Classification of Re-Inventoried Vegetation Parcels According to the Drought Recovery Policy, 2001

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ABSTRACT

This report evaluates the 2001 water table and vegetation conditions for 142 re-inventoried vegetation parcels and classifies each parcel with regard to the Drought Recovery Policy (DRP). To the extent data were available, each parcel was evaluated to track recovery of water table and perennial cover conditions. For each parcel, the estimated water level was analyzed for proximity to its average April 1985-87 ("baseline") level and to the root zone range of the parcel's vegetation type, and the perennial cover data were analyzed for their response to precipitation and water table conditions. When a parcel located in a wellfield area showed both (1) clear evidence that the water table was high enough to recharge the rooting zone and (2) a response in perennial cover such that it equaled or exceeded 1984-87 levels, it was classified as free from the management restraints of the DRP. However, if for a given parcel either the water table remained below baseline (or the rooting zone) or the perennial cover failed to reach baseline level, the parcel was classified as still subject to the management constraints of the DRP.

Of the 142 parcels, 2001 vegetation data were available for 93 parcels. Of the 93, 29 were classified as Control parcels and three were classified as in need of more information before a determination of DRP status could be made. Thirty Wellfield parcels were classified as still subject to the DRP and 31 were classified as free from the DRP (DRPfree). About 10 of these Wellfield parcels were in the type A management category for purposes of the baseline inventory. The 49 parcels without 2001 vegetation data were classified as Control, DRP, DRPfree, and "more study." About 10 of the 49 were type A parcels. These assignments were made on the basis of previous years' vegetation data, if any, and recovery of the water table in 2001. Examples of Control, DRP and DRPfree parcels are discussed, and data for all 142 parcels are presented. A few parcels warranted additional discussion due to anomalous data and additional considerations.

INTRODUCTION

This report presents an evaluation of the 2001 water table and vegetation conditions for the purpose of describing each re-inventoried vegetation parcel's status relative to the Drought Recovery Policy (DRP). Similar reports were prepared for 1998 (Inyo County Water Dept. staff 1999), 1999 (Manning 2000a), and 2000 (Manning 2001a).

To perform the analysis, all relevant data from the vegetation parcels monitored throughout the Owens Valley are evaluated to track recovery of water table and perennial cover conditions. For each monitored parcel, the estimated water level is analyzed for its proximity to its average April 1985-87 ("baseline") level and to the root zone range of the parcel's vegetation type, and the perennial cover data are analyzed for their response to precipitation and water table conditions. When a parcel located in a wellfield area shows both (1) clear evidence that the water table is high enough to recharge the rooting zone and (2) a response in perennial cover such that it equals or exceeds 1984-87 levels, it is classified as free from the management restraints of the DRP. However, if for a given parcel either the water table remains below baseline (or the rooting zone) or the perennial cover fails to demonstrate a clear return to baseline level, the parcel is classified as still subject to the management constraints of the DRP.

BACKGROUND

This report section provides the text of the DRP and reviews the approach taken by Inyo County in this and all previous reports which evaluated monitoring data with regard to the DRP (Inyo County Water Dept. staff 1999, Manning 2000a, and Manning 2001a). Strengths and limitations of the monitoring data as well as the techniques employed to analyze them are discussed.

Drought Recovery Policy

The City of Los Angeles Department of Water and Power (LADWP) and the County of Inyo are required by the Inyo/Los Angeles Water Agreement (City of Los Angeles and County of Inyo 1990a) and the Green Book (City of Los Angeles and County of Inyo 1990b) to jointly manage the water resources of the Owens Valley. In the early 1990s, LADWP and Inyo County adopted the DRP. Under this policy, the entities are to "conservatively manage groundwater pumping during this drought and during a period of recovery following the drought." The text of the DRP follows (also attached as Appendix A):

Recognizing the experimental nature of the management and mitigation techniques, and under the severe conditions of the current drought, it has been agreed by LADWP and Inyo County to conservatively manage groundwater pumping during this drought and during a period of recovery following the drought, LADWP and Inyo County have agreed that the following policy will govern future groundwater pumping:

Recognizing the current extended drought, the Standing Committee establishes a policy for annual management of groundwater pumping during this drought. The goal of this policy is that soil water within the rooting zone recover to a degree sufficient so that the vegetation protection goals of the Agreement are achieved. To this end, groundwater pumping during this drought, as well as the period of recovery, will be conducted in an environmentally conservative manner, taking into consideration soil water, water table, and vegetation conditions. It is recognized that soil water in the rooting zone is naturally replenished by precipitation and from the water table. Further, soil water, water tables, and vegetation conditions will be monitored by the Technical Group to ensure that the goal of this policy is being achieved and for purposes of evaluating the effectiveness of the existing well turn-off / turn-on provisions.

This policy is to provide guidance to the Standing Committee for establishing annual pumping programs during the current drought as well as during a period of recovery. It is intended that groundwater pumping will continue to be conducted in an environmentally conservative manner as was done during the 1990-91 and 1991-92 runoff years until there has been a substantial recovery in soil moisture and water table conditions in areas of Types B, C, and D vegetation that have been affected by groundwater pumping. The Standing Committee will establish annual pumping programs based on an evaluation of current conditions, including soil moisture level, water table depth, degree of water table recovery, soil type, vegetation conditions, the results of studies pertaining to vegetation recovery, and compliance with the goals of the Agreement. It is probable that this policy will result in reduced annual pumping programs as compared to annual pumping programs based solely on soil moisture conditions.

All appropriate available environmental monitoring data have been evaluated annually by Inyo County Water Department (ICWD) personnel since 1998 to assess the status of individual parcels relative to recovery from the 1987-92 drought. Data for each monitored parcel have been evaluated on a case-by-case basis. The objective of the evaluation has been to determine for each wellfield parcel whether there is clear evidence that both (1) the water table rose under the parcel to a level reasonably capable of recharging soil in the root zone of the parcel's vegetation type, and (2) perennial vegetation subsequently exhibited a response to the higher water level by increasing to or exceeding its baseline cover level. Thus, to free a parcel from the management restrictions of the DRP, both the water table and the perennial cover must show evidence of recovery. If data for a parcel show recovery of the water table to approximately its pre-drought level but failure of perennial cover to meet baseline levels, it is classified as still subject to the DRP restrictions. Similarly, if the perennial cover within a parcel matches or exceeds baseline level in any given year, but water table data do not show evidence that the water table is recharging the soil water in the root zone, then it is classified as still subject to the DRP. Obviously, if neither the water table nor the perennial cover approximate baseline levels, the parcel is classified as still subject to the DRP.

The Technical Group performs several types of environmental monitoring. Soil water is monitored monthly using the neutron probe at 33 permanent monitoring sites which are located in wellfield and control areas of the valley. Water table levels are routinely monitored using numerous shallow test wells located throughout the valley. Vegetation conditions are monitored annually in conjunction with the soil water monitoring at the 33 permanent sites and by re-inventorying selected LADWP-mapped vegetation units (parcels) located in both wellfield and control areas of the valley.

In accordance with the DRP, the monitoring data are evaluated in the following way.

Vegetation

Estimating Perennial Vegetation Cover

Vegetation is not uniform within wellfields or throughout the valley. From 1984 through 1987 LADWP personnel conducted a field inventory of vegetation conditions throughout the Owens Valley. Units of relatively homogeneous vegetation were delineated into vegetation parcels. Within each parcel, LADWP personnel ran line-point transects to collect quantitative data on plant species cover and composition.

The Agreement goal states that water resources will be managed to avoid decreases and changes in vegetation. The Green Book states "The 1984-87 inventory shall be used as a "baseline" to determine whether vegetation cover and/or species composition has changed." Therefore, baseline parcel data established by the inventory are compared with data collected within the parcel using similar techniques in subsequent time periods to assess conditions. The Green Book states, "This inventory is the only one of sufficient accuracy to permit comparison." In 1991, the Technical Group implemented an annual monitoring program to re-inventory vegetation in a subset of the parcels to assess vegetation conditions. The results of this monitoring effort have been described in numerous Technical Group reports (e.g. Manning 1992a, 1997, 1998, 1999a, 2000b, 2001b) and memoranda.

To assess vegetation status annually with regard to the DRP, the average cover of all perennial plant species (combined) is calculated for each re-inventoried parcel, and this is compared with the average perennial cover measured during the baseline period. Results of the comparison are used in conjunction with estimated water table levels (discussed below) to determine if conditions in the parcel have recovered from the 1987-92 drought. To be classified as recovered, average perennial cover must match or exceed average baseline perennial cover. Reasons for this standard are consistency with Control parcel response and problems with applying more rigorous determinations of change from baseline, such as a statistical test for the difference between means. Both reasons are explained below.

Consistency with Controls

The Green Book provides that one method of determining whether a change in vegetation cover is measurable is to compare cover and composition in "the affected area with vegetation data from one or more control sites located in areas which have similar vegetation, soil, and precipitation conditions." Control areas are routinely monitored in the re-inventory procedure; these are parcels for which it has been determined that water tables were not affected by pumping during the 1987-92 drought. Monitoring results have shown that total perennial cover in Control parcels has, on average, remained at or has been well above the baseline average (Figure 1). (These results were presented and described by Manning 2001b)

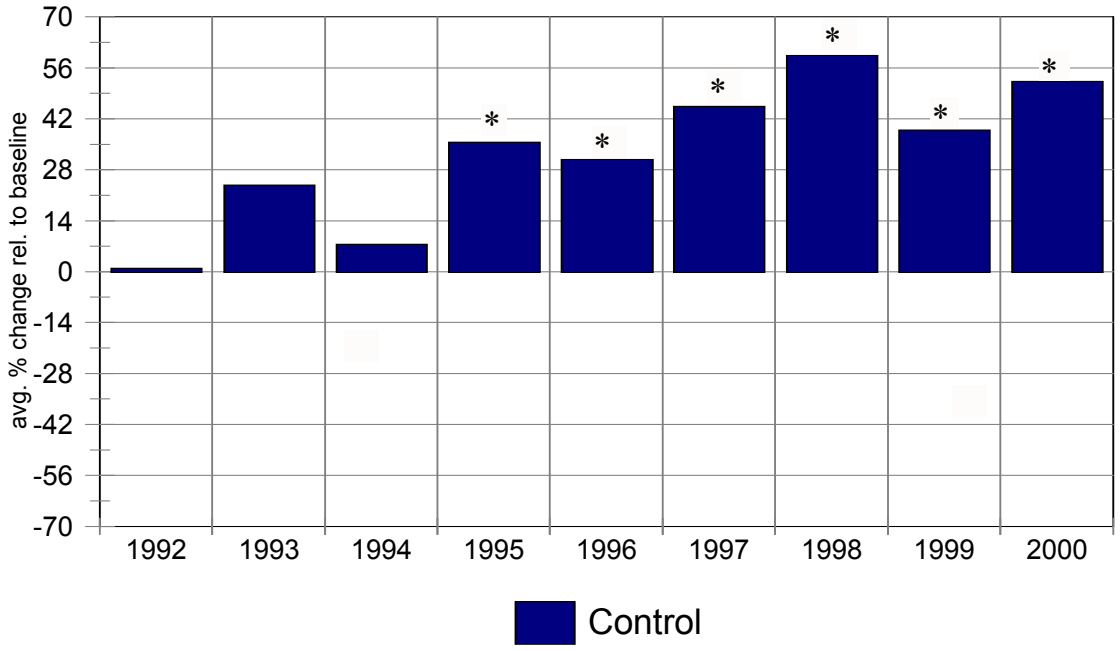

Figure 1. Change in perennial cover relative to baseline for Control parcels, 1992-2000. To generate this graph, the difference in a given year's perennial cover relative to its baseline amount was calculated. For example, if the baseline cover was 20% and the 2000 cover was 28%, the change relative to baseline would be +40%. These differences were then averaged for all Control parcels monitored during the year shown. If there had been no difference relative to baseline, the change would be zero (the bar would not be visible). Control parcel average change relative to baseline was greater than baseline in all years shown; therefore all bars rise up from the zero line. A paired t-test was used within the Control parcel group to test for a difference between baseline cover and the given year's cover. Asterisks denote statistically significant changes from baseline ($p \leq 0.05$). (Results shown in this figure are updated annually, and were most recently shown by Manning 2001b.)

The Control group data in Figure 1 show the general response in Owens Valley perennial vegetation cover in the absence of pumping for parcels which contain groundwater dependent (phreatophytic) plant communities. In the last year of the six year drought, 1992, perennial cover in the Control group of parcels was, on average, equal to baseline levels. Perennial cover remained at baseline through 1994 (although it averaged higher than baseline, it was not statistically significantly higher). In 1995, a year of above average precipitation in the Owens Valley, perennial cover in the Control group exceeded baseline, and since then it has exceeded baseline in all years. These results provide an empirical model for perennial cover recovery in

the Wellfields. When a parcel's water table has demonstrably returned to levels that existed prior to the drought and when this recovery is accompanied by a perennial cover response that achieves or exceeds the baseline level, it is reasonable to conclude that the parcel has recovered from the effects of drought and pumping during the drought.

Problems with Applying Statistical Tests

Despite the Green Book assertion (quoted above) that the baseline inventory is the only one of sufficient accuracy to permit comparison with future conditions, monitoring efforts have revealed some limitations of this procedure. A prominent obstacle hampering successful application the re-inventory procedure for all parcels is the uneven quality of the baseline vegetation inventory data. The Green Book stated that parcels were delineated based on "contiguous assemblages of plants with relatively similar cover and composition," but re-inventory data suggest that many parcels are heterogeneous in their plant cover and composition. Some parcels, especially those delineated during the first years of the baseline inventory program are very large in areal extent, and the larger the parcel, the more likely it is to contain heterogeneous plant assemblages. The Green Book also states that "a minimum of five transects were run on each parcel." However, evaluation of actual field data has revealed that fewer than five transects were run for many parcels and no transects were run in some parcels. When no transects were run in a parcel, baseline cover and composition were estimated visually; therefore no quantitative data exist for those parcels. The Green Book re-inventory procedure was based on the Green Book assertions that parcels were homogeneous and that adequate quantitative baseline data existed for each delineated parcel, but this has proven not to be the case for parcels in some important wellfield areas.

The above obstacles have made it necessary to rely on other aspects of the 1984-87 inventory procedure to support the hypothesis that the baseline data represent a reasonably accurate assessment of baseline vegetation conditions. Accordingly, it is assumed that, because baseline "transects were located visually choosing lines that appeared to cover the representative units of vegetation within the parcel" (Green Book), LADWP personnel captured in their data the prevailing cover and composition they observed in the parcel. That is, the cover and species composition data they collected were considered by them to be unbiased depictions of true conditions as they were visually assessed. In fact, the Green Book describes how steps were taken to collect additional data, beyond the usual five transects, if an unacceptably high amount of "variability" was encountered in the parcel. It is assumed that field researchers were satisfied that their data adequately depicted parcel conditions when they ceased collecting transect data. For this reason, comparisons of the parcel's average baseline perennial cover with average perennial cover measured in a subsequent year was used to determine whether there was a change from baseline.

The Green Book states that statistical analysis will be used to determine whether vegetation has changed. However, application of standard statistical analyses to the baseline and re-inventory data has been problematic. Typically, a t-test is the appropriate parametric test for determining the difference between two means (for example the parcel average baseline

perennial cover versus the cover in a subsequent year). Several problems have been encountered regarding the application of a t-test to the re-inventory data. When means and variances are calculated for the baseline data, one often finds large variances. In addition, high variances are also commonly obtained from the re-inventory data. Although variance can often be diminished by increasing the number of samples (transects), it is impossible to obtain additional baseline transect data. It is also conceivable that an inordinate number of re-inventory transects would need to be run to reduce the variance to a level useful for statistical analysis, because parcels were not as homogeneous as LADWP researchers assumed. Furthermore, baseline data deficiencies and the fact that baseline transects were subjectively located (but the locations were not recorded) lead to the problem that basic assumptions of the t-test are not met. Thus, the tests cannot reliably detect differences between baseline averages and those measured in a subsequent year.

Nevertheless, t-tests are run on the data in an effort to explore the results. It is recognized that the power of this test as applied to these data is weak, due to the above problems. Because of the low power, it is understood that when the test does detect a significant difference (at the 95% probability level) the difference between means is likely to be significant. In contrast, when the t-test fails to detect a significant difference, there is still a reasonably good chance that there is a difference between means, but the t-test cannot reliably detect it. The statistical results should not and are not used as the only support for a measured change in perennial cover.

Other Concerns With Vegetation Monitoring

The re-inventory line-point transect method is a relatively easy way to characterize parcel perennial cover. However, a decade of experience with the method as applied to monitor vegetation changes at the parcel scale has shown that it has its limitations. Limitations include its potential inability to reliably assess conditions in heterogeneous vegetation parcels and to monitor changes in particular species within a parcel. Furthermore, unresolved problems with the baseline vegetation map, such as the imprecise method used to delineate parcel boundaries, and the human error factor introduced when field researchers must rely on their best judgment for determining parcel boundaries or how to maneuver around unexpected new disturbances often introduce uncertainty into the data.

Lack of homogeneity within many of the vegetation parcels can result in the randomly located line-point transects providing biased data. A truly homogeneous plant assemblage could be characterized with a single transect; that is, if the vegetation were uniform in spatial pattern and species composition, any given line-point transect should capture the total site cover and the relative cover of each species. In reality, native vegetation is not known to possess true homogeneity. Therefore, more than one transect is expected to be required to adequately estimate the site's total cover and species composition. The more homogeneous the site, the fewer transects should be required, and the more heterogeneous, the more transects may be required. Because transects are placed throughout the parcel at random, there is always a chance that they will result in a depiction of conditions that are not truly representative of the entire parcel. For example, a parcel may contain a subtle elevation gradient where the lower elevations

support higher cover than the higher elevations. If random transects occur in equal proportions across the elevations, then they should provide a reasonable estimate of parcel cover. However, if the transects happen to be predominantly placed in the lower parts of the parcel, they will show higher cover and thus not reflect conditions throughout the parcel. No attempt is made to control transect locations in this regard. However, obvious disturbances such as roads are avoided by the field researchers.

