EVALUATION OF ATTRIBUTABILITY AND SIGNIFICANCE OF VEGETATION CHANGES IN BLACKROCK 94

REPORT

Prepared by Staff of the Los Angeles Department of Water and Power
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Executive Summary

This report is prepared in conformance with the October 21, 2013, *Arbitrators' Findings and Partial Interim Award on Issues Submitted for Dispute Resolution Pursuant to the Stipulation and Order for Judgment in California Superior Court Case 12908* (Interim Order). The Interim Order directs the City of Los Angeles to prepare and submit a report on the attributability and significance of measurable changes in vegetation cover within vegetation parcel Blackrock 94 (Blackrock 94) pursuant to Water Agreement Section IV.B and Green Book Section I.C1. Water Agreement Section IV.B provides the threshold for making a determination of attributability:

> "*Decreases and changes in vegetation and other environmental effects shall be considered "attributable to groundwater pumping, or a change in surface water management practices,"* ***if the decrease, change, or effect would not have occurred but for groundwater pumping and/or a change in past surface water management practices***" (Water Agreement, page 18, paragraph 4, emphasis added).

Water Agreement Section IV.B further provides only "***if the decrease, change, or effect is determined to be attributable to groundwater pumping or to changes in past surface water management practices****, the Technical Group then shall determine whether the decrease, change or effect is significant*" (Water Agreement, page 19, paragraph 2).

Accordingly, the relevant factors pertaining to vegetation and hydrogeology were evaluated to determine if measurable changes to vegetation or other environmental effects within Blackrock 94 are attributable to groundwater pumping or changes in LADWP's past surface water management practices. In conformance with the Interim Order, the significance of measurable changes are evaluated without regard as to whether the change or other effect is attributable to groundwater pumping or changes in past surface water management practices.

Attributability Findings

After evaluating the relevant factors outlined in Green Book Section I.C.1.b, *Determining Attributability*, LADWP concluded that variations in total perennial vegetation cover and composition within Blackrock 94 were due to fluctuations in wet/dry climatic cycles. LADWP found that while shrub cover remained relatively stable, changes in total perennial cover were primarily the result of changes in grass cover that were also driven by fluctuations in wet/dry climatic cycles. While other factors including grazing, wildfire, and the expansion of Highway 395 have reduced the amount of vegetation cover within the parcel, the primary driver of decreases in vegetation cover are periods of decreased precipitation and runoff, which limit the amount of water available for grasses and other vegetation within the parcel. Total perennial cover within the parcel has also been shown to rebound during multiple years of increased precipitation and runoff.

Groundwater pumping in the area of Blackrock 94 has been largely limited to groundwater pumping to supply the Blackrock Fish Hatchery since 1992. While other wells in the area have operated since 1992, the amount of pumping from these other wells has been limited, only a few percent of the total pumping in the Thibaut-Sawmill and southern Taboose Aberdeen Wellfields, so as not to be attributable to vegetation changes since that time. While the effects of a major drought between 1987 and 1994 combined with increased groundwater pumping between 1987 and 1992 resulted in decreases in the groundwater table beneath Blackrock 94, a four-year period of increased precipitation and 140% of average snowpack runoff between 1995 and

1998, in combination with reduced groundwater pumping, resulted in total perennial vegetation cover within Blackrock 94 to be 21% higher and grass cover to 7% higher in 1998 than that observed during LADWP's 1986 initial vegetation inventory baseline.

The principal source of groundwater pumping in the area, pumping for the Blackrock Fish Hatchery, has been persistent and essentially steady-state since 1972. Any suppression of the water table caused by Blackrock Fish Hatchery supply pumping had stabilized during the 14 years prior to LADWP's 1986 initial vegetation inventory and any effect on vegetation cover and composition caused by hatchery pumping was reflected in the 1986 inventory and each vegetation inventory since. The steady Blackrock Fish Hatchery supply pumping has caused no further suppression or fluctuations in the groundwater table since the 1986 initial vegetation inventory, therefore Blackrock Fish Hatchery pumping is not attributable to vegetation changes since that time.

Since 1992, pumping for the Blackrock Hatchery has made up 90% of all pumping in the Thibaut-Sawmill and central and south Taboose-Aberdeen Wellfields. Since 1998, Blackrock Hatchery Pumping has accounted for about 95% of all groundwater pumping in the Thibaut-Sawmill Wellfield. Moreover, over three quarters of the remaining 5% of the pumping in the Thibaut-Sawmill Wellfield is from wells screened to a deeper aquifer and which do not have a direct effect on the shallow water table beneath Blackrock 94.

Vegetation cover in Blackrock 94 in 1998 was 20% higher than observed during the 1986 initial vegetation inventory of the parcel, which is used as a baseline. Since the other wells in the in the Thibaut-Sawmill and south and central Taboose-Aberdeen Wellfields have been operated infrequently since 1998 and the pumping from the wells in the Thibaut-Sawmill Wellfield has generally been from the deeper aquifer, it was concluded that pumping from these other wells is not attributable to changes in vegetation cover or composition in Blackrock 94.

Green Book Section I prescribes:

> "*When reference is made to changes in surface water management practices, changes will be determined in comparison with past practices since 1970"* (Green Book, page 1, paragraph 1).

LADWP conducted a thorough review and analysis of LADWP's surface water management practices in the area of Blackrock 94. It was conclusively demonstrated that LADWP has not changed its surface water management practices since 1970, either in the overall area surrounding Blackrock 94 or on Sawmill Creek, the principle creek that could affect Blackrock 94. LADWP examined water diversions for agricultural uses, water spreading, and to the Los Angeles Aqueduct (LAA). Water diverted to agricultural uses was shown to remain unchanged since 1970. LADWP's water spreading practices both in the overall area surrounding Blackrock 94 and on Sawmill Creek, which is adjacent to Blackrock 94, are highly correlated with runoff. Water is reliably spread during wet periods of high runoff and not spread during periods of drought or low runoff. LADWP's diversions to the LAA are marginally less between 1991 and 2012 than between 1970 and 1990, however the reduced diversions to the LAA were found to not be statistically significant. Therefore, changes in LADWP's surface water management practices are not attributable for measurable changes in vegetation within Blackrock 94.

Significance Findings

LADWP has completed an analysis of significance in conformance with the Arbitrator's October 21, 2013 Interim Order. LADWP's analysis followed the provisions of Green Book Section I.C.1.c and, based upon the evidence, found the measureable changes in vegetation cover and composition in Blackrock 94 are not significant because:

- Measurable changes in vegetation cover are not attributable to groundwater pumping or to changes in LADWP's past surface water management practices since 1970.
- Measurable changes in vegetation cover are attributable to periods of drought and fluctuations in wet/dry climatic cycles. During periods of drought or low runoff and precipitation, total perennial vegetation cover tends to decrease; during wet periods and associated high runoff and precipitation, vegetation cover rebounds.
- Similar trends in vegetation cover and composition observed at Blackrock 94 are also observed in control parcels in other areas of the Owens Valley.
- The size of the measurably different vegetation cover within the Blackrock 94 parcel is only about 2% of the Blackrock Vegetation and Wellfield Management Area.
- Because measurable changes in vegetation fluctuate widely, corresponding to changes in runoff and precipitation, the degree of change is not significant (an example of this is vegetation cover increased over 400%, from 12% to 50%, between 1994 and 1998, during a period of 140% of average runoff).
- Measurable changes in vegetation are not permanent and clearly fluctuate with available runoff and precipitation.
- There is no indication of an effect on air quality associated with Blackrock 94.
- The cumulative effect of adverse vegetation change since the Water Agreement was signed is zero. There has never been a determination pursuant to the provisions of the Water Agreement that a significant change in vegetation that is attributable to groundwater pumping or to changes in LADWP's surface water management practices.
- Existing enhancement/mitigation projects provide significant environmental benefits through the creation and/or conversion of more than 2,400 acres to meadow area.
- Changes in rare plants within Blackrock 94 are driven by changes in precipitation and are not significant.
- There is no indication of an effect on human health associated with Blackrock 94.

Since measureable vegetation changes within Blackrock 94 were found to be attributable to fluctuations in wet/dry climatic cycles and not attributable to groundwater pumping or to changes in past surface water management practices, these changes cannot be considered to be significant in the context of the Water Agreement. However, even when considered in their own light these changes cannot be considered as significant because the measurable changes to vegetation in Blackrock 94 do not meet the criteria laid out by Green Book Section I.C.1.c in order to be determined significant.

Conclusion

Measurable changes in vegetation within Blackrock 94 are a result in fluctuations in wet/dry climatic cycles. While factors including grazing, wildfire, and the expansion of Highway 395 have reduced vegetation cover within the parcel, the primary driver of decreases in vegetation cover are periods of decreased precipitation and runoff, which during dry periods limits the amount of water available for vegetation within the parcel. Vegetation cover in control parcels located in other areas of the Owens Valley also follow patterns similar to that observed in Blackrock 94: vegetation cover decreases during periods of drought, low runoff, and low precipitation and increases during wet periods of high runoff and high precipitation.

Because measurable changes in vegetation within Blackrock 94 are attributable to fluctuations in wet/dry climatic cycles and not attributable to groundwater pumping or changes in past surface water management practices, these changes are not significant in the context of the Water Agreement which allows a determination of significance to be considered only "*if the decease, change, or effect is determined to be attributable to groundwater pumping or to changes in past surface water management practices…*" (Water Agreement Section IV.B, page 19, paragraph 2) and "…*if the decrease, change, or effect would not have occurred* ***but for*** *groundwater pumping and/or a change in past surface water management practices*" (Water Agreement Section IV.B, page 18, paragraph 4). However, even when measurable changes in vegetation within the parcel are considered on their own merits, these changes do not meet the criteria laid out in Green Book Section I.C.1.c to be determined significant.

Evaluation of Attributability and Significance of Vegetation Changes in Blackrock 94

Prepared by Staff of the Los Angeles Department of Water and Power
December 18, 2013

This report contains the Los Angeles Department of Water and Power's (LADWP) evaluation of the attributability and significance of a measurable vegetation change in Blackrock 94 (also referred to as BLK094), prepared in conformance with the October 21, 2013 *Arbitrators' Findings and Partial Interim Award on Issues Submitted for Dispute Resolution Pursuant to the Stipulation and Order for Judgment* in California Superior Court Case 12908 (Interim Order)[1]. The evaluations within this report are conducted in conformance with *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* (Water Agreement) and the corresponding analysis contained in this report are formatted to follow the provisions of Green Book Sections I.C.1.b, *Determining Attributability,* and I.C.1.c, *Determining Degree of Significance.*

Section I.C.1.b of this report documents LADWP's evaluation of whether or not a measurable change in vegetation at Blackrock 94 is attributable to groundwater pumping or changes in surface water management practices since 1970. Section I.C.1.c of this report documents LADWP's evaluation of the significance of vegetation changes in Blackrock 94. The evaluation of significance, as contained in this report, is unusual in that the provisions of the Water Agreement require that an evaluation of significance be conducted only after a change in vegetation has been determined to be attributable to groundwater pumping or a change in LADWP's surface water management practices from those practices conducted since 1970:

> *"**If the decrease, change, or effect is determined to be attributable** to groundwater pumping or changes in past surface water management practices, the Technical Group shall determine whether the decrease, change, or effect is significant"* (Water Agreement, Section IV.B, page 19, paragraph 2, emphasis added).

In this particular case, neither a determination of attributability relating to changes in vegetation within Blackrock 94 has been made by the Technical Group, nor has a determination been made through the dispute resolution process. The analysis of significance contained in this report is submitted in compliance with the Interim Order, and the addition of this analysis in no way implies that a measurable change in vegetation within Blackrock 94 is attributable to LADWP's groundwater pumping or changes in LADWP's surface water management practices.

LADWP has determined based upon the evidence contained herein that changes in vegetation in vegetation parcel Blackrock 94 are attributable to changes in wet/dry climactic cycles.

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[1] This report is supported by attached appendices containing the data and analytical methods supporting the accompanying analysis. It is important to note that the County's February 2, 2011 report failed to provide the data and methods of analysis used in that report. Pursuant to the Interim Order, LADWP expects that the County's response to this report will rely solely on data and analysis provided by the County to LADWP in the County's February 2, 2011 report and any data and analysis contained herein.

Moreover, vegetation changes are not attributable to groundwater pumping or changes in surface water management practices.

Background Information

On February 2, 2011 the Inyo County Water Department (ICWD) released a report titled "*Analysis of Conditions in Vegetation Parcel Blackrock 94*" which claimed that measureable negative impacts to vegetative condition had occurred within Blackrock 94. The ICWD claimed that the negative impacts were attributable to groundwater pumping within the Thibaut-Sawmill and Taboose-Aberdeen Wellfields and reduced surface water spreading in the vicinity of Blackrock 94. The ICWD report, however failed to find that LADWP had changed its surface water management practices. The ICWD report also ignored the steady-state pumping at the Blackrock Hatchery and instead inferred that wide-range pumping across those wellfields impacted vegetation. Lastly, the ICWD claimed that the impacts were significant. The ICWD then recommended that groundwater pumping management be altered in the Thibaut/Sawmill Wellfield to avoid further impacts to vegetation within Blackrock 94.

LADWP found that there were some measurable changes in the vegetation of Blackrock 094, but disagreed with the methods and findings contained within the ICWD report. Those methods and findings are critical when analyzing attributability and significance pursuant to Green Book Section 1.C. Plainly stated, the errors that plague the ICWD measurability finding also undermine its conclusions related to attributability and significance.

Blackrock 94

Blackrock 94 is a 333-acre parcel, located approximately eight miles north of Independence, California. It is positioned in an upland area along the western flank of the Owens Valley near Sawmill Creek (Figure 1). The parcel area was mapped as being a combination of "Alkali Grassland", "Alkali Scrubland", and an undesignated upland area by LADWP in a 1973-1974 vegetation survey (section 5.5.2.3) and as "Alkali Meadow" by LADWP in 1986. There are three distinct soil units within the parcel and each soil unit has a corresponding ecological site designation. The three soil units are Cartago loamy sand, Shondow loam, and Winerton fine sandy loam. The three ecological sites are Sandy, Saline Meadow, and Saline Bottom. Blackrock 94 soils are described in greater detail in section 5.2.5.5 of this report. The three corresponding ecological sites are described in detail in section 5.5.5.1 of this report.

Blackrock 94 is also located in LADWP's Thibaut-Sawmill Wellfield. Approximately 95% of the groundwater pumped within the Thibaut-Sawmill Wellfield occurs at the Blackrock Fish Hatchery, located approximately 1.6 miles to the northeast of the parcel. Additionally, LADWP manages surface water operations in the area of Blackrock 94. LADWP's past surface water management practices in the area of Blackrock 94 are to provide water for agriculture, to divert water into the Los Angeles Aqueduct (LAA), and to spread water[2] when there is insufficient capacity in the LAA to convey additional water, which is typically[3] during periods of high runoff.

[2] See Glossary for definition.
[3] LADWP's water spreading practices are described in Section 5.7.

