCY BAND FLUCTUATIONS
(NET CURRENT, TIDAL, AND SUPERTIDAL
FREQUENCY FLUCTUATIONS HAVE BEEN REMOVED)

SUB-APPENDIX NS1

POINT LOMA OUTFALL EXTENSION OCEAN MEASUREMENT PROGRAM

The Ocean Measurement Program for the Point Loma Ocean Plan Compliance Program was conducted between January 31, and September 26, 1990. Additional supplemental current, temperature, and water quality measurements were taken between September 26 and October 30, 1990, and between January 8 and April 26, 1991. The measurement program included current and temperature measurements, water quality profiles, biological studies, and bacterial disappearance studies.

The following table summarizes the continuous temperature and current meter sampling program. A complete description of the Point Loma Outfall Extension Ocean Measurement Program is presented in Volume I of the Point Loma Outfall Extension Report prepared for the City of San Diego (April 1991). Data taken after September 26, 1990, is presented in a supplemental document titled "Point Loma Outfall Extension, Ocean Measurement Program, Supplemental Data Report" (December 1991).

Table NS1-1

PT. LOMA OUTFALL EXTENSION
CURRENT METER DEPTHS AND COORDINATES

Station	Latitude	Longitude	Station Depth (m)	Current Meter	Meter Depths (m)	Deployment
C1	32°41.02'N	117°16.08'W	20.7	1	15.0 - 18.8	01/31/90-09/26/90
C2	32°40.55'N	117°16.42'W	56.1	1	19.0 - 20.0	01/31/90-09/26/90
				2	39.0 - 40.0	01/31/90-09/26/90
				3	51.0 - 52.0	01/31/90-09/26/90
C3	32°40.45'N	117°17.23'W	68.9	1	19.0 - 21.0	01/31/90-09/26/90
				2	39.0 - 41.0	01/31/90-09/26/90
				3	59.0 - 61.0	01/31/90-09/26/90
C4	32°40.33'N	117°18.15'W	81.1	1	19.2 - 20.7	01/31/90-09/26/90
				2	39.2 - 40.7	01/31/90-09/26/90
				3	59.0 - 60.7	01/31/90-10/30/90 & 01/08/91-04/26/91
				4	76.0 - 77.7	01/31/90-10/30/90 & 01/08/91-04/26/91
C5	32°40.18'N	117°19.18'W	96.0	1	18.8 - 19.9	01/31/90-09/26/90
				2	38.8 - 39.9	01/31/90-09/26/90
				3	58.6 - 60.4	01/31/90-10/30/90 & 01/08/91-04/26/91
				4	78.6 - 80.4	01/31/90-10/30/90 & 01/08/91-04/26/91
C6	32°41.53'N	117°17.02'W	56.7	1	17.9 - 20.1	01/31/90-09/26/90
				2	49.9 - 52.1	01/31/90-09/26/90
C7	32°41.31'N	117°18.34'W	80.5	1	18.4 - 20.7	01/31/90-09/26/90
				2	75.4 - 77.7	01/31/90-09/26/90

PLCMLOC.WK4(ajs)

SUB-APPENDIX NS2

CURRENT SPEED AND DIRECTION PROBABILITIES

Lists and matricies of the distributional probabilities of the seasonal currents at moorings C4 and C5 are provided. Each meter and season is represented by a set consisting of three pages. The first page lists the distribution of current speeds, in cm/sec, for a specific mooring, current meter depth, and season. For example, the label "PL90520S.WIN" near the top of the page indicates that the data was collected at Point Loma (PL) during 1990 (90) at mooring C5 (5) at a depth of 20m (20) and contains Speed/Direction information (S) for the winter season (WIN).

The cumulative probability listing contains the percentage of the observations that had speeds up to, and including, the indicated speed. For example, the values:

Speed	Cumulative Probability
1	00.14
2	00.49
etc.	:

would indicate that 0.14 percent of the observations had speeds up to, and including, 1 cm/sec; 0.49 percent had speeds up to, and including, 2 cm/sec, etc.

The average speed associated with each the flows by 10 degree sectors (true) are also listed. For example:

Direction	Average Speed
000-010	18.45
010-020	19.58
:	:

indicates that the average speed of the currents flowing between 000 degrees and 010 degrees is 18.45 cm/sec, etc.

The next page contains the directional probabilities of the flows by 10 degree sectors. For example:

Direction	Probabilities
1	0.06227
2	0.01168
:	:
36	0.06868

indicates that 6.2 percent of the flows are within a heading of 000 degrees (true) and a heading of 010 degrees ("1"). Another 1.17 percent are between 010 degrees and 020 degrees ("2"), and 6.9 percent are between 350 degrees and 360 degrees ("36").

The third and final page in the group contains the joint occurrence of a flow by speed (in 1 cm/sec increments) and direction of flow (in 10 degree sectors). The labeling convention is slightly different from that used on the first two pages. A direction of "11" still indicates a flow between a heading of 100 degrees (true) and 110 degrees. However, a speed of "11" indicates a current speed in the range from 11 cm/sec to < 12 cm/sec. The matrix elements contain the total number of observations corresponding to each speed-direction condition. The probability can be obtained by dividing the total number of observations (listed at the bottom of the page).

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:21:49


        PL90520S.WIN   2850


    Distributions
    -------------

        Spd  CumPrb        Dir     AvgSpd
        ---  ------      -------   ------
          1     .14       0- 10    18.45
          2     .49      10- 20    19.58
          3    1.68      20- 30    19.47
          4    3.54      30- 40    15.20
          5    6.07      40- 50    14.04
          6    9.05      50- 60    12.16
          7   12.60      60- 70    11.34
          8   16.14      70- 80    10.29
          9   20.46      80- 90    10.50
         10   24.00      90-100    11.07
         11   28.11     100-110    12.51
         12   32.63     110-120    10.78
         13   34.84     120-130    13.31
         14   39.65     130-140    14.54
         15   43.30     140-150    16.38
         16   47.79     150-160    17.32
         17   52.07     160-170    19.78
         18   56.39     170-180    21.71
         19   60.70     180-190    20.56
         20   64.63     190-200    23.43
         21   68.60     200-210    22.06
         22   72.11     210-220    17.90
         23   76.42     220-230    15.87
         24   80.07     230-240    14.94
         25   82.98     240-250    13.50
         26   85.61     250-260    13.74
         27   87.89     260-270     9.14
         28   89.40     270-280     8.82
         29   90.74     280-290     8.15
         30   92.21     290-300     8.07
         31   93.58     300-310     9.28
         32   94.81     310-320    10.11
         33   95.54     320-330    10.94
         34   96.46     330-340    14.78
         35   97.02     340-350    16.03
         36   97.54     350-360    17.46
         37   97.86
         38   98.14
         39   98.25
         40   98.74
         41   98.95
         42   99.16
         43   99.40
         44   99.44
         45   99.68
         46   99.82
         47   99.86
         48   99.93
         49   99.93
         50   99.96
         51   99.96
         52  100.00
```

spd	Direction																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	2	3	2	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
37:	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
34:	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	4	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
33:	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	3	3	7	2	1	3	0	1	0	0	0	0	0	0	0	0	0	0	0	1
32:	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	4	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	3
31:	2	0	2	0	0	1	0	0	0	0	0	0	0	0	3	2	0	5	4	3	3	2	1	0	1	0	0	0	0	0	0	0	0	2	0	4
30:	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	4	2	7	6	2	3	0	0	1	0	0	0	0	0	0	0	0	2	2	4
29:	0	0	1	0	0	0	1	0	1	0	0	0	0	2	0	2	4	5	9	6	3	1	0	0	1	0	0	0	0	0	0	0	0	2	2	2
28:	1	0	2	0	1	0	0	0	0	0	0	0	1	0	1	2	1	8	5	4	2	3	1	0	0	0	0	0	0	0	0	0	1	0	3	2
27:	6	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	7	4	2	3	8	2	0	0	0	0	0	0	0	0	0	0	0	1	0	4
26:	6	2	1	0	1	1	1	0	0	0	1	0	2	0	1	1	4	6	8	13	7	1	1	1	0	0	0	0	0	0	0	0	0	2	1	4
25:	4	2	5	3	1	1	1	0	1	0	0	2	1	1	3	2	6	8	7	7	4	4	2	1	0	0	0	0	0	0	0	2	1	2	2	2
24:	4	3	2	1	1	2	0	0	0	0	0	0	2	1	4	5	11	12	11	7	3	3	1	0	1	0	0	0	0	0	0	0	0	0	3	6
23:	8	1	3	2	0	3	0	1	0	0	0	0	5	2	2	6	5	10	12	15	4	6	5	0	0	0	0	0	0	0	0	0	0	4	3	7
22:	5	3	5	4	4	0	0	1	0	0	0	0	0	4	2	9	10	15	16	9	14	3	2	0	0	0	0	0	0	0	0	1	0	4	7	5
21:	11	1	4	4	2	0	3	0	0	3	0	1	2	2	2	5	4	3	13	9	5	7	1	2	1	0	0	1	0	0	0	0	0	5	5	4
20:	8	1	4	9	4	1	1	1	1	1	2	0	2	1	3	4	6	8	10	8	5	5	3	3	1	0	0	0	0	1	0	1	2	3	4	10
19:	10	1	4	5	1	1	3	1	0	1	1	1	1	3	7	9	5	8	10	10	2	3	1	0	0	0	0	1	0	0	1	0	1	6	8	7
18:	5	1	2	4	1	0	4	2	1	1	1	2	2	1	5	3	7	5	23	6	10	4	2	3	2	0	0	0	0	0	0	1	2	6	10	7
17:	2	0	1	9	3	4	2	3	1	2	1	2	5	3	1	2	7	9	9	1	8	5	5	1	0	3	0	1	0	0	0	0	2	10	11	10
16:	6	2	5	3	1	1	2	0	3	2	1	1	1	2	5	12	9	7	6	5	4	3	0	1	1	3	1	0	0	0	2	2	4	14	7	6
15:	9	0	3	5	0	1	3	1	2	5	1	1	4	4	4	5	3	8	15	7	5	2	5	3	3	4	0	0	0	0	0	1	4	5	11	4
14:	2	2	0	3	2	5	2	3	1	1	0	2	3	1	4	7	5	5	11	3	0	7	2	1	0	0	0	0	0	0	2	1	3	8	9	9
13:	4	1	2	3	2	7	11	0	4	2	3	2	5	2	5	7	5	5	2	7	4	7	0	0	4	3	2	1	0	0	1	2	3	12	10	9
12:	0	0	0	4	4	1	2	1	2	1	2	4	1	3	0	2	0	3	0	2	1	2	1	1	1	0	3	0	0	0	0	3	4	9	1	5
11:	2	1	5	2	6	4	6	4	2	3	7	1	5	4	3	5	2	4	7	3	1	2	2	1	2	0	3	4	1	2	1	2	10	10	7	5
10:	4	0	1	5	8	3	4	5	1	1	2	2	3	8	2	5	4	0	3	1	3	1	3	2	5	2	0	1	3	1	2	3	10	7	6	6
9:	6	0	3	5	5	2	4	1	2	4	3	2	6	0	5	7	1	0	3	4	0	3	2	1	3	0	3	4	2	0	1	5	1	4	4	5
8:	4	1	1	5	3	1	6	2	4	5	2	6	2	3	2	8	3	3	4	2	1	2	4	1	2	0	1	5	2	4	6	0	10	8	5	5
7:	5	1	2	4	4	3	3	2	2	3	2	3	2	1	3	3	4	3	8	2	4	2	2	2	1	0	3	1	3	0	1	3	3	5	4	7
6:	2	0	1	5	2	5	3	2	4	1	1	4	5	2	3	3	1	1	5	4	1	3	4	2	1	2	1	3	0	3	1	3	6	7	7	3
5:	1	1	0	3	0	3	4	3	3	2	0	4	6	3	1	3	1	1	4	3	1	7	1	0	1	0	1	4	1	0	0	5	5	4	7	2
4:	4	0	1	1	2	5	4	1	3	4	0	3	1	2	0	1	2	1	6	4	2	2	0	3	0	0	1	0	0	1	2	4	2	2	2	6
3:	3	0	0	2	0	2	5	3	3	3	3	2	1	0	1	0	4	3	2	2	3	3	1	0	0	0	2	2	0	0	0	2	1	0	0	0
2:	1	0	0	1	0	2	4	3	0	1	0	0	3	0	1	0	2	0	1	1	0	2	1	1	0	0	0	2	1	2	3	0	2	0	0	0
1:	2	0	0	0	0	0	1	2	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0
0:	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0

Total number of observations = 2850

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:23: 3


        PL90540S.WIN   2850

    Distributions
    -------------

        Spd  CumPrb       Dir     AvgSpd
        ---  ------     -------   ------
          1   20.53       0- 10    12.77
          2   27.72      10- 20    11.42
          3   30.88      20- 30    12.31
          4   33.89      30- 40    10.79
          5   37.37      40- 50     9.60
          6   41.51      50- 60     6.32
          7   45.23      60- 70     5.94
          8   48.95      70- 80     6.43
          9   52.88      80- 90     6.98
         10   56.91      90-100     6.58
         11   61.23     100-110     7.70
         12   65.37     110-120     5.88
         13   67.89     120-130     8.00
         14   71.26     130-140     8.54
         15   74.81     140-150     9.51
         16   77.65     150-160    12.43
         17   80.11     160-170    12.11
         18   82.77     170-180     9.26
         19   85.54     180-190     7.85
         20   87.54     190-200     8.72
         21   89.54     200-210     5.00
         22   91.12     210-220     5.64
         23   92.84     220-230     4.56
         24   94.11     230-240     6.77
         25   95.05     240-250     3.14
         26   95.96     250-260     3.82
         27   96.88     260-270     3.49
         28   97.89     270-280     3.35
         29   98.49     280-290     4.68
         30   98.84     290-300     4.78
         31   99.02     300-310     7.61
         32   99.16     310-320     8.12
         33   99.44     320-330    10.65
         34   99.68     330-340    13.65
         35   99.86     340-350    13.93
         36   99.93     350-360    12.53
         37   99.96
         38   99.96
         39   99.96
         40  100.00
```

```
Spd                                                      Direction
---   --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --  --
       1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24  25  26  27  28  29  30  31  32  33  34  35  36

 60:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 59:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 58:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 57:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 56:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 55:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 54:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 53:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 52:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 51:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 50:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 49:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 48:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 47:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 46:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 45:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 44:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 43:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 42:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 41:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 40:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 39:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 38:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 37:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 36:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
 35:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   2   0
 34:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   0   1   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   1   0
 33:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   2   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   2   1   0
 32:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   2   1   0
 31:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   2   1   0
 30:   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   3   0   0
 29:   0   1   0   1   0   0   0   0   0   0   0   0   0   0   0   0   5   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   1   0   1   0
 28:   0   0   0   0   0   0   0   0   0   0   0   0   0   1   0   2   3   1   0   1   0   0   0   0   0   0   0   0   0   0   0   1   3   2   3   0
 27:   0   0   1   1   0   0   0   0   0   0   0   0   0   0   0   1   4   2   0   0   0   0   0   0   0   0   0   0   0   0   0   1   4  11   2   2
 26:   0   0   0   0   2   0   0   0   0   0   0   0   0   0   1   4   0   2   1   1   0   0   0   0   0   0   0   0   0   0   0   0   1   9   4   1
 25:   0   0   1   2   0   0   0   0   0   0   0   1   0   0   1   4   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   2   8   6   1
 24:   1   0   2   1   1   0   0   0   0   0   0   0   1   0   1   1   2   3   2   0   0   0   0   0   0   0   0   0   0   0   0   0   1   6   3   2
 23:   3   0   2   1   2   0   0   0   0   0   1   0   1   1   0   6   2   1   3   0   0   0   0   0   0   0   0   0   0   0   1   1   1   6   3   1
 22:   0   0   2   6   2   0   0   0   0   0   0   0   1   2   2   7   3   4   2   0   0   0   0   0   0   0   0   0   0   0   0   0   4   8   3   3
 21:   0   0   2   2   0   2   1   0   0   0   2   0   2   1   2   9   1   2   4   2   1   0   0   0   0   0   0   0   0   0   0   0   3   3   5   1
 20:   2   1   1   2   4   0   0   1   1   1   0   0   0   2   4   4   2   1   1   2   0   0   0   0   0   0   0   0   0   0   1   2   6   9   6   4
 19:   1   0   3   4   2   1   0   0   1   0   0   0   2   2   3  10   6   2   0   1   0   0   0   0   0   0   0   0   1   0   2   3   0   8   5   0
 18:   1   1   2   3   4   3   0   0   0   2   1   0   2   2   4  11   6   2   5   5   0   1   0   1   1   0   0   0   0   0   0   3   7   4   6   2
 17:   3   1   3   5   3   2   2   0   0   2   0   1   2   1   2   6   8   0   1   3   2   1   0   2   0   0   1   0   0   0   0   3   4  12   4   2
 16:   0   0   2   6   4   2   3   1   1   0   1   0   0   2   2   2   4   6   3   0   0   0   0   0   0   0   0   0   0   1   2   5   7  12   4   0
 15:   3   0   2  12   4   1   1   1   0   2   1   1   3   2   5   2   5   1   4   0   0   3   1   0   0   1   0   0   1   1   3   5   5   6   5   0
 14:   0   1   4   9   8   1   0   3   1   1   4   0   0   5   2   9  12   3   2   3   0   0   0   3   0   0   1   0   0   3   1   5   5   6   6   3
 13:   0   1   2  14   3   1   2   2   5   1   1   1   2   2   1   6   8   2   4   1   3   4   1   0   0   0   0   1   2   1   5   1   4   9   5   1
 12:   0   0   0   4   3   0   3   2   2   1   2   0   5   4   0   4   3   3   3   1   0   2   0   0   0   1   1   1   0   0   7   3   4   8   3   2
 11:   2   1   4   7   4   2   2   2   3   2   2   2   1   1   9   6   8   8   6   4   0   1   2   1   0   0   0   1   0   0   7   6   9   9   4   2
 10:   2   1   5   9   2   3   6   3   2   2   3   0   3   5   1   4   5   4   4   6   1   3   3   1   0   1   1   1   0   1  12   8   5  10   4   2
  9:   0   0   2   6   5   4   5   1   0   4   3   4   1   4   4   4   9   4   6   4   1   2   2   4   1   1   1   1   2   4   7   8   3   7   1   0
  8:   0   0   5   7   3   3   5   1   2   3   1   2   3   1   2   2   6   4   9   5   1   1   0   3   2   2   1   2   1   3  14   3   8   4   3   0
  7:   0   0   3   9   2   2   3   3   3   1   2   4   1   3   7   2   4   4   5   1   1   1   3   0   5   1   2   4   2   2   7   8   5   3   2   1
  6:   0   0   1   5   4   7   5   2   2   5   0   2   3   4   1   5   6   5   6   3   1   1   0   1   0   2   5   2   6   3   5  10   1   2   0   1
  5:   3   0   2   5   5   5   6   3   2   3   1   2   2   4   2   1   3   9   2   5   1   3   0   1   2   2   5   4   2   9   9   5   4   5   1   0
  4:   0   0   0   6   3   3   8   1   1   3   3   1   5   4   3   5   4   1   2   0   2   3   0   2   3   0   2   2   3   3   7   7   7   4   1   0
  3:   0   0   2   3   5   2   3   1   3   2   2   2   1   0   5   0   2   3   2   2   3   2   1   0   2   2   3   5   5   4   4   3   7   3   1   1
  2:   1   1   1   1   1   1   5   2   3   2   3   0   1   3   2   8   3   2   4   2   0   1   6   1   3   1   2   2   1   2   5   2   6   7   4   1
  1:   2   1   3  11   5   8   4   5   4   2   3   4   6   2   7  12  12   8   9   7   3   4   3   2   5   4   7   8   5   6   5   7   7  10  10   4
  0:   2   2   4  15  20  20  20  10   7  14   9  10  15  20  18  26  29  30  36  13  13  17  10   8  15  10  18  18   9  16  14  25  25  38  21   8

          Total number of observations =    2850
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
30:	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29:	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
27:	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
26:	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
25:	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
24:	3	3	0	1	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
23:	4	3	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6
22:	8	1	0	2	1	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	3
21:	11	2	2	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	9
20:	10	4	0	5	3	1	0	0	1	0	0	0	0	0	0	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	3	11
19:	13	8	0	9	0	0	0	0	0	1	1	0	0	1	2	2	2	3	3	1	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2	8
18:	16	10	0	5	4	0	0	0	0	0	0	0	3	1	2	4	5	6	3	0	1	0	0	0	0	0	0	0	0	0	0	0	5	5	9	12
17:	14	12	1	8	2	0	1	1	0	1	0	0	1	1	2	7	2	1	0	4	0	2	0	0	0	0	0	0	0	0	0	1	0	3	4	9
16:	12	19	0	9	2	1	0	0	0	1	0	0	0	0	2	6	2	4	1	1	1	1	0	1	0	0	0	0	0	0	0	1	2	1	5	10
15:	15	15	2	8	3	1	3	0	1	0	1	0	5	5	5	7	1	5	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	4	11	17
14:	25	14	0	15	6	0	2	1	1	0	2	1	1	0	5	4	3	6	3	2	1	2	0	1	1	0	0	0	0	0	0	1	1	7	9	14
13:	17	13	1	16	7	2	2	2	2	0	0	0	2	3	4	6	1	3	5	3	1	2	0	0	0	0	1	0	0	0	2	0	3	3	14	20
12:	9	6	0	9	3	1	1	1	3	0	1	3	0	3	1	4	3	1	2	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	4	9
11:	32	19	3	17	10	5	5	2	2	2	2	1	3	2	8	3	2	4	6	6	4	4	0	1	0	0	1	0	0	0	0	3	3	11	9	22
10:	26	16	2	24	15	5	4	2	2	4	2	2	7	4	6	2	3	3	6	4	5	2	2	1	1	1	0	1	1	0	2	5	3	9	13	24
9:	30	2	5	20	14	3	8	3	2	1	2	3	3	10	2	1	2	5	7	6	2	3	2	0	1	0	0	1	0	1	2	2	3	9	10	22
8:	23	14	1	18	13	10	5	4	6	7	7	7	4	5	6	3	3	2	2	5	3	3	0	2	2	1	1	3	0	1	1	4	3	7	8	15
7:	34	6	1	17	11	8	7	4	6	4	5	3	11	8	4	7	3	4	3	3	1	3	4	0	2	1	1	3	1	4	2	2	6	9	11	28
6:	15	3	0	16	11	10	9	8	5	3	6	5	5	2	10	8	3	5	6	4	2	2	1	1	1	0	0	1	2	0	1	5	5	13	10	14
5:	11	1	0	9	10	11	7	4	8	9	5	7	7	3	0	4	2	4	7	0	4	3	2	1	3	2	0	0	0	3	5	5	10	14	8	12
4:	18	0	1	8	12	7	7	9	2	6	2	4	4	3	3	5	4	1	5	2	2	2	2	4	3	1	4	1	2	0	4	7	2	17	5	12
3:	14	0	0	9	7	4	5	9	3	2	8	2	6	4	4	4	5	4	2	1	1	3	2	2	0	5	1	1	0	2	3	8	6	7	14	11
2:	6	0	0	2	3	2	2	6	3	5	5	4	3	1	4	3	1	3	6	4	1	0	2	2	1	1	1	3	2	0	6	5	7	10	4	10
1:	4	0	0	2	1	2	1	1	1	4	2	2	4	0	1	1	1	0	2	1	2	0	2	1	1	0	1	1	0	2	0	7	2	0	5	6
0:	1	0	0	0	2	1	1	0	0	0	0	0	1	0	2	1	1	2	1	1	0	1	0	0	2	0	0	1	1	0	1	1	0	2	1	3

Total number of observations =   2849

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:10: 5


        PL90560S.WIN   2849


    Distributions
    -------------

        Spd  CumPrb       Dir     AvgSpd
        ---  ------     -------   ------
          1     .95      0- 10    11.83
          2    3.05     10- 20    14.91
          3    7.20     20- 30    11.79
          4   12.78     30- 40    11.12
          5   18.78     40- 50     9.17
          6   25.13     50- 60     7.28
          7   31.87     60- 70     7.71
          8   39.84     70- 80     6.25
          9   46.82     80- 90     8.88
         10   53.39     90-100     6.54
         11   60.72    100-110     6.79
         12   67.46    110-120     6.66
         13   69.81    120-130     7.89
         14   74.55    130-140     9.26
         15   79.05    140-150     9.74
         16   83.01    150-160    11.18
         17   85.89    160-170     9.95
         18   88.59    170-180    11.06
         19   91.79    180-190     9.13
         20   93.93    190-200     9.69
         21   95.54    200-210     8.37
         22   96.88    210-220     9.06
         23   97.75    220-230     6.07
         24   98.46    230-240     6.38
         25   99.02    240-250     6.26
         26   99.30    250-260     4.92
         27   99.47    260-270     5.73
         28   99.65    270-280     5.91
         29   99.79    280-290     4.83
         30   99.82    290-300     5.50
         31   99.86    300-310     5.52
         32   99.93    310-320     5.91
         33   99.93    320-330     8.35
         34   99.93    330-340     9.33
         35   99.96    340-350    11.58
         36   99.96    350-360    11.48
         37  100.00
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:17:23


        PL91560S.WIN   2783


    Distributions
    -------------

        Spd  CumPrb       Dir    AvgSpd
        ---  ------     -------  ------
          1    3.34      0- 10   12.99
          2    6.25     10- 20   12.83
          3   10.89     20- 30    9.80
          4   17.07     30- 40    9.28
          5   25.91     40- 50    7.66
          6   34.64     50- 60    7.39
          7   44.59     60- 70    6.62
          8   53.00     70- 80    6.14
          9   60.51     80- 90    6.67
         10   67.48     90-100    7.08
         11   72.98    100-110    7.43
         12   78.30    110-120    6.75
         13   80.31    120-130    8.12
         14   84.73    130-140    8.25
         15   88.11    140-150    7.66
         16   90.48    150-160    7.56
         17   92.74    160-170    7.90
         18   94.07    170-180    8.70
         19   95.33    180-190    8.45
         20   96.30    190-200    8.87
         21   97.38    200-210    6.62
         22   97.95    210-220    5.56
         23   98.42    220-230    6.86
         24   98.85    230-240    5.50
         25   99.10    240-250    4.14
         26   99.53    250-260    5.34
         27   99.68    260-270    4.61
         28   99.75    270-280    5.36
         29   99.78    280-290    6.06
         30   99.78    290-300    6.75
         31   99.78    300-310    7.03
         32   99.86    310-320    9.04
         33   99.89    320-330    8.24
         34   99.89    330-340    9.69
         35   99.93    340-350   10.59
         36  100.00    350-360   11.60
         37  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
26:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
25:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	2	4
24:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0
23:	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	2	1	2	1
22:	1	0	0	2	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	0
21:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	3
20:	2	1	0	0	0	0	0	0	0	1	0	0	0	1	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	1	3	1	9	5	2
19:	3	1	0	1	0	1	0	0	1	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	3	5	2	4
18:	2	0	0	4	0	0	2	0	0	0	1	0	1	1	2	1	1	0	1	1	1	1	0	0	0	1	1	0	0	0	2	1	0	4	6	1
17:	1	0	1	2	4	0	0	1	0	0	0	0	2	2	2	2	2	3	2	0	0	1	0	0	0	0	0	0	1	0	0	1	1	3	1	5
16:	3	0	2	9	4	0	1	0	1	0	2	1	0	0	1	1	0	6	4	0	0	0	1	1	1	0	0	0	0	1	0	0	1	8	8	7
15:	5	0	0	11	4	3	0	0	0	1	1	0	3	3	0	2	2	4	5	3	0	0	0	0	0	0	0	0	0	1	1	1	4	2	5	5
14:	8	0	3	6	5	2	0	3	1	1	2	3	8	1	3	3	1	3	5	1	1	1	0	1	0	0	0	1	0	2	0	4	2	11	7	5
13:	6	1	3	12	5	7	3	1	3	3	1	2	7	2	7	3	2	10	1	1	1	0	0	1	0	0	0	1	0	1	1	0	4	15	11	8
12:	3	1	0	6	2	2	1	0	2	2	0	3	1	1	3	2	0	2	4	2	1	0	0	0	0	0	0	0	0	3	0	1	1	5	5	3
11:	5	0	4	9	5	4	5	1	2	3	7	3	7	3	5	2	7	11	10	1	0	0	2	0	0	0	0	0	1	0	1	5	5	20	9	11
10:	7	0	2	10	12	6	4	4	2	7	1	2	4	1	5	6	9	1	7	3	0	0	1	0	1	1	0	0	1	0	3	8	6	14	15	10
9:	5	1	4	15	11	11	6	0	2	5	4	4	4	10	6	11	6	11	7	1	5	3	6	0	0	1	1	1	1	2	2	5	10	12	16	5
8:	4	0	3	15	14	3	9	6	6	10	7	3	3	6	6	11	10	16	6	6	2	3	3	2	1	1	2	2	0	3	1	6	7	19	19	4
7:	2	0	4	14	10	14	10	4	7	6	4	4	10	8	4	17	8	14	11	1	6	2	2	1	0	3	1	4	1	1	2	3	11	21	17	7
6:	6	0	3	9	14	12	8	6	5	8	7	11	7	11	9	9	5	11	10	7	3	2	3	1	3	1	1	7	2	3	6	8	10	38	23	8
5:	2	0	1	12	16	8	10	6	6	9	6	9	16	6	14	12	7	7	10	5	4	3	2	2	0	3	4	4	3	4	2	7	5	18	12	8
4:	3	0	2	16	12	12	9	6	7	9	10	8	12	4	14	7	7	6	4	5	5	7	3	3	3	2	7	4	2	2	7	4	12	18	11	3
3:	0	1	1	6	12	9	4	4	6	4	3	2	5	3	11	4	7	3	9	6	4	3	2	1	4	2	3	2	3	6	8	4	10	10	6	4
2:	0	0	0	8	5	5	6	3	3	4	2	6	2	3	4	6	2	3	7	2	4	3	3	1	4	2	2	2	0	1	3	2	9	11	8	3
1:	0	0	0	4	4	2	6	4	3	3	0	2	1	2	1	4	3	4	4	1	3	3	1	1	2	4	2	2	1	1	0	0	5	6	1	1
0:	0	0	0	3	7	1	3	3	3	2	3	2	2	3	2	3	5	3	5	1	0	3	0	4	3	3	3	3	1	3	4	3	4	4	3	1

Total number of observations = 2783

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:19: 0


          PL90580S.WIN   2850


     Distributions
     -------------

          Spd  CumPrb          Dir    AvgSpd
          ---  ------        -------  ------
            1    1.96          0- 10   14.04
            2    3.89         10- 20   12.52
            3    7.05         20- 30    9.16
            4   10.14         30- 40   11.10
            5   14.49         40- 50   10.41
            6   19.16         50- 60   10.82
            7   24.18         60- 70   10.69
            8   30.53         70- 80    8.48
            9   37.26         80- 90    9.35
           10   44.60         90-100   10.13
           11   51.23        100-110    9.40
           12   57.93        110-120    8.36
           13   61.05        120-130    8.83
           14   66.42        130-140   10.00
           15   71.12        140-150   12.21
           16   75.05        150-160   10.43
           17   78.84        160-170    8.83
           18   82.53        170-180    9.75
           19   84.70        180-190    8.77
           20   87.82        190-200    8.46
           21   90.11        200-210   10.88
           22   91.72        210-220    9.56
           23   93.47        220-230    7.00
           24   94.88        230-240    7.09
           25   95.37        240-250    6.50
           26   96.49        250-260    9.22
           27   97.23        260-270    7.40
           28   97.65        270-280    8.57
           29   97.82        280-290    9.69
           30   98.04        290-300   12.47
           31   98.25        300-310   12.05
           32   98.49        310-320   13.98
           33   98.91        320-330   16.34
           34   99.02        330-340   14.78
           35   99.19        340-350   13.72
           36   99.26        350-360   13.23
           37   99.33
           38   99.37
           39   99.47
           40   99.54
           41   99.61
           42   99.72
           43   99.72
           44   99.72
           45   99.72
           46   99.72
           47   99.75
           48   99.79
           49   99.79
           50   99.82
           51   99.82
           52   99.82
           53   99.86
           54   99.86
           55   99.86
           56   99.96
           57  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
34:	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
32:	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	2	2	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	1	3	0
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	1	1
29:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	0
28:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0	1	0
27:	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	4	1	0
26:	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	4	2	3	3
25:	2	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	3	7	6	3	3
24:	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	2	3	0
23:	4	0	1	2	1	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	7	9	4	4
22:	5	0	1	4	1	1	0	2	1	1	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	4	6	7	3	8
21:	1	0	0	4	2	1	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	4	5	10	7	5
20:	2	0	2	7	1	1	0	1	1	1	0	0	0	0	3	2	0	0	0	2	0	0	0	0	0	0	0	0	0	2	7	3	10	8	7	5
19:	3	3	4	7	3	6	4	2	2	1	1	2	1	1	0	2	1	0	0	0	0	0	0	0	0	1	0	1	0	2	4	6	6	14	4	8
18:	2	2	0	3	3	4	6	0	1	1	0	0	0	0	3	0	1	0	0	0	0	1	0	0	0	0	1	0	2	3	1	4	6	7	5	6
17:	7	4	3	12	2	4	4	1	1	4	1	0	0	1	1	2	0	4	0	1	4	1	0	0	0	0	1	1	1	3	5	3	4	14	8	8
16:	10	3	5	10	8	7	7	1	1	3	0	0	3	0	1	1	0	0	2	0	0	0	0	0	0	1	0	2	0	3	7	2	7	11	4	9
15:	9	4	7	7	2	6	6	1	3	5	1	0	4	3	2	0	2	2	0	0	1	0	0	0	0	0	0	2	1	2	2	4	6	9	17	4
14:	10	4	4	10	4	7	5	6	6	4	2	3	1	2	1	2	1	0	1	0	0	3	0	1	0	2	0	1	2	2	3	9	6	12	13	7
13:	7	2	8	15	8	5	12	4	6	6	2	0	3	2	2	2	1	1	1	1	0	1	0	0	0	2	0	2	3	4	8	11	5	11	6	12
12:	6	4	4	9	9	2	7	3	3	2	3	2	0	0	2	2	1	0	0	0	0	0	0	0	0	0	0	1	2	3	0	4	0	6	6	8
11:	7	1	7	22	9	12	10	7	9	11	3	3	4	2	4	0	1	1	3	3	0	0	1	0	1	0	0	3	5	3	5	10	6	16	10	12
10:	12	0	9	15	7	14	13	6	9	10	5	4	3	2	1	4	2	2	2	0	4	3	1	2	0	0	0	2	1	2	7	7	4	13	14	9
9:	4	1	11	15	12	10	16	11	10	10	2	4	5	0	3	1	1	2	4	4	2	1	2	1	4	0	0	2	4	4	8	4	4	19	14	14
8:	9	1	9	16	19	6	18	7	6	9	4	2	3	2	1	3	3	3	3	2	1	1	0	1	1	1	2	3	1	1	4	6	11	15	10	8
7:	7	5	15	20	6	9	8	8	8	8	3	7	6	0	2	3	1	0	5	0	0	0	1	5	1	0	1	3	1	2	5	6	9	11	9	6
6:	4	1	8	10	3	6	8	13	2	4	6	1	4	1	2	0	0	1	1	2	0	0	3	1	2	1	0	1	1	0	11	4	9	14	10	9
5:	6	4	9	12	5	4	5	5	6	5	0	5	0	3	3	5	1	2	1	1	4	2	0	2	3	2	0	2	0	0	8	4	4	8	5	7
4:	0	1	15	8	6	5	5	8	7	6	3	2	4	0	2	2	3	2	0	2	0	1	0	2	2	0	1	1	2	4	2	5	6	8	5	4
3:	2	0	5	8	5	2	3	6	4	4	1	0	2	3	0	0	0	0	1	1	1	1	4	0	2	2	2	1	5	1	3	3	3	6	6	1
2:	0	0	5	11	2	5	5	5	4	2	3	2	3	1	0	3	2	1	0	2	1	2	1	0	1	0	1	3	1	2	2	6	3	7	2	2
1:	0	0	4	5	3	5	0	3	2	1	0	2	2	0	1	0	1	1	1	1	0	0	1	1	0	2	1	4	0	2	1	6	3	1	0	1
0:	1	0	2	1	4	4	3	3	1	1	0	1	1	0	2	2	1	0	1	1	1	0	0	0	0	1	0	1	2	2	4	0	5	3	5	3

Total number of observations =   2850

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:20:21


          PL91580S.WIN   3968


     Distributions
     -------------

          Spd  CumPrb       Dir    AvgSpd
          ---  ------     -------  ------
            1    3.33      0- 10     9.74
            2    7.13     10- 20    12.45
            3   12.90     20- 30    10.03
            4   20.21     30- 40     9.75
            5   28.02     40- 50     8.54
            6   36.42     50- 60     7.84
            7   45.74     60- 70     7.08
            8   54.06     70- 80     6.69
            9   60.96     80- 90     8.51
           10   67.57     90-100     7.38
           11   73.11    100-110     7.11
           12   78.68    110-120     7.82
           13   81.12    120-130     7.94
           14   85.28    130-140     8.16
           15   88.26    140-150     9.70
           16   90.90    150-160     9.06
           17   93.09    160-170     8.99
           18   94.78    170-180     9.34
           19   95.69    180-190     7.62
           20   96.82    190-200     6.65
           21   97.76    200-210     6.18
           22   98.26    210-220     6.21
           23   98.71    220-230     5.91
           24   99.14    230-240     5.55
           25   99.32    240-250     4.71
           26   99.50    250-260     5.83
           27   99.60    260-270     5.78
           28   99.75    270-280     5.72
           29   99.77    280-290     7.47
           30   99.77    290-300     8.54
           31   99.80    300-310    10.84
           32   99.80    310-320    10.31
           33   99.82    320-330     9.56
           34   99.82    330-340    10.15
           35   99.82    340-350    11.17
           36   99.85    350-360     9.92
           37   99.85
           38   99.85
           39   99.85
           40   99.87
           41   99.87
           42   99.87
           43   99.92
           44   99.92
           45   99.92
           46   99.92
           47   99.95
           48   99.95
           49   99.95
           50   99.95
           51   99.95
           52   99.95
           53   99.95
           54   99.95
           55   99.95
           56   99.95
           57   99.95
           58   99.95
           59   99.95
           60   99.95
           61  100.00
```

Spd	Direction																																		
---	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0
26:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0
25:	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	2	0	0
24:	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
23:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	5	4	2	1	0	0
22:	2	0	0	0	2	0	1	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	1	1	2	1
21:	0	0	0	0	1	1	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	3	2	2	1	2	1	2
20:	2	0	0	3	3	0	0	0	1	1	0	0	1	1	2	3	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	5	2	3	2	4
19:	3	0	0	0	1	1	0	0	1	0	2	0	0	0	2	1	5	3	1	0	0	0	0	0	0	0	0	2	2	4	2	4	1	3	2	5
18:	3	1	0	4	0	0	0	0	0	0	2	1	1	2	3	1	1	1	0	0	0	0	0	0	0	0	0	1	0	2	3	4	2	3	1	0
17:	4	1	2	1	5	2	0	0	2	1	1	2	1	0	2	5	1	0	0	0	0	3	1	0	0	0	0	2	1	3	7	6	6	1	5	2
16:	4	4	0	6	8	5	0	0	1	1	1	1	3	0	4	3	1	4	2	0	1	0	0	0	0	0	1	1	2	1	8	7	4	5	3	6
15:	4	1	0	9	6	2	1	2	4	0	0	2	5	1	4	5	2	3	1	1	4	0	0	0	0	1	0	0	3	7	5	4	5	7	8	8
14:	12	0	1	7	10	9	5	1	1	3	5	1	4	2	3	4	1	2	1	1	2	1	1	0	0	1	2	1	0	2	4	5	4	7	9	6
13:	6	2	1	10	12	13	8	2	5	4	3	5	4	5	8	5	0	2	7	4	1	4	0	1	2	0	2	8	0	3	10	4	6	6	7	5
12:	6	1	1	7	5	3	4	1	2	6	4	3	5	3	2	3	1	2	4	2	1	4	1	1	1	2	1	0	2	1	2	5	1	3	4	3
11:	4	1	2	15	17	9	9	2	7	12	6	10	3	8	14	10	7	7	7	3	4	2	2	2	1	1	1	9	7	5	4	4	7	9	3	7
10:	7	3	2	12	12	14	9	4	7	8	4	5	11	8	6	8	7	3	6	5	3	7	4	5	0	1	6	7	9	3	2	7	4	3	4	14
9:	10	0	3	13	19	17	7	7	5	14	13	8	17	8	5	10	5	9	9	2	2	5	4	1	1	3	8	4	9	2	3	7	8	11	4	9
8:	10	1	1	15	16	9	15	9	7	12	6	8	15	15	8	14	4	4	5	4	1	9	1	4	4	5	7	8	6	5	8	5	9	9	5	10
7:	3	1	1	11	23	23	20	9	5	11	15	9	18	11	17	12	7	5	12	10	5	11	6	1	3	2	10	10	9	8	9	4	7	8	4	10
6:	10	1	1	6	24	14	23	7	8	7	17	12	19	8	6	18	8	9	15	10	9	9	9	4	6	6	15	23	8	12	12	6	6	5	9	8
5:	5	0	1	7	18	13	14	12	6	12	14	20	11	10	5	9	5	8	9	11	6	11	4	2	3	5	11	19	14	13	16	8	11	10	3	7
4:	9	0	1	7	13	15	11	12	7	9	9	6	15	7	7	13	1	5	7	6	10	10	10	6	6	5	12	17	17	12	9	12	11	4	4	5
3:	6	1	1	6	13	14	13	10	1	12	14	6	10	6	6	7	9	1	5	9	7	11	4	6	4	5	9	22	17	9	11	10	7	6	7	5
2:	5	1	0	3	17	8	11	7	4	8	5	5	7	2	3	4	7	1	4	5	7	7	11	5	9	6	6	20	9	6	12	11	3	6	0	4
1:	3	0	0	6	3	9	7	2	3	4	8	1	3	2	1	1	3	0	4	2	3	10	5	3	6	2	7	13	6	8	7	5	4	5	1	4
0:	4	0	0	3	5	6	4	0	2	4	3	0	6	1	1	1	2	1	2	1	6	8	3	3	4	5	8	17	11	5	3	4	3	2	0	4

Total number of observations =   3968

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:28:13


          PL90460S.WIN   2851


     Distributions
     -------------

          Spd  CumPrb        Dir    AvgSpd
          ---  ------      -------  ------
            1     .63       0- 10   11.11
            2    2.35      10- 20   12.22
            3    5.72      20- 30   12.64
            4   10.31      30- 40   10.97
            5   15.75      40- 50    9.02
            6   23.29      50- 60    9.08
            7   31.15      60- 70    8.29
            8   38.44      70- 80    8.94
            9   46.44      80- 90    8.68
           10   54.96      90-100    8.28
           11   62.68     100-110    6.20
           12   68.78     110-120    7.98
           13   71.97     120-130    7.57
           14   77.62     130-140    7.03
           15   81.83     140-150    7.17
           16   85.58     150-160    8.86
           17   88.50     160-170   10.81
           18   90.74     170-180    9.85
           19   92.88     180-190   10.26
           20   94.88     190-200    7.42
           21   96.53     200-210    8.70
           22   97.79     210-220    7.88
           23   98.53     220-230    6.88
           24   98.91     230-240    4.33
           25   99.23     240-250    5.87
           26   99.44     250-260    5.46
           27   99.54     260-270    5.36
           28   99.72     270-280    6.25
           29   99.79     280-290    6.65
           30   99.86     290-300    7.46
           31   99.93     300-310    8.73
           32  100.00     310-320    8.75
           33  100.00     320-330    9.89
           34  100.00     330-340   11.04
           35  100.00     340-350   10.64
           36  100.00     350-360   10.85
           37  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
30:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
28:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27:	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
26:	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
25:	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1
24:	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
23:	1	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2
22:	3	5	1	1	1	3	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0
21:	2	3	7	10	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2	3	1	3
20:	3	3	10	4	2	1	0	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	5	7	6	2
19:	4	9	7	11	0	1	1	1	1	0	0	0	0	0	0	2	1	0	1	0	1	0	0	0	0	0	0	0	0	2	3	1	2	7	1	1
18:	5	6	14	7	2	1	1	2	1	0	0	0	0	0	0	2	1	0	1	0	0	3	0	0	0	0	0	0	0	0	1	0	1	4	3	6
17:	2	12	14	7	0	1	1	0	1	0	0	0	0	0	0	0	2	4	1	0	1	2	0	0	0	0	0	1	1	0	0	1	2	4	4	3
16:	7	9	20	10	2	1	1	3	1	0	0	0	0	0	0	1	1	1	2	0	1	0	0	0	0	0	0	0	0	1	2	5	2	4	7	2
15:	8	18	21	9	4	2	1	1	0	0	0	1	0	1	0	2	3	0	7	1	2	1	0	0	0	0	1	2	0	0	2	1	2	5	6	6
14:	9	18	30	10	5	3	2	0	0	0	1	0	3	0	1	0	0	2	3	1	3	0	1	0	0	0	0	0	0	1	1	2	4	12	5	3
13:	10	18	16	14	8	9	8	5	4	3	0	3	4	2	1	2	4	8	3	0	1	0	0	0	0	1	0	1	0	1	2	2	5	12	8	6
12:	8	11	14	13	3	4	4	0	3	1	0	0	0	1	1	1	1	1	0	1	0	2	0	0	0	0	0	2	1	1	0	0	1	7	3	7
11:	14	21	22	16	7	7	8	10	4	3	2	2	3	1	1	3	6	3	3	2	1	3	0	0	0	0	2	1	0	0	2	2	8	8	6	3
10:	19	23	18	24	7	5	11	9	2	3	4	4	3	2	2	8	4	7	4	3	2	1	3	0	0	0	0	0	0	1	8	6	6	14	9	8
9:	20	25	17	27	10	11	13	7	6	9	1	2	5	2	3	2	3	5	3	2	2	4	5	1	8	2	1	3	4	0	6	2	3	10	12	7
8:	16	16	12	26	19	8	16	9	7	5	1	3	5	2	2	5	2	3	2	2	1	5	0	0	0	0	1	3	3	3	0	5	10	8	13	15
7:	14	15	13	17	16	11	13	4	6	4	2	2	5	4	1	1	3	0	6	0	2	2	3	1	0	3	1	3	4	3	4	2	9	12	9	13
6:	17	9	14	20	16	4	5	11	7	11	5	3	6	3	5	2	3	2	1	5	6	6	1	1	1	3	2	11	4	1	3	0	6	9	15	6
5:	11	10	10	15	14	10	13	8	6	5	2	4	2	5	4	0	1	3	2	1	1	3	1	5	6	8	2	6	5	3	5	6	6	14	8	10
4:	4	4	7	10	3	7	9	7	5	2	5	0	6	6	2	4	1	1	2	1	4	3	3	3	2	3	7	4	3	3	2	4	8	10	3	7
3:	6	5	2	8	6	5	3	6	0	3	1	4	3	4	1	4	3	3	3	1	2	3	4	3	2	0	4	5	3	2	2	8	6	8	4	4
2:	2	0	2	1	4	4	4	0	1	5	3	1	2	0	1	5	2	2	2	1	3	4	2	3	2	3	3	4	1	4	4	2	9	7	1	2
1:	2	0	2	1	1	0	5	0	0	0	2	0	1	0	2	1	1	3	1	2	1	3	2	0	2	1	1	5	1	1	1	1	1	2	1	2
0:	0	0	0	1	1	2	1	0	2	1	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	2	0	0	0	2	1

Total number of observations = 2851

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:27:10


        PL91460S.WIN   3967

     Distributions
     -------------

        Spd  CumPrb       Dir     AvgSpd
        ---  ------     -------   ------
          1    1.66       0- 10    11.05
          2    4.26      10- 20    13.07
          3    8.29      20- 30    11.71
          4   13.84      30- 40    10.82
          5   20.62      40- 50     8.74
          6   28.94      50- 60     7.70
          7   37.79      60- 70     7.74
          8   46.43      70- 80     8.65
          9   55.05      80- 90     8.18
         10   63.32      90-100     7.96
         11   70.10     100-110     7.80
         12   76.15     110-120     8.42
         13   78.88     120-130     7.43
         14   84.02     130-140     8.05
         15   87.65     140-150     7.97
         16   90.40     150-160     8.69
         17   92.94     160-170     9.29
         18   95.01     170-180     8.00
         19   96.50     180-190     9.03
         20   97.50     190-200     8.29
         21   98.29     200-210     7.96
         22   98.64     210-220     7.92
         23   98.89     220-230     7.66
         24   99.37     230-240     6.47
         25   99.57     240-250     9.26
         26   99.75     250-260     7.69
         27   99.85     260-270     6.01
         28   99.90     270-280     5.43
         29   99.95     280-290     6.74
         30   99.95     290-300     7.52
         31   99.97     300-310     8.70
         32  100.00     310-320     9.15
         33  100.00     320-330     8.43
         34  100.00     330-340     9.38
         35  100.00     340-350     9.81
         36  100.00     350-360     9.34
         37  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
30:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
27:	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26:	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
25:	0	2	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
24:	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	1	0
23:	0	1	0	4	1	0	0	1	1	1	0	0	0	0	1	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	0
22:	1	0	0	2	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0
21:	0	2	1	1	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	3	0
20:	2	1	2	5	2	1	0	1	0	1	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	2	5	2	1
19:	3	0	0	1	2	3	1	0	2	1	0	0	1	2	0	0	0	0	1	2	0	0	0	1	0	0	0	0	1	0	1	2	4	5	3	4
18:	4	1	0	10	3	0	2	0	1	3	1	0	0	1	1	3	0	2	2	1	0	0	0	0	2	1	0	1	0	0	4	0	2	7	2	5
17:	2	2	1	8	4	1	1	1	1	4	1	3	1	0	2	1	0	3	5	2	3	0	0	0	2	0	0	0	0	2	3	4	3	11	8	3
16:	7	1	3	10	9	2	3	3	0	1	0	0	2	1	1	4	4	0	4	1	2	3	0	0	3	1	0	0	1	1	3	6	2	10	5	8
15:	10	2	1	13	6	3	3	3	1	2	2	1	1	3	1	8	2	2	1	1	2	0	1	0	4	0	0	1	0	1	1	3	3	12	8	7
14:	8	4	1	19	13	6	4	3	2	2	0	2	2	3	3	4	2	2	4	0	1	1	3	2	2	1	2	1	1	3	4	3	6	11	7	12
13:	16	3	4	29	12	8	3	4	4	5	6	7	1	6	4	5	6	4	4	4	1	2	2	1	0	1	0	0	0	3	3	7	7	14	19	9
12:	6	0	1	17	11	6	3	3	1	2	5	3	3	1	3	4	4	5	2	1	2	3	1	0	1	1	0	0	0	1	3	2	1	3	5	4
11:	12	3	3	28	11	10	11	5	4	9	4	13	6	4	6	5	10	5	5	4	4	2	2	2	4	2	0	1	3	2	1	6	10	14	15	14
10:	16	2	3	34	23	11	15	6	3	6	1	7	7	6	12	7	5	7	9	5	4	4	1	4	2	1	3	1	1	5	0	4	9	12	18	15
9:	23	4	2	26	22	13	19	5	9	7	9	7	6	8	8	14	15	9	12	2	4	5	1	4	3	2	2	3	2	2	10	8	10	17	18	17
8:	12	4	4	25	31	18	17	9	7	10	13	8	10	13	13	12	9	14	10	11	2	7	2	2	4	1	4	3	4	3	12	7	9	11	7	14
7:	12	1	5	26	35	21	13	9	7	15	9	5	12	6	6	17	5	13	5	9	3	10	6	3	5	2	4	3	5	9	3	8	12	12	12	15
6:	13	0	1	23	38	21	17	12	8	14	9	8	7	11	7	19	6	8	7	11	9	3	2	3	8	3	1	4	2	3	12	6	6	21	12	16
5:	8	2	1	16	24	17	11	8	9	16	9	11	13	8	5	12	8	9	1	10	8	10	1	6	4	3	5	4	7	2	8	8	11	23	17	15
4:	2	2	0	5	14	13	19	9	2	11	9	6	11	5	8	9	6	8	8	5	3	2	3	7	4	6	3	7	2	8	5	9	15	17	12	14
3:	4	0	0	6	11	13	10	3	6	10	2	4	6	7	7	7	9	5	6	3	6	4	4	7	0	2	8	7	2	4	5	14	6	15	8	9
2:	1	1	0	3	5	12	4	1	3	11	3	2	3	7	4	7	3	6	5	2	4	2	2	2	4	1	3	3	4	4	5	7	7	10	10	9
1:	4	0	0	2	5	4	8	1	2	2	1	2	2	1	6	1	3	3	4	1	3	1	0	2	0	1	0	7	1	1	6	5	8	9	5	2
0:	1	1	0	3	3	3	5	1	1	3	2	2	2	1	2	0	0	1	1	1	0	0	1	2	0	1	1	2	2	3	1	3	5	10	2	0

