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REPORT ON BIOLOGICAL MONITORING

PILLAR POINT MARSH,

HALF MOON BAY, CALIFORNIA

Presented To

Coastside County Water District
766 Main Street
Half Moon Bay, California 94019

Project 90029

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SCOPE AND OBJECTIVES

This report presents the results of 1 $_{1/3}$ years of monitoring soil moisture and root-zone salinity and reaction, and observing for signs of plant stress in the Pillar Point Marsh, located near Princeton, Half Moon Bay, California. Concern has been expressed that municipal development of the local groundwater resource may adversely impact the marsh, either by removing a significant volume of the total subsurface flow into the wetland, or by removing an important part of the freshwater inflow.

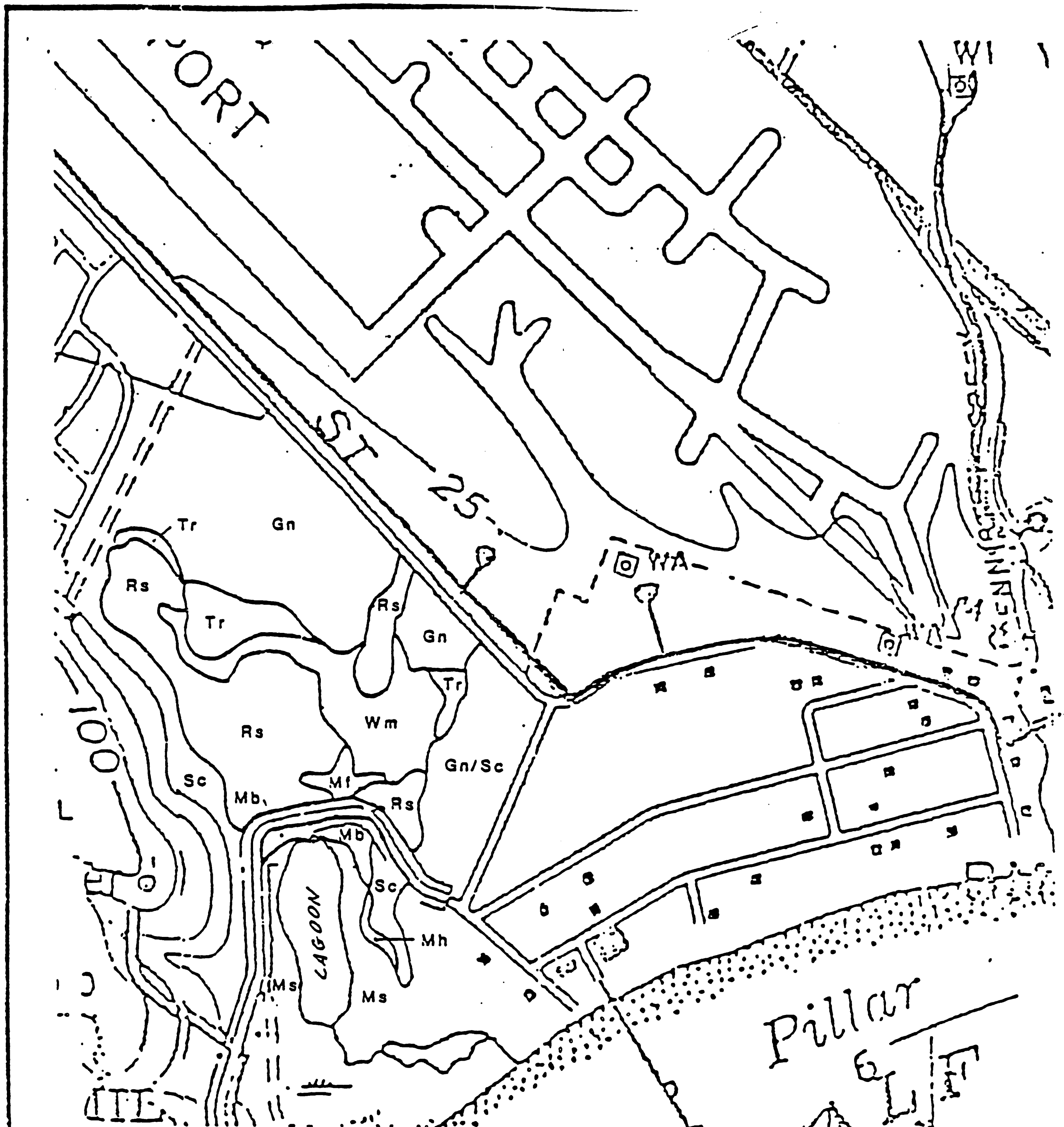
A reduction in the groundwater inflow could conceivably dry up at least the outer or higher portions of the marsh, particularly the seasonally wet areas, shortening the saturated or wet soil conditions period. A reduction in freshwater inflow could also conceivably salinize the brackish or freshwater portions of the marsh area, either by allowing greater shallow zone salt water intrusion, or by reducing the important winter salt flushing flows. Depending on magnitude, both potential effects on soil moisture and root zone salinity would have the tendency to change the productivity and species composition of the plant communities, and may cause plant community boundaries to expand or shrink in response to these changing environmental conditions. Significant changes in soil moisture and salinity or soil pH could produce immediate effects on the vegetation, including lowered productivity and stunted growth, or in the extreme, death of sensitive or intolerant species and replacement by less desirable species.