Finally, as the Agreement and Green Book recognize, other factors besides the water table affect vegetation, and the influence of these other factors may affect vegetation at less than the parcel scale. For example, a cloudburst may drop precipitation unevenly or on a discrete area of a parcel. Removal of live vegetation by herbivores may also affect certain parts of a parcel. Random selection of transects guarantees that no one area is subjectively monitored, but the tradeoff is that there is always a chance that transects could be clustered or scattered in such a pattern that certain components of a parcel are overly represented.

Recognizing the potential limitations in the ability of randomly located line-point transects to assess parcel conditions, the overall trend in perennial cover is considered for parcels frequently monitored. An uncharacteristic high or low cover reading in any given year should be regarded with caution. Other information sources should be consulted, such as the firsthand observations of the field researchers, data from a permanent monitoring site, and an overlay of GPS'ed transect locations on remotely sensed imagery (in GIS) to look for disproportionate sampling of parcel features before conclusions are drawn about the accuracy of anomalous data. In many cases, it is best to gather data for a subsequent year before a given year's data can be assessed for its place within a trend.

Plant Communities and Vegetation Types

The DRP acknowledges that both precipitation and ground water replenish soil water in the rooting zone. Water in excess of average available precipitation is required to sustain plant communities containing or dominated by phreatophytic species. Only parcels with plant communities dominated by phreatophytes are re-inventoried.

When preparing the baseline vegetation maps, LADWP personnel assigned each parcel to a plant community. Groundwater dependent plant communities they recognized include the following scrub and meadow types: Desert Sink, Greasewood Scrub, Rabbitbrush Scrub, Nevada Saltbush Scrub, Alkali Meadow, Rabbitbrush Meadow, and Nevada Saltbush Meadow. Next, the parcels were sorted into "management types," types A, B, C, D, and E. All types except A were believed to require periodic or constant inputs of water from water sources other than precipitation, such as the water table or irrigation (Green Book). In fact, however, the type A classification includes a vast number of parcels which were classified as phreatophytic scrub or meadow communities (Manning 1992b; Groeneveld 1992). The lumping of phreatophytic with non-phreatophytic communities into a single management type, A, could result in serious damage to native vegetation if management strategies ignore the water requirements of large areas of phreatophytic vegetation. In practice, however, several type A parcels with phreatophytic

vegetation are routinely monitored. The Green Book anticipated the need to scrutinize the management type assignments, and states, "Should it be determined through ongoing monitoring, studies, or analysis, that vegetation is incorrectly classified, it will be reclassified as appropriate." The Green Book also called for the following further study, "Analysis of Vegetation Map Data Base and Refinement, if necessary, of the Vegetation Management Maps." Neither activity has been completed.

Parcels classified as all seven of the plant communities listed above are re-inventoried. A list of these communities and the management types to which they were assigned appears in Table 1. Unfortunately, the DRP was developed shortly after the Green Book was written, and thus fails to specify that some areas of type A vegetation were in need of recovery. Because the DRP says that pumping will be conducted in an environmentally conservative manner "until there has been a substantial recovery in soil moisture and water table conditions in areas of Types B, C, and D vegetation that have been affected by groundwater pumping," the management for phreatophytic type A vegetation remains unclear. The County has re-inventoried, evaluated, and classified several type A parcels in its past DRP reports (Inyo County Water Dept. staff 1999, Manning 2000a, and Manning 2001a), and the parcel management type has been noted in previous results.

Table 1. List of re-inventoried phreatophytic plant communities and their assignment to management types. Five of the seven communities were assigned to two management types.

Community	**TYPE**		
	A	**B**	**C**
Desert Sink	✓		
Greasewood Scrub	✓		
Rabbitbrush Scrub	✓	✓	
Nevada Saltbush Scrub	✓	✓	
Alkali Meadow	✓		✓
Rabbitbrush Meadow	✓		✓
Nevada Saltbush Meadow	✓		✓

The Technical Group has not re-inventoried type D parcels, which are parcels dominated by riparian species.

Summary

To evaluate the status of a parcel with regard to the DRP, average baseline perennial cover is compared directly with average perennial cover in a subsequent year. Limitations of the data are considered, especially in instances where a difference in trend or pattern appears. The final determination of DRP status is made in conjunction with an evaluation of water table conditions, discussed below.

Water Table

Estimating Parcel Depth to Water (DTW)

Approximately 350 monitoring wells throughout the valley show water levels in the shallow aquifer. Depth to water table (DTW) is routinely measured by LADWP. These data are used to estimate DTW at the scale of the vegetation parcel.

To produce an estimate of the average DTW beneath the monitored parcels, actual DTW values are subject to a kriging procedure (Harrington and Howard 2000). The procedure uses the DTW measured in each suitable monitoring well, and it creates a grid with interpolated DTW estimates assigned to each grid cell. Thus, for any given vegetation parcel, the grid cell values for cells with their centers inside parcel boundaries are averaged to provide an estimate of the general DTW conditions for the parcel. This technique is superior to using a single monitoring well (a point location that may or may not be located within the parcel) to characterize DTW underneath an entire parcel which may be many acres in extent, because it allows information from other monitoring wells to be included and, in effect, weights that information according to the well's distance from the parcel.

LADWP hydrographers routinely record measurements for all wells in April and (usually) October of each year. To keep the timing of the kriged data consistent from year to year, April DTW values are used. April was selected because it is typically the time when water tables are the highest for a parcel because it is during the runoff period but prior to any effects of annual pumping and intense evapotranspiration.

Gauging Water Table Recovery

For the DRP analysis, the kriged average parcel DTW for April of each year is compared with the average of the April kriged values for the "baseline" years 1985-87 for that parcel. A given year's DTW is compared with the baseline and also with its proximity to the vegetation rooting zone. The root zone, as specified in the Green Book, is 2m for grass-dominated parcels and 4m for shrub-dominated. For more than half of the re-inventoried parcels, the baseline average DTW value falls within or near the root zone of the dominant vegetation. Noteworthy exceptions include: 28 meadow parcels with baseline average DTW deeper than 3m and five scrub parcels with baseline average DTW exceeding 5m.

The April 1985-87 baseline average DTW has been used as a target for assessing each parcel's progress toward recovery from the 1987-92 drought (e.g. Inyo County Water Dept. staff 1999, Manning 2000a; 2001a). This target was agreed to informally by Technical Group members (R. Jackson, personal communication) as a reasonable approximation of the site-specific water table level needed to induce vegetation recovery. By using the kriged average April DTW estimates for April of 1985-87, it was reasoned not only that pre-drought water levels would be adequately estimated, but also that each estimate would be within the realm of water table levels actually occurring under the parcel during the time (approximately) that baseline vegetation data were collected. However, in cases where the 1985-87 average water table level is below the root zone of the parcel's dominant vegetation, the 1985-87 "baseline" must be viewed as a threshold at which to begin examining the vegetation data for a response to rising water levels. Simply achieving the 1985-87 calculated "baseline" level may not be sufficient to promote perennial vegetation cover in all cases because of the following reasons:

(1) It is possible that the 1985-87 target does not truly represent the water table conditions experienced by the vegetation immediately prior to the LADWP inventory because their inventory began in 1984. Many areas of the valley were inventoried during 1985 or 1986. Thus, for most parcels, the 1985-87 average DTW incorporates water table levels that occurred after vegetation was originally measured. These later water levels did not influence the previously-assessed vegetation. Unfortunately, however, DTW data from 1984 and earlier years are sparse, such that kriging estimates using these data would possess greater uncertainty. Calculating a 1982-84 average April DTW for a parcel may result in a highly unreliable value. In contrast, the 1987 water level measurements were more abundant and, even though occurring after some vegetation was inventoried, were often relatively shallow because they occurred at the very beginning of the drought, typically before the heavy pumping that occurred 1987-89.

(2) It is possible that the 1985-87 target does not truly represent the water table conditions experienced by the vegetation immediately prior to the LADWP inventory because groundwater pumping occurred from some wellfield areas during the 1985-87 baseline period. Depending on how much was pumped, when it was pumped, and when annual recharge due to runoff fully affected the wellfield area, water levels within the year could have fluctuated considerably. Thus, the April DTW measurement may not be representative of either the highest or even the average water table levels experienced near a given monitoring well for the year. It is possible that water levels were higher in those parcels in a month other than April and that those higher water levels exerted more influence over the baseline vegetation conditions than water levels in April. Using the kriging technique, high water levels that occurred in months other than April are not captured in the information. Given the intermittent monitoring well measurements during months other than April and October, however, it would be very difficult to reconstruct reasonably accurate DTW estimates for other time periods.

(3) It is possible that, for a given parcel, the uncertainty of the 1985-87 DTW measurements was high. Fewer monitoring wells existed during the 1985-87 time period than are presently available. For example, test wells at most permanent monitoring sites were installed after 1987. New monitoring wells serve to improve the accuracy of the kriged DTW estimate. However, when new wells are introduced and the results compared with DTW

estimated for the same location without those ground control points, there could be a shift in the overall estimate, higher or lower, that is an artifact of the newly introduced data and not something that actually occurred with the water table.

(4) It is possible that DTW estimates for a given parcel are poor because of the parcel's distance from a suitable monitoring well. DTW estimates derived using kriging tend to be most reliable when there are several monitoring wells near a point (grid cell) being estimated. But, there are exceptions to this general rule: for example, when two nearby monitoring wells are bisected by a fault. Generally, the farther a grid cell is from the nearest well, the greater the uncertainty in its DTW measurement. Some vegetation parcels are located a considerable distance from the nearest monitoring well, thus it is possible that the kriged DTW estimates for these parcels could be erroneous due to lack of known DTW control points. This may not always be the case, however, if assumptions made about the aquifer are robust and hold true for the distant parcel. Regardless, without a nearby test well, it is impossible to corroborate DTW estimates.

(5) As mentioned earlier, inaccuracies in the baseline or in a subsequent year's vegetation data confound interpretations of the relationship between water table and perennial cover.

(6) Achieving the "baseline" water level may not elicit an abrupt vegetation response. Time may be necessary not only for sufficient water to be absorbed into the rooting zone but also for rebuilding lost vegetation biomass. Furthermore, if mature plants (particularly shrubs) have died in the parcel, time and appropriate conditions will be necessary to initiate and sustain recruitment of new individuals into the site. Therefore, although a realistic pre-drought water level might be achieved, additional time may be required before the vegetation responds and returns to baseline level.

Despite all the above limitations on using the 1985-87 average baseline DTW as the sole indicator of water table recovery, in the majority of parcels, raising the water table to this level has corresponded with a return of perennial cover to baseline or above. In some parcels where the 1985-87 average baseline DTW is well within the root zone, vegetation response has been observed when the water level reaches the bottom of the root zone, that is, before water levels achieve the 1985-87 baseline. It has been postulated that vegetation in these parcels is being supplied by adequate soil water derived from the water table. In some other parcels, the 1985-87 baseline average is below the root zone, and when the 1985-87 level has been achieved, perennial cover has failed to reach baseline levels. In these parcels, the threshold for recovery should be set at the bottom of the root zone. These examples serve as justification to consider more than simply the 1985-87 average baseline DTW as the sole indicator of recovery. Therefore, the County has used both the 1985-87 baseline average DTW and the bottom of the root zone as targets for achieving recovery from the drought. Whichever level is associated with a parcel's perennial cover increase to baseline is viewed as the recovered water level.

Finally, for a few parcels, water table recovery to the 1985-87 baseline level which happened to be within the root zone was not associated with an increase in perennial cover to baseline. One of the factors listed above may be occurring in these parcels, such as a time lag in the response of the vegetation. Nevertheless, there is always a possibility that parcel vegetation

has been so severely impacted, either by water deficit or some other factor(s), that simply restoring the site's hydrology may not be the only factor needed to cause an increase in perennial cover.

Soil Water

For purposes of monitoring according to the Water Agreement, soil water is routinely monitored at the 33 permanent monitoring sites. These sites were instrumented originally with psychrometers, but have since been modified to accommodate more reliable monitoring with the neutron probe. Vegetation in each parcel containing each permanent monitoring site is annually re-inventoried. Soil water monitoring has shown that as the water table rises, a wetted front moves up through the subsoil above the water table. This standard environmental principle is the process whereby water is wicked up, via capillarity, some distance above the saturated water table. The thickness of the "capillary fringe," is governed by soil properties such as porosity and texture. Because soil properties vary from site to site, and even within a site, it is difficult to estimate the spatial variability of the capillary fringe thickness. Neutron probe measurements have shown that the capillary fringe usually ranges from 1 - 2m in thickness above the water table (ICWD data on file).

No soil water data were collected before the drought so pre drought soil water conditions are unknown. Furthermore, it is infeasible and probably impossible to accurately quantify the soil water status in the rooting zone under entire Owens Valley vegetation parcels. Therefore, DTW measurements and vegetation responses are used as surrogates for soil water conditions. In essence, the monitored Owens Valley vegetation serves as the organism in a bioassay, a standard experimental technique used in biology. In a bioassay, the researcher tests for the presence or quantity of a substance (in this case, available soil water in the root zone) by using the living organism's response. Because data have shown that increased soil water conditions are associated with increased vegetation cover, an increase in vegetation cover is likely to signify an increase in soil water. When perennial cover increases to baseline levels, and when the increase occurs in conjunction with a rise in water table, it is reasonable to conclude that soil water supplied from the water table has recovered to a level sufficient to support baseline levels of perennial cover. In sum, soil water status must be addressed for purposes of the DRP, so it is assessed indirectly from surrogate measurements of both water table and vegetation response. When both the water table and vegetation show a positive response consistent with the DRP goal, it is concluded that soil water recovery is sufficient.

Permanent Monitoring Site Data

Data from the permanent monitoring sites are occasionally consulted to gather further information on apparent anomalies or changes in parcel DTW or perennial cover data. This occurs in instances where: a parcel has experienced a change in water table or perennial cover inconsistent with the parcel's previous trend, or a parcel appears to have achieved conditions that would free it from the DRP. Data from the permanent monitoring site are consulted to see if they

corroborate parcel data. For example, if parcel perennial cover showed an abrupt increase from one year to the next, the permanent monitoring site data are examined for an increase. If none, or if a decrease was measured at the permanent transect, this information could be used in conjunction with other data or observations to draw conclusions about the parcel's actual status. Because permanent monitoring sites may represent an extremely small portion of the parcel, their data are used with caution. When consulted in the DRP evaluation, the data consulted and how they were used are explained.

Parcel Evaluation

The County evaluates re-inventory parcel monitoring data with regard to the DRP to determine whether, since the 1987-92 drought, the data show both water table recovery (to baseline or the bottom of the root zone) and an increase in perennial cover to at least baseline. This evaluation is performed on a parcel-by-parcel basis. As discussed above, these two factors in combination are used as a surrogate for soil water recovery. The County's evaluation has been applied to all monitored parcels located in wellfield areas. (Although the DRP does not explicitly specify wellfields, its emphasis on pumping management implies that it targets areas affected by groundwater pumping. By definition, these are the wellfield areas.) The end result of the DRP evaluation is that Wellfield parcels are determined to be either (1) free from the DRP because both water table and perennial cover have shown recovery or (2) still subject to the DRP because either water table, perennial cover, or both have failed to show recovery. A few other parcels exhibit anomalies in their DTW or perennial cover data which can be explained using other available information, and as a result, it is possible to classify them. However, peculiar data for a small number of parcels have made it impossible to reliably classify them; more data would be needed to understand past and present conditions in those parcels.

The rest of this report explains the evaluation as it was applied to 2001 data and conditions. First, precipitation amounts prior to the 2001 growing season are presented. Brief descriptions of the 2001 vegetation and DTW data follow. Next, there is a review of the method used to separate Control from Wellfield parcels. Finally, the procedures used to classify each parcel are presented, and results are discussed.

2001 PRECIPITATION

Methods

Precipitation data were assembled for all seven Inyo County Water Department (ICWD) rain gauges and for the Bishop airport weather station (NCDC 1982-2001). Total precipitation for fall and winter preceding the 2001 growing season (October 1, 2000 through April 30, 2001) was tabulated.

Results

Slightly more precipitation fell during October 2000 through April 2001 than fell during the same months of the two previous years. Figure 2a shows the average precipitation for

ICWD's seven rain gauges, 1993-2001. During the 2001 winter season, precipitation was again below average, as shown for data from the Bishop airport (Figure 2b).

Owens Valley 2001 precipitation was not abundant by any standard. But, precipitation prior to the 2001 growing season was sufficient to cause shrub seed germination at several permanent monitoring sites, and this was significantly more germination than occurred in 1999 or 2000 (ICWD data on file). The reason for the increased germination could be the overall higher 2001 precipitation, the pattern of 2001 precipitation events, a combination of these, or some other reason. Analysis of precipitation patterns from 1999-2001 pre growing seasons showed that prior to 2001, there were two relatively large precipitation events, in which winter storms yielded 13 - 38mm (0.5 - 1.5 inch). For 2000, the two largest winter events were smaller in magnitude than 2001. In 1999, there was only one event which approximated the moderate events of 2000 (ICWD data on file).