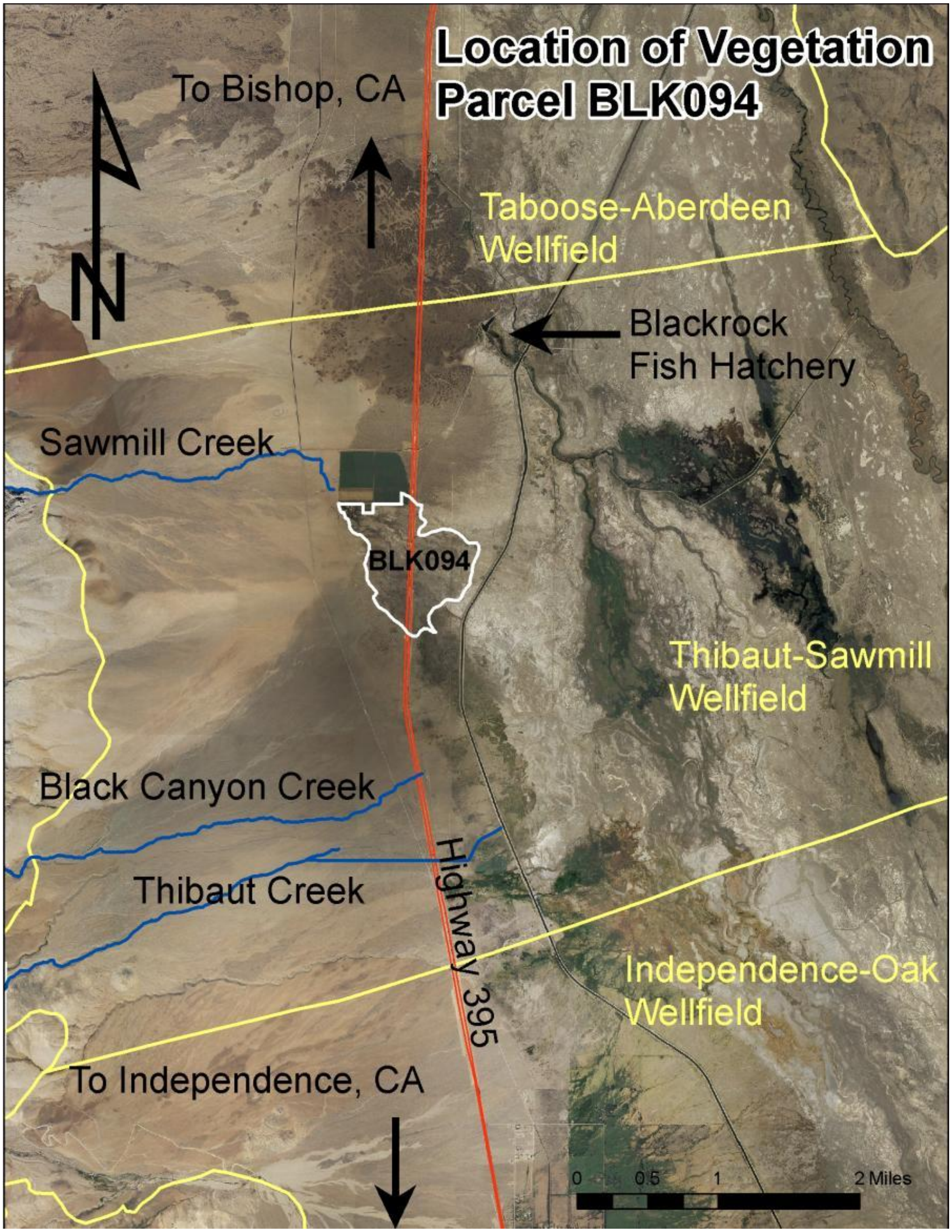


Figure 1. Location of Blackrock 94 in relationship to other significant features in Owens Valley.

Initial Vegetation Inventory (Baseline Inventory) Data

The vegetative conditions of lands owned by the City of Los Angeles (City) throughout the Owens Valley were assessed and mapped by the LADWP between 1985 and 1987[4]. This assessment is also referred to as the "initial vegetation inventory" and is used as a vegetation baseline pursuant to the Water Agreement. The initial vegetation inventory or baseline inventory data is a comparative tool by which to analyze vegetation in the Owens Valley. There is no requirement under the Water Agreement or Green Book that LADWP maintain baseline conditions when such changes are beyond its control. For example, LADWP is powerless to control changes in vegetation conditions resulting from climatic conditions and precipitation. During the initial vegetation inventory, much of the City's land within the Owens Valley was delineated, using aerial imagery, into areas or parcels of similar vegetation species composition and vegetative cover. "*Areas of similar color and appearance were assumed to have somewhat uniform plant cover and species composition*" (Green Book Section II.A.2.c, page 36). LADWP estimated vegetation cover and composition within each parcel through field sampling. Field sampling of the vegetation within each parcel was accomplished by vegetation transect. LADWP located its vegetation transects within each parcel "*by choosing lines that appeared to cover the representative units of vegetation within the parcel. With regard to the parcel area, transect locations were generally toward the center of the parcels…"* (Green Book Section II.A.2.d.iv, page 38). A complete description of LADWP's methods for vegetation mapping is in Green Book Section II.A.2, page 36. These parcels were later classified by the ICWD into parcels that were affected by groundwater pumping, "wellfield parcels", and parcels that were not affected by groundwater pumping, "control parcels".

Re-inventory Methods of the ICWD and the LADWP

In 1991, the ICWD began monitoring vegetation conditions throughout the Owens Valley using a method of locating transects within vegetation parcels randomly. Monitoring efforts by the ICWD have continued each year from 1991 to present. In 2004, LADWP began monitoring vegetation conditions throughout the Owens Valley using fixed locations for its vegetation transects. Monitoring efforts by LADWP have continued each year from 2004 to present. There are advantages and disadvantages of each transect location method. Both methods struggle with comparisons to the initial vegetation inventory because the initial vegetation inventory data is spatially biased due the preference of locating transects only within "representative units of vegetation". On the parcel scale, both the ICWD and LADWP transects have always been spatially distributed to characterize the variability in vegetation within the entire parcel as compared to just the "representative units of vegetation". Neither method provides a proper re-inventory of vegetation parcels and neither method comports with Green Book Box I.C.1.a.ii (Green Book, page 22), which requires that "*future line-point transects should be performed in a similar manner as the initial inventory to determine whether vegetation has change*(d), *but the technique may be modified…"* since the Green Book has not been modified pursuant to Water Agreement Section XXV for either transect method. However, for the purposes of analyzing

[4] The locations of the vegetation transects were not recorded during LADWP's 1984-1987 initial vegetation inventory and mapping effort. Therefore, neither of the ICWD or LADWP vegetation monitoring programs allow for an accurate comparison with the initial vegetation inventory baseline data.

variations in vegetation cover or composition since 1991, no better data set exists. For completeness, data from both methods are presented in this report.

1.0 Introduction

The overall goal of the Water Agreement is presented in its Section III.A:

> "*The overall goal of managing the water resources within Inyo County is to avoid certain described decreases and changes in vegetation and to cause no significant effect on the environment which cannot be acceptably mitigated while providing a reliable supply of water for export to Los Angeles and for use in Inyo County"* (Water Agreement, page 10, paragraph 1).

Green Book Section I.A provides additional explanation of the Water Agreement's overall goal as it pertains to the effects of water gathering on vegetation and the environment:

> *"This means that **groundwater pumping** and **<u>changes</u> in surface water management practices** will be managed with the goal of avoiding significant decreases and changes in Owens Valley vegetation from conditions documented in 1984 to 1987, and of avoiding other significant environmental impacts*" (Green Book, page 1, paragraph 2, emphasis added).

Water Agreement Section IV.B and Green Book Section I.C.1 provide the standards to be used by the Technical Group when determining whether or not an alleged adverse change to vegetation or the environment is measureable, and whether or not it is attributable to LADWP's groundwater pumping or to changes in LADWP's surface water management practices as compared to those practices since 1970. If it has been found that a change is measurable and attributable, then the Technical Group needs to determine whether or not that change is significant.

2.0 Water Agreement Provisions Applying to Attributability

The Water Agreement and Green Book mandate that the Technical Group will only consider the attributability of an alleged impact after it has been determined to be measurable:

> "*Once it has been determined that there has been a measurable vegetation decrease or change, it must be determined whether the impact is attributable to groundwater pumping or to <u>changes</u> in surface water management practices*" (Green Book Section I.C.1.b, page 23, paragraph 2; also see Water Agreement Section IV.B, page 18, paragraph 3, emphasis added).

The Interim Order found that the City and County of Inyo (County) agreed that a measurable change in vegetation had occurred in Blackrock 94, thereby satisfying the measurability requirement. In considering the "attributability" of a measurable change, it then must be determined if measurable changes in vegetation or the environment "*would not have occurred but for groundwater pumping and/or a change in past surface water management practices.*"

The threshold for making a determination of attributability is provided in Water Agreement Section IV.B:

> "*Decreases and changes in vegetation and other environmental effects shall be considered "attributable to groundwater pumping, or to a change in surface water management practices,"* ***if the decrease, change, or effect would not have occurred <u>but for</u> groundwater pumping and/or a change in past surface water management practices"*** (Water Agreement, page 18, paragraph 4, emphasis added).

While the definition of groundwater pumping is relatively straightforward: groundwater extracted through means of a groundwater pump, the definition of "a change in past surface water management practices" requires additional explanation. The Green Book provides:

> "*When reference is made to changes in surface water management practices, changes will be determined in comparison with past practices since 1970*" (Green Book, Section I, page 1, paragraph 1).

LADWP's surface water management practices have always been subject to the amount of surface water available, which in turn is highly correlated with Eastern Sierra Mountain runoff, which in turn is highly correlated with precipitation Pursuant to California State Constitution Article X, Section 2 and California Water Code Section 100, LADWP's surface water management philosophy has continuously focused on operating its surface water works in a manner that puts its water rights to the highest and best beneficial uses possible. These uses include: diverting water into the LAA for export to the City, diverting water for agriculture, water spreading for groundwater recharge and to avoid damaging or overtopping the LAA, diverting water for operational uses (typically for maintenance of an LAA facility), and diverting water for mitigation projects and other beneficial uses within the Owens Valley[5].

While the principles affecting surface water management practices have remained constant since 1970, the relative amounts of water diverted to various uses varies year-to-year, even day-to-day, with changes in runoff. Two examples of LADWP's surface water management practices pertaining to Sawmill Creek[6], which is the most significant surface water feature in relation to Blackrock 94, are:

- The volume of water in Sawmill Creek flowing out of the mountains during June 2005 was 888 acre-feet. LADWP's water management practices on Sawmill Creek during that month were: 236 acre-feet of water was diverted into the LAA, 111 acre-feet were diverted to 8-Mile Ranch for agricultural uses, and 326 acre-feet of water was spread for groundwater recharge.

[5] Other beneficial uses include enhancement and mitigation projects, domestic uses, and stockwater.

[6] LADWP spreads water from numerous surface water sources in the Eastern Sierra. A complete discussion of LADWP's surface water management practices is included in Section 5.7.

- The volume of water in Sawmill Creek flowing out of the mountains during June 2012 was 228 acre-feet. LADWP's water management practices on Sawmill Creek during that month were: 48 acre-feet were diverted into the LAA, 134 acre-feet were diverted to 8-Mile Ranch for agricultural uses, and no water was spread for groundwater recharge.

Even though LADWP did not spread the same amount of water for groundwater recharge in June 2012 and June 2005, LADWP did not change its surface water management practices between those periods. The rationale being that:

- LADWP's past surface water management practices, as they apply to water spreading from Sawmill Creek are straightforward: if the LAA has the capacity to receive additional water, then any water above that required for 8-Mile Ranch is diverted into the LAA; if the LAA does not have the capacity to receive additional water, then any water above that diverted to 8-Mile Ranch is spread for groundwater recharge.
- The Owens Valley runoff in 2005 was about 565,593 acre-feet, or about 136% of average[7], and the corresponding amount of runoff during June 2005 was in excess of what LADWP could safely divert into the LAA. Consistent with past practices, excess water from Sawmill Creek, during that period, was spread for groundwater recharge. Conversely, the Owens Valley runoff in 2012 was only about 238,272 acre-feet, or approximately 57% of average. The nominal amount of runoff in June 2012 was well within the capacity in the LAA, and in accordance with its past practices LADWP did not spread water from Sawmill Creek in June 2012.
- The entire flow of Sawmill Creek in June 2012 was less than the amount of water diverted for spreading in June 2005. Therefore, even if it was desired, it would have been impossible to spread the same amount of water in June 2012 as was spread in June 2005 because there was simply not enough water in the creek. To even attempt to spread any water in June 2012 would have required substantial reductions in the amount of water diverted to the LAA and 8-Mile Ranch as compared to what would typically be diverted in similar runoff conditions, which in and of itself would be a change in surface water management practices.

Other conditions that have affected LADWP's past water management practices as they apply to water spreading since 1970 include:

- Maintaining, in accordance with the provisions of Water Agreement, a reliable supply of water for both export to the City and uses in Inyo County (Water Agreement, Section III.A, page 8).

[7] The 1961-2010 long-term (50 year) average Eastern Sierra runoff in the Owens River Basin is 412,284 acre-feet.

- Abiding by California Department of Fish and Wildlife requirements to maintain in-creek flows in sufficient amounts to keep fish in good condition (water spreading during low runoff years may not allow for sufficient in-creek flows).
- Spreading water during periods of drought or very low runoff may conflict with the State constitutional requirements "*that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare"* (California State Constitution, Article X, Section 2).
- Other reasons as discussed in Section 5.7, of this report.

Most importantly, the Water Agreement requires that LADWP conduct any changes in its surface water management practices commensurate with its surface water management practices since 1970. Accordingly, any evaluation of changes in surface water management practices must be evaluated in light of annual variations in runoff, which is the main driver in determining LADWP's year-to-year surface water operations.

In the addition to considering groundwater pumping and changes in surface water management practices when determining the attributability of a measurable change in vegetation, the Water Agreement requires the Technical Group to consider:

> "…*all relevant factors, including a comparison of the affected area with an area of similar vegetation, soils, rainfall, and other relevant conditions where such a decrease has not occurred or not occurred to the same degree"* (Water Agreement Section IV.B, page 19, paragraph 1).

After considering all relevant factors, the Technical Group must find that a measurable change would not have occurred "*but for*" groundwater pumping or a change in past surface water management practices:

> "…**the decrease, change, or effect would not have occurred <u>but for</u> groundwater pumping and/or a change in past surface water management practices**" (Water Agreement, page 18, paragraph 4, emphasis added).

3.0 Water Agreement Provisions Applying to Significance

The Water Agreement applies to LADWP's activities, but does not hold LADWP responsible for changes to vegetation caused by factors outside of LADWP's control:

> "*The goals and principles of this Stipulation and Order shall apply primarily within the Owens Valley, but shall be applied as appropriate to activities of the Department within Inyo County*" (Water Agreement, page 6, paragraph 2).

Significant changes to vegetation may occur due to other factors unrelated to the effects of groundwater pumping or to changes in LADWP's past surface water management practices. The extent of LADWP's responsibility for changes in vegetation or the environment is acknowledged in Water Agreement Section IV.B, which provides:

> "*Decreases and changes in vegetation and other environmental effects shall be considered "attributable to groundwater pumping or a change in surface water management practices," if the decrease, change, or effect would not have occurred but for groundwater pumping and/or a change in past surface water management practices*" (Water Agreement, page 18, paragraph 4).

Accordingly, the Water Agreement requires the Technical Group to only consider the significance of a measurable change in vegetation or the environment if that change has been determined to be attributable to groundwater pumping or changes in the past surface water management practices of LADWP:

> *"If the decrease, change, or effect is determined to be attributable to groundwater pumping or changes in past surface water management practices, the Technical Group shall determine whether the decrease, change, or effect is significant"* (Water Agreement, Section IV.B, page 19, paragraph 2).

Prior to making a determination of significance, the Water Agreement and Green Book provide a list of factors to be considered by the Technical Group (Water Agreement Section IV.B, page 19; Green Book Section I.C.1.c, pages 26 and 27): 1) *"The size, location, and use of the area that has been affected"*, 2) *"The degree of the decrease, change, or effect within the affected area"*, 3) *"The permanency of the decrease, change or effect"*, 4) *"Whether the decrease, change, or effect causes a violation of air quality standards"*, 5) *"The cumulative effect of the impact when judged in relation to all such areas of the Owens Valley"*, 6) *"The value of existing enhancement and mitigation projects addressing the environmental consequences of similar impacts"*, 7) *"The impact, if any, on rare or endangered species and other vegetation of concern",* and 8) *"Whether the decrease, change, or effect affects human health."*

The Green Book requires the Technical Group to consider *each factor* on the list (Green Book, page 26, paragraph 2) and the Water Agreement states that the Technical Group's analysis should weigh all relevant factors in making the determination as to whether a measurable and attributable change is, or is not, significant (Water Agreement, page 19, paragraph 2).

In summary, a determination of significance can only be made if a measurable change in vegetation or the environment has been properly determined to be attributable to LADWP's groundwater pumping or to <u>changes</u> in LADWP's past surface water management practices "*in comparison with past practices since 1970.*" Then only after considering each of the factors presented in Water Agreement Section IV.B and Green Book Section I.C.1.c and weighing all of the evidence pertaining to significance, including the compensating *"value of existing enhancement and mitigation projects addressing the environmental consequences of similar impacts*", may the Technical Group make a determination as to whether or not a measurable, attributable change in vegetation is significant.

In the case of Blackrock 94, while there has been a measurable change in vegetation cover, that change fails to meet the "*but for*" test under Water Agreement Section IV.B. Specifically, measurable changes to vegetation in Blackrock 94 are not attributable to groundwater pumping or changes in surface water management practices. Even if significance applied to factors other than groundwater pumping or changes in surface water management practices, which under the Water Agreement it does not, the changes in vegetation in Blackrock 94 in and of themselves were found not to be significant.[8]

[8] See Section 6.