Subtle, non-dramatic changes in the extent and seasonal duration of wet or saturated soil conditions, and a slight annual but progressive increase in root zone salinity would likely not be apparent over the short term. In the absence of other factors or environmental disturbances, the species composition and boundary movement of such marginally impacted plant communities (as defined by dominant species) would be expected to change gradually over a period of years and would not be detected by a single years worth of biological monitoring. More tolerant, weedy species, already a concern in the marsh, could invade and displace the more desirable native wetland plants in a slow progression over time.

The wetland plant communities of the Pillar Point Marsh area can be considered to be a particularly valuable wildlife habitat because of the great number of wetland types present, forming a rich and diverse mosaic of food, cover, and nesting areas within a relatively small overall area. The wetland is also important as it provides habitat to a number of sensitive, endangered and protected species, including the San Francisco garter snake. The wetland communities and their dominant plants include the following (see Figure 1).

1. Salt marsh (Ms) - (pickleweed zone)
2. High salt marsh (Mh) - (jaumea-salt grass-frankenia zone)
3. Brackish marsh (Mb) - (saltrush - silverweed zone)
4. Freshwater emergent marsh (Mf) - (bulrush-cat-tail zone)
5. Riparian thicket (Rs) - (dense areas of willows)
6. Seasonal wetlands (Wm) - (swamp smartweed; silverweed; and sedge-rush)
7. Transition zone (Tr) - (generally weedy areas; bristly oxtongue, bull thistle, horse-tail)
8. Coastal scrub (Cs) - (coyote bush, annual grasses and weeds)
9. Grassland (Gr) - (oatgrass, ryegrass, brome)

If more subtle changes were to occur with respect to salinity and soil moisture, one years worth of plant community monitoring by measuring species composition and relative abundance in each of the above plant communities on a bi-monthly basis would likely not define early the potential on-set of serious long-term wetland sustainability problems. More significant, and more dramatic changes in soil moisture and root-zone salinity, however, may have more immediate effects on the productivity and vigor of plant communities, for instance by causing germination problems, failure to regenerate after severe frost damage, early die-back, or failure to produce flowers and seeds. Only in the most



LEGEND

Ms	Salt marsh	Tr	Transition zone
Mh	High marsh	Sc	Coastal scrub
Mb	Brackish marsh	Gn	Grassland
Mf	Freshwater emergent marsh	Sc/Gn	Mixed coastal scrub and grassland
Wm	Seasonally wet meadow		

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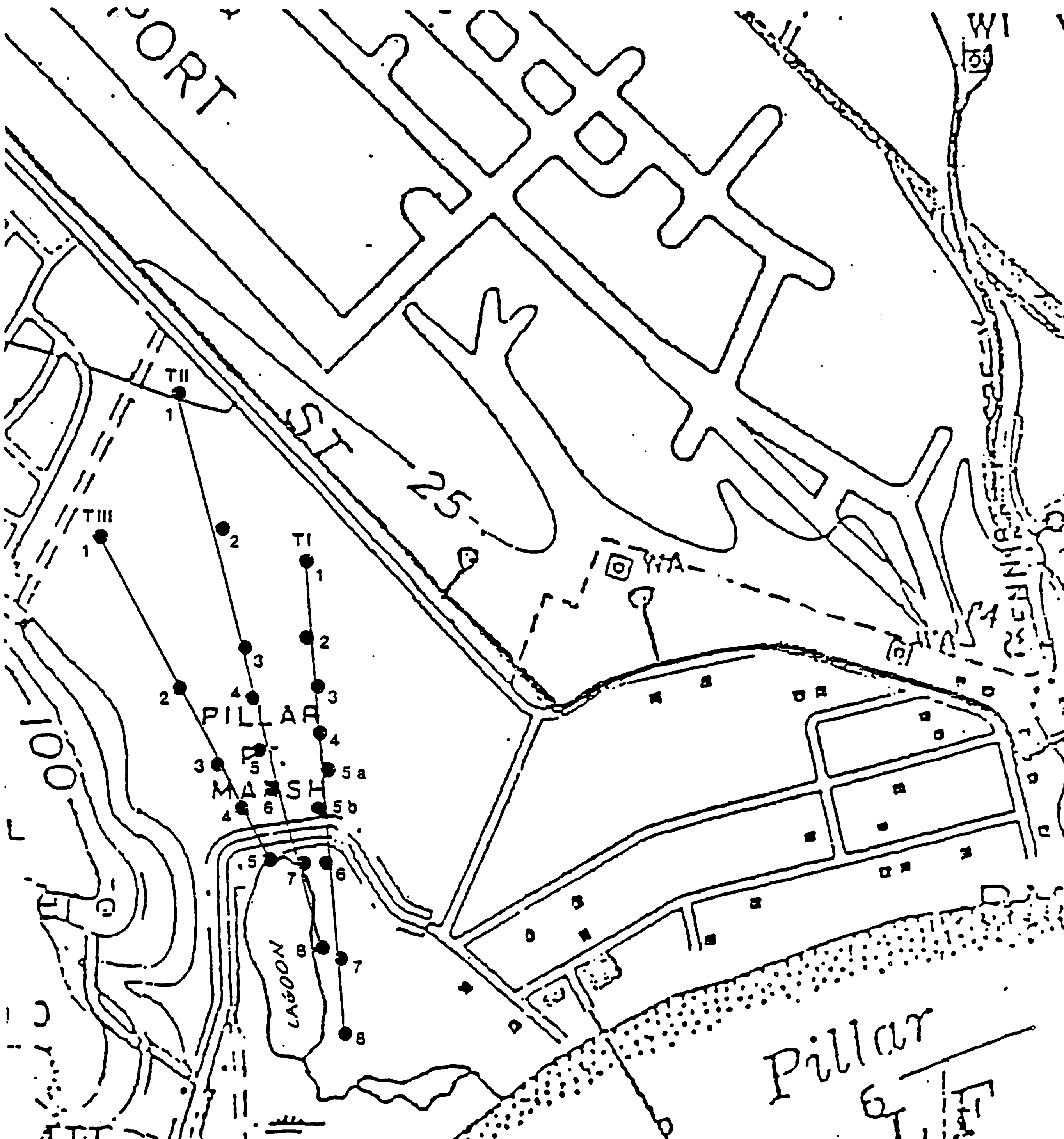
Questa Engineering Corp. Point Richmond, Calif.	PILLAR POINT MARSH PLANT COMMUNITIES	Fi 1

extreme cases, (sudden early drying of a wetland soil or severe saline shock), would death of wetland plants be expected.