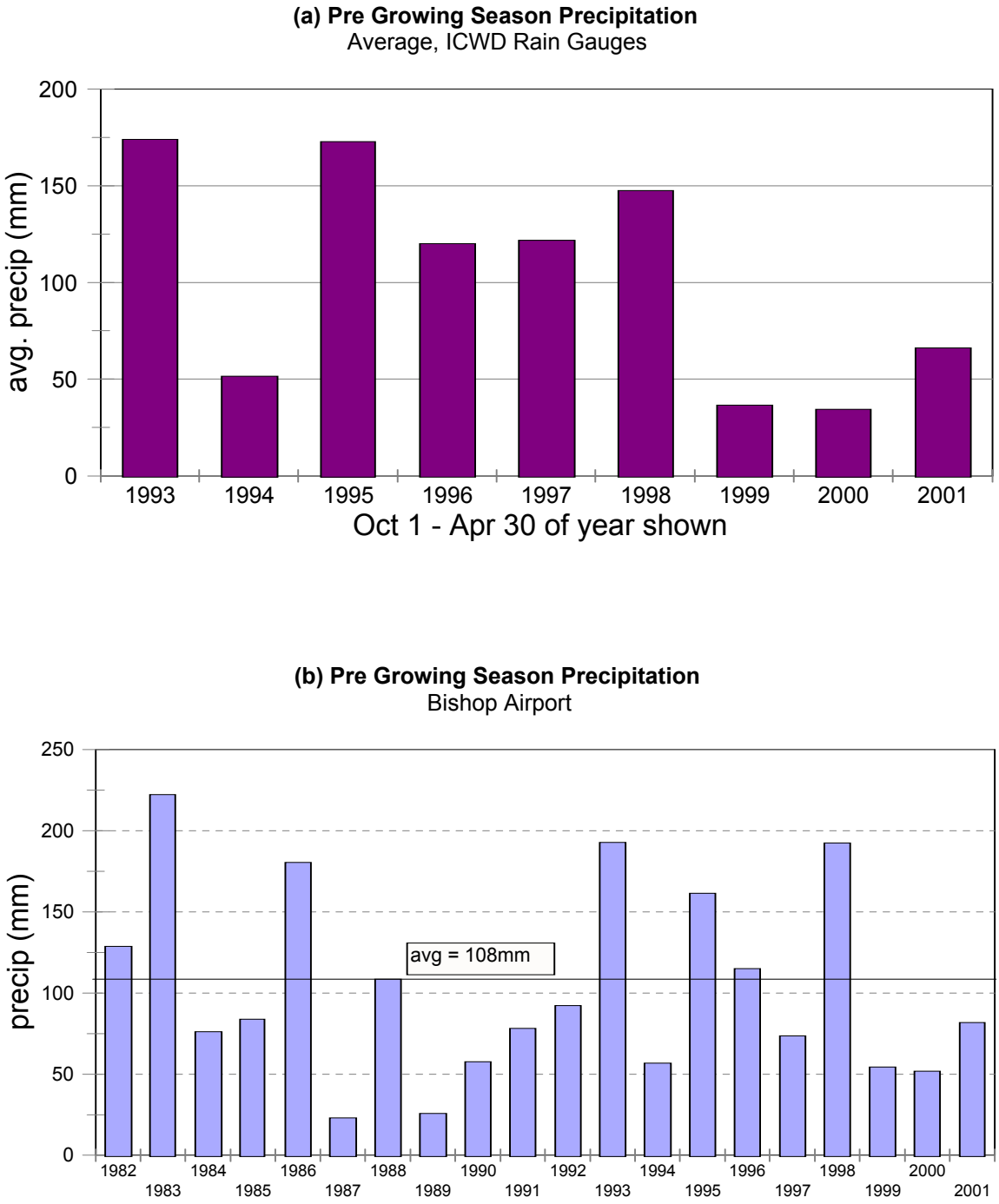

Figure 2. Pre growing season (October 1 through April 30 of year shown) precipitation: (a) average of seven ICWD rain gauges, and (b) total at the Bishop airport.

VEGETATION CONDITIONS

Methods

In 2001, 93 vegetation parcels were re-inventoried. Ninety-two of these parcels had been re-inventoried in 2000, and one parcel, IND029, was added in 2001. Baseline data for IND029 (one transect) were collected between September 1984 and September 1985, and the parcel had never been re-inventoried. Baseline data showed that IND029 was a type C Alkali Meadow. It was added in 2001 to begin monitoring the area around well 382.

Most of the parcels included in the re-inventory monitoring program were selected in 1992, but since 1992, a few parcels have been added in an effort to expand the monitoring to include vegetation in areas relevant to ongoing management. Parcel selection criteria were reviewed by Manning (2000b). Briefly, the following guidelines were used to assist in parcel selection: parcel contains a permanent monitoring site; actual baseline transect data exist for the parcel; parcel location allowed sampling over a wide geographic area; parcel was classified as a phreatophytic plant community, preferably in management category type B or C; parcel size is relatively small and thus more likely to contain relatively homogeneous vegetation; and parcel was free from known major confounding factors such as regular irrigation or land surface alterations. Few parcels meet all the above criteria; for example, several re-inventoried parcels containing permanent monitoring sites have no available baseline transect data, are large and heterogeneous, and were classified as management category Type A. Not all parcels are re-inventoried every year. Some have been moved to a low priority because they do not meet most of the above guidelines, and others are not done due to scheduling constraints in a given year.

Details of the field methods used for re-inventory can be found in previous reports (e.g., Manning 2000b). Briefly, transect start points and bearings are randomly generated in the office using computer software. In the field, researchers locate start points using GPS, then immediately record the actual transect location and bearing into the GPS device. They set up a temporary 50m transect using a measuring tape and portable end posts. At 50cm intervals, beginning at 50cm, researchers visually identify and record the top layer of live plant material.

In the office, total hits on plants are tallied. Transect results from the baseline period (1984-87) and all years in which parcels were re-inventoried are summarized in terms of average cover of all perennial species combined. Average perennial cover in a given year is directly compared with baseline. In addition, the software program Statistica is used to perform t-tests to further evaluate the difference between baseline perennial cover and perennial cover in a subsequent year. A one-tailed test was used to detect a difference not only in amount of change but also in direction (positive or negative) (Sokal and Rohlf 1987). Using the t-test, a change is considered significant if the probability (p) that the means were different due to chance alone was ≤ 0.05.

Results

Parcel perennial cover for each year the parcel was monitored is listed in Appendix B. These values are graphed, along with water table depths (discussed below) in Figures 3-144. (Because there are so many graphs, they are placed in this report as Appendix C).

2001 DEPTH TO WATER DATA

Methods

DTW data for April 2001 were compiled then analyzed using the kriging procedures described by Harrington and Howard (2000). The analysis produced an ArcView grid coverage depicting estimated DTW as of April 2001 throughout the Owens Valley.

Each grid cell with its center point falling within a line point parcel boundary was identified and the values for the parcel averaged to generate an estimated DTW under each parcel. These values were converted from feet to meters.

Kriged 2001 DTW estimates were used to compare with both the parcel's 1985-87 average "baseline" DTW and with its 2m or 4m root zone depth.

Results

The 2001 data were added to the kriged DTW data from 1985-2000; average DTW values calculated for each parcel each year are presented in Appendix D and are graphed in Figures 3 - 144 (Appendix C). DTW stayed approximately the same from April 2000 to April 2001; the overall average change was a decline of less than 0.1m. Notable exceptions were four parcels where DTW changed more than 1m or more. Under BGP154 the water table declined 1.4m, under LNP045 and LNP050, it declined 1m, and under TIN053, it rose 1.1m. DTW data for 2001 require further investigation for seven parcels in the PLC (Poleta Canyon) area, as noted on graphs.

DISTINGUISHING CONTROL FROM WELLFIELD PARCELS

As discussed in the Background section, the DRP focuses the need for recovery on water tables, soil water, and vegetation in areas affected by pumping. One objective of the vegetation re-inventory monitoring program has been to compare DTW and vegetation conditions in parcels affected by LADWP groundwater pumping with parcels not affected by pumping. Therefore, it is necessary to distinguish Control parcels from Wellfield parcels.

Methods

To identify Controls, parcels were sorted according to their water table drawdown from April 1987 through April 1989. This time period corresponded both with the beginning of the drought and with high pumping amounts throughout the Owens Valley. Therefore, it was

hypothesized that parcels affected by pumping would experience greater water table drawdowns than parcels distant from pumps. As discussed by Manning (2001a), change in DTW from 1987 to 1989, alone, did not satisfactorily sort the parcels into two distinct groups: Control and Wellfield. However, the parcels did sort roughly into three groups. Using the water table changes in conjunction with information from previous analyses (Inyo County Water Dept. staff 1999; Manning 2000a), and parcel geographic location, the parcels were assigned to the Control or Wellfield group. The 43 parcels with less than 0.6m of water table drawdown during 1987-89 were classified as "Control" parcels, not likely to be influenced by groundwater pumping. Many of these parcels were located far from pumps. BLK074 was an exception in that its change in water table was -0.26m, but it was located near pumps so was classified as a Wellfield parcel. (Manning (2001a) presents a more detailed discussion of BLK074.) The 69 parcels with water table declines exceeding 1.4m were considered "Wellfield" parcels, affected by pumping during the early part of the drought. For the 22 parcels with intermediate DTW change, ranging from -0.68 to -1.32m, classification to Control or Wellfield groups was done on a case-by-case basis (Manning 2001a).

Results

Parcels are sorted by change in DTW from 1987-89 in Table 2. Table 2 also shows the three parcel groups: (1) parcels with changes from positive through -0.6m, which were classified as Control except for BLK074; (2) parcels with declines beyond 1.4m which were classified as Wellfield; and (3) parcels with intermediate declines, which were classified on a case-by-case basis. The case-by-case analysis resulted in the assignments shown in Table 3.

Table 2. Change in water table (m) from April 1987 to April 1989. Parcels are sorted from amount of increase to greatest decline; those for which there were no 1987-89 DTW data are shown as "nd." As discussed in the text, parcels with changes from positive through -0.6m were designated as Controls (with one exception), and parcels with no data were included in this group. Declines beyond 1.4m were classified as Wellfield. Classification of parcels with intermediate declines (shaded in table) was done on a case-by-case basis.

PARCEL	diff 87-89	PARCEL	diff 87-89	PARCEL	diff 87-89	PARCEL	diff 87-89
1 BGP013	nd	37 IND156	-0.335	73 LNP050	-1.32	108 LAW065	-3.2
2 BGP204	nd	38 BGP031	-0.35	74 BLK099	-1.41	109 BLK095	-3.34
3 BGP205	nd	39 IND122	-0.38	75 LAW167	-1.44	110 LAW076	-3.39
4 FSL179	nd	40 IND151	-0.395	76 FSL065	-1.48	111 LAW107	-3.4
5 FSL187	nd	41 PLC220	-0.46	77 FSL118	-1.49	112 FSL123	-3.42
6 MAN060	nd	42 PLC056	-0.47	78 MAN037	-1.53	113 LAW137	-3.52
7 PLC251	nd	43 BGP047	-0.47	79 LAW030	-1.56	114 LAW063	-3.53
8 PLC263	nd	44 PLC064	-0.47	80 TIN006	-1.59	115 BLK094	-3.73
9 IND096	0.87	45 IND163	-0.5	81 LAW154	-1.6	116 TIN050	-3.8
10 UNW073	0.63	46 IND099	-0.5	82 BGP162	-1.62	117 IND106	-3.87
11 UNW072	0.4	47 PLC059	-0.51	83 BLK075	-1.81	118 TIN068	-3.89
12 LNP019	0.04	48 PLC072	-0.51	84 TIN028	-1.82	119 TIN064	-3.91
13 PLC113	-0.05	49 PLC028	-0.58	85 BLK077	-1.87	120 BLK039	-4.01
14 PLC106	-0.07	50 BLK115	-0.59	86 IND029	-1.87	121 IND205	-4.01

PARCEL	diff 87-89	PARCEL	diff 87-89	PARCEL	diff 87-89	PARCEL	diff 87-89
15 PLC111	-0.08	51 BIS055	-0.6	87 BGP086	-1.89	122 LAW062	-4.28
16 PLC137	-0.1	52 BIS068	-0.68	88 BGP088	-1.9	123 LAW112	-4.37
17 PLC136	-0.12	53 PLC055	-0.68	89 IND019	-2.08	124 BLK033	-4.54
18 PLC110	-0.13	54 MAN034	-0.73	90 MAN007	-2.18	125 BLK016	-4.6
19 LNP018	-0.16	55 UNW039	-0.76	91 FSL051	-2.23	126 LAW120	-4.63
20 PLC125	-0.16	56 FSL116	-0.79	92 FSP004	-2.24	127 IND132	-4.67
21 PLC092	-0.19	57 BLK069	-0.87	93 FSP006	-2.28	128 LAW078	-4.71
22 IND087	-0.19	58 PLC007	-0.89	94 BLK142	-2.32	129 LAW104	-5
23 PLC121	-0.22	59 IND066	-0.93	95 LAW122	-2.33	130 IND231	-5.22
24 UNW079	-0.24	60 UNW029	-0.95	96 LAW109	-2.34	131 MAN017	-5.44
25 PLC241	-0.24	61 LNP045	-0.97	97 LAW040	-2.34	132 BLK009	-5.5
26 PLC187	-0.24	62 IND067	-0.99	98 BLK143	-2.37	133 BLK024	-5.59
27 PLC097	-0.26	63 UHL052	-0.99	99 IND035	-2.43	134 BLK044	-5.59
28 BLK074	-0.26	64 MAN014	-1.03	100 LAW110	-2.5	135 TIN053	-5.63
29 PLC239	-0.26	65 IND119	-1.1	101 MAN006	-2.7	135 IND139	-5.84
30 PLC223	-0.27	66 BIS085	-1.1	102 FSL122	-2.71	137 LAW085	-5.97
31 PLC246	-0.27	67 IND064	-1.11	103 MAN042	-2.73	138 BLK002	-6
32 PLC240	-0.27	68 TIN030	-1.16	104 BLK021	-2.82	139 IND133	-6.73
33 PLC193	-0.28	69 IND021	-1.16	105 BGP154	-2.84	140 LAW052	-7.5
34 PLC069	-0.3	70 BGP157	-1.2	106 BLK040	-3.04	141 BLK011	-7.58
35 PLC065	-0.3	71 IND011	-1.26	107 IND111	-3.08	142 LAW082	-8.05
36 PLC024	-0.32	72 BLK006	-1.28				

Table 3. Assignment of the 22 parcels with 1987 to 1989 change in April DTW ranging from -0.68 to -1.32m (shaded in Table 2) to Control, Wellfield, or More Study groups. Assignments were made on a case-by-case basis and were described by Manning (2001a).

Control	Wellfield	More Study
LNP050	BGP157	IND064
MAN014	BIS068	IND066
PLC055	BIS085	IND067
UNW029	BLK006	IND119
UNW039	BLK069	
	FSL116	
	IND011	
	IND021	
	LNP045	
	MAN034	
	PLC007	
	TIN030	
	UHL052	

To summarize, 55 of the 142 parcels listed in Table 2 were classified as Control. Four parcels could not be classified (IND064, IND066, IND067, and IND119). Eighty-three parcels were classified as Wellfield. As discussed below, Wellfield parcels were examined for DTW and perennial cover conditions to see if they were still subject to or free from provisions of the DRP.

CLASSIFYING PARCELS ACCORDING TO THE DROUGHT RECOVERY POLICY

Methods

DTW and perennial cover data (if available) were compiled for Control parcels. No further analyses were performed on these parcels.

In 2001, there were no changes in the 1985-2000 DTW data used to evaluate parcels according to the DRP in 2000. Therefore, all parcels classified as free from the DRP based on 2000 data were still regarded as such in 2001. Methods used to evaluate and classify parcels based on the 2000 data are reviewed below.

Evaluation of 2000 Data

DTW and perennial cover data (if available) were examined for each of the 82 Wellfield parcels after the 2000 growing season (Manning 2001a). Estimated DTW was analyzed for its proximity to the 1985-87 baseline average level and to the root zone range of the parcel's plant community. Perennial cover data were analyzed for responses to precipitation and water table conditions. When a parcel located in a wellfield area showed both (1) clear evidence that the water table is high enough to recharge the rooting zone and (2) a response in average perennial cover such that it equals or exceeds 1984-87 levels, it was classified as free from the management constraints of the DRP. However, if for a given parcel either the water table remained below baseline (or the rooting zone) or the perennial cover failed to demonstrate a clear return to baseline level, the parcel was classified as still subject to the management constraints of the DRP.

To evaluate the 2000 data, the fact that 1999 and 2000 were low precipitation years was considered (Figure 2). Because groundwater dependent vegetation cannot be sustained with precipitation alone, in areas where perennial cover remained at or above baseline levels 1999-2000, it was inferred that soil water was sufficiently recharged via the water table. Thus, if the water table and perennial cover trend had been generally upward during the late 1990's, if during 1999 and/or afterwards DTW was at or near baseline, and if the perennial cover equaled or exceeded baseline level following return of the water table, it was assumed that at least a weak connection had been made between the perennial plant roots and the groundwater.

The timing of precipitation and water table and vegetation response was also considered. Pre growing season precipitation in 1995 and 1998 was high (Figure 2). There were somewhat lower amounts in 1996 and 1997, and 1999 and 2000 were dry. Runoff during 1995 and 1998,

however, often resulted in higher parcel water tables in April 1996 and April 1999, respectively. If the perennial cover responded significantly to this rise in groundwater during a dry year, then the parcel could be considered for release from the DRP. Two tests of true recovery, especially for perennial cover increases that occurred in 1996 or 1997, were whether perennial cover was maintained, without significant lowering of groundwater, through 2000 and whether the increase in perennial cover was statistically significantly higher than baseline (and therefore responding like a Control parcel). In either case, it may be reasonable to assume that the water table was at least weakly connected to the perennial vegetation root zone.

The above considerations allowed most Wellfield parcels to be classified as either free from the DRP ("DRPfree") or still subject to the DRP ("DRP"). For a handful of parcels, additional information beyond the above considerations was used to make a determination; these are described as the "exceptions" (in Results below). To facilitate classification of parcels according to the DRP, and to ensure that the methods described above are repeatable, the above considerations were re-written in the style of a classification key, presented below.

The following questions were asked sequentially of all Wellfield parcels which had 2000 vegetation data:

1) Was the water table at baseline average or above in April 1995 or afterwards AND was average perennial cover at baseline or above following the water table return to baseline? If so, the parcel could be released from the DRP.

2) Was the 2000 water table in the root zone range for the parcel's vegetation type AND was the 2000 perennial cover greater than or equal to baseline average? If so, the parcel could be released from the DRP.

3) Was the 2000 water table in the root zone range for the parcel's vegetation type AND was the 1996, 1997, or 1999 perennial cover statistically significantly above baseline? If so, the parcel could be released from the DRP. If not, the parcel was still subject to the DRP.

Finally, for parcels with no 2000 vegetation data, Wellfield parcels were tentatively released from the DRP if the water table met or rose above baseline average in 1995 or afterwards.

Evaluation of 2001 Data

All parcels classified as DRPfree based on the 2000 data remained in this classification as of 2001. Therefore, it was only necessary to evaluate the 38 parcels previously classified as DRP to see if conditions had changed such that any parcel could be considered free from the DRP in 2001. Two parcels were added to this group: MAN037, which had been classified as "more study" by Manning (2001a) but reclassified as DRP based on additional studies (Manning 2001c) and the new-for-2001 parcel, IND029.