4.0 Hydrologic Conditions Affecting Change in Vegetation within the Owens Valley and Blackrock 94

Eastern Sierra runoff into the Owens Valley between 1961 and 2010 averaged 412,284 acre-feet (LADWP Annual Owens Valley Report, May 2013). Groundwater pumping during this same period averaged 76,363 acre-feet (Appendix 4.1). From a hydrologic perspective, runoff has a greater overall influence on the groundwater table throughout the Owens Valley than groundwater pumping.

On a localized scale, groundwater pumping may have a more pronounced effect on the groundwater table near wells, although the effects of pumping may be offset by stream infiltration or water spreading. Moreover, while the water table may have an effect on phreatophytic vegetation, factors such as precipitation, water spreading, and soil type affect soil moisture. Soil moisture in turn, directly affects vegetation cover and composition.

4.1. The "wet" period of the late 1960s provided very favorable conditions for vegetation

Considerable runoff, increased precipitation, and minimal groundwater pumping during the late 1960's gave rise to elevated groundwater levels throughout the Owens Valley by 1970. The average runoff between 1965 and 1969 was 506,765 acre-feet or 123% of the long-term (50-year) average (Appendix 4.1). Valley floor precipitation between 1964 and 1968 was 131% of the 1961-2010 long-term average (Appendix 4.2). Groundwater pumping for the entire Owens Valley during the 1965-1969 period averaged only 7,339 acre-feet annually. Owens Valley annual water exports between 1965 and 1969 averaged less than 100,000 acre-feet (Appendix 4.3). The combination of high runoff, low groundwater pumping, and moderate water exports resulted in a substantial amount of water remaining in the Owens Valley, providing very favorable conditions for vegetation.

4.2. Early to mid-1970s conditions provided less favorable circumstances for vegetation

After the completion of the second LAA in 1970, LADWP increased groundwater pumping in the Owens Valley to meet the increased capacity of its aqueduct system. Groundwater pumping in the Owens Valley increased from the 1965-1969 annual average of 7,339 acre-feet to 149,562 acre-feet in 1971. In October 1972, groundwater pumping for the Blackrock Fish Hatchery began and, combined with other area wells, total groundwater pumping in the Thibaut-Sawmill Wellfield increased from 7,618 acre-feet in 1972 to 12,929 acre-feet in 1973 (Table b.i.2). Blackrock Hatchery annual pumping volumes have remained relatively stable since 1972, averaging about 12,200 acre-feet per year (Figure b.i.4).

The Eastern Sierra experienced a dryer period in the 1970s. The 506,765 acre-feet of average annual runoff received during the late 1960s decreased to 380,646 acre-feet in 1970, 321,921 acre-feet in 1971, and 276,882 acre-feet in 1972. The average Owens Valley snowpack runoff between 1970 and 1977 was 344,330 acre-feet, or about 84% of the long-term average. The average valley floor precipitation between 1969 and 1976 was 77% of the long-term (50-year) average.

A 1973-1974 vegetation survey conducted by LADWP designated much of the area now called Blackrock 94 as “Alkali Scrubland” (Section 5.5.2.3), leaving the remaining upland portion of the parcel area as unclassified (neither alkali scrubland nor alkali grassland). Alkali Scrubland is a designation corresponding to Water Agreement vegetation “Type B”[9]. LADWP’s 1973-1974 vegetation survey further noted that the alkali scrubland in the area had not changed from previous years.

In response to this eight-year period of decreased average annual snowpack runoff and increased groundwater pumping of the early to mid-1970s the water table beneath Blackrock 94 declined. The Depth-to-water (DTW) is the distance from the ground surface to the groundwater table. The DTW at monitoring well V158, located just west of the parcel, decreased from 16.9 feet in 1972 to 39.2 feet by 1978. Similarly, calculated depth to water at monitoring wells T806 and T807, within the Blackrock 94 parcel, decreased from eight feet and 12 feet in 1972 to 21 feet and 29 feet, respectively by 1978 (Table b.i.5). Blackrock Hatchery pumping accounted for approximately 84% of all pumping in the Thibaut-Sawmill Wellfield between 1972 and 1977. Hydrologic conditions of the early to mid-1970s were not favorable to vegetation conditions. Declines in the water table, decreased valley floor precipitation, and reduced surface water spreading during this period suggest reductions in vegetation cover between 1974 and 1977.

4.3. The very wet period between 1977 and 1986 provided excellent conditions for vegetation

Eastern Sierra storm patterns changed once again in 1977, providing for a nine-year period of increased average annual snowpacks. Snowpack runoff between 1978[10] and 1986 averaged 563,482 acre-feet annually or about 137% of average. Valley floor precipitation between 1977 and 1985 averaged 132% of the long-term average. During periods of high runoff, ample surface water is available and LADWP often pumps less groundwater. Even though the abundant runoff brought about a decrease in overall Owens Valley groundwater pumping during this period (from 153,024 acre-feet in 1977 to an average of 69,313 acre-feet between 1978 and 1986), annual groundwater pumping in the Thibaut-Sawmill Wellfield did not decrease substantially, remaining at 11,386 acre-feet during the same period. The reason for continued pumping in the Thibaut-Sawmill Wellfield was due to the water demands of the Blackrock Fish Hatchery. Blackrock Hatchery supply pumping accounted for approximately 99% of all pumping in the wellfield during this period (Table b.i.5).

Snowpack runoff between 1978 and 1986 averaged 563,482 acre-feet annually or about 137% of average. Valley floor precipitation between 1977 and 1985 averaged 132% of the

[9] Water Agreement Section II.B describes Type B vegetation as being “*comprised of scrub dominated communities, including rabbitbrush and Nevada Saltbush communities with evapotranspiration greater than precipitation.*”

[10] Late season 1977 storms contributed to the April 1, 1978 snowpack.

The increased precipitation and runoff between 1978 and 1986, and resultant increases in water spreading, caused groundwater levels in the area of Blackrock 94 to increase. The DTW at monitoring well V158 rose to 12.6 feet in 1986, a 26.6-foot increase above the depth-to-water at the well in 1978. Similarly, the DTW also increased at monitoring wells T806 and T807, located within Blackrock 94, with calculated DTW levels of 5.3 feet and 8.5 feet respectively. These dramatic increases in groundwater levels in the area of Blackrock 94 occurred while groundwater pumping in the Thibaut-Sawmill Wellfield was maintained at an average amount of 11,386 acre-feet per year. Pumping was almost entirely to supply water to the Blackrock Hatchery.

4.4. The 1986 initial vegetation inventory at Blackrock 94 followed nine years of above-average runoff and precipitation

The backdrop during which LADWP's 1986 initial vegetation inventory (also referred to as a baseline inventory) was conducted was following nine years of above-average runoff and precipitation. Although the water table beneath Blackrock 94 had been marginally suppressed over the previous 14 years by relatively steady-state and unabated groundwater pumping for the Blackrock Hatchery, the water table beneath the parcel was the highest on record due to repeated years of high runoff, increased precipitation, and water spreading. Perennial vegetation cover in Blackrock 94 was estimated to be 41% and grass cover 21% in 1986. Increases in grass cover, likely associated with nine years of increased precipitation and water spreading, lead to in a change in vegetation classification within the parcel area from "Alkali Scrubland" and unclassified upland in 1974 to "Alkali Meadow" in 1986.

4.5. An eight-year drought, beginning in 1987, provided very unfavorable conditions for vegetation

An eight-year period of lower snowpack commenced in 1987 and runoff fell to an average of only 281,931 acre-feet annually between 1987 and 1994 (about 68% of the long-term average). Precipitation on the valley floor between 1986 and 1993 declined to 70% of the long-term average. In order to maintain a reliable water supply to the City of Los Angeles during this period of drought, LADWP increased groundwater pumping throughout the Owens Valley. Groundwater pumping in the Thibaut-Sawmill Wellfield increased to an average of 19,785 acre-feet annually between 1987 and 1991. In response to multiple years of low runoff and increased pumping during this period, groundwater levels in the area of Blackrock 94 declined. By 1993, DTW in well V158 had dropped to 38.6 feet, nearly as low as it was during the 1970-1977 drought. Also in 1993 the DTW in well T806, in the eastern area of Blackrock 94, was 21.1 feet below ground surface, which was approximately 17 feet lower than the DTW estimate during the wet period during the mid-1980s (Table b.i.5). The water table in well T807 was measured to be 26.6 feet below ground surface in 1994. Total perennial vegetation cover in Blackrock 94 was measured at 12% in 1994, which represented a 70% decrease in vegetation cover from that measured during the 1986 initial vegetation inventory. In summary, the 1987-1994 drought provided very unfavorable conditions for vegetation in Blackrock 94 and throughout the Owens Valley.

4.6. A wet period between 1994 and 1998 gave rise to record high vegetation cover in Blackrock 94

The period between 1994 and 1998 was once again a wet period for the Eastern Sierra, characterized by a four-year average runoff of 583,324 acre-feet (141 % of the long-term average) between 1995 and 1998. Similarly, valley floor precipitation between 1994 and 1997 was 129% of the long-term average. While average annual groundwater pumping in the Thibaut-Sawmill wellfield remained somewhat elevated at 14,742 acre-feet during this period, groundwater elevations in the Blackrock 94 area increased. The DTW in Blackrock 94 monitoring wells T806 and T807 changed from 19.5 feet and 26.6 feet, respectively in 1994 to 13.0 feet and 18.3 feet, respectively by 1998. Moreover, total perennial vegetation cover within Blackrock 94 increased over 400%, from 12% in 1994 to 50% by 1998. Grass cover increased over 500% within the parcel, from 6% in 1994 to 31% in 1998.

By 1998, total perennial vegetation cover was 21% higher and grass cover was 7% higher than measured during the 1986 initial vegetation inventory following the wet period between 1995 and 1998. The high vegetation cover recorded in 1998 for Blackrock 94, clearly demonstrates a full recovery from any decreases in vegetation cover that occurred during the 1987-1994 drought.

4.7. Since 1998, runoff and precipitation have generally been below average and vegetation cover in Blackrock 94 exhibited a parallel response

Runoff and precipitation during the 15-year period between 1999 and 2013 was generally below normal, averaging 367,220 acre-feet (89% of the long-term average). Average valley floor precipitation was 83% of the long-term average.

This 15-year period can be further subdivided into a six-year period of 81% of average runoff between 1999 and 2004, followed by two higher than normal runoff years averaging 142% of normal in 2005 and 2006, and ending with a seven-year period averaging 81% of normal snowpack runoff between 2007 and 2013. While the 2007-2013 period did include a single year of 141% of average runoff in 2011, it also included a state-wide drought, which was most pronounced in the Owens Valley between 2007 and 2009, along with the two lowest back-to-back runoff years since 1960 in 2012 and 2013 (average snowpack runoff in 2012 and 2013 was about 56% of normal and average valley-floor precipitation in 2011 and 2012 was about 39% of normal).

Groundwater pumping in the Thibaut-Sawmill Wellfield between 1999 and 2012 averaged 12,812 acre-feet per year with 95% of the pumping occurring at the Blackrock Hatchery. Groundwater pumping from the central and southern wells in the Taboose-Aberdeen Wellfield (W106, W109, W110, W111, W114, and W370) only averaged 244 acre-feet per year, or about 2% of the Thibaut-Sawmill Wellfield pumping during this period (Table b.i.2). Despite this extended period of lower runoff, groundwater levels beneath Blackrock 94 have remained stable and currently resemble the groundwater levels following the wet period between 1995 and 1998 (Figure b.i.9). The average DTW at monitoring well T806 between 1999 and 2013 remained relatively stable at 12.6 feet. The average DTW at monitoring well T807 between 1999 and 2013 remained relatively stable at 18.3 feet. It is an important concept to recognize that the high vegetation cover documented in Blackrock 94 between 1997 and 1999, occurred with groundwater elevations similar to the groundwater elevations between 1999 and 2013, and that the major hydrological change in the area has been a reduction in average precipitation and snowpack runoff as compared to the 1995-1998 period.

It is an important concept to recognize that the high vegetation cover documented in Blackrock 94 between 1997 and 1999, occurred with groundwater elevations similar to the groundwater elevations between 1999 and 2013, and that the major hydrological change in the area has been a reduction in average precipitation and snowpack runoff as compared to the 1995-1998 period.

Changes in vegetation cover at Blackrock 94 between 1999 and 2013 generally paralleled runoff patterns (Figure b.v.3). Following the wet 1995-1998 period, total perennial cover in Blackrock 94 was 50%. Cover values varied, but generally declined during the dryer period between 1999 and 2004. By 2004, total perennial vegetation cover measured 18%. During the above-average runoff period of 2005 and 2006, total perennial vegetation cover increased to 31%. During the 2007 to 2009 drought, total perennial cover declined to 19%. Total perennial cover was 27% in 2010 and 26% in 2011, which were two years with average and above average runoff, then declined during the back-to-back historically low runoff years of 2012 and 2013 with total perennial cover measuring 20% and 15% respectively.

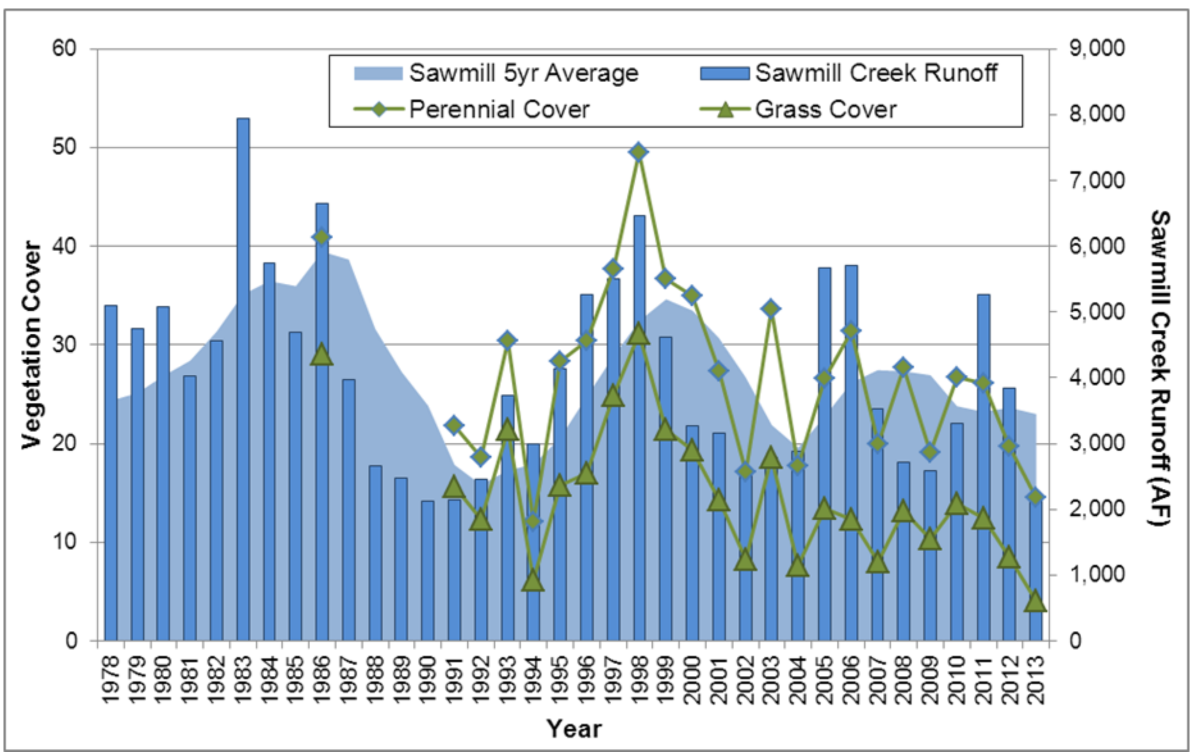


Figure b.v.3 Relationships between total perennial cover (vegetation cover, diamond)/grass cover (triangle) and Sawmill Creek annual runoff/five-year average annual runoff.

5.0 Section I.C.1.b – Determining Attributability

Green Book Section I.C.1.b. provides the basis and reason for conducting an analysis to determine if measurable changes in vegetation in Blackrock 94 are attributable to groundwater pumping or a change in past surface water management practices:

> "*Once it has been determined that there has been a measurable vegetation decrease or change, it must be determined whether the impact is attributable to groundwater pumping or to changes in surface water management practices*" (Green Book, page 23, paragraph 2).

Water Agreement Section IV.B provides the threshold for making a determination of attributability:

> "*Decreases and changes in vegetation and other environmental effects shall be considered "attributable to groundwater pumping, or a change in surface water management practices,"* ***if the decrease, change, or effect would not have occurred <u>but for</u> groundwater pumping and/or a change in past surface water management practices***" (Water Agreement, page 18, paragraph 4, emphasis added).