It was felt that the monitoring of soil moisture, root-zone salinity and reaction, and the visual appearance of plant stress would provide enough of an early warning system so that management actions could be immediately taken if serious impacts on the wetlands from groundwater development were beginning to be observed. At the same time, data would begin to be developed to judge future, longer term impacts such as might occur from gradual salt build-up or the drying of the peripheral seasonally wet areas. (Long-term changes, for instance, could include the displacement of the brackish marsh by salt marsh species, and the freshwater marsh by brackish species.) This data can then be used in conjunction with earlier biological inventory work including that completed by Gankin (1976), Flint (1977,78), WESCO and Ulrich (1982), and Patterson (1987) to note trends and conditions apparent only over the long term and resultant from more subtle changes in soil moisture and salinity.

METHODS

Three soil-vegetation transect lines were established through the upland and wetland plant communities of the Pillar Point marsh area, as shown in Figure 2. Some 22 observation points are included. This soil moisture, salinity and pH data is included in Appendix 1. The transects were laid out in consultation with the San Mateo County Planning Department so as to traverse all of the major plant communities, providing a means to compare soil moisture levels and apparent plant stress among the communities. The grassland and coastal scrub types were included as comparative or control points. In the initial site visit of December 1989, soil samples were obtained and soil moisture, soil-pH, and soil-salinity levels on 1:1 soil-water extracts were determined in the laboratory. This was to re-establish a long-term baseline, against which future years soil samples might be judged. Some comparison with earlier soil salinity determinations made by Flint (1976) and Ulrich and WESCO Laboratories (1982) was also thought to be possible.



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Questa Engineering Corp. Point Richmond, Calif.	PILLAR POINT MARSH TRANSECT LOCATIONS AND SAMPLING POINTS	Fig 2

Initially, soil moisture levels were determined with a Soil Moisture Equipment Corporation (SMEC) soil-tensiometer, and soil-water samples were obtained with a SMEL porous-cup suction lysimeter. This proved to be a time consuming and costly procedure, and after several of the instruments were broken, lost, or removed by visitors to the marsh, a second, less time consuming, but equally effective approach was adapted. Soil moisture levels were determined using a direct reading 2.5' Aquaterr 100 moisture meter probe. This instrument was developed to assist farmers in judging soil moisture levels for irrigation scheduling, and after calibration, reads out directly in soil moisture content on a scale from 0 to 100. Since this resistivity type meter is somewhat affected by the salt content of soils, the instrument was separately calibrated to 100 for the saturated salt-marsh, brackish, and freshwater marsh wetland soils. The soil moisture readings from the moisture meter probe were then correlated with soil tensiometer readings (0 to 100 centibars scale) to determine soil moisture levels when plants might be under moisture stress, and when permanent wilting point (p.w.p.) occurs. Generally saturated soils have soil tensiometer readings less than 1 centibar, very moist soils to 5 centibars, moist soils 10 - 15 centibars, damp soils 20 - 30 centibars and dry soils above 80 centibars. Wetland plants are likely stressed at levels above 30 centibars, equivalent to about 65 - 70 on the moisture probe. Permanent wilting point (pwp) and death would occur above this, or at moisture probe values less than 55 - 60 for most wetland plants. Upland plants can generally withstand moisture stresses much higher than this.

Soil moisture content at 10- and 18-inch depths were determined monthly at the 22 specified sampling locations along the 3 transects. In some cases a shallow hole was first dug in the soil with a tile spade or 3" mud auger to allow advancement of the moisture probe. It was not possible to occupy the exact site at each subsequent sampling period as the prior disturbance would have affected soil moisture content. Sampling points were also distributed over an area at successive visits so as not to overlay impact the sensitive plant communities. This may have introduced some inadvertent variability into the data set. All soils were replaced in the excavations and backfilled upon completion of the readings.

In addition to the soil-moisture determinations, a sample of root-zone soil water was obtained for selective stations using either the porous cup suction lysimeter, or where free water occurred, a 1" dia. x 12" stainless steel bailer. Soil-water pH and electrical conductivity readings were obtained in the field using an Omega Scientific PHH-49D combined pH-salinity meter. The electrical conductivity readings are expressed as mmhos/cm x 1000. This instrument has a built-in cup with internal probes that allow readings on as little as 5 ml. of sample. In many instances by summer or late fall the soils were too dry to allow sampling soil moisture with the suction cup lysimeter during the same day visit to the marsh.

In addition to the soil-moisture and salinity-reactivity determinations, observations were made at each sampling site with respect to the relative abundance, vigor or stress of the dominant plants. In particular, wilting stress, salt burns on leaf tips, early browning, stunting or pre-mature die-back was of interest, along with notes on general growth, flowering, and seed set.