Total number of observations = 3967

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:25:53


         PL90477S.WIN   2851


     Distributions
     -------------

         Spd   CumPrb         Dir    AvgSpd
         ---   ------       -------  ------
           1     1.33         0- 10    9.76
           2     3.30        10- 20    8.50
           3     5.86        20- 30   10.47
           4     9.54        30- 40    8.55
           5    13.85        40- 50    7.95
           6    19.50        50- 60    8.68
           7    26.13        60- 70    8.79
           8    34.20        70- 80   10.06
           9    42.23        80- 90   11.62
          10    50.65        90-100   10.56
          11    59.94       100-110   10.65
          12    66.99       110-120    9.83
          13    69.91       120-130    8.80
          14    76.89       130-140    9.20
          15    81.94       140-150    7.03
          16    85.97       150-160    7.96
          17    89.23       160-170    7.79
          18    92.39       170-180    9.06
          19    94.60       180-190    8.85
          20    96.04       190-200    8.33
          21    97.02       200-210    9.19
          22    97.79       210-220    7.99
          23    98.14       220-230    9.05
          24    98.60       230-240   11.40
          25    98.95       240-250   11.07
          26    99.16       250-260   11.61
          27    99.33       260-270   12.97
          28    99.47       270-280   12.33
          29    99.61       280-290   12.05
          30    99.82       290-300   13.27
          31    99.93       300-310   13.01
          32    99.96       310-320   10.92
          33    99.96       320-330   10.53
          34   100.00       330-340    9.09
          35   100.00       340-350    9.65
          36   100.00       350-360    8.65
          37   100.00
```

Spd	Direction																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0	0	0	0	0
28:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0
27:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0
26:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	1	0	0	0	0	0
25:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	1	2	0	0	0	0	0
24:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2	5	0	0	0	0	0
23:	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	5	0	0	0	0	1
22:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	3	0	1	0	0	1
21:	1	0	1	0	0	0	0	2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	1	1	2	2	0	1	1
20:	0	0	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	2	1	5	6	2	0	0	4	1
19:	2	0	1	0	0	1	1	1	1	3	2	0	0	1	0	0	0	0	2	0	0	0	1	2	3	2	1	0	2	1	4	1	5	1	1	2
18:	3	0	2	1	0	1	1	1	2	7	1	1	0	0	0	0	0	1	0	0	0	1	0	3	4	2	8	4	1	6	3	2	1	4	0	3
17:	10	1	5	1	0	2	2	4	4	7	5	1	0	0	0	0	0	1	0	0	0	0	1	2	4	4	5	1	4	5	4	5	7	0	3	2
16:	9	0	6	5	1	2	4	1	4	7	6	1	0	0	0	1	0	0	0	0	0	1	0	0	6	4	3	3	5	2	8	4	3	3	2	2
15:	17	0	3	7	1	4	2	4	9	5	3	3	1	1	1	1	0	0	0	0	1	0	1	2	4	6	5	3	4	5	9	5	2	3	3	0
14:	21	0	7	9	2	3	4	5	2	8	4	2	3	1	1	0	0	3	0	3	3	4	1	1	2	2	5	3	2	8	9	7	3	4	7	5
13:	21	0	7	14	10	4	8	13	8	7	3	3	3	4	1	3	1	0	1	2	0	1	1	3	4	4	2	7	6	5	15	12	9	7	7	3
12:	10	0	5	6	2	3	2	1	4	4	5	1	1	2	0	1	0	0	3	1	1	0	0	1	0	0	2	2	0	2	3	5	3	6	3	4
11:	22	1	6	12	8	3	12	7	6	10	5	4	4	1	3	2	3	3	7	0	1	2	3	2	2	2	7	4	6	9	7	4	4	6	11	12
10:	37	3	19	8	8	5	6	10	13	15	14	4	8	6	4	6	2	1	4	1	1	3	1	1	1	1	5	4	7	6	10	11	9	12	11	8
9:	37	1	9	17	5	9	11	7	9	10	5	3	9	3	3	3	2	2	1	2	1	1	2	2	3	3	4	2	5	5	8	7	4	15	12	10
8:	28	2	13	15	7	5	3	15	6	6	4	3	4	2	2	4	3	3	0	3	0	1	1	5	8	3	4	9	5	8	8	3	7	10	12	17
7:	36	1	9	14	9	3	10	7	8	9	4	2	4	1	4	3	1	2	4	1	0	6	2	3	5	4	4	6	8	6	8	9	4	8	8	17
6:	23	1	6	19	6	12	8	9	3	10	4	1	2	3	4	3	1	2	4	2	0	1	0	0	3	1	4	3	8	9	8	4	4	5	7	9
5:	18	2	7	11	9	9	8	1	3	10	1	3	2	1	4	5	2	2	0	0	1	4	2	0	4	1	2	4	4	5	9	2	7	7	1	10
4:	15	0	4	11	6	3	3	5	3	3	4	2	3	3	1	2	2	2	1	3	1	2	1	3	2	1	3	2	4	2	3	2	1	11	4	5
3:	7	0	1	5	7	5	8	3	0	2	0	2	3	2	1	3	1	1	2	2	3	3	3	1	2	1	2	1	1	5	3	5	2	2	7	9
2:	3	1	0	10	2	2	6	1	1	3	1	2	1	1	3	2	0	3	2	0	0	1	0	0	3	3	2	1	1	2	1	2	4	4	3	2
1:	3	0	0	3	3	1	2	2	1	6	1	0	0	0	2	1	1	0	2	0	0	1	1	0	0	2	1	0	0	2	4	2	2	3	3	7
0:	4	0	2	4	2	2	1	0	0	0	3	0	1	0	2	0	0	0	0	1	0	3	0	0	0	0	0	1	1	0	1	1	4	0	2	3

Total number of observations = 2851

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:24:41


        PL91477S.WIN    3967

    Distributions
    -------------

        Spd  CumPrb         Dir     AvgSpd
        ---  ------       -------   ------
          1    1.81        0- 10     9.56
          2    4.03       10- 20     7.88
          3    7.94       20- 30     7.72
          4   11.92       30- 40     8.60
          5   17.77       40- 50     8.33
          6   23.44       50- 60     8.33
          7   30.07       60- 70     7.94
          8   36.17       70- 80    10.18
          9   43.06       80- 90    10.00
         10   49.81       90-100     9.90
         11   56.31      100-110    10.28
         12   63.05      110-120    12.09
         13   66.02      120-130    10.63
         14   71.59      130-140    12.38
         15   76.46      140-150     9.94
         16   80.69      150-160     9.21
         17   84.37      160-170     8.73
         18   87.12      170-180     9.27
         19   89.64      180-190    10.04
         20   91.20      190-200     8.07
         21   93.17      200-210     7.56
         22   94.73      210-220     9.79
         23   95.87      220-230    11.96
         24   96.75      230-240    10.47
         25   97.35      240-250    12.93
         26   98.21      250-260    12.26
         27   98.56      260-270    12.33
         28   99.04      270-280    14.72
         29   99.32      280-290    13.17
         30   99.55      290-300    11.57
         31   99.62      300-310    11.26
         32   99.72      310-320     8.69
         33   99.80      320-330     8.27
         34   99.85      330-340     9.04
         35   99.87      340-350     8.29
         36   99.95      350-360     8.98
         37   99.95
         38   99.95
         39   99.95
         40  100.00
```

Spd	Direction																																		
---	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0	0	0	0	0	0
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	3	1	0	1	0	0	0	0	0
28:	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	1	5	1	0	0	0	0	0	0	0
27:	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	3	0	1	0	2	4	1	3	0	0	0	1	0	0
26:	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	2	2	0	0	5	1	1	0	0	0	0	0	0
25:	0	0	0	0	0	0	0	0	2	1	2	1	1	1	0	0	0	0	0	1	0	1	2	0	4	2	5	4	5	1	0	0	0	1	0	0
24:	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	2	3	3	9	2	0	0	0	0	0	0	0
23:	0	0	0	0	0	0	0	1	0	2	1	3	2	2	0	0	0	0	0	0	0	1	3	0	4	2	1	7	2	3	1	0	0	0	0	0
22:	0	0	0	0	0	0	1	0	1	1	2	0	1	2	0	0	0	0	0	0	0	2	6	0	3	2	5	6	5	4	4	0	0	0	0	0
21:	0	0	0	1	0	0	0	1	2	2	0	3	4	3	1	0	0	1	3	0	1	2	4	3	3	4	2	8	9	2	1	0	1	1	0	0
20:	1	0	0	0	0	1	2	0	2	4	0	7	6	2	0	0	1	1	4	2	0	2	3	2	9	4	5	7	5	3	3	0	2	0	0	0
19:	0	0	0	1	0	0	0	2	2	6	4	3	5	1	1	0	0	0	2	2	0	1	4	2	5	3	2	6	3	3	3	0	0	0	0	1
18:	1	0	0	1	1	1	4	2	5	7	5	4	3	2	0	1	0	2	3	3	0	3	3	2	5	9	8	11	7	2	3	2	0	0	0	0
17:	1	0	0	2	2	1	0	2	7	12	6	3	6	1	0	0	2	0	6	6	0	5	0	5	4	6	7	10	4	3	2	3	0	2	1	0
16:	0	0	0	2	2	2	1	6	9	2	5	4	8	2	4	2	1	0	5	1	0	4	7	7	12	9	8	14	7	8	7	3	0	3	1	0
15:	0	0	0	1	2	4	5	9	5	15	13	4	10	6	2	2	1	1	6	2	3	3	1	7	15	12	12	11	5	4	2	1	1	2	0	1
14:	1	2	0	7	5	4	7	4	10	8	6	4	11	4	0	4	2	1	8	9	1	8	3	8	14	9	14	8	10	9	5	3	1	1	0	2
13:	0	1	0	3	6	4	5	10	5	16	8	7	11	5	4	5	3	2	6	9	2	2	2	7	17	10	20	14	11	5	9	2	5	3	1	1
12:	3	0	0	3	3	2	5	7	3	7	8	1	7	0	4	2	2	2	1	4	1	1	2	3	3	12	5	7	4	7	4	2	1	0	2	0
11:	1	0	1	10	7	4	7	11	12	15	12	13	16	10	6	6	5	3	5	11	5	7	2	8	20	16	6	11	12	6	8	4	5	0	2	0
10:	1	3	2	12	4	8	8	12	13	18	10	11	10	4	3	6	2	3	6	11	4	6	8	10	17	13	5	10	5	5	7	7	6	4	0	4
9:	1	0	1	14	5	7	10	4	17	17	8	5	8	2	6	4	6	3	11	18	6	10	4	7	13	5	9	13	12	10	8	3	9	7	2	3
8:	6	1	5	9	11	5	13	12	10	22	13	6	16	7	0	4	4	8	7	17	8	9	5	12	4	8	10	6	8	3	3	4	5	7	2	3
7:	1	0	2	6	9	3	15	7	10	12	8	10	11	2	4	6	5	2	9	23	4	5	10	6	8	7	9	13	7	10	8	3	2	2	2	1
6:	4	0	1	3	11	17	14	5	10	24	9	6	8	3	4	2	6	1	8	15	9	11	9	8	8	7	11	13	12	3	5	4	4	5	1	2
5:	2	2	1	9	8	4	10	5	13	17	12	4	11	2	2	1	5	2	9	18	7	7	6	4	5	4	12	7	8	5	4	4	8	3	1	3
4:	2	1	3	7	8	7	13	5	11	12	8	3	13	2	3	8	3	2	8	22	7	5	7	11	6	6	8	3	7	5	3	5	4	9	3	2
3:	0	0	0	9	4	6	13	6	9	12	3	3	8	3	1	0	0	4	4	10	2	8	3	6	8	7	5	6	4	5	2	2	3	2	0	0
2:	0	2	0	7	4	2	10	5	3	6	10	2	4	2	3	2	3	1	5	13	2	7	5	7	4	4	6	8	3	10	3	6	3	1	2	0
1:	0	1	0	2	4	4	7	3	4	11	3	0	6	1	0	1	1	0	3	6	2	3	0	2	4	2	6	3	2	0	0	3	1	1	1	1
0:	0	0	0	1	2	1	1	0	4	4	2	4	2	2	0	1	1	1	4	5	3	3	4	0	3	1	4	3	1	3	6	1	3	2	0	0

Total number of observations =   3967

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:40:13


          PL90520S.WIN    2850
          Dir   Prob.
          ---  ------
            1  .04842
            2  .00877
            3  .02246
            4  .03404
            5  .02070
            6  .02070
            7  .02807
            8  .01474
            9  .01474
           10  .01614
           11  .01193
           12  .01579
           13  .02491
           14  .01930
           15  .02632
           16  .04561
           17  .04772
           18  .05895
           19  .08772
           20  .06877
           21  .04456
           22  .03789
           23  .01895
           24  .01123
           25  .01193
           26  .00596
           27  .00737
           28  .01053
           29  .00456
           30  .00491
           31  .00807
           32  .01474
           33  .02737
           34  .05088
           35  .05088
           36  .05439

          Total number of observations =    2850
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:40:47


          PL90540S.WIN   2850
          Dir   Prob.
          ---   ------
            1  .00912
            2  .00421
            3  .02140
            4  .05509
            5  .03544
            6  .02561
            7  .02947
            8  .01544
            9  .01509
           10  .01860
           11  .01579
           12  .01298
           13  .02211
           14  .02737
           15  .03228
           16  .05825
           17  .06140
           18  .04211
           19  .04421
           20  .02526
           21  .01158
           22  .01754
           23  .01123
           24  .01053
           25  .01368
           26  .00982
           27  .01754
           28  .01825
           29  .01404
           30  .02070
           31  .04140
           32  .04386
           33  .05263
           34  .08386
           35  .04632
           36  .01579

          Total number of observations =   2850
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  4: 2:55


          pl91560s.win   2783
          Dir   Prob.
          ---  ------
            1  .02695
            2  .00216
            3  .01186
            4  .06288
            5  .05282
            6  .03665
            7  .03126
            8  .01868
            9  .02156
           10  .02803
           11  .02192
           12  .02336
           13  .03414
           14  .02659
           15  .03629
           16  .03845
           17  .03126
           18  .04240
           19  .04168
           20  .01868
           21  .01473
           22  .01258
           23  .01042
           24  .00683
           25  .00791
           26  .00898
           27  .00970
           28  .01186
           29  .00611
           30  .01222
           31  .01653
           32  .02479
           33  .04204
           34  .09594
           35  .07079
           36  .04096

          Total number of observations =   2783
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:38:22


        PL90580S.WIN    2850
        Dir   Prob.
        ---   ------
          1  .04456
          2  .01404
          3  .04842
          4  .08351
          5  .04456
          6  .04561
          7  .05228
          8  .03649
          9  .03263
         10  .03544
         11  .01439
         12  .01404
         13  .01719
         14  .00807
         15  .01404
         16  .01333
         17  .00807
         18  .00772
         19  .00912
         20  .00807
         21  .00737
         22  .00596
         23  .00526
         24  .00561
         25  .00596
         26  .00561
         27  .00351
         28  .01263
         29  .01228
         30  .01825
         31  .03789
         32  .04667
         33  .05965
         34  .09509
         35  .06807
         36  .05860

        Total number of observations =   2850
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  4: 2:55


          pl91560s.win   2783
          Dir   Prob.
          ---   ------
            1  .02695
            2  .00216
            3  .01186
            4  .06288
            5  .05282
            6  .03665
            7  .03126
            8  .01868
            9  .02156
           10  .02803
           11  .02192
           12  .02336
           13  .03414
           14  .02659
           15  .03629
           16  .03845
           17  .03126
           18  .04240
           19  .04168
           20  .01868
           21  .01473
           22  .01258
           23  .01042
           24  .00683
           25  .00791
           26  .00898
           27  .00970
           28  .01186
           29  .00611
           30  .01222
           31  .01653
           32  .02479
           33  .04204
           34  .09594
           35  .07079
           36  .04096

          Total number of observations =   2783
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:39:20


          PL91580S.WIN   3968
          Dir   Prob.
          ---   ------
            1  .03075
            2  .00504
            3  .00454
            4  .03831
            5  .05872
            6  .04713
            7  .04108
            8  .02218
            9  .01991
           10  .03251
           11  .03327
           12  .02646
           13  .04108
           14  .02520
           15  .02772
           16  .03528
           17  .02067
           18  .01764
           19  .02545
           20  .01915
           21  .01815
           22  .02848
           23  .01714
           24  .01109
           25  .01260
           26  .01285
           27  .02671
           28  .04662
           29  .03528
           30  .02999
           31  .03982
           32  .03453
           33  .02923
           34  .03075
           35  .02218
           36  .03251

          Total number of observations =   3968
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:42:35


          PL90460S.WIN   2851
          Dir   Prob.
          ---  ------
            1  .06805
            2  .08629
            3  .09646
            4  .09260
            5  .04700
            6  .03508
            7  .04244
            8  .02981
            9  .02034
           10  .02069
           11  .01052
           12  .01017
           13  .01719
           14  .01157
           15  .00947
           16  .01578
           17  .01578
           18  .01719
           19  .01649
           20  .00842
           21  .01228
           22  .01578
           23  .00912
           24  .00631
           25  .00807
           26  .00877
           27  .00877
           28  .01789
           29  .01052
           30  .00947
           31  .01754
           32  .01789
           33  .03613
           34  .06103
           35  .04525
           36  .04384

          Total number of observations =   2851
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:43:28


          PL91460S.WIN   3967
          Dir   Prob.
          ---   ------
            1  .04386
            2  .01034
            3  .00832
            4  .08016
            5  .07184
            6  .04689
            7  .04311
            8  .02218
            9  .01865
           10  .03479
           11  .02168
           12  .02294
           13  .02420
           14  .02370
           15  .02521
           16  .03580
           17  .02622
           18  .02672
           19  .02445
           20  .01941
           21  .01563
           22  .01487
           23  .00807
           24  .01210
           25  .01311
           26  .00781
           27  .00907
           28  .01210
           29  .00958
           30  .01437
           31  .02344
           32  .03050
           33  .03529
           34  .06403
           35  .05092
           36  .04865

          Total number of observations =    3967
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:41:59


          PL90477S.WIN   2851
          Dir   Prob.
          ---   ------
            1  .11470
            2  .00456
            3  .03999
            4  .06033
            5  .03087
            6  .02771
            7  .03578
            8  .03472
            9  .03262
           10  .04700
           11  .02631
           12  .01333
           13  .01719
           14  .01122
           15  .01263
           16  .01403
           17  .00666
           18  .00947
           19  .01157
           20  .00737
           21  .00456
           22  .01263
           23  .00737
           24  .01087
           25  .02105
           26  .01649
           27  .02736
           28  .02525
           29  .02981
           30  .04034
           31  .05331
           32  .03402
           33  .03087
           34  .03893
           35  .03928
           36  .04981

          Total number of observations =   2851
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:41:23


          PL91477S.WIN   3967
          Dir   Prob.
          ---  ------
            1  .00630
            2  .00328
            3  .00403
            4  .02773
            5  .02496
            6  .02193
            7  .03806
            8  .03000
            9  .04285
           10  .06428
           11  .03983
           12  .02899
           13  .04739
           14  .01840
           15  .01210
           16  .01437
           17  .01336
           18  .01008
           19  .03126
           20  .05268
           21  .01689
           22  .02949
           23  .02748
           24  .03277
           25  .05243
           26  .04235
           27  .04941
           28  .06100
           29  .04210
           30  .03101
           31  .02571
           32  .01563
           33  .01613
           34  .01437
           35  .00529
           36  .00605

          Total number of observations =   3967
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:37:41


        PL90520S.SPR   4368


    Distributions
    -------------

        Spd  CumPrb       Dir     AvgSpd
        ---  ------     -------   ------
          1    3.46      0- 10    16.69
          2    5.84     10- 20    18.07
          3    8.70     20- 30    15.04
          4   12.87     30- 40    11.75
          5   17.26     40- 50     8.75
          6   21.73     50- 60     7.25
          7   27.31     60- 70     8.64
          8   32.65     70- 80     6.76
          9   37.89     80- 90     7.04
         10   43.20     90-100     8.73
         11   48.35    100-110     9.50
         12   52.98    110-120     9.33
         13   55.33    120-130    10.50
         14   59.75    130-140    11.80
         15   64.17    140-150    12.93
         16   68.41    150-160    15.43
         17   71.84    160-170    15.73
         18   75.23    170-180    15.96
         19   77.93    180-190    15.31
         20   80.68    190-200    13.12
         21   83.38    200-210    10.75
         22   85.87    210-220    10.21
         23   87.71    220-230     9.21
         24   89.56    230-240     8.92
         25   91.09    240-250     6.16
         26   92.24    250-260     6.50
         27   93.13    260-270     6.88
         28   94.18    270-280     5.69
         29   94.96    280-290     6.34
         30   95.67    290-300     5.42
         31   96.43    300-310     6.99
         32   96.98    310-320     7.74
         33   97.21    320-330    10.95
         34   97.64    330-340    12.50
         35   98.05    340-350    14.45
         36   98.58    350-360    15.15
         37   98.86
         38   99.13
         39   99.20
         40   99.43
         41   99.54
         42   99.68
         43   99.73
         44   99.75
         45   99.77
         46   99.84
         47   99.91
         48   99.91
         49   99.93
         50   99.95
         51   99.95
         52   99.98
         53   99.98
         54   99.98
         55  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
39:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
38:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
37:	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
35:	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	7	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0
34:	3	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	3	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
33:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	1	4
32:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	2
31:	5	0	0	0	0	0	0	0	0	0	0	0	1	0	1	2	3	4	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	2	1	1
30:	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	4	2	0	2	0	0	0	0	0	0	0	0	0	0	0	3	7	3
29:	9	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	3	3	2	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	5
28:	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	7	5	1	0	1	0	0	0	0	0	0	0	0	0	0	3	4	6	3
27:	8	1	0	1	0	1	0	0	0	0	0	0	1	1	2	2	6	5	4	2	2	1	0	0	0	0	0	0	0	0	0	0	0	1	2	6
26:	4	0	0	0	0	0	0	0	0	0	0	0	2	2	2	3	4	4	8	2	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2	3
25:	10	1	1	1	0	0	1	0	0	0	0	0	4	0	2	5	4	1	7	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3	4	4
24:	9	0	2	1	0	0	0	0	0	1	0	0	2	3	5	8	3	4	5	2	3	4	0	0	0	0	0	0	0	0	0	0	5	3	1	6
23:	11	2	1	2	1	0	0	0	0	0	1	1	3	4	2	8	7	5	3	1	4	2	0	0	0	0	0	0	0	0	0	0	2	5	7	9
22:	8	0	2	1	0	0	1	0	0	0	1	2	3	4	3	4	9	9	5	3	0	2	1	0	0	0	0	0	0	0	0	0	2	7	7	6
21:	7	5	1	2	0	0	0	0	0	0	1	1	0	8	5	12	10	8	11	1	1	0	2	0	0	0	0	0	0	0	0	0	5	9	9	11
20:	11	4	0	2	1	0	1	1	0	2	2	2	4	3	4	8	12	15	8	2	0	3	0	0	0	0	0	0	0	0	0	1	2	7	10	13
19:	5	2	2	2	1	1	2	0	1	1	2	1	5	2	8	14	11	8	16	2	1	1	0	0	0	0	0	0	0	0	0	2	5	10	3	12
18:	12	4	2	3	1	1	3	0	0	0	0	0	3	6	6	15	12	6	2	3	1	1	2	1	0	0	0	0	0	0	1	1	1	7	7	17
17:	8	3	1	4	0	3	1	3	0	2	1	4	5	4	5	12	17	16	11	5	1	1	2	0	0	1	0	0	0	0	1	3	0	9	10	15
16:	8	3	3	3	0	0	3	0	0	1	2	2	9	7	4	15	9	9	18	6	1	1	1	0	2	0	1	0	0	0	2	0	3	12	12	13
15:	8	3	1	3	1	1	3	1	2	5	1	2	7	5	11	16	16	18	15	5	5	1	1	2	1	0	0	0	0	1	1	1	4	12	16	16
14:	11	4	3	4	3	1	2	3	1	6	3	4	8	7	10	12	22	17	9	6	6	1	3	1	0	2	0	0	0	2	2	2	9	7	13	9
13:	16	2	2	7	2	2	5	1	2	1	3	6	8	10	6	11	12	16	10	10	3	4	0	1	3	2	0	0	0	3	4	3	5	5	13	15
12:	2	1	3	1	1	2	5	1	2	3	1	2	3	3	5	5	3	8	5	2	3	3	0	1	1	1	1	1	1	0	3	3	2	9	8	8
11:	14	3	3	5	4	3	3	1	5	2	3	2	7	5	12	9	12	18	12	10	2	1	0	2	2	1	2	3	0	0	1	12	4	7	17	15
10:	13	2	0	1	3	5	8	2	2	2	4	11	16	4	15	13	16	20	16	11	5	4	1	3	2	0	1	1	0	0	5	4	7	6	8	14
9:	16	1	1	5	3	3	4	1	6	3	5	9	14	9	5	15	9	8	15	12	5	9	3	2	0	0	3	3	3	2	8	6	5	13	11	15
8:	7	0	1	2	2	5	5	6	1	3	4	4	14	12	13	9	8	18	15	8	8	4	2	2	5	1	2	4	2	2	6	1	7	19	20	7
7:	10	1	1	2	3	6	4	4	4	3	7	9	11	5	6	11	13	8	16	12	7	11	3	2	4	2	2	1	4	3	8	2	10	13	11	14
6:	13	1	1	6	6	3	8	2	5	12	7	6	12	7	9	10	9	7	14	12	10	6	4	2	5	3	1	1	2	2	10	5	7	15	12	9
5:	4	1	3	4	5	2	4	2	6	1	2	6	9	7	4	6	12	8	18	6	7	5	3	4	4	1	0	2	2	0	7	4	7	15	10	14
4:	4	1	0	2	2	5	6	6	1	7	4	3	11	8	6	4	6	8	13	8	7	4	2	4	2	3	3	4	1	5	6	9	11	14	6	6
3:	5	0	0	4	3	8	9	1	6	3	5	5	12	6	4	6	1	6	8	5	8	8	2	1	3	1	0	3	1	3	9	8	10	15	5	8
2:	6	0	1	4	0	6	4	5	4	6	2	3	5	7	1	4	5	6	5	1	3	5	2	0	6	1	1	2	1	4	2	3	3	8	5	4
1:	6	0	0	2	1	7	5	4	3	4	1	2	6	5	3	3	4	2	3	1	4	3	2	1	1	0	2	2	1	1	4	6	4	6	1	4
0:	2	0	0	1	3	3	7	7	4	1	1	6	7	4	8	4	4	6	5	3	3	7	2	1	7	6	2	4	1	8	7	6	5	6	6	4

Total number of observations =   4368

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:35:56


        PL90540S.SPR   1398


    Distributions
    -------------

        Spd  CumPrb       Dir     AvgSpd
        ---  ------     -------   ------
          1    1.86      0- 10    14.67
          2    3.86     10- 20      .00
          3    6.29     20- 30    14.47
          4   10.59     30- 40    10.92
          5   15.38     40- 50    10.55
          6   20.96     50- 60     8.39
          7   25.54     60- 70     7.28
          8   32.19     70- 80     7.54
          9   36.91     80- 90     6.09
         10   40.70     90-100     6.18
         11   45.92    100-110     5.24
         12   50.79    110-120     8.56
         13   54.43    120-130     7.07
         14   60.59    130-140     7.35
         15   66.38    140-150     8.16
         16   71.39    150-160    10.29
         17   75.39    160-170    10.40
         18   79.54    170-180     9.30
         19   82.83    180-190    12.17
         20   85.34    190-200     9.10
         21   87.55    200-210     3.31
         22   89.84    210-220     4.50
         23   91.49    220-230     3.92
         24   93.78    230-240     3.54
         25   95.49    240-250     2.69
         26   96.71    250-260     3.00
         27   97.35    260-270     3.69
         28   98.07    270-280     4.36
         29   98.71    280-290     5.90
         30   98.86    290-300     8.79
         31   99.21    300-310    12.33
         32   99.43    310-320    15.17
         33   99.57    320-330    16.06
         34   99.64    330-340    17.57
         35   99.79    340-350    18.13
         36   99.79    350-360    16.04
         37   99.93
         38  100.00
```

Direction

Spd	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0
28:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	4	1	1
27:	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	2	2	1
26:	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	3	2	0
25:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	2	3	6	0	1
24:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	4	10	3	3
23:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6	3	15	5	1
22:	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	6	9	3	1
21:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	4	4	11	9	1	0
20:	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	7	7	2	6	2
19:	0	0	2	2	2	1	0	0	0	0	0	1	0	0	0	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	7	10	3	0
18:	0	0	2	2	1	0	0	0	0	0	0	0	0	0	2	4	2	0	1	1	0	0	0	0	0	0	0	0	0	0	2	5	8	11	4	1
17:	0	0	2	5	5	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	9	11	11	6	2
16:	0	0	2	3	4	0	0	1	0	0	0	0	0	0	0	2	1	1	5	1	0	0	0	0	0	0	0	0	0	0	7	9	10	3	2	5
15:	0	0	0	4	2	0	0	1	0	1	0	0	0	1	2	3	3	2	1	1	0	0	0	0	0	0	0	0	0	1	11	9	11	8	5	4
14:	0	0	4	1	6	0	1	2	0	1	0	1	0	1	0	5	3	2	1	0	1	0	0	0	0	0	0	0	0	1	5	6	15	16	3	6
13:	0	0	1	6	4	3	3	1	1	0	0	2	3	0	0	3	1	2	1	0	0	0	0	0	0	0	0	0	0	0	5	8	15	13	7	7
12:	0	0	0	4	0	0	0	0	0	0	1	1	0	0	1	6	1	6	3	3	0	0	0	0	0	0	0	0	0	1	3	8	8	1	2	2
11:	0	0	1	5	2	1	2	1	0	2	0	0	1	4	3	4	3	3	4	1	0	0	0	0	0	0	0	1	1	1	6	8	6	5	0	3
10:	1	0	0	4	4	2	5	3	1	1	2	0	0	1	5	4	0	2	0	1	0	0	0	0	0	0	0	1	0	3	7	2	6	8	3	7
9:	1	0	1	3	4	2	4	1	1	1	2	0	1	2	2	3	3	0	2	0	0	0	0	0	0	0	1	0	0	0	1	10	1	3	2	2
8:	0	0	0	8	4	2	3	0	2	4	0	2	2	4	1	5	3	0	2	1	0	0	0	2	0	1	0	0	0	1	4	4	4	7	0	0
7:	0	0	1	9	1	2	4	3	0	4	0	1	5	8	7	9	1	6	0	1	0	2	1	0	0	0	1	0	2	1	11	2	2	7	1	1
6:	0	0	0	3	4	2	0	3	0	5	3	0	2	2	2	4	2	6	4	0	0	0	0	1	1	0	0	0	1	1	7	5	2	4	0	0
5:	0	0	1	7	7	1	3	5	0	6	3	3	2	2	3	3	1	5	0	1	0	2	1	2	0	1	0	1	3	3	5	2	3	0	2	0
4:	0	0	0	2	6	1	3	2	1	2	2	2	2	5	1	3	1	5	2	2	2	1	1	1	2	1	2	2	3	0	3	1	2	2	2	0
3:	0	0	0	3	2	3	3	2	3	5	3	1	1	3	2	4	5	1	1	0	3	2	1	1	0	1	1	3	1	1	2	0	1	1	0	0
2:	0	0	0	1	0	2	1	1	1	2	2	0	1	0	0	3	2	0	1	0	3	0	1	2	2	0	0	1	3	2	1	1	0	0	1	0
1:	0	0	0	0	0	0	1	2	1	2	2	2	0	0	3	1	0	0	0	1	3	0	1	1	2	2	0	1	0	0	1	2	0	0	0	0
0:	0	0	0	0	0	0	3	0	0	1	1	0	1	1	2	1	0	1	0	1	1	1	0	3	1	2	3	1	0	0	2	0	0	0	0	0

Total number of observations = 1398

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:35: 9


         PL90560S.SPR   2732


     Distributions
     -------------

         Spd  CumPrb        Dir    AvgSpd
         ---  ------      -------  ------
           1    2.20       0- 10    14.20
           2    5.01      10- 20     9.59
           3    8.86      20- 30    12.26
           4   14.20      30- 40    10.98
           5   20.50      40- 50    10.18
           6   27.75      50- 60     7.51
           7   34.74      60- 70     6.34
           8   41.22      70- 80     5.56
           9   48.02      80- 90     5.19
          10   53.77      90-100     6.85
          11   60.58     100-110     6.57
          12   65.67     110-120     6.01
          13   68.45     120-130     7.37
          14   72.95     130-140     6.46
          15   77.05     140-150     8.14
          16   80.75     150-160     9.37
          17   84.37     160-170    10.39
          18   87.04     170-180    10.39
          19   89.24     180-190     8.17
          20   91.58     190-200     6.00
          21   93.59     200-210     7.42
          22   95.24     210-220     5.66
          23   96.45     220-230     5.70
          24   97.44     230-240     4.88
          25   98.32     240-250     3.50
          26   98.76     250-260     3.71
          27   99.19     260-270     2.73
          28   99.38     270-280     3.12
          29   99.60     280-290     3.72
          30   99.74     290-300     4.48
          31   99.89     300-310     5.43
          32   99.89     310-320     8.71
          33   99.96     320-330    10.69
          34  100.00     330-340    15.00
          35  100.00     340-350    15.99
          36  100.00     350-360    15.08
          37  100.00
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:48: 6


          PL90520S.SPR    4368
          Dir   Prob.
          ---   ------
            1   .06227
            2   .01168
            3   .00824
            4   .01717
            5   .01053
            6   .01557
            7   .02175
            8   .01168
            9   .01259
           10   .01580
           11   .01442
           12   .02129
           13   .04396
           14   .03434
           15   .03915
           16   .05952
           17   .06342
           18   .06960
           19   .07166
           20   .03549
           21   .02427
           22   .02221
           23   .00870
           24   .00710
           25   .01099
           26   .00572
           27   .00481
           28   .00710
           29   .00435
           30   .00824
           31   .01992
           32   .01877
           33   .02999
           34   .05952
           35   .05952
           36   .06868

          Total number of observations =    4368
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:47:31


          PL90540S.SPR    1398
          Dir   Prob.
          ---   ------
            1  .00215
            2  .00000
            3  .01216
            4  .05365
            5  .04149
            6  .01645
            7  .02575
            8  .02003
            9  .00787
           10  .02647
           11  .01502
           12  .01216
           13  .01502
           14  .02432
           15  .02647
           16  .05222
           17  .02504
           18  .03219
           19  .02361
           20  .01073
           21  .00930
           22  .00572
           23  .00429
           24  .00930
           25  .00572
           26  .00572
           27  .00572
           28  .00787
           29  .01073
           30  .01216
           31  .07082
           32  .08798
           33  .10730
           34  .12661
           35  .05079
           36  .03720

          Total number of observations =    1398
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:46:52


          PL90560S.SPR   2732
          Dir   Prob.
          ---   ------
            1  .03441
            2  .01281
            3  .01135
            4  .05893
            5  .11493
            6  .05307
            7  .02526
            8  .01903
            9  .01867
           10  .02635
           11  .01611
           12  .01867
           13  .02599
           14  .02086
           15  .02965
           16  .04868
           17  .03551
           18  .02892
           19  .02306
           20  .00988
           21  .00695
           22  .00586
           23  .00183
           24  .00293
           25  .00110
           26  .00256
           27  .00403
           28  .00769
           29  .00732
           30  .01135
           31  .02562
           32  .02965
           33  .03880
           34  .07613
           35  .08053
           36  .06552

          Total number of observations =    2732
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:48:42


           PL90580S.SPR   2727
           Dir   Prob.
           ---   ------
             1  .12761
             2  .00440
             3  .02200
             4  .08838
             5  .05171
             6  .02494
             7  .03667
             8  .01907
             9  .02274
            10  .03044
            11  .01577
            12  .01760
            13  .02127
            14  .02200
            15  .01834
            16  .02384
            17  .01687
            18  .01540
            19  .02017
            20  .00917
            21  .00990
            22  .00917
            23  .00513
            24  .00733
            25  .00807
            26  .00917
            27  .00697
            28  .01247
            29  .01063
            30  .01467
            31  .02127
            32  .02567
            33  .04730
            34  .07664
            35  .05831
            36  .06894

           Total number of observations =   2727
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:51: 4


          PL90460S.SPR    4368
          Dir   Prob.
          ---   ------
            1  .03617
            2  .04029
            3  .04922
            4  .08104
            5  .03434
            6  .02587
            7  .03068
            8  .01946
            9  .02312
           10  .03045
           11  .02724
           12  .02335
           13  .02953
           14  .02862
           15  .03159
           16  .04304
           17  .02312
           18  .02701
           19  .03205
           20  .01717
           21  .01351
           22  .01625
           23  .01053
           24  .01190
           25  .01351
           26  .01007
           27  .00939
           28  .01282
           29  .01007
           30  .01328
           31  .02244
           32  .02289
           33  .03320
           34  .05723
           35  .04785
           36  .04167

          Total number of observations =    4368
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:46:16


          PL90477S.SPR   4368
          Dir   Prob.
          ---  ------
            1  .06777
            2  .00069
            3  .01557
            4  .04167
            5  .02862
            6  .01328
            7  .01763
            8  .01946
            9  .01969
           10  .02747
           11  .02656
           12  .02518
           13  .03503
           14  .02335
           15  .02244
           16  .02335
           17  .01259
           18  .01557
           19  .01763
           20  .01419
           21  .01007
           22  .01442
           23  .02289
           24  .02335
           25  .03800
           26  .03434
           27  .04052
           28  .05678
           29  .02953
           30  .02862
           31  .04853
           32  .04281
           33  .04441
           34  .05151
           35  .02381
           36  .02266

          Total number of observations =   4368
```

Direction

Spd	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0
28:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	1
27:	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0
26:	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	4	2
25:	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	2
24:	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	6	5
23:	3	0	1	2	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	7	6	1
22:	3	0	0	2	3	0	0	0	0	0	0	0	0	0	0	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	7	5	7
21:	4	1	2	0	2	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	4	14	10
20:	8	0	1	2	5	0	0	0	0	0	0	0	0	0	1	1	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	13	9	10
19:	5	1	1	2	6	0	1	0	0	1	0	0	1	0	0	2	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	10	13	12
18:	6	0	0	3	8	3	0	0	0	0	0	0	1	1	0	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	7	11	8
17:	9	3	1	3	15	1	0	1	0	0	0	0	0	0	1	3	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	3	6	10	8
16:	4	1	2	8	11	3	1	0	1	1	0	0	0	1	1	2	2	6	3	0	0	1	0	0	0	0	0	0	0	0	0	2	3	13	21	12
15:	5	2	1	12	17	6	2	0	0	2	1	0	3	0	2	4	3	2	0	1	1	0	0	0	0	0	0	0	0	0	2	1	2	11	13	8
14:	5	2	4	11	9	3	0	1	0	1	0	1	1	2	3	5	2	2	2	0	2	0	0	0	0	0	0	0	0	1	0	1	6	13	18	17
13:	1	0	1	13	21	8	1	0	0	2	2	0	1	2	4	5	2	7	1	1	2	0	0	0	0	0	0	0	0	0	0	2	6	13	15	13
12:	1	0	1	6	12	0	1	0	1	4	0	1	3	2	3	5	6	3	1	0	0	0	0	0	0	0	0	0	0	0	1	3	3	7	7	5
11:	3	1	2	10	20	8	2	2	0	2	2	1	2	1	6	9	3	6	4	0	1	0	0	0	0	0	0	0	0	1	2	3	7	13	10	18
10:	5	3	1	13	23	6	1	0	1	2	2	5	4	1	7	13	7	5	7	2	0	1	0	0	0	0	0	0	1	1	2	9	17	20	14	13
9:	2	1	3	11	19	9	7	3	1	1	5	4	9	3	7	8	4	4	6	0	0	0	0	0	0	0	0	0	0	0	4	10	7	10	11	8
8:	3	2	3	18	31	11	6	5	3	5	5	2	6	3	7	10	9	6	10	1	0	2	0	1	0	0	0	0	1	0	2	5	10	7	7	5
7:	3	2	2	8	26	17	1	7	5	10	5	6	4	5	4	5	9	5	7	6	1	1	3	1	0	0	0	1	0	1	7	7	4	8	4	2
6:	6	7	3	14	18	14	7	5	8	8	4	4	5	12	6	8	7	9	3	4	1	1	0	1	1	1	0	1	1	3	9	6	5	4	1	4
5:	0	5	2	8	22	13	12	5	8	11	3	8	10	4	10	10	8	5	4	2	2	2	1	0	0	2	1	1	2	4	11	4	8	4	5	1
4:	5	3	0	5	10	15	10	7	5	7	4	6	9	9	8	10	4	4	1	2	2	2	0	2	0	0	1	5	2	7	10	3	5	3	3	3
3:	3	1	0	3	10	12	9	3	8	6	2	4	6	1	4	9	6	2	6	4	0	3	0	2	0	1	3	4	7	6	5	7	6	2	1	0
2:	3	0	0	4	10	8	3	5	2	5	6	4	2	2	6	6	1	4	3	1	1	0	0	1	1	2	3	4	2	2	3	6	2	0	0	3
1:	2	0	0	0	9	3	5	5	6	3	3	2	2	3	0	3	2	0	2	1	3	3	1	0	1	1	3	3	3	1	6	0	0	1	0	0
0:	0	0	0	1	5	5	0	3	2	1	0	3	2	5	1	4	3	0	1	2	2	0	0	0	0	0	0	2	1	4	6	4	0	3	0	0

Total number of observations = 2732

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date: 2/ 7/1995  Time: 15:38:23