The following analysis was conducted in accordance with the provisions of Green Book Section I.C.1.b. *Determining Attributability*[11].

5.1. LADWP Evaluation I.C.1.b.i – Recent and historic water table changes and response to pumping as measured at the monitoring sites in Blackrock 94.

5.1.1. Introduction

The Green Book provides:

> *"A determination of whether an impact is attributable to groundwater pumping or changes in surface water management practices will be based on evaluation and consideration of relevant factors…"* (Green Book, page 23, paragraph 3).

This section evaluates how groundwater pumping from wells in the Thibaut-Sawmill and central and south Taboose-Aberdeen Wellfields may have affected groundwater levels in and around Blackrock 94 and consists of eleven subsections. The evaluation is generally organized to first provide some relevant background information regarding the hydrologic system in the area (subsections 5.1.2-5.1.3) followed by an evaluation of the effects of groundwater pumping in the area on Blackrock 94 (subsections 5.1.4-5.1.10), and concluding with a summary and conclusions of the analysis (subsection 5.1.11).

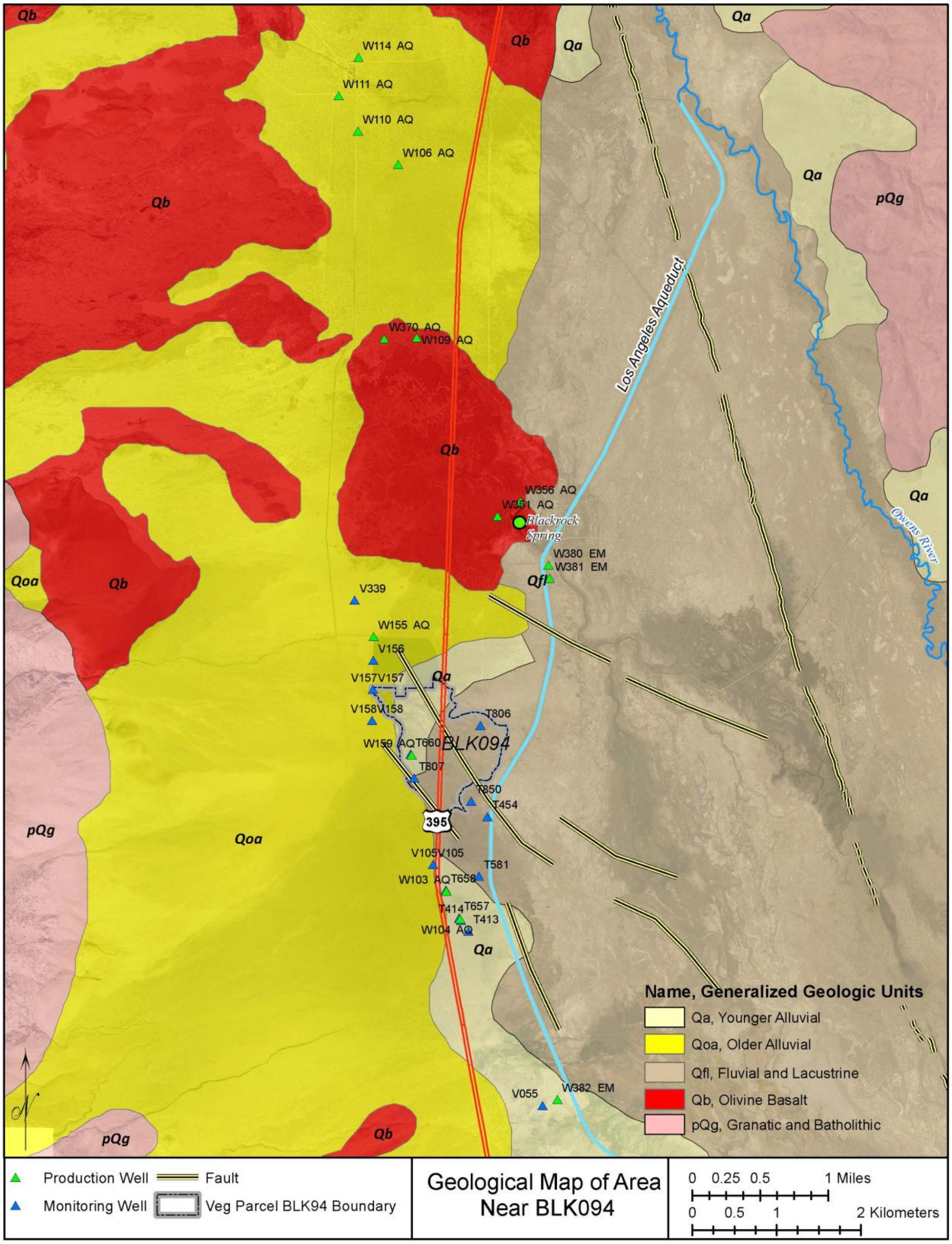
[11] The Green Book has a specific order of the factors to be considered in determining attributability. This report ultimately concludes that the measurable changes to vegetation in Blackrock 94 are not attributable to LADWP's groundwater pumping or changes surface water management practices. The discussion of groundwater pumping begins in Section 5.1. The discussion of changes in surface water management practices begins in Section 5.7.

Section 5.1.2 explains the geohydrology of the area near Blackrock 94, describing the alluvial and fluvial formation under Blackrock 94 and volcanic formation under Blackrock Hatchery. The ground elevation near Blackrock 94 increases from east to west, and the DTW beneath the parcel is affected by this increase in ground elevation. Section 5.1.4 reviews the groundwater pumping from Thibaut-Sawmill and central and south Taboose-Aberdeen Wellfields showing that pumping for hatchery supply was about 89% of total pumping from the wellfield for the 1973-2012 period. A water balance of Blackrock Hatchery, presented in Section 5.1.5 finds that while average annual pumping to supply the hatchery is approximately 12,200 acre-feet per year, that approximately 3,000 acre-feet of water is circulated from hatchery fish rearing ponds back to the shallow aquifer annually. Given that Big Blackrock Spring historically flowed at about 7,000 acre-feet per year prior to pumping to supply the hatchery, the net groundwater withdrawal for hatchery supply is on the average 2,200 acre-feet per year.

The following section presents the long-term groundwater level fluctuations near Blackrock 94, showing that groundwater levels respond mainly to runoff driven recharge. Section 5.1.8 evaluates changes in groundwater levels under monitoring sites TS1 and TS2, within the parcel, in response to Owens Valley runoff and groundwater pumping. It was determined that groundwater table fluctuations are correlated with Owens Valley runoff and not correlated with Blackrock Hatchery pumping. A period of protracted drought between 1987 and 1994, coupled with elevated groundwater pumping in the late 1980s resulted in water table declines in the area of the parcel. A period of 140% of average runoff between 1994 and 1998 provided for both water table and vegetation recovery in the parcel. Since 1998, approximately 95% of all pumping in the wellfield is the relatively constant pumping for the Blackrock Hatchery and groundwater levels have remained constant. Section 5.1.9 evaluates the relative effect of pumping from nearby wells on groundwater levels under Blackrock 94, showing that potential effects are mainly a function of the distance from the parcel. Simulation of a number of pumping scenarios in Section 5.1.10, shows that effects of Hatchery pumping on groundwater levels under Blackrock was about 1.5 to 2 feet and occurred soon after pumping to supply the hatchery began in 1972. Groundwater table suppression due to pumping to supply Blackrock Hatchery was stable prior to the 1986 initial vegetation inventory.

5.1.2. Hydrogeology of Thibaut- Sawmill and South and Central Taboose-Aberdeen Wellfields

The hydrogeology of Owens Valley, including the Thibaut-Sawmill and Taboose-Aberdeen Wellfields, is described in the United States Geological Survey WSP 2370-H, Evaluation of the Hydrologic System and Water Management Alternatives, Owens Valley, California (USGS WSP 2370-H), which is a product of a cooperative study between the United States Geological Survey, Inyo County, and LADWP. Both Blackrock 94 and the Blackrock Fish Hatchery (the largest source of groundwater pumping in the area), are located in the Thibaut-Sawmill Wellfield. As shown in Figure b.i.1, most of the area within the Thibaut-Sawmill Wellfield consists of fluvial, alluvial, and volcanic formations.



Sec. 5.1 Figure b.i.1. Geology of the Thibaut-Sawmill and South Taboose-Aberdeen Wellfields.

The area to the north and west of the Blackrock Hatchery (Hatchery) is characterized by a shallow (less than 150 feet from ground surface) volcanic formation, while areas to the east and south (including the formation underlying Blackrock 94) are comprised of predominantly alluvial and/or fluvial formations. A review of driller's logs for the wells in the area shows that the volcanic formation is thickest in the north and thins out toward the south. The thickness of the volcanic formation under the Blackrock Hatchery is approximately 150 feet, whereas under Blackrock 94, the volcanic formation is only about 10 feet thick. The volcanic formation in the Thibaut-Sawmill Wellfield has much higher transmissivity (at least one order of magnitude higher) than fluvial and alluvial formations in the area, resulting a much higher ability to transmit groundwater.

As noted-above, the distance from the ground surface to the groundwater table is known as "Depth-to-Water" (DTW), and this is an important parameter when evaluating the condition of groundwater-dependent vegetation. The Water Table Elevation (WTE) is the measurement of groundwater levels in reference to the mean sea level and is an important parameter for understanding the geohydrology of the area. The geohydrology of southwestern Thibaut-Sawmill Wellfield is complicated due to the extension of the Springfield Fault, a Westside branch of the Owens Valley Fault as identified in geologic maps of the area (Jennings, 1977). Faults reduce the transmissivity of aquifers and act as barriers to groundwater movement. The effects of geology and faulting on WTE can be seen in various monitoring wells in that area, especially V055, V105, V156, V157, V158, and V339, located from south to north respectively and shown on Figure b.i.1, all of which have long-term water level measurements. Figure b.i.2 presents hydrographs for these wells and the effects of geology and faulting are discussed herein.

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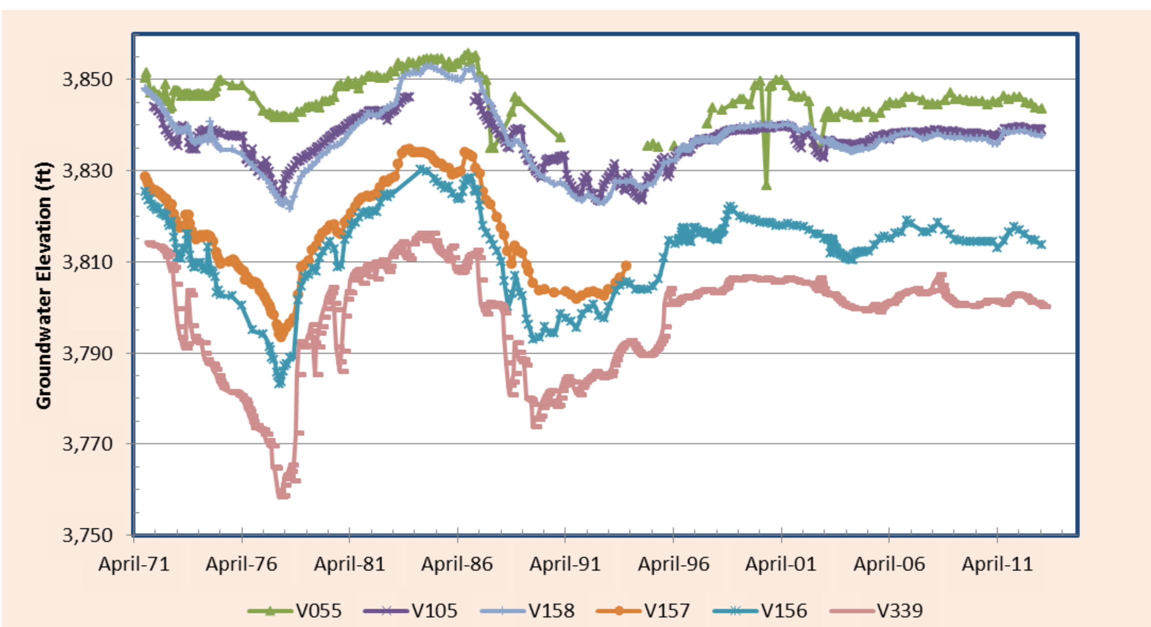


Sec. 5.1 Figure b.i.2. Hydrographs of Monitoring Wells West of Valley Floor Near BLK94.

The general groundwater gradient in the Owens Valley is from Eastern Sierra Nevada Mountains and Inyo/White Mountains toward the Owens River and then regionally southward. However, the WTE in V105 and V158 are 20 to 25 feet higher than those in V156, which itself has WTE values that are about 15 feet higher than those in V339. Faulting may be the main cause of this anomaly, but the nature and extent of this fault is not well understood. Therefore, the geohydrologic understanding of this area is based mainly on inferences from WTE in various nearby monitoring wells.

The two production wells that supply the Blackrock Hatchery (W351 and W356) are relatively shallow (less than 180 feet deep) and pump primarily from the volcanic formation. Accordingly, these wells draw water primarily from this area of the aquifer with far greater transmissivity, which extends to north and west of the Hatchery, and not primarily from the lower transmissivity fluvial and alluvial formations to the east and south of the Hatchery (see Figure b.i.1). As a result, the drawdown from pumping the Hatchery supply wells is generally transmitted within the volcanic formation to the north and west of the Hatchery and is smaller, but extends over a larger area.

The groundwater aquifer underlying the area is recharged by gauged (measured) and un-gauged (unmeasured) streams along the Eastern Sierra Mountains, to the west of the Blackrock Hatchery and Blackrock 94. These streams include Division, Sawmill, Black Canyon, and Thibaut Creeks. In particular, recharge to aquifer under Blackrock 94 is from Sawmill and Black Canyon Creeks, along with the recharge from the north. The formation under the Thibaut-Sawmill Wellfield is generally divided into a shallow and a deep aquifer, and stream infiltration in the west recharges both aquifers through the alluvial formation.

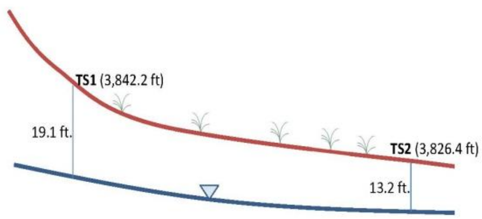
5.1.3. Ground Elevation near Blackrock 94

Figure b.i.3 presents a map of the Thibaut-Sawmill Wellfield area in the vicinity of Blackrock 94. This map shows ground elevation contour lines that slope upward from east to west, moving from the valley floor toward alluvial fans. The ground elevation on the valley floor in this area is approximately 3,810 feet above mean sea level (fmsl); the ground elevation within the Blackrock 94 varies between 3,820 fmsl to 3,865 fmsl. Therefore, the ground elevation at Blackrock 94 is generally 10 to 55 feet higher than the ground elevation on the valley floor in the area to the east of the parcel. The highest ground elevation in Blackrock 94 is located in the northwest area of the parcel.

Sec. 5.1 Figure b.i.3. Ground Elevation near BLK94.

The difference in ground elevation has a clear effect on the difference in DTW under the Blackrock 94. Permanent vegetation monitoring site TS1 is located on the western edge of Blackrock 94 with a ground elevation of approximately 3,846 fmsl, while TS2 is located near the eastern boundary of Blackrock 94 and has a ground elevation of 3,831 fmsl, resulting in a 15 feet of difference in ground elevation between TS1 and TS2. Taking into account the difference in ground elevation, the DTW under permanent monitoring site TS1 is generally about 5-7 feet greater than DTW under permanent monitoring site TS2 (Table b.i.1 and the adjacent sketch show an example of the DTW and WTE in April 2010, a nearly average runoff year, for monitoring well T807 located at TS1 and T806 located at TS2).