In recognition that 2001 was a low precipitation year, the 40 potential DRP parcels were queried based on the same criteria presented above. Positive changes in both water table and perennial cover were evaluated for evidence that soil water had recovered sufficiently to support perennial cover at baseline level. Thus, the following questions were asked sequentially:

1) Was the water table at baseline average or above in April 2001 AND was average 2001 perennial cover greater than or equal to baseline? If so, the parcel could be released from the DRP.

2) Was the 2001 water table in the root zone range for the parcel's vegetation type AND was average 2001 perennial cover greater than or equal to baseline? If so, the parcel could be released from the DRP. If not, the parcel is still subject to the DRP.

(Note: the third question used in 2000 proved irrelevant to the 2001 parcels, because none of the 40 potential DRP parcels exhibited perennial cover statistically significantly higher than baseline in 2001.)

There were no 2001 vegetation data for nine of the 40 parcels. For these nine, the parcel would be placed in the DRPfree category if 2001 DTW recovered to the 1985-87 baseline.

ArcView maps showing the location and 2001 DRP status of the monitored parcels were created.

Results

Control Parcels 2001

DTW and perennial cover data (if available) are presented for all 55 re-inventoried Control parcels in Table 4.

Table 4. Summary of DTW and perennial cover data for Control parcels. The columns show: mapped plant **community and type** (i.e., A, B, C, etc.) Community codes are:

35400 Rabbitbrush Scrub
36120 Desert Sink
36130 Greasewood Scrub
36150 Nevada Saltbush Scrub
45310 Alkali Meadow
45340 Rabbitbrush Meadow
45350 Nevada Saltbush Meadow

The **parcel** identifier in which the first 3 letters are an abbreviation for the USGS 7.5 minute quadrangle map on which it is located and the 3 numbers are the mapped parcel number. Parcels are sorted alphabetically. The USGS quadrangles are: Big Pine, Bishop, Blackrock, Fish Slough, Fish Springs, Independence, Laws, Lone Pine, Manzanar, Poleta

Canyon, Tinemaha Reservoir, Uhlmeyer Springs, and Union Wash

Under DTW the three columns are: **baseline DTW** in meters, which is the average of 1985-87 depth to water for that parcel ("nd" indicates no data available), the **DTW 2001** in meters, and the **difference** between the baseline average and 2001.

Perennial percent vegetation cover is shown for the LA**DWP** baseline year and as collected by Inyo County in 2001 (**INY01**). The **difference** between baseline and 2001 is shown. Perennial cover data with question marks indicate that no DWP baseline transect data were available, only summaries of the baseline vegetation conditions. Blanks under INY01 indicate the parcel was not inventoried in 2001.

The final column shows the parcel's **DRP status** in 2001, where:

C = Control

"w" preceding the status indicates that no 2001 vegetation data were collected

(Table 4)

	COMMUNITY and TYPE	PARCEL	DTW BASELINE DTW (avg 85-87)	DTW DTW (m) 2001	DTW DIFFERENCE BASE-01 (m)	PERENNIAL % cover DWP	PERENNIAL % cover INY01	PERENNIAL % cover DIFFERENCE 01-BASE	INYO DRP status2001
1	45310A	BGP013	nd	1.6		20.50	37.29	16.79	C
2	45310A	PLC136	nd	1.9		12.40	18.93	6.53	C
3	45310A	BLK115	1.37	1.4	-0.03	9.58	21.31	11.73	C
4	45310A	FSL187	nd	nd		14.33	41.71	27.38	C
5	35400B	PLC072	3.51	5.7	-2.19	15.33	25.79	10.46	C
6	35400B	PLC092	nd	5.7		10.50	16.13	5.63	C
7	35400B	PLC113	3.80	3.9	-0.10	13.00	19.81	6.81	C
8	36150B	IND122	1.99	1.2	0.79	29.33	35.63	6.30	C
9	36150B	IND096	1.46	0.4	1.06	29.33	23.33	-6.00	C
10	36150B	LNP019[1]	5.48	5.0	0.48	16.17	48.69	32.52	C
11	36150B	UNW039	1.71	1.7	0.01	27.17	31.32	4.15	C
12	45310C	BIS055	1.93	2.1	-0.17	44.60	52.17	7.57	C
13	45310C	IND1633	2.22	1.8	0.42	12.75	12.14	-0.61	C
14	45310C	LNP018[1]	6.58	5.8	0.78	18.33	44.33	26.00	C
15	45310C	BGP205	nd	2.2		22.83	27.81	4.98	C
16	45310C	MAN060	nd	nd		59.33	82.64	23.31	C
17	45310C	PLC024	2.39	3.8	-1.41	35.42	53.71	18.29	C
18	45310C	BGP047	1.70	2.2	-0.50	45.50	23.00	-22.50	C
19	45310C	BGP031	2.50	3.0	-0.50	16.80	30.43	13.63	C
20	45310C	PLC097	nd	3.5		35.17	56.14	20.97	C
21	45310C	PLC121	1.75	2.9		41.33	44.18	2.85	C
22	45310C	LNP050[1]	3.89	4.7	-0.81	48.00	48.50	0.50	C
23	45310C	UNW029	2.22	2.9	-0.68	16.75	19.93	3.18	C
24	45310C	PLC223	4.36	4.6	-0.24	15.00	28.67	13.67	C
25	45340C	PLC106	3.26	3.0	0.26	30?	19.93	-10.07	C
26	45340C	PLC137	nd	1.9		27.20	57.43	30.23	C
27	45350C	BGP204	nd	2.2		27.17	42.43	15.26	C

(Table 4)

	COMMUNITY and TYPE	PARCEL	DTW BASELINE DTW (avg 85-87)	DTW (m) 2001	DTW DIFFERENCE BASE-01 (m)	PERENNIAL % cover DWP	INY01	DIFFERENCE 01-BASE	INYO DRP status2001
28	45350C	MAN014	1.98	1.9	0.08	22.00	15.29	-6.71	C
29	45350C	UNW079[1]	6.29	6.4	-0.11	40.25	51.14	10.89	C
30	35400A	PLC239	1.97	2.6	-0.63	13.17			wC
31	35400A	PLC111	3.22	3.3	-0.08	8.83			wC
32	35400A	PLC064	3.63	4.0	-0.37	9.67			wC
33	35400A	PLC065	3.41	3.7	-0.29	10.67			wC
34	36130A	PLC246	1.93	2.8	-0.87	7.50			wC
35	36130A	PLC069	3.62	4.0	-0.38	12.00			wC
36	36150A	PLC241	1.92	2.5	-0.58	11.33			wC
37	36150A	PLC251	nd	nd		8.67			wC
38	36150A	PLC240	1.90	2.6	-0.70	11.17			wC
39	36150A	PLC055	2.69	2.7	-0.01	7.33			wC
40	45340A	PLC125	2.77	2.8	-0.03	10.89			wC
41	45340A	PLC263	nd	nd		10.25			wC
42	35400B	PLC110	3.13	2.9	0.23	13.17			wC
43	35400B	PLC193	2.75	3.0	-0.25	16.00			wC
44	35400B	PLC187	2.76	2.8	-0.04	12.83			wC
45	36150B	UNW073[1]	5.58	5.5	0.08	15.50			wC
46	36150B	PLC059	3.35	3.4	-0.05	17.00			wC
47	36150B	IND099	0.29	0.4	-0.11	20.00			wC
48	36150B	UNW072[1]	3.97	3.8	0.17	18.50			wC
49	45310C	PLC028	2.95	3.2	-0.25	38.50			wC
50	45310C	IND151[3]	2.29	1.7	0.59	45.50			wC
51	45310C	PLC220	2.66	2.9	-0.24	35.90			wC
52	45310C	IND087	1.50	1.4	0.10	38.00			wC
53	45310C	IND156[3]	1.69	1.5	0.19	31.00			wC
54	45340C	FSL179	nd	nd		52.17			wC
55	45340C	PLC056	2.20	2.5	-0.30	16.83			wC

Superscript 1 = 1985 not used in 1985-87 baseline average
Superscript 3 = 1987 not used in 1985-87 baseline average

Within Table 4, there are 29 parcels with 2001 vegetation data and 26 without 2001 vegetation data. These two groups are organized by vegetation management type, with type A parcels appearing first in each group. Table 5 summarizes the status of all 55 Control parcels.

Table 5. Status of Control parcels based on 2001 data. "wC" indicates that no vegetation data were collected in the parcel during 2001.

	Numbers of Parcels	
	C	wC
Type A	4	12
Type B	7	7

Type C	18	7
TOTAL	29	26

Figure 93 (Appendix C1 and inserted below) shows an example of a Control parcel, UNW029. This parcel is located about halfway between Lone Pine and Manzanar, east of the LA Aqueduct and west of the lower Owens River. Kriged DTW show a small decline in the estimated water level of 0.95m from 1987-89 (Table 2). By 1992, the water table began to rise gradually. The 1985-87 baseline DTW was 2.22m, the 2001 DTW was 2.9m, and from 1985-2001 the water table ranged between 2.1 and 3.3m (Appendix D). As corroborated by the perennial cover data, it is likely that these water levels were sufficient to supply ground water to the grass root zone of this parcel both during and after the drought. UNW029 was mapped as a type C Alkali Meadow with 16.8% baseline perennial cover in 1985. Perennial cover has exceeded baseline in all years UNW029 has been re-inventoried, 1992-2001 (Appendix B). In some years -- 1993, 1995, 1998, and 2000 -- perennial cover was statistically significantly greater than baseline, as noted with the asterisks in Figure 93.

Figure 93 (from Appendix C1). Example of a Control parcel, UNW029.

Not all Control parcel graphs follow the UNW029 example. Monitoring wells occur less frequently in non wellfield areas of the valley, so DTW data for Control parcels often contain gaps or anomalous estimates. Furthermore, Control parcels are subject to the same vegetation sampling and analysis limitations as all other parcels, such as inadequate baseline data, vegetation heterogeneity, biased (although random) transect placement, field sampling errors, and disturbances that occur at scales other than the parcel scale. As shown in Table 4, five Control parcels in 2001 exhibited lower cover than baseline.

Wellfield Parcels 2001

One parcel, TIN028, was moved from the DRP to the DRPfree classification based on 2001 data. TIN028, a type A Greasewood Scrub parcel, showed DTW at baseline in 2000 and 2001. Perennial cover averaged above baseline in 2001 (Figure 87, Appendix C1 and inserted below). These conditions allow this parcel to be freed from the DRP. This parcel contains permanent monitoring site BP4, and soil water data for the site show that the water table is recharging the root zone (ICWD data on file).

Figure 87 (from Appendix C1). TIN028 was classified as free from the DRP in 2001 because both its water table achieved the 1985-87 baseline level and perennial cover averaged above baseline. Evidence that the water table is recharging soil in the root zone of this parcel was obtained from the permanent monitoring site located in TIN028 (BP4).

Overall in 2001, of the 83 Wellfield parcels, 39 were determined to be still subject to the provisions of the DRP, and 44 were DRPfree. Four parcels were still classified as in need of more study.

Results of classification of the 23 type A Wellfield parcels are presented in Table 6. One parcel, FSP006, was classified as both types A and C because it crosses the boundary between two USGS quadrangles.

Table 6. Summary of DTW and perennial cover data for type A Wellfield parcels. Column headings, symbols, and abbreviations are described in the legend for Table 4. The final column shows the parcel's **DRP status** in 2001, where:

DRP = still subject to the Drought Recovery Policy
DRPfree = free from the Drought Recovery Policy and
more study = areas with DTW and/or vegetation changes that should be investigated further
"w" preceding the status indicates that the classification was made based on DTW information only (no 2001 vegetation data were collected)

An asterisk next to the DRP status indicates the parcel classification was an exception to the criteria stated in the Methods section. Reasons are explained in the text.

(Table 6)			DTW			PERENNIAL % cover			
	COMMUNITY and TYPE	PARCEL	BASELINE DTW (avg 85-87)	DTW (m) 2001	DIFFERENCE BASE-01 (m)	DWP	INY01	DIFFERENCE 01-BASE	INYO DRP status2001
1	36120A	BLK077	2.68	3.7	-1.02	16.33	14.69	-1.64	**DRP**
2	45310AC	FSP006	3.18	4.4	-1.22	25?	14.86	-10.14	**DRP**
3	36150A	IND231	2.77	6.6	-3.83	7.6?	9.40	1.80	**DRP**
4	45310A	LAW065	3.18	5.5	-2.32	9.67	8.21	-1.46	**DRP**
5	45310A	TIN068	3.79	4.7	-0.91	13.50	13.75	0.25	**DRP**
6	36150A	IND106	2.90	4.6	-1.70	8?	14.67	6.67	**DRP***
7	45310A	FSL065	1.31	2.0	-0.69	21.33	36.38	15.05	**DRPfree**
8	36130A	LAW063	4.07	6.0	-1.93	11.50	8.75	-2.75	**DRPfree**
9	36130A	TIN028	3.60	3.6	0.00	17.50	19.57	2.07	**DRPfree**
10	36120A	BLK069	1.69	2.0	-0.31	19?	18.67	-0.33	**DRPfree***
11	36120A	BLK040	2.33	2.7	-0.37	9.00			**wDRP**
12	45310A	BLK095	1.34	4.1	-2.76	16.43			**wDRP**
13	35400A	FSL118	4.20	6.4	-2.20	9.58			**wDRP**

(Table 6)			DTW			PERENNIAL % cover			
	COMMUNITY and TYPE	PARCEL	BASELINE DTW (avg 85-87)	DTW (m) 2001	DIFFERENCE BASE-01 (m)	DWP	INY01	DIFFERENCE 01-BASE	INYO DRP status2001
14	36130A	LAW104	4.87	5.4	-0.53	8.80			wDRP
15	36120A	TIN006	2.81	3.6	-0.79	24.00			wDRP
16	36130A	UHL052	4.17	6.1	-1.93	16.00			wDRP
17	36120A	BLK006	2.08	2.8	-0.72	16.50			wDRPfree
18	35400A	FSL122	2.02	2.3	-0.28	11.00			wDRPfree
19	36130A	LAW076	2.75	4.2	-1.45	6.50			wDRPfree
20	36150A	LAW154	2.85	2.9	-0.05	12.17			wDRPfree
21	35400A	LAW167	3.00	3.1	-0.10	4.70			wDRPfree
22	36120A	MAN034	2.45	2.8	-0.35	15.33			wDRPfree
23	36120A	IND066	1.11	2.1	-0.99	12.25			wmore study

Results of classification of the 65 types B and C Wellfield parcels are presented in Table 7. FSP006 is also included in Table 7.

Table 7. Summary of DTW and perennial cover data for types B and C Wellfield parcels. Column headings, symbols, and abbreviations are described in the legends for Tables 4 and 6.

(Table 7)			DTW			PERENNIAL % cover			
	COMMUNITY and TYPE	PARCEL	BASELINE DTW (avg 85-87)	DTW (m) 2001	DIFFERENCE BASE-01 (m)	DWP	INY01	DIFFERENCE 01-BASE	ICWD DRP status2001
1	36150B	BGP162	5.74	7.1	-1.36	30.33	11.80	-18.53	DRP
2	45340C	BIS085	4.27	6.0	-1.73	31.38	25.79	-5.59	DRP
3	35400B	BLK002	5.75	9.1	-3.35	16.00	14.68	-1.32	DRP
4	45310C	BLK009	2.75	3.1	-0.35	28.83	21.18	-7.65	DRP
5	36150B	BLK021	1.95	2.8	-0.85	30.67	17.86	-12.81	DRP
6	45350C	BLK024	3.53	4.2	-0.67	25.00	22.80	-2.20	DRP
7	45310C	BLK033	3.54	3.3	0.24	13.67	8.47	-5.20	DRP
8	45310C	BLK075	1.71	1.7	0.01	38.83	31.37	-7.46	DRP
9	45310C	BLK094	1.14	4.2	-3.06	40.56	27.35	-13.21	DRP
10	45340C	FSP004	4.07	5.2	-1.13	16.00	17.67	1.67	DRP
11	45310AC	FSP006	3.18	4.4	-1.22	25?	14.86	-10.14	DRP
12	45310C	IND029	1.46	3.6	-2.14	22.00	24.86	2.86	DRP
13	45350C	IND111	2.91	3.5	-0.59	40.60	36.50	-4.10	DRP
14	36150B	IND132	2.66	3.9	-1.24	32.90	18.68	-14.22	DRP
15	36150B	IND133	4.24	6.5	-2.26	13.5?	8.71	-4.79	DRP
16	45350C	IND139	1.94	3.1	-1.16	48.50	26.41	-22.09	DRP
17	45310C	LAW030	6.75	9.2	-2.45	23.08	24.50	1.42	DRP
18	45310C	LAW052	2.87	5.0	-2.13	27.83	4.93	-22.90	DRP
19	45340C	LAW062	3.92	5.9	-1.98	21.44	10.79	-10.65	DRP
20	45340C	LAW082	3.85	5.1	-1.25	16.50	3.64	-12.86	DRP
21	45310C	LAW085	4.19	4.6	-0.41	30.1?	10.20	-11.10	DRP
22	45350C	LAW112	3.82	4.1	-0.28	20.33	19.64	-0.69	DRP
23	45340C	LAW137	5.09	5.7	-0.61	20.42	22.86	2.44	DRP
24	36150B	MAN007	2.91	3.4	-0.49	28.00	20.84	-7.16	DRP

(Table 7)