          PL90580S.SPR   2727

     Distributions
     -------------

          Spd  CumPrb          Dir    AvgSpd
          ---  ------        -------  ------
            1    2.05         0- 10   11.94
            2    4.18        10- 20   14.46
            3    8.10        20- 30   10.26
            4   12.32        30- 40   10.34
            5   17.79        40- 50    8.30
            6   24.39        50- 60    8.34
            7   31.54        60- 70    7.51
            8   38.58        70- 80    6.74
            9   46.20        80- 90    7.25
           10   53.06        90-100    7.43
           11   59.99       100-110    8.53
           12   65.82       110-120    7.44
           13   68.57       120-130    7.99
           14   74.15       130-140    9.30
           15   78.25       140-150    9.92
           16   82.87       150-160    9.02
           17   86.03       160-170   11.16
           18   89.07       170-180    9.10
           19   91.57       180-190    7.72
           20   93.51       190-200    8.72
           21   94.98       200-210    8.69
           22   96.22       210-220    5.92
           23   97.25       220-230    5.61
           24   97.69       230-240    5.00
           25   98.09       240-250    5.75
           26   98.57       250-260    5.30
           27   98.86       260-270    5.39
           28   99.27       270-280    6.07
           29   99.49       280-290    8.33
           30   99.67       290-300    9.84
           31   99.78       300-310    9.63
           32   99.89       310-320   13.70
           33   99.96       320-330   13.92
           34   99.96       330-340   12.80
           35  100.00       340-350   13.06
           36  100.00       350-360   11.68
           37  100.00
```

Spd	Direction																																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0
30:	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
29:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1
28:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0
27:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	3	1	0
26:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	1	0
25:	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	0
24:	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	1
23:	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	3	2	0	1
22:	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	4	2	3	5
21:	5	0	1	2	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	7	7	2	3
20:	6	0	1	4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	8	10	4	2
19:	10	0	1	5	1	1	0	0	0	0	0	0	0	0	1	1	2	1	0	0	0	0	0	0	0	0	0	0	1	0	3	2	3	8	6	7
18:	10	1	0	9	3	0	0	2	0	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	6	12	9	6
17:	18	2	3	6	0	0	0	0	1	1	1	0	1	2	0	1	2	1	1	0	0	0	0	0	0	0	0	0	1	2	3	4	4	9	11	9
16:	11	2	1	6	4	0	1	1	1	0	0	0	1	5	4	5	4	1	1	2	1	0	0	0	0	0	0	1	1	1	1	1	6	6	10	8
15:	25	2	4	12	6	2	0	0	1	0	0	0	1	2	3	4	7	2	2	2	1	0	0	0	0	0	0	1	1	1	0	1	10	15	11	10
14:	16	1	2	12	2	3	1	1	0	1	1	2	0	2	2	4	1	3	5	0	3	0	0	0	0	0	0	0	0	0	2	3	4	13	13	15
13:	27	1	7	9	8	2	6	2	0	4	1	2	4	6	3	7	3	3	1	1	1	0	0	0	0	1	0	0	1	2	1	1	3	13	14	18
12:	10	0	2	10	3	6	1	0	2	2	0	1	4	2	3	0	1	1	1	1	0	0	0	0	0	0	0	0	0	2	1	1	4	6	3	8
11:	15	0	3	17	6	3	6	0	4	4	4	2	2	5	3	4	2	5	7	2	0	1	1	0	1	0	1	2	1	1	4	5	11	15	14	8
10:	26	2	6	28	16	4	6	2	7	5	8	3	4	1	1	2	4	2	2	4	1	1	1	0	2	0	1	3	2	3	0	2	4	11	8	17
9:	18	1	6	28	10	7	14	4	4	4	1	4	4	3	3	5	3	3	3	0	5	2	1	3	3	4	1	0	1	0	3	2	5	11	14	7
8:	23	0	5	26	9	7	9	2	5	12	8	7	4	5	4	2	5	3	3	2	4	5	1	3	0	1	1	5	3	4	1	5	5	13	7	9
7:	22	0	2	18	20	6	15	7	6	10	6	7	11	4	4	1	3	0	2	1	2	2	1	1	1	1	3	2	2	6	1	0	4	4	7	10
6:	23	0	3	11	18	7	9	8	7	9	2	5	6	8	8	6	2	5	3	4	3	2	1	1	3	2	2	3	4	1	5	4	3	7	4	6
5:	15	0	1	14	8	7	15	7	12	10	4	6	2	4	5	3	1	3	2	2	3	2	2	2	3	3	1	2	2	2	4	3	8	12	1	9
4:	17	0	4	9	10	4	6	5	1	9	4	2	2	3	2	0	1	3	3	1	1	2	1	3	2	3	3	4	2	6	6	6	4	7	4	9
3:	8	0	1	5	6	4	6	4	6	6	1	3	5	2	0	4	2	2	4	0	1	4	1	2	4	5	1	3	2	2	7	1	2	5	1	5
2:	5	0	2	4	4	3	2	4	2	4	1	3	2	0	1	5	1	3	8	1	1	3	2	1	2	2	2	4	3	1	6	2	4	7	4	8
1:	5	0	1	3	4	0	1	2	2	0	0	0	2	4	1	4	0	0	5	0	0	0	1	0	0	2	2	2	0	1	2	4	4	3	0	3
0:	6	0	3	2	3	1	2	1	1	1	0	1	2	1	0	5	1	1	1	2	0	1	1	4	1	1	1	2	1	0	1	1	1	1	4	2

Total number of observations =   2727

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:33: 8


         PL90460S.SPR   4368

     Distributions
     -------------

         Spd   CumPrb        Dir     AvgSpd
         ---   ------      -------   ------
           1     2.34        0- 10    13.60
           2     5.01       10- 20    14.38
           3     8.33       20- 30    14.80
           4    13.23       30- 40    12.08
           5    18.93       40- 50     8.09
           6    26.14       50- 60     8.63
           7    34.20       60- 70     7.94
           8    42.58       70- 80     7.91
           9    50.41       80- 90     7.09
          10    58.31       90-100     7.31
          11    64.65      100-110     7.81
          12    71.11      110-120     7.42
          13    73.65      120-130     8.49
          14    78.53      130-140     8.60
          15    82.94      140-150     9.47
          16    86.15      150-160     8.99
          17    89.86      160-170     8.88
          18    91.99      170-180     7.78
          19    93.61      180-190     7.86
          20    95.22      190-200     6.65
          21    96.29      200-210     6.47
          22    97.37      210-220     6.27
          23    98.26      220-230     5.63
          24    98.92      230-240     4.96
          25    99.24      240-250     6.24
          26    99.57      250-260     5.36
          27    99.77      260-270     6.32
          28    99.82      270-280     6.00
          29    99.86      280-290     5.64
          30    99.89      290-300     5.47
          31    99.91      300-310     7.44
          32    99.93      310-320     9.29
          33    99.98      320-330     9.20
          34    99.98      330-340     9.95
          35    99.98      340-350    11.72
          36    99.98      350-360    12.99
          37    99.98
          38   100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
30:	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29:	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
27:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
26:	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3
25:	1	3	4	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
24:	2	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4
23:	1	5	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	3
22:	8	5	9	6	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2	1
21:	5	7	4	7	0	0	0	0	0	0	0	0	0	1	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	4	6	4
20:	5	8	11	5	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	4	7	1
19:	8	10	5	11	1	0	2	1	1	0	0	0	1	0	2	3	2	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	5	5	9
18:	3	7	11	9	2	0	0	0	1	1	1	0	0	2	1	2	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	2	1	7	2	16
17:	7	10	12	13	1	1	0	0	0	1	3	1	2	1	4	4	2	3	2	1	0	0	0	0	0	0	0	0	0	0	1	4	2	7	3	8
16:	10	14	24	22	2	4	2	0	1	4	2	0	1	4	7	1	2	1	0	0	0	2	0	0	1	0	0	1	0	0	2	5	5	9	19	17
15:	13	15	19	14	3	1	5	0	0	2	1	2	4	4	4	8	4	6	4	1	0	0	1	0	0	1	1	1	0	1	0	1	6	5	10	3
14:	9	13	16	30	7	7	5	6	0	5	1	3	9	4	8	11	2	3	7	1	0	0	0	0	0	0	2	1	0	0	2	8	7	7	10	9
13:	13	11	17	28	7	2	3	7	4	1	5	0	4	3	9	10	5	7	9	4	0	1	1	0	1	1	2	2	0	2	6	5	7	13	14	9
12:	4	4	10	9	5	4	3	2	2	1	6	2	2	6	4	5	6	2	6	1	0	0	1	0	0	0	1	0	0	0	1	3	3	8	7	3
11:	10	9	14	26	10	12	15	4	6	6	6	6	12	12	14	9	4	6	13	4	2	4	1	0	1	2	1	3	0	0	7	8	13	17	12	13
10:	13	11	7	32	11	6	5	5	4	6	6	10	9	12	13	18	6	9	5	3	5	6	4	1	3	1	2	1	1	2	0	7	4	20	13	16
9:	8	17	18	30	8	13	11	8	8	14	11	8	14	12	6	13	10	4	11	6	8	5	4	3	4	2	3	4	5	2	10	8	15	17	11	14
8:	13	6	11	28	17	8	17	6	12	12	15	14	8	5	10	21	12	7	7	4	8	5	1	3	9	4	2	1	5	5	5	7	8	15	14	17
7:	10	3	4	28	16	10	20	7	8	19	9	12	16	10	13	16	6	9	14	8	5	8	1	11	8	5	3	6	8	4	11	6	15	18	13	6
6:	4	10	3	17	15	11	8	8	12	11	13	8	10	11	10	19	10	14	15	6	7	9	3	4	5	4	3	6	7	8	10	7	12	25	16	11
5:	5	3	2	14	11	5	8	11	14	19	7	16	10	9	12	14	8	11	12	11	5	6	3	8	3	4	3	7	0	7	8	7	13	27	10	2
4:	0	1	1	7	9	6	6	4	10	11	17	6	6	12	7	6	6	10	9	10	4	4	9	3	4	2	5	8	4	7	10	4	8	17	10	6
3:	3	2	1	3	12	7	11	6	6	7	7	7	14	4	2	4	4	5	13	5	3	8	8	4	11	7	3	2	6	4	8	4	9	7	5	2
2:	1	0	1	2	7	8	3	5	4	3	2	2	4	6	6	8	2	5	5	4	5	6	5	8	2	4	4	5	3	3	5	4	6	3	4	0
1:	0	0	0	2	5	5	5	1	5	4	2	4	1	5	4	5	6	5	1	3	5	2	1	5	2	2	3	4	2	6	6	3	2	5	4	2
0:	0	0	0	1	1	0	5	3	2	6	4	1	1	1	1	7	1	8	7	3	1	5	3	2	4	5	3	4	3	6	2	5	2	3	1	1

Total number of observations =   4368

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:34:12


        PL90477S.SPR   4368


    Distributions
    -------------

        Spd  CumPrb        Dir     AvgSpd
        ---  ------      -------   ------
          1    5.04        0- 10    11.56
          2    8.77       10- 20    14.17
          3   13.10       20- 30     9.45
          4   18.52       30- 40     8.12
          5   24.13       40- 50     7.62
          6   30.70       50- 60     8.51
          7   38.76       60- 70     8.02
          8   46.82       70- 80     7.88
          9   54.30       80- 90     9.15
         10   61.54       90-100     8.77
         11   68.11      100-110     9.51
         12   74.52      110-120    10.69
         13   77.24      120-130     9.42
         14   82.46      130-140     8.90
         15   86.54      140-150     7.61
         16   89.84      150-160     7.80
         17   92.61      160-170     6.37
         18   94.76      170-180     6.09
         19   96.18      180-190     6.36
         20   97.37      190-200     7.29
         21   98.12      200-210     7.64
         22   98.60      210-220     6.91
         23   99.02      220-230     7.18
         24   99.40      230-240     7.92
         25   99.61      240-250     8.96
         26   99.79      250-260    10.79
         27   99.82      260-270    10.29
         28   99.89      270-280     9.24
         29   99.95      280-290     8.33
         30   99.98      290-300     8.34
         31  100.00      300-310     7.13
         32  100.00      310-320     7.27
         33  100.00      320-330     7.86
         34  100.00      330-340     8.08
         35  100.00      340-350     8.86
         36  100.00      350-360    11.20
         37  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
29:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
27:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0
26:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
25:	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	0	0	0	0	0	0	0	0
24:	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	2	0
23:	3	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3	1	2	0	0	1	0	1	0	2	0	2
22:	4	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	2	3	1	1	0	1	0	1	0	1
21:	4	0	0	1	0	2	0	0	0	1	1	1	0	0	0	2	0	0	0	0	0	0	0	0	1	2	1	1	0	0	1	0	0	1	1	1
20:	5	0	0	0	0	0	0	0	1	3	1	4	0	2	0	0	0	0	0	0	0	0	1	1	1	1	2	4	0	2	0	1	1	0	0	3
19:	4	1	0	1	0	0	0	2	3	0	1	2	5	1	0	1	0	0	0	0	0	0	0	0	2	4	2	3	1	2	2	2	1	3	5	4
18:	11	0	0	2	0	1	1	1	0	0	1	2	2	2	0	2	0	0	0	1	0	2	0	1	2	4	7	7	1	1	2	1	2	4	1	1
17:	16	0	1	2	0	2	2	0	2	1	6	4	7	0	1	2	0	0	0	0	1	0	2	0	0	6	6	6	3	1	3	2	6	7	2	3
16:	21	0	4	2	3	1	0	1	4	2	3	6	6	4	3	2	2	0	1	1	1	1	2	1	5	5	4	9	3	4	3	5	0	2	3	7
15:	16	1	2	5	4	1	0	7	3	1	9	7	6	3	1	2	0	0	2	2	0	1	3	2	4	8	8	8	8	4	4	4	5	6	4	3
14:	13	0	2	7	6	4	4	2	6	9	6	8	7	4	4	2	1	1	1	2	2	1	5	4	9	5	7	12	4	4	8	2	3	7	5	11
13:	22	0	5	10	6	1	2	6	2	7	7	11	7	2	7	3	1	0	4	3	3	0	4	10	6	8	11	12	14	6	11	7	8	11	5	6
12:	11	0	2	8	4	1	9	1	3	3	2	4	5	4	3	4	0	1	4	1	0	1	2	3	1	1	10	4	3	3	3	6	4	4	2	2
11:	24	0	6	11	10	6	4	3	5	10	7	9	9	7	6	6	0	4	3	2	4	3	4	5	21	9	13	16	5	11	6	9	21	12	4	5
10:	18	0	4	13	11	0	5	8	4	12	6	5	17	10	5	4	2	5	5	6	2	3	5	12	8	11	13	13	4	7	18	14	12	13	7	5
9:	17	0	8	16	6	9	8	3	8	15	12	2	9	11	6	11	6	8	4	2	2	5	2	6	17	10	11	13	6	6	17	13	21	11	9	6
8:	22	0	8	16	11	4	9	9	7	5	9	4	13	10	5	5	6	3	4	6	4	6	8	4	18	14	14	22	4	6	11	12	13	18	6	11
7:	17	1	8	16	10	4	2	5	8	11	7	5	15	11	5	8	8	5	3	2	1	5	7	6	16	14	13	21	20	13	17	17	14	23	8	6
6:	26	0	7	16	8	6	6	3	3	6	7	12	6	4	12	12	6	7	4	8	9	13	9	10	16	8	13	17	11	7	13	17	21	17	4	8
5:	16	0	3	13	10	4	7	5	6	11	6	4	7	5	7	6	5	10	11	6	3	4	6	10	6	8	10	19	6	8	15	7	16	15	9	3
4:	9	0	3	10	7	2	1	7	6	7	5	4	4	4	13	6	3	6	8	4	6	3	12	6	6	7	10	9	6	7	16	14	7	19	5	3
3:	5	0	2	11	9	0	5	7	6	3	7	3	12	5	7	9	4	8	5	3	1	7	5	9	7	6	1	15	5	7	17	10	10	16	6	4
2:	5	0	1	12	8	2	6	4	0	5	5	4	5	4	4	4	5	3	6	3	5	3	8	3	6	4	6	17	6	5	13	11	9	6	1	0
1:	3	0	0	3	3	3	4	5	5	3	2	1	4	3	4	3	2	1	4	4	0	2	8	5	6	2	4	6	5	9	16	12	12	10	7	2
0:	0	0	1	7	9	5	2	6	3	5	5	6	6	5	4	8	4	6	8	5	0	3	6	4	5	4	5	8	12	9	16	19	8	16	8	2

Total number of observations = 4368

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:48:27


           PL90520S.SUM   4189


        Distributions
        -------------

           Spd  CumPrb        Dir    AvgSpd
           ---  ------      -------  ------
             1    2.51       0- 10    17.67
             2    4.87      10- 20    14.38
             3    8.78      20- 30    11.44
             4   13.39      30- 40    10.41
             5   19.31      40- 50     8.03
             6   26.00      50- 60     7.68
             7   32.18      60- 70     7.34
             8   38.74      70- 80     7.78
             9   45.79      80- 90     8.45
            10   52.30      90-100     9.02
            11   58.53     100-110     8.93
            12   64.07     110-120     9.20
            13   66.98     120-130     8.79
            14   72.19     130-140     9.37
            15   76.22     140-150    10.28
            16   80.09     150-160    11.60
            17   83.81     160-170    12.47
            18   86.32     170-180    12.39
            19   88.76     180-190    13.04
            20   90.52     190-200    11.83
            21   92.27     200-210    10.53
            22   93.77     210-220     8.10
            23   94.99     220-230     8.55
            24   95.75     230-240     6.43
            25   96.32     240-250     6.16
            26   96.63     250-260     7.28
            27   97.16     260-270     6.88
            28   97.68     270-280     6.42
            29   97.99     280-290     7.59
            30   98.31     290-300     7.90
            31   98.47     300-310     7.52
            32   98.64     310-320     7.49
            33   98.85     320-330     8.84
            34   99.02     330-340     9.87
            35   99.14     340-350    11.55
            36   99.26     350-360    16.45
            37   99.28
            38   99.38
            39   99.43
            40   99.45
            41   99.52
            42   99.55
            43   99.64
            44   99.71
            45   99.71
            46   99.74
            47   99.79
            48   99.83
            49   99.90
            50   99.90
            51   99.95
            52  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
50:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
46:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
42:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
40:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
38:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
35:	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
34:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1
33:	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
32:	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
31:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3
30:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
29:	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5
28:	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	3
27:	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5
26:	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	1	0	0	0	0	0	0	0	0	0	0	1	1	3	2	5
25:	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2	3	0
24:	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	6
23:	4	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	3	4	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	5	9
22:	7	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	6	3	11	2	0	0	0	0	0	1	0	1	0	0	0	0	4	1	3	8
21:	11	1	0	2	0	0	0	1	0	0	0	0	1	0	0	4	10	3	8	3	2	0	0	0	0	0	0	0	1	0	0	2	1	4	5	4
20:	4	0	1	3	1	0	0	1	0	1	1	3	1	1	3	9	5	5	13	3	2	0	0	0	0	0	1	1	0	0	0	0	1	2	3	8
19:	12	2	1	1	0	0	0	0	0	0	0	2	2	2	1	8	3	7	7	4	0	1	1	0	0	0	1	0	0	0	0	2	1	7	4	5
18:	8	1	0	3	1	1	1	0	1	0	2	2	0	7	4	10	7	9	9	5	5	0	0	1	0	1	0	0	0	0	2	1	2	6	6	7
17:	6	1	2	5	1	0	0	1	2	1	5	0	4	2	5	5	8	9	10	14	1	0	0	0	1	0	0	0	0	2	0	2	1	5	7	5
16:	4	2	2	3	2	3	5	2	3	9	2	3	3	3	5	13	9	11	15	7	5	2	0	1	0	0	0	0	2	2	8	1	4	6	9	10
15:	9	1	3	6	1	2	3	3	0	4	2	1	8	11	6	9	7	12	22	6	1	4	3	0	0	2	0	0	3	2	3	2	3	5	7	11
14:	8	0	1	4	7	4	3	4	2	6	7	9	6	5	5	9	9	8	10	6	6	1	0	1	0	2	2	3	1	1	0	3	3	4	10	19
13:	8	1	2	9	3	10	8	0	3	6	3	8	4	4	12	7	23	11	21	2	6	9	3	0	2	0	0	1	0	2	0	1	6	12	15	16
12:	4	0	3	5	5	4	3	6	4	2	4	2	2	4	2	8	4	8	10	6	4	3	2	0	1	0	0	1	1	0	3	1	3	5	7	5
11:	9	0	1	8	6	2	5	2	3	6	5	4	15	6	4	12	13	12	21	15	3	7	5	3	4	2	0	0	1	1	1	4	6	12	23	11
10:	9	2	3	13	8	7	7	4	6	8	6	13	6	4	8	19	11	19	12	5	10	4	4	2	1	2	3	4	2	6	2	6	7	17	8	13
9:	14	0	3	6	9	3	9	4	6	6	4	8	9	4	13	11	8	14	11	9	5	5	5	4	5	6	4	4	3	3	5	6	7	21	20	19
8:	12	0	6	19	10	10	14	4	6	9	5	11	14	13	10	10	10	8	6	10	9	7	4	2	7	3	4	2	4	4	8	10	8	16	13	7
7:	6	1	3	10	16	9	12	6	7	7	9	8	7	10	9	11	8	9	10	11	5	5	2	6	9	5	4	2	1	3	6	10	7	14	16	11
6:	4	0	3	4	8	9	16	5	6	5	4	6	8	7	5	14	6	8	11	10	6	5	6	4	8	5	3	3	4	8	10	5	8	25	11	9
5:	5	1	4	8	10	14	13	12	8	3	5	13	11	7	7	8	6	8	18	7	5	4	2	0	6	6	3	4	1	5	9	7	13	16	24	7
4:	8	0	0	8	6	10	13	8	1	6	3	4	21	15	5	9	6	6	10	7	5	5	3	6	3	4	4	7	1	2	9	4	9	19	15	6
3:	2	0	0	3	13	8	10	3	5	6	5	4	7	7	3	2	5	5	9	4	3	7	4	3	7	7	2	6	1	5	5	6	8	14	10	4
2:	1	1	1	1	5	6	10	6	3	6	6	3	3	1	3	3	5	4	5	4	1	6	0	4	5	4	4	4	8	3	4	7	7	10	13	7
1:	1	1	0	3	3	3	2	3	0	3	2	1	4	4	3	2	2	1	5	2	4	1	0	0	4	4	1	5	4	1	4	7	9	5	4	1
0:	0	0	0	1	2	4	6	4	2	3	4	4	0	1	3	1	1	4	2	1	2	5	2	5	4	0	3	2	0	1	3	8	5	9	7	6

Total number of observations =   4189

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:49:22


          PL90540S.SUM   2505


     Distributions
     -------------

          Spd  CumPrb        Dir     AvgSpd
          ---  ------      -------   ------
            1    3.03        0- 10    14.49
            2    6.11       10- 20    15.20
            3   11.14       20- 30    10.93
            4   16.01       30- 40     9.04
            5   22.83       40- 50     7.46
            6   31.02       50- 60     6.34
            7   39.32       60- 70     6.17
            8   46.83       70- 80     6.70
            9   53.73       80- 90     6.12
           10   60.48       90-100     6.87
           11   65.99      100-110     8.19
           12   71.18      110-120     8.34
           13   73.65      120-130     8.31
           14   78.36      130-140     8.97
           15   81.88      140-150    10.92
           16   85.19      150-160    10.41
           17   87.54      160-170    11.53
           18   89.86      170-180    11.00
           19   91.70      180-190    10.06
           20   93.25      190-200     8.32
           21   94.45      200-210     7.99
           22   95.29      210-220     8.71
           23   96.21      220-230     5.69
           24   97.05      230-240     4.20
           25   97.64      240-250     4.22
           26   98.12      250-260     4.35
           27   98.76      260-270     3.93
           28   99.04      270-280     3.33
           29   99.32      280-290     4.07
           30   99.52      290-300     3.46
           31   99.64      300-310     5.29
           32   99.80      310-320     5.84
           33   99.80      320-330     7.01
           34   99.84      330-340     9.91
           35   99.92      340-350    12.20
           36   99.96      350-360    12.22
           37   99.96
           38  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30:	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29:	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
28:	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
27:	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26:	6	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2
25:	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2
24:	2	3	0	1	0	0	0	0	0	0	0	0	0	2	1	1	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
23:	6	4	0	3	0	0	0	0	0	0	0	0	0	0	2	0	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
22:	3	2	1	2	0	0	0	0	0	0	0	1	1	0	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5
21:	4	4	0	0	0	0	0	0	0	0	2	0	0	0	0	1	2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1
20:	5	6	0	1	0	0	0	0	0	0	0	0	1	1	1	0	2	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3
19:	5	4	0	2	0	0	0	0	0	0	1	0	0	0	1	5	0	1	4	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6	5	3
18:	6	4	0	1	0	0	0	0	0	0	0	0	1	2	1	5	1	6	3	0	0	0	0	0	0	0	0	0	0	0	1	1	0	4	7	3
17:	8	3	1	2	1	1	0	0	0	0	0	0	0	1	2	2	5	4	5	2	0	0	0	0	0	0	0	0	0	0	0	0	2	5	8	6
16:	8	2	0	5	1	0	0	0	0	0	0	0	0	1	1	4	1	2	5	3	2	1	0	0	0	0	0	0	0	0	0	1	2	4	8	8
15:	5	3	2	0	2	0	0	0	1	0	3	2	3	1	5	7	5	2	11	5	1	2	0	0	0	0	0	0	0	0	0	0	2	4	7	10
14:	2	5	1	5	3	0	2	1	0	2	3	2	1	3	2	6	5	5	8	5	1	1	0	0	0	0	0	0	0	0	0	1	2	5	10	7
13:	8	4	1	9	4	4	4	2	2	3	3	1	1	4	4	7	6	7	11	4	3	2	2	0	0	1	0	0	0	0	0	0	4	8	4	5
12:	3	3	1	6	1	0	1	0	0	1	1	2	1	4	2	1	3	7	5	1	0	1	0	0	0	0	0	0	0	0	1	2	1	4	6	4
11:	5	1	1	12	4	2	1	2	1	1	4	4	1	6	4	9	6	7	10	5	5	3	0	0	0	0	0	0	0	0	1	4	5	10	11	5
10:	11	2	2	12	6	2	1	7	2	3	1	3	6	1	3	9	3	7	10	6	0	1	1	1	1	1	0	1	0	0	1	1	4	8	8	13
9:	12	6	0	14	6	5	7	5	3	5	3	5	7	4	3	6	10	3	8	4	1	7	1	1	0	0	0	1	1	0	5	2	6	10	9	9
8:	12	6	0	16	7	5	6	5	3	7	4	2	8	7	5	6	5	9	14	7	3	3	2	0	0	0	0	1	0	0	0	2	9	6	4	9
7:	8	5	2	13	10	8	4	5	7	5	4	6	6	4	5	7	12	4	12	10	2	2	1	0	3	2	1	0	3	1	3	2	7	8	7	9
6:	5	4	4	15	11	9	9	6	9	9	2	8	5	6	5	7	3	9	11	8	8	5	3	1	2	1	6	0	0	1	5	8	8	5	7	3
5:	2	4	2	16	10	16	8	4	3	5	5	5	7	7	6	9	6	8	8	5	3	2	2	5	4	3	4	1	4	2	1	4	8	10	4	12
4:	10	3	0	12	8	5	7	2	3	5	5	3	8	4	6	5	5	7	10	8	2	1	2	3	5	2	1	1	4	3	6	4	6	9	1	5
3:	4	2	0	6	6	2	2	7	4	2	9	1	3	2	2	5	2	2	6	5	3	1	3	4	3	7	2	0	2	1	4	5	7	6	1	1
2:	5	1	1	8	5	9	5	4	3	4	1	0	2	6	3	7	1	3	7	6	1	0	1	2	1	2	1	4	2	3	3	5	4	8	5	3
1:	1	0	0	1	2	3	7	3	2	1	2	0	0	4	1	3	4	1	4	2	1	0	1	1	5	2	2	3	3	1	2	4	4	4	2	1
0:	0	1	0	3	1	0	3	1	3	3	1	2	1	1	0	2	1	2	4	3	1	2	2	2	1	2	4	3	2	2	6	5	8	4	0	0

Total number of observations =   2505

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:44:47


          PL90560S.SUM   4417


     Distributions
     -------------

          Spd  CumPrb         Dir    AvgSpd
          ---  ------       -------  ------
            1    5.25         0- 10    9.41
            2    9.40        10- 20   11.60
            3   14.67        20- 30   11.26
            4   21.19        30- 40   11.25
            5   28.55        40- 50    8.07
            6   35.91        50- 60    7.01
            7   43.15        60- 70    5.61
            8   50.85        70- 80    5.72
            9   57.62        80- 90    6.27
           10   64.16        90-100    5.74
           11   69.96       100-110    6.36
           12   75.23       110-120    7.58
           13   77.45       120-130    7.97
           14   81.82       130-140    7.50
           15   84.60       140-150    8.28
           16   87.98       150-160    9.30
           17   90.36       160-170    9.88
           18   92.46       170-180   12.81
           19   93.82       180-190   12.37
           20   94.95       190-200   10.51
           21   96.02       200-210   10.12
           22   96.83       210-220    7.03
           23   97.42       220-230    7.53
           24   97.87       230-240    6.01
           25   98.23       240-250    4.78
           26   98.55       250-260    4.87
           27   98.80       260-270    5.39
           28   99.09       270-280    4.12
           29   99.23       280-290    2.53
           30   99.46       290-300    3.47
           31   99.57       300-310    3.89
           32   99.66       310-320    4.82
           33   99.68       320-330    4.84
           34   99.82       330-340    5.44
           35   99.91       340-350    6.23
           36   99.95       350-360    7.78
           37   99.95
           38   99.98
           39   99.98
           40   99.98
           41  100.00
```

Spd	Direction																																		
---	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30:	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29:	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	0	2	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27:	2	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
26:	1	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
25:	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	1	4	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24:	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	1	3	2	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
23:	3	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	2	4	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22:	3	2	0	0	1	0	0	0	0	0	0	0	0	0	0	1	2	5	4	2	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2
21:	4	4	0	6	3	0	0	0	0	0	0	0	0	0	0	1	2	1	4	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
20:	7	3	1	8	5	0	0	0	0	0	0	1	0	0	0	2	1	5	7	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2
19:	3	1	2	11	0	0	0	0	0	0	0	1	0	0	2	3	4	4	8	4	2	1	2	0	0	0	0	0	0	0	0	0	0	0	1	1
18:	10	2	4	12	2	0	0	0	0	0	0	1	0	0	1	5	2	3	6	7	0	2	0	0	0	0	0	0	0	0	0	0	1	0	1	1
17:	7	1	3	29	5	3	0	0	0	0	0	0	0	3	2	2	2	8	10	6	4	1	1	0	0	0	0	0	0	0	0	0	0	0	2	4
16:	9	3	4	25	6	3	0	1	1	1	2	0	1	0	2	6	4	5	14	3	2	3	1	1	0	0	0	0	0	0	0	0	1	1	1	5
15:	14	7	3	30	8	3	1	0	1	1	1	2	0	0	10	11	6	4	11	6	3	3	5	0	0	0	0	0	0	0	1	1	1	3	5	8
14:	10	3	5	29	9	3	1	0	1	1	1	1	6	2	1	5	10	3	10	4	2	1	1	1	2	0	0	0	0	0	0	0	0	2	3	6
13:	20	9	2	38	11	7	2	3	2	0	2	4	8	5	5	10	9	6	12	12	2	0	5	0	1	1	0	0	0	0	0	1	1	5	1	9
12:	13	3	1	16	8	2	0	3	2	3	0	2	3	2	3	2	7	3	4	2	7	0	2	0	0	0	0	1	0	0	0	0	0	3	1	5
11:	22	3	5	45	15	1	7	0	3	3	3	4	4	8	8	14	12	12	21	10	7	1	0	1	0	1	1	0	0	0	0	1	2	2	5	12
10:	20	5	8	26	20	2	5	4	5	6	8	4	9	7	12	22	13	10	15	8	6	8	3	2	2	0	4	1	0	2	1	0	2	8	3	5
9:	25	7	8	27	31	7	8	3	6	5	5	5	10	9	10	14	15	9	11	15	5	6	3	1	1	1	2	1	0	1	1	4	1	9	9	14
8:	30	5	8	37	23	13	8	9	6	7	1	4	9	7	9	16	10	12	15	11	8	5	4	5	1	2	5	0	0	0	4	1	3	2	8	11
7:	23	3	5	42	27	11	10	8	10	10	3	10	18	9	14	15	18	12	17	9	8	10	7	5	1	4	0	3	0	2	0	1	2	5	7	11
6:	31	5	6	26	20	9	11	7	9	6	8	10	9	6	9	9	12	10	17	8	5	9	10	6	4	3	4	2	0	3	3	5	5	6	15	12
5:	24	2	2	25	32	7	11	14	10	8	4	10	8	8	7	12	13	9	10	10	10	8	8	4	5	2	2	6	2	1	4	5	5	9	14	14
4:	21	5	5	22	26	16	12	9	9	4	6	7	7	3	6	14	10	10	9	11	8	7	4	6	2	4	2	5	2	3	3	4	7	20	19	17
3:	24	5	0	9	14	8	12	10	4	9	9	3	4	6	8	9	9	6	12	11	5	8	5	6	10	2	4	5	3	3	6	7	9	13	14	16
2:	11	0	2	9	16	9	11	9	6	5	3	4	3	5	4	8	5	3	9	4	2	8	8	3	4	3	7	5	4	4	7	3	10	15	9	15
1:	8	1	0	5	15	3	9	6	1	5	3	3	3	5	6	4	3	3	7	8	6	5	2	1	3	5	3	5	4	4	6	3	7	6	14	11
0:	15	5	0	15	9	7	8	3	9	13	7	1	2	4	6	8	2	3	7	4	1	5	4	2	5	2	1	3	3	7	6	6	6	24	17	12

Total number of observations =   4417

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:46:38


          PL90580S.SUM   4189


     Distributions
     -------------

          Spd  CumPrb        Dir    AvgSpd
          ---  ------      -------  ------
            1    6.52       0-  10    9.12
            2   10.91      10-  20    8.95
            3   14.94      20-  30   13.88
            4   19.65      30-  40   10.01
            5   24.99      40-  50    8.50
            6   30.99      50-  60    7.13
            7   38.08      60-  70    5.92
            8   45.67      70-  80    6.57
            9   52.97      80-  90    7.04
           10   59.80      90-100     6.33
           11   66.41     100-110     6.24
           12   71.57     110-120     7.14
           13   74.55     120-130     8.53
           14   79.35     130-140     8.81
           15   83.96     140-150     8.51
           16   87.11     150-160     8.76
           17   89.33     160-170     9.92
           18   91.48     170-180    10.05
           19   93.15     180-190    10.57
           20   94.39     190-200    13.11
           21   95.30     200-210    12.87
           22   96.01     210-220     9.89
           23   96.71     220-230     8.96
           24   97.40     230-240     7.14
           25   97.97     240-250     5.89
           26   98.54     250-260     5.58
           27   98.66     260-270     7.55
           28   99.00     270-280     7.19
           29   99.40     280-290     6.20
           30   99.59     290-300     7.69
           31   99.67     300-310     8.78
           32   99.71     310-320     9.70
           33   99.76     320-330     9.99
           34   99.79     330-340     9.71
           35   99.83     340-350     9.89
           36   99.93     350-360     9.14
           37   99.93
           38   99.95
           39  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30:	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29:	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27:	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0
26:	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25:	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	4	6	2	1	0	0	0	0	0	0	0	0	0	2	1	0	0
24:	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	6	4	5	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0
23:	1	1	1	4	1	0	0	0	0	0	0	0	0	0	1	2	2	3	0	4	4	1	1	0	0	0	0	0	0	0	0	0	0	0	3	0
22:	4	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	3	1	3	4	2	2	0	0	1	0	1	0	0	1	0	0	0	1	1	2
21:	2	0	1	4	0	1	0	0	0	0	0	0	0	0	0	3	3	1	0	4	3	2	1	0	0	0	0	0	0	0	1	1	1	0	2	0
20:	4	0	4	4	0	0	0	0	0	0	0	0	1	0	0	0	4	2	1	5	3	3	1	1	0	0	0	0	0	0	0	1	3	0	0	1
19:	1	0	2	3	1	1	0	0	0	0	0	0	0	0	0	3	6	5	3	5	2	0	3	1	0	0	0	0	0	0	2	2	3	3	4	2
18:	2	1	5	9	3	0	0	0	0	0	0	0	2	0	2	4	3	6	6	5	0	4	0	1	0	0	0	0	1	0	0	2	4	4	2	4
17:	4	3	3	9	4	1	0	0	0	1	0	0	1	1	3	7	1	7	8	6	2	2	2	0	0	0	1	0	0	2	1	5	1	5	7	3
16:	5	3	4	7	0	1	1	0	0	0	0	0	2	2	1	8	5	5	10	1	3	1	2	1	0	0	1	1	1	2	2	4	7	7	4	2
15:	6	2	3	8	3	3	1	1	4	0	0	2	4	7	6	5	5	7	6	5	6	4	1	2	1	2	2	0	1	0	3	2	5	13	7	5
14:	14	7	0	21	9	5	4	6	2	2	3	3	3	7	4	2	10	10	6	12	7	9	1	1	2	1	1	4	0	1	6	3	7	6	9	5
13:	12	3	5	21	7	5	0	3	4	5	4	5	9	8	4	7	6	8	12	3	8	5	2	1	1	1	3	2	4	3	4	9	9	5	6	7
12:	10	5	3	13	8	1	0	2	1	3	2	1	2	1	4	8	6	6	6	4	1	4	1	2	0	1	1	2	0	3	7	2	1	5	7	2
11:	15	5	3	12	6	4	2	2	4	9	3	4	8	7	7	12	12	12	9	9	8	5	4	3	1	1	1	2	0	3	8	9	7	8	6	5
10:	16	9	1	24	8	2	3	6	9	9	6	4	8	8	9	12	14	9	8	9	7	2	2	2	5	3	2	5	6	7	7	5	8	23	12	7
9:	16	6	3	19	10	4	8	3	4	6	7	8	14	22	7	15	11	12	8	10	12	4	7	3	2	3	2	4	8	6	12	5	8	7	5	5
8:	18	6	3	18	14	6	10	5	7	7	9	7	12	18	7	15	9	7	20	8	6	12	6	3	6	0	4	6	7	4	4	4	9	11	14	4
7:	17	5	3	30	11	14	9	4	7	12	4	7	9	9	11	19	18	15	17	11	10	4	6	0	2	2	4	4	4	2	7	5	8	12	7	9
6:	14	5	1	17	14	9	8	12	10	10	7	7	15	7	11	13	15	10	18	13	10	7	2	4	3	4	6	5	6	1	5	8	3	4	9	4
5:	9	6	2	16	9	9	10	10	7	11	12	8	5	8	5	11	11	14	7	7	6	5	5	3	6	6	4	3	3	1	7	4	4	8	4	5
4:	14	5	1	17	9	10	6	4	10	10	9	5	3	4	4	14	3	9	8	7	7	5	7	2	4	4	3	2	5	3	5	3	7	5	5	5
3:	10	7	1	15	8	3	6	5	7	9	7	5	10	6	1	6	4	4	10	8	2	5	4	5	6	3	2	3	7	1	8	5	3	7	3	1
2:	8	2	1	7	4	7	6	4	2	12	5	4	3	3	6	12	3	10	6	6	0	6	6	5	7	2	1	4	5	3	3	2	3	2	3	6
1:	10	1	3	9	4	9	7	7	4	9	5	2	3	0	3	7	10	8	10	2	3	6	5	5	6	3	3	5	6	5	2	4	4	4	7	3
0:	15	9	1	15	8	6	9	6	5	7	8	6	3	5	8	12	8	8	14	5	8	11	3	6	4	8	4	3	7	8	4	4	11	13	11	10

Total number of observations = 4189

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date: 2/ 7/1995  Time: 15:45:39


        PL90460S.SUM   4416

    Distributions
    -------------

        Spd  CumPrb       Dir    AvgSpd
        ---  ------     -------  ------
          1    2.97       0- 10    9.44
          2    6.39      10- 20   11.29
          3   11.87      20- 30   11.94
          4   18.73      30- 40   10.00
          5   26.79      40- 50    8.05
          6   35.46      50- 60    6.63
          7   44.18      60- 70    6.52
          8   52.74      70- 80    6.90
          9   60.44      80- 90    6.25
         10   67.55      90-100    6.40
         11   73.08     100-110    7.98
         12   78.03     110-120    6.56
         13   80.30     120-130    7.82
         14   84.56     130-140    9.80
         15   87.82     140-150    9.36
         16   90.56     150-160   10.58
         17   92.16     160-170   11.83
         18   93.84     170-180    9.54
         19   95.36     180-190    7.81
         20   96.35     190-200    8.11
         21   97.17     200-210    6.43
         22   97.80     210-220    6.11
         23   98.23     220-230    5.35
         24   98.66     230-240    5.01
         25   99.00     240-250    4.52
         26   99.18     250-260    4.31
         27   99.37     260-270    4.13
         28   99.59     270-280    5.71
         29   99.75     280-290    6.00
         30   99.80     290-300    5.41
         31   99.84     300-310    6.25
         32   99.93     310-320    6.45
         33  100.00     320-330    6.76
         34  100.00     330-340    8.45
         35  100.00     340-350    9.84
         36  100.00     350-360   11.02
         37  100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30:	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29:	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	1	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	2	2	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27:	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0
26:	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25:	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	4	6	2	1	0	0	0	0	0	0	0	0	0	2	1	0	0
24:	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	6	4	5	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0
23:	1	1	1	4	1	0	0	0	0	0	0	0	0	0	1	2	2	3	0	4	4	1	1	0	0	0	0	0	0	0	0	0	0	0	3	0
22:	4	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	3	1	3	4	2	2	0	0	1	0	1	0	0	1	0	0	0	1	1	2
21:	2	0	1	4	0	1	0	0	0	0	0	0	0	0	0	3	3	1	0	4	3	2	1	0	0	0	0	0	0	0	1	1	1	0	2	0
20:	4	0	4	4	0	0	0	0	0	0	0	0	1	0	0	0	4	2	1	5	3	3	1	1	0	0	0	0	0	0	0	1	3	0	0	1
19:	1	0	2	3	1	1	0	0	0	0	0	0	0	0	0	3	6	5	3	5	2	0	3	1	0	0	0	0	0	0	2	2	3	3	4	2
18:	2	1	5	9	3	0	0	0	0	0	0	0	2	0	2	4	3	6	6	5	0	4	0	1	0	0	0	0	1	0	0	2	4	4	2	4
17:	4	3	3	9	4	1	0	0	0	1	0	0	1	1	3	7	1	7	8	6	2	2	2	0	0	0	1	0	0	2	1	5	1	5	7	3
16:	5	3	4	7	0	1	1	0	0	0	0	0	2	2	1	8	5	5	10	1	3	1	2	1	0	0	1	1	1	2	2	4	7	7	4	2
15:	6	2	3	8	3	3	1	1	4	0	0	2	4	7	6	5	5	7	6	5	6	4	1	2	1	2	2	0	1	0	3	2	5	13	7	5
14:	14	7	0	21	9	5	4	6	2	2	3	3	3	7	4	2	10	10	6	12	7	9	1	1	2	1	1	4	0	1	6	3	7	6	9	5
13:	12	3	5	21	7	5	0	3	4	5	4	5	9	8	4	7	6	8	12	3	8	5	2	1	1	1	3	2	4	3	4	9	9	5	6	7
12:	10	5	3	13	8	1	0	2	1	3	2	1	2	1	4	8	6	6	6	4	1	4	1	2	0	1	1	2	0	3	7	2	1	5	7	2
11:	15	5	3	12	6	4	2	2	4	9	3	4	8	7	7	12	12	12	9	9	8	5	4	3	1	1	1	2	0	3	8	9	7	8	6	5
10:	16	9	1	24	8	2	3	6	9	9	6	4	8	8	9	12	14	9	8	9	7	2	2	2	5	3	2	5	6	7	7	5	8	23	12	7
9:	16	6	3	19	10	4	8	3	4	6	7	8	14	22	7	15	11	12	8	10	12	4	7	3	2	3	2	4	8	6	12	5	8	7	5	5
8:	18	6	3	18	14	6	10	5	7	7	9	7	12	18	7	15	9	7	20	8	6	12	6	3	6	0	4	6	7	4	4	4	9	11	14	4
7:	17	5	3	30	11	14	9	4	7	12	4	7	9	9	11	19	18	15	17	11	10	4	6	0	2	2	4	4	4	2	7	5	8	12	7	9
6:	14	5	1	17	14	9	8	12	10	10	7	7	15	7	11	13	15	10	18	13	10	7	2	4	3	4	6	5	6	1	5	8	3	4	9	4
5:	9	6	2	16	9	9	10	10	7	11	12	8	5	8	5	11	11	14	7	7	6	5	5	3	6	6	4	3	3	1	7	4	4	8	4	5
4:	14	5	1	17	9	10	6	4	10	10	9	5	3	4	4	14	3	9	8	7	7	5	7	2	4	4	3	2	5	3	5	3	7	5	5	5
3:	10	7	1	15	8	3	6	5	7	9	7	5	10	6	1	6	4	4	10	8	2	5	4	5	6	3	2	3	7	1	8	5	3	7	3	1
2:	8	2	1	7	4	7	6	4	2	12	5	4	3	3	6	12	3	10	6	6	0	6	6	5	7	2	1	4	5	3	3	2	3	2	3	6
1:	10	1	3	9	4	9	7	7	4	9	5	2	3	0	3	7	10	8	10	2	3	6	5	5	6	3	3	5	6	5	2	4	4	4	7	3
0:	15	9	1	15	8	6	9	6	5	7	8	6	3	5	8	12	8	8	14	5	8	11	3	6	4	8	4	3	7	8	4	4	11	13	11	10

Total number of observations = 4189

Spd	Direction																																		
---	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28:	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
27:	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
26:	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
25:	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
24:	1	0	0	1	1	0	0	0	0	0	0	0	0	0	2	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
23:	1	1	2	1	1	0	0	0	0	0	0	0	0	1	2	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
22:	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
21:	1	1	0	3	3	0	1	0	0	0	0	0	2	3	0	2	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2
20:	2	2	1	3	1	0	0	0	1	0	0	0	1	2	1	3	5	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	2	4	5
19:	2	2	2	3	0	0	0	1	0	1	0	0	0	2	1	4	6	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	7
18:	2	1	2	6	2	0	0	1	0	0	1	0	0	4	6	7	7	6	5	1	0	1	0	0	0	0	0	0	0	0	0	0	1	6	2	6
17:	2	0	0	9	6	3	0	1	2	0	2	0	1	2	4	4	9	4	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	7	5	10
16:	4	1	1	10	5	0	1	0	0	2	2	0	2	1	5	4	5	4	2	1	0	0	0	0	0	0	0	1	0	0	3	0	1	4	7	5
15:	7	2	1	17	13	0	4	3	3	0	2	2	6	8	2	6	6	7	3	1	2	1	0	0	0	0	1	0	0	0	1	0	2	8	7	6
14:	3	2	2	19	7	5	3	3	1	0	4	2	2	6	8	11	5	5	5	2	2	1	0	0	0	0	0	0	1	0	1	2	0	13	15	14
13:	11	7	5	17	11	6	3	1	3	3	1	1	6	8	3	8	7	12	10	2	1	2	0	0	0	0	1	2	1	3	2	4	11	8	13	15
12:	2	2	1	9	5	4	4	1	2	0	0	4	4	2	4	1	5	7	2	3	0	1	1	0	0	0	0	0	2	0	1	2	2	6	16	7
11:	7	2	6	25	16	6	8	7	1	5	4	5	3	6	6	9	12	7	12	2	4	4	1	1	1	0	0	4	2	0	3	6	4	10	15	15
10:	10	4	2	16	23	8	9	7	3	6	13	4	6	6	11	11	8	13	6	4	3	2	1	2	1	1	1	0	0	2	5	2	7	14	22	11
9:	14	4	4	16	21	8	8	5	9	11	7	2	12	7	12	15	10	10	8	6	8	3	1	1	2	1	1	3	0	1	5	3	10	27	28	31
8:	12	10	4	24	24	16	9	9	7	12	6	9	9	12	11	16	14	9	7	8	2	2	3	6	1	1	2	3	7	1	4	7	10	19	22	22
7:	16	4	1	32	20	18	17	12	11	11	8	12	9	10	10	16	10	17	10	10	4	10	2	2	1	5	2	3	6	4	5	6	12	24	22	16
6:	7	0	0	27	17	19	18	12	12	14	8	10	17	10	8	21	5	10	14	7	5	8	5	5	3	2	5	6	3	8	6	9	12	30	22	20
5:	12	6	3	15	25	18	22	10	12	16	10	10	11	11	9	21	12	10	11	7	8	6	1	6	4	5	4	7	9	11	4	8	9	17	20	13
4:	11	3	0	23	21	11	11	15	11	14	11	6	7	8	10	9	7	11	22	4	9	14	5	3	4	4	5	14	7	4	10	9	5	26	14	8
3:	10	1	1	10	10	17	17	6	11	12	3	10	10	9	7	3	8	14	10	2	7	8	3	5	1	9	7	5	8	7	12	9	12	16	13	10
2:	5	0	1	8	21	13	12	8	10	6	6	4	9	2	11	6	4	4	13	3	10	5	4	2	6	3	9	2	1	2	4	7	4	18	10	9
1:	2	0	1	5	13	4	9	3	6	5	0	4	7	3	1	3	2	7	6	2	1	3	3	7	4	2	5	7	2	5	5	5	8	2	4	5
0:	0	1	0	4	11	8	6	5	6	4	1	4	4	7	3	2	1	3	5	3	3	3	0	2	2	4	6	0	1	1	5	2	11	7	5	1

Total number of observations =   4416

```
Program ES2SCC - Version 1.2,  8/13/94

Date:  2/ 7/1995   Time: 18::16: 5
Program ES2SCC - Version 1.2,  8/13/94

Date:  2/ 7/1995   Time: 18::16:40
Program ES2SCC - Version 1.2,  8/13/94

Date:  2/ 7/1995   Time: 18::17:35
PL90477E.SUM    -.46    -.70     .00     0  3958
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 18:19:33


          PL90477S.SUM   3958


     Distributions
     -------------

          Spd  CumPrb         Dir    AvgSpd
          ---  ------       -------  ------
            1    4.55        0- 10    10.84
            2    8.21       10- 20    10.71
            3   12.78       20- 30     9.84
            4   18.27       30- 40     7.69
            5   24.58       40- 50     5.58
            6   31.86       50- 60     5.88
            7   40.35       60- 70     6.38
            8   47.68       70- 80     7.50
            9   55.23       80- 90     7.25
           10   63.26       90-100     8.60
           11   69.98      100-110     8.67
           12   75.52      110-120     8.57
           13   78.25      120-130     9.01
           14   83.22      130-140     9.57
           15   86.74      140-150     9.23
           16   89.94      150-160     9.44
           17   92.60      160-170    10.16
           18   94.42      170-180    10.36
           19   95.98      180-190     9.26
           20   97.17      190-200     8.45
           21   98.05      200-210     6.78
           22   98.84      210-220     6.29
           23   99.24      220-230     7.90
           24   99.55      230-240     8.07
           25   99.75      240-250     9.23
           26   99.82      250-260     9.95
           27   99.95      260-270     8.24
           28   99.97      270-280     9.48
           29  100.00      280-290     8.84
           30  100.00      290-300     9.26
           31  100.00      300-310     8.00
           32  100.00      310-320     8.62
           33  100.00      320-330     8.01
           34  100.00      330-340     8.07
           35  100.00      340-350     8.75
           36  100.00      350-360     8.64
           37  100.00
```

Spd	Direction																																			
---	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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28:	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
27:	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1
26:	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
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22:	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
21:	1	1	0	3	3	0	1	0	0	0	0	0	2	3	0	2	4	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2
20:	2	2	1	3	1	0	0	0	1	0	0	0	1	2	1	3	5	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	2	4	5
19:	2	2	2	3	0	0	0	1	0	1	0	0	0	2	1	4	6	6	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	7
18:	2	1	2	6	2	0	0	1	0	0	1	0	0	4	6	7	7	6	5	1	0	1	0	0	0	0	0	0	0	0	0	0	1	6	2	6
17:	2	0	0	9	6	3	0	1	2	0	2	0	1	2	4	4	9	4	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	7	5	10
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14:	3	2	2	19	7	5	3	3	1	0	4	2	2	6	8	11	5	5	5	2	2	1	0	0	0	0	0	0	1	0	1	2	0	13	15	14
13:	11	7	5	17	11	6	3	1	3	3	1	1	6	8	3	8	7	12	10	2	1	2	0	0	0	0	1	2	1	3	2	4	11	8	13	15
12:	2	2	1	9	5	4	4	1	2	0	0	4	4	2	4	1	5	7	2	3	0	1	1	0	0	0	0	0	2	0	1	2	2	6	16	7
11:	7	2	6	25	16	6	8	7	1	5	4	5	3	6	6	9	12	7	12	2	4	4	1	1	1	0	0	4	2	0	3	6	4	10	15	15
10:	10	4	2	16	23	8	9	7	3	6	13	4	6	6	11	11	8	13	6	4	3	2	1	2	1	1	1	0	0	2	5	2	7	14	22	11
9:	14	4	4	16	21	8	8	5	9	11	7	2	12	7	12	15	10	10	8	6	8	3	1	1	2	1	1	3	0	1	5	3	10	27	28	31
8:	12	10	4	24	24	16	9	9	7	12	6	9	9	12	11	16	14	9	7	8	2	2	3	6	1	1	2	3	7	1	4	7	10	19	22	22
7:	16	4	1	32	20	18	17	12	11	11	8	12	9	10	10	16	10	17	10	10	4	10	2	2	1	5	2	3	6	4	5	6	12	24	22	16
6:	7	0	0	27	17	19	18	12	12	14	8	10	17	10	8	21	5	10	14	7	5	8	5	5	3	2	5	6	3	8	6	9	12	30	22	20
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3:	10	1	1	10	10	17	17	6	11	12	3	10	10	9	7	3	8	14	10	2	7	8	3	5	1	9	7	5	8	7	12	9	12	16	13	10
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1:	2	0	1	5	13	4	9	3	6	5	0	4	7	3	1	3	2	7	6	2	1	3	3	7	4	2	5	7	2	5	5	5	8	2	4	5
0:	0	1	0	4	11	8	6	5	6	4	1	4	4	7	3	2	1	3	5	3	3	3	0	2	2	4	6	0	1	1	5	2	11	7	5	1

Total number of observations =   4416

Spd	Direction																																		
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60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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28:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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24:	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
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21:	1	0	1	1	0	0	0	0	1	0	1	0	2	0	3	4	4	4	1	1	0	0	0	0	0	0	0	3	0	1	0	0	0	0	2	1
20:	2	1	0	2	0	0	0	1	0	2	1	2	1	3	4	2	2	1	0	1	0	0	0	0	1	1	0	1	0	1	2	2	0	0	0	2
19:	3	0	0	1	0	1	0	0	1	0	1	2	3	2	2	5	1	5	2	1	0	1	0	1	1	0	1	0	0	4	3	0	1	2	1	2
18:	4	0	1	0	1	0	0	1	0	1	0	3	4	4	1	3	4	5	3	2	1	1	0	0	3	4	1	2	3	1	2	2	0	1	1	3
17:	2	3	2	2	0	0	1	1	0	3	5	0	2	3	1	4	2	5	2	1	0	0	1	2	2	7	2	3	1	1	1	5	2	1	1	4
16:	3	0	0	1	3	0	0	3	0	3	1	3	3	1	5	6	9	5	8	5	2	0	0	3	6	4	3	4	1	6	6	2	3	4	2	0
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11:	4	1	0	5	2	2	1	6	4	7	10	6	14	7	5	7	3	7	5	7	2	4	2	4	11	9	5	9	6	2	7	14	7	20	8	6
10:	10	1	1	7	0	2	8	1	8	9	12	3	11	7	7	8	9	4	12	4	5	4	8	9	14	4	5	7	12	14	12	14	12	8	5	9
9:	5	1	1	7	4	2	7	5	4	16	8	4	19	7	1	10	13	9	8	5	7	2	6	6	14	10	10	15	12	16	11	23	13	21	10	6
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7:	6	0	3	14	3	9	6	9	7	6	10	5	12	6	9	14	7	7	11	7	5	6	6	8	10	4	4	3	7	15	21	13	11	14	8	4
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0:	0	0	1	6	10	12	6	5	3	3	4	3	7	3	7	9	8	2	4	6	7	4	3	2	5	1	2	1	4	7	9	7	7	9	4	9

Total number of observations =   3958

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:58:12


          PL90520S.SUM   4189
          Dir   Prob.
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            1  .04846
            2  .00406
            3  .00979
            4  .03056
            5  .02817
            6  .02626
            7  .03342
            8  .01910
            9  .01623
           10  .02316
           11  .02005
           12  .02602
           13  .03247
           14  .02817
           15  .02817
           16  .04392
           17  .04201
           18  .04631
           19  .06565
           20  .03581
           21  .02220
           22  .01934
           23  .01098
           24  .01003
           25  .01599
           26  .01313
           27  .00931
           28  .01194
           29  .00907
           30  .01217
           31  .01958
           32  .02292
           33  .03056
           34  .05920
           35  .06374
           36  .06207

          Total number of observations =   4189
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:58:41


         PL90540S.SUM   2505
         Dir   Prob.
         ---   ------
           1  .06467
           2  .03713
           3  .00798
           4  .06627
           5  .03513
           6  .02834
           7  .02675
           8  .02156
           9  .01836
          10  .02236
          11  .02156
          12  .01876
          13  .02555
          14  .02874
          15  .02794
          16  .04711
          17  .03952
          18  .04232
          19  .06587
          20  .03633
          21  .01477
          22  .01357
          23  .00838
          24  .00798
          25  .00998
          26  .00918
          27  .00838
          28  .00599
          29  .00838
          30  .00559
          31  .01557
          32  .02036
          33  .03553
          34  .05389
          35  .04750
          36  .05269

         Total number of observations =   2505
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date: 2/ 8/1995  Time:  8:53:33


          PL90560S.SUM   4417
          Dir   Prob.
          ---   ------
            1  .08196
            2  .01992
            3  .01743
            4  .11546
            5  .06950
            6  .02581
            7  .02626
            8  .02015
            9  .01924
           10  .01970
           11  .01494
           12  .01743
           13  .02355
           14  .02015
           15  .02830
           16  .04437
           17  .04007
           18  .03849
           19  .06090
           20  .03871
           21  .02355
           22  .02083
           23  .01721
           24  .00996
           25  .00928
           26  .00679
           27  .00792
           28  .00838
           29  .00408
           30  .00679
           31  .00951
           32  .00951
           33  .01426
           34  .03056
           35  .03464
           36  .04437

          Total number of observations =   4417
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:54: 6


          PL90580S.SUM   4189
          Dir   Prob.
          ---   ------
            1  .05491
            2  .02220
            3  .01432
            4  .07400
            5  .03390
            6  .02435
            7  .02148
            8  .01910
            9  .02077
           10  .02912
           11  .02172
           12  .01862
           13  .02793
           14  .02936
           15  .02483
           16  .04751
           17  .04154
           18  .04392
           19  .05109
           20  .04249
           21  .03390
           22  .02769
           23  .01814
           24  .01241
           25  .01361
           26  .01050
           27  .01098
           28  .01313
           29  .01695
           30  .01337
           31  .02339
           32  .02125
           33  .02841
           34  .03700
           35  .03294
           36  .02316

          Total number of observations =    4189
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:51:54


          PL90460S.SUM    4416
          Dir   Prob.
          ---  ------
            1  .03306
            2  .01336
            3  .00928
            4  .06975
            5  .06273
            6  .03714
            7  .03668
            8  .02491
            9  .02514
           10  .02763
           11  .02015
           12  .02015
           13  .02944
           14  .03057
           15  .03125
           16  .04416
           17  .03714
           18  .03895
           19  .03555
           20  .01608
           21  .01585
           22  .01676
           23  .00679
           24  .00951
           25  .00679
           26  .00838
           27  .01110
           28  .01291
           29  .01132
           30  .01110
           31  .01721
           32  .01857
           33  .02740
           34  .06114
           35  .06409
           36  .05797

          Total number of observations =    4416
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 8/1995  Time:  8:54:34


           PL90477S.SUM   3958
           Dir   Prob.
           ---  ------
             1  .02097
             2  .00354
             3  .00480
             4  .03335
             5  .01945
             6  .01718
             7  .01895
             8  .01844
             9  .01996
            10  .03386
            11  .02804
            12  .02400
            13  .03941
            14  .02754
            15  .02678
            16  .04346
            17  .03562
            18  .03158
            19  .02956
            20  .02324
            21  .01895
            22  .02602
            23  .01996
            24  .02274
            25  .03891
            26  .02400
            27  .02122
            28  .03613
            29  .02779
            30  .03537
            31  .04447
            32  .04118
            33  .04017
            34  .04826
            35  .02628
            36  .02880

           Total number of observations =   3958
```

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:52:43


        PL90460S.FAL    1406


    Distributions
    -------------

        Spd   CumPrb        Dir     AvgSpd
        ---   ------      -------   ------
          1     4.48        0- 10    11.21
          2     7.75       10- 20    13.67
          3    11.81       20- 30     6.50
          4    17.00       30- 40     8.69
          5    23.19       40- 50     8.15
          6    30.94       50- 60     7.22
          7    39.90       60- 70     6.65
          8    49.08       70- 80     8.91
          9    56.69       80- 90     7.25
         10    63.66       90-100     9.54
         11    70.48      100-110     8.27
         12    76.46      110-120     8.38
         13    79.23      120-130     9.85
         14    83.07      130-140     8.81
         15    87.13      140-150    10.46
         16    89.47      150-160     9.54
         17    91.96      160-170     8.31
         18    93.74      170-180     9.52
         19    94.88      180-190     8.32
         20    96.30      190-200     9.12
         21    97.16      200-210     6.35
         22    97.80      210-220     7.44
         23    98.22      220-230     7.93
         24    98.72      230-240     3.85
         25    98.93      240-250     4.58
         26    99.22      250-260     5.92
         27    99.29      260-270     7.35
         28    99.29      270-280     7.76
         29    99.43      280-290     3.50
         30    99.57      290-300    10.18
         31    99.72      300-310     7.42
         32    99.79      310-320     8.91
         33    99.93      320-330     7.80
         34    99.93      330-340    10.48
         35    99.93      340-350     9.46
         36   100.00      350-360     8.89
         37   100.00
```

Spd	Direction																																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
60:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
46:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
34:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
31:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
30:	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
29:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
28:	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
27:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
25:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1
24:	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23:	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
22:	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
21:	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1
20:	4	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	0
19:	3	0	0	3	4	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	5
18:	2	0	0	3	1	2	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0
17:	2	0	0	4	2	2	0	1	0	1	0	0	2	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	2	1
16:	4	0	0	5	6	1	0	3	0	1	0	0	1	0	0	2	0	1	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	5
15:	3	0	0	0	1	2	2	1	2	1	0	1	3	0	1	3	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	3	5
14:	3	0	0	3	7	0	2	2	1	2	1	3	3	4	5	4	1	0	2	1	1	1	0	0	0	0	1	0	0	0	0	0	1	4	3	2
13:	4	0	0	4	6	0	2	0	0	2	0	0	5	5	4	3	0	3	0	0	0	0	1	0	0	0	1	2	0	2	0	0	2	2	2	4
12:	4	0	0	4	3	1	0	0	1	0	0	0	0	3	3	2	2	1	0	0	0	0	1	0	0	0	1	1	0	1	1	2	1	4	0	3
11:	9	0	0	10	6	2	1	2	1	3	1	1	2	2	3	4	1	5	2	2	0	1	0	0	0	0	0	1	0	1	2	0	2	5	8	7
10:	4	1	0	9	8	4	4	2	1	2	2	0	5	2	2	4	1	2	2	3	2	4	2	0	2	2	3	1	0	1	3	5	1	2	2	8
9:	6	0	0	9	10	1	3	2	3	4	1	0	4	5	7	2	2	0	5	4	3	1	1	1	0	0	0	2	0	0	2	4	4	4	3	5
8:	5	0	1	14	13	9	2	2	1	3	3	1	2	3	2	3	0	2	5	2	2	2	1	1	0	3	1	1	0	0	2	6	2	4	4	5
7:	7	1	1	15	17	5	2	4	4	3	4	4	2	1	4	5	4	4	4	2	3	7	2	0	2	1	1	2	1	0	3	2	0	4	1	7
6:	3	0	0	12	13	7	3	2	3	4	1	3	4	4	2	6	3	3	0	0	2	2	3	2	3	1	1	2	0	1	1	0	4	10	9	12
5:	5	0	0	12	13	7	4	1	4	2	2	3	2	3	1	4	2	1	3	3	3	3	1	0	1	0	0	2	0	2	0	4	7	1	6	7
4:	6	0	1	8	13	4	3	2	4	1	0	0	1	1	2	4	1	0	0	1	1	2	2	0	6	0	0	1	3	1	1	1	0	5	3	9
3:	4	0	0	5	10	6	6	3	2	3	1	0	1	1	0	0	0	0	1	1	3	1	0	1	1	3	0	0	0	0	0	0	3	4	6	7
2:	2	0	0	3	9	3	5	2	3	0	2	0	1	2	1	1	1	0	1	0	1	1	0	1	0	0	1	1	0	0	0	0	2	5	4	5
1:	0	0	0	7	3	1	3	0	1	0	1	1	1	2	0	2	0	0	0	0	0	0	0	2	0	2	1	0	1	0	0	1	2	6	5	4
0:	1	0	0	7	3	4	5	0	0	3	0	0	1	1	0	0	1	1	0	0	2	0	0	2	4	0	2	1	1	0	3	1	1	6	7	6