Sec. 5.1 Table b.i.1. DTW and WTE under TS1 and TS2 in April 2010



Monitoring Well	Ground Elevation (fmsl)	DTW (ft)	WTE (fmsl)
T807 @ TS1	3,842.2	19.1	3,823.1
T806 @ TS2	3,826.4	13.2	3,813.2

5.1.4. Groundwater pumping in Thibaut-Sawmill and Taboose-Aberdeen Wellfields

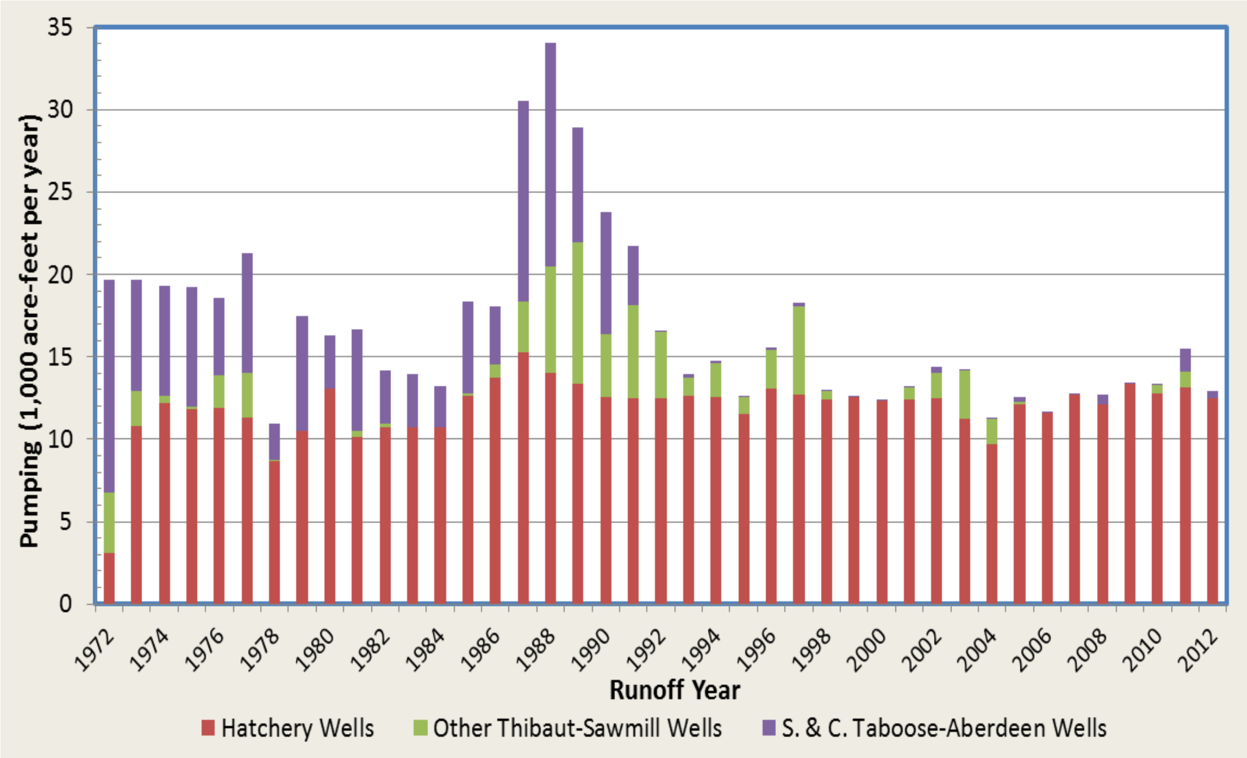
Groundwater pumping by individual wells in Thibaut-Sawmill and Taboose Aberdeen Wellfields with the exception of wells in northern Taboose-Aberdeen Wellfield, which have no effect on DTW under Blackrock 94, is shown in Appendices 5.1 Section 5.1.1. Wells in these wellfields are grouped according to their effect on groundwater levels beneath Blackrock 94 and shown in Table b.i.2 and Figure b.i.4. Most of the wells in these wellfields are relatively shallow and withdraw water from shallow volcanic formations in the area. The exceptions are wells in southwestern Thibaut-Sawmill Wellfield and deep wells that withdraw water formations below volcanic formation and have much less of a direct effect on the shallow groundwater levels beneath Blackrock 94.

Sec. 5.1 Table b.i. 2. Groundwater Pumping from Taboose-Aberdeen and Thibaut-Sawmill Wellfields.

RO YR	Hatchery	Other TS	Total TS	South TA	Center TA	S. & C. TA	Total
1972	3,104	3,664	6,768	3,899	9,010	12,909	19,677
1973	10,787	2,142	12,929	3,542	3,196	6,738	19,667
1974	12,179	428	12,607	2,970	3,748	6,718	19,325
1975	11,818	187	12,005	1,584	5,663	7,247	19,252
1976	11,873	1,992	13,865	1,301	3,371	4,672	18,537
1977	11,314	2,692	14,006	1,493	5,787	7,280	21,286
1978	8,689	74	8,763	362	1,847	2,209	10,972
1979	10,518	0	10,518	512	6,477	6,989	17,507
1980	13,084	3	13,087	807	2,428	3,235	16,322
1981	10,133	378	10,511	1	6,169	6,170	16,681
1982	10,743	185	10,928	59	3,200	3,259	14,187
1983	10,696	2	10,698	625	2,661	3,286	13,984
1984	10,705	0	10,705	323	2,222	2,545	13,250
1985	12,654	90	12,744	244	5,384	5,628	18,372
1986	13,731	791	14,522	1,034	2,537	3,571	18,093
1987	15,275	3,045	18,320	1,543	10,652	12,195	30,515
1988	14,030	6,447	20,477	3,763	9,818	13,581	34,058
1989	13,334	8,598	21,932	1,581	5,398	6,979	28,911
1990	12,590	3,754	16,344	7	7,400	7,407	23,751
1991	12,511	5,645	18,156	37	3,540	3,577	21,733
1992	12,491	4,035	16,526	34	42	76	16,602
1993	12,640	1,099	13,739	102	90	192	13,931
1994	12,579	2,026	14,605	168	18	186	14,791
1995	11,512	1,028	12,540	51	0	51	12,591
1996	13,078	2,362	15,440	105	0	105	15,545
1997	12,724	5,322	18,046	205	0	205	18,251
1998	12,428	512	12,940	5	0	5	12,945
1999	12,525	0	12,525	34	0	34	12,559
2000	12,318	18	12,336	7	0	7	12,343
2001	12,432	708	13,140	1	0	1	13,141
2002	12,469	1,532	14,001	415	0	415	14,416
2003	11,206	2,962	14,168	1	0	1	14,169
2004	9,670	1,548	11,218	9	0	9	11,227
2005	12,115	133	12,248	337	0	337	12,585
2006	11,590	26	11,616	75	0	75	11,691
2007	12,732	0	12,732	16	0	16	12,748
2008	12,126	0	12,126	579	0	579	12,705
2009	13,354	0	13,354	101	1	102	13,456
2010	12,764	552	13,316	63	0	63	13,379
2011	13,118	946	14,064	499	902	1,401	15,465
2012	12,520	0	12,520	372	0	372	12,892
Average 1973-2012	**12,126**	**1,532**	**13,658**	**624**	**2,314**	**2,938**	**16,596**
Average 1992-2012	**12,304**	**1,181**	**13,486**	**151**	**50**	**202**	**13,687**
Average 1998-2012	**12,224**	**596**	**12,820**	**168**	**60**	**228**	**13,048**

TS: Thibaut-Sawmill Wellfield; TA: Taboose-Aberdeen Wellfield; S.: South; C.: Centeral

RO Yr is Runoff Year



Sec. 5.1 Figure b.i.4. Pumping Wells in Taboose-Aberdeen and Thibaut-Sawmill Wellfields

Groundwater pumping to supply Blackrock Hatchery has been the bulk of pumping in this area. Table b.i.3 summarizes the relationship between Hatchery supply pumping and the total pumping from the Thibaut-Sawmill wells and south and central Taboose-Aberdeen Wellfields. As shown in this table, Hatchery supply pumping has been 89% of pumping from Thibaut-Sawmill Wellfield since 1973. Since the signing of Inyo/ Los Angeles Water Agreement, pumping by other wells in Thibaut-Sawmill Wellfield has been about 9% of total pumping. Lower pumping and higher runoff in 1990s result in substantial recovery of water groundwater levels by 1998. Since 1998, pumping for Hatchery supply has been 95% of all pumping in Thibaut-Sawmill Wellfield. Similar results can be seen when considering total pumping from all wells in Thibaut-Sawmill and south and central Taboose-Aberdeen wellfields.

Sec. 5.1 Table b.i. 3. Hatchery Pumping as a percentage of pumping from Thibaut-Sawmill and South and Central Taboose-Aberdeen Wellfields

Period	Hatchery Pumping as % of TS wellfield	Hatchery Pumping as % of TS & S. and C. TA wellfields
1973-2012	89	73
1992-2012	91	90
1998-2012	95	94

5.1.5. Blackrock Hatchery Water Balance

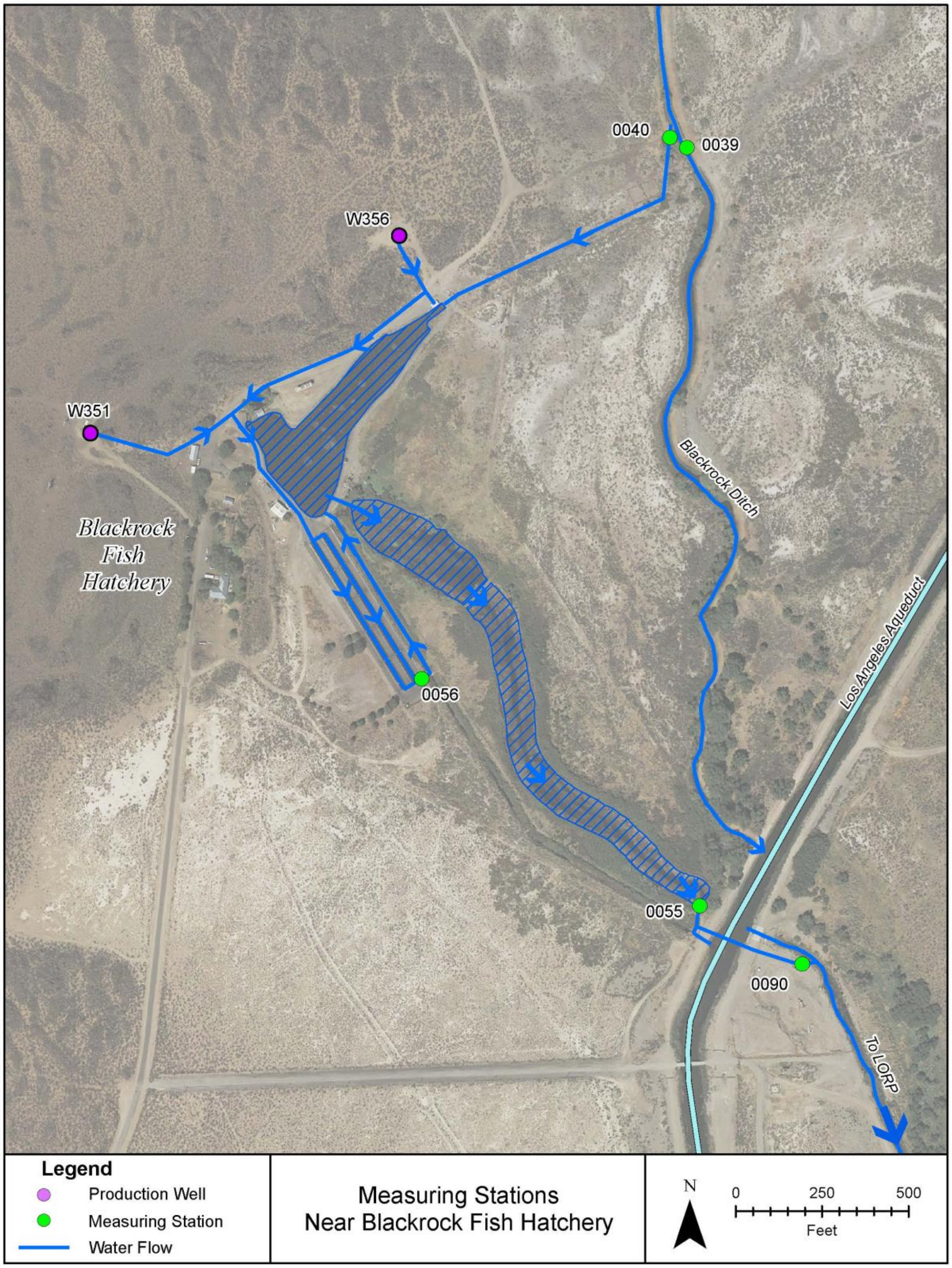
To evaluate the effect of groundwater pumping in the Thibaut-Sawmill Wellfield on groundwater levels under Blackrock 94, pumping from all nearby wells was reviewed. Since groundwater pumping to supply Blackrock Hatchery constitutes approximately 89 percent of all pumping in the Thibaut-Sawmill Wellfield since 1973 (Table b.i.3), it is important to understand the how the Hatchery affects the water table in the wellfield. To assist in the development of this understanding, the following water balance of the Hatchery is presented.

Prior to the start of pumping to supply the Hatchery in October of 1972, Big Blackrock Spring flowed (1991 EIR, Table 9-4). The average flow of Big Blackrock Spring for the period of 1934 to 1971 was approximately 7,000 acre-feet per year and water from the spring flowed east into the LAA.

Figure b.i.5 shows the current plumbing of the Hatchery and gauge (measuring) stations that allow for development of a water balance for the Hatchery. Two groundwater pumping wells, W351 and W356, are the primary sources of water supply to the Hatchery. Groundwater supply to the Hatchery is supplemented with surface water inflow via a diversion from Blackrock Ditch, which is measured at Gauge Station #0040. Outflow from the Hatchery is measured using Gauge Station #0055. Once the Hatchery outflow is measured, water can flow into either the LAA or to continue eastward toward the Lower Owens River.

The current plumbing configuration has been in place since 1998. Prior to 1998, after water flowed through the Hatchery tailrace, it was measured using gauge station #0056, whereby a portion of water flowed to the Hatchery ponds and a portion to the LAA without being measured. Therefore, data prior to 1998 is not reliable for the purpose of conducting an accurate water balance of the Blackrock Hatchery.

Table b.i.4 shows water balance calculations for the Blackrock Hatchery. The average total annual inflow to the Hatchery between 1998 and 2012 from both the Hatchery supply wells and the Blackrock Ditch was 15,800 acre-feet per year. The average total outflow from Blackrock Hatchery for the 1998 to 2012 period (as measured at gauge station 0055) was approximately 12,800 acre-feet per year. Based on these long-term average inflow and outflow rates, approximately 3,000 acre-feet per year of water supplied to the Hatchery is circulated back to the aquifer by percolation through the bottom of the Hatchery rearing ponds. This estimate appears reasonable because wells W351 and W356 are only 470 feet and 250 feet away from the Hatchery ponds, respectively, and can cause up to 30 feet of drawdown under the ponds when they are pumping.



Sec. 5.1 Figure b.i.5. Schematic of Blackrock Hatchery Plumbing.

Sec. 5.1 Table b.i. 4. Water Balance for Blackrock Hatchery (volumes in acre-feet per year)

RO Yr	0040	W351	W356	Inflow	0055	Outflow	Circulate
Average 1998-2012	**3,595**	**12,090**	**135**	**15,820**	**12,807**	**12,807**	**3,013**
2012-13	2,164	12,463	57	14,684	14,190	14,190	494
2011-12	3,971	13,113	5	17,089	15,381	15,381	1,708
2010-11	4,493	12,618	146	17,257	16,715	16,715	542
2009-10	3,582	13,351	3	16,936	12,718	12,718	4,218
2008-09	3,251	11,804	322	15,377	9,956	9,956	5,421
2007-08	2,171	12,500	232	14,903	11,290	11,290	3,613
2006-07	6,222	11,573	17	17,812	12,353	12,353	5,459
2005-06	5,319	11,751	364	17,434	13,662	13,662	3,772
2004-05	3,105	9,668	2	12,775	10,699	10,699	2,076
2003-04	2,681	11,201	5	13,887	10,659	10,659	3,228
2002-03	2,363	11,651	818	14,832	10,939	10,939	3,893
2001-02	2,748	12,421	11	15,180	11,805	11,805	3,375
2000-01	2,574	12,286	32	14,892	12,381	12,381	2,511
1999-00	3,987	12,520	5	16,512	13,742	13,742	2,770
1998-99	5,301	12,426	2	17,729	15,620	15,620	2,109
1997-98	3,872	12,698	26	16,596	14,017		
1996-97	1,104	13,048	30	14,182	10,786		
1995-96	0	9,488	2,024	11,512	4,895		
1994-95	0	12,572	7	12,579	9,440		
1993-94	1,790	12,625	15	14,430	11,568		
1992-93	701	12,454	37	13,192	12,216		
1991-92	1,390	12,485	26	13,901	12,882		
1990-91	5,525	12,403	187	18,115	17,066		
1989-90	5,004	12,186	1,148	18,338	17,207		
1988-89	3,402	11,101	2,929	17,432	16,188		
1987-88	1,329	13,077	2,198	16,604	14,630		
1986-87	1,161	12,677	1,054	14,892	10,650		
1985-86	0	11,138	1,516	12,654	3,048		
1984-85	5,619	4,103	6,602	16,324	11,770		
1983-84	7,611	3,441	7,255	18,307	15,252		
1982-83	6,753	3,299	7,444	17,496	16,157		
1981-82	7,855	3,085	7,048	17,988	14,696		
1980-81	4,569	5,246	7,838	17,653	12,775		
1979-80	9,415	1,860	8,658	19,933	15,929		
1978-79	5,639	5,665	3,024	14,328			
1977-78	5,268	11,314		16,582			
1976-77	5,200	11,873		17,073			
1975-76	7,761	11,818		19,579			
1974-75	7,906	12,179		20,085			
1973-74	7,084	10,787		17,871			

Station 0040: Inflow form Blackrock Ditch
Station 0055: Outflow to Los Angels Aqueduct
Refer to Figure b.i.4 for the locations of gauges near Blackrock Hatchery
Outflow can be reliabily calculated for years after 1997

RO Yr is Runoff Year

The surface area of the Blackrock Hatchery rearing ponds is approximately 5 acres. Surface evaporation from the Hatchery ponds and evapotranspiration from adjacent vegetation is a very small percentage of losses and does not affect the overall water balance. The ponds are located atop a volcanic formation with very high hydraulic conductivity and transmissivity. Because there is 20-30 feet of difference between the water level in the pond and the groundwater level in the underlying volcanic formation, the high percolation rate appears reasonable.