	COMMUNITY and TYPE	PARCEL	DTW BASELINE DTW (avg 85-87)	DTW (m) 2001	DIFFERENCE BASE-01 (m)	PERENNIAL % cover DWP	INY01	DIFFERENCE 01-BASE	ICWD DRP status2001
25	36150B	MAN037	2.68	3.1	-0.42	42.00	25.43	-16.57	**DRP***
26	45310C	BGP0861	3.21	3.4	-0.19	19.17	47.29	28.12	**DRPfree**
27	45350C	BGP154	4.56	5.5	-0.94	24.17	28.89	4.72	**DRPfree**
28	35400B	BGP157	4.10	3.4	0.70	28.60	54.00	25.40	**DRPfree**
29	45310C	BLK016	2.04	2.3	-0.26	22.20	39.09	16.89	**DRPfree**
30	45310C	BLK039	3.05	2.8	0.25	21.67	27.80	6.13	**DRPfree**
31	45340C	BLK044	4.43	3.6	0.83	23.00	27.14	4.14	**DRPfree**
32	36150B	BLK074	1.58	1.9	-0.32	30.67	49.35	18.68	**DRPfree**
33	45310C	BLK099	0.88	2.1	-1.22	48.00	43.09	-4.91	**DRPfree**
34	45310C	BLK142	2.42	2.0	0.42	26.00	29.63	3.63	**DRPfree**
35	45310C	FSL123	2.10	2.5	-0.40	57.67	54.07	-3.60	**DRPfree**
36	45310C	IND011	0.90	1.8	-0.90	30.33	55.36	25.03	**DRPfree**
37	45310C	IND035	1.40	2.3	-0.90	49.50	49.44	-0.06	**DRPfree**
38	45310C	LAW078	2.28	3.7	-1.42	51.71	38.27	-13.44	**DRPfree**
39	45310C	LAW107	1.99	2.7	-0.71	46.86	55.43	8.57	**DRPfree**
40	45310C	LAW122	2.90	3.7	-0.80	59.56	71.57	12.01	**DRPfree**
41	45350C	LNP0451	4.10	4.6	-0.50	48.00	36.86	-11.14	**DRPfree**
42	45310C	MAN006	1.58	1.9	-0.32	22.75	29.28	6.53	**DRPfree**
43	36150B	PLC007	3.54	4.1	-0.56	26.70	29.72	3.02	**DRPfree**
44	45310C	TIN030	3.74	4.3	-0.56	31.42	35.17	3.75	**DRPfree**
45	45310C	TIN050	3.65	3.4	0.25	36.33	55.88	19.55	**DRPfree**
46	45310C	TIN053	4.26	4.4	-0.14	35.00	61.63	26.63	**DRPfree**
47	45310C	TIN064	6.06	6.6	-0.54	32.50	33.80	1.30	**DRPfree**
48	45310C	FSL051	2.94	3.9	-0.96	58.17	64.43	6.26	**DRPfree***
49	45310C	FSL116	2.39	4.2	-1.81	52.88	55.14	2.26	**DRPfree***
50	45310C	IND019	1.28	2.1	-0.82	75.00	63.94	-11.06	**DRPfree***
51	45310C	LAW110	2.82	3.9	-1.08	35.17	68.12	32.95	**DRPfree***
52	45310C	LAW120	4.39	5.2	-0.81	25.92	47.00	21.08	**DRPfree***
53	45310C	IND064	1.24	2.4	-1.16	38.50	26.64	-11.86	**more study**
54	45350C	IND067	1.25	1.8	-0.55	34.75	27.07	-7.68	**more study**
55	45310C	IND119	1.34	2.3	-0.96	33.67	13.11	-20.56	**more study**
56	35400B	BIS068	1.99	2.6	-0.61	15.40			**wDRP**
57	45310C	BLK011	2.69	4.5	-1.81	9.25			**wDRP**
58	36150B	LAW040	5.93	7.3	-1.37	14.67			**wDRP**
59	36150B	BGP088	3.52	3.5	0.02	18.55			**wDRPfree**
60	45310C	BLK143	2.50	1.5	1.00	39.83			**wDRPfree**
61	45340C	IND021	0.94	1.7	-0.76	68.00			**wDRPfree**
62	45310C	IND205	2.46	3.1	-0.64	26.25			**wDRPfree**
63	35400B	MAN017	3.24	4.0	-0.76	6.50			**wDRPfree**
64	35400B	MAN042	3.69	4.9	-1.21	18.00			**wDRPfree**
65	45310C	LAW109	2.84	4.1	-1.26	17.88			**wDRPfree***

Superscript 1 = 1985 not used in 1985-87 baseline average

Table 8. Summary of 2001 classification according to the DRP for 83 Wellfield and 4 more study parcels. (The asterisks show that FSP006, which is DRP, was counted as both A

and C, but it was only counted once in the column total.)

	Numbers of Parcels					
	DRP	wDRP	**DRPfree**	wDRPfree	**more study**	wmore study
Type A	**6***	6	**4**	6	**0**	1
Type B	**7**	2	**3**	3	**0**	0
Type C	**18***	1	**24**	4	**3**	0
TOTAL	**30**	9	**31**	13	**3**	1

Data for a type B Wellfield parcel that in 2001 was still subject to the DRP are presented below for BGP162 (Figure 9, inserted from Appendix C1). BGP162 is a large parcel east of Big Pine and west of the Owens River. The 1985-87 baseline average DTW was 5.74m. From 1987-89, the water table was drawn down an estimated 1.62m (Table 2). Although the water table showed some recovery after the drought, in 2001, it was still estimated at 7.1m. This depth is below both the baseline and the root zone of this type B Nevada Saltbush Scrub. In all years vegetation has been re-inventoried in this parcel, it has averaged well below baseline (Figure 9 and Appendix A). Baseline perennial cover was 30.3%, 2001 perennial cover was 11.8%. These data indicate that conditions in BGP162 have failed to recover from the drought.

Figure 9 (from Appendix C1). BGP162 was classified as still subject to the DRP in 2001 because its water table remained below the 1985-87 baseline level and the 4m root zone and perennial cover averaged below baseline.

It is possible for a DRP parcel to exhibit higher perennial cover than baseline. This occurs when the parcel water table remains below the 1985-87 baseline average DTW and below the root zone. In 2001, seven DRP parcels showed higher perennial cover than baseline, but water tables remained unrecovered. The seven parcels are: FSP004, IND029, IND106, IND231, LAW030, LAW137, and TIN068. One or more of the following may be influencing the apparent perennial cover response in these DRP parcels: slightly higher precipitation prior to the 2001 growing season; inadequate baseline data; biased (although random) placement of 2001 transects such that they did not adequately assess conditions throughout the parcel; inaccurate DTW estimates; and intermittent irrigation. Conditions in these parcels will be re-assessed following the 2002 growing season to see if increased perennial cover is sustained or if new DTW data indicates higher water tables. Of these seven parcels, six were classified consistent with the DRP evaluation criteria, and one, IND106, was classified as DRP in exception to the criteria. An explanation of why IND106 was classified as DRP occurs below under "Exceptions." Reasons why the other six DRP parcels may have exhibited perennial cover above baseline are discussed here.

FSP004: This parcel is in the Big Pine wellfield, west of Highway 395 and south of the irrigated fields south of Big Pine. The 1985-87 baseline average DTW for this type C Rabbitbrush Meadow is 4.07m (Table 7 and Figure 35). The water table beneath this parcel dropped nearly 5m during the drought. Since the drought, it gradually rose, peaking in 1999 at 4.9m. In 2001, DTW was 5.2m (Figure 35 and Appendix D). Because this water level is below the 1985-87 baseline and far below the plant root zone for this parcel, there is not convincing evidence that the water table sufficiently recovered from the drought or recharged soil in the 2m root zone. Baseline perennial cover for this parcel was 16%. The parcel was first re-inventoried in 1996, and its perennial cover from 1996-2000 was 14.8, 13.1, 15.5, 11.1, and 10.9. In 2001, the average perennial cover was measured as 17.7, thus greater than baseline for the first time in all years it has been monitored (Appendix B). This parcel is situated such that it could receive irrigation tailwater from the type E parcel immediately to its north. Inspection of the 15 transects for 2001 show the range in measured cover to be 4 - 49% (with the average = 17.7). Transect #9

in 2001 had 49% perennial cover, making it by far the highest cover transect ever run in this parcel in any year, including baseline. Transect 9 was located in a drainage channel area of the parcel that had high cover of both rabbitbrush (*Chrysothamnus nauseosus*) and sedges (*Carex* sp.), and relative to the other transects, its cover and composition were uncharacteristic of the rest of the parcel. If this transect were removed and the 2001 perennial cover recalculated, it would average 15.4%, thus below baseline. Because the 2001 perennial cover appears to have been highly influenced by one anomalous transect, and because water levels beneath this parcel have failed to achieve even the low baseline level, it is consistent with this DRP evaluation to continue to regard FSP004 as still subject to the DRP. Should the water table rise to at least baseline, it is likely that perennial cover throughout the parcel may show significant improvement. At that time, the parcel could be regarded as DRPfree.

IND029: This parcel is located west of well 382 in the Thibaut Sawmill wellfield. The 1985-87 baseline average DTW for this parcel was 1.46m (Table 7 and Figure 39). Its water table declined during the drought and has risen somewhat since the drought. In 2001, DTW was the highest it has been since 1989 (3.6m) (Figure 39 and Appendix D). However, this level is well below both the 1.46m baseline and the 2m root zone range for this type C Alkali Meadow parcel. Because the water table beneath this parcel has been gradually rising, it is possible that this upward trend will continue until the root zone is achieved. IND029 was first re-inventoried in 2001, so vegetation data from 1986 through 2000 are lacking. Data for only one baseline transect were found. Baseline perennial cover was 22% and two-thirds of this cover was phreatophytic grass (*Sporobolus airoides*) (14% absolute cover). The 14 transects from 2001 showed 24.9% perennial cover, but only 3% was accounted for by *S. airoides,* and the parcel is now dominated by sagebrush (*Artemisia tridentata*), a shrub species not even recorded during baseline. It is possible that low water table levels in combination with high precipitation during the mid and late 1990's promoted germination and establishment of nearby alluvial fan species in this parcel; that is, IND029l may be in transition from a type C Alkali Meadow to a type A Sagebrush Scrub. Regardless, due to its lack of water table recovery and to remain consistent with the parcel evaluation criteria, IND029 should be considered still subject to the DRP.

IND231: This parcel is in the Symmes Shepherd wellfield. The 1985-87 baseline average DTW for this parcel was 2.77m (Table 6 and Figure 52). Its water table declined about 6m during the drought and has risen somewhat since the drought. In 2001, the water level was the highest it has been since 1987, but still very deep at 6.6m (Figure 52 and Appendix D). The root zone for this type A Nevada Saltbush Scrub would be 4m. Baseline perennial cover was reported to be 7.6%, the lowest perennial cover of all the re-inventoried parcels. No actual baseline transect data exist for IND231, and it has long been suspected that the reported baseline cover is erroneous (Manning 1992a). Permanent monitoring site SS2 is located in this parcel. It was first run in 1987, and 34.4% cover was recorded. Since 1987, the transect cover has been trending downward; in 2001, it was 3%. Since IND231 was first re-inventoried in 1991, perennial cover has ranged from 3.9 to 16.9% and it tends to be higher in wetter years (1991, 1993, 1995, 1996, and 2001) (Figure 52 and Appendix B). With its very low water table, uncertain baseline perennial cover, poor permanent monitoring site conditions, and fluctuating parcel perennial

cover in recent years, IND231 cannot be regarded as recovered from the DRP.

LAW030: This parcel is located in the northeast part of the Laws wellfield on the downslope side of the Upper McNally Canal where it turns from eastward trending to southward trending. The 1985-87 baseline average DTW for this parcel was 6.75m (Table 7 and Figure 53). Its water table declined during the drought and has displayed an irregular pattern since the drought. In 2001, it was estimated at 9.2m, thus well below baseline and the 2m root zone for this type C Alkali Meadow (Figure 53 and Appendix D). LAW030 was selected for re-inventory because it is a relatively small Alkali Meadow parcel located near frequently used LADWP groundwater pumps that are not officially linked to a permanent monitoring site. Baseline perennial cover for the parcel, calculated from 12 transects, was 23.1%. During the drought, the type E irrigated agricultural field to the north of LAW030 was being irrigated with water from Coldwater Creek. In 1991, the DTW for LAW030 was 9.8m and the perennial cover was 12% (Figure 53, Appendix B and D). After 1994, however, the type E field was taken out of production, and most of the water from Coldwater Creek has been routed through a large ditch which flows diagonally through LAW030. This enhanced spreading in LAW030 has been associated with increased cover of perennial species, especially near the ditch. In effect, this type C parcel has been irrigated while the cultivated type E field has not. It can be reasoned that the perennial cover measured in recent years (24.5% in 2001) results from the effects of irrigation, not recovery of the water table. It is uncertain whether irrigation of LAW030 will continue in future years or whether the type E field will once again be cultivated, thereby curtailing the LAW030 irrigation water. For these reasons, LAW030 continues to be included in the re-inventory. The true test of recovery for this parcel would be maintenance of the baseline perennial cover (or above) in the absence of irrigation. With the low water levels estimated for this parcel, however, it is unlikely that 23% or greater cover will persist without water table recovery. Because of its lack of water table recovery as of 2001, and to be consistent with the classification criteria, LAW030 was classified as still subject to the DRP.

LAW137: This parcel is located in the southeastern area of the Laws wellfield, east and south of the McNally Pasture enhancement/mitigation project. The 1985-87 baseline average DTW for this parcel was 5.09m (Table 7 and Figure 66). Its water table declined during the drought and has gradually risen since the drought. In 2001, it was estimated at 5.7m, thus below baseline and well below the 2m root zone for this type C Rabbitbrush Meadow (Figure 66 and Appendix D). Baseline perennial cover was 20.4% and was calculated from 12 transects with a range in cover from 12-32%. Re-inventory transects have displayed a much wider range, indicating that this large parcel is not very homogeneous. In 2001, the average perennial cover was 22.9%, calculated from 14 transects ranging from 1-70%. The heterogeneity of LAW137 has made interpretation of its transect data and overall conditions problematic. Parts of the parcel are barren while other areas receive water in some years. The wide range in 2001 transect data do not indicate that perennial cover recovery has occurred throughout this parcel. Because of its low estimated water level, and to be consistent with the evaluation criteria, this parcel is classified as still subject to the DRP. A new test well was recently installed in LAW137; this should improve the parcel's future DTW estimates.

TIN068: This parcel is located southeast of well 349, east of the Owens River, and it contains permanent monitoring site TA5. The 1985-87 baseline average DTW for this parcel was 3.79m (Table 6 and Figure 92). Its water table declined during the drought and has gradually risen since the drought. In 1999 it peaked at 4.2m and in 2001 it was estimated at 4.7m (Figure 92 and Appendix D). Thus the water table has remained below baseline and below the 2m root zone for this type A Alkali Meadow. Baseline perennial cover for this parcel is relatively low, 13.5%, and perennial cover has ranged from 10.3-20.9% from 1992 through 2001 (Appendix B). In 2001, perennial cover was 13.8%. The trend in parcel perennial cover was mimicked at TA5 from1992 to about 1997, but since 1998, cover at TA5 has declined, opposite the trend in the parcel. The lack of corroborative information from the permanent monitoring site makes it difficult to interpret parcel-wide conditions for TIN068. It is possible that water from the water table recharges the root zone at this site, and a newly installed monitoring well, located just outside the northwest corner of TIN068, should provide improved DTW estimates for this parcel in the future. Due to the apparent lack of water table recovery, however, this parcel is classified as still subject to the DRP for the purposes of this evaluation. New information may improve the understanding of conditions in this parcel.

Exceptions

Exceptions to the DRP criteria were made for eight parcels. These eight are marked with an asterisk in the ICWD status column of Tables 6 and 7. Of these, the criteria applied to two parcels, IND106 and MAN037, suggested they could be freed from the DRP, but other data and information, described below, suggest they should be managed as still subject to the DRP. The other six parcels (FSL051, FSL116, IND019, LAW109, LAW110, and LAW120) were classified as free from the DRP even though they failed to meet the criteria presented. Again, other data and information were evaluated for these parcels, as explained below.

IND106: This parcel is located east of Independence and straddles Mazourka Canyon Road. The 1999 DTW estimate for IND106 was 4.3m, thus near but not within the root zone range of this Nevada Saltbush Scrub parcel. Since 1999, April DTW estimates have been 4.2m and 4.6m for 2000 and 2001, respectively (Figure 44 and Appendix D). The 1985-87 baseline target for IND106 is 2.9m, therefore well above the water table level achieved recently (Figure 44). Because there are test wells in and near the parcel, the DTW estimates for this parcel are probably accurate. Perennial cover for this parcel has consistently averaged above baseline in all years monitored, 1991-2001 (Figure 44 and Appendix B). However, with the low cover values measured in recent years (14 - 17%), and the lack of a perennial cover response to the "high" water level in 1999, it is not obvious that the plant roots have reconnected with the water table. No LADWP baseline transect data exist for IND106, and the reported very low baseline cover value of 8% has long been questioned (Manning 1992a). Because non-drought conditions prevailed during 1984-85 when this parcel was supposed to have been originally inventoried, and because 8% has been exceeded in all years IND106 has been monitored, both through the drought and since the drought ended, the 8% cover must be regarded with skepticism. Since 1991, the perennial cover has exceeded 20% in high precipitation years, so there is evidence that the cover at the site is being primarily influenced by precipitation, not groundwater. IND106 contains permanent monitoring site IO2, and the site is currently in OFF status. Although

vegetation cover along the permanent transect was high (28%) when first monitored in 1987 (a dry year), cover has dropped severely and in 2001 was measured at 3%. Soil water data from IO2 show that water from the water table has barely reached the plant root zone in one neutron access tube (ICWD data on file). If the soil water continues to be recharged via the water table, perennial vegetation throughout the parcel may respond in the future, but a response was not apparent as of 2001. Therefore, IND106 continues to be classified as subject to the DRP.

MAN037: This parcel is in the middle of the Bairs Georges wellfield and is west of Highway 395. The water table underneath MAN037 returned to baseline (2.68m) in 1996, but in all years except 2000, the perennial cover has been well below the vegetation baseline average of 42% (Figure 74). Based in the high perennial cover measured in the parcel during the 2000 field season (43.7%), the parcel was temporarily placed in the "more study" category until additional information could be collected on actual vegetation conditions throughout the parcel. Data from the permanent monitoring site located in this parcel, BG2, did not corroborate the sudden increase in perennial cover. Along the permanent transect, cover declined between 1999 and 2000, from 24% to 17%. Analysis of the 2000 transect locations revealed that, although selected randomly via computer, the transects over-represented the relatively higher-cover swales that run through the parcel. While the swales account for only approximately 20% of the parcel area, about 50% of the transects were randomly placed in the swales; thus the 2000 data over-weighted perennial vegetation in the swales, and the data did not provide an accurate view of 2000 vegetation conditions throughout the entire parcel (Manning 2001c). In an attempt to resolve the problems with the 2000 re-inventory data, a series of field tests were performed in 2001 (Manning 2001c). Results of these studies indicated that perennial cover throughout MAN037 had not recovered to baseline in 2000. Further, the 2001 re-inventory data averaged only 25% cover (Table 7), so vegetation conditions during 2001 remained below baseline. Due to the lack of perennial cover recovery, MAN037 has been classified as DRP.