RESULTS AND DISCUSSION

Although the Pillar Point Marsh monitoring took place during the fifth year of a severe drought, no significant pre-mature or unseasonal plant stress was observed in the wetland plant communities. All plants flowered and set seed at appropriate times. No unusual stunting, leaf tip burning, or pre-mature dieback was observed. Although no specifically planned or routine monitoring or observations of the marsh wildlife were conducted, there we no affects on the habitat observed that would adversely impact the wildlife. The most potentially troublesome finding was the continued advancement of the swamp smartweed and, to a much less extent, nettle, into the freshwater emergent marsh, and the advancement of the invasive weedy species, including bristly oxtongue and bull thistle, from the transition zone into the seasonal wetland areas. These concerns were raised by Flint as early as 1977 and Patterson in 1986. Since moisture levels appeared to remain satisfactory in these communities, it is not known whether this advancement is a result of the previous agricultural disturbances, which allowed the initiation of the weed population, is an artifact of the drought, or, less likely, a result of groundwater withdrawal. Soil moisture levels remained elevated at a level thought capable of supporting seasonal hydric plants throughout their growing periods at all wetland observation points. The soil moisture observation points for the wetland plant communities were consistently much higher than the adjacent upland plant communities, which served as control points. The facultative and facultative wet plants, including rye-grass and brome, which were common to the seasonal wetland, transition zone, and grassland areas, were observed to dry first in the grasslands and then transition zone, following a moisture gradient.

Root zone pH valves were monitored along with salinity, measured as specific conductance. The pH values remained remarkably stable throughout the monitoring period for all sites and were well within the tolerance levels of the wetland plants. Because of this, pH levels will not be discussed further.

Root zone salinity values increased in nearly all sites from a low (less saline) level associated with the late December 1989 sampling period to a high (more saline) nearly a year later in late fall, before the advent of the unusually light winter rains. Some large fluctuations were observed in the saltmarsh and brackish marsh which were not seasonal, but likely associated with the occasional very high tides that flood the marsh. Salinity levels returned to approximately similar conditions of the previous 1990 spring by late April 1991, after the receipt of the heavy March 1991 rains.

As discussed by Flint (1977) the normal tidal cycle at Pillar Point has been altered and dampened by the construction of the breakwater in the early 1970's. Wave heights have been reduced, and a sand bar has accreted along the bayshore, restricting tidal action. Salinity levels measured were well within the tolerance range of the respective salt marsh, brackish, and freshwater marsh plants resident to these communities. Evaporative concentrations of salts in the brackish marsh were noted in late summer and early fall. However, field evidence indicated much variability in salinity readings over a short local area. Salinity levels in the freshwater marsh did not change appreciably over the year, and were within a range of natural fluctuation that would be expected, associated with changes in rainfall, or sampling and analysis error. However, slight, progressive, but over the long term significant increases in root zone salinity may not be noticeable or detectable after only one year of monitoring. Also, any possible increase in salinity or reaction cannot be separated from normal fluctuations associated with the drought.

The following paragraphs discuss the monitoring results with respect to each of the plant communities of the Pillar Point marsh area.

Salt Marsh (Ms)

The salt marsh plant community appeared unaffected, as would be expected over the short-term. This pickleweed community receives the majority of its moisture from tidal flooding, so the moisture supply is virtually unaffected by either drought or groundwater development. Data points TI-8, TII-7, 8 are representative of this community. TI-8 and TII-8 are in the lower, more saline portion of the marsh, but salinity levels (to 29.5 mmlos) are well within the known tolerances of pickleweed. Salinities in this more distinctly tidally influenced area of the marsh fluctuate less than for TII-7. This upper marsh area, just below the road, is more brackish in character, probably reflecting both the surface fresh-water flow through the culvert, and any up-welling of shallow groundwater. Fluctuations in salinity are likely also associated with the occasional high tide flushing of the wetland system.

Brackish Marsh (Mb)

Immediately above these last two points, just below the road, is a small brackishwater marsh community, consisting of saltrush, silverweed, and minor slough sedge with some cat-tails and tules areas. Immediately below the road, near the culvert, narrow leaf cat-tail and California bulrush predominate, (TIII-5) while along the east side of the wetland, above the pickleweed and jaumea, saltrush and silverweed predominate (TI-6).

This community appeared healthy and non-stressed during all site visits, and it appears to remain largely unchanged in location and composition from that reported by Flint (1977) and Patterson (1987). Salt levels ranged from 3.5 to 4.8 mmhos for the upper cat-tail-tule area, and from 6.4 to 10.5 for the saltrush-silverweed area. Salinity levels fluctuated widely in this community, as it receives both the occasional high tide and freshwater outflow, but remained within the tolerance of the dominant plants. The bulrush-cat-tail portion remained permanently saturated at 10", while the higher saltrush-silverweed portion dried to a damp condition at 10", but remained saturated at 18".

A diminished freshwater outflow could endanger the narrow brackish community where it occurs immediately below the hook in the road, but there were no short-term visual indications of stress such as early die-back before seed-set, or failure to re-generate after the unusually severe winter of 1990-91 frost. If this community were severely salt stressed over the long-term, it would likely be displaced by such species as alkali bulrush, cord grass, pickleweed, or jaumea, depending on elevation, salinity level, and associated duration of tidal inundation and ponding.