Total number of observations =   1406

```
Program CMDIST - Ver. 1.0a 11/08/91 (8/14/94)

Date:  2/ 7/1995  Time: 15:53:31


        PL90477S.FAL    1405


    Distributions
    -------------

        Spd  CumPrb        Dir    AvgSpd
        ---  ------      -------  ------
          1    2.92       0- 10    8.76
          2    5.84      10- 20    8.12
          3   10.96      20- 30    6.86
          4   19.29      30- 40    6.84
          5   27.26      40- 50    6.15
          6   37.01      50- 60    5.54
          7   45.20      60- 70    6.89
          8   53.81      70- 80    7.05
          9   61.35      80- 90    8.31
         10   68.97      90-100    9.86
         11   75.87     100-110    8.59
         12   82.06     110-120    6.80
         13   84.27     120-130    8.19
         14   88.54     130-140   10.26
         15   90.96     140-150    8.73
         16   92.95     150-160    6.70
         17   94.66     160-170    6.35
         18   95.94     170-180    9.00
         19   96.51     180-190    7.15
         20   97.22     190-200    5.84
         21   97.94     200-210    4.76
         22   98.36     210-220    6.02
         23   98.86     220-230    5.05
         24   99.43     230-240    6.34
         25   99.57     240-250    6.24
         26   99.57     250-260    6.97
         27   99.79     260-270    7.24
         28   99.86     270-280    6.70
         29   99.93     280-290    9.10
         30  100.00     290-300   10.05
         31  100.00     300-310    8.93
         32  100.00     310-320    8.36
         33  100.00     320-330    9.65
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         35  100.00     340-350   10.64
         36  100.00     350-360    8.71
         37  100.00
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Direction

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Date:  2/ 8/1995  Time:  9: 0:52


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           Total number of observations =    1406
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Date:  2/ 8/1995  Time:  9: 1:20


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           36  .05552

          Total number of observations =    1405
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THE CITY OF SAN DIEGO · STATE OF CALIFORNIA ·

SEMPER VIGILANS

Appendix S

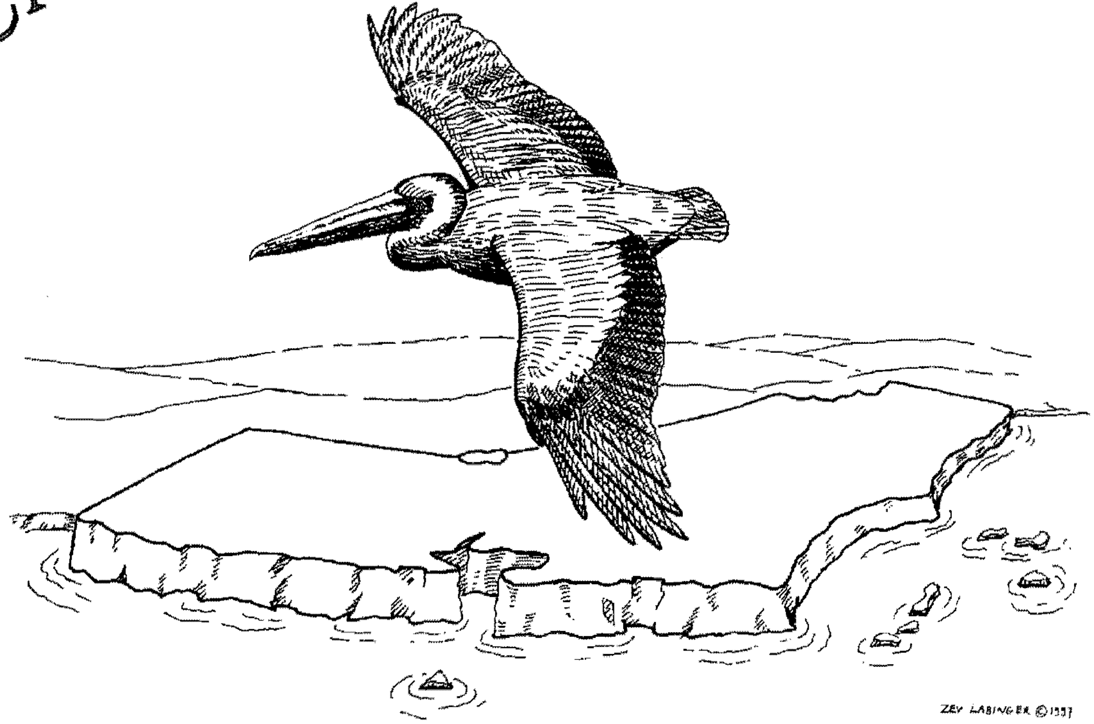
2001 California Ocean Plan

APPENDIX S

2001 CALIFORNIA OCEAN PLAN

WATER QUALITY CONTROL PLAN
OCEAN WATERS OF CALIFORNIA

CALIFORNIA OCEAN PLAN


ZEV LABINGER ©1997

2001

STATE WATER RESOURCES CONTROL BOARD
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Gray Davis, Governor

California Environmental Protection Agency
Winston H. Hickox, Secretary

State Water Resources Control Board
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Peter S. Silva, Member
Richard Katz, Member
•
Celeste Cantú, Executive Director
Tom Howard, Chief Deputy Director

Cover drawing by:
Zev Labinger, 1997

State of California

STATE WATER RESOURCES CONTROL BOARD

2001

CALIFORNIA OCEAN PLAN

WATER QUALITY CONTROL PLAN

OCEAN WATERS OF CALIFORNIA

Effective December 3, 2001

Adopted by the State Water Resources Control Board on November 16, 2000.
Approved by the U. S. Environmental Protection Agency on December 3, 2001.

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our Web-site at http://www.swrcb.ca.gov .

STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 2000-108

ADOPTION OF THE PROPOSED AMENDMENTS TO THE CALIFORNIA OCEAN PLAN
(OCEAN PLAN)

WHEREAS:

1. The Ocean Plan was adopted by the State Water Resources Control Board (SWRCB) in 1972 and amended in 1978, 1983, 1988, 1990, and 1997.
2. The SWRCB is responsible for reviewing Ocean Plan water quality standards and for modifying and adopting standards in accordance with Section 303(c)(1) of the federal Clean Water Act and Section 13170.2 of the California Water Code (CWC).
3. The SWRCB initiated a public review of the Ocean Plan in 1991, including a public hearing, and adopted a workplan in 1992 for considering issues identified by the comments received.
4. The SWRCB reviewed these issues and amended the Ocean Plan in 1997.
5. The SWRCB staff reviewed the high priority issues remaining from the 1992 Workplan, selected five issues for further analyses, and based upon this analysis proposed five additional amendments to the Ocean Plan.
6. The SWRCB staff has also identified a sixth issue consisting of minor administrative changes to the Ocean Plan to update terminology and references.
7. The proposed amendments are the following:

   Issue 1: Replacement of the acute toxicity effluent limitation in Table "A" with an acute toxicity water quality objective.

   Issue 2: Revision of chemical water quality objectives for protection of human health.

   Issue 3: Addition of provisions for compliance determination for chemical water quality objectives.

   Issue 4: Revisions of the format and organization of the Ocean Plan.

Issue 5: Development of special protection for water quality and designated uses specifying procedures for nomination and designation of special category waters.

Issue 6: Administrative changes to the Ocean Plan that include:

a. Defining governmental agencies referenced in the Ocean Plan,
b. Defining dredged materials,
c. Describing the relationship of the Ocean Plan to other State plans and policies,
d. Updating the reference for the radioactivity water quality objective,
e. Changing the test method references for total and fecal bacteria and for acute toxicity,
f. Changing a subtitle in Appendix II, and
g. Changing the Ocean Plan's effective date.

8. The SWRCB prepared and circulated a draft Functional Equivalent Document (FED) in accordance with the provisions of the California Environmental Quality Act and Title 14, California Code of Regulations 15251(g).

9. The SWRCB held three public hearings in Sacramento, Irvine, and Monterey in November and December of 1998. The SWRCB has carefully considered all testimony and comments received on this matter and has determined that the adoption of the proposed Ocean Plan amendments will not have a significant adverse effect on the environment.

10. The SWRCB staff has prepared a draft Final FED, Attachment A to this resolution, which includes the specific proposed amendments to the Ocean Plan and responses to the comments received at the hearings.

11. The SWRCB has considered relevant management agency agreements in accordance with CWC Section 13179.1.

12. Amendments to the Ocean Plan do not become effective until approved by the Office of Administrative Law and the U.S. Environmental Protection Agency.

THEREFORE BE IT RESOLVED THAT:

The SWRCB:

1. Approves the draft Final FED identified as Attachment A to the resolution, as revised at the November 16, 2000 Board Meeting.

2. Approves the proposed amendments to the Ocean Plan, as revised at the November 16, 2000 Board Meeting.

3. Agrees to reassess and modify as appropriate the Minimum Level values in Appendix II of the Ocean Plan during the triennial reviews to consider and reflect the availability and use of more sensitive analytical methods. Prior to adoption of new Minimum Levels, the SWRCB will consider environmental and economic effects.

4. Authorizes the SWRCB Executive Director to sign the Certificate of Fee Exemption identified as Attachment B to the resolution.

5. Authorizes the SWRCB staff to submit the amended Ocean Plan to the Office of Administrative Law and the U.S. Environmental Protection Agency for final approval.

CERTIFICATION

The undersigned, Administrative Assistant to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on November 16, 2000.

Maureen Marché

Maureen Marché
Administrative Assistant to the Board

CALIFORNIA OCEAN PLAN

TABLE OF CONTENTS

LIST OF TABLES

CALIFORNIA OCEAN PLAN

WATER QUALITY CONTROL PLAN FOR OCEAN WATERS OF CALIFORNIA

INTRODUCTION

A. Purpose and Authority

1. In furtherance of legislative policy set forth in Section 13000 of Division 7 of the California Water Code (CWC) (Stats. 1969, Chap. 482) pursuant to the authority contained in Section 13170 and 13170.2 (Stats. 1971, Chap. 1288) the State Water Resources Control Board hereby finds and declares that protection of the quality of the ocean* waters for use and enjoyment by the people of the State requires control of the discharge of waste* to ocean* waters in accordance with the provisions contained herein. The Board finds further that this plan shall be reviewed at least every three years to guarantee that the current standards are adequate and are not allowing degradation* to marine species or posing a threat to public health.

B. Principles

1. Harmony Among Water Quality Control Plans and Policies.

   a. In the adoption and amendment of water quality control plans, it is the intent of this Board that each plan will provide for the attainment and maintenance of the water quality standards of downstream waters.

   b. To the extent there is a conflict between a provision of this plan and a provision of another statewide plan or policy, or a regional water quality control plan (basin plan), the more stringent provision shall apply except where pursuant to Chap. III.I of this Plan, the SWRCB has approved an exception to the Plan requirements.

C. Applicability

1. This plan is applicable, in its entirety, to point source discharges to the ocean*. Nonpoint sources of waste* discharges to the ocean* are subject to Chapter I Beneficial Uses, Chapter II - WATER QUALITY OBJECTIVES (wherein compliance with water quality objectives shall, in all cases, be determined by direct measurements in the receiving waters) and Chapter III - PROGRAM OF IMPLEMENTATION Parts A.2, D, E, and H.

2. This plan is not applicable to discharges to enclosed* bays and estuaries* or inland waters, nor is it applicable to vessel wastes, or the control of dredged* material.

3. Provisions regulating the thermal aspects of waste* discharged to the ocean* are set forth in the Water Quality Control Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed* Bays and Estuaries* of California.

4. Within this Plan, references to the State Board or SWRCB shall mean the State Water Resources Control Board. References to a Regional Board or RWQCB shall mean a California Regional Water Quality Control Board. References to the Environmental Protection Agency, US EPA, or EPA shall mean the federal Environmental Protection Agency.

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* See Appendix I for definition of terms.

I. BENEFICIAL USES

A. The beneficial uses of the ocean* waters of the State that shall be protected include industrial water supply; water contact and non-contact recreation, including aesthetic enjoyment; navigation; commercial and sport fishing; mariculture*; preservation and enhancement of designated Areas* of Special Biological Significance (ASBS); rare and endangered species; marine habitat; fish migration; fish spawning and shellfish* harvesting.

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* See Appendix I for definition of terms.

II. WATER QUALITY OBJECTIVES

A. General Provisions

1. This chapter sets forth limits or levels of water quality characteristics for ocean* waters to ensure the reasonable protection of beneficial uses and the prevention of nuisance. The discharge of waste* shall not cause violation of these objectives.

2. The Water Quality Objectives and Effluent Limitations are defined by a statistical distribution when appropriate. This method recognizes the normally occurring variations in treatment efficiency and sampling and analytical techniques and does not condone poor operating practices.

3. Compliance with the water quality objectives of this chapter shall be determined from samples collected at stations representative of the area within the waste field where initial* dilution is completed.

B. Bacterial Characteristics

1. Water-Contact Standards

    a. Within a zone bounded by the shoreline and a distance of 1,000 feet from the shoreline or the 30-foot depth contour, whichever is further from the shoreline, and in areas outside this zone used for water contact sports, as determined by the Regional Board, but including all kelp* beds, the following bacterial objectives shall be maintained throughout the water column:

        (1) Samples of water from each sampling station shall have a density of total coliform organisms less than 1,000 per 100 ml (10 per ml); provided that not more than 20 percent of the samples at any sampling station, in any 30-day period, may exceed 1,000 per 100 ml (10 per ml), and provided further that no single sample when verified by a repeat sample taken within 48 hours shall exceed 10,000 per 100 ml (100 per ml).

        (2) The fecal coliform density based on a minimum of not less than five samples for any 30-day period, shall not exceed a geometric mean of 200 per 100 ml nor shall more than 10 percent of the total samples during any 60-day period exceed 400 per 100 ml.

    b. The "Initial* Dilution Zone" of wastewater outfalls shall be excluded from designation as "kelp* beds" for purposes of bacterial standards, and Regional Boards should recommend extension of such exclusion zone where warranted to the SWRCB (for consideration under Chapter III.H.). Adventitious assemblages of kelp plants on waste discharge structures (e.g., outfall pipes and diffusers) do not constitute kelp* beds for purposes of bacterial standards.

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* See Appendix I for definition of terms.

2. Shellfish* Harvesting Standards

    a. At all areas where shellfish* may be harvested for human consumption, as determined by the Regional Board, the following bacterial objectives shall be maintained throughout the water column:

        (1) The median total coliform density shall not exceed 70 per 100 ml, and not more than 10 percent of the samples shall exceed 230 per 100 ml.

C. Physical Characteristics

1. Floating particulates and grease and oil shall not be visible.

2. The discharge of waste* shall not cause aesthetically undesirable discoloration of the ocean* surface.

3. Natural* light shall not be significantly* reduced at any point outside the initial* dilution zone as the result of the discharge of waste*.

4. The rate of deposition of inert solids and the characteristics of inert solids in ocean* sediments shall not be changed such that benthic communities are degraded*.

D. Chemical Characteristics

1. The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding waste* materials.
2. The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.
3. The dissolved sulfide concentration of waters in and near sediments shall not be significantly* increased above that present under natural conditions.
4. The concentration of substances set forth in Chapter II, Table B, in marine sediments shall not be increased to levels which would degrade* indigenous biota.
5. The concentration of organic materials in marine sediments shall not be increased to levels that would degrade* marine life.
6. Nutrient materials shall not cause objectionable aquatic growths or degrade* indigenous biota.
7. Numerical Water Quality Objectives
    a. Table B water quality objectives apply to all discharges within the jurisdiction of this Plan.
    b. Table B Water Quality Objectives

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* See Appendix I for definition of terms.

TABLE B
WATER QUALITY OBJECTIVES

		Limiting Concentrations		
	Units of Measurement	6-Month Median	Daily Maximum	Instantaneous Maximum
OBJECTIVES FOR PROTECTION OF MARINE AQUATIC LIFE				
Arsenic	ug/l	8.	32.	80.
Cadmium	ug/l	1.	4.	10.
Chromium (Hexavalent) (see below, a)	ug/l	2.	8.	20.
Copper	ug/l	3.	12.	30.
Lead	ug/l	2.	8.	20.
Mercury	ug/l	0.04	0.16	0.4
Nickel	ug/l	5.	20.	50.
Selenium	ug/l	15.	60.	150.
Silver	ug/l	0.7	2.8	7.
Zinc	ug/l	20.	80.	200.
Cyanide (see below, b)	ug/l	1.	4.	10.
Total Chlorine Residual (For intermittent chlorine sources see below, c)	ug/l	2.	8.	60.
Ammonia (expressed as nitrogen)	ug/l	600.	2400.	6000.
Acute* Toxicity	TUa	N/A	0.3	N/A
Chronic* Toxicity	TUc	N/A	1.	N/A
Phenolic Compounds (non-chlorinated)	ug/l	30.	120.	300.
Chlorinated Phenolics	ug/l	1.	4.	10.
Endosulfan	ug/l	0.009	0.018	0.027
Endrin	ug/l	0.002	0.004	0.006
HCH*	ug/l	0.004	0.008	0.012
Radioactivity	Not to exceed limits specified in Title 17, Division 1, Chapter 5, Subchapter 4, Group 3, Article 3, Section 30253 of the California Code of Regulations. Reference to Section 30253 is prospective, including future changes to any incorporated provisions of federal law, as the changes take effect.			

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* See Appendix I for definition of terms.

Table B Continued

Chemical	30-day Average (ug/l)	
	Decimal Notation	Scientific Notation
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – NONCARCINOGENS		
acrolein	220.	2.2×10^{2}
antimony	1,200.	1.2×10^{3}
bis(2-chloroethoxy) methane	4.4	4.4×10^{0}
bis(2-chloroisopropyl) ether	1,200.	1.2×10^{3}
chlorobenzene	570.	5.7×10^{2}
chromium (III)	190,000.	1.9×10^{5}
di-n-butyl phthalate	3,500.	3.5×10^{3}
dichlorobenzenes*	5,100.	5.1×10^{3}
diethyl phthalate	33,000.	3.3×10^{4}
dimethyl phthalate	820,000.	8.2×10^{5}
4,6-dinitro-2-methylphenol	220.	2.2×10^{2}
2,4-dinitrophenol	4.0	4.0×10^{0}
ethylbenzene	4,100.	4.1×10^{3}
fluoranthene	15.	1.5×10^{1}
hexachlorocyclopentadiene	58.	5.8×10^{1}
nitrobenzene	4.9	4.9×10^{0}
thallium	2.	$2. \times 10^{0}$
toluene	85,000.	8.5×10^{4}
tributyltin	0.0014	1.4×10^{-3}
1,1,1-trichloroethane	540,000.	5.4×10^{5}
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – CARCINOGENS		
acrylonitrile	0.10	1.0×10^{-1}
aldrin	0.000022	2.2×10^{-5}
benzene	5.9	5.9×10^{0}
benzidine	0.000069	6.9×10^{-5}
beryllium	0.033	3.3×10^{-2}
bis(2-chloroethyl) ether	0.045	4.5×10^{-2}
bis(2-ethylhexyl) phthalate	3.5	3.5×10^{0}
carbon tetrachloride	0.90	9.0×10^{-1}
chlordane*	0.000023	2.3×10^{-5}
chlorodibromomethane	8.6	8.6×10^{0}

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* See Appendix I for definition of terms.

Table B Continued

	30-day Average (ug/l)	
Chemical	Decimal Notation	Scientific Notation
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – CARCINOGENS		
chloroform	130.	1.3×10^{2}
DDT*	0.00017	1.7×10^{-4}
1,4-dichlorobenzene	18.	1.8×10^{1}
3,3'-dichlorobenzidine	0.0081	8.1×10^{-3}
1,2-dichloroethane	28.	2.8×10^{1}
1,1-dichloroethylene	0.9	9×10^{-1}
dichlorobromomethane	6.2	6.2×10^{0}
dichloromethane	450.	4.5×10^{2}
1,3-dichloropropene	8.9	8.9×10^{0}
dieldrin	0.00004	4.0×10^{-5}
2,4-dinitrotoluene	2.6	2.6×10^{0}
1,2-diphenylhydrazine	0.16	1.6×10^{-1}
halomethanes*	130.	1.3×10^{2}
heptachlor	0.00005	5×10^{-5}
heptachlor epoxide	0.00002	2×10^{-5}
hexachlorobenzene	0.00021	2.1×10^{-4}
hexachlorobutadiene	14.	1.4×10^{1}
hexachloroethane	2.5	2.5×10^{0}
isophorone	730.	7.3×10^{2}
N-nitrosodimethylamine	7.3	7.3×10^{0}
N-nitrosodi-N-propylamine	0.38	3.8×10^{-1}
N-nitrosodiphenylamine	2.5	2.5×10^{0}
PAHs*	0.0088	8.8×10^{-3}
PCBs*	0.000019	1.9×10^{-5}
TCDD equivalents*	0.0000000039	3.9×10^{-9}
1,1,2,2-tetrachloroethane	2.3	2.3×10^{0}
tetrachloroethylene	2.0	2.0×10^{0}
toxaphene	0.00021	2.1×10^{-4}
trichloroethylene	27.	2.7×10^{1}
1,1,2-trichloroethane	9.4	9.4×10^{0}
2,4,6-trichlorophenol	0.29	2.9×10^{-1}
vinyl chloride	36.	3.6×10^{1}

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* See Appendix I for definition of terms.

Table B Notes:

a) Dischargers may at their option meet this objective as a total chromium objective.

b) If a discharger can demonstrate to the satisfaction of the Regional Board (subject to EPA approval) that an analytical method is available to reliably distinguish between strongly and weakly complexed cyanide, effluent limitations for cyanide may be met by the combined measurement of free cyanide, simple alkali metal cyanides, and weakly complexed organometallic cyanide complexes. In order for the analytical method to be acceptable, the recovery of free cyanide from metal complexes must be comparable to that achieved by the approved method in 40 CFR PART 136, as revised May 14, 1999.

c) Water quality objectives for total chlorine residual applying to intermittent discharges not exceeding two hours, shall be determined through the use of the following equation:

$$\log y = -0.43 (\log x) + 1.8$$

where: y = the water quality objective (in ug/l) to apply when chlorine is being discharged;
x = the duration of uninterrupted chlorine discharge in minutes.

E. Biological Characteristics

1. Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded*.

2. The natural taste, odor, and color of fish, shellfish*, or other marine resources used for human consumption shall not be altered.

3. The concentration of organic materials in fish, shellfish* or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.

F. Radioactivity

1. Discharge of radioactive waste* shall not degrade* marine life.

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* See Appendix I for definition of terms.

III. PROGRAM OF IMPLEMENTATION

A. General Provisions

1. Effective Date

a. The *Water Quality Control Plan, Ocean Waters of California, California Ocean Plan* was adopted and has been effective since 1972. There have been multiple amendments of the Ocean Plan since its adoption.

This document includes the most recent amendments of the Ocean Plan as approved by the SWRCB on November 16, 2000. However, amendments in this version of the Ocean Plan do not become effective until approved by the US EPA. Persons using the Ocean Plan prior to US EPA approval of this version should reference the 1997 Ocean Plan. Once approved by the US EPA, this document (the 2001 Ocean Plan) will supercede the 1997 Ocean Plan.

2. General Requirements For Management Of Waste Discharge To The Ocean*

a. Waste* management systems that discharge to the ocean* must be designed and operated in a manner that will maintain the indigenous marine life and a healthy and diverse marine community.

b. Waste discharged* to the ocean* must be essentially free of:

(1) Material that is floatable or will become floatable upon discharge.

(2) Settleable material or substances that may form sediments which will degrade* benthic communities or other aquatic life.

(3) Substances which will accumulate to toxic levels in marine waters, sediments or biota.

(4) Substances that significantly* decrease the natural* light to benthic communities and other marine life.

(5) Materials that result in aesthetically undesirable discoloration of the ocean* surface.

c. Waste* effluents shall be discharged in a manner which provides sufficient initial* dilution to minimize the concentrations of substances not removed in the treatment.

d. Location of waste* discharges must be determined after a detailed assessment of the oceanographic characteristics and current patterns to assure that:

(1) Pathogenic organisms and viruses are not present in areas where shellfish* are harvested for human consumption or in areas used for swimming or other body-contact sports.

(2) Natural water quality conditions are not altered in areas designated as being of special biological significance or areas that existing marine laboratories use as a source of seawater.

(3) Maximum protection is provided to the marine environment.

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* See Appendix I for definition of terms.

e. Waste* that contains pathogenic organisms or viruses should be discharged a sufficient distance from shellfishing* and water-contact sports areas to maintain applicable bacterial standards without disinfection. Where conditions are such that an adequate distance cannot be attained, reliable disinfection in conjunction with a reasonable separation of the discharge point from the area of use must be provided. Disinfection procedures that do not increase effluent toxicity and that constitute the least environmental and human hazard should be used.

3. Areas of Special Biological Significance

   a. ASBS* shall be designated by the SWRCB following the procedures provided in Appendix IV. A list of ASBS* is available in Appendix V.

4. Combined Sewer Overflow: Not withstanding any other provisions in this plan, discharges from the City of San Francisco's combined sewer system are subject to the US EPA's Combined Sewer Overflow Policy.

B. Table A Effluent Limitations

TABLE A
EFFLUENT LIMITATIONS

		Limiting Concentrations		
	Unit of Measurement	Monthly (30-day Average)	Weekly (7-day Average)	Maximum at any time
Grease and Oil	mg/l	25.	40.	75.
Suspended Solids			See below +	
Settleable Solids	Ml/l	1.0	1.5	3.0
Turbidity	NTU	75.	100.	225.
PH	Units		Within limit of 6.0 to 9.0 at all times	

Table A Notes:

\+ Suspended Solids: Dischargers shall, as a 30-day average, remove 75% of suspended solids from the influent stream before discharging wastewaters to the ocean*, except that the effluent limitation to be met shall not be lower than 60 mg/l. Regional Boards may recommend that the SWRCB (Chapter IIIJ), with the concurrence of the Environmental Protection Agency, adjust the lower effluent concentration limit (the 60 mg/l above) to suit the environmental and effluent characteristics of the discharge. As a further consideration in making such recommendation for adjustment, Regional Boards should evaluate effects on existing and potential water* reclamation projects.

If the lower effluent concentration limit is adjusted, the discharger shall remove 75% of suspended solids from the influent stream at any time the influent concentration exceeds four times such adjusted effluent limit.

1. Table A effluent limitations apply only to publicly owned treatment works and industrial discharges for which Effluent Limitations Guidelines have not been established pursuant to Sections 301, 302, 304, or 306 of the Federal Clean Water Act.

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* See Appendix I for definition of terms.

2. Table A effluent limitations shall apply to a discharger's total effluent, of whatever origin (i.e., gross, not net, discharge), except where otherwise specified in this Plan.

3. The SWRCB is authorized to administer and enforce effluent limitations established pursuant to the Federal Clean Water Act. Effluent limitations established under Sections 301, 302, 306, 307, 316, 403, and 405 of the aforementioned Federal Act and administrative procedures pertaining thereto are included in this plan by reference. Compliance with Table A effluent limitations, or Environmental Protection Agency Effluent Limitations Guidelines for industrial discharges, based on Best Practicable Control Technology, shall be the minimum level of treatment acceptable under this plan, and shall define reasonable treatment and waste control technology.

C. Implementation Provisions for Table B

1. Effluent concentrations calculated from Table B water quality objectives shall apply to a discharger's total effluent, of whatever origin (i.e., gross, not net, discharge), except where otherwise specified in this Plan.

2. Effluent limitations shall be imposed in a manner prescribed by the SWRCB such that the concentrations set forth below as water quality objectives shall not be exceeded in the receiving water upon completion of initial* dilution, except that objectives indicated for radioactivity shall apply directly to the undiluted waste* effluent.

3. Calculation of Effluent Limitations

   a. Effluent limitations for water quality objectives listed in Table B, with the exception of acute* toxicity and radioactivity, shall be determined through the use of the following equation:

   Equation 1: $Ce = Co + Dm (Co - Cs)$

   where:

   Ce = the effluent concentration limit, ug/l

   Co = the concentration (water quality objective) to be met at the completion of initial* dilution, ug/l

   Cs = background seawater concentration (see Table C below), ug/l

   Dm = minimum probable initial* dilution expressed as parts seawater per part wastewater.

TABLE C
BACKGROUND SEAWATER CONCENTRATIONS (Cs)

Waste Constituent	Cs (ug/l)
Arsenic	3.
Copper	2.
Mercury	0.0005
Silver	0.16
Zinc	8.

For all other Table B parameters, Cs = 0.

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* See Appendix I for definition of terms.

b. Determining a Mixing Zone for the Acute* Toxicity Objective

The mixing zone for the acute* toxicity objective shall be ten percent (10%) of the distance from the edge of the outfall structure to the edge of the chronic mixing zone (zone of initial dilution). There is no vertical limitation on this zone. The effluent limitation for the acute* toxicity objective listed in Table B shall be determined through the use of the following equation:

Equation 2: $Ce = Ca + (0.1)\ Dm\ (Ca)$

where:

Ca = the concentration (water quality objective) to be met at the edge of the acute mixing zone.

Dm = minimum probable initial* dilution expressed as parts seawater per part wastewater (This equation applies only when $Dm > 24$).

c. Toxicity Testing Requirements based on the Minimum Initial* Dilution Factor for Ocean Waste Discharges

(1) Dischargers shall conduct acute* toxicity testing if the minimum initial* dilution of the effluent is greater than 1,000:1 at the edge of the mixing zone.

(2) Dischargers shall conduct either acute* or chronic* toxicity testing if the minimum initial* dilution ranges from 350:1 to 1,000:1 depending on the specific discharge conditions. The RWQCB shall make this determination.

(3) Dischargers shall conduct chronic* toxicity testing for ocean waste discharges with minimum initial* dilution factors ranging from 100:1 to 350:1. The RWQCBs may require that acute toxicity testing be conducted in addition to chronic as necessary for the protection of beneficial uses of ocean waters.

(4) Dischargers shall conduct chronic toxicity testing if the minimum initial* dilution of the effluent falls below 100:1 at the edge of the mixing zone.

d. For the purpose of this Plan, minimum initial* dilution is the lowest average initial* dilution within any single month of the year. Dilution estimates shall be based on observed waste flow characteristics, observed receiving water density structure, and the assumption that no currents, of sufficient strength to influence the initial* dilution process, flow across the discharge structure.

e. The Executive Director of the SWRCB shall identify standard dilution models for use in determining Dm, and shall assist the Regional Board in evaluating Dm for specific waste discharges. Dischargers may propose alternative methods of calculating Dm, and the Regional Board may accept such methods upon verification of its accuracy and applicability.

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* See Appendix I for definition of terms.

f. The six-month median shall apply as a moving median of daily values for any 180-day period in which daily values represent flow weighted average concentrations within a 24-hour period. For intermittent discharges, the daily value shall be considered to equal zero for days on which no discharge occurred.

g. The daily maximum shall apply to flow weighted 24 hour composite samples.

h. The instantaneous maximum shall apply to grab sample determinations.

i. If only one sample is collected during the time period associated with the water quality objective (e.g., 30-day average or 6-month median), the single measurement shall be used to determine compliance with the effluent limitation for the entire time period.

j. Discharge requirements shall also specify effluent limitations in terms of mass emission rate limits utilizing the general formula:

Equation 3: lbs/day = 0.00834 x Ce x Q

where:

Ce = the effluent concentration limit, ug/l

Q = flow rate, million gallons per day (MGD)

k. The six-month median limit on daily mass emissions shall be determined using the six-month median effluent concentration as Ce and the observed flow rate Q in millions of gallons per day. The daily maximum mass emission shall be determined using the daily maximum effluent concentration limit as Ce and the observed flow rate Q in millions of gallons per day.

l. Any significant change in waste* flow shall be cause for reevaluating effluent limitations.

4. Minimum* Levels

For each numeric effluent limitation, the Regional Board must select one or more Minimum* Levels (and their associated analytical methods) for inclusion in the permit. The "reported" Minimum* Level is the Minimum* Level (and its associated analytical method) chosen by the discharger for reporting and compliance determination from the Minimum* Levels included in their permit.

a. Selection of Minimum* Levels from Appendix II

The Regional Board must select all Minimum* Levels from Appendix II that are below the effluent limitation. If the effluent limitation is lower than all the Minimum* Levels in Appendix II, the Regional Board must select the lowest Minimum* Level from Appendix II.

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* See Appendix I for definition of terms.

b. Deviations from Minimum* Levels in Appendix II

The Regional Board, in consultation with the State Water Board's Quality Assurance Program, must establish a Minimum* Level to be included in the permit in any of the following situations:

1. A pollutant is not listed in Appendix II.
2. The discharger agrees to use a test method that is more sensitive than those described in 40 CFR 136 (revised May 14, 1999).
3. The discharger agrees to use a Minimum* Level lower than those listed in Appendix II.
4. The discharger demonstrates that their calibration standard matrix is sufficiently different from that used to establish the Minimum* Level in Appendix II and proposes an appropriate Minimum* Level for their matrix.
5. A discharger uses an analytical method having a quantification practice that is not consistent with the definition of Minimum* Level (e.g., US EPA methods 1613, 1624, 1625).

5. Use of Minimum* Levels

a. Minimum* Levels in Appendix II represent the lowest quantifiable concentration in a sample based on the proper application of method-specific analytical procedures and the absence of matrix interferences. Minimum* Levels also represent the lowest standard concentration in the calibration curve for a specific analytical technique after the application of appropriate method-specific factors.

Common analytical practices may require different treatment of the sample relative to the calibration standard. Some examples are given below:

Substance or Grouping	Method-Specific Treatment	Most Common Factor
Volatile Organics	No differential treatment	1
Semi-Volatile Organics	Samples concentrated by extraction	1000
Metals	Samples diluted or concentrated	½ , 2 , and 4
Pesticides	Samples concentrated by extraction	100

b. Other factors may be applied to the Minimum* Level depending on the specific sample preparation steps employed. For example, the treatment typically applied when there are matrix effects is to dilute the sample or sample aliquot by a factor of ten. In such cases, this additional factor must be applied during the computation of the reporting limit. Application of such factors will alter the reported Minimum* Level.

c. Dischargers are to instruct their laboratories to establish calibration standards so that the Minimum* Level (or its equivalent if there is differential treatment of samples relative to calibration standards) is the lowest calibration standard. At no time is the discharger to use analytical data derived from *extrapolation* beyond the lowest point of the calibration curve. In accordance with Section 4b, above, the discharger's laboratory may employ a calibration standard lower than the Minimum* Level in Appendix II.

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* See Appendix I for definition of terms.

6. Sample Reporting Protocols

   a. Dischargers must report with each sample result the reported Minimum* Level (selected in accordance with Section 4, above) and the laboratory's current MDL*.

   b. Dischargers must also report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

      (1) Sample results greater than or equal to the reported Minimum* Level must be reported "as measured" by the laboratory (i.e., the measured chemical concentration in the sample).

      (2) Sample results less than the reported Minimum* Level, but greater than or equal to the laboratory's MDL*, must be reported as "Detected, but Not Quantified", or DNQ. The laboratory must write the estimated chemical concentration of the sample next to DNQ as well as the words "Estimated Concentration" (may be shortened to "Est. Conc.").

      (3) Sample results less than the laboratory's MDL* must be reported as "Not Detected", or ND.

7. Compliance Determination

   Sufficient sampling and analysis shall be required to determine compliance with the effluent limitation.

   a. Compliance with Single-Constituent Effluent Limitations

      Dischargers are out of compliance with the effluent limitation if the concentration of the pollutant (see Section 7c, below) in the monitoring sample is greater than the effluent limitation and greater than or equal to the reported Minimum* Level.

   b. Compliance with Effluent Limitations expressed as a Sum of Several Constituents

      Dischargers are out of compliance with an effluent limitation which applies to the sum of a group of chemicals (e.g., PCB's) if the sum of the individual pollutant concentrations is greater than the effluent limitation. Individual pollutants of the group will be considered to have a concentration of zero if the constituent is reported as ND or DNQ.

   c. Multiple Sample Data Reduction

      The concentration of the pollutant in the effluent may be estimated from the result of a single sample analysis or by a measure of central tendency (arithmetic mean, geometric mean, median, etc.) of multiple sample analyses when all sample results are quantifiable (i.e., greater than or equal to the reported Minimum* Level). When one or more sample results are reported as ND or DNQ, the central tendency concentration of the pollutant shall be the median (middle) value of the multiple samples. If, in an even number of samples, one or both of the middle values is ND or DNQ, the median will be the lower of the two middle values.

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* See Appendix I for definition of terms.

d. Powerplants and Heat Exchange Dischargers

Due to the large total volume of powerplant and other heat exchange discharges, special procedures must be applied for determining compliance with Table B objectives on a routine basis. Effluent concentration values (Ce) shall be determined through the use of equation 1 considering the minimal probable initial* dilution of the combined effluent (in-plant waste streams plus cooling water flow). These concentration values shall then be converted to mass emission limitations as indicated in equation 3. The mass emission limits will then serve as requirements applied to all inplant waste* streams taken together which discharge into the cooling water flow, except that limits for total chlorine residual, acute* (if applicable per Section (3)(c)) and chronic* toxicity and instantaneous maximum concentrations in Table B shall apply to, and be measured in, the combined final effluent, as adjusted for dilution with ocean water. The Table B objective for radioactivity shall apply to the undiluted combined final effluent.

8. Pollutant Minimization Program

a. Pollutant Minimization Program Goal

The goal of the Pollutant Minimization Program is to reduce all potential sources of a pollutant through pollutant minimization (control) strategies, including pollution prevention measures, in order to maintain the effluent concentration at or below the effluent limitation.

Pollution prevention measures may be particularly appropriate for persistent bioaccumulative priority pollutants where there is evidence that beneficial uses are being impacted. The completion and implementation of a Pollution Prevention Plan, required in accordance with CA Water Code Section 13263.3 (d) will fulfill the Pollution Minimization Program requirements in this section.

b. Determining the need for a Pollutant Minimization Program

1. The discharger must develop and conduct a Pollutant Minimization Program if all of the following conditions are true:

   (a) The calculated effluent limitation is less than the reported Minimum* Level

   (b) The concentration of the pollutant is reported as DNQ

   (c) There is evidence showing that the pollutant is present in the effluent above the calculated effluent limitation.

2. Alternatively, the discharger must develop and conduct a Pollutant Minimization Program if all of the following conditions are true:

   (a) The calculated effluent limitation is less than the Method Detection Limit*.

   (b) The concentration of the pollutant is reported as ND.

   (c) There is evidence showing that the pollutant is present in the effluent above the calculated effluent limitation.

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* See Appendix I for definition of terms.

c. Regional Boards may include special provisions in the discharge requirements to require the gathering of evidence to determine whether the pollutant is present in the effluent at levels above the calculated effluent limitation. Examples of evidence may include:

   1. health advisories for fish consumption,
   2. presence of whole effluent toxicity,
   3. results of benthic or aquatic organism tissue sampling,
   4. sample results from analytical methods more sensitive than methods included in the permit (in accordance with Section 4b, above).
   5. the concentration of the pollutant is reported as DNQ and the effluent limitation is less than the MDL

d. Elements of a Pollutant Minimization Program

   The Regional Board may consider cost-effectiveness when establishing the requirements of a Pollutant Minimization Program. The program shall include actions and submittals acceptable to the Regional Board including, but not limited to, the following:

   1. An annual review and semi-annual monitoring of potential sources of the reportable pollutant, which may include fish tissue monitoring and other bio-uptake sampling;
   2. Quarterly monitoring for the reportable pollutant in the influent to the wastewater treatment system;
   3. Submittal of a control strategy designed to proceed toward the goal of maintaining concentrations of the reportable pollutant in the effluent at or below the calculated effluent limitation;
   4. Implementation of appropriate cost-effective control measures for the pollutant, consistent with the control strategy; and,
   5. An annual status report that shall be sent to the Regional Board including:
      (a) All Pollutant Minimization Program monitoring results for the previous year;
      (b) A list of potential sources of the reportable pollutant;
      (c) A summary of all action taken in accordance with the control strategy; and,
      (d) A description of actions to be taken in the following year.

9. Toxicity Reduction Requirements

a. If a discharge consistently exceeds an effluent limitation based on a toxicity objective in Table B, a toxicity reduction evaluation (TRE) is required. The TRE shall include all reasonable steps to identify the source of toxicity. Once the source(s) of toxicity is identified, the discharger shall take all reasonable steps necessary to reduce toxicity to the required level.

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* See Appendix I for definition of terms.

b. The following shall be incorporated into waste discharge requirements: (1) a requirement to conduct a TRE if the discharge consistently exceeds its toxicity effluent limitation, and (2) a provision requiring a discharger to take all reasonable steps to reduce toxicity once the source of toxicity is identified.

D. Implementation Provisions for Bacterial Assessment and Remedial Action Requirements

1. The requirements listed below shall be used to determine the occurrence and extent of any impairment of a beneficial use due to bacterial contamination, generate information which can be used in the development of an enterococcus standard, and provide the basis for remedial actions necessary to minimize or eliminate any impairment of a beneficial use.

   a. Measurement of enterococcus density shall be conducted at all stations where measurement of total and fecal coliforms are required. In addition to the requirements of Chapter II.B.I, if a shore station consistently exceeds a coliform objective or exceeds a geometric mean enterococcus density of 24 organisms per 100 ml for a 30-day period or 12 organisms per 100 ml for a six-month period, the Regional Board shall require the appropriate agency to conduct a survey to determine if that agency's discharge is the source of the contamination. The geometric mean shall be a moving average based on no less than five samples per month, spaced evenly over the time interval. When a sanitary survey identifies a controllable source of indicator organisms associated with a discharge of sewage, the Regional Board shall take action to control the source.

   b. Waste discharge requirements shall require the discharger to conduct sanitary surveys when so directed by the Regional Board. Waste discharge requirements shall contain provisions requiring the discharger to control any controllable discharges identified in a sanitary survey.

E. Implementation Provisions For Areas* of Special Biological Significance (ASBS)

1. Waste* shall not be discharged to areas designated as being of special biological significance. Discharges shall be located a sufficient distance from such designated areas to assure maintenance of natural water quality conditions in these areas.

2. Regional Boards may approve waste discharge requirements or recommend certification for limited-term (i.e. weeks or months) activities in ASBS*. Limited-term activities include, but are not limited to, activities such as maintenance/repair of existing boat facilities, restoration of sea walls, repair of existing storm water pipes, and replacement/repair of existing bridges. Limited-term activities may result in temporary and short-term changes in existing water quality. Water quality degradation shall be limited to the shortest possible time. The activities must not permanently degrade water quality or result in water quality lower than that necessary to protect existing uses, and all practical means of minimizing such degradation shall be implemented.

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* See Appendix I for definition of terms.

F. Revision of Waste* Discharge Requirements

1. The Regional Board shall revise the waste* discharge requirements for existing* discharges as necessary to achieve compliance with this Plan and shall also establish a time schedule for such compliance.

2. The Regional Boards may establish more restrictive water quality objectives and effluent limitations than those set forth in this Plan as necessary for the protection of beneficial uses of ocean* waters.

3. Regional Boards may impose alternative less restrictive provisions than those contained within Table B of the Plan, provided an applicant can demonstrate that:

    a. Reasonable control technologies (including source control, material substitution, treatment and dispersion) will not provide for complete compliance; or

    b. Any less stringent provisions would encourage water* reclamation;

4. Provided further that:

    a. Any alternative water quality objectives shall be below the conservative estimate of chronic* toxicity, as given in Table D, and such alternative will provide for adequate protection of the marine environment;

    b. A receiving water quality toxicity objective of 1 TUc is not exceeded; and

    c. The State Board grants an exception (Chapter III. I.) to the Table B limits as established in the Regional Board findings and alternative limits.

TABLE D
CONSERVATIVE ESTIMATES OF CHRONIC TOXICITY

Constituent	Estimate of Chronic Toxicity (ug/l)
Arsenic	19.
Cadmium	8.
Hexavalent Chromium	18.
Copper	5.
Lead	22.
Mercury	0.4
Nickel	48.
Silver	3.
Zinc	51.
Cyanide	10.
Total Chlorine Residual	10.0
Ammonia	4000.0
Phenolic Compounds (non-chlorinated)	a) (see below)
Chlorinated Phenolics	a)
Chlorinated Pesticides and PCB's	b)

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* See Appendix I for definition of terms.

Table D Notes:

a) There are insufficient data for phenolics to estimate chronic toxicity levels. Requests for modification of water quality objectives for these waste* constituents must be supported by chronic toxicity data for representative sensitive species. In such cases, applicants seeking modification of water quality objectives should consult the Regional Water Quality Control Board to determine the species and test conditions necessary to evaluate chronic effects.

b) Limitations on chlorinated pesticides and PCB's shall not be modified so that the total of these compounds is increased above the objectives in Table B.

G. Monitoring Program

1. The Regional Boards shall require dischargers to conduct self-monitoring programs and submit reports necessary to determine compliance with the waste* discharge requirements, and may require dischargers to contract with agencies or persons acceptable to the Regional Board to provide monitoring reports. Monitoring provisions contained in waste discharge requirements shall be in accordance with the Monitoring Procedures provided in Appendix III.

2. Where the Regional Board is satisfied that any substance(s) of Table B will not significantly occur in a discharger's effluent, the Regional Board may elect not to require monitoring for such substance(s), provided the discharger submits periodic certification that such substance(s) is not added to the waste* stream, and that no change has occurred in activities that could cause such substance(s) to be present in the waste* stream. Such election does not relieve the discharger from the requirement to meet the objectives of Table B.

3. The Regional Board may require monitoring of bioaccumulation of toxicants in the discharge zone. Organisms and techniques for such monitoring shall be chosen by the Regional Board on the basis of demonstrated value in waste* discharge monitoring.

H. Discharge Prohibitions

1. Hazardous Substances

   a. The discharge of any radiological, chemical, or biological warfare agent or high-level radioactive waste* into the ocean* is prohibited.

2. Areas Designated for Special Water Quality Protection

   a. Waste* shall not be discharged to designated Areas* of Special Biological Significance except as provided in Chapter III E. Implementation Provisions For Areas of Special Biological Significance.

3. Sludge

   a. Pipeline discharge of sludge to the ocean* is prohibited by federal law; the discharge of municipal and industrial waste* sludge directly to the ocean*, or into

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* See Appendix I for definition of terms.

a waste* stream that discharges to the ocean*, is prohibited by this Plan. The discharge of sludge digester supernatant directly to the ocean*, or to a waste* stream that discharges to the ocean* without further treatment, is prohibited.

b. It is the policy of the SWRCB that the treatment, use and disposal of sewage sludge shall be carried out in the manner found to have the least adverse impact on the total natural and human environment. Therefore, if federal law is amended to permit such discharge, which could affect California waters, the SWRCB may consider requests for exceptions to this section under Chapter III, H. of this Plan, provided further that an Environmental Impact Report on the proposed project shows clearly that any available alternative disposal method will have a greater adverse environmental impact than the proposed project.

4. By-Passing

a. The by-passing of untreated wastes* containing concentrations of pollutants in excess of those of Table A or Table B to the ocean* is prohibited.

I. State Board Exceptions to Plan Requirements

1. The State Board may, in compliance with the California Environmental Quality Act, subsequent to a public hearing, and with the concurrence of the Environmental Protection Agency, grant exceptions where the Board determines:

a. The exception will not compromise protection of ocean* waters for beneficial uses, and,

b. The public interest will be served.

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* See Appendix I for definition of terms.

APPENDIX I

DEFINITION OF TERMS

ACUTE TOXICITY

a. Acute Toxicity (TUa)

Expressed in Toxic Units Acute (TUa)

$$TUa = \frac{100}{\text{96-hr LC 50\%}}$$

b. Lethal Concentration 50% (LC 50)

LC 50 (percent waste giving 50% survival of test organisms) shall be determined by static or continuous flow bioassay techniques using standard marine test species as specified in Appendix III, Chapter II. If specific identifiable substances in wastewater can be demonstrated by the discharger as being rapidly rendered harmless upon discharge to the marine environment, but not as a result of dilution, the LC 50 may be determined after the test samples are adjusted to remove the influence of those substances.