FSL051, LAW109, and LAW110: These three parcels lay adjacent to and just north of the Owens River in Laws. All three have been classified as free from the DRP, but they do not strictly meet the stated criteria. For each parcel, DTW data showed that 1999 DTW came very close to but did not achieve baseline level (Figures 30, 62, and 116). Despite the rise in water level, the DTW data indicated that water tables for these three parcels were still below the 2m root zone. Based solely on these two factors, the parcels would all be classified as still subject to the DRP. However, perennial cover in FSL051 and LAW110 has been at or above baseline average since 1999, and cover has averaged 58% or higher (Figures 30 and 62). For an Alkali Meadow to achieve perennial cover greater than 50% in a dry year – or any year -- strongly suggests either irrigation or shallow groundwater. Two factors are likely to be influencing the water status of these parcels. First, water pumped from the gravel pits on Five Bridges Road is placed in a ditch that flows into then terminates in LAW109. Second, as discussed by Manning (2001a), subirrigation from the river may be occurring beneath these parcels. Neither water source can be accounted for in the kriging algorithm because there are no adequate monitoring wells in places that can readily detect it.

FSL116: This parcel is located near the intersection of Five Bridges and Riverside roads, northeast of Bishop. Its perennial cover exceeded baseline and was 68% and 55% in 2000 and 2001, respectively (Figure 32). However, DTW data show a decline in the water table in recent years and the water table in the 4m range (Figure 32 and Appendix D). Other evidence suggests that this parcel is subirrigated during the fall and winter months when water is supplied to Farmer's Pond (R. Harrington, personal communication). The kriged DTW values reflect water table conditions in April, only. It is possible that the soil was recharged by the winter irrigation but that the water table then dropped following the irrigation period and was recorded as being beyond the root zone by April. Assuming this scenario, and given the perennial vegetation response, FSL116 has been classified as free from the DRP.

IND019: As in the past (Inyo County Water Dept. staff 1999; Manning 2000a; Manning 2001a), this parcel continues to be classified as free from the DRP. It is located east of Fort Independence and west of the LA Aqueduct. Water levels exceeded baseline 1997-1999 and have been within the Alkali Meadow grass root zone since 1997 (Figure 38 and Appendix D). Perennial cover has exceeded 60% since 1998, suggesting groundwater or irrigation were affecting the parcel (Appendix B). LADWP baseline data indicate that only one transect was run in this parcel, so it is possible the baseline cover may have been overestimated. Although considered free from the DRP, the water table began a downward trend in 2000, which, if influenced by pumping from the Independence Oak wellfield, suggests there could be declines in perennial cover if the trend continues.

LAW120: This parcel is located in the Laws wellfield, south of the Laws Railroad Museum. The baseline average DTW for LAW120 is 4.39m. Although the water table has risen since the end of the drought, it has failed to achieve the baseline target. Thus, it has also failed to reach the 2m rooting zone for this type C Alkali Meadow parcel (Figure 64). Despite the low estimated water levels, perennial cover in the parcel has exceeded baseline since 1995 (Figure 64 and Appendix B). Permanent monitoring site L3, located within LAW120, exhibits a thick capillary fringe. At L3, recent measures of the water table show it to be about 4.8m, but the capillary fringe extends into the 2m root zone (ICWD data on file). Therefore, soil water is reaching the root zone from below in at least part of this parcel. Another factor contributing to perennial cover in LAW120 is intermittent water spreading over part of the parcel. Such spreading was observed only in 1998. Although not strictly meeting the criteria for release from the DRP, because LAW120 appears to have had soil in the root zone recharged from the water table, it was classified as DRPfree.

Additional Concerns

Some parcels that have been classified as DRPfree are beginning to show downward trends in both water table and perennial cover. Data for BGP154 (Figure 7), BLK099 (Figure 27), FSL051 (Figure 30), FSL116 (Figure 32), FSL123 (Figure 33), LAW063 (Figure 56), LAW107 (Figure 61), and LNP045 (Figure 69) show this trend. The downward trends appear most steep and significant for BLK099 (located in the Thibaut Sawmill wellfield near wells 103 and 104) and LNP045 (which may be affected by well 390 or other wells in Lone Pine). Below

average precipitation 1999-2001 and/or changes in surface water management practices may be affecting conditions in these parcels.

Conditions in many DRP parcels are poor. For examples, see BGP162 (Figure 9), BLK021 (Figure 17), IND139 (Figure 50), LAW052 (Figure 54), and MAN007 (Figure 74). Of the 30 DRP parcels with 2001 vegetation data, 23 show water tables well below baseline. Based on the 2001 data, seven parcels -- BLK009 (Figure 15), BLK024 (Figure 18), BLK075 (Figure 24), FSP004 (Figure 35), IND111 (Figure 45), LAW112 (Figure 63), and LAW137 (Figure 66) – were relatively close to recovery and may show recovery in the near future if soil water conditions improve. Reasons for the failure of water table recovery in the remaining 23 parcels should be examined. For a few parcels, improved 2002 DTW estimates from new monitoring wells may assist in recovery assessment.

Mapping of Results

Maps showing location and 2001 DRP status of all 142 monitored parcels are presented in Figure 145. These results show that although progress has been made in some parts of the Owens Valley, many parts of the valley have still not experienced sufficient water table and/or perennial vegetation recovery since the end of the 1987-92 drought to release them from the provisions of the Inyo/LA Standing Committee's Drought Recovery Policy (Appendix A). Areas where data show a lack of water table recovery to 1985-87 levels and a lack of perennial vegetation recovery to 1984-87 baseline level are: about half of the Laws wellfield; the Big Pine wellfield east and south of town; the western side of the Taboose Aberdeen and Thibaut Sawmill wellfields; the western side of the Independence Oak wellfield; most of the Symmes Shepard wellfield; and the center of the Bairs Georges wellfield. In addition, areas on the Bishop Cone were classified as still subject to the DRP.

Noteworthy areas where both water tables and perennial cover have achieved baseline include: the Laws wellfield areas closest to the Owens River, the north end of the Big Pine wellfield near Highway 168, and scattered parcels throughout the Taboose Aberdeen and Thibaut Sawmill wellfields.

The following two legal sized pages contain Figure 145. The figure legends appears below:

Figure 145. Map of parcels and 2001 status with regard to the Drought Recovery Policy for (a) the northern half of Owens Valley and (b) the southern half. Locations of permanent monitoring sites and LADWP production wells are also displayed. See map legend for explanation of colors and symbols.

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REFERENCES CITED

City of Los Angeles and County of Inyo. 1990a. Appendix B. Stipulation and Order for Judgement, section II: Agreement between the county of Inyo and the City of Los Angeles and its Department of Water and Power on a long term groundwater management plan for Owens Valley and Inyo County. In: Draft EIR: Water from the Owens Valley to supply the second Los Angeles Aqueduct; 1970 to 1990, and 1990 onward, pursuant to a long term groundwater management plan. SCH #89080705. 67 pp.

City of Los Angeles and County of Inyo. 1990b. Technical Appendix F. Green book for the long-term groundwater management plan for the Owens Valley and Inyo County. In: Draft EIR: Water from the Owens Valley to supply the second Los Angeles Aqueduct; 1970 to 1990, and 1990 onward, pursuant to a long term groundwater management plan. SCH #89080705. 176 pp.

Groeneveld, David P. 1992. Owens Valley, California plant ecology: Effects from export groundwater pumping and measures to conserve the local environment. pp. 128-155 in: C. A. Hall, Jr., V. Doyle-Jones, and B. Widawski (eds). The History of Water: Eastern Sierra Nevada, Owens Valley, White-Inyo Mountains. White Mountain Research Station Symposium Volume 4.

Harrington, Robert and Chris Howard. 2000. Depth to groundwater beneath vegetation reinventory parcels. Inyo County Water Dept. report, June 15, 2000.

Inyo County Water Dept. staff. 1999. Condition of selected vegetation parcels and assessment according to the Drought Recovery Policy. Inyo/LA Technical Group Report, March 2, 1999.

Manning, Sally. 1992a. Measuring Vegetation Change: Preliminary Report. Report submitted to Inyo/LA Technical Group, February 1992 and May 1992.

Manning, Sara J. 1992b. Describing and managing Owens Valley vegetation according to water use. pp. 156-170 in: C. A. Hall, Jr., V. Doyle-Jones, and B. Widawski (eds). The History of Water: Eastern Sierra Nevada, Owens Valley, White-Inyo Mountains. White Mountain Research Station Symposium Volume 4.

Manning, Sally. 1997. Line Point data analysis, 1996: Overview. Report submitted to Inyo/LA Technical Group, March 1997.

Manning, Sally. 1998. Results of 1997 vegetation re-inventory. Report submitted to Inyo/LA Technical Group, May 1998. Amended May 28, 1998.

Manning, Sally. 1999a. Summary of 1998 perennial cover and life form changes in parcels inventoried with line-point transects. Report submitted to Inyo/LA Technical Group April 14, 1999.

Manning, Sally. 2000a. The 1999 status of Owens Valley vegetation parcels according to the Drought Recovery Policy. Inyo/LA Technical Group Report, March 13, 2000.

Manning, Sally. 2000b. Summary of 1999 perennial cover and life form changes in parcels inventoried with line-point transects. Inyo/LA Technical Group Report, April 25, 2000.

Manning, Sara J. 2001a. The 2000 status of Owens Valley vegetation parcels according to the Drought Recovery Policy. Inyo/LA Technical Group Report, March 26, 2001.

Manning, Sara J. 2001b. Vegetation conditions in monitored Owens Valley parcels in 2000. Inyo/LA Technical Group Report, August 23, 2001.

Manning, Sara J. 2001c. Report on 2001 perennial vegetation conditions in Bairs Georges wellfield parcel Manzanar 37: Evidence that vegetation is still subject to the Drought Recovery Policy. Inyo/LA Technical Group Report, September 6, 2001.

NCDC (National Climatic Data Center). 1982-2001. Local climatological data. Bishop, CA.

Sokal, Robert R. and F. James Rohlf. 1987. Introduction to biostatistics. 2nd ed. New York: W. H. Freeman.

Appendix A. Photocopy of Drought Recovery Policy

Appendix B. Perennial cover for each parcel, all years. Shading indicates a statistically significant difference from baseline (one-tailed t-test at $p \leq 0.05$). Asterisks by parcel indicate no DWP transect data.

(Appendix B)	% COVER, PERENNIALS ONLY											
PARCEL	DWP	INY91	INY92	INY93	INY94	INY95	INY96	INY97	INY98	INY99	INY00	INY01
1 BGP013	20.50		37.67					30.42	38.17	29.08	33.57	37.29
2 BGP031	16.80		24.83	27.42	27.75	38.42	33.17	38.17	36.50	23.33	32.57	30.43
3 BGP047	45.50		21.07	22.25	22.08	29.00	32.57	31.93	33.29	42.29	32.86	23.00
4 BGP086	19.17		29.13	31.00	44.00	37.33	39.07	45.00	40.79	43.36	44.14	47.29
5 BGP088	18.55						17.87	25.00	33.60	14.67	24.20	
6 BGP154	24.17	18.13	12.93	16.14	17.92	21.86	28.61	43.78	30.44	24.67	35.67	28.89
7 BGP157	28.60		7.73			27.25	26.67	38.00	39.67	25.25	48.71	54.00
8 BGP162	30.33	8.44	7.08	8.04	10.15	12.21	14.47	10.90	16.20	8.50	22.47	11.80
9 BGP204	27.17		19.50			27.00	32.71	35.36	35.43	32.71	34.57	42.43
10 BGP205	22.83		11.56	14.19	28.25	28.44	18.75	22.56	31.81	19.69	22.56	27.81
11 BIS055	44.60										67.22	52.17
12 BIS068	15.40		9.25			16.20	13.57	17.57		8.21	6.93	
13 BIS085	31.38		23.83								25.50	25.79
14 BLK002	16.00						13.66			8.31	10.68	14.68
15 BLK006	16.50		25.83								25.54	
16 BLK009	28.83	8.05	22.22	18.50	14.30	26.35	22.27	26.95	31.77	22.05	24.91	21.18
17 BLK011	9.25										20.67	
18 BLK016	22.20	15.50	10.50	17.77	12.00	19.00	17.95	29.18	21.64	22.23	33.18	39.09
19 BLK021	30.67		19.67				12.67	17.42	26.00	14.42	11.43	17.86
20 BLK024	25.00	22.54	23.55	26.06	21.83	34.22	23.95	25.35	32.85	16.10	26.70	22.80
21 BLK033	13.67		6.83	17.75	8.50	9.75	11.87	13.93	15.27	8.47	6.27	8.47
22 BLK039	21.67		8.33	24.64	11.29	20.86	29.93	20.53	31.87	24.13	22.93	27.80
23 BLK040	9.00		3.42									
24 BLK044*	23.00	16.20	14.17	28.69	14.58	25.50	25.54	36.46	39.46	25.00	26.86	27.14
25 BLK069*	19.00	15.44	14.00	16.00	11.28	14.22	21.67	20.06	22.11	13.28	15.28	18.67
26 BLK074	30.67		33.10	34.30	28.70	49.65	44.85	44.10	50.25	40.25	38.30	49.35
27 BLK075	38.83		7.83	18.14	4.06	10.33	14.50	23.20	30.20	21.20	33.35	31.37
28 BLK077	16.33		6.33								13.81	14.69
29 BLK094	40.56	21.83	18.56	31.11	12.06	28.67	30.80	38.20	49.70	36.60	35.15	27.35

(Appendix B)	% COVER, PERENNIALS ONLY											
PARCEL	DWP	INY91	INY92	INY93	INY94	INY95	INY96	INY97	INY98	INY99	INY00	INY01
30 BLK095	16.43										23.45	
31 BLK099	48.00	46.12	43.82	48.36	42.41	47.59	56.36	50.14	66.77	79.45	62.09	43.09
32 BLK115	9.58		22.43	17.88	15.44	15.43	27.94	30.69	23.81	20.81	24.75	21.31
33 BLK142	26.00	25.33	25.00	33.21	22.36	31.64	22.87	39.33	32.38	19.00	20.25	29.63
34 BLK143	39.83										75.36	
35 FSL051	58.17	7.83	16.75	24.75	27.50					57.57	83.21	64.43
36 FSL065	21.33		23.64	26.06	19.75	25.69	25.44	20.50	26.38	41.81	39.13	36.38
37 FSL116	52.88		37.00								68.43	55.14
38 FSL118	9.58		6.63									
39 FSL122	11.00		7.40									
40 FSL123	57.67		18.22	26.17	29.67		43.83	49.92	61.08	65.00	55.71	54.07
41 FSL179	52.17						60.83					
42 FSL187	14.33		45.64	33.43	35.64	38.57	31.14	37.29	47.36	59.43	42.14	41.71
43 FSP004	16.00						14.80	13.07	15.53	11.13	10.87	17.67
44 FSP006*	25.00	14.82	15.92	12.50	10.08	20.17	13.75	24.17	23.33	10.08	15.79	14.86
45 IND011	30.33		22.55	39.93	36.64	39.42	55.21	60.57	54.93	62.77	63.36	55.36
46 IND019	75.00		33.15	50.06	32.63	51.50	53.75	56.19	66.25	62.31	65.50	63.94
47 IND021	68.00		37.92									
48 IND029	22.00											24.86
49 IND035	49.50		61.50	52.44	26.21	44.64	43.00	57.56	71.44	48.31	67.31	49.44
50 IND064	38.50		23.14	40.07	24.21	33.43	33.93	36.50	37.00	18.21	25.21	26.64
51 IND066	12.25		10.33									
52 IND067	34.75		13.29			27.25	29.93	43.73	39.60	20.13	17.53	27.07
53 IND087	38.00	30.44										
54 IND096	29.33	20.16	16.00	22.31	18.31	28.13	31.32	23.53	27.95	16.44	25.72	23.33
55 IND099*	20.00	14.00										
56 IND106*	8.00	14.33	10.83	16.68	10.26	23.11	14.53	19.05	23.85	14.63	17.06	14.67
57 IND111	40.60	22.56	24.55	33.95	17.11	36.21	31.21	36.47	48.11	36.95	38.89	36.50
58 IND119	33.67		13.15	18.81	11.88	19.31	22.11	13.33	16.39	8.39	14.00	13.11
59 IND122	29.33						25.94	31.56	34.63	35.00	35.69	35.63
60 IND132*	32.90	16.29	9.10	19.96	13.50	27.45	24.00	22.75	26.88	14.27	29.45	18.68
61 IND133*	13.50										9.21	8.71

(Appendix B)	% COVER, PERENNIALS ONLY											
PARCEL	DWP	INY91	INY92	INY93	INY94	INY95	INY96	INY97	INY98	INY99	INY00	INY01
62 IND139	48.50	10.56	12.62	19.86	8.09	28.91	24.32	16.23	38.91	20.45	24.32	26.41
63 IND151	45.50						23.79					
64 IND156	31.00	19.00										
65 IND163	12.75	8.71	10.82	14.67	7.71	18.50	16.41	18.27	23.59	15.91	16.36	12.14
66 IND205*	26.25						32.00					
67 IND231*	7.60	10.50	3.89	13.14	9.79	12.00	13.87	10.40	16.93	7.47	5.47	9.40
68 LAW030	23.08	12.00						16.25	21.16	27.25	32.07	24.50
69 LAW040	14.67		9.17				11.75	9.25	16.75	13.83	9.43	
70 LAW052	27.83	4.16						4.91	7.75	8.83	4.50	4.93
71 LAW062	21.44		1.50			3.00	5.50	9.71	11.21	18.07	13.50	10.79
72 LAW063	11.50	4.54	2.44	5.31	5.50	7.92	8.75	11.37	6.31	15.13	9.88	8.75
73 LAW065	9.67		1.75	4.08	3.58	7.58	6.00	5.28	5.07	7.92	7.00	8.21
74 LAW076	6.50		2.80								9.79	
75 LAW078	51.71		7.50					20.21	24.57	44.50	55.41	38.27
76 LAW082	16.50	5.50						2.58	5.83	4.33	5.14	3.64
77 LAW085*	30.10	5.11	5.79	17.92	5.50	18.75	13.79	9.78	10.87	12.50	19.00	10.20
78 LAW104	8.80		3.83									
79 LAW107	46.86		22.08	13.08	18.08	26.25	24.66	34.83	38.00	62.25	61.71	55.43
80 LAW109	17.88	3.18										
81 LAW110	35.17	11.33	10.89	20.64	29.14		40.88	38.81		59.41	63.71	68.12
82 LAW112	20.33		16.33			14.50	25.58	13.83	20.05	13.67	11.57	19.64
83 LAW120	25.92	14.18	12.58	19.17	11.58	29.08	28.83	29.50	41.66	33.17	41.29	47.00
84 LAW122	59.56		58.92	58.08	43.00	57.58	68.25	64.33	65.58	88.25	56.29	71.57
85 LAW137	20.42		8.63			15.25	12.43	16.00	18.36	21.86	16.50	22.86
86 LAW154	12.17		10.00				15.75					
87 LAW167	4.70		4.79				7.07					
88 LNP018	18.33		22.08	27.67	22.44	53.11	29.28	38.50	32.83	26.33	45.44	44.33
89 LNP019	16.17		36.67				23.21	32.64	41.93	34.79	37.57	48.69
90 LNP045	48.00		44.83			44.58	49.50	39.86	45.21	48.00	56.29	36.86
91 LNP050	48.00		16.14	47.39	20.94	39.67	38.22	29.44	56.44	39.06	46.06	48.50
92 MAN006	22.75		8.04	19.93	14.86	22.50	33.83	24.56	34.28	12.78	30.39	29.28
93 MAN007	28.00	14.94	11.92	15.54	10.04	28.75	9.68	13.85	24.38	16.40	18.30	20.84