Freshwater Emergent Marsh (Mf)

No signs of vegetative stress were observed in the bulrush - cat-tail community. This community was ponded and saturated during the late winter and early spring of 1990, but had dried to a still very visibly moist condition at 10" by late summer. The emergent marsh was again ponded briefly in December 1990 and more extensively from the March 1991 rains. The soil was still at or very nearly saturated at 18" in the fall of 1990 in the lower (TII-5b) sampling point, but only damp at TII-5a. TII-5a is higher, near the boundary of the seasonal wetland, and is a mixture of swamp smartweed and California bulrush. TII-5b is lower and ponded for a prolonged period. Bulrush, cat-tail, and water parsley are dominant in the lower part. Salinities were well within the tolerance range of these freshwater emergent plants and ranged from 0.6 to 1.4 mmhos. Moisture or salt stress of the bulrush or cat-tails could lead to die-back prior to setting seeds in these plants, but this was not observed. The tules and cat-tails developed into the typically very dense, almost impenetrable stand by late spring, with heights of the tules to 7-8'. Fall senescence was similar in this community to other bulrush - cat-tail communities in the region. Since these plants were already dormant and had died back to ground level by the time the late December 1990 freeze occurred, little damage was apparently done, and the plants responded vigorously after the March 1991 rains.

An increased dryness or less prolonged ponding of this community could lead to invasion and displacement by either the surrounding willows or by the invasive swamp smartweed or coast nettle. This could not be readily discerned by the current monitoring, although it appears that the swamp smartweed is aggressively invading the edges of the community as is present in significant amounts mixed in with the bulrush. Flint (1977) also noted this concern in his report, along with coast nettle invasion indicating a historic trend. Flints' map possibly indicates a somewhat greater distribution of emergent marsh than occurs presently, but a more thorough study of sequential aerial photography would be needed to more accurately assess this. Flint also expressed great concern over the threat of advancement by coast nettle. Although nettle was observed near the higher sampling point (TII-5a) it was not dominant, and it was present in only very low amounts in the lower, more ponded sampling point (TII-5b). Indeed any change could be more a long-term trend resultant from the altered surface water runoff patterns in the area, and further complicated by the persistent drought, than an impact of groundwater development.

An increase in salinity would likely favor a shift from California bulrush, to the more salt tolerant alkali bulrush, but no alkalai bulrush plants were observed, and salinity levels remained low, in the range of tolerance of California bulrush and common cat-tail.

Riparian Thicket(Rs)

The willow thickets or riparian woodland areas also appeared healthy and vigorous throughout the monitoring period. No evidence of wilting, browning or tip burning, or pre-mature leaf drop was noted for any of the willow thicket monitoring points. A dense nearly impenetrable thicket had developed by late spring, precluding continued access to point TIII-3.

As indicated by the results for sample points TII-5 and 6, and TIII-4, the soils remained very moist at 10" throughout the monitoring period, and saturated or near-saturated at the 18-inch depth except for a time in the late summer and early fall. Moisture levels appeared adequate to support the willows as moisture levels were always well above p.w.p. Salt levels climbed somewhat between the winter stormwater runoff flushing period, and the summer period, presumably after some advancement by subsurface seawater, and concentration by evapotranspiration. However, observed salinity levels were well within the salt tolerances of arroyo willow. As would be expected, both a salinity and moisture gradient was observed, with the soils closer to the road more continuously saturated and slightly more saline (1.4 vs .60 mmhos). The upper willow area, near the trailer park dried to a damp condition by late fall. This willow area apparently receives a large part of its moisture supply from surface runoff, including from the adjacent mobile home park, and would not be expected to be impacted by groundwater withdrawal.

The willow community is essentially a monotype in this area, with few other plants growing under the dense, shaded, canopy; except at the edges and openings. Based on a visual comparison with Flint's (1977) and Patterson's (1987) mapping, it appears that the community boundary is relatively stable, and at least within the limits of this method of observation, have not expanded or shrunk appreciably.

Coastal Scrub (Cs)

Sample point TI-7, is representative of the coastal scrub community. This community is dominated by coyote bush, and includes such other upland or wetland transition zone plants as gum plant, salt bush, blackberry, and wire grass. In many areas the coastal scrub is weedy and contains mustard, bullthistle, and other weeds. The coyote bush community occurs on elevated ground peripheral to the pickleweed marsh areas. The plants in this community are tolerant of saline soils, the occasional extreme tidal flooding, and poor subsoil drainage. Like the grassland type, the monitoring of this area serves as a control point to evaluate the adjacent salt marsh. Low soil moisture, (below permanent wilting point) occurred in this community in August, somewhat latter than the grassland area, but much before the weedy or transition zone wetland areas.

There is a possibility that the coyote bush community and in particular australian salt bush could move down slope from their current slightly higher, better drained ground to invade the upper peripheral brackish marsh zone where it occurs just below the road, if this lower area dried appreciably. It could displace the silverweed, saltrush, jaumea, and frankenia, which occurs there, if a diminished freshwater outflow occurs in this zone. There were no short-term visual indications of this occurring, such as dieback of these plants. The frankenia plants apparently were severely impacted by the late December 1990 severe freeze, and are coming back only slowly from this condition.

Transition Zone and Seasonal Wetland (Tr-Wm)

The transition from the grassland area to the seasonal wetland is not abrupt, but is marked by a break in slope with an elevation drop of 2- to 3-feet. Much of this area, which was referred to as the flood overflow area by Flint (1977) and the transitional zone by Patterson (1987), is very weedy. The weed population consists of plants that compete well in saturated to moist soils and invade disturbed sites. This area was disced in 1989, prior to initiation of monitoring, and probably annually before that. Vegetation observed during the monitoring included prickly oxtongue, bullthistle, coast nettle, giant horsetail, silverweed, plantain, and swamp smartweed (TII-4, TIII-2). Prickly tongue and bullthistle dominated, and formed a dense impenetrable thicket by mid-summer, when the stalks had grown to 4- to 5-feet and dried. However, in some areas wild berries are more dominant, as near TI-4. Sedge and wire grass predominated at sample point TI-3.