When it is not possible to measure the 96-hour LC 50 due to greater than 50 percent survival of the test species in 100 percent waste, the toxicity concentration shall be calculated by the expression:

$$TUa = \frac{\log(100 - S)}{1.7}$$

where:

S = percentage survival in 100% waste. If S > 99, TUa shall be reported as zero.

AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS) are those areas designated by the SWRCB as requiring protection of species or biological communities to the extent that alteration of natural water quality is undesirable.

CHLORDANE shall mean the sum of chlordane-alpha, chlordane-gamma, chlordene-alpha, chlordene-gamma, nonachlor-alpha, nonachlor-gamma, and oxychlordane.

CHRONIC TOXICITY: This parameter shall be used to measure the acceptability of waters for supporting a healthy marine biota until improved methods are developed to evaluate biological response.

a. Chronic Toxicity (TUc)

Expressed as Toxic Units Chronic (TUc)

$$TUc = \frac{100}{NOEL}$$

b. No Observed Effect Level (NOEL)

The NOEL is expressed as the maximum percent effluent or receiving water that causes no observable effect on a test organism, as determined by the result of a critical life stage toxicity test listed in Appendix II.

DDT shall mean the sum of 4,4'DDT, 2,4'DDT, 4,4'DDE, 2,4'DDE, 4,4'DDD, and 2,4'DDD.

DEGRADE: Degradation shall be determined by comparison of the waste field and reference site(s) for characteristic species diversity, population density, contamination, growth anomalies, debility, or supplanting of normal species by undesirable plant and animal species. Degradation occurs if there are significant differences in any of three major biotic groups, namely, demersal fish, benthic invertebrates, or attached algae. Other groups may be evaluated where benthic species are not affected, or are not the only ones affected.

DICHLOROBENZENES shall mean the sum of 1,2- and 1,3-dichlorobenzene.

DOWNSTREAM OCEAN WATERS shall mean waters downstream with respect to ocean currents.

DREDGED MATERIAL: Any material excavated or dredged from the navigable waters of the United States, including material otherwise referred to as "spoil".

ENCLOSED BAYS are indentations along the coast which enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

ENDOSULFAN shall mean the sum of endosulfan-alpha and -beta and endosulfan sulfate.

ESTUARIES AND COASTAL LAGOONS are waters at the mouths of streams that serve as mixing zones for fresh and ocean waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include but are not limited to the Sacramento-San Joaquin Delta as defined by Section 12220 of the California Water Code, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

HALOMETHANES shall mean the sum of bromoform, bromomethane (methyl bromide) and chloromethane (methyl chloride).

HCH shall mean the sum of the alpha, beta, gamma (lindane) and delta isomers of hexachlorocyclohexane.

INITIAL DILUTION is the process which results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge.

For a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from the submarine outfalls, the momentum of the discharge and its initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally.

For shallow water submerged discharges, surface discharges, and nonbuoyant discharges, characteristic of cooling water wastes and some individual discharges, turbulent mixing results primarily from the momentum of discharge. Initial dilution, in these cases, is considered to be completed when the momentum induced velocity of the discharge ceases to produce significant mixing of the waste, or the diluting plume reaches a fixed distance from the discharge to be specified by the Regional Board, whichever results in the lower estimate for initial dilution.

KELP BEDS, for purposes of the bacteriological standards of this plan, are significant aggregations of marine algae of the genera Macrocystis and Nereocystis. Kelp beds include the total foliage canopy of Macrocystis and Nereocystis plants throughout the water column.

MARICULTURE is the culture of plants and animals in marine waters independent of any pollution source.

MATERIAL: (a) In common usage: (1) the substance or substances of which a thing is made or composed (2) substantial; (b) For purposes of this Ocean Plan relating to waste disposal, dredging and the disposal of dredged material and fill, MATERIAL means matter of any kind or description which is subject to regulation as waste, or any material dredged from the navigable waters of the United States. See also, DREDGED MATERIAL.

MDL (Method Detection Limit) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, as defined in 40 CFR PART 136 Appendix B.

MINIMUM LEVEL (ML) is the concentrations at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method-specified sample weights, volumes and processing steps have been followed.

NATURAL LIGHT: Reduction of natural light may be determined by the Regional Board by measurement of light transmissivity or total irradiance, or both, according to the monitoring needs of the Regional Board.

OCEAN WATERS are the territorial marine waters of the State as defined by California law to the extent these waters are outside of enclosed bays, estuaries, and coastal lagoons. If a discharge outside the territorial waters of the State could affect the quality of the waters of the State, the discharge may be regulated to assure no violation of the Ocean Plan will occur in ocean waters.

PAHs (polynuclear aromatic hydrocarbons) shall mean the sum of acenaphthylene, anthracene, 1,2-benzanthracene, 3,4-benzofluoranthene, benzo[k]fluoranthene, 1,12-benzoperylene, benzo[a]pyrene, chrysene, dibenzo[ah]anthracene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene and pyrene.

PCBs (polychlorinated biphenyls) shall mean the sum of chlorinated biphenyls whose analytical characteristics resemble those of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254 and Aroclor-1260.

SHELLFISH are organisms identified by the California Department of Health Services as shellfish for public health purposes (i.e., mussels, clams and oysters).

SIGNIFICANT difference is defined as a statistically significant difference in the means of two distributions of sampling results at the 95 percent confidence level.

TCDD EQUIVALENTS shall mean the sum of the concentrations of chlorinated dibenzodioxins (2,3,7,8-CDDs) and chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their respective toxicity factors, as shown in the table below.

Isomer Group	Toxicity Equivalence Factor
	1.0
2,3,7,8-tetra CDD	
2,3,7,8-penta CDD	0.5
2,3,7,8-hexa CDDs	0.1
2,3,7,8-hepta CDD	0.01
octa CDD	0.001
2,3,7,8 tetra CDF	0.1
1,2,3,7,8 penta CDF	0.05
2,3,4,7,8 penta CDF	0.5
2,3,7,8 hexa CDFs	0.1
2,3,7,8 hepta CDFs	0.01
octa CDF	0.001

WASTE: As used in this Plan, waste includes a discharger's total discharge, of whatever origin, i.e., gross, not net, discharge.

WATER RECLAMATION: The treatment of wastewater to render it suitable for reuse, the transportation of treated wastewater to the place of use, and the actual use of treated wastewater for a direct beneficial use or controlled use that would not otherwise occur.

APPENDIX II

MINIMUM* LEVELS

The Minimum* Levels identified in this appendix represent the lowest concentration of a pollutant that can be quantitatively measured in a sample given the current state of performance in analytical chemistry methods in California. These Minimum* Levels were derived from data provided by state-certified analytical laboratories in 1997 and 1998 for pollutants regulated by the California Ocean Plan and shall be used until new values are adopted by the SWRCB. There are four major chemical groupings: volatile chemicals, semi-volatile chemicals, inorganics, pesticides & PCB's. "No Data" is indicated by "--".

TABLE II-1

MINIMUM* LEVELS – VOLATILE CHEMICALS

		Minimum* Level (ug/L)	
Volatile Chemicals	**CAS Number**	**GC Method** [a]	**GCMS Method** [b]
Acrolein	107028	2.	5
Acrylonitrile	107131	2.	2
Benzene	71432	0.5	2
Bromoform	75252	0.5	2
Carbon Tetrachloride	56235	0.5	2
Chlorobenzene	108907	0.5	2
Chlorodibromomethane	124481	0.5	2
Chloroform	67663	0.5	2
1,2-Dichlorobenzene (volatile)	95501	0.5	2
1,3-Dichlorobenzene (volatile)	541731	0.5	2
1,4-Dichlorobenzene (volatile)	106467	0.5	2
Dichlorobromomethane	75274	0.5	2
1,1-Dichloroethane	75343	0.5	1
1,2-Dichloroethane	107062	0.5	2
1,1-Dichloroethylene	75354	0.5	2
Dichloromethane	75092	0.5	2
1,3-Dichloropropene (volatile)	542756	0.5	2
Ethyl benzene	100414	0.5	2
Methyl Bromide	74839	1.	2
Methyl Chloride	74873	0.5	2
1,1,2,2-Tetrachloroethane	79345	0.5	2
Tetrachloroethylene	127184	0.5	2
Toluene	108883	0.5	2
1,1,1-Trichloroethane	71556	0.5	2
1,1,2-Trichloroethane	79005	0.5	2
Trichloroethylene	79016	0.5	2
Vinyl Chloride	75014	0.5	2

Table II-1 Notes

a) GC Method = Gas Chromatography
b) GCMS Method = Gas Chromatography / Mass Spectrometry
* To determine the lowest standard concentration in an instrument calibration curve for these techniques, use the given ML (see Chapter III, "Use of Minimum* Levels").

TABLE II-2
MINIMUM* LEVELS – SEMI VOLATILE CHEMICALS

		Minimum* Level (ug/L)			
Semi-Volatile Chemicals	**CAS Number**	**GC Method [a, *]**	**GCMS Method [b, *]**	**HPLC Method [c,*]**	**COLOR Method [d]**
Acenapthylene	208968	--	10	0.2	--
Anthracene	120127	--	10	2	--
Benzidine	92875	--	5	--	--
Benzo(a)anthracene	56553	--	10	2	--
Benzo(a)pyrene	50328	--	10	2	--
Benzo(b)fluoranthene	205992	--	10	10	--
Benzo(g,h,i)perylene	191242	--	5	0.1	--
Benzo(k)floranthene	207089	--	10	2	--
Bis 2-(1-Chloroethoxy) methane	111911	--	5	--	--
Bis(2-Chloroethyl)ether	111444	10	1	--	--
Bis(2-Chloroisopropyl)ether	39638329	10	2	--	--
Bis(2-Ethylhexyl) phthalate	117817	10	5	--	--
2-Chlorophenol	95578	2	5	--	--
Chrysene	218019	--	10	5	--
Di-n-butyl phthalate	84742	--	10	--	--
Dibenzo(a,h)anthracene	53703	--	10	0.1	--
1,2-Dichlorobenzene (semivolatile)	95504	2	2	--	--
1,3-Dichlorobenzene (semivolatile)	541731	2	1	--	--
1,4-Dichlorobenzene (semivolatile)	106467	2	1	--	--
3,3-Dichlorobenzidine	91941	--	5	--	--
2,4-Dichlorophenol	120832	1	5	--	--
1,3-Dichloropropene	542756	--	5	--	
Diethyl phthalate	84662	10	2	--	--
Dimethyl phthalate	131113	10	2	--	--
2,4-Dimethylphenol	105679	1	2	--	--
2,4-Dinitrophenol	51285	5	5	--	--
2,4-Dinitrotoluene	121142	10	5	--	--
1,2-Diphenylhydrazine	122667	--	1	--	--
Fluoranthene	206440	10	1	0.05	--
Fluorene	86737	--	10	0.1	--
Hexachlorobenzene	118741	5	1	--	--
Hexachlorobutadiene	87683	5	1	--	--
Hexachlorocyclopentadiene	77474	5	5	--	--

Table II-2 continued on next page...

Table II-2 (Continued)
Minimum* Levels – Semi Volatile Chemicals

Semi-Volatile Chemicals	CAS Number	Minimum* Level (ug/L)			
		GC Method [a,*]	GCMS Method [b,*]	HPLC Method [c,*]	COLOR Method [d]
Hexachloroethane	67721	5	1	--	--
Indeno(1,2,3-cd)pyrene	193395	--	10	0.05	--
Isophorone	78591	10	1	--	--
2-methyl-4,6-dinitrophenol	534521	10	5	--	--
3-methyl-4-chlorophenol	59507	5	1	--	--
N-nitrosodi-n-propylamine	621647	10	5	--	--
N-nitrosodimethylamine	62759	10	5	--	--
N-nitrosodiphenylamine	86306	10	1	--	--
Nitrobenzene	98953	10	1	--	--
2-Nitrophenol	88755	--	10	--	--
4-Nitrophenol	100027	5	10	--	--
Pentachlorophenol	87865	1	5	--	--
Phenanthrene	85018	--	5	0.05	--
Phenol	108952	1	1	--	50
Pyrene	129000	--	10	0.05	--
2,4,6-Trichlorophenol	88062	10	10	--	--

Table II-2 Notes:

a) GC Method = Gas Chromatography
b) GCMS Method = Gas Chromatography / Mass Spectrometry
c) HPLC Method = High Pressure Liquid Chromatography
d) COLOR Method = Colorimetric

* To determine the lowest standard concentration in an instrument calibration curve for this technique, multiply the given ML by 1000 (see Chapter III, "Use of Minimum* Levels").

TABLE II-3
MINIMUM* LEVELS - INORGANICS

		Minimum* Level (ug/L)								
Inorganic Substances	**CAS Number**	**COLOR Method**[a]	**DCP Method**[b]	**FAA Method**[c]	**GFAA Method**[d]	**HYDRIDE Method**[e]	**ICP Method**[f]	**ICPMS Method**[g]	**SPGFAA Method**[h]	**CVAA Method**[i]
Antimony	7440360	--	1000.	10.	5.	0.5	50.	0.5	5.	--
Arsenic	7440382	20.	1000.	--	2.	1.	10.	2.	2.	--
Beryllium	7440417	--	1000.	20.	0.5	--	2.	0.5	1.	--
Cadmium	7440439	--	1000.	10.	0.5	--	10.	0.2	0.5	--
Chromium (total)	--	--	1000.	50.	2.	--	10.	0.5	1.	--
Chromium (VI)	18540299	10.	--	5.	--	--	--	--	--	--
Copper	7440508	--	1000.	20.	5.	--	10.	0.5	2.	--
Cyanide	57125	5.	--	--	--	--	--	--	--	--
Lead	7439921	--	10000.	20.	5.	--	5.	0.5	2.	--
Mercury	7439976	--	--	--	--	--	--	0.5	--	0.2
Nickel	7440020	--	1000.	50.	5.	--	20.	1.	5.	--
Selenium	7782492	--	1000.	--	5.	1.	10.	2.	5.	--
Silver	7440224	--	1000.	10.	1.	--	10.	0.2	2.	--
Thallium	7440280	--	1000.	10.	2.	--	10.	1.	5.	--
Zinc	7440666	--	1000.	20.	--	--	20.	1.	10.	--

Table II-3 Notes

a) COLOR Method = Colorimetric
b) DCP Method = Direct Current Plasma
c) FAA Method = Flame Atomic Absorption
d) GFAA Method = Graphite Furnace Atomic Absorption
e) HYDRIDE Method = Gaseous Hydride Atomic Absorption
f) ICP Method = Inductively Coupled Plasma
g) ICPMS Method = Inductively Coupled Plasma / Mass Spectrometry
h) SPGFAA Method = Stabilized Platform Graphite Furnace Atomic Absorption (i.e., US EPA 200.9)
i) CVAA Method = Cold Vapor Atomic Absorption

* To determine the lowest standard concentration in an instrument calibration curve for these techniques, use the given ML (see Chapter III, "Use of Minimum* Levels").

TABLE II-4
MINIMUM* LEVELS – PESTICIDES AND PCBs

		Minimum* Level (ug/L)
Pesticides – PCB's	**CAS Number**	**GC Method[a,*]**
Aldrin	309002	0.005
Chlordane	57749	0.1
4,4'-DDD	72548	0.05
4,4'-DDE	72559	0.05
4,4'-DDT	50293	0.01
Dieldrin	60571	0.01
a-Endosulfan	959988	0.02
b-Endosulfan	33213659	0.01
Endosulfan Sulfate	1031078	0.05
Endrin	72208	0.01
Heptachlor	76448	0.01
Heptachlor Epoxide	1024573	0.01
a-Hexachlorocyclohexane	319846	0.01
b-Hexachlorocyclohexane	319857	0.005
d-Hexachlorocyclohexane	319868	0.005
g-Hexachlorocyclohexane (Lindane)	58899	0.02
PCB 1016	--	0.5
PCB 1221	--	0.5
PCB 1232	--	0.5
PCB 1242	–	0.5
PCB 1248	–	0.5
PCB 1254	–	0.5
PCB 1260	–	0.5
Toxaphene	8001352	0.5

Table II-4 Notes

a) GC Method = Gas Chromatography

* To determine the lowest standard concentration in an instrument calibration curve for this technique, multiply the given ML by 100 (see Chapter III, "Use of Minimum* Levels").

APPENDIX III

STANDARD MONITORING PROCEDURES

The purpose of this appendix is to provide direction to the Regional Boards on the implementation of the California Ocean Plan and to ensure the reporting of useful information. It is not feasible to cover all circumstances and conditions that could be encountered by all dischargers. Therefore, this appendix should be considered as the basic component of any discharger monitoring program. Regional Boards can deviate from the procedures required in the appendix only with the approval of the State Water Resources Control Board unless the Ocean Plan allows for the selection of alternate protocols by the Regional Boards. If no direction is given in this appendix for a specific provision of the Ocean Plan, it is within the discretion of the Regional Board to establish the monitoring requirements for the provision.

The following text is referenced by applicable chapter in the Ocean Plan. All references to 40 CFR PART 136 are to the revised edition of May 14, 1999.

Ocean Plan Chapter II. B. Bacterial Standards:

For all bacterial analyses, sample dilutions should be performed so the range of values extends from 2 to 16,000. The detection methods used for each analysis shall be reported with the results of the analysis.

Detection methods used for coliforms (total and fecal) shall be those presented in Table 1A of 40 CFR PART 136, unless alternate methods have been approved in advance by US EPA pursuant to 40 CFR PART 136.

Detection methods used for enterococcus shall be those presented in EPA publication EPA 600/4-85/076, Test Methods for *Escherichia coli* and Enterococci in Water By Membrane Filter Procedure or any improved method determined by the Regional Board to be appropriate.

Ocean Plan Chapter II. H Table B. Compliance with Table B Objectives:

Procedures, calibration techniques, and instrument/reagent specifications used to determine compliance with Table B shall conform to the requirements of federal regulations (40 CFR PART 136). All methods shall be specified in the monitoring requirement section of waste discharge requirements.

Where methods are not available in 40 CFR PART 136, the Regional Boards shall specify suitable analytical methods in waste discharge requirements. Acceptance of data should be predicated on demonstrated laboratory performance.

Laboratories analyzing monitoring data shall be certified by the Department of Health Services, in accordance with the provisions of Section 13176 CWC, and must include quality assurance quality control data with their reports.

The State or Regional Board may, subject to EPA approval, specify test methods which are more sensitive than those specified in 40 CFR PART 136. Total chlorine residual is likely to be a method detection limit effluent limitation in many cases. The limit of detection of total chlorine residual in standard test methods is less than or equal to 20 ug/l.

Monitoring for the substances in Table B shall be required periodically. For discharges less than 1 MGD (million gallons per day), the monitoring of all the Table B parameters should consist of at least one complete scan of the Table B constituents one time in the life of the waste discharge requirements. For discharges between 1 and 10 MGD, the monitoring frequency shall be at least one complete scan of the Table B substances annually. Discharges greater than 10 MGD shall be required to monitor at least semiannually.

Compliance monitoring for the acute toxicity objective (TUa) in Table B shall be determined using an US EPA approved protocol as provided in 40 CFR PART 136. Acute toxicity monitoring requirements in permits prepared by the Regional Boards shall use marine test species instead of freshwater species when measuring compliance.

The Regional Board shall require the use of critical life stage toxicity tests specified in this Appendix to measure TUc. Other species or protocols will be added to the list after SWRCB review and approval. A minimum of three test species with approved test protocols shall be used to measure compliance with the toxicity objective. If possible, the test species shall include a fish, an invertebrate, and an aquatic plant. After a screening period, monitoring can be reduced to the most sensitive species. Dilution and control water should be obtained from an unaffected area of the receiving waters. The sensitivity of the test organisms to a reference toxicant shall be determined concurrently with each bioassay test and reported with the test results.

Use of critical life stage bioassay testing shall be included in waste discharge requirements as a monitoring requirement for all discharges greater than 100 MGD by January 1, 1991 at the latest. For other major dischargers, critical life stage bioassay testing shall be included as a monitoring requirement one year before the waste discharge requirement is scheduled for renewal.

The tests presented in Table III-1 shall be used to measure TUc. Other tests may be added to the list when approved by the State Board.

TABLE III-1
APPROVED TESTS – CHRONIC TOXICITY (TUc)

Species	Effect	Tier	Reference
giant kelp, *Macrocystis pyrifera*	percent germination; germ tube length	1	1,3
red abalone, *Haliotis rufescens*	Abnormal shell development	1	1,3
oyster, *Crassostrea gigas*; mussels, *Mytilus spp.*	Abnormal shell development; percent survival	1	1,3
urchin, *Strongylocentrotus purpuratus*; sand dollar, *Dendraster excentricus*	Percent normal development	1	1,3
urchin, *Strongylocentrotus purpuratus*; sand dollar, *Dendraster excentricus*	Percent fertilization	1	1,3
shrimp, *Holmesimysis costata*	Percent survival; growth	1	1,3
shrimp, *Mysidopsis bahia*	Percent survival; growth; fecundity	2	2,4
topsmelt, *Atherinops affinis*	Larval growth rate; percent survival	1	1,3
Silversides, *Menidia beryllina*	Larval growth rate; percent survival	2	2,4

Table III-1 Notes

The first tier test methods are the preferred toxicity tests for compliance monitoring. A Regional Board can approve the use of a second tier test method for waste discharges if first tier organisms are not available.

Protocol References

1. Chapman, G.A., D.L. Denton, and J.M. Lazorchak. 1995. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to west coast marine and estuarine organisms. U.S. EPA Report No. EPA/600/R-95/136.

2. Klemm, D.J., G.E. Morrison, T.J. Norberg-King, W.J. Peltier, and M.A. Heber. 1994. Short-term methods for estimating the chronic toxicity of effluents and receiving water to marine and estuarine organisms. U.S. EPA Report No. EPA-600-4-91-003.

3. SWRCB 1996. Procedures Manual for Conducting Toxicity Tests Developed by the Marine Bioassay Project. 96-1WQ.

4. Weber, C.I., W.B. Horning, I.I., D.J. Klemm, T.W. Nieheisel, P.A. Lewis, E.L. Robinson, J. Menkedick and F. Kessler (eds). 1988. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. EPA/600/4-87/028. National Information Service, Springfield, VA.

APPENDIX IV

PROCEDURES FOR THE NOMINATION AND DESIGNATION OF AREAS* OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS).

1. Any person may nominate areas of ocean waters for designation as ASBS by the SWRCB. Nominations shall be made to the appropriate RWQCB and shall include:

    (a) Information such as maps, reports, data, statements, and photographs to show that:

        (1) Candidate areas are located in ocean waters as defined in the "Ocean Plan".

        (2) Candidate areas are intrinsically valuable or have recognized value to man for scientific study, commercial use, recreational use, or esthetic reasons.

        (3) Candidate areas need protection beyond that offered by waste discharge restrictions or other administrative and statutory mechanisms.

    (b) Data and information to indicate whether the proposed designation may have a significant effect on the environment.

        (1) If the data or information indicate that the proposed designation will have a significant effect on the environment, the nominee must submit sufficient information and data to identify feasible changes in the designation that will mitigate or avoid the significant environmental effects.

2. The SWRCB or a RWQCB may also nominate areas for designation as ASBS on their own motion.

3. A RWQCB may decide to (a) consider individual ASBS nominations upon receipt, (b) consider several nominations in a consolidated proceeding, or (c) consider nominations in the triennial review of its water quality control plan (basin plan). A nomination that meets the requirements of 1. above may be considered at any time but not later than the next scheduled triennial review of the appropriate basin plan or Ocean Plan.

4. After determining that a nomination meets the requirements of paragraph 1. above, the Executive Officer of the affected RWQCB shall prepare a Draft Nomination Report containing the following:

    (a) The area or areas nominated for designation as ASBS.

    (b) A description of each area including a map delineating the boundaries of each proposed area.

    (c) A recommendation for action on the nomination(s) and the rationale for the recommendation. If the Draft Nomination Report recommends approval of the proposed designation, the Draft Nomination Report shall comply with the CEQA documentation requirements for a water quality control plan amendment in Section 3777, Title 23, California Code of Regulations.

5. The Executive Officer shall, at a minimum, seek informal comment on the Draft Nomination Report from the SWRCB, Department of Fish and Game, other interested state and federal agencies, conservation groups, affected waste dischargers, and other interested parties. Upon incorporation of responses from the consulted agencies, the Draft Nomination Report shall become the Final Nomination Report.

6. (a) If the Final Nomination Report recommends approval of the proposed designation, the Executive Officer shall ensure that processing of the nomination complies with the CEQA consultation requirements in Section 3778, Title 23, California Code of Regulations and proceed to step 7 below.

   (b) If the Final Nomination Report recommends against approval of the proposed designation, the Executive Officer shall notify interested parties of the decision. No further action need be taken. The nominating party may seek reconsideration of the decision by the RWQCB itself.

7. The RWQCB shall conduct a public hearing to receive testimony on the proposed designation. Notice of the hearing shall be published three times in a newspaper of general circulation in the vicinity of the proposed area or areas and shall be distributed to all known interested parties 45 days in advance of the hearing. The notice shall describe the location, boundaries, and extent of the area or areas under consideration, as well as proposed restrictions on waste discharges within the area.

8. The RWQCB shall respond to comments as required in Section 3779, Title 23, California Code of Regulations, and 40 C.F.R. Part 25 (July 1, 1999).

9. The RWQCB shall consider the nomination after completing the required public review processes required by CEQA.

   (a) If the RWQCB supports the recommendation for designation, the board shall forward to the SWRCB its recommendation for approving designation of the proposed area or areas and the supporting rationale. The RWQCB submittal shall include a copy of the staff report, hearing transcript, comments, and responses to comments.

   (b) If the RWQCB does not support the recommendation for designation, the Executive Officer shall notify interested parties of the decision, and no further action need be taken.

10. After considering the RWQCB recommendation and hearing record, the SWRCB may approve or deny the recommendation, refer the matter to the RWQCB for appropriate action, or conduct further hearing itself. If the SWRCB acts to approve a recommended designation, the SWRCB shall amend Appendix V, Table V-1, of this Plan. The amendment will go into effect after approval by the Office of Administrative Law and US EPA. In addition, after the effective date of a designation, the affected RWQCB shall revise its water quality control plan in the next triennial review to include the designation.

11. The SWRCB Executive Director shall advise other agencies to whom the list of designated areas is to be provided that the basis for an ASBS designation is limited to protection of marine life from waste discharges.

APPENDIX V

AREAS* OF SPECIAL BIOLOGICAL SIGNIFICANCE

TABLE V-1
AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE
(DESIGNATED OR APPROVED BY THE STATE WATER RESOURCES CONTROL BOARD)

No.	ASBS Name	Date Designated	SWRCB Resolution No.	Region No.
1.	Pygmy Forest Ecological Staircase	March 21, 1974,	74-28	1
2.	Del Mar Landing Ecological Reserve	March 21, 1974,	74-28	1
3.	Gerstle Cove	March 21, 1974,	74-28	1
4.	Bodega Marine Life Refuge	March 21, 1974,	74-28	1
5.	Kelp Beds at Saunders Reef	March 21, 1974,	74-28	1
6.	Kelp Beds at Trinidad Head	March 21, 1974,	74-28	1
7.	Kings Range National Conservation Area	March 21, 1974,	74-28	1
8.	Redwoods National Park	March 21, 1974,	74-28	1
9.	James V. Fitzgerald Marine Reserve	March 21, 1974,	74-28	2
10.	Farallon Island	March 21, 1974,	74-28	2
11.	Duxbury Reef Reserve and Extension	March 21, 1974,	74-28	2
12.	Point Reyes Headland Reserve and Extension	March 21, 1974,	74-28	2
13.	Double Point	March 21, 1974,	74-28	2
14.	Bird Rock	March 21, 1974,	74-28	2
15.	Ano Nuevo Point and Island	March 21, 1974,	74-28	3
16.	Point Lobos Ecological Reserve	March 21, 1974,	74-28	3
17.	San Miguel, Santa Rosa, and Santa Cruz Islands	March 21, 1974,	74-28	4
18.	Julia Pfeiffer Burns Underwater Park	March 21, 1974,	74-28	3
19.	Pacific Grove Marine Gardens Fish Refuge and Hopkins Marine Life Refuge	March 21, 1974,	74-28	3
20.	Ocean Area Surrounding the Mouth of Salmon Creek	March 21, 1974,	74-28	3
21.	San Nicolas Island and Begg Rock	March 21, 1974,	74-28	4
22.	Santa Barbara Island, Santa Barbara County and Anacapa Island	March 21, 1974,	74-28	4
23.	San Clemente Island	March 21, 1974,	74-28	4

Table V-1 Continued on next page...

Table V-1 (Continued)

Areas of Special Biological Significance
(Designated or Approved by the State Water Resources Control Board)

No.	ASBS Name	Date Designated	SWRCB Resolution No.	Region No.
24.	Mugu Lagoon to Latigo Point	March 21, 1974,	74-28	4
25.	Santa Catalina Island – Subarea One, Isthmus Cove to Catalina Head	March 21, 1974,	74-28	4
26.	Santa Catalina Island - Subarea Two, North End of Little Harbor to Ben Weston Point	March 21, 1974,	74-28	4
27.	Santa Catalina Island - Subarea Three, Farnsworth Bank Ecological Reserve	March 21, 1974,	74-28	4
28.	Santa Catalina Island - Subarea Four, Binnacle Rock to Jewfish Point	March 21, 1974,	74-28	4
29.	San Diego-La Jolla Ecological Reserve	March 21, 1974,	74-28	9
30.	Heisler Park Ecological Reserve	March 21, 1974,	74-28	9
31.	San Diego Marine Life Refuge	March 21, 1974,	74-28	9
32.	Newport Beach Marine Life Refuge	April 18, 1974	74-32	8
33.	Irvine Coast Marine Life Refuge	April 18, 1974	74-32	8
34.	Carmel Bay	June 19, 1975	75-61	3

THE CITY OF SAN DIEGO • STATE OF CALIFORNIA

SEMPER VIGILANS

Appendix T

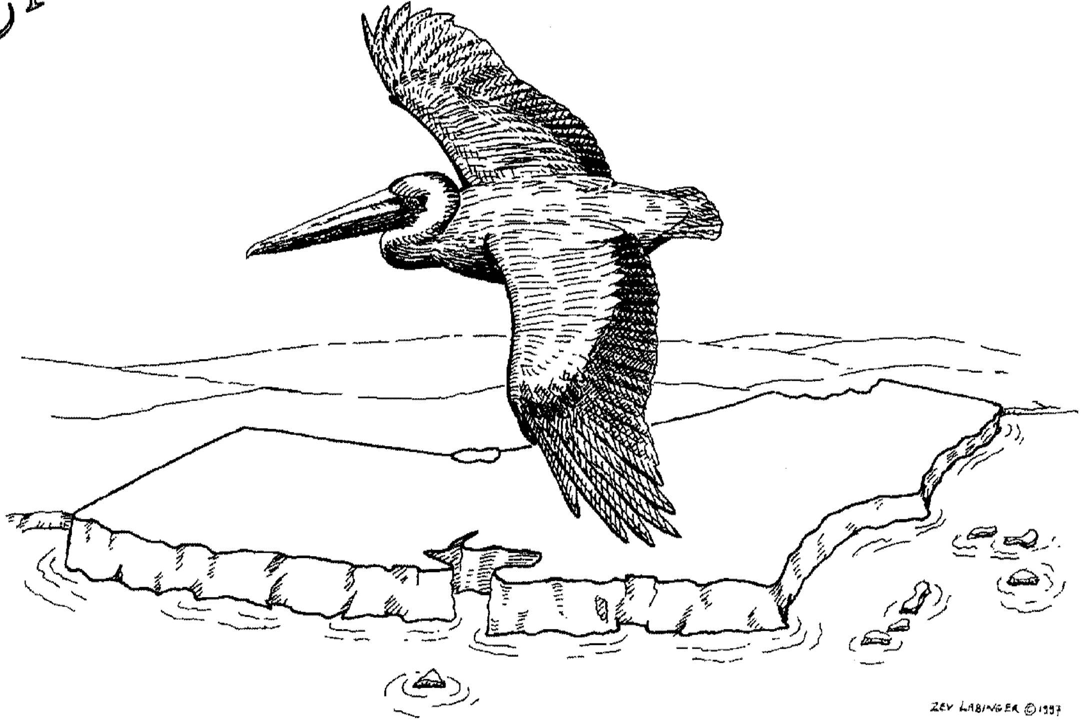
2005 California Ocean Plan

APPENDIX T

2005 CALIFORNIA OCEAN PLAN

WATER QUALITY CONTROL PLAN
OCEAN WATERS OF CALIFORNIA

CALIFORNIA OCEAN PLAN



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2005

STATE WATER RESOURCES CONTROL BOARD
CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Arnold Schwarzenegger, Governor

California Environmental Protection Agency
Alan Lloyd, Ph.D., Secretary

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State of California

STATE WATER RESOURCES CONTROL BOARD

2005

CALIFORNIA OCEAN PLAN

WATER QUALITY CONTROL PLAN

OCEAN WATERS OF CALIFORNIA

Effective February 14, 2006

Adopted by the State Water Resources Control Board on January 20, 2005 and April 21, 2005.
Approved by the Office of Administrative Law on October 12, 2005.
Approved by the U. S. Environmental Protection Agency on February 14, 2006.

STATE WATER BOARD
RESOLUTION NO. 2005-0013

ADOPTION OF THE PROPOSED AMENDMENT TO THE CALIFORNIA OCEAN PLAN (OCEAN PLAN)

WHEREAS:

1. The Ocean Plan was adopted by the State Water Board in 1972 and amended in 1978, 1983, 1988, 1990, 1997, and 2001.

2. The State Water Board is responsible for reviewing Ocean Plan water quality standards and for modifying and adopting standards in accordance with Section 303(c)(1) of the federal Clean Water Act and Section 13170.2 of the California Water Code (CWC).

3. The State Water Board held scoping meetings regarding four potential Ocean Plan amendments on January 23, 2004 and February 3, 2004.

4. The State Water Board held a public hearing for the Triennial Review of the Ocean Plan on May 24, 2004 to receive additional public comment for potential revisions of the Ocean Plan.

5. State Water Board staff is proposing an amendment to the Ocean Plan regarding water contact bacterial standards as the first issue to be considered for this Triennial Review.

6. The State Water Board prepared and circulated a draft Functional Equivalent Document (FED) in accordance with the provisions of the California Environmental Quality Act and Title 14, California Code of Regulations 15251(g).

7. The State Water Board held a public hearing in Sacramento on October 6, 2004. The State Water Board determined that the bacterial issue needed more consideration and deferred a decision until the January 2005 workshop.

8. On December 16, 2004, the U.S. Environmental Protection Agency (USEPA) adopted the Water Quality Standards for Coastal and Great Lakes Recreation Waters; Final Rule. This rule establishes enterococcus criteria for California's coastal waters, including bays and estuaries.

9. The State Water Board staff has prepared a draft Final FED, an Attachment to this resolution, which includes the specific proposed amendment to the Ocean Plan and responses to the comments received at the hearing. The proposed amendments are identical to USEPA's geometric mean and single sample maximum criteria.

10. Amendments to the Ocean Plan do not become effective until approved by the Office of Administrative Law (OAL) and USEPA.

THEREFORE BE IT RESOLVED THAT THE STATE WATER BOARD:

1. Revises the bacterial water quality objectives for ocean waters in Chapter II, Section B of the Ocean Plan as shown in the Attachment (Final FED Amendment of the Water Quality Control Plan Ocean Waters of California).

2. Approves the draft Final FED as part of the Attachment to the resolution.

3. Authorizes the State Water Board's Executive Director to sign the Certificate of Fee Exemption.

4. Authorizes the State Water Board staff to submit the amended Ocean Plan to OAL and USEPA for final approval.

CERTIFICATION

The undersigned, Clerk to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Board held on January 20, 2005.

Debbie Irvin

Debbie Irvin
Clerk to the Board

STATE WATER BOARD
RESOLUTION NO. 2005 - 0035

ADOPTION OF THE PROPOSED AMENDMENTS TO THE CALIFORNIA OCEAN PLAN (OCEAN PLAN)

WHEREAS:

1. The Ocean Plan was adopted by the State Water Board in 1972 and amended in 1978, 1983, 1988, 1990, 1997, and 2001.

2. The State Water Board is responsible for reviewing Ocean Plan water quality standards and for modifying and adopting standards in accordance with Section 303(c)(1) of the federal Clean Water Act and Section 13170.2 of the California Water Code (CWC).

3. The State Water Board held scoping meetings regarding four potential Ocean Plan amendments on January 23, 2004 and February 3, 2004. These included the following proposed revisions: a) Choice of Indicator Organisms for Water-Contact Bacterial Standards, b) Establishing a Fecal Coliform Standard for Shellfish Harvesting Areas, c) Reclassifying Areas of Special Biological Significance (ASBS) to State Water Quality Protection Areas (SWQPAs) and establishing implementation provisions for discharges into SWQPAs, and d) Reasonable Potential: Determining the likelihood that the concentration of a pollutant would cause or contribute to an exceedance of water quality standards.

4. The State Water Board held a public hearing for the Triennial Review of the Ocean Plan on May 24, 2004 to receive additional public comment on other potential revisions of the Ocean Plan.

5. The State Water Board prepared and circulated a draft Functional Equivalent Document (FED) in accordance with the provisions of the California Environmental Quality Act and Title 14, California Code of Regulations 15251(g). The draft FED addressed Water-Contact Bacterial Standards and Reasonable Potential.

6. The State Water Board held a public hearing in Sacramento on October 6, 2004. The State Water Board received comments on the proposed bacterial and reasonable potential amendments. Staff informed the Board that the reasonable potential issue needed to undergo an external scientific peer review, pursuant to California Health and Safety Code section 57004. The State Water Board also determined that the bacterial issue needed more consideration and deferred a decision until the January 2005 workshop.

7. On January 20, 2005, the State Water Board adopted the modified bacterial water quality objectives for ocean waters in Chapter II, Section B of the Ocean Plan.

8. The State Water Board has received and considered the results of two external scientific peer reviews of the reasonable potential proposal. The peer reviews indicate that the proposed rule is based upon sound scientific knowledge, methods, and practices.

9. Assembly Bill 2800 (Chapter 385, Statutes of 2000) added sections to the Public Resources Code (PRC) that are relevant to ASBS, including Section 36750 of the PRC, which classified ASBS as SWQPAs as of January 1, 2003 without State Water Board action.

10. Senate Bill 512 (SB) (Chapter 854, Statutes of 2004) amended the marine managed areas portion of the PRC, effective January 1, 2005, to clarify that ASBS are a subset of SWQPAs and require special protection as determined by the State Water Board pursuant to the Ocean Plan and the Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (California Thermal Plan).

11. The classification of ASBS as a subset of SWQPAs does not change the ASBS designated use for these areas. Waste discharges to ASBS are still prohibited under the Ocean Plan unless an exception is granted.

12. After consideration of public comments received at the scoping meetings and based on SB 512, the State Water Board now proposes only minor changes to the Ocean Plan regarding ASBS and exceptions.

13. The State Water Board staff has prepared a Final FED, covering the reasonable potential and the ASBS and exception issues, which is an Attachment to this resolution. The Final FED includes the specific proposed amendments to the Ocean Plan. The State Water Board has carefully considered all testimony and comments received on these issues.

14. On April 6, 2005, the State Water Board held a public hearing to consider the draft Final FED, the amendments regarding ASBS and exceptions, and changes in the reasonable potential amendments since the October 6, 2004 public hearing.

15. Amendments to the Ocean Plan do not become effective until approved by the Office of Administrative Law (OAL) and the U.S. Environmental Protection Agency.

THEREFORE BE IT RESOLVED THAT:

The State Water Board:

1. Deletes the existing Ocean Plan language in Chapter III, Section G(2) that allows discharger certification *in lieu* of monitoring and adds general reasonable potential language in Chapter III Section C of the Ocean Plan, and adds the reasonable potential analysis procedure language in a new Ocean Plan Appendix VI, as shown on the Attachment to this Resolution.

2. Incorporates the Classification of ASBS as SWQPAs, according to the PRC, renames certain ASBS to coincide with name changes in other corresponding Marine Managed Areas, clarifies that all exceptions are subject to Triennial Review, and adds a new Appendix VII with a Table VII–1 listing exceptions to the Ocean Plan, as shown on the Attachment to this Resolution.

3. Approves the Final FED attached to the resolution.

4. Authorizes the Executive Director to sign the Certificate of Fee Exemption.

5. Authorizes staff to submit the amended Ocean Plan to the Office of Administrative Law and the USEPA for final approval.

CERTIFICATION

The undersigned, Clerk to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Board held on April 21, 2005.

Debbie Irvin

Debbie Irvin
Clerk to the Board

CALIFORNIA OCEAN PLAN

TABLE OF CONTENTS

APPENDICES

4. Within this Plan, references to the State Board or SWRCB shall mean the State Water Resources Control Board. References to a Regional Board or RWQCB shall mean a California Regional Water Quality Control Board. References to the Environmental Protection Agency, USEPA, or EPA shall mean the federal Environmental Protection Agency.

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* See Appendix I for definition of terms.

I. BENEFICIAL USES

A. The beneficial uses of the ocean* waters of the State that shall be protected include industrial water supply; water contact and non-contact recreation, including aesthetic enjoyment; navigation; commercial and sport fishing; mariculture*; preservation and enhancement of designated Areas* of Special Biological Significance (ASBS); rare and endangered species; marine habitat; fish migration; fish spawning and shellfish* harvesting.

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* See Appendix I for definition of terms.

II. WATER QUALITY OBJECTIVES

A. General Provisions

1. This chapter sets forth limits or levels of water quality characteristics for ocean* waters to ensure the reasonable protection of beneficial uses and the prevention of nuisance. The discharge of waste* shall not cause violation of these objectives.

2. The Water Quality Objectives and Effluent Limitations are defined by a statistical distribution when appropriate. This method recognizes the normally occurring variations in treatment efficiency and sampling and analytical techniques and does not condone poor operating practices.

3. Compliance with the water quality objectives of this chapter shall be determined from samples collected at stations representative of the area within the waste field where initial* dilution is completed.

B. Bacterial Characteristics

1. Water-Contact Standards

   Both the SWRCB and the California Department of Health Services (DHS) have established standards to protect water contact recreation in coastal waters from bacterial contamination. Subsection a of this section contains bacterial objectives adopted by the SWRCB for ocean waters used for water contact recreation. Subsection b describes the bacteriological standards adopted by DHS for coastal waters adjacent to public beaches and public water contact sports areas in ocean waters.

   a. SWRCB Water-Contact Standards

      (1) Within a zone bounded by the shoreline and a distance of 1,000 feet from the shoreline or the 30-foot depth contour, whichever is further from the shoreline, and in areas outside this zone used for water contact sports, as determined by the Regional Board (i.e., waters designated as REC-1), but including all kelp* beds, the following bacterial objectives shall be maintained throughout the water column:

      30-day Geometric Mean – The following standards are based on the geometric mean of the five most recent samples from each site:

      i. Total coliform density shall not exceed 1,000 per 100 ml;
      ii. Fecal coliform density shall not exceed 200 per 100 ml; and
      iii. Enterococcus density shall not exceed 35 per 100ml.

      Single Sample Maximum:

      i. Total coliform density shall not exceed 10,000 per 100 ml;
      ii. Fecal coliform density shall not exceed 400 per 100ml;
      iii. Enterococcus density shall not exceed 104 per 100 ml; and

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* See Appendix I for definition of terms.

iv. Total coliform density shall not exceed 1,000 per 100 ml when the fecal coliform/total coliform ratio exceeds 0.1.

(2) The "Initial* Dilution Zone" of wastewater outfalls shall be excluded from designation as "kelp* beds" for purposes of bacterial standards, and Regional Boards should recommend extension of such exclusion zone where warranted to the SWRCB (for consideration under Chapter III.H.). Adventitious assemblages of kelp plants on waste discharge structures (e.g., outfall pipes and diffusers) do not constitute kelp* beds for purposes of bacterial standards.

b. DHS Standards

DHS has established minimum protective bacteriological standards for coastal waters adjacent to public beaches and for public water-contact sports areas in ocean waters. These standards are found in the California Code of Regulations, title 17, section 7958, and they are identical to the objectives contained in subsection a. above. When a public beach or public water-contact sports area fails to meet these standards, DHS or the local public health officer may post with warning signs or otherwise restrict use of the public beach or public water-contact sports area until the standards are met. The DHS regulations impose more frequent monitoring and more stringent posting and closure requirements on certain high-use public beaches that are located adjacent to a storm drain that flows in the summer.

For beaches not covered under AB 411 regulations, DHS imposes the same standards as contained in Title 17 and requires weekly sampling but allows the county health officer more discretion in making posting and closure decisions.

2. Shellfish* Harvesting Standards

a. At all areas where shellfish* may be harvested for human consumption, as determined by the Regional Board, the following bacterial objectives shall be maintained throughout the water column:

(1) The median total coliform density shall not exceed 70 per 100 ml, and not more than 10 percent of the samples shall exceed 230 per 100 ml.

C. <u>Physical Characteristics</u>

1. Floating particulates and grease and oil shall not be visible.

2. The discharge of waste* shall not cause aesthetically undesirable discoloration of the ocean* surface.

3. Natural* light shall not be significantly* reduced at any point outside the initial* dilution zone as the result of the discharge of waste*.

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* See Appendix I for definition of terms.

4. The rate of deposition of inert solids and the characteristics of inert solids in ocean* sediments shall not be changed such that benthic communities are degraded*.

D. Chemical Characteristics

1. The dissolved oxygen concentration shall not at any time be depressed more than 10 percent from that which occurs naturally, as the result of the discharge of oxygen demanding waste* materials.
2. The pH shall not be changed at any time more than 0.2 units from that which occurs naturally.
3. The dissolved sulfide concentration of waters in and near sediments shall not be significantly* increased above that present under natural conditions.
4. The concentration of substances set forth in Chapter II, Table B, in marine sediments shall not be increased to levels which would degrade* indigenous biota.
5. The concentration of organic materials in marine sediments shall not be increased to levels that would degrade* marine life.
6. Nutrient materials shall not cause objectionable aquatic growths or degrade* indigenous biota.
7. Numerical Water Quality Objectives
    a. Table B water quality objectives apply to all discharges within the jurisdiction of this Plan.
    b. Table B Water Quality Objectives

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* See Appendix I for definition of terms.

TABLE B
WATER QUALITY OBJECTIVES

	Units of Measurement	Limiting Concentrations 6-Month Median	 Daily Maximum	 Instantaneous Maximum
OBJECTIVES FOR PROTECTION OF MARINE AQUATIC LIFE				
Arsenic	ug/l	8.	32.	80.
Cadmium	ug/l	1.	4.	10.
Chromium (Hexavalent) (see below, a)	ug/l	2.	8.	20.
Copper	ug/l	3.	12.	30.
Lead	ug/l	2.	8.	20.
Mercury	ug/l	0.04	0.16	0.4
Nickel	ug/l	5.	20.	50.
Selenium	ug/l	15.	60.	150.
Silver	ug/l	0.7	2.8	7.
Zinc	ug/l	20.	80.	200.
Cyanide (see below, b)	ug/l	1.	4.	10.
Total Chlorine Residual (For intermittent chlorine sources see below, c)	ug/l	2.	8.	60.
Ammonia (expressed as nitrogen)	ug/l	600.	2400.	6000.
Acute* Toxicity	TUa	N/A	0.3	N/A
Chronic* Toxicity	TUc	N/A	1.	N/A
Phenolic Compounds (non-chlorinated)	ug/l	30.	120.	300.
Chlorinated Phenolics	ug/l	1.	4.	10.
Endosulfan	ug/l	0.009	0.018	0.027
Endrin	ug/l	0.002	0.004	0.006
HCH*	ug/l	0.004	0.008	0.012
Radioactivity	Not to exceed limits specified in Title 17, Division 1, Chapter 5, Subchapter 4, Group 3, Article 3, Section 30253 of the California Code of Regulations. Reference to Section 30253 is prospective, including future changes to any incorporated provisions of federal law, as the changes take effect.			

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* See Appendix I for definition of terms.

Table B Continued

	30-day Average (ug/l)	
Chemical	Decimal Notation	Scientific Notation
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – NONCARCINOGENS		
acrolein	220.	2.2×10^{2}
antimony	1,200.	1.2×10^{3}
bis(2-chloroethoxy) methane	4.4	4.4×10^{0}
bis(2-chloroisopropyl) ether	1,200.	1.2×10^{3}
chlorobenzene	570.	5.7×10^{2}
chromium (III)	190,000.	1.9×10^{5}
di-n-butyl phthalate	3,500.	3.5×10^{3}
dichlorobenzenes*	5,100.	5.1×10^{3}
diethyl phthalate	33,000.	3.3×10^{4}
dimethyl phthalate	820,000.	8.2×10^{5}
4,6-dinitro-2-methylphenol	220.	2.2×10^{2}
2,4-dinitrophenol	4.0	4.0×10^{0}
ethylbenzene	4,100.	4.1×10^{3}
fluoranthene	15.	1.5×10^{1}
hexachlorocyclopentadiene	58.	5.8×10^{1}
nitrobenzene	4.9	4.9×10^{0}
thallium	2.	$2. \times 10^{0}$
toluene	85,000.	8.5×10^{4}
tributyltin	0.0014	1.4×10^{-3}
1,1,1-trichloroethane	540,000.	5.4×10^{5}
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – CARCINOGENS		
acrylonitrile	0.10	1.0×10^{-1}
aldrin	0.000022	2.2×10^{-5}
benzene	5.9	5.9×10^{0}
benzidine	0.000069	6.9×10^{-5}
beryllium	0.033	3.3×10^{-2}
bis(2-chloroethyl) ether	0.045	4.5×10^{-2}
bis(2-ethylhexyl) phthalate	3.5	3.5×10^{0}
carbon tetrachloride	0.90	9.0×10^{-1}
chlordane*	0.000023	2.3×10^{-5}
chlorodibromomethane	8.6	8.6×10^{0}

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* See Appendix I for definition of terms.

Table B Continued

Chemical	30-day Average (ug/l) Decimal Notation	30-day Average (ug/l) Scientific Notation
OBJECTIVES FOR PROTECTION OF HUMAN HEALTH – CARCINOGENS		
chloroform	130.	1.3×10^{2}
DDT*	0.00017	1.7×10^{-4}
1,4-dichlorobenzene	18.	1.8×10^{1}
3,3'-dichlorobenzidine	0.0081	8.1×10^{-3}
1,2-dichloroethane	28.	2.8×10^{1}
1,1-dichloroethylene	0.9	9×10^{-1}
dichlorobromomethane	6.2	6.2×10^{0}
dichloromethane	450.	4.5×10^{2}
1,3-dichloropropene	8.9	8.9×10^{0}
dieldrin	0.00004	4.0×10^{-5}
2,4-dinitrotoluene	2.6	2.6×10^{0}
1,2-diphenylhydrazine	0.16	1.6×10^{-1}
halomethanes*	130.	1.3×10^{2}
heptachlor	0.00005	5×10^{-5}
heptachlor epoxide	0.00002	2×10^{-5}
hexachlorobenzene	0.00021	2.1×10^{-4}
hexachlorobutadiene	14.	1.4×10^{1}
hexachloroethane	2.5	2.5×10^{0}
isophorone	730.	7.3×10^{2}
N-nitrosodimethylamine	7.3	7.3×10^{0}
N-nitrosodi-N-propylamine	0.38	3.8×10^{-1}
N-nitrosodiphenylamine	2.5	2.5×10^{0}
PAHs*	0.0088	8.8×10^{-3}
PCBs*	0.000019	1.9×10^{-5}
TCDD equivalents*	0.0000000039	3.9×10^{-9}
1,1,2,2-tetrachloroethane	2.3	2.3×10^{0}
tetrachloroethylene	2.0	2.0×10^{0}
toxaphene	0.00021	2.1×10^{-4}
trichloroethylene	27.	2.7×10^{1}
1,1,2-trichloroethane	9.4	9.4×10^{0}
2,4,6-trichlorophenol	0.29	2.9×10^{-1}
vinyl chloride	36.	3.6×10^{1}

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* See Appendix I for definition of terms.

Table B Notes:

a) Dischargers may at their option meet this objective as a total chromium objective.

b) If a discharger can demonstrate to the satisfaction of the Regional Board (subject to EPA approval) that an analytical method is available to reliably distinguish between strongly and weakly complexed cyanide, effluent limitations for cyanide may be met by the combined measurement of free cyanide, simple alkali metal cyanides, and weakly complexed organometallic cyanide complexes. In order for the analytical method to be acceptable, the recovery of free cyanide from metal complexes must be comparable to that achieved by the approved method in 40 CFR PART 136, as revised May 14, 1999.

c) Water quality objectives for total chlorine residual applying to intermittent discharges not exceeding two hours, shall be determined through the use of the following equation:

$$\log y = -0.43 (\log x) + 1.8$$

where: y = the water quality objective (in ug/l) to apply when chlorine is being discharged;
x = the duration of uninterrupted chlorine discharge in minutes.

E. Biological Characteristics

1. Marine communities, including vertebrate, invertebrate, and plant species, shall not be degraded*.

2. The natural taste, odor, and color of fish, shellfish*, or other marine resources used for human consumption shall not be altered.

3. The concentration of organic materials in fish, shellfish* or other marine resources used for human consumption shall not bioaccumulate to levels that are harmful to human health.

F. Radioactivity

1. Discharge of radioactive waste* shall not degrade* marine life.

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* See Appendix I for definition of terms.

III. PROGRAM OF IMPLEMENTATION

A. General Provisions

1. Effective Date

   a. The *Water Quality Control Plan, Ocean Waters of California, California Ocean Plan* was adopted and has been effective since 1972. There have been multiple amendments of the Ocean Plan since its adoption.

2. General Requirements For Management Of Waste Discharge To The Ocean*

   a. Waste* management systems that discharge to the ocean* must be designed and operated in a manner that will maintain the indigenous marine life and a healthy and diverse marine community.

   b. Waste discharged* to the ocean* must be essentially free of:

      (1) Material that is floatable or will become floatable upon discharge.

      (2) Settleable material or substances that may form sediments which will degrade* benthic communities or other aquatic life.

      (3) Substances which will accumulate to toxic levels in marine waters, sediments or biota.

      (4) Substances that significantly* decrease the natural* light to benthic communities and other marine life.

      (5) Materials that result in aesthetically undesirable discoloration of the ocean* surface.

   c. Waste* effluents shall be discharged in a manner which provides sufficient initial* dilution to minimize the concentrations of substances not removed in the treatment.

   d. Location of waste* discharges must be determined after a detailed assessment of the oceanographic characteristics and current patterns to assure that:

      (1) Pathogenic organisms and viruses are not present in areas where shellfish* are harvested for human consumption or in areas used for swimming or other body-contact sports.