(Appendix B)	% COVER, PERENNIALS ONLY											
PARCEL	DWP	INY91	INY92	INY93	INY94	INY95	INY96	INY97	INY98	INY99	INY00	INY01
94 MAN014	22.00		19.33			14.92	17.57	15.71	23.21	18.21	21.21	15.29
95 MAN017	6.50						5.19	13.63	7.50	16.63	9.13	
96 MAN034	15.33		9.50									
97 MAN037	42.00	7.36	8.06	19.00	18.22	26.28	14.92	24.08	28.67	20.88	43.68	25.43
98 MAN042	18.00						20.19				39.59	
99 MAN060	59.33		74.25	75.08	82.08	83.17	77.92	64.83	82.83	76.58	86.79	82.64
100 PLC007	26.70						32.61	26.78	33.00	25.94	28.56	29.72
101 PLC024	35.42		34.67	46.83	41.58	51.67	41.83	38.25	59.92	30.00	51.93	53.71
102 PLC028	38.50		19.00									
103 PLC055	7.33		15.69									
104 PLC056	16.83						19.21					
105 PLC059	17.00		27.00				23.07					
106 PLC064	9.67		4.67				8.58					
107 PLC065	10.67		6.71				16.79					
108 PLC069	12.00		6.08									
109 PLC072	15.33		17.33			24.64	30.57	21.86	24.29	27.64	24.29	25.79
110 PLC092	10.50		11.80			14.92	10.47	21.00	15.53	13.60	17.67	16.13
111 PLC097	35.17		21.28	28.00	38.17	50.38		62.50		71.36	45.21	56.14
112 PLC106*	30.00	19.38	17.73	16.00	15.07	17.25	19.21	21.29	28.21	17.57	18.14	19.93
113 PLC110	13.17		10.00									
114 PLC111	8.83		9.58									
115 PLC113	13.00		8.13			16.71	14.19	17.00	12.38	14.63	15.81	19.81
116 PLC121	41.33		35.28	48.13	43.81	43.31	63.71	54.00	46.94	62.24	47.47	44.18
117 PLC125	10.89		9.79				13.71					
118 PLC136	12.40		15.92	34.33	20.00	29.00	40.46	22.77	29.00	22.38	28.93	18.93
119 PLC137	27.20	41.38	51.50	37.08	47.17		40.08	61.92	51.46	59.00	47.13	57.43
120 PLC187	12.83		14.21				21.86					
121 PLC193	16.00		12.94				15.13					
122 PLC220	35.90	52.85										
123 PLC223	15.00	24.88	17.13	31.64	25.86	35.29	27.20	25.93	24.00	26.93	28.20	28.67
124 PLC239	13.17		9.93									
125 PLC240	11.17		14.78									

(Appendix B)	% COVER, PERENNIALS ONLY											
PARCEL	DWP	INY91	INY92	INY93	INY94	INY95	INY96	INY97	INY98	INY99	INY00	INY01
126 PLC241	11.33		12.42									
127 PLC246	7.50		9.93									
128 PLC251	8.67		5.43				10.36					
129 PLC263	10.25		11.25									
130 TIN006*	24.00	14.06										
131 TIN028	17.50	12.53	17.09	18.40	11.55	18.90	18.45	15.86	20.73	11.05	14.50	19.57
132 TIN030	31.42										41.78	35.17
133 TIN050	36.33									35.31	39.19	55.88
134 TIN053	35.00										61.69	61.63
135 TIN064	32.50	22.75								33.33	28.73	33.80
136 TIN068	13.50		12.50	17.69	10.31	16.63	20.88	17.75	11.56	13.19	18.81	13.75
137 UHL052	16.00		10.79									
138 UNW029	16.75		20.83	22.17	18.42	28.75	23.67	19.62	24.77	17.15	26.71	19.93
139 UNW039	27.17	7.50	29.86	27.05	20.55	34.77	44.27	28.18	48.82	35.50	43.55	31.32
140 UNW072	18.50		6.33				7.39			11.06		
141 UNW073	15.50		16.50				11.36	14.82	19.14			
142 UNW079	40.25		41.29			53.67	54.85	27.54	41.83	40.08	35.5	51.14

Appendix C. **Figures 3 - 144.** Graphs showing parcel perennial cover and estimated water table levels (relative to land surface) for each monitored parcel. The 1984-87 LADWP baseline perennial cover is graphed as the first bar; for reference, a line marks this level throughout all years. Asterisks above perennial cover bars indicate a statistically significant difference from baseline. The average of 1985-87 estimated water levels was used as the baseline water level. This level is plotted as a line across the water table graph. Missing water level data or data to be omitted due to errors or very large discrepancies in their estimations are marked with an "x" on the water table graphs. Water level data are presented in Appendix D.

Graphs are arranged as follows:

Appendix C1: **Figures 3 - 95** include all parcels for which 2001 vegetation data were collected. Parcels are arranged alphabetically.

Appendix C2: **Figures 96 - 144** include all parcels without 2001 vegetation data. These parcels are also arranged alphabetically.

Appendix D. Parcel average DTW, 1985-2001, estimated with kriging. Blanks indicate no data available; shaded data not used, per R. Harrington.

(Appendix D) PARCEL	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
BGP013								-1.5	-1.3	-1.6	-1.2	-1.6	-1.3	-1.2	-1.3	-1.4	-1.6
BGP031		-2.4	-2.6	-2.7	-2.9	-2.9	-3.0	-3.0	-2.7	-2.9	-2.6	-2.7	-2.6	-2.5	-2.9	-2.8	-3.0
BGP047	-1.6	-1.7	-1.7	-2.1	-2.2	-2.3	-2.3	-2.4	-2.1	-2.3	-1.8	-2.0	-1.9	-1.9	-2.0	-2.2	-2.2
BGP086		-3.1	-3.3	-4.9	-5.2	-4.4	-4.4	-4.4	-4.2	-3.5	-3.1	-3.2	-2.2	-3.3	-2.6	-2.8	-3.4
BGP088	-3.7	-3.5	-3.4	-5.0	-5.3	-4.6	-4.5	-4.3	-3.8	-3.4	-2.7	-3.4	-2.0	-4.0	-2.7	-3.1	-3.5
BGP154	-4.4	-4.3	-5.1	-7.2	-7.9	-6.7	-6.6	-6.6	-6.6	-5.5	-5.5	-5.1	-4.0	-5.2	-4.3	-4.1	-5.5
BGP157	-3.9	-4.2	-4.1	-5.4	-5.3	-4.9	-4.7	-3.7	-3.5	-3.0	-2.6	-2.7	-2.3	-3.3	-2.6	-2.9	-3.4
BGP162	-5.6	-5.7	-6.0	-7.0	-7.6	-8.0	-8.0	-8.1	-7.6	-7.8	-7.0	-6.7	-6.5	-6.8	-6.6	-6.7	-7.1
BGP204				-2.1	-2.2	-2.3	-2.4	-2.4	-2.3	-2.3	-2.0	-1.9	-1.9	-1.8	-1.9	-2.1	-2.2
BGP205				-2.1	-2.2	-2.3	-2.4	-2.4	-2.3	-2.3	-2.0	-2.0	-1.9	-1.9	-1.9	-2.1	-2.2
BIS055	-1.7	-1.7	-2.4	-2.5	-3.0	-3.1	-3.0	-2.7	-2.2	-2.6	-2.0	-2.2	-2.5	-2.5	-1.8	-2.2	-2.1
BIS068	-1.8	-2.0	-2.2	-2.4	-2.9	-3.0	-2.9	-2.8	-2.3	-2.7	-2.3	-2.3	-2.5	-2.6	-2.0	-2.3	-2.6
BIS085	-4.0	-4.3	-4.5	-5.3	-5.6	-5.8	-6.0	-6.4	-5.5	-5.5	-5.5	-4.8	-6.0	-6.0	-5.2	-5.5	-6.0
BLK002	-5.1	-6.1	-6.0	-10.9	-12.0	-12.2	-11.6	-10.9	-10.8	-10.2	-10.3	-7.4	-9.7	-9.5	-9.1	-9.6	-9.1
BLK006	-1.9	-2.5	-1.8	-2.5	-3.1	-3.7	-3.4	-3.4	-3.3	-3.2	-3.1	-2.7	-2.7	-2.5	-2.5	-2.7	-2.8
BLK009	-2.1	-3.4	-2.7	-6.4	-8.3	-8.4	-7.6	-6.4	-5.9	-5.1	-5.0	-3.9	-3.9	-3.4	-2.9	-3.3	-3.1
BLK011	-1.7	-3.6	-2.8	-7.7	-10.4	-10.9	-9.6	-8.6	-7.9	-7.1	-6.8	-4.0	-5.0	-4.8	-4.0	-4.5	-4.5
BLK016	-1.5	-2.7	-2.0	-4.4	-6.6	-7.1	-6.6	-5.9	-5.2	-4.5	-4.2	-3.6	-3.1	-2.6	-2.0	-2.3	-2.3
BLK021	-1.7	-2.4	-1.8	-2.9	-4.6	-5.3	-5.3	-5.3	-4.6	-4.2	-3.7	-3.5	-3.0	-2.9	-2.6	-2.7	-2.8
BLK024	-3.0	-4.0	-3.6	-5.7	-9.2	-9.6	-9.0	-8.3	-7.6	-6.8	-6.6	-5.5	-4.8	-4.8	-4.3	-4.3	-4.2
BLK033	-3.3	-3.6	-3.7	-4.9	-8.2	-8.8	-8.4	-7.4	-6.9	-5.8	-5.8	-4.7	-3.9	-4.0	-3.5	-3.4	-3.3
BLK039	-2.9	-3.2	-3.0	-4.5	-7.1	-7.9	-7.7	-6.6	-6.2	-5.3	-5.2	-3.9	-3.5	-3.4	-3.0	-2.8	-2.8
BLK040	-2.2	-2.6	-2.2	-3.2	-5.2	-6.0	-6.2	-5.7	-5.2	-4.6	-4.3	-3.6	-3.1	-3.1	-2.8	-2.7	-2.7
BLK044	-4.1	-4.5	-4.7	-6.7	-10.3	-10.9	-10.3	-8.5	-8.0	-6.6	-6.7	-5.0	-4.4	-4.3	-3.7	-3.7	-3.6
BLK069	-1.6	-2.0	-1.5	-2.0	-2.4	-2.8	-2.7	-2.9	-2.8	-2.7	-2.5	-2.3	-2.2	-1.9	-2.0	-2.0	-2.0
BLK074	-1.2	-1.6	-2.0	-1.8	-2.2	-3.0	-2.9	-3.1	-2.8	-2.8	-2.8	-2.3	-2.1	-2.0	-1.9	-1.9	-1.9
BLK075	-1.0	-1.8	-2.2	-2.6	-4.1	-4.8	-4.4	-5.1	-4.0	-4.2	-4.7	-3.1	-2.3	-2.3	-1.9	-1.8	-1.7
BLK077	-1.2	-2.4	-4.4	-4.8	-6.3	-7.4	-7.1	-7.5	-6.8	-6.4	-6.6	-4.7	-2.4	-4.2	-3.8	-3.9	-3.7
BLK094	-0.8	-1.3	-1.3	-3.9	-5.1	-6.5	-6.8	-7.0	-7.0	-6.7	-6.8	-3.9	-4.4	-4.1	-3.8	-4.0	-4.2
BLK095	-1.5	-1.3	-1.1	-3.8	-4.5	-5.7	-5.8	-6.0	-5.9	-5.7	-5.9	-3.6	-4.3	-4.1	-3.8	-4.1	-4.1
BLK099	-1.2	-0.7	-0.7	-1.7	-2.2	-2.8	-2.7	-3.0	-2.7	-2.9	-2.7	-2.1	-2.2	-1.4	-1.8	-2.1	-2.1

(Appendix D) PARCEL	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
BLK115	-1.3	-1.6	-1.3	-1.7	-1.9	-2.0	-1.9	-1.9	-1.8	-1.8	-1.7	-1.9	-1.8	-1.9	-1.8	-1.8	-1.4
BLK142	-2.0	-3.4	-1.9	-3.8	-4.2	-4.1	-3.7	-3.5	-3.2	-2.8	-2.5	-2.2	-2.0	-1.9	-1.8	-2.1	-2.0
BLK143	-2.1	-3.5	-2.0	-3.6	-4.3	-3.9	-3.4	-3.3	-2.9	-2.6	-2.3	-2.0	-1.7	-1.4	-1.2	-1.6	-1.5
FSL051	-2.4	-3.1	-3.3	-5.5	-5.6	-5.9	-6.0	-5.6	-5.7	-5.2	-5.4	-4.2	-4.6	-4.3	-3.3	-3.9	-3.9
FSL065	-1.1	-1.8	-1.0	-2.5	-2.5	-2.4	-2.4	-1.8	-1.4	-1.7	-1.9	-1.4	-1.6	-2.2	-1.9	-1.8	-2.0
FSL116	-2.5	-2.3	-2.3	-3.4	-3.1	-2.7	-2.7	-2.8	-2.1	-2.8	-2.7	-3.0	-3.7	-4.0	-3.7	-4.0	-4.2
FSL118	-4.7	-3.5	-4.4	-5.2	-5.9	-5.1	-5.0	-5.4	-3.9	-4.9	-4.1	-4.4	-5.4	-5.5	-5.4	-6.0	-6.4
FSL122	-1.9	-2.5	-1.7	-4.4	-4.4	-3.0	-3.3	-2.9	-2.6	-3.0	-2.2	-1.6	-2.0	-2.3	-1.9	-2.0	-2.3
FSL123	-1.9	-2.7	-1.7	-4.6	-5.1	-3.4	-3.6	-3.2	-2.9	-3.3	-2.6	-1.9	-2.3	-2.6	-2.1	-2.2	-2.5
FSL179																	
FSL187																	
FSP004	-3.4	-4.5	-4.3	-5.7	-6.5	-7.1	-8.6	-7.2	-7.2	-6.5	-6.8	-5.5	-5.5	-5.9	-4.9	-4.9	-5.2
FSP006	-2.5	-3.8	-3.3	-4.6	-5.5	-6.3	-6.7	-6.7	-6.3	-6.1	-6.1	-4.8	-4.4	-4.5	-3.7	-4.0	-4.4
IND011	-0.9	-0.9	-0.9	-1.8	-2.2	-2.5	-2.7	-2.7	-2.0	-1.9	-2.0	-2.8	-1.5	-0.9	-0.8	-1.7	-1.8
IND019	-1.3	-1.5	-1.0	-2.5	-3.1	-3.6	-4.0	-4.1	-3.5	-2.9	-3.4	-4.2	-0.9	-0.7	-1.2	-2.1	-2.1
IND021	-1.0	-0.9	-0.9	-1.7	-2.0	-2.4	-2.7	-2.7	-1.9	-1.7	-1.8	-3.1	-1.2	-0.7	-0.8	-1.7	-1.7
IND029	-1.6	-1.1	-1.6	-3.3	-3.5	-4.6	-4.7	-5.9	-6.0	-6.0	-5.9	-5.7	-5.6	-5.2	-4.0	-3.8	-3.6
IND035	-1.5	-1.3	-1.4	-3.3	-3.8	-4.1	-4.7	-5.3	-5.4	-5.3	-5.1	-4.7	-4.0	-3.4	-2.2	-2.4	-2.3
IND064	-1.2	-1.3	-1.2	-2.0	-2.3	-2.6	-2.4	-2.5	-2.5	-2.5	-2.5	-2.4	-2.4	-2.3	-2.2	-2.2	-2.4
IND066	-1.1	-1.0	-1.2	-1.8	-2.1	-2.3	-2.2	-2.3	-2.3	-2.3	-2.3	-2.2	-2.2	-2.1	-2.0	-2.0	-2.1
IND067	-1.2	-1.4	-1.1	-1.9	-2.1	-2.4	-2.3	-2.3	-2.2	-2.0	-1.9	-2.2	-1.8	-2.0	-1.9	-2.0	-1.8
IND087	-1.5	-1.6	-1.5	-1.7	-1.7	-1.8	-1.7	-1.7	-1.9	-2.1	-1.7	-1.8	-1.5	-1.3	-1.4	-1.4	-1.4
IND096	-0.8	-1.8	-1.8	-0.8	-0.9	-1.1	-0.8	-1.1	-1.0	-1.0	-0.9	-2.1	-0.6	-0.4	-0.5	-0.3	-0.4
IND099	-0.1	-0.4	-0.4	-0.8	-0.9	-1.2	-1.0	-1.0	-1.0	-1.0	-0.9	-3.3	-0.7	-0.6	-0.7	-0.5	-0.4
IND106	-2.5	-3.2	-3.0	-6.5	-6.9	-7.0	-8.4	-6.6	-8.0	-6.6	-6.5	-6.5	-5.9	-5.1	-4.3	-4.2	-4.6
IND111	-3.4	-2.3	-3.0	-4.8	-6.1	-6.3	-6.4	-6.4	-6.1	-5.2	-5.2	-5.0	-3.6	-3.2	-3.0	-3.2	-3.5
IND119	-1.2	-1.5	-1.3	-2.2	-2.4	-2.7	-2.5	-2.6	-2.5	-2.5	-2.5	-2.5	-2.4	-2.3	-2.3	-2.3	-2.3
IND122	-1.4	-2.5	-2.1	-2.1	-2.5	-2.6	-2.9	-2.2	-2.5	-1.9	-2.0	-2.0	-1.6	-1.3	-1.1	-1.1	-1.2
IND132	-3.0	-2.7	-2.3	-4.9	-7.0	-7.8	-7.1	-6.9	-6.7	-6.8	-6.5	-6.2	-5.5	-4.5	-3.8	-3.7	-3.9
IND133	-4.2	-4.4	-4.1	-8.4	-10.8	-11.6	-11.0	-10.4	-10.2	-10.0	-10.0	-9.7	-8.8	-7.7	-6.8	-6.4	-6.5
IND139	-1.0	-2.5	-2.3	-5.8	-8.2	-6.4	-7.1	-6.5	-5.5	-4.5	-4.7	-6.0	-4.8	-4.1	-3.6	-3.3	-3.1
IND151	-2.0	-2.5	-1.4	-2.5	-2.7	-2.6	-2.7	-2.6	-2.4	-2.7	-2.4	-2.6	-2.4	-2.3	-1.7	-2.3	-1.7
IND156	-1.3	-2.0	-0.6	-2.0	-2.0	-2.0	-2.1	-2.0	-1.9	-2.0	-1.7	-2.9	-1.8	-1.9	-1.4	-1.9	-1.5