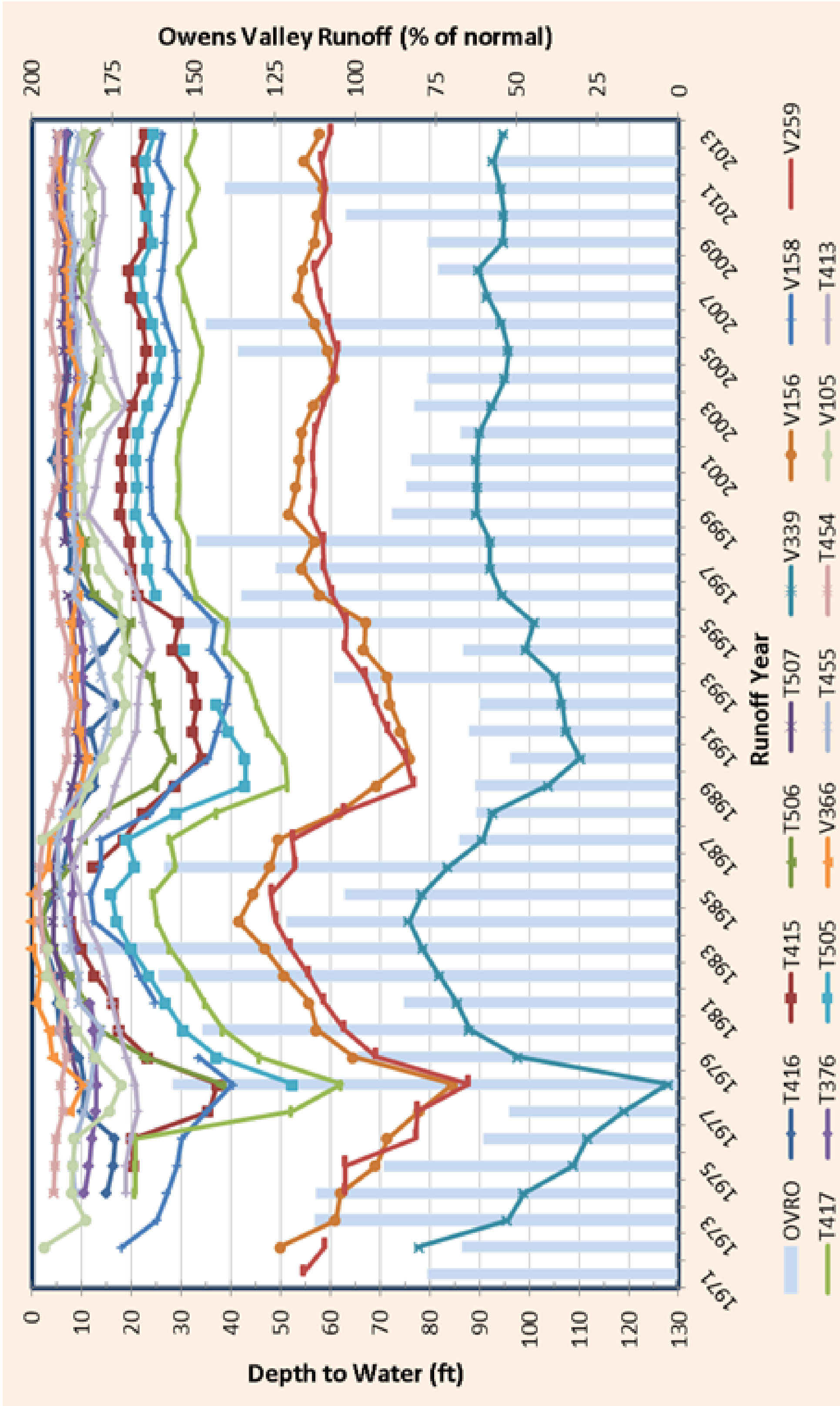
The average natural flow of Blackrock Spring as measured prior to the start of groundwater pumping to supply the Hatchery was 7,000 acre-feet per year. Since late 1972, the average groundwater pumping by wells W351 and W356 to supply the Hatchery has been 12,200 acre-feet per year. The water balance of the Hatchery suggests that an average of 3,000 acre-feet per year circulates back to the aquifer through seepage from the Hatchery rearing ponds. Therefore, the average net additional groundwater withdrawal for the Hatchery is estimated to be 2,200 acre-feet per year, as shown below:

$$W351 \,\&\, W356\ Pumping \quad 12{,}200\ \frac{af}{yr} - Circulated\ to\ Aquifer \quad 3{,}000\ \frac{af}{yr} = 9{,}200\ \frac{af}{yr}$$

$$Net\ Groundwater\ Pumping \quad 9{,}200\ \frac{af}{yr} - Natural\ Spring\ Flow \quad 7{,}000\frac{af}{yr} = 2{,}200\ \frac{af}{yr}$$

5.1.6. Long-Term Groundwater Levels in Thibaut-Sawmill and Southern Taboose-Aberdeen Wellfields

To evaluate the long-term groundwater level fluctuations in the Thibaut-Sawmill and south and central Taboose-Aberdeen wellfields, a number of monitoring wells with recorded groundwater level measurements since early 1970s were utilized. Figure b.i.6 shows hydrographs of DTW for 16 monitoring wells with data back to the early 1970s. It is clear that groundwater levels in all monitoring wells followed similar general trends. Groundwater levels generally dropped during dry years and rose in wet years. In almost all cases, the lowest DTW occurred during the drought period of 1976-1977, followed by the drought period of 1987-1992. The highest water levels in these monitoring wells occurred in the mid-1980s after the Eastern Sierra experienced successive wet years (substantial amounts of precipitation and runoff) between 1978 and 1986. As discussed in Section 5.7 of this report, in addition to recharge from the creeks on alluvial fans, groundwater spreading is an important recharge component during high runoff years. The drought of 1987-1992, combined with elevated groundwater pumping during that period, resulted in lowered groundwater levels. During the second half of the 1990s groundwater levels rose due to four years of higher than normal runoff, and by 1999 groundwater levels recovered substantially to pre-drought levels (see Appendix 5.1.2, Chapter 5, Drought Recovery Report by MWH Americas, Inc.). Since the late 1990s to present, DTW has been generally stable in the Thibaut-Sawmill and south and central Taboose-Aberdeen Wellfields, with fluctuations mainly due to variations in runoff-induced recharge to the groundwater aquifer.



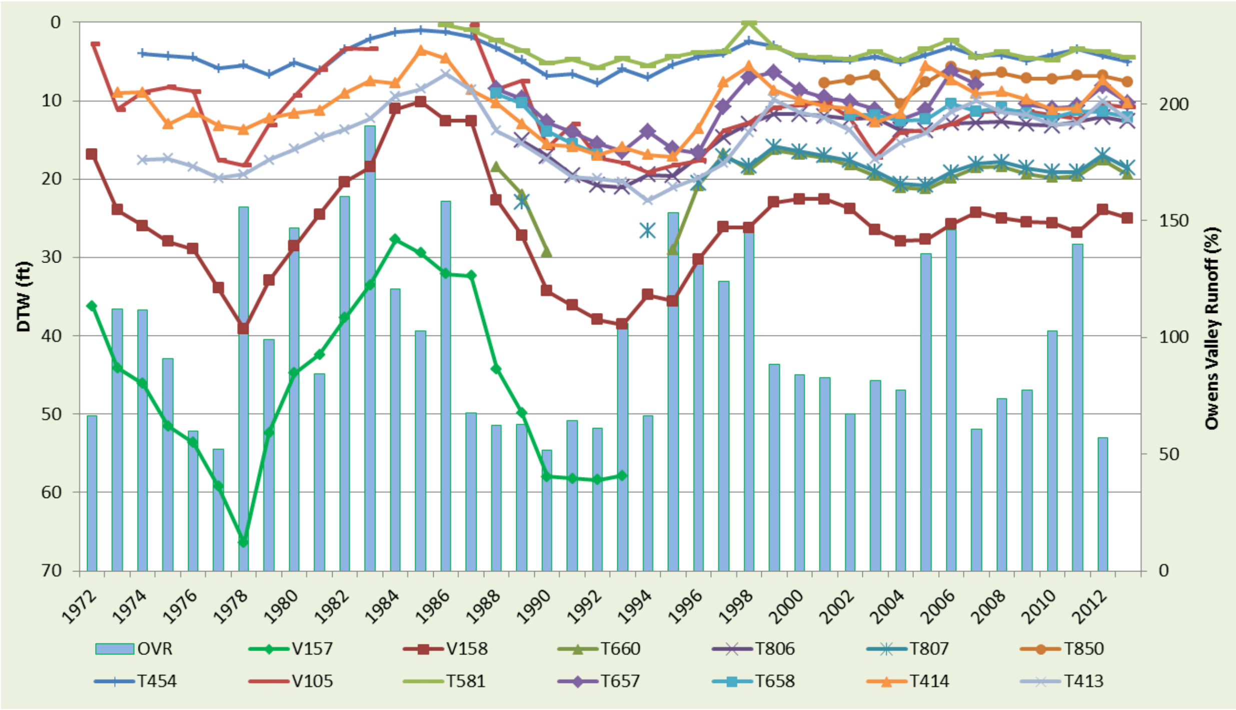
Sec. 5.1 Figure b.i.6. Long-Term Hydrograph of Selected Monitoring Wells in Thibaut-Sawmill and Taboose-Aberdeen Wellfields

Factors affecting water levels in both the shallow and deep aquifers include regional and local geohydrology, groundwater recharge as represented by the Owens Valley runoff, and groundwater pumping. Groundwater levels in the shallow aquifer are affected by additional factors including precipitation and evapotranspiration from vegetation utilizing water from the shallow aquifer. Monitoring wells that are located in the valley floor generally have shallower groundwater levels with smaller fluctuations due to variations in runoff-induced recharge and groundwater pumping (monitoring wells T454, T376, T380, T455, T505, and T413 in Figure b.i.6). The DTW is deeper in the monitoring wells located near the perimeter of the valley and on the alluvial fans, as ground elevation increases. The valley perimeter and alluvial fan wells also have greater fluctuations in DTW between dry and wet years (monitoring wells V339, V156, V259, V157, and V158 in Figure b.i.6).

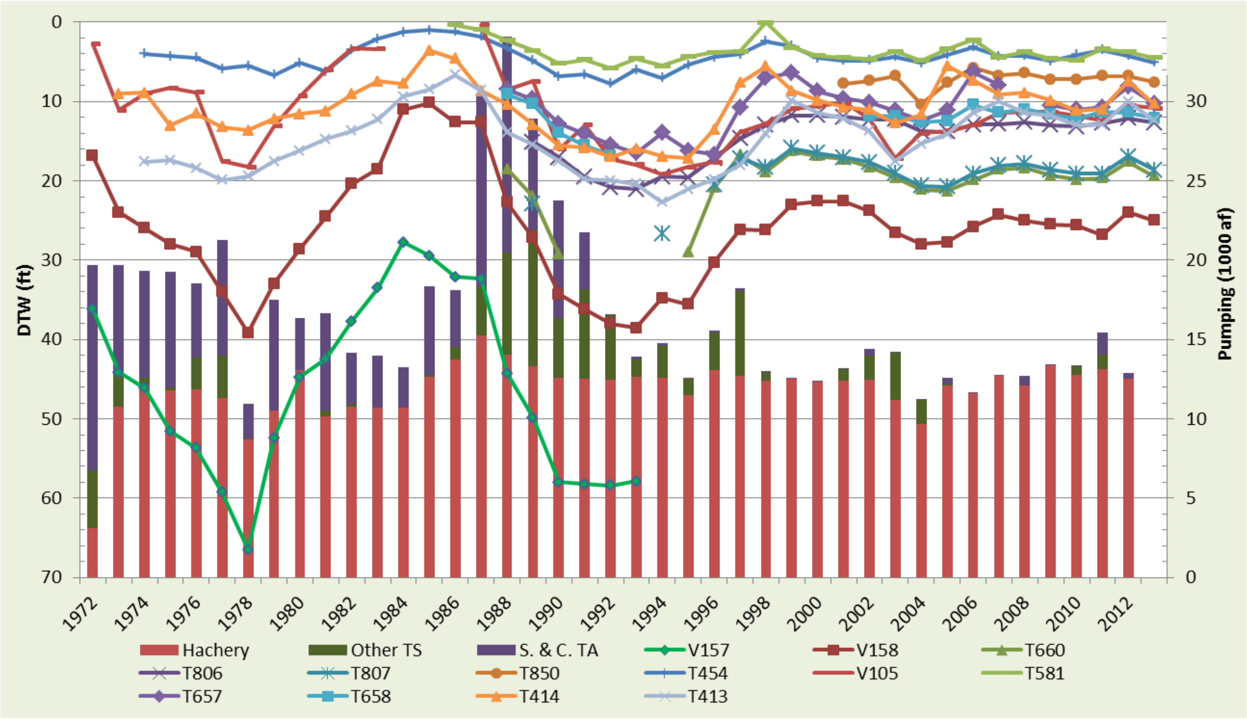
5.1.7. Water Levels in the Vicinity of Blackrock 94

As a part of the attributability analysis of conditions in Blackrock 94, factors that affect groundwater level fluctuations beneath Blackrock 94 were evaluated. While regional and local geology remain constant, other factors such as runoff change from year to year and season to season. The two main factors that may affect groundwater levels beneath Blackrock 94 are runoff driven groundwater recharge and pumping from nearby wells. In the Thibaut-Sawmill Wellfield, similar to the rest of Owens Valley, groundwater recharge can generally be represented by the Owens Valley runoff, which is calculated as the sum of measured runoff for all streams flowing into the Owens River system. Groundwater recharge, as represented by the Owens Valley runoff, also includes other infrequent factors such as water spreading along the alluvial fans to the west of Blackrock 94 during high runoff conditions. Water spreading causes short-term increases on groundwater levels under Blackrock 94 as water mounds during spreading operations then dissipates. The majority of groundwater pumping in the Thibaut-Sawmill Wellfield has been by the wells supplying Blackrock Hatchery. Since 1972, when groundwater pumping for the Hatchery supply started, approximately 89 percent of the pumping in the Thibaut-Sawmill Wellfield has been by the wells supplying Blackrock Hatchery.

Figure b.i.7 shows hydrographs of 13 monitoring wells near Blackrock 94. The top graph compares groundwater changes to the Owens Valley runoff as an indicator of recharge to the aquifer. The bottom graph compares groundwater changes to groundwater pumping in the Taboose-Aberdeen and Thibaut Sawmill Wellfields. Groundwater pumping is indicated as the sum of pumping for Hatchery supply, pumping from the other Thibaut-Sawmill Wellfield wells, and pumping from wells located in south and central Taboose-Aberdeen Wellfield. When reviewing these graphs, it should be noted that the effect of runoff and pumping in each year is reflected in DTW changes in the following year.



Sec. 5.1 Figure b.i.7. Hydrograph of Monitoring Wells near BLK94
OVR (Owens Valley Runoff in percent of normal)



Sec. 5.1 Figure b.i.8. Hydrograph of Monitoring Wells near BLK94

To better understand the effect of runoff versus pumping, it is helpful to consider specific time periods that represent unique conditions.