      (2) Natural water quality conditions are not altered in areas designated as being of special biological significance or areas that existing marine laboratories use as a source of seawater.

      (3) Maximum protection is provided to the marine environment.

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* See Appendix I for definition of terms.

e. Waste* that contains pathogenic organisms or viruses should be discharged a sufficient distance from shellfishing* and water-contact sports areas to maintain applicable bacterial standards without disinfection. Where conditions are such that an adequate distance cannot be attained, reliable disinfection in conjunction with a reasonable separation of the discharge point from the area of use must be provided. Disinfection procedures that do not increase effluent toxicity and that constitute the least environmental and human hazard should be used.

3. Areas of Special Biological Significance

a. ASBS* shall be designated by the SWRCB following the procedures provided in Appendix IV. A list of ASBS* is available in Appendix V.

4. Combined Sewer Overflow: Not withstanding any other provisions in this plan, discharges from the City of San Francisco's combined sewer system are subject to the US EPA's Combined Sewer Overflow Policy.

B. Table A Effluent Limitations

TABLE A
EFFLUENT LIMITATIONS

		Limiting Concentrations		
	Unit of Measurement	Monthly (30-day Average)	Weekly (7-day Average)	Maximum at any time
Grease and Oil	mg/l	25.	40.	75.
Suspended Solids			See below +	
Settleable Solids	Ml/l	1.0	1.5	3.0
Turbidity	NTU	75.	100.	225.
PH	Units		Within limit of 6.0 to 9.0 at all times	

Table A Notes:

\+ Suspended Solids: Dischargers shall, as a 30-day average, remove 75% of suspended solids from the influent stream before discharging wastewaters to the ocean*, except that the effluent limitation to be met shall not be lower than 60 mg/l. Regional Boards may recommend that the SWRCB (Chapter IIIJ), with the concurrence of the Environmental Protection Agency, adjust the lower effluent concentration limit (the 60 mg/l above) to suit the environmental and effluent characteristics of the discharge. As a further consideration in making such recommendation for adjustment, Regional Boards should evaluate effects on existing and potential water* reclamation projects.

If the lower effluent concentration limit is adjusted, the discharger shall remove 75% of suspended solids from the influent stream at any time the influent concentration exceeds four times such adjusted effluent limit.

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1. Table A effluent limitations apply only to publicly owned treatment works and industrial discharges for which Effluent Limitations Guidelines have not been established pursuant to Sections 301, 302, 304, or 306 of the Federal Clean Water Act.

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* See Appendix I for definition of terms.

2. Table A effluent limitations shall apply to a discharger's total effluent, of whatever origin (i.e., gross, not net, discharge), except where otherwise specified in this Plan.
3. The SWRCB is authorized to administer and enforce effluent limitations established pursuant to the Federal Clean Water Act. Effluent limitations established under Sections 301, 302, 306, 307, 316, 403, and 405 of the aforementioned Federal Act and administrative procedures pertaining thereto are included in this plan by reference. Compliance with Table A effluent limitations, or Environmental Protection Agency Effluent Limitations Guidelines for industrial discharges, based on Best Practicable Control Technology, shall be the minimum level of treatment acceptable under this plan, and shall define reasonable treatment and waste control technology.

C. Implementation Provisions for Table B

1. Effluent concentrations calculated from Table B water quality objectives shall apply to a discharger's total effluent, of whatever origin (i.e., gross, not net, discharge), except where otherwise specified in this Plan.
2. If the Regional Water Board determines, using the procedures in Appendix VI, that a pollutant is discharged into ocean* waters at levels which will cause, have the reasonable potential to cause, or contribute to an excursion above a Table B water quality objective, the Regional Water Board shall incorporate a water quality-based effluent limitation in the Waste Discharge Requirement for the discharge of that pollutant.
3. Effluent limitations shall be imposed in a manner prescribed by the State Water Board such that the concentrations set forth below as water quality objectives shall not be exceeded in the receiving water upon completion of initial* dilution, except that objectives indicated for radioactivity shall apply directly to the undiluted waste* effluent.
4. Calculation of Effluent Limitations
    a. Effluent limitations for water quality objectives listed in Table B, with the exception of acute* toxicity and radioactivity, shall be determined through the use of the following equation:

Equation 1: $Ce = Co + Dm\ (Co - Cs)$

where:

Ce = the effluent concentration limit, ug/l

Co = the concentration (water quality objective) to be met at the completion of initial* dilution, ug/l

Cs = background seawater concentration (see Table C below), ug/l

Dm = minimum probable initial* dilution expressed as parts seawater per part wastewater.

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* See Appendix I for definition of terms.

TABLE C
BACKGROUND SEAWATER CONCENTRATIONS (Cs)

Waste Constituent	Cs (ug/l)
Arsenic	3.
Copper	2.
Mercury	0.0005
Silver	0.16
Zinc	8.

For all other Table B parameters, Cs = 0.

b. Determining a Mixing Zone for the Acute* Toxicity Objective

The mixing zone for the acute* toxicity objective shall be ten percent (10%) of the distance from the edge of the outfall structure to the edge of the chronic mixing zone (zone of initial dilution). There is no vertical limitation on this zone. The effluent limitation for the acute* toxicity objective listed in Table B shall be determined through the use of the following equation:

Equation 2: $Ce = Ca + (0.1)\ Dm\ (Ca)$

where:

Ca = the concentration (water quality objective) to be met at the edge of the acute mixing zone.

Dm = minimum probable initial* dilution expressed as parts seawater per part wastewater (This equation applies only when $Dm > 24$).

c. Toxicity Testing Requirements based on the Minimum Initial* Dilution Factor for Ocean Waste Discharges

(1) Dischargers shall conduct acute* toxicity testing if the minimum initial* dilution of the effluent is greater than 1,000:1 at the edge of the mixing zone.

(2) Dischargers shall conduct either acute* or chronic* toxicity testing if the minimum initial* dilution ranges from 350:1 to 1,000:1 depending on the specific discharge conditions. The RWQCB shall make this determination.

(3) Dischargers shall conduct chronic* toxicity testing for ocean waste discharges with minimum initial* dilution factors ranging from 100:1 to 350:1. The RWQCBs may require that acute toxicity testing be conducted in addition to chronic as necessary for the protection of beneficial uses of ocean waters.

(4) Dischargers shall conduct chronic toxicity testing if the minimum initial* dilution of the effluent falls below 100:1 at the edge of the mixing zone.

d. For the purpose of this Plan, minimum initial* dilution is the lowest average initial* dilution within any single month of the year. Dilution estimates shall be based on

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* See Appendix I for definition of terms.

observed waste flow characteristics, observed receiving water density structure, and the assumption that no currents, of sufficient strength to influence the initial* dilution process, flow across the discharge structure.

e. The Executive Director of the SWRCB shall identify standard dilution models for use in determining Dm, and shall assist the Regional Board in evaluating Dm for specific waste discharges. Dischargers may propose alternative methods of calculating Dm, and the Regional Board may accept such methods upon verification of its accuracy and applicability.

f. The six-month median shall apply as a moving median of daily values for any 180-day period in which daily values represent flow weighted average concentrations within a 24-hour period. For intermittent discharges, the daily value shall be considered to equal zero for days on which no discharge occurred.

g. The daily maximum shall apply to flow weighted 24 hour composite samples.

h. The instantaneous maximum shall apply to grab sample determinations.

i. If only one sample is collected during the time period associated with the water quality objective (e.g., 30-day average or 6-month median), the single measurement shall be used to determine compliance with the effluent limitation for the entire time period.

j. Discharge requirements shall also specify effluent limitations in terms of mass emission rate limits utilizing the general formula:

Equation 3: lbs/day = 0.00834 x Ce x Q

where:

Ce = the effluent concentration limit, ug/l

Q = flow rate, million gallons per day (MGD)

k. The six-month median limit on daily mass emissions shall be determined using the six-month median effluent concentration as Ce and the observed flow rate Q in millions of gallons per day. The daily maximum mass emission shall be determined using the daily maximum effluent concentration limit as Ce and the observed flow rate Q in millions of gallons per day.

l. Any significant change in waste* flow shall be cause for reevaluating effluent limitations.

5. Minimum* Levels

For each numeric effluent limitation, the Regional Board must select one or more Minimum* Levels (and their associated analytical methods) for inclusion in the permit. The "reported" Minimum* Level is the Minimum* Level (and its associated analytical method) chosen by the discharger for reporting and compliance determination from the Minimum* Levels included in their permit.

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* See Appendix I for definition of terms.

a. Selection of Minimum* Levels from Appendix II

The Regional Board must select all Minimum* Levels from Appendix II that are below the effluent limitation. If the effluent limitation is lower than all the Minimum* Levels in Appendix II, the Regional Board must select the lowest Minimum* Level from Appendix II.

b. Deviations from Minimum* Levels in Appendix II

The Regional Board, in consultation with the State Water Board's Quality Assurance Program, must establish a Minimum* Level to be included in the permit in any of the following situations:

1. A pollutant is not listed in Appendix II.
2. The discharger agrees to use a test method that is more sensitive than those described in 40 CFR 136 (revised May 14, 1999).
3. The discharger agrees to use a Minimum* Level lower than those listed in Appendix II.
4. The discharger demonstrates that their calibration standard matrix is sufficiently different from that used to establish the Minimum* Level in Appendix II and proposes an appropriate Minimum* Level for their matrix.
5. A discharger uses an analytical method having a quantification practice that is not consistent with the definition of Minimum* Level (e.g., US EPA methods 1613, 1624, 1625).

6. Use of Minimum* Levels

a. Minimum* Levels in Appendix II represent the lowest quantifiable concentration in a sample based on the proper application of method-specific analytical procedures and the absence of matrix interferences. Minimum* Levels also represent the lowest standard concentration in the calibration curve for a specific analytical technique after the application of appropriate method-specific factors.

Common analytical practices may require different treatment of the sample relative to the calibration standard. Some examples are given below:

Substance or Grouping	Method-Specific Treatment	Most Common Factor
Volatile Organics	No differential treatment	1
Semi-Volatile Organics	Samples concentrated by extraction	1000
Metals	Samples diluted or concentrated	½ , 2 , and 4
Pesticides	Samples concentrated by extraction	100

b. Other factors may be applied to the Minimum* Level depending on the specific sample preparation steps employed. For example, the treatment typically applied when there are matrix effects is to dilute the sample or sample aliquot by a factor of ten. In such cases, this additional factor must be applied during the computation of the reporting limit. Application of such factors will alter the reported Minimum* Level.

c. Dischargers are to instruct their laboratories to establish calibration standards so that the Minimum* Level (or its equivalent if there is differential treatment of

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* See Appendix I for definition of terms.

samples relative to calibration standards) is the lowest calibration standard. At no time is the discharger to use analytical data derived from *extrapolation* beyond the lowest point of the calibration curve. In accordance with Section 4b, above, the discharger's laboratory may employ a calibration standard lower than the Minimum* Level in Appendix II.

7. Sample Reporting Protocols

   a. Dischargers must report with each sample result the reported Minimum* Level (selected in accordance with Section 4, above) and the laboratory's current MDL*.

   b. Dischargers must also report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

      (1) Sample results greater than or equal to the reported Minimum* Level must be reported "as measured" by the laboratory (i.e., the measured chemical concentration in the sample).

      (2) Sample results less than the reported Minimum* Level, but greater than or equal to the laboratory's MDL*, must be reported as "Detected, but Not Quantified", or DNQ. The laboratory must write the estimated chemical concentration of the sample next to DNQ as well as the words "Estimated Concentration" (may be shortened to "Est. Conc.").

      (3) Sample results less than the laboratory's MDL* must be reported as "Not Detected", or ND.

8. Compliance Determination

   Sufficient sampling and analysis shall be required to determine compliance with the effluent limitation.

   a. Compliance with Single-Constituent Effluent Limitations

      Dischargers are out of compliance with the effluent limitation if the concentration of the pollutant (see Section 7c, below) in the monitoring sample is greater than the effluent limitation and greater than or equal to the reported Minimum* Level.

   b. Compliance with Effluent Limitations expressed as a Sum of Several Constituents

      Dischargers are out of compliance with an effluent limitation which applies to the sum of a group of chemicals (e.g., PCB's) if the sum of the individual pollutant concentrations is greater than the effluent limitation. Individual pollutants of the group will be considered to have a concentration of zero if the constituent is reported as ND or DNQ.

   c. Multiple Sample Data Reduction

      The concentration of the pollutant in the effluent may be estimated from the result of a single sample analysis or by a measure of central tendency (arithmetic mean, geometric mean, median, etc.) of multiple sample analyses when all sample results are quantifiable (i.e., greater than or equal to the reported Minimum* Level). When one or more sample results are reported as ND or DNQ, the central tendency concentration of the pollutant shall be the median (middle) value of the

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* See Appendix I for definition of terms.

multiple samples. If, in an even number of samples, one or both of the middle values is ND or DNQ, the median will be the lower of the two middle values.

d. Powerplants and Heat Exchange Dischargers

Due to the large total volume of powerplant and other heat exchange discharges, special procedures must be applied for determining compliance with Table B objectives on a routine basis. Effluent concentration values (Ce) shall be determined through the use of equation 1 considering the minimal probable initial* dilution of the combined effluent (in-plant waste streams plus cooling water flow). These concentration values shall then be converted to mass emission limitations as indicated in equation 3. The mass emission limits will then serve as requirements applied to all inplant waste* streams taken together which discharge into the cooling water flow, except that limits for total chlorine residual, acute* (if applicable per Section (3)(c)) and chronic* toxicity and instantaneous maximum concentrations in Table B shall apply to, and be measured in, the combined final effluent, as adjusted for dilution with ocean water. The Table B objective for radioactivity shall apply to the undiluted combined final effluent.

9. Pollutant Minimization Program

a. Pollutant Minimization Program Goal

The goal of the Pollutant Minimization Program is to reduce all potential sources of a pollutant through pollutant minimization (control) strategies, including pollution prevention measures, in order to maintain the effluent concentration at or below the effluent limitation.

Pollution prevention measures may be particularly appropriate for persistent bioaccumulative priority pollutants where there is evidence that beneficial uses are being impacted. The completion and implementation of a Pollution Prevention Plan, required in accordance with CA Water Code Section 13263.3 (d) will fulfill the Pollution Minimization Program requirements in this section.

b. Determining the need for a Pollutant Minimization Program

1. The discharger must develop and conduct a Pollutant Minimization Program if all of the following conditions are true:
    (a) The calculated effluent limitation is less than the reported Minimum* Level
    (b) The concentration of the pollutant is reported as DNQ
    (c) There is evidence showing that the pollutant is present in the effluent above the calculated effluent limitation.
2. Alternatively, the discharger must develop and conduct a Pollutant Minimization Program if all of the following conditions are true:
    (a) The calculated effluent limitation is less than the Method Detection Limit*.
    (b) The concentration of the pollutant is reported as ND.
    (c) There is evidence showing that the pollutant is present in the effluent above the calculated effluent limitation.

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* See Appendix I for definition of terms.

c. Regional Boards may include special provisions in the discharge requirements to require the gathering of evidence to determine whether the pollutant is present in the effluent at levels above the calculated effluent limitation. Examples of evidence may include:

   1. health advisories for fish consumption,
   2. presence of whole effluent toxicity,
   3. results of benthic or aquatic organism tissue sampling,
   4. sample results from analytical methods more sensitive than methods included in the permit (in accordance with Section 4b, above).
   5. the concentration of the pollutant is reported as DNQ and the effluent limitation is less than the MDL

d. Elements of a Pollutant Minimization Program

   The Regional Board may consider cost-effectiveness when establishing the requirements of a Pollutant Minimization Program. The program shall include actions and submittals acceptable to the Regional Board including, but not limited to, the following:

   1. An annual review and semi-annual monitoring of potential sources of the reportable pollutant, which may include fish tissue monitoring and other bio-uptake sampling;
   2. Quarterly monitoring for the reportable pollutant in the influent to the wastewater treatment system;
   3. Submittal of a control strategy designed to proceed toward the goal of maintaining concentrations of the reportable pollutant in the effluent at or below the calculated effluent limitation;
   4. Implementation of appropriate cost-effective control measures for the pollutant, consistent with the control strategy; and,
   5. An annual status report that shall be sent to the Regional Board including:
      (a) All Pollutant Minimization Program monitoring results for the previous year;
      (b) A list of potential sources of the reportable pollutant;
      (c) A summary of all action taken in accordance with the control strategy; and,
      (d) A description of actions to be taken in the following year.

10. Toxicity Reduction Requirements

   a. If a discharge consistently exceeds an effluent limitation based on a toxicity objective in Table B, a toxicity reduction evaluation (TRE) is required. The TRE shall include all reasonable steps to identify the source of toxicity. Once the source(s) of toxicity is identified, the discharger shall take all reasonable steps necessary to reduce toxicity to the required level.

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* See Appendix I for definition of terms.

b. The following shall be incorporated into waste discharge requirements: (1) a requirement to conduct a TRE if the discharge consistently exceeds its toxicity effluent limitation, and (2) a provision requiring a discharger to take all reasonable steps to reduce toxicity once the source of toxicity is identified.

D. Implementation Provisions for Bacterial Characteristics

1. Water-Contact Monitoring

a. Weekly samples shall be collected from each site. The geometric mean shall be calculated using the five most recent sample results.

b. If a single sample exceeds any of the single sample maximum (*SSM*) standards, repeat sampling at that location shall be conducted to determine the extent and persistence of the exceedance. Repeat sampling shall be conducted within 24 hours of receiving analytical results and continued until the sample result is less than the SSM standard or until a sanitary survey is conducted to determine the source of the high bacterial densities.

i) Total coliform density will not exceed 10,000 per 100 ml; or
ii) Fecal coliform density will not exceed 400 per 100 ml; or
iii) Total coliform density will not exceed 1,000 per 100 ml when the ratio of fecal/total coliform exceeds 0.1;
iv) enterococcus density will not exceed 104 per 100 ml.

When repeat sampling is required because of an exceedance of any one single sample density, values from all samples collected during that 30-day period will be used to calculate the geometric mean.

c. It is state policy that the geometric mean bacterial objectives are strongly preferred for use in water body assessment decisions, for example, in developing the Clean Water Act section 303(d) list of impaired waters, because the geometric mean objectives are a more reliable measure of long-term water body conditions. In making assessment decisions on bacterial quality, single sample maximum data must be considered together with any available geometric mean data. The use of only single sample maximum bacterial data is generally inappropriate unless there is a limited data set, the water is subject to short-term spikes in bacterial concentrations, or other circumstances justify the use of only single sample maximum data.

d. For monitoring stations outside of the defined water-contact recreation zone (REC-1), samples will be analyzed for total coliform only.

E. Implementation Provisions For Areas* of Special Biological Significance (ASBS)

1. Waste* shall not be discharged to areas designated as being of special biological significance. Discharges shall be located a sufficient distance from such designated areas to assure maintenance of natural water quality conditions in these areas.

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* See Appendix I for definition of terms.

2. Regional Boards may approve waste discharge requirements or recommend certification for limited-term (i.e. weeks or months) activities in ASBS*. Limited-term activities include, but are not limited to, activities such as maintenance/repair of existing boat facilities, restoration of sea walls, repair of existing storm water pipes, and replacement/repair of existing bridges. Limited-term activities may result in temporary and short-term changes in existing water quality. Water quality degradation shall be limited to the shortest possible time. The activities must not permanently degrade water quality or result in water quality lower than that necessary to protect existing uses, and all practical means of minimizing such degradation shall be implemented.

F. Revision of Waste* Discharge Requirements

1. The Regional Board shall revise the waste* discharge requirements for existing* discharges as necessary to achieve compliance with this Plan and shall also establish a time schedule for such compliance.

2. The Regional Boards may establish more restrictive water quality objectives and effluent limitations than those set forth in this Plan as necessary for the protection of beneficial uses of ocean* waters.

3. Regional Boards may impose alternative less restrictive provisions than those contained within Table B of the Plan, provided an applicant can demonstrate that:
    a. Reasonable control technologies (including source control, material substitution, treatment and dispersion) will not provide for complete compliance; or
    b. Any less stringent provisions would encourage water* reclamation;

4. Provided further that:
    a. Any alternative water quality objectives shall be below the conservative estimate of chronic* toxicity, as given in Table D, and such alternative will provide for adequate protection of the marine environment;
    b. A receiving water quality toxicity objective of 1 TUc is not exceeded; and
    c. The State Board grants an exception (Chapter III. I.) to the Table B limits as established in the Regional Board findings and alternative limits.

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* See Appendix I for definition of terms.

TABLE D
CONSERVATIVE ESTIMATES OF CHRONIC TOXICITY

Constituent	**Estimate of Chronic Toxicity (ug/l)**
Arsenic	19.
Cadmium	8.
Hexavalent Chromium	18.
Copper	5.
Lead	22.
Mercury	0.4
Nickel	48.
Silver	3.
Zinc	51.
Cyanide	10.
Total Chlorine Residual	10.0
Ammonia	4000.0
Phenolic Compounds (non-chlorinated)	a) (see below)
Chlorinated Phenolics	a)
Chlorinated Pesticides and PCB's	b)

Table D Notes:

a) There are insufficient data for phenolics to estimate chronic toxicity levels. Requests for modification of water quality objectives for these waste* constituents must be supported by chronic toxicity data for representative sensitive species. In such cases, applicants seeking modification of water quality objectives should consult the Regional Water Quality Control Board to determine the species and test conditions necessary to evaluate chronic effects.

b) Limitations on chlorinated pesticides and PCB's shall not be modified so that the total of these compounds is increased above the objectives in Table B.

G. Monitoring Program

1. The Regional Water Boards shall require dischargers to conduct self-monitoring programs and submit reports necessary to determine compliance with the waste* discharge requirements, and may require dischargers to contract with agencies or persons acceptable to the Regional Water Board to provide monitoring reports. Monitoring provisions contained in waste discharge requirements shall be in accordance with the Monitoring Procedures provided in Appendices III and VI.

2. The Regional Water Board may require monitoring of bioaccumulation of toxicants in the discharge zone. Organisms and techniques for such monitoring shall be chosen by the Regional Water Board on the basis of demonstrated value in waste* discharge monitoring.

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* See Appendix I for definition of terms.

H. Discharge Prohibitions

1. Hazardous Substances

   a. The discharge of any radiological, chemical, or biological warfare agent or high-level radioactive waste* into the ocean* is prohibited.

2. Areas Designated for Special Water Quality Protection

   a. Waste* shall not be discharged to designated Areas* of Special Biological Significance except as provided in Chapter III. E. Implementation Provisions For Areas of Special Biological Significance.

3. Sludge

   a. Pipeline discharge of sludge to the ocean* is prohibited by federal law; the discharge of municipal and industrial waste* sludge directly to the ocean*, or into a waste* stream that discharges to the ocean*, is prohibited by this Plan. The discharge of sludge digester supernatant directly to the ocean*, or to a waste* stream that discharges to the ocean* without further treatment, is prohibited.

   b. It is the policy of the SWRCB that the treatment, use and disposal of sewage sludge shall be carried out in the manner found to have the least adverse impact on the total natural and human environment. Therefore, if federal law is amended to permit such discharge, which could affect California waters, the SWRCB may consider requests for exceptions to this section under Chapter III. H. of this Plan, provided further that an Environmental Impact Report on the proposed project shows clearly that any available alternative disposal method will have a greater adverse environmental impact than the proposed project.

4. By-Passing

   a. The by-passing of untreated wastes* containing concentrations of pollutants in excess of those of Table A or Table B to the ocean* is prohibited.

I. State Board Exceptions to Plan Requirements

1. The State Water Board may, in compliance with the California Environmental Quality Act, subsequent to a public hearing, and with the concurrence of the Environmental Protection Agency, grant exceptions where the Board determines:

   a. The exception will not compromise protection of ocean* waters for beneficial uses, and,

   b. The public interest will be served.

2. All exceptions issued by the State Water Board and in effect at the time of the Triennial Review will be reviewed at that time. If there is sufficient cause to re-open or revoke any exception, the State Water Board may direct staff to prepare a report and to schedule a public hearing. If after the public hearing the State Water Board decides to re-open, revoke, or re-issue a particular exception, it may do so at that time.

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* See Appendix I for definition of terms.

APPENDIX I

DEFINITION OF TERMS

ACUTE TOXICITY

a. Acute Toxicity (TUa)

Expressed in Toxic Units Acute (TUa)

$$TUa = \frac{100}{\text{96-hr LC 50\%}}$$

b. Lethal Concentration 50% (LC 50)

LC 50 (percent waste giving 50% survival of test organisms) shall be determined by static or continuous flow bioassay techniques using standard marine test species as specified in Appendix III, Chapter II. If specific identifiable substances in wastewater can be demonstrated by the discharger as being rapidly rendered harmless upon discharge to the marine environment, but not as a result of dilution, the LC 50 may be determined after the test samples are adjusted to remove the influence of those substances.

When it is not possible to measure the 96-hour LC 50 due to greater than 50 percent survival of the test species in 100 percent waste, the toxicity concentration shall be calculated by the expression:

$$TUa = \frac{\log (100 - S)}{1.7}$$

where:

S = percentage survival in 100% waste. If S > 99, TUa shall be reported as zero.

AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS) are those areas designated by the State Water Board as ocean areas requiring protection of species or biological communities to the extent that alteration of natural water quality is undesirable. All Areas of Special Biological Significance are also classified as a subset of STATE WATER QUALITY PROTECTION AREAS.

CHLORDANE shall mean the sum of chlordane-alpha, chlordane-gamma, chlordene-alpha, chlordene-gamma, nonachlor-alpha, nonachlor-gamma, and oxychlordane.

CHRONIC TOXICITY: This parameter shall be used to measure the acceptability of waters for supporting a healthy marine biota until improved methods are developed to evaluate biological response.

a. Chronic Toxicity (TUc)

Expressed as Toxic Units Chronic (TUc)

$$TUc = \frac{100}{NOEL}$$

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* See Appendix I for definition of terms.

b. No Observed Effect Level (NOEL)

The NOEL is expressed as the maximum percent effluent or receiving water that causes no observable effect on a test organism, as determined by the result of a critical life stage toxicity test listed in Appendix II.

DDT shall mean the sum of 4,4'DDT, 2,4'DDT, 4,4'DDE, 2,4'DDE, 4,4'DDD, and 2,4'DDD.

DEGRADE: Degradation shall be determined by comparison of the waste field and reference site(s) for characteristic species diversity, population density, contamination, growth anomalies, debility, or supplanting of normal species by undesirable plant and animal species. Degradation occurs if there are significant differences in any of three major biotic groups, namely, demersal fish, benthic invertebrates, or attached algae. Other groups may be evaluated where benthic species are not affected, or are not the only ones affected.

DICHLOROBENZENES shall mean the sum of 1,2- and 1,3-dichlorobenzene.

DOWNSTREAM OCEAN WATERS shall mean waters downstream with respect to ocean currents.

DREDGED MATERIAL: Any material excavated or dredged from the navigable waters of the United States, including material otherwise referred to as "spoil".

ENCLOSED BAYS are indentations along the coast which enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. This definition includes but is not limited to: Humboldt Bay, Bodega Harbor, Tomales Bay, Drakes Estero, San Francisco Bay, Morro Bay, Los Angeles Harbor, Upper and Lower Newport Bay, Mission Bay, and San Diego Bay.

ENDOSULFAN shall mean the sum of endosulfan-alpha and -beta and endosulfan sulfate.

ESTUARIES AND COASTAL LAGOONS are waters at the mouths of streams that serve as mixing zones for fresh and ocean waters during a major portion of the year. Mouths of streams that are temporarily separated from the ocean by sandbars shall be considered as estuaries. Estuarine waters will generally be considered to extend from a bay or the open ocean to the upstream limit of tidal action but may be considered to extend seaward if significant mixing of fresh and salt water occurs in the open coastal waters. The waters described by this definition include but are not limited to the Sacramento-San Joaquin Delta as defined by Section 12220 of the California Water Code, Suisun Bay, Carquinez Strait downstream to Carquinez Bridge, and appropriate areas of the Smith, Klamath, Mad, Eel, Noyo, and Russian Rivers.

HALOMETHANES shall mean the sum of bromoform, bromomethane (methyl bromide) and chloromethane (methyl chloride).

HCH shall mean the sum of the alpha, beta, gamma (lindane) and delta isomers of hexachlorocyclohexane.

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* See Appendix I for definition of terms.

INITIAL DILUTION is the process which results in the rapid and irreversible turbulent mixing of wastewater with ocean water around the point of discharge.

For a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from the submarine outfalls, the momentum of the discharge and its initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally.

For shallow water submerged discharges, surface discharges, and nonbuoyant discharges, characteristic of cooling water wastes and some individual discharges, turbulent mixing results primarily from the momentum of discharge. Initial dilution, in these cases, is considered to be completed when the momentum induced velocity of the discharge ceases to produce significant mixing of the waste, or the diluting plume reaches a fixed distance from the discharge to be specified by the Regional Board, whichever results in the lower estimate for initial dilution.

KELP BEDS, for purposes of the bacteriological standards of this plan, are significant aggregations of marine algae of the genera Macrocystis and Nereocystis. Kelp beds include the total foliage canopy of Macrocystis and Nereocystis plants throughout the water column.

MARICULTURE is the culture of plants and animals in marine waters independent of any pollution source.

MATERIAL: (a) In common usage: (1) the substance or substances of which a thing is made or composed (2) substantial; (b) For purposes of this Ocean Plan relating to waste disposal, dredging and the disposal of dredged material and fill, MATERIAL means matter of any kind or description which is subject to regulation as waste, or any material dredged from the navigable waters of the United States. See also, DREDGED MATERIAL.

MDL (Method Detection Limit) is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, as defined in 40 CFR PART 136 Appendix B.

MINIMUM LEVEL (ML) is the concentrations at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method-specified sample weights, volumes and processing steps have been followed.

NATURAL LIGHT: Reduction of natural light may be determined by the Regional Board by measurement of light transmissivity or total irradiance, or both, according to the monitoring needs of the Regional Board.

OCEAN WATERS are the territorial marine waters of the State as defined by California law to the extent these waters are outside of enclosed bays, estuaries, and coastal lagoons. If a discharge outside the territorial waters of the State could affect the quality of the waters of the State, the discharge may be regulated to assure no violation of the Ocean Plan will occur in ocean waters.

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* See Appendix I for definition of terms.

PAHs (polynuclear aromatic hydrocarbons) shall mean the sum of acenaphthylene, anthracene, 1,2-benzanthracene, 3,4-benzofluoranthene, benzo[k]fluoranthene, 1,12-benzoperylene, benzo[a]pyrene, chrysene, dibenzo[ah]anthracene, fluorene, indeno[1,2,3-cd]pyrene, phenanthrene and pyrene.

PCBs (polychlorinated biphenyls) shall mean the sum of chlorinated biphenyls whose analytical characteristics resemble those of Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254 and Aroclor-1260.

SHELLFISH are organisms identified by the California Department of Health Services as shellfish for public health purposes (i.e., mussels, clams and oysters).

SIGNIFICANT difference is defined as a statistically significant difference in the means of two distributions of sampling results at the 95 percent confidence level.

STATE WATER QUALITY PROTECTION AREAS (SWQPAs) are nonterrestrial marine or estuarine areas designated to protect marine species or biological communities from an undesirable alteration in natural water quality. All Areas of Special Biological Significance (ASBS) that were previously designated by the State Water Board in Resolutions 74-28, 74-32, and 75-61 are now also classified as a subset of State Water Quality Protection Areas and require special protections afforded by this Plan.

TCDD EQUIVALENTS shall mean the sum of the concentrations of chlorinated dibenzodioxins (2,3,7,8-CDDs) and chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their respective toxicity factors, as shown in the table below.

Isomer Group	Toxicity Equivalence Factor
	1.0
2,3,7,8-tetra CDD	
2,3,7,8-penta CDD	0.5
2,3,7,8-hexa CDDs	0.1
2,3,7,8-hepta CDD	0.01
octa CDD	0.001
2,3,7,8 tetra CDF	0.1
1,2,3,7,8 penta CDF	0.05
2,3,4,7,8 penta CDF	0.5
2,3,7,8 hexa CDFs	0.1
2,3,7,8 hepta CDFs	0.01
octa CDF	0.001

WASTE: As used in this Plan, waste includes a discharger's total discharge, of whatever origin, i.e., gross, not net, discharge.

WATER RECLAMATION: The treatment of wastewater to render it suitable for reuse, the transportation of treated wastewater to the place of use, and the actual use of treated wastewater for a direct beneficial use or controlled use that would not otherwise occur.

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* See Appendix I for definition of terms.

APPENDIX II
MINIMUM* LEVELS

The Minimum* Levels identified in this appendix represent the lowest concentration of a pollutant that can be quantitatively measured in a sample given the current state of performance in analytical chemistry methods in California. These Minimum* Levels were derived from data provided by state-certified analytical laboratories in 1997 and 1998 for pollutants regulated by the California Ocean Plan and shall be used until new values are adopted by the SWRCB. There are four major chemical groupings: volatile chemicals, semi-volatile chemicals, inorganics, pesticides & PCB's. "No Data" is indicated by "--".

TABLE II-1
MINIMUM* LEVELS – VOLATILE CHEMICALS

		Minimum* Level (ug/L)	
Volatile Chemicals	**CAS Number**	**GC Method** [a]	**GCMS Method** [b]
Acrolein	107028	2.	5
Acrylonitrile	107131	2.	2
Benzene	71432	0.5	2
Bromoform	75252	0.5	2
Carbon Tetrachloride	56235	0.5	2
Chlorobenzene	108907	0.5	2
Chlorodibromomethane	124481	0.5	2
Chloroform	67663	0.5	2
1,2-Dichlorobenzene (volatile)	95501	0.5	2
1,3-Dichlorobenzene (volatile)	541731	0.5	2
1,4-Dichlorobenzene (volatile)	106467	0.5	2
Dichlorobromomethane	75274	0.5	2
1,1-Dichloroethane	75343	0.5	1
1,2-Dichloroethane	107062	0.5	2
1,1-Dichloroethylene	75354	0.5	2
Dichloromethane	75092	0.5	2
1,3-Dichloropropene (volatile)	542756	0.5	2
Ethyl benzene	100414	0.5	2
Methyl Bromide	74839	1.	2
Methyl Chloride	74873	0.5	2
1,1,2,2-Tetrachloroethane	79345	0.5	2
Tetrachloroethylene	127184	0.5	2
Toluene	108883	0.5	2
1,1,1-Trichloroethane	71556	0.5	2
1,1,2-Trichloroethane	79005	0.5	2
Trichloroethylene	79016	0.5	2
Vinyl Chloride	75014	0.5	2

Table II-1 Notes

a) GC Method = Gas Chromatography

b) GCMS Method = Gas Chromatography / Mass Spectrometry

* To determine the lowest standard concentration in an instrument calibration curve for these techniques, use the given ML (see Chapter III, "Use of Minimum* Levels").

TABLE II-2
MINIMUM* LEVELS – SEMI VOLATILE CHEMICALS

		Minimum* Level (ug/L)			
Semi-Volatile Chemicals	**CAS Number**	**GC Method [a,*]**	**GCMS Method [b,*]**	**HPLC Method [c,*]**	**COLOR Method [d]**
Acenapthylene	208968	--	10	0.2	--
Anthracene	120127	--	10	2	--
Benzidine	92875	--	5	--	--
Benzo(a)anthracene	56553	--	10	2	--
Benzo(a)pyrene	50328	--	10	2	--
Benzo(b)fluoranthene	205992	--	10	10	--
Benzo(g,h,i)perylene	191242	--	5	0.1	--
Benzo(k)floranthene	207089	--	10	2	--
Bis 2-(1-Chloroethoxy) methane	111911	--	5	--	--
Bis(2-Chloroethyl)ether	111444	10	1	--	--
Bis(2-Chloroisopropyl)ether	39638329	10	2	--	--
Bis(2-Ethylhexyl) phthalate	117817	10	5	--	--
2-Chlorophenol	95578	2	5	--	--
Chrysene	218019	--	10	5	--
Di-n-butyl phthalate	84742	--	10	--	--
Dibenzo(a,h)anthracene	53703	--	10	0.1	--
1,2-Dichlorobenzene (semivolatile)	95504	2	2	--	--
1,3-Dichlorobenzene (semivolatile)	541731	2	1	--	--
1,4-Dichlorobenzene (semivolatile)	106467	2	1	--	--
3,3-Dichlorobenzidine	91941	--	5	--	--
2,4-Dichlorophenol	120832	1	5	--	--
1,3-Dichloropropene	542756	--	5	--	
Diethyl phthalate	84662	10	2	--	--
Dimethyl phthalate	131113	10	2	--	--
2,4-Dimethylphenol	105679	1	2	--	--
2,4-Dinitrophenol	51285	5	5	--	--
2,4-Dinitrotoluene	121142	10	5	--	--
1,2-Diphenylhydrazine	122667	--	1	--	--
Fluoranthene	206440	10	1	0.05	--
Fluorene	86737	--	10	0.1	--
Hexachlorobenzene	118741	5	1	--	--
Hexachlorobutadiene	87683	5	1	--	--
Hexachlorocyclopentadiene	77474	5	5	--	--

Table II-2 continued on next page...

Table II-2 (Continued)
Minimum* Levels – Semi Volatile Chemicals

Semi-Volatile Chemicals	CAS Number	Minimum* Level (ug/L) GC Method [a,*]	GCMS Method [b,*]	HPLC Method [c,*]	COLOR Method [d]
Hexachloroethane	67721	5	1	--	--
Indeno(1,2,3-cd)pyrene	193395	--	10	0.05	--
Isophorone	78591	10	1	--	--
2-methyl-4,6-dinitrophenol	534521	10	5	--	--
3-methyl-4-chlorophenol	59507	5	1	--	--
N-nitrosodi-n-propylamine	621647	10	5	--	--
N-nitrosodimethylamine	62759	10	5	--	--
N-nitrosodiphenylamine	86306	10	1	--	--
Nitrobenzene	98953	10	1	--	--
2-Nitrophenol	88755	--	10	--	--
4-Nitrophenol	100027	5	10	--	--
Pentachlorophenol	87865	1	5	--	--
Phenanthrene	85018	--	5	0.05	--
Phenol	108952	1	1	--	50
Pyrene	129000	--	10	0.05	--
2,4,6-Trichlorophenol	88062	10	10	--	--

Table II-2 Notes:

a) GC Method = Gas Chromatography
b) GCMS Method = Gas Chromatography / Mass Spectrometry
c) HPLC Method = High Pressure Liquid Chromatography
d) COLOR Method= Colorimetric

* To determine the lowest standard concentration in an instrument calibration curve for this technique, multiply the given ML by 1000 (see Chapter III, "Use of Minimum* Levels").

TABLE II-3
MINIMUM* LEVELS - INORGANICS

		Minimum* Level (ug/L)								
Inorganic Substances	**CAS Number**	**COLOR Method**[a]	**DCP Method**[b]	**FAA Method**[c]	**GFAA Method**[d]	**HYDRIDE Method**[e]	**ICP Method**[f]	**ICPMS Method**[g]	**SPGFAA Method**[h]	**CVAA Method**[i]
Antimony	7440360	--	1000.	10.	5.	0.5	50.	0.5	5.	--
Arsenic	7440382	20.	1000.	--	2.	1.	10.	2.	2.	--
Beryllium	7440417	--	1000.	20.	0.5	--	2.	0.5	1.	--
Cadmium	7440439	--	1000.	10.	0.5	--	10.	0.2	0.5	--
Chromium (total)	--	--	1000.	50.	2.	--	10.	0.5	1.	--
Chromium (VI)	18540299	10.	--	5.	--	--	--	--	--	--
Copper	7440508	--	1000.	20.	5.	--	10.	0.5	2.	--
Cyanide	57125	5.	--	--	--	--	--	--	--	--
Lead	7439921	--	10000.	20.	5.	--	5.	0.5	2.	--
Mercury	7439976	--	--	--	--	--	--	0.5	--	0.2
Nickel	7440020	--	1000.	50.	5.	--	20.	1.	5.	--
Selenium	7782492	--	1000.	--	5.	1.	10.	2.	5.	--
Silver	7440224	--	1000.	10.	1.	--	10.	0.2	2.	--
Thallium	7440280	--	1000.	10.	2.	--	10.	1.	5.	--
Zinc	7440666	--	1000.	20.	--	--	20.	1.	10.	--

Table II-3 Notes

a) COLOR Method = Colorimetric
b) DCP Method = Direct Current Plasma
c) FAA Method = Flame Atomic Absorption
d) GFAA Method = Graphite Furnace Atomic Absorption
e) HYDRIDE Method = Gaseous Hydride Atomic Absorption
f) ICP Method = Inductively Coupled Plasma
g) ICPMS Method = Inductively Coupled Plasma / Mass Spectrometry
h) SPGFAA Method = Stabilized Platform Graphite Furnace Atomic Absorption (i.e., US EPA 200.9)
i) CVAA Method = Cold Vapor Atomic Absorption

* To determine the lowest standard concentration in an instrument calibration curve for these techniques, use the given ML (see Chapter III, "Use of Minimum* Levels").

TABLE II-4
MINIMUM* LEVELS – PESTICIDES AND PCBs

Pesticides – PCB's	CAS Number	Minimum* Level (ug/L) GC Method[a,*]
Aldrin	309002	0.005
Chlordane	57749	0.1
4,4'-DDD	72548	0.05
4,4'-DDE	72559	0.05
4,4'-DDT	50293	0.01
Dieldrin	60571	0.01
a-Endosulfan	959988	0.02
b-Endosulfan	33213659	0.01
Endosulfan Sulfate	1031078	0.05
Endrin	72208	0.01
Heptachlor	76448	0.01
Heptachlor Epoxide	1024573	0.01
a-Hexachlorocyclohexane	319846	0.01
b-Hexachlorocyclohexane	319857	0.005
d-Hexachlorocyclohexane	319868	0.005
g-Hexachlorocyclohexane (Lindane)	58899	0.02
PCB 1016	--	0.5
PCB 1221	--	0.5
PCB 1232	--	0.5
PCB 1242	--	0.5
PCB 1248	--	0.5
PCB 1254	--	0.5
PCB 1260	--	0.5
Toxaphene	8001352	0.5

Table II-4 Notes

a) GC Method = Gas Chromatography

* To determine the lowest standard concentration in an instrument calibration curve for this technique, multiply the given ML by 100 (see Chapter III, "Use of Minimum* Levels").

APPENDIX III

STANDARD MONITORING PROCEDURES

The purpose of this appendix is to provide direction to the Regional Boards on the implementation of the California Ocean Plan and to ensure the reporting of useful information. It is not feasible to cover all circumstances and conditions that could be encountered by all dischargers. Therefore, this appendix should be considered as the basic component of any discharger monitoring program. Regional Boards can deviate from the procedures required in the appendix only with the approval of the State Water Resources Control Board unless the Ocean Plan allows for the selection of alternate protocols by the Regional Boards. If no direction is given in this appendix for a specific provision of the Ocean Plan, it is within the discretion of the Regional Board to establish the monitoring requirements for the provision.

The following text is referenced by applicable chapter in the Ocean Plan. All references to 40 CFR PART 136 are to the revised edition of May 14, 1999.

Ocean Plan Chapter II. B. Bacterial Standards:

For all bacterial analyses, sample dilutions should be performed so the range of values extends from 2 to 16,000. The detection methods used for each analysis shall be reported with the results of the analysis.

Detection methods used for coliforms (total and fecal) shall be those presented in Table 1A of 40 CFR PART 136, unless alternate methods have been approved in advance by US EPA pursuant to 40 CFR PART 136.

Detection methods used for enterococcus shall be those presented in EPA publication EPA 600/4-85/076, Test Methods for *Escherichia coli* and Enterococci in Water By Membrane Filter Procedure or any improved method determined by the Regional Board to be appropriate.

Ocean Plan Chapter II. H Table B. Compliance with Table B Objectives:

Procedures, calibration techniques, and instrument/reagent specifications used to determine compliance with Table B shall conform to the requirements of federal regulations (40 CFR PART 136). All methods shall be specified in the monitoring requirement section of waste discharge requirements.

Where methods are not available in 40 CFR PART 136, the Regional Boards shall specify suitable analytical methods in waste discharge requirements. Acceptance of data should be predicated on demonstrated laboratory performance.

Laboratories analyzing monitoring data shall be certified by the Department of Health Services, in accordance with the provisions of Section 13176 CWC, and must include quality assurance quality control data with their reports.

The State or Regional Board may, subject to EPA approval, specify test methods which are more sensitive than those specified in 40 CFR PART 136. Total chlorine residual is likely to be a method detection limit effluent limitation in many cases. The limit of detection of total chlorine residual in standard test methods is less than or equal to 20 ug/l.

Monitoring for the substances in Table B shall be required periodically. For discharges less than 1 MGD (million gallons per day), the monitoring of all the Table B parameters should consist of at least one complete scan of the Table B constituents one time in the life of the waste discharge requirements. For discharges between 1 and 10 MGD, the monitoring frequency shall be at least one complete scan of the Table B substances annually. Discharges greater than 10 MGD shall be required to monitor at least semiannually.

Compliance monitoring for the acute toxicity objective (TUa) in Table B shall be determined using an US EPA approved protocol as provided in 40 CFR PART 136. Acute toxicity monitoring requirements in permits prepared by the Regional Boards shall use marine test species instead of freshwater species when measuring compliance.

The Regional Board shall require the use of critical life stage toxicity tests specified in this Appendix to measure TUc. Other species or protocols will be added to the list after SWRCB review and approval. A minimum of three test species with approved test protocols shall be used to measure compliance with the toxicity objective. If possible, the test species shall include a fish, an invertebrate, and an aquatic plant. After a screening period, monitoring can be reduced to the most sensitive species. Dilution and control water should be obtained from an unaffected area of the receiving waters. The sensitivity of the test organisms to a reference toxicant shall be determined concurrently with each bioassay test and reported with the test results.

Use of critical life stage bioassay testing shall be included in waste discharge requirements as a monitoring requirement for all discharges greater than 100 MGD by January 1, 1991 at the latest. For other major dischargers, critical life stage bioassay testing shall be included as a monitoring requirement one year before the waste discharge requirement is scheduled for renewal.

The tests presented in Table III-1 shall be used to measure TUc. Other tests may be added to the list when approved by the State Board.

TABLE III-1
APPROVED TESTS – CHRONIC TOXICITY (TUc)

Species	Effect	Tier	Reference
giant kelp, *Macrocystis pyrifera*	percent germination; germ tube length	1	1,3
red abalone, *Haliotis rufescens*	Abnormal shell development	1	1,3
oyster, *Crassostrea gigas*; mussels, *Mytilus spp.*	Abnormal shell development; percent survival	1	1,3
urchin, *Strongylocentrotus purpuratus*; sand dollar, *Dendraster excentricus*	Percent normal development	1	1,3
urchin, *Strongylocentrotus purpuratus*; sand dollar, *Dendraster excentricus*	Percent fertilization	1	1,3
shrimp, *Holmesimysis costata*	Percent survival; growth	1	1,3
shrimp, *Mysidopsis bahia*	Percent survival; growth; fecundity	2	2,4
topsmelt, *Atherinops affinis*	Larval growth rate; percent survival	1	1,3
Silversides, *Menidia beryllina*	Larval growth rate; percent survival	2	2,4

Table III-1 Notes

The first tier test methods are the preferred toxicity tests for compliance monitoring. A Regional Board can approve the use of a second tier test method for waste discharges if first tier organisms are not available.

Protocol References

1. Chapman, G.A., D.L. Denton, and J.M. Lazorchak. 1995. Short-term methods for estimating the chronic toxicity of effluents and receiving waters to west coast marine and estuarine organisms. U.S. EPA Report No. EPA/600/R-95/136.