(Appendix D) PARCEL	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
IND163	-2.1	-2.4	-1.0	-2.7	-2.7	-2.8	-2.8	-2.7	-2.7	-2.7	-2.7	-2.8	-2.7	-2.6	-1.7	-2.5	-1.8
IND205	-2.9	-2.1	-2.4	-3.6	-6.4	-6.1	-6.0	-6.3	-6.3	-5.1	-4.6	-3.6	-3.0	-2.3	-2.6	-2.7	-3.1
IND231	-2.0	-3.1	-3.2	-7.6	-8.4	-8.4	-9.1	-9.0	-8.9	-8.4	-8.4	-9.0	-8.8	-8.0	-7.1	-6.7	-6.6
LAW030	-4.2	-7.8	-8.2	-10.8	-9.8	-9.8	-9.8	-9.8	-9.8	-10.1	-10.0	-10.0	-10.0	-10.4	-8.1	-8.9	-9.2
LAW040	-3.7	-7.3	-6.8	-11.1	-9.1	-8.9	-9.1	-9.0	-9.0	-10.9	-9.1	-9.4	-10.1	-9.1	-5.0	-6.9	-7.3
LAW052	-3.1	-2.5	-3.0	-9.0	-10.5	-7.5	-8.2	-8.3	-8.9	-6.6	-7.7	-5.8	-6.8	-6.4	-2.8	-4.9	-5.0
LAW062	-2.8	-4.2	-4.7	-8.2	-9.0	-9.0	-9.1	-9.0	-9.6	-7.8	-8.9	-6.1	-7.9	-6.4	-3.5	-5.4	-5.9
LAW063	-2.6	-4.6	-4.9	-8.0	-8.5	-8.3	-8.9	-8.4	-9.0	-7.9	-8.6	-6.6	-8.2	-7.2	-3.8	-5.7	-6.0
LAW065	-2.1	-3.5	-3.9	-6.6	-7.1	-6.1	-7.5	-6.3	-7.7	-6.7	-7.4	-5.9	-7.2	-6.7	-3.9	-5.5	-5.5
LAW076	-2.1	-3.5	-2.6	-5.4	-6.0	-5.0	-6.0	-5.6	-6.3	-5.1	-5.9	-4.3	-5.1	-5.2	-2.8	-4.0	-4.2
LAW078	-2.3	-2.1	-2.5	-5.5	-7.2	-8.3	-7.0	-8.0	-8.4	-5.7	-6.6	-4.2	-5.4	-4.6	-2.2	-3.4	-3.7
LAW082	-4.0	-4.1	-3.5	-9.2	-11.6	-11.2	-11.0	-10.7	-11.2	-7.6	-8.9	-6.4	-7.6	-6.9	-3.3	-4.9	-5.1
LAW085	-3.7	-5.1	-3.8	-7.9	-9.8	-11.7	-9.9	-10.1	-9.9	-7.3	-8.0	-5.8	-6.4	-6.0	-3.7	-4.4	-4.6
LAW104	-3.9	-5.7	-5.0	-8.7	-10.0	-11.7	-10.3	-9.6	-9.0	-7.5	-7.7	-6.6	-7.3	-6.8	-5.2	-5.5	-5.4
LAW107	-1.8	-2.4	-1.8	-3.9	-5.2	-6.6	-5.6	-6.0	-5.9	-4.4	-4.7	-3.2	-3.8	-3.5	-1.8	-2.5	-2.7
LAW109	-2.3	-3.1	-3.1	-5.3	-5.5	-5.7	-6.0	-5.6	-5.8	-5.2	-5.5	-4.2	-4.8	-4.5	-3.3	-3.9	-4.1
LAW110	-2.4	-3.3	-2.7	-4.8	-5.2	-5.6	-5.9	-5.4	-5.7	-4.8	-5.0	-3.9	-4.4	-4.5	-3.1	-3.7	-3.9
LAW112	-3.0	-4.6	-3.9	-7.1	-8.2	-9.6	-8.3	-8.1	-7.1	-6.1	-5.8	-4.8	-5.6	-4.8	-3.8	-4.0	-4.1
LAW120	-4.0	-4.8	-4.3	-7.1	-8.9	-10.3	-10.1	-10.3	-9.1	-6.8	-6.5	-5.5	-6.5	-5.8	-4.8	-5.2	-5.2
LAW122	-2.8	-3.7	-2.2	-3.4	-4.6	-5.7	-5.8	-6.2	-5.4	-4.6	-3.9	-3.2	-3.4	-3.5	-2.8	-3.5	-3.7
LAW137	-4.5	-4.7	-6.1	-8.6	-9.6	-9.6	-9.8	-9.5	-9.6	-8.4	-8.6	-6.5	-6.9	-7.1	-5.7	-5.9	-5.7
LAW154	-3.0	-3.5	-2.1	-3.0	-3.7	-4.3	-4.0	-4.5	-3.6	-3.3	-2.4	-2.8	-2.5	-3.1	-2.6	-2.9	-2.9
LAW167	-3.1	-3.4	-2.5	-3.3	-3.9	-4.5	-4.2	-4.5	-3.8	-3.6	-2.8	-3.2	-3.0	-3.7	-3.0	-3.3	-3.1
LNP018		-7.3	-5.9	-6.4	-6.1	-6.0	-5.9	-5.5	-5.5	-4.9	-5.1	-5.5	-5.4	-5.8	-5.7	-6.0	-5.8
LNP019		-6.0	-4.9	-5.3	-4.9	-4.6	-4.8	-4.4	-4.6	-4.1	-4.2	-4.4	-4.3	-4.9	-4.3	-4.8	-5.0
LNP045		-4.7	-3.5	-3.6	-4.5	-4.4	-5.1	-4.8	-4.9	-4.1	-4.0	-2.7	-2.8	-3.1	-2.8	-3.6	-4.6
LNP050		-4.2	-3.5	-4.1	-4.8	-4.8	-5.2	-5.1	-5.1	-4.4	-4.1	-2.8	-3.0	-3.2	-2.9	-3.7	-4.7
MAN006	-1.1	-1.9	-1.7	-3.1	-4.4	-3.9	-3.4	-3.1	-2.8	-3.1	-3.0	-2.8	-2.5	-2.3	-2.0	-1.9	-1.9
MAN007	-2.2	-3.5	-3.0	-4.9	-5.2	-5.3	-4.8	-4.5	-4.3	-4.3	-4.1	-3.9	-3.7	-3.5	-3.3	-3.4	-3.4
MAN014	-1.8	-2.3	-1.8	-2.8	-2.8	-2.8	-2.9	-2.5	-2.3	-2.5	-2.4	-2.4	-2.3	-2.3	-2.1	-2.3	-1.9
MAN017	-2.5	-3.6	-3.7	-7.1	-9.1	-6.9	-6.0	-5.7	-5.5	-5.8	-5.7	-5.0	-4.7	-4.0	-3.7	-3.7	-4.0
MAN034	-1.6	-3.1	-2.6	-3.1	-3.3	-4.5	-3.7	-3.5	-3.1	-3.3	-3.1	-2.7	-2.7	-2.4	-2.1	-2.6	-2.8
MAN037	-1.2	-3.7	-3.2	-4.6	-4.7	-5.8	-5.0	-3.9	-3.5	-3.6	-3.5	-2.7	-2.7	-2.6	-2.3	-3.0	-3.1

(Appendix D) PARCEL	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
MAN042	-2.1	-4.2	-4.7	-7.1	-7.4	-8.0	-6.2	-5.6	-5.7	-5.5	-5.7	-4.8	-4.9	-4.3	-4.2	-4.5	-4.9
MAN060																	
PLC007	-3.5	-3.1	-4.0	-4.4	-4.9	-5.1	-4.9	-4.7	-4.5	-4.5	-4.2	-3.9	-4.2	-4.2	-3.9	-4.1	-4.1
PLC024	-2.5	-2.1	-2.6	-2.7	-2.9	-3.1	-3.0	-3.8	-2.9	-3.9	-2.5	-3.2	-2.5	-2.5	-2.7	-2.8	-3.8
PLC028	-2.7	-2.9	-3.3	-3.5	-3.9	-4.0	-3.9	-3.7	-3.5	-3.7	-3.6	-3.1	-3.4	-4.2	-3.1	-3.3	-3.2
PLC055	-2.6	-2.9	-2.5	-2.8	-3.2	-3.0	-2.9	-2.9	-2.7	-2.7	-2.4	-2.5	-2.5	-2.8	-2.7	-2.8	-2.7
PLC056	-2.2	-2.2	-2.2	-2.2	-2.6	-2.4	-2.3	-2.5	-2.1	-2.5	-1.9	-1.9	-2.0	-1.9	-2.0	-2.2	-2.5
PLC059	-3.5	-3.3	-3.3	-3.6	-3.8	-3.8	-3.8	-3.8	-3.6	-3.4	-3.3	-3.5	-3.4	-3.6	-3.6	-3.6	-3.4
PLC064	-3.8	-3.3	-3.8	-3.9	-4.2	-4.3	-4.3	-4.4	-4.3	-4.2	-4.3	-3.9	-4.0	-3.8	-3.7	-3.7	-4.0
PLC065	-3.6	-3.0	-3.7	-3.8	-4.0	-4.0	-4.0	-4.0	-4.0	-3.9	-3.9	-3.7	-3.8	-3.6	-3.6	-3.7	-3.7
PLC069	-3.7	-3.3	-3.8	-3.8	-4.1	-4.1	-4.2	-4.2	-4.2	-4.2	-4.2	-3.8	-3.9	-3.5	-3.5	-3.6	-4.0
PLC072	-3.5	-3.9	-3.1	-3.5	-3.6	-3.7	-3.7	-3.8	-3.5	-3.5	-3.3	-3.6	-3.2	-3.7	-3.5	-3.6	-5.7
PLC092	-3.7	-5.0	-3.6	-3.7	-3.8	-3.2	-3.2	-3.4	-3.2	-3.3	-3.2	-3.0	-2.9	-4.8	-4.8	-4.9	-5.7
PLC097	-5.1	-5.2	-4.3	-4.6	-4.6	-3.3	-3.5	-3.5	-3.2	-3.2	-3.0	-3.2	-2.8	-3.8	-3.6	-3.9	-3.5
PLC106	-3.2	-3.1	-3.4	-3.4	-3.5	-3.5	-3.5	-3.6	-3.3	-3.3	-3.2	-3.2	-3.0	-2.8	-2.8	-3.1	-3.0
PLC110	-3.1	-3.0	-3.3	-3.3	-3.4	-3.4	-3.4	-3.5	-3.1	-3.2	-2.7	-2.7	-2.9	-2.6	-2.5	-3.0	-2.9
PLC111	-3.0	-3.0	-3.6	-3.6	-3.7	-3.7	-3.7	-3.7	-3.5	-3.4	-3.0	-3.1	-3.3	-2.9	-2.9	-3.4	-3.3
PLC113	-3.8	-3.6	-4.0	-4.0	-4.1	-4.0	-4.1	-4.1	-4.0	-4.0	-3.9	-3.9	-3.9	-3.7	-3.7	-3.9	-3.9
PLC121	-1.2	-1.3	-2.8	-2.9	-3.0	-3.0	-3.0	-3.0	-2.8	-2.8	-1.0	-1.0	-2.7	-1.0	-1.3	-2.9	-2.9
PLC125	-2.5	-2.6	-3.1	-3.2	-3.3	-3.3	-3.3	-3.3	-3.0	-3.0	-2.1	-2.1	-2.8	-2.1	-2.1	-2.9	-2.8
PLC136	-5.7	-4.1	-3.9	-4.0	-4.0	-2.4	-2.6	-2.8	-2.6	-2.7	-2.5	-2.1	-2.0	-1.9	-1.8	-3.7	-1.9
PLC137	-5.9	-4.3	-4.1	-4.1	-4.2	-2.2	-2.4	-2.7	-2.5	-2.6	-2.6	-1.9	-2.0	-1.7	-1.7	-2.8	-1.9
PLC187	-2.8	-2.5	-3.0	-3.1	-3.2	-3.2	-3.2	-3.3	-3.0	-3.1	-2.4	-2.2	-2.7	-2.2	-2.3	-2.8	-2.8
PLC193	-2.8	-2.6	-2.8	-3.0	-3.1	-3.1	-3.2	-3.1	-2.9	-3.0	-2.6	-2.7	-2.8	-2.5	-3.1	-2.9	-3.0
PLC220	-2.6	-2.7	-2.6	-2.8	-3.1	-3.0	-2.9	-3.0	-2.7	-3.0	-2.5	-2.6	-2.5	-2.7	-2.8	-2.8	-2.9
PLC223	-4.5	-4.1	-4.5	-4.5	-4.8	-4.6	-4.6	-4.7	-4.5	-4.7	-4.3	-4.2	-4.3	-4.2	-4.3	-4.4	-4.6
PLC239	-2.0	-1.8	-2.1	-2.2	-2.4	-2.5	-2.5	-2.5	-2.2	-2.4	-2.0	-1.9	-2.1	-2.0	-2.2	-2.4	-2.6
PLC240	-1.9	-1.6	-2.2	-2.3	-2.4	-2.6	-2.6	-2.6	-2.3	-2.4	-2.0	-1.9	-2.2	-1.9	-2.1	-2.5	-2.6
PLC241	-2.0	-1.7	-2.1	-2.2	-2.3	-2.5	-2.4	-2.5	-2.2	-2.3	-1.9	-1.9	-2.1	-1.9	-2.1	-2.4	-2.5
PLC246	-2.0	-1.5	-2.3	-2.4	-2.5	-2.7	-2.6	-2.7	-2.4	-2.6	-2.1	-2.0	-2.4	-2.1	-2.4	-2.7	-2.8
PLC251																	
PLC263																	
TIN006	-2.8	-2.9	-2.7	-3.6	-4.3	-5.0	-5.1	-5.1	-5.1	-5.1	-5.0	-4.2	-3.8	-3.7	-3.5	-3.5	-3.6

(Appendix D) PARCEL	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
TIN028	-3.8	-4.1	-2.8	-4.1	-4.7	-5.2	-5.2	-5.1	-5.0	-4.7	-4.7	-4.5	-4.3	-4.1	-3.8	-3.6	-3.6
TIN030	-2.4	-4.4	-4.4	-5.5	-5.6	-6.2	-6.2	-6.5	-6.5	-5.8	-5.2	-4.6	-4.4	-4.2	-3.8	-4.1	-4.3
TIN050	-3.2	-4.3	-3.5	-7.0	-7.3	-6.6	-6.2	-5.6	-5.4	-5.7	-4.7	-4.3	-3.8	-3.6	-3.2	-4.2	-3.4
TIN053	-3.7	-4.8	-4.2	-9.7	-9.8	-8.9	-8.0	-7.0	-6.4	-7.9	-5.6	-5.4	-4.7	-4.7	-4.1	-5.5	-4.4
TIN064	-5.6	-6.2	-6.3	-9.2	-10.2	-10.4	-9.6	-9.0	-8.5	-8.8	-7.8	-7.3	-6.8	-6.2	-5.9	-6.8	-6.6
TIN068	-3.5	-4.2	-3.7	-7.3	-7.6	-7.8	-7.1	-6.6	-6.0	-6.9	-5.3	-5.2	-4.7	-4.5	-4.2	-5.2	-4.7
UHL052	-2.0	-5.1	-5.3	-6.0	-6.3	-6.9	-7.1	-7.1	-6.7	-6.7	-6.9	-6.1	-5.8	-6.1	-6.0	-6.2	-6.1
UNW029	-2.1	-2.1	-2.4	-3.2	-3.3	-3.3	-3.3	-3.1	-3.1	-3.1	-2.9	-2.9	-2.8	-2.8	-2.4	-2.8	-2.9
UNW039	-1.4	-2.3	-1.4	-2.1	-2.2	-2.2	-2.2	-1.8	-1.7	-1.8	-1.5	-1.3	-1.3	-1.2	-1.1	-1.3	-1.7
UNW072		-4.0	-3.9	-3.9	-3.5	-3.5	-3.5	-3.6	-3.5	-3.3	-3.4	-3.1	-3.2	-3.1	-3.2	-3.6	-3.8
UNW073		-6.0	-5.2	-5.0	-4.6	-4.6	-4.9	-5.0	-4.9	-4.6	-4.7	-4.2	-4.1	-4.2	-4.6	-5.0	-5.5
UNW079		-6.3	-6.3	-4.1	-6.5	-4.4	-6.0	-4.4	-6.0	-6.3	-6.5	-6.2	-6.2	-5.8	-5.9	-5.7	-6.4