- Between 1987 and 1992, the Blackrock area experienced both (1) well below normal runoff and (2) above-average pumping, which resulted in groundwater levels declining to the second lowest levels during their period of record. It is difficult to separate the effect of each factor.

- During the period of 1972-1977, the total groundwater pumping in the Taboose-Aberdeen and Thibaut-Sawmill Wellfields, including Hatchery pumping, was relatively constant while the average Owens Valley runoff was only about 83 percent of normal. A decreasing trend in groundwater levels can be seen clearly in the hydrographs of all monitoring wells (Figure b.i.8). Monitoring well V157 showed over 32 feet of water level drop even though total pumping was relatively constant.

- Between 1978 and 1986, the average Owens Valley runoff was over 135 percent of normal causing groundwater levels to rise to their highest point of their period of record. Groundwater pumping in the wellfield was higher than average at about 15,000 acre-feet per year (Table b.i.2).

- During 2005 and 2006, Owens Valley runoff was over 150 percent of normal while total pumping was at the constant level of approximately 12,200 acre-feet per year. Again, all monitoring wells show a clear increasing trend in groundwater levels in response to high runoff.

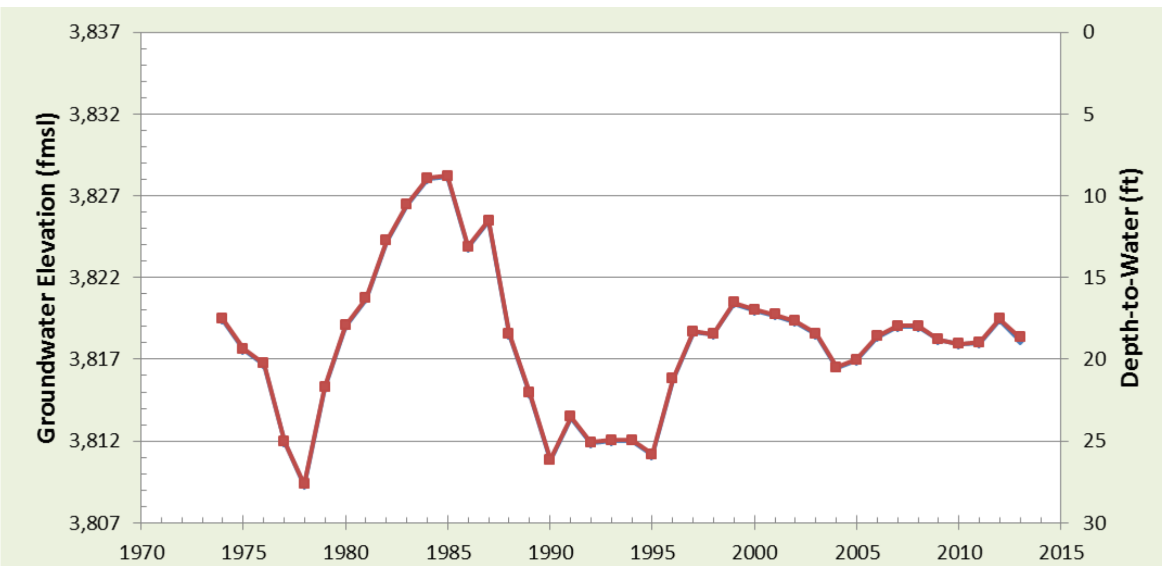
These observations demonstrate that runoff-driven recharge of the aquifer is the main factor affecting water levels under Blackrock 94. Given the strong effect of runoff-driven recharge on groundwater levels, it can also be concluded that even in the absence of pumping, groundwater levels under Blackrock 94 would have declined during the late 1980s and early 1990s due to successive years of well below normal runoff.

Monitoring wells provide a measure of groundwater levels at discrete points near Blackrock 94. Groundwater level measurements at monitoring wells were used to calculate the average WTE and DTW under Blackrock 94. Appendix 5.1.3 shows all of the data used to calculate average DTW under Blackrock 94. To ensure that all water level measurements are made relative to the same reference point, instead of DTW, WTE was used for interpolation[12]. The Spatial Analyst Tool of Arc GIS software, a commercial GIS data processing application, was used for interpolation and calculation of average WTE under the parcel area. While Arc GIS provides several options for interpolation, the Ordinary Kriging (a method used to interpolate spatially

[12] DTW is a measurement of the water table using the ground surface at a specific monitoring well as a reference point. DTW at different monitoring wells may have differing reference points due to variations in topography. Comparing two DTW readings is meaningless unless the ground surface elevations associated with each DTW reading are taken into account. WTE uses mean sea level as a common reference point in locating the water table and allows differences in WTE to be easily compared.

distributed data) option was used to interpolate WTE for the area near the Blackrock 94, resulting in a contour map of WTE under the parcel for April of each year. A high resolution Digital Surface Model of the area was used to create a contour map of ground elevation near Blackrock 94. Finally, the difference between ground elevation and WTE resulted in a contour map of DTW. The contour map of DTW was then intersected with a polygon of the boundary of Blackrock 94, and the average DTW under Blackrock 94 was calculated for each year. Because many monitoring wells were installed in late 1980s, as shown in Appendix 5.1.3, there are more data points available for interpolating water levels in years after 1989. Therefore, the calculated average WTE and DTW are much more reliable for years after 1989 than previous years.

Figure b.i.9 shows a hydrograph of calculated average WTE and DTW under Blackrock 94 between 1974 and 2013. For years prior to 1974, there were not enough data points to produce a contour map that covered the entire parcel area. This hydrograph shows that the average DTW under Blackrock 94 was about 16 feet in 1974, dropping to about 27 feet in 1978 due to the drought of 1977-78. Following this drought and in response to the successive higher than normal runoff conditions of late 1970s and early 1980s[13], the groundwater beneath Blackrock 94 rose to the highest ever recorded at 8 feet below ground surface in 1985. Another period of drought and elevated groundwater pumping between 1987 and 1992 resulted in a groundwater level decline to about 25 feet below ground surface. Higher than normal runoff and pumping mainly for Hatchery supply resulted in substantial water level recovery by the late 1990s. Since that time, water levels have been generally stable with fluctuations corresponding to differences in Owens Valley runoff.



Sec. 5.1 Figure b.i.9. Average Calculated WTE and DTW using Kriging of nearby Monitoring Wells

[13] Eastern Sierra runoff between 1978 and 1986 averaged about 134% of normal. Over 188,000 acre-feet of surface water runoff was spread in the area between Tinemaha Reservoir and Alabama Gates during that nine year period, resulting in unusually high groundwater levels in the area (The area described extends from about 10 miles north of Blackrock 94 to about 16 miles to the south).

The post-1999 water levels are similar to that of early 1970s. If successive high runoff conditions similar to what occurred in the late 1970s and the first half of 1980s are repeated and given current stable level of pumping in Thibaut-Sawmill Wellfield, water levels under Blackrock 94 can be expected to rise again to the high levels of mid-1980s.

In a report prepared by MWH Americas, Inc. (MWH, 2001), the recovery from the drought period between 1987 and 1992 was evaluated for the entire Owens Valley. Chapter 4 of the report (Appendix 5.1.3) evaluated the recovery in Thibaut-Sawmill Wellfield by considering water levels and soil moisture at all permanent vegetation monitoring sites in the wellfield.

The MWH Americas, Inc. evaluation concluded that:

1. Approximately 90% of shallow monitoring wells in Thibaut-Sawmill Wellfield exhibited substantial (80% or greater) recovery by late 1990s.
2. The groundwater storage gains since 1992 have more than replaced the amounts depleted during the late 1980s and early 1990s.
3. Soil moisture in the higher portion of the soil profile is predominately influence by precipitation, land surface use activities, and evapotranspiration.
4. Soil moisture in the lower portion of the soil profile, to the extent that it is influenced groundwater levels has recovered to pre-drought conditions.

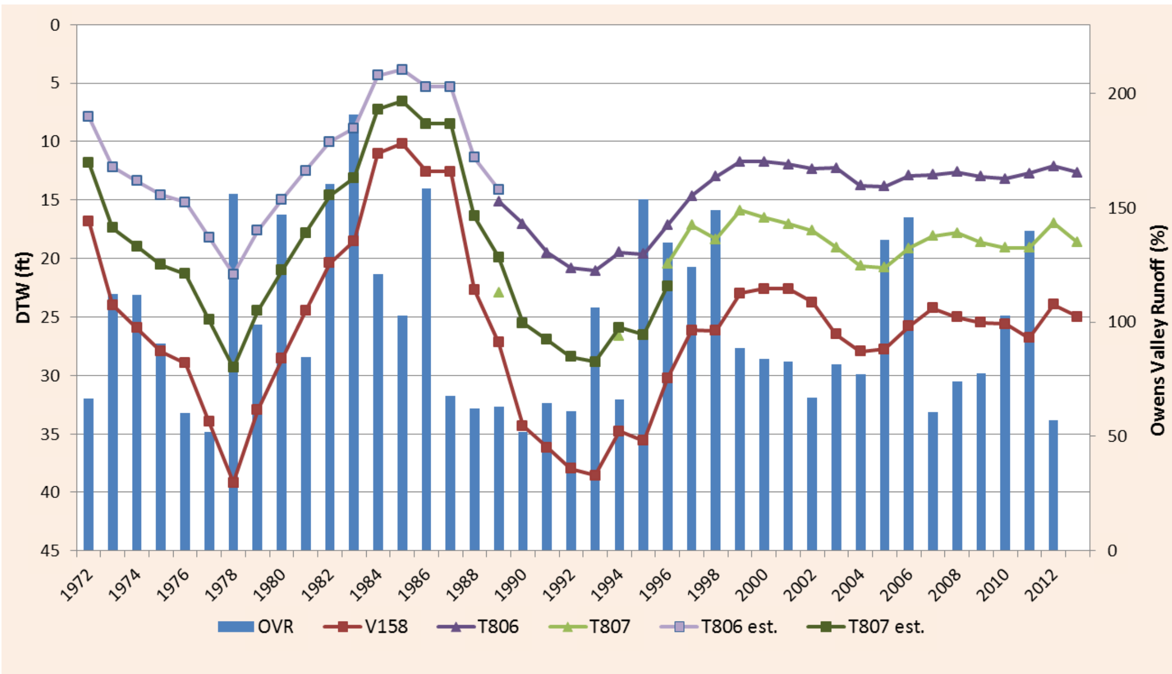
Additional analyses of soil moisture are included in sections 5.2.2.4 and 5.6 of this report.

5.1.8. Groundwater Levels under Permanent Monitoring Sites TS1 and TS2

Permanent vegetation monitoring sites TS1 and TS2 are located near the western and eastern edges of Blackrock 94, respectively (Figure b.i.3). TS2 is located near the valley floor with a surface elevation of 3,832 fmsl and TS1 is located at the edge of an alluvial fan with an elevation 3,848 fmsl, a 16-foot elevation difference between the two monitoring sites.

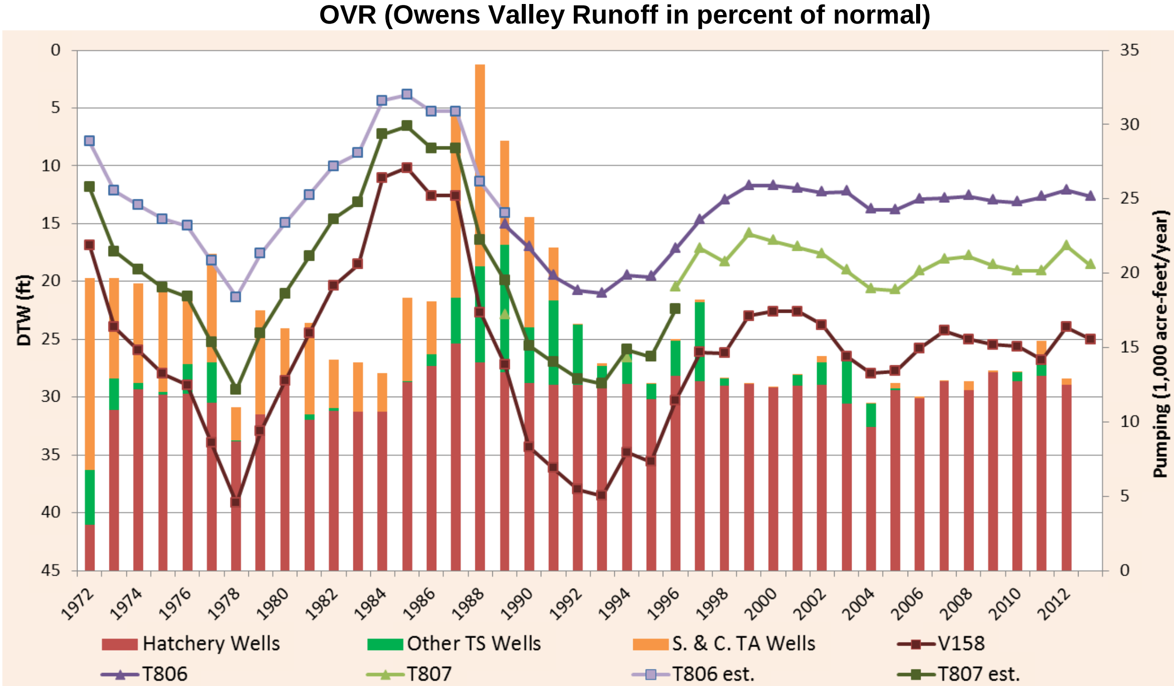
This elevation difference is one of the factors that explain the difference in DTW under these two monitoring sites. Monitoring well T807 represents DTW at site TS1 and monitoring well T806 represents DTW at monitoring Site TS2 (both wells were installed in 1989). Although measured DTW in these monitoring wells does not go back to 1970s, the DTW in monitoring well V158, located just west of Blackrock 94 has a period of record from 1972 to the present and a very high correlation with DTW in wells T806 and T807 ($r = 0.97$ with T806 and $r = 0.91$ with T807). These high correlations allow DTW in T806 and T807 to be reliably estimated as far back as 1972. Appendix 5.1.4 shows the pumping, runoff, and measured and/or estimated DTW in T806 and T807, using the DTW correlation relationship with V158.

Figures b.i.10 and 11 show measured and calculated DTW in T806 and T807 and the measured DTW in V158 (also see table b.i.5). These figures compare both Owens Valley runoff and groundwater pumping volumes to DTW at Blackrock 94 monitoring sites TS1 and TS2. Groundwater pumping is presented as the sum of Blackrock Hatchery pumping, pumping from other wells in the Thibaut-Sawmill Wellfield, and pumping from wells in south and central Taboose-Aberdeen Wellfield.



Sec. 5.1 Figure b.i.10. Measured and Estimated DTW under Monitoring Sites TS1 and TS2

OVR (Owens Valley Runoff in percent of normal)



Sec. 5.1 Figure b.i.11. Measured and Estimated DTW under Monitoring Sites TS1 and TS2

Sec. 5.1 Table b.i.5. Pumping, OwensValley Runoff (RO) and DTW in V158, T806, and T807.