2. Klemm, D.J., G.E. Morrison, T.J. Norberg-King, W.J. Peltier, and M.A. Heber. 1994. Short-term methods for estimating the chronic toxicity of effluents and receiving water to marine and estuarine organisms. U.S. EPA Report No. EPA-600-4-91-003.

3. SWRCB 1996. Procedures Manual for Conducting Toxicity Tests Developed by the Marine Bioassay Project. 96-1WQ.

4. Weber, C.I., W.B. Horning, I.I., D.J. Klemm, T.W. Nieheisel, P.A. Lewis, E.L. Robinson, J. Menkedick and F. Kessler (eds). 1988. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms. EPA/600/4-87/028. National Information Service, Springfield, VA.

APPENDIX IV

PROCEDURES FOR THE NOMINATION AND DESIGNATION OF AREAS* OF SPECIAL BIOLOGICAL SIGNIFICANCE (ASBS).

1. Any person may nominate areas of ocean waters for designation as ASBS by the SWRCB. Nominations shall be made to the appropriate RWQCB and shall include:

    (a) Information such as maps, reports, data, statements, and photographs to show that:

        (1) Candidate areas are located in ocean waters as defined in the "Ocean Plan".

        (2) Candidate areas are intrinsically valuable or have recognized value to man for scientific study, commercial use, recreational use, or esthetic reasons.

        (3) Candidate areas need protection beyond that offered by waste discharge restrictions or other administrative and statutory mechanisms.

    (b) Data and information to indicate whether the proposed designation may have a significant effect on the environment.

        (1) If the data or information indicate that the proposed designation will have a significant effect on the environment, the nominee must submit sufficient information and data to identify feasible changes in the designation that will mitigate or avoid the significant environmental effects.

2. The SWRCB or a RWQCB may also nominate areas for designation as ASBS on their own motion.

3. A RWQCB may decide to (a) consider individual ASBS nominations upon receipt, (b) consider several nominations in a consolidated proceeding, or (c) consider nominations in the triennial review of its water quality control plan (basin plan). A nomination that meets the requirements of 1. above may be considered at any time but not later than the next scheduled triennial review of the appropriate basin plan or Ocean Plan.

4. After determining that a nomination meets the requirements of paragraph 1. above, the Executive Officer of the affected RWQCB shall prepare a Draft Nomination Report containing the following:

    (a) The area or areas nominated for designation as ASBS.

    (b) A description of each area including a map delineating the boundaries of each proposed area.

    (c) A recommendation for action on the nomination(s) and the rationale for the recommendation. If the Draft Nomination Report recommends approval of the proposed designation, the Draft Nomination Report shall comply with the CEQA documentation requirements for a water quality control plan amendment in Section 3777, Title 23, California Code of Regulations.

5. The Executive Officer shall, at a minimum, seek informal comment on the Draft Nomination Report from the SWRCB, Department of Fish and Game, other interested state and federal agencies, conservation groups, affected waste dischargers, and other interested parties. Upon incorporation of responses from the consulted agencies, the Draft Nomination Report shall become the Final Nomination Report.

6. (a) If the Final Nomination Report recommends approval of the proposed designation, the Executive Officer shall ensure that processing of the nomination complies with the CEQA consultation requirements in Section 3778, Title 23, California Code of Regulations and proceed to step 7 below.

   (b) If the Final Nomination Report recommends against approval of the proposed designation, the Executive Officer shall notify interested parties of the decision. No further action need be taken. The nominating party may seek reconsideration of the decision by the RWQCB itself.

7. The RWQCB shall conduct a public hearing to receive testimony on the proposed designation. Notice of the hearing shall be published three times in a newspaper of general circulation in the vicinity of the proposed area or areas and shall be distributed to all known interested parties 45 days in advance of the hearing. The notice shall describe the location, boundaries, and extent of the area or areas under consideration, as well as proposed restrictions on waste discharges within the area.

8. The RWQCB shall respond to comments as required in Section 3779, Title 23, California Code of Regulations, and 40 C.F.R. Part 25 (July 1, 1999).

9. The RWQCB shall consider the nomination after completing the required public review processes required by CEQA.

   (a) If the RWQCB supports the recommendation for designation, the board shall forward to the SWRCB its recommendation for approving designation of the proposed area or areas and the supporting rationale. The RWQCB submittal shall include a copy of the staff report, hearing transcript, comments, and responses to comments.

   (b) If the RWQCB does not support the recommendation for designation, the Executive Officer shall notify interested parties of the decision, and no further action need be taken.

10. After considering the RWQCB recommendation and hearing record, the SWRCB may approve or deny the recommendation, refer the matter to the RWQCB for appropriate action, or conduct further hearing itself. If the SWRCB acts to approve a recommended designation, the SWRCB shall amend Appendix V, Table V-1, of this Plan. The amendment will go into effect after approval by the Office of Administrative Law and US EPA. In addition, after the effective date of a designation, the affected RWQCB shall revise its water quality control plan in the next triennial review to include the designation.

11. The SWRCB Executive Director shall advise other agencies to whom the list of designated areas is to be provided that the basis for an ASBS designation is limited to protection of marine life from waste discharges.

APPENDIX V

STATE WATER QUALITY PROTECTION AREAS AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE

TABLE V-1
STATE WATER QUALITY PROTECTION AREAS AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE (DESIGNATED OR APPROVED BY THE STATE WATER RESOURCES CONTROL BOARD)

No.	ASBS Name	Date Designated	SWRCB Resolution No.	Region No.
1.	Jughandle Cove	March 21, 1974,	74-28	1
2.	Del Mar Landing	March 21, 1974,	74-28	1
3.	Gerstle Cove	March 21, 1974,	74-28	1
4.	Bodega	March 21, 1974,	74-28	1
5.	Saunders Reef	March 21, 1974,	74-28	1
6.	Trinidad Head	March 21, 1974,	74-28	1
7.	King Range	March 21, 1974,	74-28	1
8.	Redwoods National Park	March 21, 1974,	74-28	1
9.	James V. Fitzgerald	March 21, 1974,	74-28	2
10.	Farallon Islands	March 21, 1974,	74-28	2
11.	Duxbury Reef	March 21, 1974,	74-28	2
12.	Point Reyes Headlands	March 21, 1974,	74-28	2
13.	Double Point	March 21, 1974,	74-28	2
14.	Bird Rock	March 21, 1974,	74-28	2
15.	Año Nuevo	March 21, 1974,	74-28	3
16.	Point Lobos	March 21, 1974,	74-28	3
17.	San Miguel, Santa Rosa, and Santa Cruz Islands	March 21, 1974,	74-28	3
18.	Julia Pfeiffer Burns	March 21, 1974,	74-28	3
19.	Pacific Grove	March 21, 1974,	74-28	3
20.	Salmon Creek Coast	March 21, 1974,	74-28	3
21.	San Nicolas Island and Begg Rock	March 21, 1974,	74-28	4
22.	Santa Barbara and Anacapa Islands	March 21, 1974,	74-28	4
23.	San Clemente Island	March 21, 1974,	74-28	4

Table V-1 Continued on next page...

Table V-1 (Continued)

Areas of Special Biological Significance (Designated or Approved by the State Water Resources Control Board)

No.	ASBS Name	Date Designated	SWRCB Resolution No.	Region No.
24.	Laguna Point to Latigo Point	March 21, 1974,	74-28	4
25.	Northwest Santa Catalina Island	March 21, 1974,	74-28	4
26.	Western Santa Catalina Island	March 21, 1974,	74-28	4
27.	Farnsworth Bank	March 21, 1974,	74-28	4
28.	Southeast Santa Catalina	March 21, 1974,	74-28	4
29.	La Jolla	March 21, 1974,	74-28	9
30.	Heisler Park	March 21, 1974,	74-28	9
31.	San Diego-Scripps	March 21, 1974,	74-28	9
32.	Robert E. Badham	April 18, 1974	74-32	8
33.	Irvine Coast	April 18, 1974	74-32	8,9
34.	Carmel Bay	June 19, 1975	75-61	3

APPENDIX VI

Reasonable Potential Analysis Procedure for determining which Table B Objectives require effluent limitations

In determining the need for an effluent limitation, the Regional Water Board shall use all representative information to characterize the pollutant discharge using a scientifically defensible statistical method that accounts for the averaging period of the water quality objective, accounts for and captures the long-term variability of the pollutant in the effluent, accounts for limitations associated with sparse data sets, accounts for uncertainty associated with censored data sets, and (unless otherwise demonstrated) assumes a lognormal distribution of the facility-specific effluent data.

The purpose of the following procedure (see also Figure VI-1) is to provide direction to the Regional Water Boards for determining if a pollutant discharge causes, has the reasonable potential to cause, or contributes to an excursion above Table B water quality objectives in accordance with 40 CFR 122.44 (d)(1)(iii). The Regional Water Board may use an alternative approach for assessing reasonable potential such as an appropriate stochastic dilution model that incorporates both ambient and effluent variability. The permit fact sheet or statement of basis will document the justification or basis for the conclusions of the reasonable potential assessment. This appendix does not apply to permits or any portion of a permit where the discharge is regulated through best management practices (BMP) unless such discharge is also subject to numeric effluent limitations.

Step 1: Identify C_o, the applicable water quality objective from Table B for the pollutant.

Step 2: Does information about the receiving water body or the discharge support a reasonable potential assessment (RPA) without characterizing facility-specific effluent monitoring data? If yes, go to *Step 13* to conduct an RPA based on best professional judgment (BPJ). Otherwise, proceed to *Step 3.*

Step 3: Is facility-specific effluent monitoring data available? If yes, proceed to *Step 4.* Otherwise, go to *Step 13.*

Step 4: Adjust all effluent monitoring data C_e, including censored (ND or DNQ) values to the concentration X expected after complete mixing. For Table B pollutants use $X = (C_e + D_m C_s) / (D_m + 1)$; for acute toxicity use $X = C_e / (0.1 D_m + 1)$; where D_m is the minimum probable initial dilution expressed as parts seawater per part wastewater and C_s is the background seawater concentration from Table C. For ND values, C_e is replaced with "<MDL;" for DNQ values C_e is replaced with "<ML." Go to *Step 5.*

Step 5: Count the total number of samples *n*, the number of censored (ND or DNQ) values, *c* and the number of detected values, *d, such that* $n = c + d$.

Is any *detected* pollutant concentration after complete mixing greater than C_o? If yes, the discharge causes an excursion of C_o; go to *Endpoint 1.* Otherwise, proceed to *Step 6.*

Step 6: Does the effluent monitoring data contain three or more detected observations ($d \geq 3$)? If yes, proceed to *Step 7* to conduct a parametric RPA. Otherwise, go to *Step11* to conduct a nonparametric RPA.

Step 7: Conduct a parametric RPA. Assume data are lognormally distributed, unless otherwise demonstrated. Does the data consist entirely of detected values ($c/n = 0$)? If yes,

- calculate summary statistics M_L and S_L, the mean and standard deviation of the natural logarithm transformed effluent data expected after complete mixing, $\ln(X)$,
- go to *Step 9.*

Otherwise, proceed to *Step 8.*

Step 8: Is the data censored by 80% or less ($c/n \leq 0.8$)? If yes,

- calculate summary statistics M_L and S_L using the censored data analysis method of Helsel and Cohn (1988),
- go to *Step 9.*

Otherwise, go to Step 11.

Step 9: Calculate the UCB i.e., the one-sided, upper 95 percent confidence bound for the 95th percentile of the effluent distribution after complete mixing. For lognormal distributions, use $UCBL_{(.95,.95)} = \exp(M_L + S_L\, g'_{(.95,.95,n)})$, where g' is a normal tolerance factor obtained from the table below (Table VI-1). Proceed to *Step 10.*

Step 10: Is the UCB greater than C_o? If yes, the discharge has a reasonable potential to cause an excursion of C_o; go to *Endpoint 1.* Otherwise, the discharge has no reasonable potential to cause an excursion of C_o; go to *Endpoint 2.*

Step 11: Conduct a non-parametric RPA. Compare each data value X to C_o. Reduce the sample size n by 1 for each tie (i.e., inconclusive censored value result) present. An adjusted ND value having C_o < MDL is a tie. An adjusted DNQ value having C_o < ML is also a tie.

Step 12: Is the adjusted $n > 15$? If yes, the discharge has no reasonable potential to cause an excursion of C_o; go to *Endpoint 2.* Otherwise, go to *Endpoint 3.*

Step 13: Conduct an RPA based on BPJ. Review all available information to determine if a water quality-based effluent limitation is required, notwithstanding the above analysis in *Steps 1* through *12*, to protect beneficial uses. Information that may be used includes: the facility type, the discharge type, solids loading analysis, lack of dilution, history of compliance problems, potential toxic impact of discharge, fish tissue residue data, water quality and beneficial uses of the receiving water, CWA 303(d) listing for the pollutant, the presence of endangered or threatened species or critical habitat, and other information.

Is data or other information unavailable or insufficient to determine if a water quality-based effluent limitation is required? If yes, go to *Endpoint 3.* Otherwise, go to either *Endpoint 1* or *Endpoint 2* based on BPJ.

Endpoint 1: An effluent limitation must be developed for the pollutant. Effluent monitoring for the pollutant, consistent with the monitoring frequency in Appendix III, is required.

Endpoint 2: An effluent limitation is not required for the pollutant. Appendix III effluent monitoring is not required for the pollutant; the Regional Board, however, may require occasional monitoring for the pollutant or for whole effluent toxicity as appropriate.

Endpoint 3: The RPA is inconclusive. Monitoring for the pollutant or whole effluent toxicity testing, consistent with the monitoring frequency in Appendix III, is required. An existing effluent limitation for the pollutant shall remain in the permit, otherwise the permit shall include a reopener clause to allow for subsequent modification of the permit to include an effluent limitation if the monitoring establishes that the discharge causes, has the reasonable potential to cause, or contributes to an excursion above a Table B water quality objective.

Appendix VI References:

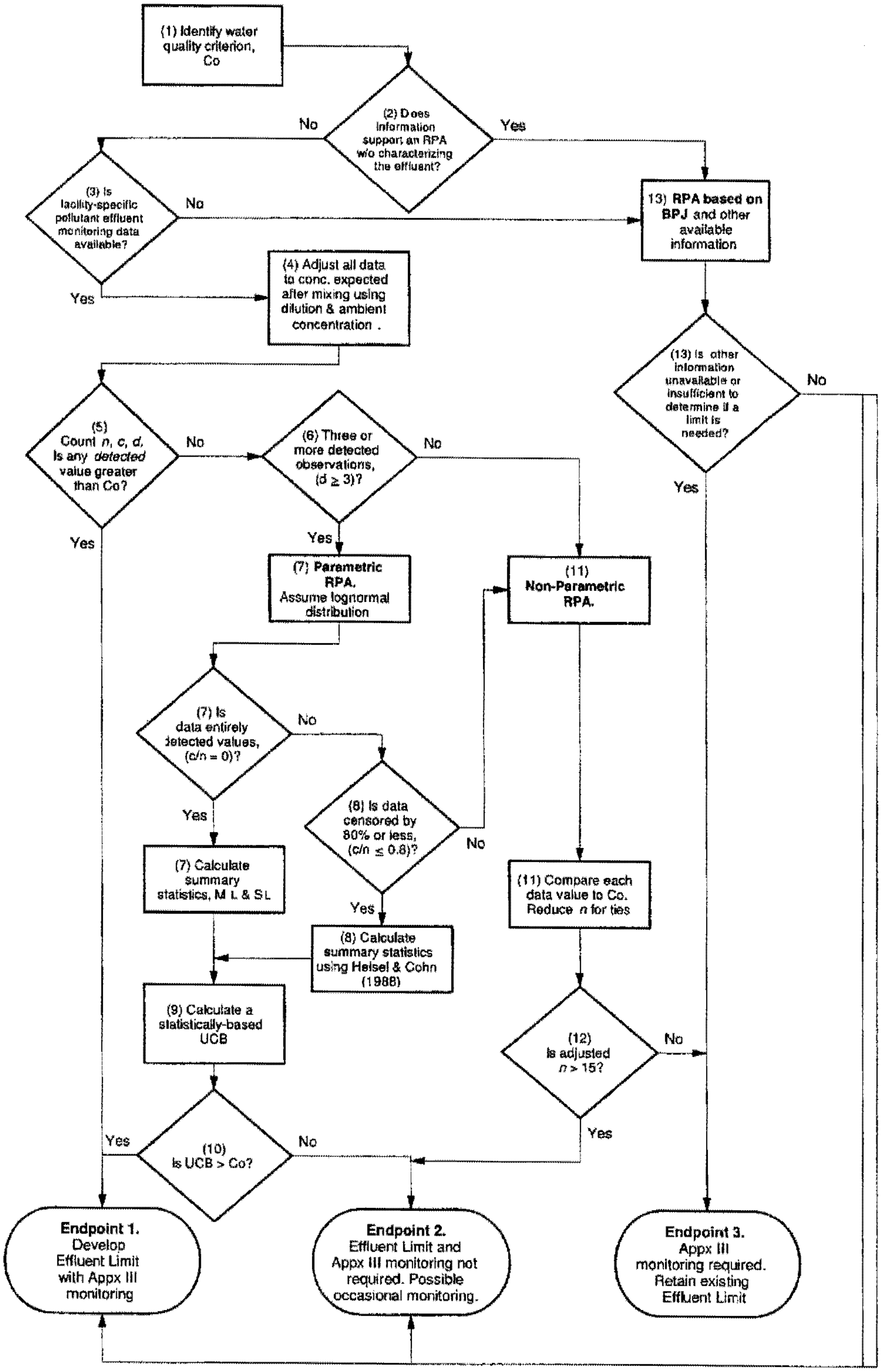
Helsel D. R. and T. A. Cohn. 1988. Estimation of descriptive statistics for multiply censored water quality data. Water Resources Research, Vol 24(12):1977-2004.

Hahn J. H. and W. Q. Meeker. 1991. Statistical Intervals, A guide for practitioners. J. Wiley & Sons, NY.

Table VI-1: Tolerance factors $g'_{(.95,.95,n)}$ for calculating normal distribution one-sided upper 95 percent tolerance bounds for the 95^{th} percentile (Hahn & Meeker 1991)

n	$g'_{(.95,.95,n)}$	n	$g'_{(.95,.95,n)}$
2	26.260	21	2.371
3	7.656	22	2.349
4	5.144	23	2.328
5	4.203	24	2.309
6	3.708	25	2.292
7	3.399	26	2.275
8	3.187	27	2.260
9	3.031	28	2.246
10	2.911	29	2.232
11	2.815	30	2.220
12	2.736	35	2.167
13	2.671	40	2.125
14	2.614	50	2.065
15	2.566	60	2.022
16	2.524	120	1.899
17	2.486	240	1.819
18	2.453	480	1.766
19	2.423	∞	1.645
20	2.396		

Figure VI-1: Reasonable potential analysis flow chart



APPENDIX VII

EXCEPTIONS TO THE CALIFORNIA OCEAN PLAN

TABLE VII-1
EXCEPTIONS TO THE OCEAN PLAN

(GRANTED BY THE STATE WATER RESOURCES CONTROL BOARD)

Year	Resolution	Applicable Provision	Discharger
1977	77-11	Discharge Prohibition, ASBS #23	US Navy San Clemente Island
1983	83-78	Discharge Prohibition, ASBS #7	Humboldt County Resort Improvement District No.1
1984	84-78	Discharge Prohibition, ASBS #34	Carmel Sanitary District
1990	90-105	Discharge Prohibition, ASBS #21	US Navy San Nicolas Island
2004	2004-0052	Discharge Prohibition, ASBS #31	UC Scripps Institution of Oceanography

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Appendix U

Correspondence

THE CITY OF SAN DIEGO • STATE OF CALIFORNIA • SEMPER VIGILANS

Correspondence

U.S. Fish & Wildlife Service

THE CITY OF SAN DIEGO

October 29, 2007

Mr. Jim Bartel
Field Supervisor
U.S. Department of Interior
Fish and Wildlife Service
6010 Hidden Valley Road
Carlsbad, CA 92011

Dear Mr. Bartel:

SUBJECT: Request for Comments on Endangered/Threatened Species - Application for Modified Secondary Treatment Requirements City of San Diego Point Loma Ocean Outfall

The City of San Diego is preparing an application to the U.S. Environmental Protection Agency and California Regional Water Quality Control Board requesting renewal of its NPDES permit for the discharge of treated wastewater to the Pacific Ocean via the 23,760-foot-long, 320-foot deep Point Loma Ocean Outfall. The City's application requests renewal of modified secondary treatment requirements for the Point Loma discharge in accordance with provisions of Section 301(h) of the Clean Water Act. The current five-year discharge permit for the modified Point Loma discharge expires in 2008.

The City's 301(h) renewal application will not request any increase in discharge flows or mass emissions. Treatment operations at the Point Loma Wastewater Treatment Plant will be conducted to insure compliance with applicable water quality standards established in the California Ocean Plan.

The City's 301(h) application will follow the format established in 40 CFR 125, Subpart G of the Clean Water Act. The application will, in part, assess compliance with NPDES effluent limits and performance goals established in the current NPDES permit (Order No. 2002-0025, NPDES CA0107409). The application will also address how the City will demonstrate compliance with requirements of the San Diego Basin Plan and California Ocean Plan.

The purpose of this letter is to solicit comments from your agency on whether the discharge would impact threatened or endangered species.

Proposed 301(h) Application

In June 2003, EPA granted a Section 301(h) waiver from secondary treatment to the City of San Diego. The EPA's decision was based on a detailed application demonstrating that the discharge of advanced primary treated wastewater 23,760 feet offshore at a depth of 320 feet was not having a detrimental effect on the ocean environment. An extensive monitoring program continues to verify that the Point Loma discharge protects San Diego's ocean waters and marine

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life. Secondary treatment waivers need to be renewed every five years. So, the City of San Diego is now applying to renew its Section 301(h) waiver.

As part of Section II.D.3 of the Large Applicant Questionnaire, the 301(h) application requires the City to identify:

- any threatened or endangered species which may inhabit or obtain nutrients from waters affected by the discharge,
- whether the discharge is consistent with the Endangered Species Act, and
- whether the discharge will affect threatened or endangered species or their critical habitat.

Previous Findings

As part of Section 301(h) applications submitted to EPA in 1979 and 1983, the City contacted the U.S. Fish and Wildlife Service (USFWS) for a determination of impacts from the City's original Point Loma discharge approximately 11,500 feet offshore at a depth of 220 feet. In response to these contacts, in a letter dated April 27, 1980, W. Sweeney, Area Manager for USFWS, noted that the California least tern may occur in the San Diego area. In a letter dated August 28, 1981, EPA requested that USFWS evaluate EPA's conclusion that the approval of a 301(h) waiver would have no impact on the California least tern population in the San Diego area. In a response letter dated April 30, 1982, USFWS Area Manager concluded that approval of a 301(h) waiver for the Point Loma discharge would not affect the California least tern population.

In 1991, the City prepared and distributed an Environmental Impact Report which assessed impacts associated with moving the Point Loma outfall discharge from 11,500 feet offshore and a depth of 220 feet to 23,760 feet offshore and a depth of 320 feet. City records indicate that USFWS received either a copy of the draft EIR or a notice of the EIR; USFWS was invited to comment on the accuracy and sufficiency of the EIR. USFWS offered no comments on the discharge relocation project and did not request a Section 7 consultation under the Endangered Species Act.

After approval of the EIR and construction of the extended outfall, the City terminated the discharge through the old outfall and initiated the discharge of advanced primary effluent from the extended outfall in November 1993, in accord with an Administrative Order issued by EPA.

In a letter to Mr. G. Kobetich, Field Supervisor, U.S. Fish and Wildlife Service, Carlsbad, California dated February 8, 1995, the City requested comments on endangered/threatened species for the Point Loma ocean outfall Section 301(h) application. No response was received.

In a letter to Mr. Ken Berg, Field Supervisor, U.S. Fish and Wildlife Service, Carlsbad, California dated June 25, 1999, the City requested comments on endangered/threatened species for the Point Loma ocean outfall Section 301(h) application. No response was received.

Current Conditions

Twenty-four endangered species covered under the federal Endangered Species Act may occur in the vicinity of Point Loma - eight marine mammals, seven birds, five sea turtles, two fish, and two invertebrates:

Marine Mammals		
Blue Whale	*Balaenoptera musculus*	Endangered
Fin Whale	*Balaenoptera physalus*	Endangered
Humpback Whale	*Meaptera novaeangliae*	Endangered
Right Whale	*Eubalaena japonica*	Endangered
Sei Whale	*Balaenoptera borealis*	Endangered
Sperm Whale	*Physeter macrocephalus*	Endangered
Guadalupe Fur Seal	*Arctocephalus townsendi*	Threatened
Steller Sea Lion	*Eumetopias jubatus*	Threatened
Birds		
California Brown Pelican	*Pelicanus occidentalis californicus*	Endangered
California Least Tern	*Sterna antillarum browni*	Endangered
Light-footed Clapper Rail	*Rallus longirostris levipes*	Endangered
Western Snowy Plover	*Charadrius alexandrinus nivosus*	Threatened
Short-tailed Albatross	*Phoebastria albatrus*	Endangered
Marbled Murrelet	*Brachyramphus marmaoratus*	Threatened
Xantus Murrelet	*Synthliboramphus hypoleucus*	Candidate
Sea Turtles		
East Pacific Green Turtle	*Celonia mydas*	Endangered
Loggerhead Turtle	*Caretta caretta*	Endangered
Leatherback Turtle	*Dermochelys coriacea*	Endangered
Olive Ridley Turtle	*Lepidochelys olivacea*	Endangered
Hawkbill Turtle	*Eretmochelys imbricata*	Endangered
Fish		
Chinook Salmon	*Oncorhynchus tshawytscha*	Endangered
Steelhead	*Oncorhynchus mykiss*	Endangered
Mollusk		
White Abalone	*Haliotis sorenseni*	Endangered
Black Abalone	*Haliotis cracherodii*	Candidate.

The U.S. Fish and Wildlife Service (FWS) and the U.S. National Marine Fisheries Service (NMFS) share responsibility for implementing the Endangered Species Act. However, the FWS has jurisdiction over marine birds while marine mammals, marine turtles, marine fish, and marine invertebrates are managed by the NMFS.

Operation of the Point Loma Ocean Outfall (PLOO) could affect endangered species by altering physical, chemical or biological conditions including: habitat suitability, water quality, biological integrity (e.g., species abundance and diversity), food web dynamics (e.g., availability of prey), or the health of organisms (e.g., bioaccumulation of toxic substances, disease, parasitism).

Monitoring data at Point Loma show effects of the discharge only in deep waters (below the euphotic zone) within or near the Zone of Initial Dilution (ZID) (City of San Diego 2007, Ocean Monitoring: http://www.sandiego.gov/mwwd/environment/oceanmonitor.shtml). Strong local currents and high initial dilution (>200:1) facilitate rapid mixing and dispersion of the effluent. Except in the immediate vicinity of the outfall, where minor alterations in dissolved oxygen, pH, and light transmittance may occur, changes in physical and chemical parameters in surrounding ocean waters have reflected natural alterations in oceanographic processes (e.g., upwelling, plankton blooms) and long-term regime changes like El Niño.

Alterations in sediment quality in the vicinity of the PLOO are only apparent at the station 400 ft from the diffusers. Changes that may be expected near large ocean outfalls, such as coarser sediments and higher sulfide levels have been periodically detected in a small, localized region near the discharge site. The change in grain size may be due to turbulence created as the current flows past the pipe on the bottom, wafting away the finer particles. Although higher sulfide levels that periodically occur adjacent to the outfall are consistent with the deposition of organic material from the discharge, other indicators of organic loading (biochemical oxygen demand, total organic carbon, total nitrogen, total volatile solids) have remained comparable to reference stations.

Concentrations of anthropogenic chemicals in sediments at Point Loma are generally near or below detection limits at all sampling stations, the notable exception being DDE, a breakdown product of the pesticide DDT. DDE, a legacy of historical discharge, is found in sediments throughout southern California. Levels of DDE at Point Loma are low relative to concentrations elsewhere in the southern California. There is no consistent pattern of metal concentrations in the sediments as a function of distance from the outfall. Trace metals are generally at or below detection levels and contaminant loading of sediments is not evident in the discharge vicinity. Sediment chemistry is comparable to reference areas along southern California's outer continental shelf.

Some descriptors of benthic community structure (e.g., abundance, species diversity) or indicators of environmental disturbance (e.g., brittle star populations) have revealed temporal differences between reference areas and sites nearest the ZID. However, results from environmental disturbance indices such as the Benthic Response Index used to evaluate the condition of benthic assemblages suggest that macrobenthic invertebrate communities in the Point Loma region remain characteristic of natural conditions. Analyses of bottom dwelling (demersal) fish and trawl-caught megabenthic invertebrate communities also suggest no spatial or temporal patterns that can be attributed to effects of wastewater discharge, but, instead appear to be related to large-scale oceanographic events (e.g., El Niño conditions in 1998) or specific site locations (e.g., near dredge material disposal sites). Biological conditions do not indicate any environmentally-significant changes associated with the discharge. A balanced indigenous population of shellfish, fish and wildlife exists immediately beyond the ZID.

While significant natural variations in fish populations are observed (in response to factors such as water temperature), the Point Loma wastewater discharge is not having any significant effect on demersal fish assemblages off Point Loma. Fish populations are healthy and lack physical abnormalities such as fin erosion or tumors. Levels of trace metals, chlorinated hydrocarbons, pesticides, and polyaromatic hydrocarbons are relatively low, with concentrations within the range found in fish throughout the southern California Bight. Arsenic, however, is an exception. Elevated levels of arsenic were found in fish species at both outfall and control stations. The source of this arsenic appears to be vents from natural hot springs off the coast of northern Baja California. Overall, no outfall-related effects are evident from bioaccumulation data.

Contaminants in fish tissues in the Point Loma area are similar to those at reference sites beyond the influence of the discharge.

As shown in the preceding table, six of the eight species of great whales that may pass through Point Loma coastal waters are endangered: the blue whale, the fin whale, the humpback whale, the right whale, the sei whale, and the sperm whale. These endangered whales primarily occur in deep water well offshore. The other two great whales, the gray whale and the minke whale, frequent shallower water. Both species were previously listed as endangered but have now recovered and have been delisted. Two other endangered marine mammals, the Guadalupe fur seal and the Steller sea lion, are occasional but uncommon visitors to San Diego offshore waters.

Of the seven species of endangered birds, only the California brown pelican and the California least tern would be regularly encountered in marine waters off Point Loma. Five species of endangered sea turtles occasionally visit Point Loma ocean waters: green, loggerhead, leatherback, olive Ridley, and hawksbill. They forage along the California coast in the summer and early fall but do not nest on west coast beaches of the United States. The two endangered salmon species are uncommon in southern California. Remaining populations of white and black abalone would be well beyond the influence of the Point Loma outfall.

Long-term monitoring shows no evidence of significant effects from operation of the PLOO on environmental conditions or biological communities. Thus, maintaining the existing discharge through the Point Loma outfall should not have an adverse impact on endangered species or threaten their critical habitat.

The City proposes to include the above information and conclusions in its 301(h) application to EPA for renewal of discharge requirements for the Point Loma Ocean Outfall. We would appreciate any comments you may have on the City's 301 (h) application and on our conclusion that the Point Loma Ocean Outfall does not adversely impact threatened or endangered species.

We would also appreciate your updating us on any new species listings or other pertinent information not reflected in the previous correspondence noted above. For your information, we are also contacting the U. S. National Marine Fisheries Service for comments on endangered species under their jurisdiction.

Please call me at (858) 292-6401 or my Deputy, Alan Langworthy, at (619) 758-2300 if you or your staff need any additional information in order to make a determination. Thank you for your assistance.

Sincerely,

Timothy C. Bertch, Ph.D.
Director
Metropolitan Wastewater Department

cc: Rich Haas
Alan Langworthy

THE CITY OF SAN DIEGO • STATE OF CALIFORNIA • SEMPER VIGILANS

Correspondence

National Marine Fisheries Service

THE CITY OF SAN DIEGO

October 29, 2007

Mr. Rodney McInnis
Regional Administrator
National Marine Fisheries Service
Southwest Regional Office
501 West Ocean Boulevard, Suite 4200
Long Beach, CA 90802-4213

Dear Mr. McInnis:

SUBJECT: Request for Comments on Endangered/Threatened Species - Application for Modified Secondary Treatment Requirements City of San Diego Point Loma Ocean Outfall

The City of San Diego is preparing an application to the U.S. Environmental Protection Agency and California Regional Water Quality Control Board requesting renewal of its NPDES permit for the discharge of treated wastewater to the Pacific Ocean via the 23,760-foot-long, 320-foot deep Point Loma Ocean Outfall. The City's application requests renewal of modified secondary treatment requirements for the Point Loma discharge in accordance with provisions of Section 301(h) of the Clean Water Act. The current five-year discharge permit for the modified Point Loma discharge expires in 2008.

The City's 301(h) renewal application will not request any increase in discharge flows or mass emissions. Treatment operations at the Point Loma Wastewater Treatment Plant will be conducted to insure compliance with applicable water quality standards established in the California Ocean Plan.

The City's 301(h) application will follow the format established in 40 CFR 125, Subpart G of the Clean Water Act. The application will, in part, assess compliance with NPDES effluent limits and performance goals established in the current NPDES permit (Order No. 2002-0025, NPDES CA0107409). The application will also address how the City will demonstrate compliance with requirements of the San Diego Basin Plan and California Ocean Plan.

The purpose of this letter is to solicit comments from your agency on whether the discharge would impact threatened or endangered species.

Proposed 301(h) Application

In June 2003, EPA granted a Section 301(h) waiver from secondary treatment to the City of San Diego. The EPA's decision was based on a detailed application demonstrating that the discharge of advanced primary treated wastewater 23,760 feet offshore at a depth of 320 feet was not having a detrimental effect on the ocean environment. An extensive monitoring program continues to verify that the Point Loma discharge protects San Diego's ocean waters and marine life. Secondary treatment waivers need to be renewed every five years. So, the City of San Diego is now applying to renew its' Section 301(h) waiver.

Metropolitan Wastewater Department
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As part of Section II.D.3 of the Large Applicant Questionnaire, the 301(h) application requires the City to identify:

- any threatened or endangered species which may inhabit or obtain nutrients from waters affected by the discharge,
- whether the discharge is consistent with the Endangered Species Act, and,
- whether the discharge will affect threatened or endangered species or their critical habitat.

Previous Findings

As part of the Section 301(h) applications submitted to EPA in 1979 and 1983, the City and EPA contacted the National Marine Fisheries Service (NMFS) for a determination of impacts from the City's original Point Loma discharge approximately 11,500 feet offshore at a depth of 220 feet. In response to these contacts, G. Howard, NMFS Regional Director noted in a February 6, 1980 letter that the following species may migrate through or occasionally visit California coastal waters.

Gray whale, *Eschrichtius robustus*
Humpback whale, *Megaptera novaeangliae*
Right whale, *Balaena glacialis*
Blue whale, *Balaenoptera musculus*
Fin whale, *Balaenoptera physalus*
Sei whale, *Balaenoptera borealis*
Sperm whale, *Physter macrocephalus*
Leatherback sea turtle, *Dermochelys coriacea*
Pacific hawksbill sea turtle, *Eretmochelys imbricata*
Green sea turtle, *Chelonia mydas*
Pacific Ridley sea turtle, *Lepidochelys olivacea*
Loggerhead sea turtle, *Caretta caretta*

In a May 15, 1980 letter from F. Anders (NMFS Acting Regional Director), NMFS expressed principal interest in the gray whale, but noted that no sewage-related disease or contamination of whales had occurred in California. Mr. Anders' letter also stated that compliance with California Ocean Plan water quality objectives would be sufficient for protecting the species from adverse effects. The letter concluded that granting a 301(h) variance would not jeopardize the continued existence of any threatened or endangered species which visit or migrate through California coastal waters. In a letter dated December 7, 1983, Mr. Anders further stated that the gray whale was the only listed species for which NMFS had management responsibility that would likely occur in the vicinity of Point Loma.

In 1991 NMFS conducted an informal Section 7 consultation under the Endangered Species Act as part of environmental planning efforts to extend the Point Loma outfall to its present length of 23,760 feet. In a July 3, 1991 letter, NMFS concluded that populations of marine mammals and endangered or threatened species under NMFS jurisdiction would not be adversely affected by the outfall extension.

In a letter dated March 27, 1995 regarding the City's 1995 Section 301(h) application, Ms. Hilda Diaz-Soltero, NMFS Regional Director, commented that no Federally listed species under the jurisdiction of the NMFS are likely to be affected by the modified discharge at the Point Loma outfall. The list of threatened or endangered species was found to be accurate, except that gray whale is no longer listed under the Endangered Species Act (although it continues to receive protection under the U.S. Marine Mammal Protection Act).

In a letter dated August 10, 1999, Mr. Rodney McInnis, Acting Regional Administrator, NMFS, Southwest Region, commented that based on the offshore distance and depth of the discharge of the wastewater and available scientific information, the National Marine Fisheries Service concludes that there are no Federally listed species under our jurisdiction that are likely to be affected by the modified discharges at the Point Loma outfall. The letter also indicated that the list of endangered and threatened species under NMFS's jurisdiction that may be found off Point Loma is current and correct.

Current Conditions

Twenty-four endangered species covered under the federal Endangered Species Act may occur in the vicinity of Point Loma - eight marine mammals, seven birds, five sea turtles, two fish, and two invertebrates:

Marine Mammals		
Blue Whale	*Balaenoptera musculus*	Endangered
Fin Whale	*Balaenoptera physalus*	Endangered
Humpback Whale	*Meaptera novaeangliae*	Endangered
Right Whale	*Eubalaena japonica*	Endangered
Sei Whale	*Balaenoptera borealis*	Endangered
Sperm Whale	*Physeter macrocephalus*	Endangered
Guadalupe Fur Seal	*Arctocephalus townsendi*	Threatened
Steller Sea Lion	*Eumetopias jubatus*	Threatened
Birds		
California Brown Pelican	*Pelicanus occidentalis californicus*	Endangered
California Least Tern	*Sterna antillarum browni*	Endangered
Light-footed Clapper Rail	*Rallus longirostris levipes*	Endangered
Western Snowy Plover	*Charadrius alexandrinus nivosus*	Threatened
Short-tailed Albatross	*Phoebastria albatrus*	Endangered
Marbled Murrelet	*Brachyramphus marmaoratus*	Threatened
Xantus Murrelet	*Synthliboramphus hypoleucus*	Candidate
Sea Turtles		
East Pacific Green Turtle	*Celonia mydas*	Endangered
Loggerhead Turtle	*Caretta caretta*	Endangered
Leatherback Turtle	*Dermochelys coriacea*	Endangered
Olive Ridley Turtle	*Lepidochelys olivacea*	Endangered
Hawkbill Turtle	*Eretmochelys imbricata*	Endangered
Fish		
Chinook Salmon	*Oncorhynchus tshawytscha*	Endangered
Steelhead	*Oncorhynchus mykiss*	Endangered
Mollusk		
White Abalone	*Haliotis sorenseni*	Endangered
Black Abalone	*Haliotis cracherodii*	Candidate.

The National Marine Fisheries Service and the U.S. Fish and Wildlife Service (FWS) share responsibility for implementing the Endangered Species Act. However, marine mammals, marine turtles, marine fish, and marine invertebrates are managed by NMFS while marine birds are under the jurisdiction of the FWS.

Operation of the Point Loma Ocean Outfall (PLOO) could affect endangered species by altering physical, chemical or biological conditions including: habitat suitability, water quality, biological integrity (e.g., species abundance and diversity), food web dynamics (e.g., availability of prey), or the health of organisms (e.g., bioaccumulation of toxic substances, disease, parasitism).

Monitoring data at Point Loma show effects of the discharge only in deep waters (below the euphotic zone) within or near the Zone of Initial Dilution (ZID) (City of San Diego 2007, Ocean Monitoring: http://www.sandiego.gov/mwwd/environment/oceanmonitor.shtml). Strong local currents and high initial dilution (>200:1) facilitate rapid mixing and dispersion of the effluent. Except in the immediate vicinity of the outfall, where minor alterations in dissolved oxygen, pH, and light transmittance may occur, changes in physical and chemical parameters in surrounding ocean waters have reflected natural alterations in oceanographic processes (e.g., upwelling, plankton blooms) and long-term regime changes like El Niño.

Alterations in sediment quality in the vicinity of the PLOO are only apparent at the station 400 ft from the diffusers. Changes that may be expected near large ocean outfalls, such as coarser sediments and higher sulfide levels have been periodically detected in a small, localized region near the discharge site. The change in grain size may be due to turbulence created as the current flows past the pipe on the bottom, wafting away the finer particles. Although higher sulfide levels that periodically occur adjacent to the outfall are consistent with the deposition of organic material from the discharge, other indicators of organic loading (biochemical oxygen demand, total organic carbon, total nitrogen, total volatile solids) have remained comparable to reference stations.

Concentrations of anthropogenic chemicals in sediments at Point Loma are generally near or below detection limits at all sampling stations, the notable exception being DDE, a breakdown product of the pesticide DDT. DDE, a legacy of historical discharge, is found in sediments throughout southern California. Levels of DDE at Point Loma are low relative to concentrations elsewhere in the southern California. There is no consistent pattern of metal concentrations in the sediments as a function of distance from the outfall. Trace metals are generally at or below detection levels and contaminant loading of sediments is not evident in the discharge vicinity. Sediment chemistry is comparable to reference areas along southern California's outer continental shelf.

Water quality parameters are monitored at stations around the outfall, in the kelp bed, along the shoreline, and at control stations to the north and south. Strong local currents and high initial dilution (>200:1) facilitate rapid mixing and dispersion of the effluent. Changes in physical and chemical parameters in surrounding ocean waters reflect natural alterations in oceanographic processes (e.g., upwelling, plankton blooms) and long-term regime changes like El Niño.

Some descriptors of benthic community structure (e.g., abundance, species diversity) or indicators of environmental disturbance (e.g., brittle star populations) have revealed temporal differences between reference areas and sites nearest the ZID. However, results from environmental disturbance indices such as the Benthic Response Index used to evaluate the condition of benthic assemblages suggest that macrobenthic invertebrate communities in the

Point Loma region remain characteristic of natural conditions. Analyses of bottom dwelling (demersal) fish and trawl-caught megabenthic invertebrate communities also suggest no spatial or temporal patterns that can be attributed to effects of wastewater discharge, but, instead appear to be related to large-scale oceanographic events (e.g., El Niño conditions in 1998) or specific site locations (e.g., near dredge material disposal sites). Biological conditions do not indicate any environmentally-significant changes associated with the discharge. A balanced indigenous population of shellfish, fish and wildlife exists immediately beyond the ZID.

While significant natural variations in fish populations are observed (in response to factors such as water temperature), the Point Loma wastewater discharge is not having any significant effect on demersal fish assemblages off Point Loma. Fish populations are healthy and lack physical abnormalities such as fin erosion or tumors. Levels of trace metals, chlorinated hydrocarbons, pesticides, and polyaromatic hydrocarbons are relatively low, with concentrations within the range found in fish throughout the southern California Bight. Arsenic, however, is an exception. Elevated levels of arsenic were found in fish species at both outfall and control stations. The source of this arsenic appears to be vents from natural hot springs off the coast of northern Baja California. Overall, no outfall-related effects are evident from bioaccumulation data. Contaminants in fish tissues in the Point Loma area are similar to those at reference sites beyond the influence of the discharge.

As shown in the preceding table, six of the eight species of great whales that may pass through Point Loma coastal waters are endangered: the blue whale, the fin whale, the humpback whale, the right whale, the sei whale, and the sperm whale. These endangered whales primarily occur in deep water well offshore. The other two great whales, the gray whale and the minke whale, frequent shallower water. Both species were previously listed as endangered but have now recovered and have been delisted. Two other endangered marine mammals, the Guadalupe fur seal and the Steller sea lion, are occasional but uncommon visitors to San Diego offshore waters.

Of the seven species of endangered birds, only the California brown pelican and the California least tern would be regularly encountered in marine waters off Point Loma. Five species of endangered sea turtles occasionally visit Point Loma ocean waters: green, loggerhead, leatherback, olive Ridley, and hawksbill. They forage along the California coast in the summer and early fall but do not nest on west coast beaches of the United States. The two endangered salmon species are uncommon in southern California. Remaining populations of white and black abalone would be well beyond the influence of the Point Loma outfall.

Long-term monitoring shows no evidence of significant effects from operation of the PLOO on environmental conditions or biological communities. Thus, maintaining the existing discharge through the Point Loma outfall should not have an adverse impact on endangered species or threaten their critical habitat.

The City proposes to include the above information and conclusions in its 301(h) application to EPA for renewal of discharge requirements for the Point Loma Ocean Outfall. We would appreciate any comments you may have on the City's 301 (h) application and on our conclusion that the Point Loma Ocean Outfall does not adversely impact threatened or endangered species.

We would also appreciate your updating us on any new species listings or other pertinent information not reflected in the previous correspondence noted above. For your information, we are also contacting the U. S. National Marine Fisheries Service for comments on endangered species under their jurisdiction.

Please call me at (858) 292-6401 or my Deputy, Alan Langworthy, at (619) 758-2300 if you or your staff need any additional information in order to make a determination. Thank you for your assistance.

Sincerely,

Timothy Bertch

Timothy C. Bertch, Ph.D.
Director
Metropolitan Wastewater Department

cc: Rich Haas
Alan Langworthy

THE CITY OF SAN DIEGO • STATE OF CALIFORNIA
SEMPER VIGILANS

Correspondence

National Marine Fisheries Service

THE CITY OF SAN DIEGO

October 29, 2007

Mr. Rodney McInnis
Regional Administrator
National Marine Fisheries Service
Southwest Regional Office
501 West Ocean Boulevard, Suite 4200
Long Beach, CA 90802-4213

Dear Mr. McInnis:

SUBJECT: Request for Comments on Essential Fish Habitat Assessment -
Application for Modified Secondary Treatment Requirements
City of San Diego Point Loma Ocean Outfall

The City of San Diego is preparing an application to the U.S. Environmental Protection Agency and California Regional Water Quality Control Board requesting renewal of its NPDES permit for the discharge of treated wastewater to the Pacific Ocean via the 23,760-foot-long, 320-foot deep Point Loma Ocean Outfall. The City's application requests renewal of modified secondary treatment requirements for the Point Loma discharge in accordance with provisions of Section 301(h) of the Clean Water Act. The current five-year discharge permit for the modified Point Loma discharge expires in 2008.

The City's 301(h) renewal application will not request any increase in discharge flows or mass emissions. Treatment operations at the Point Loma Wastewater Treatment Plant will be conducted so as to insure compliance with applicable water quality standards established in the California Ocean Plan.

The City's 301(h) application will follow the format established in 40 CFR 125, Subpart G of the Clean Water Act. The application will, in part, assess compliance with NPDES effluent limits and performance goals established in the current NPDES permit (Order No. 2002-0025, NPDES CA0107409). The application will also address how the City will demonstrate compliance with requirements of the San Diego Basin Plan and California Ocean Plan.

The purpose of this letter is to solicit concurrence from your agency that the proposed discharge would not adversely effect Essential Fish Habitat.

Proposed 301(h) Application

In June 2003, EPA granted a Section 301(h) waiver from secondary treatment to the City of San Diego. The EPA's decision was based on a detailed application demonstrating that the discharge of advanced primary treated wastewater 23,760 feet offshore at a depth of 320 feet was not having a detrimental effect on the ocean environment. An extensive monitoring program continues to verify that the Point Loma discharge protects San Diego's ocean waters and marine

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life. Secondary treatment waivers need to be renewed every five years. So, the City of San Diego is now applying to renew its' Section 301(h) waiver.

Essential Fish Habitat Assessment

The marine environment in the vicinity of Point Loma supports a wide variety of commercial fisheries. These fisheries are protected and managed by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) through its "Essential Fish Habitat" provisions. The Beneficial Use Appendix of the City of San Diego's 301(h) application will contain an Essential Fish Habitat (EFH) Assessment covering the environmental setting, regulatory background, Fishery Management Plans, species descriptions, life history profiles, the project area, proposed actions, and potential impacts of the Point Loma ocean outfall. The EFH Assessment is summarized below.

The Fisheries Management Plans (FMPs) for species that could occur in the Point Loma area are the Pacific Groundfish FMP (83 species) (Pacific Fishery Management Council (PFMC) 2006a), the Coastal Pelagic Species (CPS) FMP (6 species) (PFMC 2003, 2005), and the U.S. West Coast Fisheries for Highly Migratory Species (HMS) (13 species) (PFMC 2006b, 2007b) (Table 1).

Table 1. Federal Fishery Management Plans Covering the SCB.

Groundfish Management Plan Species
http://www.pcouncil.org/groundfish/gffmp.html
Flatfish
Arrowtooth flounder *(Atheresthes stomias)*
Butter sole *(Isopsetta isolepis)*
Curlfin sole (*Pleuronichthys decurrens*)
Dover sole (*Microstomus pacificus*)
English sole (*Parophrys vetulus*)
Flathead sole *(Hippoglossoides elassodon)*
Pacific sanddab (*Citharichthys sordidus*)
Petrale sole (*Eopsetta jordani*)
Rex sole (*Glyptocephalus zachirus*)
Rock sole (*Lepidopsetta bilineata*)
Sand sole (*Psettichthys melanostictus*)
Starry flounder (*Platichthys stellatus*)
Rockfish
Aurora rockfish (*Sebastes aurora*)
Bank rockfish (*Sebastes rufus*)
Black rockfish (*Sebastes melanops*)
Black-and-yellow rockfish (*S. chrysomelas*)
Blackgill rockfish (*Sebastes melanostomus*)
Blue rockfish (*Sebastes mystinus*)
Bocaccio (*Sebastes paucispinis*)
Bronzespotted rockfish (*Sebastes gilli*)
Brown rockfish (*Sebastes auriculatus*)
Calico rockfish (*Sebastes dallii*)
Canary rockfish (*Sebastes pinniger*)
Chameleon rockfish (*Sebastes phillipei*)
Chilipepper (*Sebastes goodei*)

Groundfish Species cont.
Squarespot rockfish (*Sebastes hopkinsi*)
Starry rockfish (*Sebastes constellatus*)
Stripetail rockfish (*Sebastes saxicola*)
Swordspine rockfish (*Sebastes ensifer*)
Tiger rockfish (*Sebastes nigrocinctus*)
Treefish (*Sebastes serriceps*)
Vermillion rockfish (*Sebastes miniatus*)
Widow rockfish (*Sebastes entomelas*)
Yelloweye rockfish (*Sebastes ruberrimus*)
Yellowmouth rockfish (*Sebastes reedi*)
Yellowtail rockfish (*Sebastes flavidus*)
Scorpionfish
Ca. scorpionfish (*Scorpaena guttatta*)
Thorneyheads
Longspine thornyhead (*Sebastolobus altivelis*)
Shortspine thornyhead (*S. alascanus*)
Roundfish
Cabezon (*Scorpaenichthvs marmoratus*)
Kelp greenling (*Hexagrammos decagrammus*)
Lingcod (*Opiodon elongatus*)
Pacific cod (*Gadus macrocephalus*)
Pacific hake (*Merluccius productus*)
Sablefish (*Anoplopoma fimbria*)
Skates, Sharks and Chimeras
Big skate (*Raja binoculata*)
California skate (*Raja inornata*)
Finescale codling *(Antimora microlepis)*

China rockfish (*Sebastes nebulosus)*
Copper rockfish (*Sebastes caurinus*)
Cowcod (*Sebastes levis*)
Darkblotched rockfish (*Sebastes crameri*)
Dusky rockfish (*Sebastes ciliatus*)
Dwarf-red rockfish (*Sebastes rufinanus*)
Flag rockfish (*Sebastes rubrivinctus*)
Freckled rockfish (*Sebastes lentiginosus*)
Gopher rockfish (*Sebastes carnatus*)
Grass rockfish (*Sebastes rastrelliger*)
Greenblotched rockfish (*Sebastes rosenblatti*)
Greenspotted rockfish (*Sebastes chlorostictus*)
Greenstriped rockfish (*Sebastes elongatus*)
Half-banded rockfish (*Sebastes semicinctus*)
Harlequin rockfish (*Sebastes variegates*)