The weedy population of the transition zone or seasonal wetland appears to have developed in response to past agricultural practices, including discing, which favors the development of these fast growing invaders of disturbed wet areas at the expense of the higher valve native wetland plants. This zone, unlike the adjacent willow thickets, was saturated to very moist during the spring and early summer, but had dried to (p.w.p.) permanent wilting point by late summer.

The main concern with the weedy community is fear that it would expand into and invade or displace the willows or emergent bullrush marsh. This could occur in the willows only if moisture levels drop very significantly, or severe salt shock occurs as the willow thicket is now well established, presumably with a deep rooting system that taps into the shallow groundwater. The dense canopy also would shade out the weeds. Based on limited observations, it appears that swamp smartweed and coast nettle are invading the emergent marsh in the less prolonged period of inundation zone at the outer edges. This may be a historic trend noted by Flint (1977) and since the elevation and duration of ponding is more likely associated with surface runoff, the possible invasion may be more associated with the drought than groundwater development. There appears to be an opportunity and management need to control the invasive weeds and restore this area to more valuable wetland plants.

Grassland (Gn)

Monitoring of the ruderal grassland areas served primarily to form a basis of comparison for the seasonal fluctuation of soil moisture between the upland and wetland areas. As would be expected, soil moisture levels in the grassland plant community did not reach the same degree of saturation as the wetland areas. The grassland soils also dried significantly by mid-summer, with the corresponding browning and drying of the annual species. A distinct soil moisture gradient was noted southward from the corner of the property towards the main willow woodland area. Moisture levels remained consistently higher in TII-3, and TI-2 near the margin of the grassland, with a corresponding increase in the percentage composition of perennial rye grass (a facultative species) and a longer green period (delayed browning) compared to the species in the areas further north (TI-1; TII-1, 2). It should be noted that the vegetation map prepared by Flint (1977) indicated that the grassland area was previously dominated by coyote bush which was presumably removed by discing by the property owner prior to the 1987 survey by Patterson.

CONCLUSIONS AND RECOMMENDATIONS

No significant short-term impacts on the Pillar Point marsh vegetation or wildlife habitat were observed during the first approximately 1 1/3 years of monitoring. No prematurely stressed vegetation was observed. Soil moisture levels and root zone salinity and reactivity were all within the perceived tolerances and requirements of the wetland plant communities during their growing and flowering periods.

Medium term or long term effects on the marsh from groundwater development cannot be accurately determined from a single years monitoring. Significant mid-to-long term effects might include the gradual die-back of the willow thickets and replacement or invasion of the willows and California bulrush communities by more salt or moisture tolerant weedy plants currently on the periphery of these communities, such as the swamp smartweed, coast nettle and blackberries. The willows could also displace the freshwater emergent marsh if seasonal ponding were greatly diminished.

The moisture and salinity monitoring did not reveal any trends that would lead to increased speculation or concern regarding the displacement of the high value brackish or freshwater wetland plants by more salt tolerant or weedy species. However, long-term, very gradual changes in late season soil moisture and salinity conditions could not be discerned from 1 1/3 years of data, and in fact if any occurred, they could not be separated from any effects of the drought.

Continued monthly or bi-monthly monitoring of soil moisture, salinity, and vegetation stress does not appear to be necessary. This could be replaced by a monitoring period to include June, and September this next year which would include the expected major fluctuations in water levels and salinity associated with the seasons. Since soil samples were collected at the start of this monitoring program and some historic soil salinity data is available from Flint (1977) and Ulrich (1982), it would also be valuable to collect soil samples periodically (bi-annually) to evaluate long-term trends.

Sampling in December 1991, 2 years after the initial monitoring, and some 15 years after Flints (1987) work would be appropriate.

Changes in plant community structure and species composition (if any were to occur) are also more reasonably expected to change over the long-term. A bi-annual field monitoring program (every other year) would be sufficient. Flints transects, established in 1977, and those by WESCO in 1982 for the lower marsh should be re-visited in June 1992 to discern any long-term trends in the marsh. The field work could be supplemented by low altitude color aerial photography including infrared photography, to discern stress in vegetation and gross changes in community structures and boundaries. It would be best to use the same flight lines and altitudes for the aerial photography as were utilized by Patterson (1986, 1" = 400' photos). The focus should be on the stability of the willow thickets, brackish and freshwater marsh communities and the spread of swamp smartweed, coast nettle and other weedy invaders into these communities.

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PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: March 27, 1990

Transect #	Plant Community	Moisture 10"	Moisture 18"	E.C. mmhos/cm	pH
TI-1	Gn	75	-	-	-
TI-2	Gn	75	-	-	-
TI-3	Wm	90	95	-	-
TI-4	Wm	95	95	.65	7.1
TI-5a	Mf	95	100	.65	7.1
TI-5b	Mf	100	100	1.4	7.2
TI-6	Mb	100	100	9.50	7.0
TI-7	Sc	85	90	-	-
TI-8	Ms	100	100	28.5	7.1
TII-1	Gn	75	-	-	-
TII-2	Gn	75	-	-	-
TII-3	Gn	80	-	-	-
TII-4	Wm	95	95	.85	7.1
TII-5	Rs	100	100	.70	7.2
TII-6	Rs	100	100	1.2	7.0
TII-7	Ms	100	100	9.5	7.1
TII-8	Ms	100	100	16.5	7.1
TIII-1	Rs	90	95	-	-
TIII-2	Tr	90	90	-	-
TIII-3	Rs	95	95	-	-
TIII-4	Rs	100	100	1.6	7.0
TIII-5	Mb	100	100	4.2	7.1

PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: April 25, 1991

Transect #	Plant Community	Moisture 10"	18"	E.C. mmhos/cm	pH
TI-1	Gn	75	85	-	-
TI-2	Gn	75	85	-	-
TI-3	Wm	90	95	-	-
TI-4	Wm	95	100	.70	7.2
TI-5a	Mf	100	100	.65	7.1
TI-5b	Mf	100	100	.70	7.1
TI-6	Mb	100	100	8.50	6.9
TI-7	Sc	80	90	-	-
TI-8	Ms	100	100	29.5	7.0
TII-1	Gn	70	85	-	-
TII-2	Gn	75	85	-	-
TII-3	Gn	75	90	-	-
TII-4	Wm	95	95	1.1	7.0
TII-5	Rs	100	100	.65	7.0
TII-6	Rs	100	100	1.1	7.1
TII-7	Ms	100	100	8.5	7.2
TII-8	Ms	100	100	18.5	7.2
TIII-1	Rs	95	95	-	-
TIII-2	Tr	90	95	-	-
TIII-3	Rs	95	100	-	-
TIII-4	Rs	100	100	1.4	6.9
TIII-5	Mb	100	100	3.5	7.0

PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: May 7, 1990

Transect #	Plant Community	Moisture 10"	18"	E.C. mmhos/cm	pH
TI-1	Gn	65	-	-	-
TI-2	Gn	65	-	-	-
TI-3	Wm	75	90	-	-
TI-4	Wm	90	95	.60	7.2
TI-5a	Mf	100	100	.60	7.1
TI-5b	Mf	100	100	1.2	7.2
TI-6	Mb	100	100	10.5	7.0
TI-7	Sc	85	90	-	-
TI-8	Ms	100	100	22.5	7.2
TII-1	Gn	65	-	-	-
TII-2	Gn	65	-	-	-
TII-3	Gn	70	-	-	-
TII-4	Wm	90	100	.95	7.2
TII-5	Rs	95	100	.70	7.1
TII-6	Rs	100	100	1.1	7.1
TII-7	Ms	100	100	9.0	7.1
TII-8	Ms	100	100	18.5	7.0
TIII-1	Rs	90	95	-	-
TIII-2	Tr	85	95	-	-
TIII-3	Rs	90	95	-	-
TIII-4	Rs	95	100	1.6	7.1
TIII-5	Mb	100	100	3.5	7.2

PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: June 14, 1990

Transect #	Plant Community	Moisture 10"	18"	E.C. mmhos/cm	pH
TI-1	Gn	60	-	-	-
TI-2	Gn	65	-	-	-
TI-3	Wm	75	85	-	-
TI-4	Wm	90	100	.65	7.2
TI-5a	Mf	95	100	.60	7.1
TI-5b	Mf	100	100	1.4	7.2
TI-6	Mb	100	100	8.5	7.1
TI-7	Sc	80	90	-	-
TI-8	Ms	100	100	26.5	7.1
TII-1	Gn	60	-	-	-
TII-2	Gn	55	-	-	-
TII-3	Gn	60	-	-	-
TII-4	Wm	95	100	.90	7.1
TII-5	Rs	95	100	1.3	7.2
TII-6	Rs	95	100	1.6	7.2
TII-7	Ms	100	100	6.8	7.1
TII-8	Ms	100	100	16.4	7.2
TIII-1	Rs	90	95	-	-
TIII-2	Tr	80	95	-	-
TIII-3	Rs	90	100	-	-
TIII-4	Rs	95	100	1.7	7.1
TIII-5	Mb	100	100	4.2	7.2

PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: July 13, 1990

Transect #	Plant Community	Moisture 10"	Moisture 18"	E.C. mmhos/cm	pH
TI-1	Gn	45	-	-	-
TI-2	Gn	40	-	-	-
TI-3	Wm	75	85	-	-
TI-4	Wm	80	85	-	-
TI-5a	Mf	85	90	-	-
TI-5b	Mf	95	100	1.6	7.2
TI-6	Mb	100	100	7.8	7.1
TI-7	Sc	65	80	-	-
TI-8	Ms	100	100	32.0	7.2
TII-1	Gn	35	-	-	-
TII-2	Gn	50	-	-	-
TII-3	Gn	45	-	-	-
TII-4	Wm	85	90		
TII-5	Rs	90	95	1.6	7.2
TII-6	Rs	90	95	1.8	7.2
TII-7	Ms	100	100	8.6	7.2
TII-8	Ms	100	100	18.4	7.1
TIII-1	Rs	80	90	-	-
TIII-2	Tr	65	85	-	-
TIII-3	Rs	-	-	-	-
TIII-4	Rs	95	100	2.2	7.1
TIII-5	Mb	95	100	4.0	7.1

PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: August 21, 1990

Transect #	Plant Community	Moisture 10"	Moisture 18"	E.C. mmhos/cm	pH
TI-1	Gn	35	-	-	-
TI-2	Gn	35	-	-	-
TI-3	Wm	65	-	-	-
TI-4	Wm	70	80	-	-
TI-5a	Mf	80	85	-	-
TI-5b	Mf	95	100	1.7	7.1
TI-6	Mb	95	100	9.8	7.1
TI-7	Sc	60	70	-	-
TI-8	Ms	100	100	29.5	7.2
TII-1	Gn	35	-	-	-
TII-2	Gn	35	-	-	-
TII-3	Gn	40	-	-	-
TII-4	Wm	80	85	-	-
TII-5	Rs	90	95	1.7	7.1
TII-6	Rs	90	95	1.8	7.2
TII-7	Ms	100	100	8.2	7.2
TII-8	Ms	95	100	23.5	7.1
TIII-1	Rs	80	85	-	-
TIII-2	Tr	60	-	-	-
TIII-3	Rs	-	-	-	-
TIII-4	Rs	95	95	2.1	7.1
TIII-5	Mb	95	100	3.8	7.2

PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: September 14, 1990

Transect #	Plant Community	Moisture 10"	Moisture 18"	E.C. mmhos/cm	pH
TI-1	Gn	15	-	-	-
TI-2	Gn	15	-	-	-
TI-3	Wm	60	80	-	-
TI-4	Wm	70	80	-	-
TI-5a	Mf	75	80	-	-
TI-5b	Mf	90	95	.75	7.1
TI-6	Mb	95	100	12.4	7.2
TI-7	Sc	50	65	-	-
TI-8	Ms	100	100	26.5	7.2
TII-1	Gn	15	-	-	-
TII-2	Gn	15	-	-	-
TII-3	Gn	10	-	-	-
TII-4	Wm	80	90	-	-
TII-5	Rs	85	95	1.6	7.2
TII-6	Rs	85	95	1.9	7.1
TII-7	Ms	95	100	8.6	7.2
TII-8	Ms	100	100	26.4	7.2
TIII-1	Rs	75	85	-	-
TIII-2	Tr	60	80	-	-
TIII-3	Rs	-	-	-	-
TIII-4	Rs	80	90	2.2	7.1
TIII-5	Mb	95	100	4.8	7.2

PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: October 19, 1990

Transect #	Plant Community	Moisture 10"	Moisture 18"	E.C. mmhos/cm	pH
TI-1	Gn	0	-	-	-
TI-2	Gn	15	-	-	-
TI-3	Wm	45	-	-	-
TI-4	Wm	60	-	-	-
TI-5a	Mf	60	-	-	-
TI-5b	Mf	70	-	.65	7.1
TI-6	Mb	90	95	9.5	7.2
TI-7	Sc	35	-	-	-
TI-8	Ms	100	100	29.4	7.2
TII-1	Gn	15	-	-	-
TII-2	Gn	15	-	-	-
TII-3	Gn	10	-	-	-
TII-4	Wm	80	85	-	-
TII-5	Rs	85	90	1.5	7.1
TII-6	Rs	85	95	1.6	7.2
TII-7	Ms	95	100	-	-
TII-8	Ms	100	100	7.6	7.2
TIII-1	Rs	70	85	-	-
TIII-2	Tr	60	80	-	-
TIII-3	Rs	-	-	-	-
TIII-4	Rs	80	85	-	-
TIII-5	Mb	95	100	4.5	7.1

PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: December 1, 1990

Transect #	Plant Community	Moisture 10"	Moisture 18"	E.C. mmhos/cm	pH
TI-1	Gn	65	35	-	-
TI-2	Gn	50	35	-	-
TI-3	Wm	70	65	-	-
TI-4	Wm	75	70	-	-
TI-5a	Mf	75	80	-	-
TI-5b	Mf	80	90	.70	7.2
TI-6	Mb	85	95	8.6	7.0
TI-7	Sc	70	75	-	-
TI-8	Ms	100	100	31.5	7.1
TII-1	Gn	60	30	-	-
TII-2	Gn	55	35	-	-
TII-3	Gn	65	70	-	-
TII-4	Wm	65	75	-	-
TII-5	Rs	85	90	1.6	7.1
TII-6	Rs	90	90	1.8	6.9
TII-7	Ms	95	100	6.8	7.1
TII-8	Ms	100	100	24.5	7.2
TIII-1	Rs	85	85	-	-
TIII-2	Tr	85	90	-	-
TIII-3	Rs	95	95	-	-
TIII-4	Rs	100	100	1.6	7.0
TIII-5	Mb	95	100	4.6	7.1

PILLAR POINT MARSH

SOIL FIELD MONITORING DATA

DATE: December . , 1989

Transect #	Plant Community	Moisture 10"	E.C. mmhos/cm	pH
TI-1	Gn	Moist 75 -	-	-
TI-2	Gn	Moist 75 -	-	-
TI-3	Wm	Sub-Sat 90 -	-	-
TI-4	Wm	Sub-Sat 90 -	-	-
TI-5a	Mf	Sat 100 -	.60	7.2
TI-6	Mb	Sat 100 -	6.4	7.1
TI-7	Sc	Sub-Sat 90 -	-	-
TI-8	Ms	Sat 100 -	29.5	7.1
TII-1	Gn	Moist 75 -	-	-
TII-2	Gn	Moist 75 -	-	-
TII-3	Gn	Moist 75 -	-	-
TII-4	Wm	Sub-Sat 90 -	-	-
TII-5	Rs	Sat 100 -	.8	7.0
TII-6	Rs	Sat 100 -	1.2	7.2
TII-7	Ms	Sat 100 -	7.0	6.9

TII-8	Ms	Sat 100 -	21.4	7,1
TIII-1	Rs	Sat 100 -	-	-
TIII-2	Tr	Sub-Sat 90 -	-	-
TIII-3	Rs	Sat 100 -	-	-
TIII-4	Rs	Sat 100 -	1.6	7.2
TIII-5	Mb	Sat 100 -	3.8	7.1