Honeycomb rockfish (*Sebastes umbrosus*)
Kelp rockfish (*Sebastes atrovirensnus*)
Mexican rockfish (*Sebastes macdonaldi*)
Olive rockfish (*Sebastes serranoides*)
Pacific ocean perch (*Sebastes alutus*)
Pink rockfish (*Sebastes eos*)
Pinkrose rockfish (*Sebastes simulator*)
Puget Sound rockfish (*Sebastes emphaeus*)
Pygmy rockfish (*Sebastes wilsoni*)
Quillback rockfish (*Sebastes maliger*)
Redbanded rockfish (*Sebastes babcocki*)
Redstripe rockfish (*Sebastes proriger*)
Rosethorn rockfish (*Sebastes helvomaculatus*)
Rosy rockfish (*Sebastes rosaceus*)
Rougheye rockfish (*Sebastes aleutianus*)
Semaphore rockfish (*Sebastes melanosema*)
Sharpchin rockfish (*Sebastes zacentrus*)
Shortbelly rockfish (*Sebastes jordani*)
Shortraker rockfish (Sebastes borealis)
Silvergray rockfish (*Sebastes brevispinis*)
Speckled rockfish (*Sebastes ovalis*)

Leopard shark (*Triakis semifasciata*)
Longnose skate (*Raja rhina*)
Pacific rattail (*Coryphaenoides acrolepis)*
Soupfin shark (*Galeorhinus zyopterus*)
Spiny dogfish (*Squalus acanthias*)
Spotted ratfish (*Hydrolagus colliei*)

Coastal Pelagic Management Plan Species
http://www.pcouncil.org/cps/cpsfmp.html
Jack mackerel (*Traxchurus symmetricus*)
Krill (euphausiids)
Pacific mackerel (*Scomber japonicus*)
Pacific sardine(*Sardinops sagax*)
Market squid (*Loligo opalescens*)
Northern anchovy (*Engraulis mordax*)

Highly Migratory Management Plan Species
http://www.pcouncil.org/hms/hmsfmp.html
Sharks
Bigeye thresher shark (*Alopias superciliosus*)
Blue shark (*Prionace glauca*)
Common thresher shark (*Alopias vulpinus*)
Pelagic thresher shark (*Alopias pelagicus*)
Shortfin mako shark (*Isurus oxyrinchus*)
Tunas
Albacore tuna (*Thunnus alalunga*)
Bigeye tuna (*Thunnus obesus*)
Northern bluefin tuna (*Thunnus orientalis*)
Skipjack tuna (*Katsuwonus pelamis*)
Yellowfin tuna (*Thunnus albacares*)
Billfish
Striped marlin (*Tetrapturus audax*)
Swordfish
Broadbill swordfish (*Xiphias gladius*)
Dolphin-fish
Dorado (mahi mahi) (*Coryphaena hippurus*)

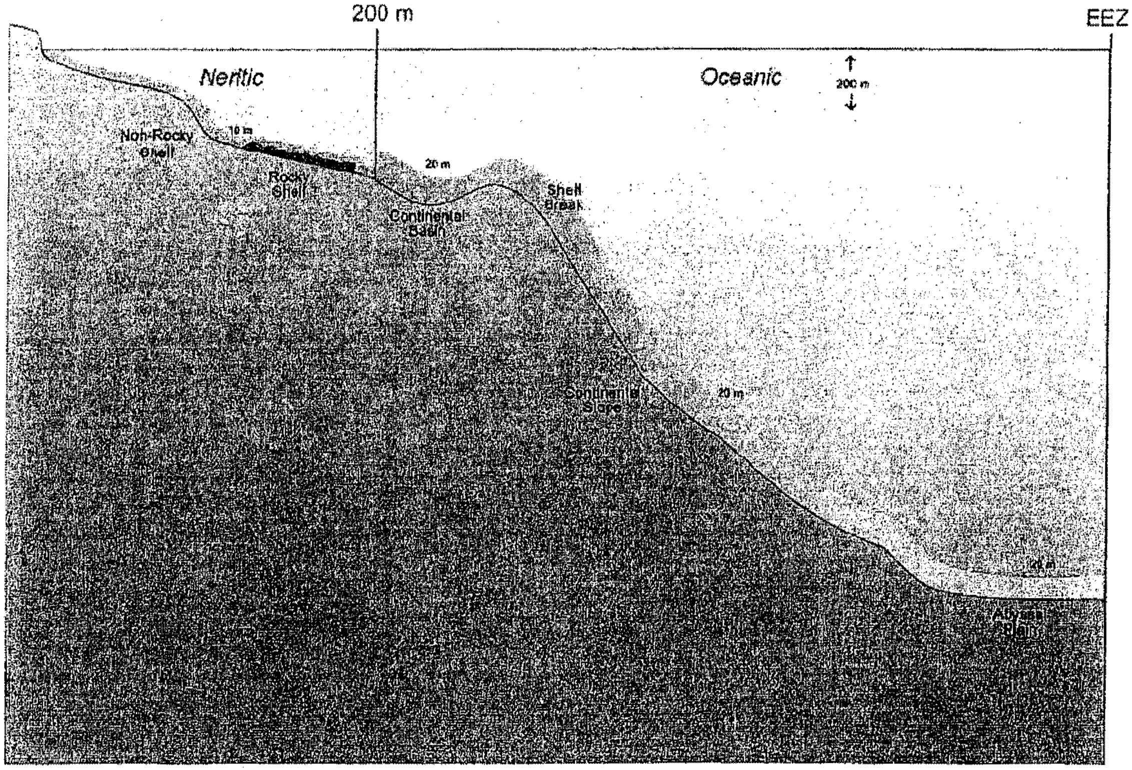
Source: NMFS 2005a, PFMC 2003, 2005, 2006a,b, 2007a,b.

Under the MSFCMA, the federal government has jurisdiction to manage fisheries in the U.S. EEZ which extends from the outer boundary of state waters (3 nautical miles (nm) (5.6 kilometers (km)) from shore) to a distance of 200 nm (370 km) from shore. Offshore fisheries in southern California ocean waters are managed by the National Marine Fisheries Service (NMFS) with assistance from the PFMC (PFMC 2007a), and the Southwest Fisheries Science Center (National Oceanic and Fisheries Administration (NOAA)) (NOAA 2007a,b). Inshore fisheries (less than 3 nm (5.6 km) from shore) are managed by the California Department of Fish and Game (CDFG) (CDFG 2007a,b) through the Nearshore Fishery Management Plan. However, in practice, state and federal fisheries agencies manage fisheries cooperatively and FMPs generally cover the area from coastal estuaries out to 200 nm (370 km) offshore.

The National Marine Fisheries Service and the Pacific Fishery Management Council designate Essential Fish Habitat and develop Fishery Management Plans for fisheries occurring within the boundary of the EEZ in the Southern California Bight (SCB) from Point Conception to the U.S./Mexico border. The MSFCMA contains provisions for identifying habitat essential to federally Managed Species (i.e., species covered under FMPs). The FMPs identify EFH, describe EFH impacts (fishing and non-fishing), and suggest measures to conserve and protect EFH. A second habitat type is also protected: Habitat Areas of Particular Concern (HAPC). These subsets of EFH are rare, sensitive, ecologically important, or located in an area that is already stressed.

The Pacific Groundfish FMP divides EFH into seven composite habitats including their waters, substrates, and biological communities: 1) estuaries - coastal bays and lagoons, 2) rocky shelf - on or within 33 ft (10 m) of rocky bottom (excluding canyons) from the high tide line to the continental shelf break, 3) nonrocky shelf - on or within 33 ft (10 m) of unconsolidated bottom (excluding the rocky shelf and canyons) from the high tide line to the continental shelf break, 4) canyon - submarine canyons, 5) continental slope/basin - on or within 66 ft (20 m) of the bottom of the continental slope and basin below the shelf break extending to the westward boundary of the EEZ, 6) neritic zone - the water column more than 33 ft (10 m) above the continental shelf, and 7) oceanic zone - the water column more than 66 ft (20 m) (wide yellow band above) above the continental slope and abyssal plain, extending to the westward boundary of the EEZ (PFMC 2006a) (Figure 1, from DON 2005).

Figure 1. Pacific Coast Groundfish Locations.



The groundfish species managed by the Pacific Groundfish FMP range throughout the EEZ and occupy diverse habitats at all stages in their life histories (Table 2). Some species are broadly dispersed during specific life stages, especially those with pelagic eggs and larvae. The distribution of other species and/or life stages may be relatively limited, as with adults of many nearshore rockfish which show strong affinities to a particular location or substrate type.

Table 2. Groundfish Species Essential Fish Habitat.

Pacific Groundfish Species EFH and Lifestages Associated With the Seven EFH Designations. A = Adults, SA = Spawning Adults, MA = Mating Adults, LJ = Large Juveniles, SJ = Small Juveniles, J = Juveniles, L = Larvae, E = Eggs, P = Parturition (PFMC 2006a). * = Associated with macrophytes, algae, or seagrass. (from DON 2005).

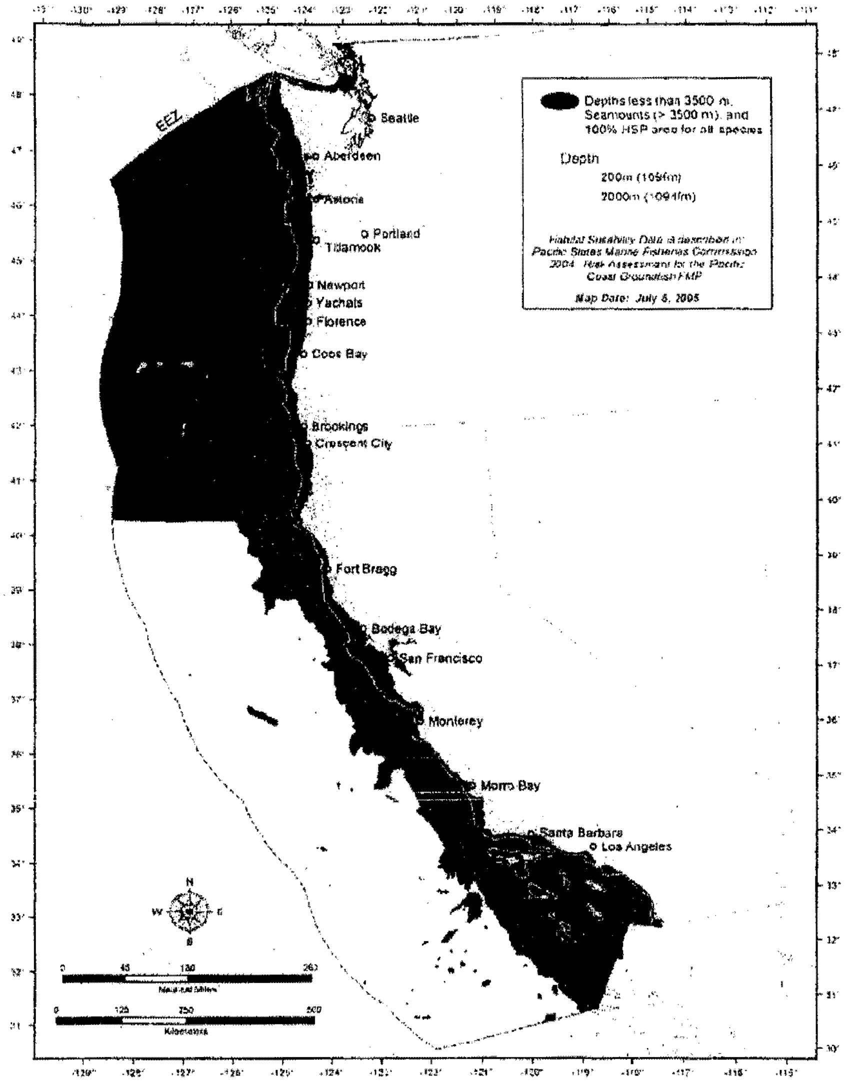
Group/Species	Estuarine	Rocky Shelf	Non-Rocky Shelf	Neritic	Canyon	Continental Slope/Basin	Ocean
Flatfish							
Curlfin Sole			A, SA	E		A, SA	E
Dover Sole			A, SA, J	L, E		A, SA, J	L, E
English Sole	A*, SA, J*, L*, E	A*, SA, J*	A*, SA, J*	L*, E		A*	
Petrale Sole			A, J	L, E		A, SA	L, E
Rex Sole	A		A, SA	E		A, SA	L, E
Rock Sole		A*, SA*, J*, E*	A*, SA*, J*, E*	L		A*, SA*, J*, E*	
Sand Sole			A, SA, J	L, E			
Pacific Sanddab	J, L, E		A*, SA, J	L, E			L, E
Rockfish							
Aurora Rockfish			A, MA, LJ			A, MA, LJ	L
Bank Rockfish		A, J	A, J		A, J	A, J	
Black Rockfish	A*, SJ*	LJ*	LJ*	A*, SJ*			A*
Black-and-yellow Rockfish		A*, MA, LJ*, SJ*, P		L*			
Blackgill Rockfish		LJ		SJ, L		A, LJ	S, LJ
Blue Rockfish		A*, MA, LJ*	LJ*	SJ*,L			
Bocaccio	SJ*, L	A*, LJ*	A*, LJ*	SJ*, L	LJ*	A*, LJ*	
Bronzespotted Rockfish						A	
Brown Rockfish	A*, MA, J*, P	A*, MA, J*, P					
Calico Rockfish	A, J	A, J	A, J				
Canary Rockfish		A, P		SJ*, L		A, P	SJ*, L
Chilipepper		A, LJ, P	A, LJ, P	SJ*, L		A, LJ, P	
China Rockfish		A, J, P		L			
Copper Rockfish	A*, LJ*, SJ*, P	A*, LJ*		SJ*, P			
Cowcod		A, J	J	L			
Darkblotched Rockfish		A, MA, LJ, P	A, MA, LJ, P			A, MA, P	SJ, L
Flag Rockfish		A, P					

Gopher Rockfish		A*, MA, J*, P	A*, A, J*, P				
Grass Rockfish		A*, J*, P					
Greenblotched Rockfish		A, J, P	A, J, P		A, J, P	A, P	
Greenspotted Rockfish		A, J, P	A, J, P				
Greenstriped Rockfish		A, P	A, P				
Honeycomb Rockfish		A, J, P			J		
Kelp Rockfish	SJ*	A*, LJ*, P		SJ*			
Mexican Rockfish		A	A	L			L
Olive Rockfish		A*, J*, P			A*, P		
Pacific Ocean Perch		A, LJ	A, LJ	SJ	A	A, P	SJ, L
Pink Rockfish		A	A			A	
Redbanded Rockfish			A			A	
Redstripe Rockfish		A, P				A, P	
Rosethorn Rockfish		A, P	A, P			A, P	
Rosy Rockfish		A, J, P					
Rougheye Rockfish		A	A			A	
Sharpchin Rockfish		A, P	A, P			A, P	L
Shortbelly Rockfish		A*, P	A*, P		A*, P	A*, P	
Silverygray Rockfish		A*	A*			A*	
Speckled Rockfish		A, J, P			A, P	A, P	
Splitnose Rockfish			A, J*, P			A, P	
Squarespot Rockfish		A, P			A, P		
Starry Rockfish		A, P				A, P	
Stripetail Rockfish			A, P			A, P	
Tiger Rockfish		A				A	
Treefish		A					
Vermilion Rockfish		A, J*	J*		A	A	
Widow Rockfish		A, MA, LJ,P	A, MA, LJ, P	SJ*, L	A, MA, LJ, P	A, MA, P	SJ*, L
Yelloweye Rockfish		A, P				A, P	
Yellowtail Rockfish		A, MA, LJ, P	A, MA, LJ, P	SJ*		A, MA, P	SJ*
<u>Scorpionfish</u>							
California Scorpionfish	E	A, SA, J	A, SA, J	E			
<u>Thornyhead</u>							
Longspine Thornyhead						A, SA, J	L, E
Shortspine Thornyhead			A			A, SA	L, E
<u>Roundfish</u>							
Cabezon	A, SA, LJ, SJ*, L, E	A, SA, LJ, E		SJ*, L			SJ*, L
Kelp Greenling	A*, SA, LJ*, SJ*, L, E	A*, SA, LJ*, E		SJ*, L			SJ*, L

Lingcod	A*, SA, LJ*, SJ*, L, E	A*, SA, LJ*, E	A*, LJ*	SJ*, L		A*	
Pacific Cod	A, SA, J, L, E		A, SA, J, E	A, SA, J, L		A, SA, E	A, SA, J, L
Pacific Flatnose					A	A	
Pacific Grenadier			A, SA, J			A, SA, J	L
Sablefish	SJ	A	A, LJ	SJ, L	A, LJ	A, SA	SJ, L, E
Skates/Sharks/ Chimeras							
Big Skate			A, MA, J, E			A, MA	
California Skate	A, MA, J, E		A, MA, J, E			Pacific Hake (Whiting)	A, SA, J, L, E
Longnose Skate			A, MA, J, E			A, MA, J, E	
Leopard Shark	A, MA, J, P	A, MA, J, P	A, MA, J, P	A, MA, J, P			
Soupfin Shark	A, MA, J, P	A, MA, J	A, MA, J, P	A, MA, J, P	A, MA, J		A, MA, J
Spiny Dogfish	A, LJ, SJ, P	A, MA, LJ	A, LJ, P	A, LJ, SJ	A	A, MA	A
Spotted Ratfish	A, MA, J	A, MA, J E	A, MA, J E			A, MA, J, E	

The Groundfish Management Plan designates EFH for Managed Species as: all waters and substrate within the following areas; 1) depths less than or equal to 11,483 ft (3,500 m) to mean higher high water level or the upriver extent of saltwater intrusion, 2) seamounts in depths greater than 11,483 ft (3,500 m), and 3) areas designated as HAPCs not already identified by the above criteria (Figure 2, from PFMC 2006a).

Figure 2. Groundfish EFH.



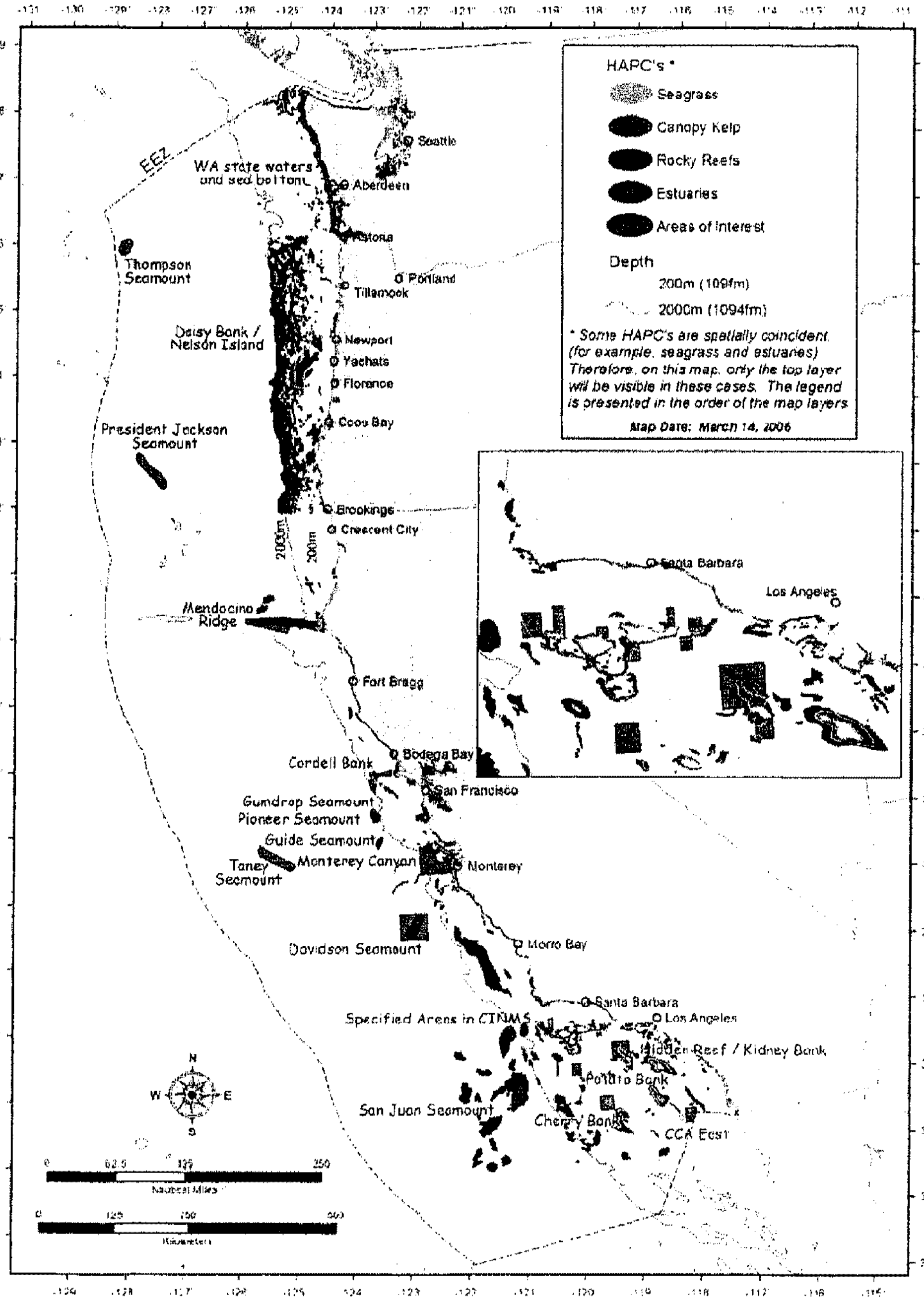
The Pacific Fisheries Management Council has identified five HAPC types: estuaries, canopy kelp, seagrass, rocky reefs, and "areas of interest" (e.g., submarine features, such as banks, seamounts, and canyons) (Table 3, Figure 3, from PFMC 2006a).

Table 3. EFH and HAPCs in the SCB.

Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPCs) (NMFS 2005a, PFMC 2003, 2005, 2006a,b, 2007a,b).		
	EFH	HAPCs
Pacific Groundfish	Marine and esturarine waters less than or equal to 11,483 ft (3,500 m) to mean higher high water level or the upwater extent of seawater intrusion, seamounts in depths greater than 3,500 m, and areas designated as HAPCs not identified by the above criteria.	Estuaries, canopy kelp, sea grass, rocky reefs, and other areas of interest.
Coastal	All marine and estuarine waters above the thermocline	No HAPCs

Pelagic Species	from the shoreline offshore to 200 nm offshore.	designated.
Highly Migratory Species	All marine waters from the shoreline offshore to 200 nm offshore.	No HAPCs designated.

Figure 3. Groundfish HAPCs.



Essential Fish Habitat identified for Managed CPS is wide-ranging. It includes the geographical range where they are currently found, have been found in the past, and may be found in the future

(PFMC 2003, 2005). In the SCB, the CPS EFH constitutes all marine and estuarine waters above the thermocline from the shoreline offshore to the limits of the EEZ with no HAPCs designated (PFMC 2005). The thermocline is an area in the water column where water temperature changes rapidly, usually from colder at the bottom to warmer on top. The CPS live near the surface primarily above the thermocline, and within a few hundred miles of the coast, so their designated EFH (Table 4) is less complex than for Groundfish Managed Species.

Table 4. Coastal Pelagic Species Essential Fish Habitat.

Coastal Pelagic Species and Lifestages Associated with EFH designations. A = Adults, J = Juveniles, L = Larvae, E = Eggs. (PFMC 2003, 2005).			
Group/Species	Coastal epipelagic	Coastal mesopelagic	Coastal benthic
Krill	E, L, J, A		
Northern anchovy	E, L, J, A		
Mackerels	E, L, J, A		
Sardine	E, L, J, A		
Market Squid	L, J, A		E

EFH for Highly Migratory Species (Table 5) such as tuna, sharks and billfish is even more extensive than for CPS (PFMC 2006b, 2007b). HMS travel widely in the ocean, both in terms of area and depth. They are usually not associated with the features typically considered fish habitat (estuaries, seagrass beds, rocky bottoms). Their habitat selection appears to be less related to physical features and more to temperature ranges, salinity levels, oxygen levels, and to currents. For the U.S. West Coast Fisheries for Highly Migratory Species, EFH occurs throughout the SCB (PFMC 2006b, 2007b). The PFMC has currently identified no HAPC for HMS.

Table 5. Highly Migratory Species Essential Fish Habitat.

Highly Migratory Species and Lifestages Associated with EFH Designations. A = Adults, SA = Sub-Adults, LJ = Late Juveniles, N= Neonate, EJ = Early Juveniles, J = Juveniles, L = Larvae, E = Eggs. (PFMC 2006b, 2007b).				
Group/Species	Coastal epi-pelagic	Coastal meso-pelagic	Oceanic epi-pelagic	Oceanic meso-pelagic
Sharks				
Blue Shark			N, EJ, LJ, SA, A	
Shortfin Mako			N, EJ, LJ, SJ, A	
Thresher Sharks	LJ, SA, A	LJ, SA, A	LJ, SA, A	LJ, SA, A
Tunas				
Albacore			J, A	
Bigeye Tuna			J, A	J, A
Northern Bluefin			J	
Skipjack			A	
Yellowfin			J	
Billfish				
Striped Marlin			A	
Swordfish				
Broadbill Swordfish			J, A	J, A
Dolphinfish				
Dorado			J, SA, A	

Essential Fish Habitat regulations require analysis of potential impacts that could have an adverse effect on EFH and Managed Species (NMFS 2007a). Adverse effect is defined as any impact which reduces the quality and/or quantity of essential fish habitat (NMFS 2004a,b). Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (NMFS 2004a,b).

The EFH regulations in 50 CFR 600.815(a)(2)(ii) (NMFS 2002a) establish a threshold for determining adverse effects (NMFS 2002b). Adverse effects are more than minimal and not temporary in nature. Temporary effects are those that are limited in duration and allow the particular environment to recover without measurable impact (NMFS 2002b). Minimal effects are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions. Whether an impact is minimal will depend on a number of factors including: the intensity of the impact at the specific site being affected, the spatial extent of the impact relative to the availability of the habitat type affected, the sensitivity/vulnerability of the habitat to the impact, the habitat functions that may be altered by the impact (e.g., shelter from predators), and the timing of the impact relative to when the species or life stage need the habitat. Thus, for Essential Fish Habitat and Managed Species an adverse effect is: 1) more than minimal, 2) not temporary, 3) causes significant changes in ecological function, and, 4) does not allow the environment to recover without measurable impact.

The Point Loma Ocean Outfall (PLOO) could have two types of effects on fisheries: physical impacts associated with the presence of the pipeline and diffusers on the ocean bottom, and biological impacts associated with the discharge of treated wastewater.

Physical Impacts

The Point Loma outfall pipeline is buried in a trench through the surf zone out to a distance of about 2,600 ft offshore. Over the next 400 ft it gradually emerges from the trench and beyond 3,000 feet offshore it lies in a bed of ballast rock on the ocean floor. At its terminus, the pipeline connects to the diffuser section with two legs, each 2,500 ft long. The outfall pipe and diffusers with their supporting bed of ballast rock form an artificial reef. The pipe and rock, covered with encrusting organisms (tube worms, anemones, barnacles), provide food and shelter to a variety of fish and invertebrates (Wolfson and Glinski 1986). This artificial habitat covers an area of about 22 acres off Point Loma (assuming a 36-ft width of pipe and ballast rock). Catches of rockfish could be enhanced over this area, but would probably be too small to be discernable in recreational or commercial landings.

The pipeline and diffusers, however, represent a potential hazard to commercial fishermen using traps that can snag on the pipe and ballast rock. Lobster, crab, and fish traps are used throughout the area. Since the location of the pipeline and diffusers is well-marked on navigation charts and commercial vessels are equipped with accurate positioning systems, it is possible to place fishing gear a safe distance away. Nevertheless, commercial trap fishermen target the pipe area, apparently choosing to risk higher gear-loss for a better yield per trap next to the high-relief rocky habitat created by the pipe and ballast rock.

Biological Impacts

Long-term research carried out in the Point Loma kelp bed has not revealed any discharge-related effects (see publications by Dayton, Tegner, and associates in References). Nor is there any suggestion in the historical fisheries catch of outfall impacts. These studies and data sets were not designed to elucidate outfall effects. The Point Loma monitoring program is, however, intended to do precisely that. The following section briefly reviews monitoring program results related to the impact on fisheries.

The discharge of treated wastewater at Point Loma could affect fisheries species by altering water or sediment quality. Water quality parameters are monitored at stations around the outfall, in the kelp bed, along the shoreline, and at control stations to the north and south (COSD (City of San Diego) 2002-2007). Strong local currents and high initial dilution (>200:1) facilitate rapid mixing and dispersion of the effluent. Except in the immediate vicinity of the outfall, where minor alterations in dissolved oxygen, pH, and light transmittance may occur, changes in physical and chemical parameters in surrounding ocean waters have reflected natural alterations in oceanographic processes (e.g., upwelling, plankton blooms) and long-term regime changes like El Niño.

Unlike dissolved components of the wastewater that are swept away by the currents, particles discharged from the outfall may settle to the ocean floor. This can change the grain size and organic content of the sediments which in turn affects the abundance and diversity of marine organisms living there. Contaminants can also be introduced since many of the potentially harmful chemicals in wastewater are bound to particles.

Alterations in sediment quality in the vicinity of the PLOO are only apparent at the station 400 ft from the wye diffusers, where coarser sediments and higher sulfide levels have been periodically detected (COSD 2002-2007). The change in grain size may be due to turbulence created as the current flows past the pipe on the bottom, wafting away the finer particles (Diener et al. 1997). Although higher sulfide levels that periodically occur adjacent to the outfall are consistent with the deposition of organic material from the discharge, other indicators of organic loading (biochemical oxygen demand, total organic carbon, total nitrogen, total volatile solids) are low relative to reference stations.

Concentrations of anthropogenic chemicals in sediments at Point Loma are generally near or below detection limits at all sampling stations, the notable exception being DDE, a breakdown product of the pesticide DDT. DDE, a legacy of historical discharge, is found in sediments throughout southern California (Mearns et al. 1991, Noblet et al. 2002). Levels of DDE at Point Loma are low relative to concentrations elsewhere in the southern California Bight (COSD 2002-2007).

There is no consistent pattern of metal concentrations in the sediments as a function of distance from the outfall - the highest levels of iron, aluminum, and copper are found at the northern reference stations. Trace metals are generally at or below detection levels.

Changes in sediment quality should also be reflected in the types of species living on and in the sediment. Two elements of the monitoring program provide this type of information: 1) benthic infauna, and 2) demersal (bottom-dwelling) fish and megabenthic invertebrates. Benthic infauna are collected by taking grab samples of the bottom. Demersal fish and invertebrates are gathered by trawling across the bottom. Living in close association with the sediments, these groups are classic indicators of altered conditions. Also, many important fisheries species live on the bottom and/or feed there.

The infaunal community around the outfall is dominated by an ophiuroid-polychaete assemblage typical of this depth and sediment type in southern California (Bergen et al. 2000, Ranasinghe et al. 2003). Changes that have occurred in the soft-bottom maroinvertebrate assemblage surrounding the outfall are mainly related to large-scale oceanographic events like El Niño (Zmarzly et al. 1994). However, there is some indication of discharge effect at the monitoring station closest to the outfall (COSD 2002-2007). Abundance of the ophiuroid *Amphiodia* which is sensitive to organic enrichment has decreased, although this has not been the case for other pollution sensitive species. Other changes in community structure suggest that the impact may be due to the presence of the outfall structure itself, rather than the influence of discharged wastewater (Posey and Ambrose 1994, Diener et al. 1997). Whatever the reason, infaunal communities near the Point Loma outfall remain similar to those observed prior to discharge and are comparable to natural indigenous communities.

Trawl samples at Point Loma are dominated by small flatfish and sea urchins. Though inherently more variable than infaunal data, the trawl data also indicate that normal oceanographic processes control the abundance and diversity of demersal fish and megabenthic invertebrates living around the outfall (COSD 2002-2007). Patterns in abundance, biomass, and species composition have remained stable since monitoring began. The fish collected by trawling are healthy, with few parasites and a low level or absence of fin rot, tumors, and other physical abnormalities.

One of the most important elements of the Point Loma monitoring program from the fisheries perspective is the measurement of chemical contaminants in fish tissues. Fish can accumulate pollutants from: 1) absorption of dissolved chemicals in the water, 2) ingestion of contaminated suspended particles or sediment particles, and 3) ingestion of contaminated food (Allen 2006, Allen et al. 2007). Incorporation of contaminants into an organism's tissue is called bioaccumulation. Contaminants can also be concentrated as they are passed through the food web when higher trophic level organisms feed on contaminated prey. Bioaccumulation has potential ecological and human health implications (OEHHA (California Office of Environmental Health Hazard Assessment) 2007a,b).

The PLOO monitoring program targets two types of fish for assessment of contaminant levels: flatfish and rockfish. Samples are taken at various distances from the outfall and at control stations to the north and south. Flatfish and rockfish at Point Loma have concentrations of metals in liver and muscle tissue characteristic of values detected throughout the southern California Bight (Mearns et al. 1991, Allen et al. 1998, 2002, 2007). Arsenic, however, is an exception. Elevated levels of arsenic were found in fish species at both outfall and control stations. The source of this arsenic appears to be vents from natural hot springs off the coast of northern Baja California. There is no apparent relationship between higher metal levels and proximity to the outfall. A variety of man-made compounds including DDT (and its derivatives) and PCBs are routinely found in fish tissue throughout the area. These chlorinated hydrocarbons are ubiquitous in southern California, but their concentration in sediments and organisms is steadily decreasing in most areas (Mearns et al. 1991, Allen et al. 1998, 2002, 2007). Samples taken near the outfall do not have higher levels of DDT and PCBs than reference samples.

The United States Food and Drug Administration has established limits for the concentration of mercury and DDT in seafood sold for human consumption (Mearns et al. 1991). Muscle tissue levels in flatfish and rockfish at Point Loma are consistently below these limits. There have been no warnings, advisories, harvest closures, or, restrictions on seafood taken from the Point Loma area.

Cumulative impacts are defined in the National Environmental Protection Act (NEPA) (42 USC § 4321 *et seq*. and 32 CFR 775 respectively) as: the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future action regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 CFR § 1508.7)

The discharge of wastewater from commercial activities, including municipal wastewater treatment plants, power generating stations, industrial plants (e.g., desalination plants), and storm water from drains into open ocean waters, bays, or estuaries can introduce chemical constituents potentially detrimental to estuarine and marine habitats. These constituents include pathogens, nutrients, sediments, heavy metals, oxygen demanding substances, hydrocarbons, and toxics. Historically, wastewater discharges have been one of the largest sources of contaminants into coastal waters. However, wastewater discharges have been regulated under increasingly stringent requirements over the last 25 years and mass emissions of most constituents have been significantly reduced (SCCWRP (Southern California Coastal Research Project) 2003, 2006). Nonpoint source/storm water runoff, on the other hand, has not been regulated to the same degree and continues to be a substantial remaining source of contamination to the coastal areas and ocean.

Human uses of the Point Loma area include swimming, surfing, snorkeling, SCUBA diving and other recreational sports, recreational and commercial fishing, mariculture, cruising, whale-watching, research and education, wastewater discharge, military activity, navigation, and shipping. Potential threats to EFH and Managed Species include degradation of water quality, habitat modification, pollution (chemicals, marine debris, etc.), introduction of exotic species, disease, natural events, and global climate change (Field et al. 2003, Jackson et al. 2001, IEF (In Ex Fishing) 2006).

In addition, fishing and non-fishing activities, individually or in combination, can adversely affect EFH and Managed Species (NOAA 1998, Dayton et al. 2003, Morgan and Chuenpagdee 2003, Hanson et al. 2003). Potential impacts of commercial fishing include over-fishing of targeted species and bycatch, both of which negatively affect fish stocks (Barnette 2001, NRC 2002, Dieter et al. 2003). Mobile fishing gears such as bottom trawls (now prohibited to deeper than 3,500 ft) disturb the seafloor and reduce structural complexity (Auster and Langton 1998, Johnson 2002). Indirect effects of trawls include increased turbidity; alteration of surface sediment, removal of prey (leading to declines in predator abundance), removal of predators, ghost fishing, and generation of marine debris (Hamilton 2000). Lost gill nets, purse seines, and long-lines may foul and disrupt bottom habitats. Recreational fishing also poses a threat because of the large number of participants and the intense, concentrated use of specific habitats (Coleman et al. 2004)

Natural stresses include storms and climate-based environmental shifts, such as harmful algal blooms and hypoxia (Scholin et al. 2000, IEF 2006). Disturbance from ship traffic and exposure to biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them vulnerable to parasites and diseases that would not normally compromise natural activities or be fatal (Pew Oceans Commissions 2003).

A number of factors influence water quality and biological conditions in the Point Loma area. Key potential influences on water quality include the Point Loma treated wastewater discharge, regional non-point source discharges, local river outflows, and other local non-point sources such as harbors, marinas, storm drains, and urban runoff.

The effects of the Point Loma discharge on water quality and biological conditions are evident only in deep waters (below the euphotic zone) within or near the Zone of Initial Dilution (ZID). Organic enrichment of the sediments due to the outfall discharge is not occurring beyond the ZID. Contaminant loading of sediments is not evident in the discharge vicinity. Sediment chemistry is comparable to reference areas along southern California's outer continental shelf. Biological conditions do not indicate any environmentally-significant changes associated with the discharge. A balanced indigenous population of shellfish, fish and wildlife exist immediately beyond the ZID.

While significant natural variations in fish populations are observed (in response to factors such as water temperature), the Point Loma wastewater discharge is not having any significant effect on demersal fish assemblages off Point Loma. Fish populations are healthy and lack physical abnormalities such as fin erosion or tumors. Levels of trace metals, chlorinated hydrocarbons, pesticides, and polyaromatic hydrocarbons are relatively low, with concentrations within the range found in fish throughout the Southern California Bight. Overall, no outfall-related effects are evident from bioaccumulation data. Contaminants in fish tissues in the Point Loma area are similar to those at reference sites beyond the influence of the discharge.

The incremental contribution by the proposed action on the marine environment is expected to be insignificant. There would not be synergistic impacts on present or reasonably foreseeable future uses of the Point Loma area.

The City of San Diego concludes that maintaining the existing discharge through the Point Loma outfall should not have an adverse effect on Essential Fish Habitat or Managed Species.

The City proposes to include the above information and conclusion in its 301(h) application to EPA for renewal of discharge requirements for the Point Loma Ocean Outfall. We would appreciate any comments you may have on this conclusion and any other comments you may have on the City's 301(h) waiver application.

Please call me at (858) 292-6401 or my Deputy, Alan Langworthy, at (619) 758-2300 if you or your staff need any additional information in order to make a determination. Thank you for your assistance.

Sincerely,

Timothy Bertch

Timothy C. Bertch, Ph.D.
Director
Metropolitan Wastewater Department

cc: Rich Haas
Alan Langworthy

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THE CITY OF SAN DIEGO • STATE OF CALIFORNIA

SEMPER VIGILANS

Correspondence

Regional Water Quality Control Board San Diego Region

THE CITY OF SAN DIEGO

October 29, 2007

Mr. John Robertus
Executive Officer
Regional Water Quality Control Board
San Diego Region
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

Dear Mr. Robertus:

SUBJECT: Request for Determinations of Compliance
City of San Diego 301(h) Waiver Application

The City of San Diego is preparing an application that requests renewal of NPDES permit requirements for the discharge of treated wastewater to the Pacific Ocean via the Point Loma Ocean Outfall. As part of this application, the City will be requesting modified secondary treatment standards for the Point Loma discharge under provisions of Section 301(h) of the Clean Water Act. The City's 301(h) application will not request any increase in discharge flow or mass emissions.

The City's 301(h) application is being developed in accordance with the format established in 40 CFR 125, Subpart G. The application will, in part, assess compliance with NPDES effluent limits and performance goals established in the current NPDES permit (Order No. 2002-0025, NPDES CA0107409). The application will also address how the City will demonstrate compliance with requirements of the Basin Plan and Ocean Plan.

As part of the 301(h) application, Section III.B.8 of Appendix B of 40 CFR 125, Subpart G, requires 301(h) applicants to:

> *Provide the determination required by 40 CFR 125.61(b)(2) for compliance with applicable provisions of State law, including water quality standards, or, if the determination has not yet been received, a copy of a letter to the appropriate agency(s) requesting the required determination.*

Section III.G.2 of Appendix B of 40 CFR 125, Subpart G, also requires the City of San Diego to obtain a determination from the State that the Point Loma outfall discharge does not cause additional treatment or control requirements on other regional point or non-point discharges.

Metropolitan Wastewater Department
9192 Topaz Way • San Diego, CA 92123
Tel (858) 292-6300 Fax (858) 292-6310

For inclusion in our 301(h) renewal application, the City requests that the Regional Board provide updated determinations that the Point Loma ocean outfall discharge (1) is in compliance with NPDES permit limits and provisions of the California Ocean Plan, and (2) does not affect treatment or control requirements on other regional point or non-point discharges.

Please call me at (858) 292-640 or Alan Langworthy at (619) 758-2300 should you need any additional information in order to make the required determinations of compliance. Thank you for your assistance.

Sincerely,

Timothy Bertch

Timothy C. Bertch, Ph.D.
Director
Metropolitan Wastewater Department

cc: Rich Haas
Alan Langworthy

THE CITY OF SAN DIEGO

MAYOR JERRY SANDERS

November 13, 2007

John Robertus, Executive Officer
California Regional Water Quality Control Board
San Diego Region 9
9174 Sky Park Court, Suite 100
San Diego, CA 92123-4340

Dear Mr. Robertus:

The City of San Diego Metropolitan Wastewater Department (MWWD) requests your approval to initiate operation of a prototype effluent disinfection system at the Point Loma Wastewater Treatment Plant (PLWTP) as soon as possible as was discussed in our meeting on November 2, 2007.

PLWTP is in 100% compliance with its present discharge permit requirements for Water Contact Standards. However, additional areas of the ocean adjacent to the PLWTP discharge are now designated for compliance with the Water Contact Standards (although the definition of these waters remains unclear). Although the PLWTP discharge is 4 ½ miles offshore and at 320 feet deep, the potential designation of a water contact area extending to off shore areas and at the deeper depths could present compliance problems in future permits if the standards were to be applied surface to bottom at 3 nautical miles from land.

To assess the new standards, the City reviewed its monitoring data and determined that single sample maximum standards as contained in the 2005 California State Ocean plan could pose a compliance challenge for the volume of water located from 2 ½ miles to the 3 mile limit from the coastline at depths greater than 130 feet. All geometric mean calculations were in compliance.

Additionally, an evaluation was made of the single sample values to determine the necessary reduction of indicator organisms in the effluent that would ensure single sample compliance.

Parameter	Standard[1] (CFU per 100 ml)	Highest Offshore Result[2] 2003-2007	Reduction Required to Meet Standard
Total Coliform	10,000	130,000[3] (est.)	1.1 log
Fecal Coliform	400	13,000	1.5 log
Enterococcus	104	2200	1.4 log
Total Coliform when Total:Fecal Rations are Greater than 0.1	1000		2.1 log

1 Bacteriological standard from the 2005 version of the Ocean Plan.
2 Highest concentration recorded in any single sample.
3 Actual sample value was ">16,000". The 130,000 CFU per 100 ml total coliform concentration was estimated on the basis of fecal coliform results from the sample.

Metropolitan Wastewater Department
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Subsequent to this laboratory testing was undertaken to evaluate the potential use of sodium hypochlorite solution as a disinfecting agent at the treatment plant in order to meet the target reductions.

Construction of area-intensive disinfection facilities is not an option at the PLWTP due to space and boundary restrictions. As a result of these space considerations, disinfection options at the site are limited. An opportunity exists, however, to make use of existing facilities in developing means of disinfecting the PLWTP effluent. Facilities already exist onsite for the storage and handling of a disinfecting chemical - sodium hypochlorite (used for onsite odor control). Additionally, the effluent travel time within the Point Loma Ocean Outfall (PLOO) affords the opportunity for long contact times to achieve effective reduction in pathogens and indicator organisms.

The bench-scale laboratory disinfection study was organized to assess whether sodium hypochlorite could be used in conjunction with the outfall travel time to achieve the 2.1 log reduction while ensuring that the PLWTP effluent complied with:

- receiving water chlorine residual requirements,
- effluent toxicity requirements, and
- Ocean Plan receiving water standards for chlorinated byproducts.

The bench-scale laboratory study had two key objectives. A first objective was to determine if sufficient reduction in indicator organisms could be achieved by sodium hypochlorite dosages within the contact times available through outfall transport. The second objective was to determine if such dosage rates were in keeping with complying with other Ocean Plan standards, including standards for chlorine residual, toxicity, and receiving water quality.

The Ocean Plan allows for a certain amount of free chlorine to be discharged. (The Ocean Plan establishes 6-month median, daily maximum, and instantaneous maximum chlorine residual standards of 2, 4, and 8 μg/l, respectively, to be achieved after completion of initial dilution.) To conservatively assure compliance with the chlorine residual standard and to minimize the formation of by-products, the laboratory study targeted a near zero residual at the end of the outfall. Several effluent flow rate scenarios were included in the study. These included:

- 432 mgd, which is the hydraulic maximum flow capacity of the PLWTP,
- 240 mgd, which is the average daily dry weather capacity of the PLWTP, and
- 180 mgd, a flow slightly above the average daily flow rate that the facility is currently experiencing.

These flow scenarios sufficiently bracket what the facility may experience to assure that the laboratory study can adequately address compliance with discharge standards for free chlorine. Those flow rates equate to specific effluent travel times through the outfall structure that would be utilized for chlorine contact and dissipation of the free chlorine through reaction with the effluent. As part of the bench-scale testing, measurements were made after a contact time of 5 minutes because this is the estimated average time between the locations in the PLWTP where the sodium hypochlorite would be applied and where the effluent samples would be taken (see

Attachment #1). It may also be utilized as a feedback control point for application of the disinfectant.

The following table presents the conservative contact times used within the study. To provide an adequate factor of safety for pathogen reduction and for chlorine residual dissipation, contact times used in the tests are approximately one-third shorter than actual outfall travel times for the three flow scenarios.

Estimated Outfall Contact Times Used for Analysis

Flow rate (MGD)	Contact Time (minutes)
180	90
240	68
432	38

PLWTP effluent was dosed at various concentrations with a solution of sodium hypochlorite. After initial testing, the dosing target range of 6 to 8 mg/l as NaOCL was selected for more intensive testing. During the tests, measurements were taken at various times for chlorine residual and bacteriological reduction. Additionally, measurements were made at 38, 60 and 90 minutes.

The final effluent after disinfection, with or without any chlorine residual that may have been present, was also tested for compliance with the effluent toxicity standards. Organisms utilized were those specified in the Ocean Plan and identified by previous testing as a most sensitive species for PLWTP effluent.

Results of the testing at a 6, 7, and 8 mg/l sodium hypochlorite dose rates are respectively presented in the following Tables. The result of toxicity screening is also presented.

Summary of Results of Laboratory "In-Pipe" Disinfection Study[1]
Initial Sodium Hypochlorite Dose Rate of 6.0 mg/l

Concentration as NaOCl (mg/l)	Contact Time[2] (minutes)	Average Total Coliform Log-Reduction	Average Fecal Coliform Log-Reduction	Average Enterococcus, Log-Reduction
6.0[3]	0	---	---	---
---	5	---	---	---
0.0	38	1.0	1.6	1.0
0.01	60	1.1	1.6	1.2
0.0	90	1.0	1.6	1.3

1 Results from bench-scale tests on PLWTP advanced primary effluent. Tests conducted during October 2007.

2 Contact time after addition of target dosage of sodium hypochlorite.

3 Initial disinfectant concentration is a calculated value. All other values are measured in the effluent after the indicated time.

Summary of Results of Laboratory "In-Pipe" Disinfection Study[1]
Initial Sodium Hypochlorite Dose Rate of 7.0 mg/l

Concentration as NaOCl (mg/l)	Contact Time[2] (minutes)	Average Total Coliform Log-Reduction	Average Fecal Coliform Log-Reduction	Average Enterococcus, Log-Reduction
7.0[3]	0	---	---	---
0.18	5			
0.08	38	2.3	2.8	1.9
0.07	60	2.5	3.0	1.9
0.07	90	2.6	3.0	2.1

[1] Results from bench-scale tests on PLWTP advanced primary effluent. Tests conducted during October 2007.

[2] Contact time after addition of target dosage of sodium hypochlorite.

[3] Initial disinfectant concentration is a calculated value. All other values are measured in the effluent after the indicated time.

Summary of Results of Laboratory "In-Pipe" Disinfection Study[1]
Initial Sodium Hypochlorite Dose Rate of 8.0 mg/l

Concentration as NaOCl (mg/l)	Contact Time[2] (minutes)	Average Total Coliform Log-Reduction	Average Fecal Coliform Log-Reduction	Average Enterococcus, Log-Reduction
8.0[3]	0	---	---	---
1.04	5			
0.66	38	3.8	3.9	2.3
0.51	60	3.8	3.8	2.4
0.40	90	4.0	4.0	2.4

[1] Results from bench-scale tests on PLWTP advanced primary effluent. Tests conducted during October 2007.

[2] Contact time after addition of target dosage of sodium hypochlorite.

[3] Initial disinfectant concentration is a calculated value. All other values are measured in the effluent after the indicated time.

Summary of Toxicity Tests Conducted on Disinfected Effluent

Sample[2]	Acute Toxicity[1] (TUa)			NPDES Permit Limit[3] (TUa)
	Test # 1	Test #2	Test #3	
Point Loma effluent (PLE) neat[4]	<3.06	3.31	<3.10	6.5
PLE + 8 mg/l NaOCl at T=90 min.	4.44	<3.19	n.t[5]	6.5
PLE + 7 mg/l NaOCl at T=90 min.	n.t[5]	n.t[5]	<3.10	6.5

[1] Test method: 96-hour static renewal Mysidopsis bahia survival

[2] Three different tests were conducted and compared to non-disinfected effluent and the NPDES permit limit.

[3] Acute toxicity standard established within Order No. R9-2002-0025.

[4] Undisinfected Point Loma effluent

[5] n.t. = not tested.

The laboratory bench scale testing established that dosing the PLWTP effluent with sodium hypochlorite solution (to attain a 7.0 mg/l dose rate) as it leaves the primary sedimentation basins will achieve the targeted reduction in indicator organisms by the time the effluent is discharged from the PLOO, and at the same time the 7.0 mg/l sodium hypochlorite dose rate would be almost fully consumed. The laboratory testing indicates a dosage of sodium hypochlorite solution that results in an initial concentration of 7.0mg/l in the effluent will result in essentially no chlorine residual after 38 minutes, the shortest possible travel time out the outfall. Toxicity testing has also established that the 7.0 mg/l dosage rate does not result in an increase in effluent toxicity.

Table B of the Ocean Plan establishes receiving water standards for a variety of toxic organic and inorganic compounds. The potential exists for methane or benzene compounds in the PLWTP effluent to become halogenated, creating such chlorinated byproducts as chloroform, chloromethane, dichloromethane, chlorodibromomethane, dichlorobromomethane, chlorinated phenolic compounds, and others. Using historical data on the average effluent concentrations for these various substances and the potential for their halogenation by a 7.0 mg/l dosage of sodium hypochlorite solution, calculations were done to assess the maximum potential formation of by-products. In all cases the PLWTP discharge would be in compliance with Ocean Plan requirements. The results of this analysis are presented in the following tables.

Compliance with Ocean Plan Standards for Phenol and Chlorinated Phenols

Parameter	Units	Ocean Plan Receiving Water Standard (to be achieved upon completion of initial dilution)	Maximum Observed 6-Month Median 2002-2006[2]	Maximum 6-Month Median Receiving Water Concentration after Initial Dilution[3]	Minimum Factor beyond Achieving Ocean Plan Compliance[4]
		6-month median			
Phenolic Compounds	ug/L	30	15.3	0.075	400
Chlorinated phenolics	ug/L	1	ND[5]	0.075[6]	13

1 From California Ocean Plan, Table B.

2 Maximum observed 6-month median PLWTP effluent phenol concentration during 2002-2006.

3 Projected maximum 6-month median receiving water concentrations are computed on the basis of (1) the maximum observed 6-month median concentration of the PLWTP effluent during 2002-2006, and (2) a minimum initial dilution of 204:1.

4 Ratio between maximum computed receiving water concentration after initial dilution and the corresponding Ocean Plan standard.

5 ND indicates not detected at the listed MDL.

6 Maximum receiving water concentration for chlorinated phenols if the PLWTP effluent were to have a chlorinated phenolic concentration equal to the observed concentration of non-chlorinated phenol.

Common Halogenated Methane and Benzene Compounds

Common Disinfection Byproduct	Concentration in ug/L				Minimum Factor beyond Achieving Ocean Plan Compliance[4]
	Ocean Plan Receiving Water Standard[1] (to be achieved upon completion of initial dilution)	PLWTP Effluent MDL	PLWTP Maximum Month Effluent Concentration 2002-2006[2]	Maximum Receiving Water Concentration after Initial Dilution[3]	
	30-Day Average				
Chlorodibromomethane	8.6	1.0	2.9	0.0140	610
Chloroform	130	1.0	11.2	< 0.055	> 2400
1,4-dichlorobenzene	18	2.3	3.8	0.019	950
Dichlorobromomethane	6.2	1.0	3.7	0.018	340
dichloromethane (methylene chloride)	450	1.0	17.9	0.087	5200
bromomethane (methyl bromide)	130[7]	1.0	ND[5]	< 0.0049	> 27,000
chloromethane (methyl chloride)	130[7]	1.0	1.2	0.0059	22,000

1 From California *Ocean Plan*, Table B. Constituents listed in order of appearance in Table B.
2 PLWTP effluent maximum observed concentration during 2002-2006.
3 Computed receiving water concentration upon completion of initial dilution. Computation based on the 204 to 1 minimum month initial dilution assigned in Order No. R9-2002-0025 and the maximum PLWTP effluent concentration from 2002-2006.
4 Ratio between maximum computed receiving water concentration after initial dilution and the corresponding Ocean Plan standard.
5 ND indicates not detected at the listed MDL. Maximum receiving water concentrations for these non-detected constituents are computed using the MDL, and are reported as "<x µg/l".

As a result of this laboratory bench scale study, it has been concluded that the "in-pipe" chlorination methodology is a viable alternative for use at the PLWTP. In conjunction with the laboratory scale study an engineering evaluation was proceeding at the treatment plant to design the necessary facility changes required to implement the process. Because sodium hypochlorite solution is already in use there for odor control, additional storage, a feed system, and control/samples points are all that need to be installed. A feed point immediately after primary sedimentation has been identified that is upstream of the existing effluent sample point. This ensures that effluent compliance sampling remains representative of the final effluent. There is also an effluent travel time of approximately 5 minutes between the feed point and the sample point so that the sample point can be used to provide feedback on the dosage level being achieved to ensure to compliance with discharge standards. Attachment #1 provides a diagram of the proposed system layout.

Because to this point the disinfection evaluation has been by calculation and bench scale testing a pilot test, a full scale prototype at the PLWTP is needed. During the prototype operation dosage rates can be confirmed and special effluent and ocean samples analyzed to demonstrate compliance. The results of the full scale prototype pilot testing can then be used to implement more permanent facilities. It is anticipated that operation of the prototype facilities at PLWTP can be implemented by the end of the calendar year. If prototype testing is adequate, an operational system (although perhaps not the permanent design) will be in place to provide continuous disinfection for the next permit period.

Your approval for the earliest possible implementation of the prototype PLWTP disinfection facilities is requested.

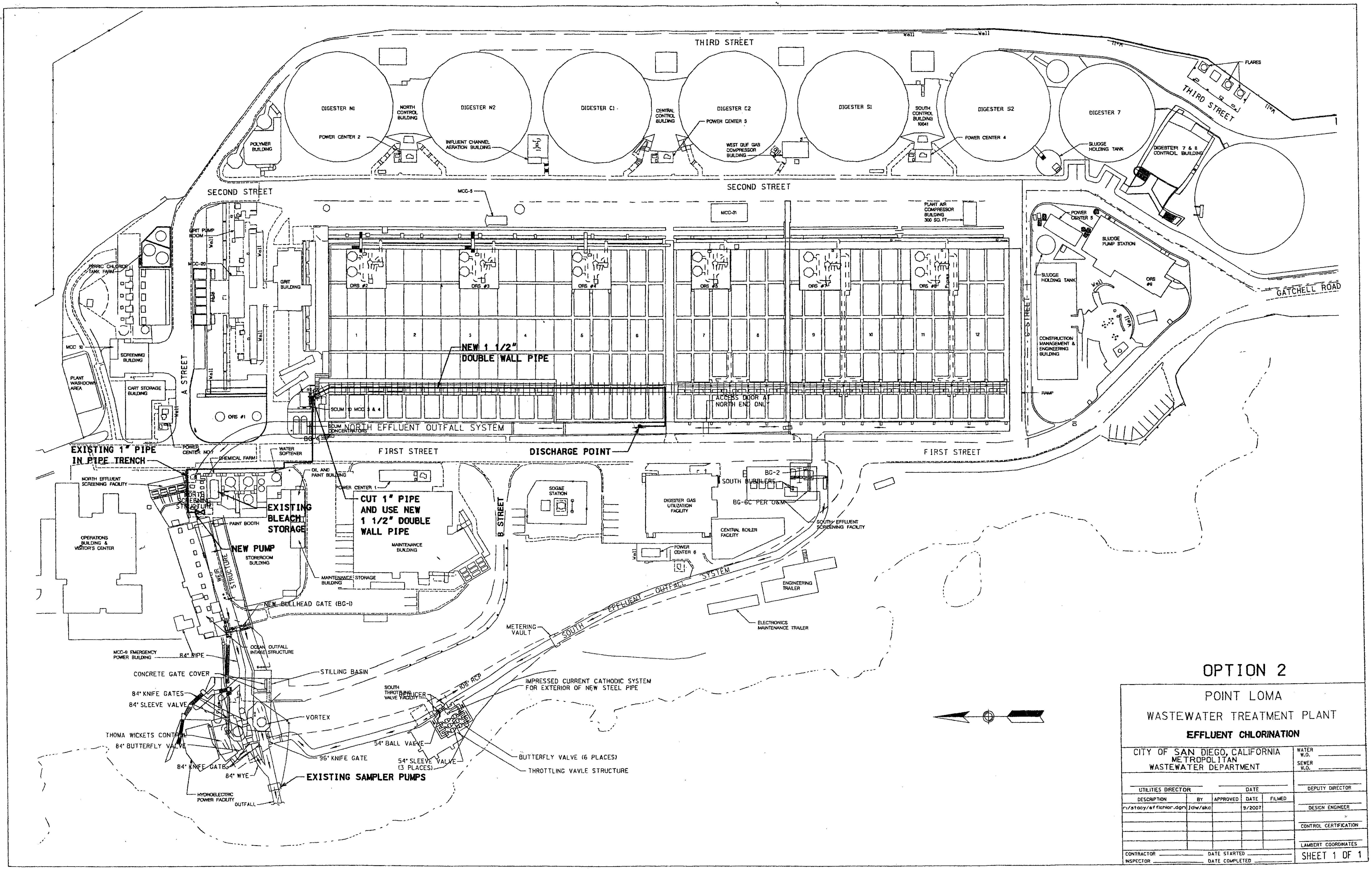
Timothy C. Bertch, Ph.D.
Director
Metropolitan Wastewater Department

TCB:ACL:oc

cc: Alexis Strauss, EPA
Alan Langworthy

G:\mgtsupp\tcb\disinfection req to rwqcb.doc

ATTACHMENT #1



OPTION 2

POINT LOMA

WASTEWATER TREATMENT PLANT

EFFLUENT CHLORINATION

CITY OF SAN DIEGO, CALIFORNIA
METROPOLITAN
WASTEWATER DEPARTMENT

WATER W.O. ____________
SEWER W.O. ____________

UTILITIES DIRECTOR ____________ DATE ____________

DEPUTY DIRECTOR

DESCRIPTION	BY	APPROVED	DATE	FILMED
r:/stacy/effichlor.dgn	jdw/skc		9/2007	

DESIGN ENGINEER

CONTROL CERTIFICATION

LAMBERT COORDINATES

CONTRACTOR ____________ DATE STARTED ____________
INSPECTOR ____________ DATE COMPLETED ____________

SHEET 1 OF 1

THE CITY OF SAN DIEGO • STATE OF CALIFORNIA

SEMPER VIGILANS

Correspondence

California Coastal Commission

NOTE: The following correspondence will be transmitted to the San Diego Coast District Office of the California Coastal Commission upon Regional Board and EPA approval of the renewed NPDES permit for the Point Loma Ocean Outfall discharge. The correspondence seeks a determination from the California Coastal Commission that the Point Loma outfall and project is consistent with provisions of the California Coastal Plan.

Letterhead

Sherilyn Sarb
Deputy Director
State of California Coastal Commission
San Diego Coast District Office
7575 Metropolitan Drive, Suite 103
San Diego, CA 92108-4402

Dear Ms. Sarb:

SUBJECT: Request for Notice of Determination
301(h) Application for Modified Secondary Treatment Requirements
City of San Diego Point Loma Ocean Outfall

The City of San Diego is preparing an application that requests that the U.S. Environmental Protection Agency and California Regional Water Quality Control Board renew the City's NPDES permit for the discharge of treated wastewater to the Pacific Ocean via the 23,760-foot-long, 320-foot deep Point Loma Ocean Outfall. The City's application requests renewal of modified secondary treatment requirements for the Point Loma discharge in accordance with provisions of Section 301(h) of the Clean Water Act. The City's current five-year discharge permit for the modified Point Loma discharge expires in 2008.

The City's 301(h) renewal application will not request any increase in discharge flows or mass emissions. Treatment operations at the Point Loma Wastewater Treatment Plant will be conducted so as to insure compliance with applicable water quality standards established in the California Ocean Plan.

The City's 301(h) application is being prepared in accordance with the format established in Title 40, Section 125, Subpart G of the *Code of Federal Regulations*. As part of this format, the City is required to identify if the discharge proposed in the 301(h) application is consistent with applicable State coastal zone management programs approved under the Coastal Zone Management Act.

Facilities at the Point Loma Wastewater Treatment Plant have been constructed in accordance with applicable Coastal Development Permits issued by your agency. City staff has been coordinating with your staff to prepare and submit Coastal Development Permit applications for several proposed Point Loma Wastewater Treatment Plant maintenance or improvement projects. The following table summarizes the status of Coastal Development Permit for these maintenance or improvement projects.

Status of Current Coastal Development Permits
Point Loma Wastewater Treatment Plant

Coastal Development Permit Number	Point Loma Facility or Project	Project or Permit Status
6-04-027-E2	Point Loma Wastewater Treatment Plant South Use Areas	Coastal Commission staff are processing a permit extension.
9-70-07	Point Loma Wastewater Treatment Plant Penstock Seismic Retrofit	Project underway.
6-05-115	Point Loma Wastewater Treatment Plant Grit Aeration System	In construction. Construction projected to be complete in September 2007.
6-07-067	Sewage Pump Stations (Groups I-IV)	Coastal Commission staff are processing re-application.

As input to the 301(h) application process, we would appreciate your providing a determination that the City's wastewater discharge operations and facilities comply with the California Coastal Plan.

Please call me at (858) 292-6401 or my deputy, Alan Langworthy, at (619) 758-2300 if you have any questions or need any additional information to evaluate the City's compliance with coastal management requirements. Thank you for your assistance.

Sincerely,

Timothy C. Bertch, Ph.D.
Director
Metropolitan Wastewater Department

cc: Alan Langworthy