RO YR	Pumping (af/yr)			OVR (af/yr)	DTW(ft)		
	Hatchery	Other TS	S. & C. TA	OV RO	V158	T806	T807
1972	3,104	3,664	12,909	276,882	16.87	*7.89*	*11.83*
1973	10,787	2,142	6,738	466,516	23.97	*12.18*	*17.41*
1974	12,179	428	6,718	465,125	25.97	*13.38*	*18.98*
1975	11,818	187	7,247	377,308	27.97	*14.59*	*20.55*
1976	11,873	1,992	4,672	249,678	28.97	*15.20*	*21.33*
1977	11,314	2,692	7,280	216,567	33.97	*18.21*	*25.26*
1978	8,689	74	2,209	648,737	39.17	*21.35*	*29.34*
1979	10,518	0	6,989	411,287	32.97	*17.61*	*24.47*
1980	13,084	3	3,235	611,023	28.59	*14.97*	*21.03*
1981	10,133	378	6,170	351,412	24.50	*12.50*	*17.82*
1982	10,743	185	3,259	667,114	20.40	*10.02*	*14.60*
1983	10,696	2	3,286	792,511	18.51	*8.88*	*13.12*
1984	10,705	0	2,545	502,366	11.04	*4.37*	*7.26*
1985	12,654	90	5,628	428,046	10.17	*3.85*	*6.57*
1986	13,731	791	3,571	658,839	12.59	*5.31*	*8.47*
1987	15,275	3,045	12,195	280,785	12.59	*5.31*	*8.47*
1988	14,030	6,447	13,581	258,845	22.67	11.39	16.39
1989	13,334	8,598	6,979	261,425	27.17	15.10	*22.92*
1990	12,590	3,754	7,407	215,375	34.32	17.06	*25.53*
1991	12,511	5,645	3,577	267,858	36.15	19.53	*26.97*
1992	12,491	4,035	76	254,358	37.98	20.82	*28.40*
1993	12,640	1,099	192	441,306	38.55	21.06	28.85
1994	12,579	2,026	186	275,497	34.79	19.49	26.62
1995	11,512	1,028	51	638,036	35.58	19.61	*26.52*
1996	13,078	2,362	105	560,366	30.27	17.16	20.49
1997	12,724	5,322	205	516,225	26.14	14.67	17.17
1998	12,428	512	5	618,668	26.19	12.98	18.34
1999	12,525	0	34	368,000	22.99	11.74	15.90
2000	12,318	18	7	348,698	22.59	11.74	16.50
2001	12,432	708	1	343,340	22.59	11.97	17.04
2002	12,469	1,532	415	278,750	23.77	12.33	17.63
2003	11,206	2,962	1	338,416	26.49	12.25	19.06
2004	9,670	1,548	9	321,253	27.95	13.77	20.64
2005	12,115	133	337	565,593	27.76	13.84	20.77
2006	11,590	26	75	606,508	25.78	12.91	19.13
2007	12,732	0	16	251,628	24.25	12.83	18.08
2008	12,126	0	579	307,425	25.01	12.62	17.81
2009	13,354	0	102	321,786	25.48	13.00	18.61
2010	12,764	552	63	426,874	25.62	13.18	19.09
2011	13,118	946	1,401	581,758	26.80	12.72	19.09
2012	12,520	0	372	237,719	23.96	12.11	16.95
TS: Thibaut-Sawmill Wellfield; TA: Taboose-Aberdeen Wellfield; S.: South; C.: Central							
OVR: Owens Valley Runoff, af/yr: Acre-feet per year						Measured	Estimated

Table b.i.5 shows Owens Valley runoff, Hatchery supply pumping, pumping from other Thibaut-Sawmill wells, pumping from wells in south and central Taboose Aberdeen Wellfield, and measured and estimated DTW in V158, T806, and T807. Using the data from this table the Spearman's Rank correlation coefficient was calculated. The Spearman's Rank correlation is a measure of any relationship between two variables, not necessarily a linear relationship.

Table b.i.6 shows the results of the correlation analysis. Correlation coefficient represents the degree that two variables are associated and is a depiction of the strength and direction of the relationship. It can vary between -1 and +1. The sign of the correlation coefficient represents a positive or negative relationship. The strength of correlation is represented by how close to zero or -1 or +1, it is. The closer to -1 or +1, the stronger the relationship and closer to zero is an indication of lack of a relationship. This table also shows the statistical significance of each relationship using a t-test statistical method. A p-value less than 0.05 indicates statistical significance with 95% confidence level while a p-value of greater than 0.05 indicates that the relationship is not significant with 95% confidence. The correlation coefficients and their statistical significance were calculated using the statistical software SigmaStat, version 3.5, by Systat Software, Inc.

Sec. 5.1 Table b.i6. Pearson Correlation Coefficient of DTW in T806 and T807 with Owens Valley Runoff, Hatchery Supply Pumping, Pumping from Other Thibaut-Sawmill Wells, and South and Central Taboose-Aberdeen Wells.

	T806 at TS2		T807 at TS1	
	Cor. Coeff	p-Value	Cor. Coeff	p-Value
Owens Valley Runoff	-0.44	0.005	-0.52	0.001
Hatchery Supply Pumping	-0.01	0.972	-0.01	0.935
Other TS Wells Pumping	0.48	0.002	0.46	0.003
S. & C. TA Wells Pumping	0.10	0.529	0.13	0.417

A p-value less than 0.05 indicates a statistically significant correlation with 95% confidence

The Correlation Coefficient value are by Spearman's Rank method

The results of correlation analysis as shown in Table b.i.6 show that the DTW in T806, located in monitoring Site TS2, and T807, located in monitoring Site TS1, are statistically significantly correlated with Owens Valley runoff with 95% confidence. The DTW in T806 and T807 and pumping from other wells in Thibaut-Sawmill Wellfield are also statistically significantly correlated with 95% confidence. Table b.i.6 also shows that DTW measurements in T806 and T807 are not correlated with Hatchery supply pumping and pumping from wells in south and central Taboose-Aberdeen Wellfield with a 95% confidence. A statistically significant correlation between Hatchery supply pumping and DTW is not expected because Hatchery supply pumping has been relatively stable since it began in 1972 and the effect of this pumping on the water table stabilized long before the 1986 period, which is used as a vegetation baseline period for Blackrock 94. The statistically significant correlation of DTW in T806 and T807 with pumping from the rest of wells in Thibaut-Sawmill Wellfield is reasonable mainly because these wells are located in the closer vicinity of Blackrock 94 and wells W155 and W159 are located directly adjacent to or within Blackrock 94 and screened partially in the shallow aquifer. All non-Hatchery supply pumping wells in Thibaut-Sawmill and southern Taboose-Aberdeen Wellfields have been pumped only minimally and periodically since 1992, as shown in Table b.i.5 and Figure b.i.11.

As demonstrated in Figures b.i.10 and 11, the hydrographs of monitoring wells T806 and T807 show DTW beneath Blackrock 94 is clearly more a function of Owens Valley runoff than groundwater pumping for Hatchery supply. Additionally, during the drought of 1987-1992, Hatchery supply pumping was relatively constant (bottom graph) while runoff was well below normal (top graph). The below normal runoff in combination with elevated pumping during the late 1980's from the wells in the area resulted in DTW in the area of these monitoring wells to decline until the end of the drought period. With the end of the drought, and during a period of higher than current pumping in the wellfield, groundwater levels began to increase in sync with increased Owens Valley runoff from 1993 to 1998 (top graph). Groundwater levels have been relatively stable since 1999, with fluctuations primarily due to the variations of runoff (as essentially the only pumping in the wellfield was the relatively constant Hatchery supply pumping). It is clear that since 1993, groundwater fluctuations under Blackrock 94 are driven by variations in runoff rather than the relatively stable groundwater pumping for Blackrock Hatchery (pumping from other wells in Thibaut-Sawmill and south and central Taboose wellfields was minimal after 1992).

5.1.9. Relative Effect of Pumping Wells on Groundwater Levels Under Blackrock 94

To evaluate the relative potential effect of each of the nearby pumping wells on groundwater levels under Blackrock 94, an *Area-of-Influence* analysis and its concepts were utilized. The Area of Influence of a well is defined as the area that would experience drawdown in the shallow aquifer as a result of a production well operating at its pumping capacity for a period of one year during average runoff conditions. A recent computer model developed by MWH Americas Inc. for the combined Taboose-Aberdeen and Thibaut-Sawmill wellfields (termed the "Taboose-Thibaut" model) was utilized for this analysis. The Taboose-Thibaut model is a groundwater model based on the USGS software MODFLOW, a widely-used groundwater flow modeling software. The Taboose-Thibaut model covers an approximately 50 square-mile area, has 500 feet by 500 feet cells size, and includes 3 model layers. This model was calibrated using the steady-state conditions of 1985 and transient conditions of runoff years 1985 to 2008. A version of the model with no pumping was used as the starting point. Next, one-year pumping of each production well was simulated, and a contour map of the resulting drawdown in the shallow aquifer at the end of the year was prepared.

Appendix 5.1.5 shows the Area-of-Influence contour maps for each of the production wells in the Thibaut-Sawmill and south and central Taboose-Aberdeen wellfields. The results of the Area of Influence analysis are summarized in Table b.i.7 and show the estimated drawdown after one year of pumping at the center of Blackrock 94. This table also shows the pumping capacity of each well, screened interval of the well, the geologic formation each well is pumping from, and the distance of each well from the center of Blackrock 94. The drawdown column represents the *relative* potential effect of each pumping well on shallow groundwater levels at the center of Blackrock 94, if the well was going to be pumped at its pumping capacity continuously for one year with average runoff conditions similar to those of the 1985 runoff year.

It is important to note that drawdown values in this table assume a starting condition of no pumping at all, while in reality Hatchery supply wells had been pumping continuously for 13 years prior to 1985 and the water table drawdown caused by the Hatchery wells had long since stabilized. It should also be noted that when pumping groundwater, the bulk of resulting drawdown occurs early on and groundwater levels stabilizes within relatively short time. Table b.i.7 shows that wells in the immediate vicinity of Blackrock 94 have the most effect on groundwater levels under the parcel, followed by the wells in south Taboose-Aberdeen Wellfield, and finally the wells east of the parcel, including Hatchery supply wells and wells W380 and W381, which are screened only to the deep aquifer.

Sec. 5.1 Table b.i.7. Relative Effect of Pumping Wells on Water Levels under BLK94.

Area	Production Well	Distance to Blk94	Pumping Capacity (cfs)	Same Geologic Formation?	Screen/Open Interval (ft)	Drawdown @ Center of BLK94 (ft)
Blackrock 94	W159	inside parcel	1.4	Yes	? - 196	10.7
	W155	0.9 mile N	1.1	Yes	? - 175	2.2
South of Blackrock 94	W103	1.1 mile S	1.6	No	200-357	1.7
	W104	1.3 mile S	1.1	No	116? - 223	1.2
	W382	2.8 mile S	1.4	No	275-615	0.8
East of Blackrock 94	W380	1.6 mile NE	3.2	No	250-690	1.8
	W381	1.5 mile NE	3.1	No	250-690	1.7
Blackrock Hatchery	Net Hatchery Pumping	1.7 mile NE	3.04	No	40-147	1.7
South Taboose-Aberdeen Wellfield	W109	3.0 mile N	4.3	No	55-140	3.1
	W370	3.0 mile N	3.3	No	96-120	2.3
Central Taboose-Aberdeen Wellfield	W106	4.3 mile N	3.2	No	68-100	1.1
	W110	4.6 mile N	5.6	No	56-174	1.9
	W111	4.9 mile N	3.2	No	120-162 & 180-184	1.0
	W114	5.1 mile N	3.2	No	56-174	0.9

Drawdown is estimated using TT model, 1 year continuous pumping during an average runoff year.
Distance is from center of Vegetation Parcel BLK94.
Net Hatchery is pumping beyond pond circulation and natural Blackrock Spring flow.

With respect to groundwater pumping to supply the Hatchery, the result of the Hatchery water balance in Section 5.1.5 was utilized. Accordingly, the 2,200 acre-feet net extra groundwater withdrawal was used for Area of Influence simulation for Hatchery pumping (Section 5.1.5). This is because the current version of the Taboose-Thibaut model does not directly simulate the circulation of water from Hatchery ponds to the aquifer. Also, the Taboose-Thibaut model was developed and calibrated with the data from 1985 to 2008 runoff year while the Hatchery pumping was already occurring for 13 years. Thus, the model could not simulate the Blackrock Spring flow in the absence of pumping. Therefore, the net additional pumping for Hatchery supply was calculated and used as an input to model for calculating the Area-of-Influence. It is understood that drawdown patterns in the immediate vicinity of Hatchery were different prior to the start of Hatchery pumping. However, from a regional perspective, at a distance of 1.6 miles away from Blackrock 94, the Hatchery facilities, including wells and the pond, are considered as one unit and the effect of Hatchery Supply pumping on Blackrock 94 is due to the net additional withdrawal.

It should also be noted that none of the currently-available computer models, including the regional USGS model of Owens Valley, were developed for the specific purpose of simulating the groundwater beneath Blackrock 94 or at the Hatchery. Current models have either very large cell size, long stress periods, or the time period that was used for steady-state and transient conditions calibration that does not allow simulation of Blackrock Spring flow under the no Hatchery pumping condition, thereby precluding more detailed analysis of the effect of pumping on the Blackrock 94. Therefore, to compensate for aforementioned limitations of the model, the net Hatchery pumping was calculated and used as an input to the Taboose-Thibaut model.

5.1.10. Groundwater Model Simulations

A regional groundwater model for the area covering Taboose-Aberdeen and Thibaut-Sawmill wellfields was also utilized to evaluate the relative effect of pumping and runoff driven recharge on groundwater levels under permanent monitoring sites TS1 and TS2. Four different simulations were conducted:

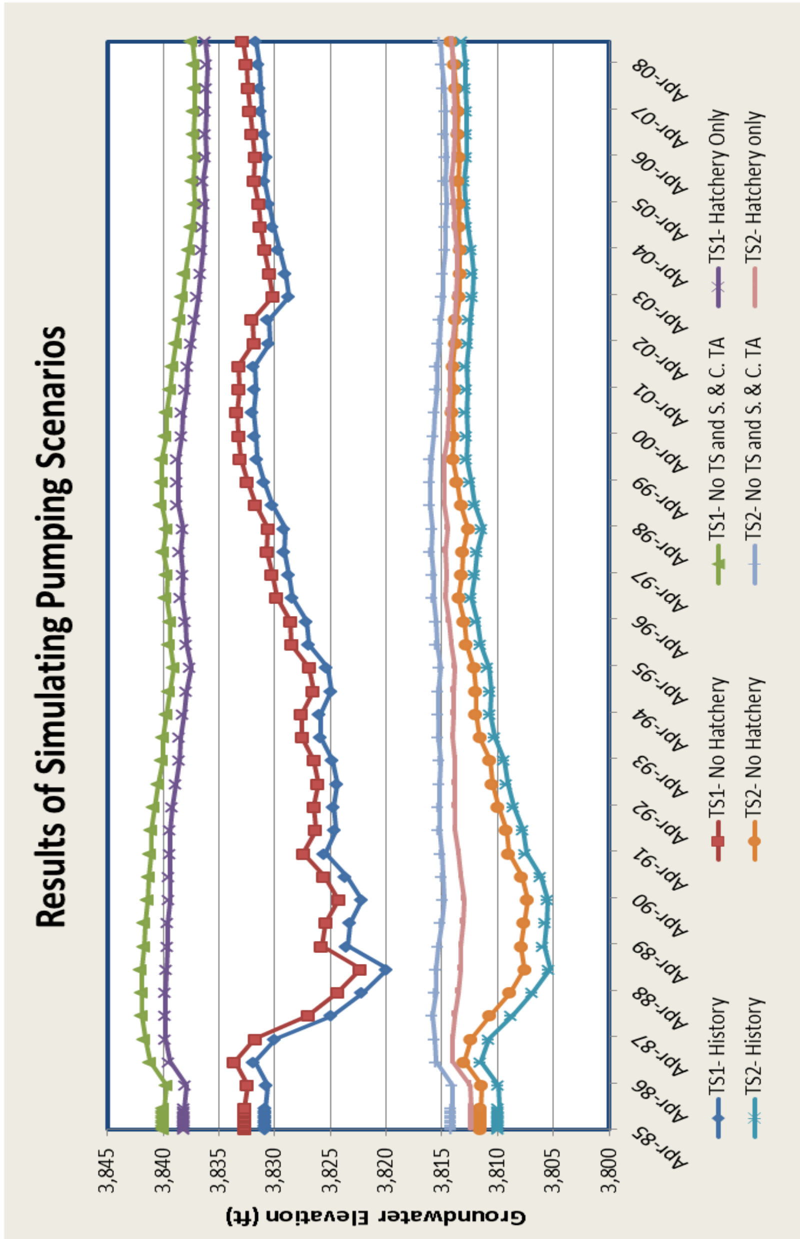
1) The actual pumping history as a basis of comparison during 1985 to 2008 runoff year using net Hatchery supply pumping. The purpose of this simulation was to provide a basis of comparison with the rest of the pumping scenarios.

2) Pumping history without Blackrock Hatchery supply groundwater pumping. This simulation should show the relative effect of pumping from the rest of wells in Thibaut-Sawmill and south and central Taboose-Aberdeen Wellfields. The wells in central Taboose-Aberdeen Wellfield were included in this group because (as shown in Table b.i.7) these wells affect groundwater levels under Blackrock 94, when operated for a full year.

3) Historic 1985 to 2008 runoff year conditions without any groundwater pumping from Thibaut-Sawmill and south and central Taboose-Aberdeen Wellfields. This simulation should show the effect of runoff fluctuations in the absence of pumping near Blackrock 94.

4) Historic 1985 to 2008 runoff conditions without pumping from any wells in Thibaut-Sawmill and south and central Taboose-Aberdeen Wellfields except for net Hatchery supply. As a comparison with no pumping from Thibaut-Sawmill and south and central Taboose-Aberdeen wellfields, this scenario should show the effect of net additional pumping for Hatchery supply on WTE under Blackrock 94.

Hydrographs of WTE under permanent monitoring sites TS1 and TS2 for each of the above simulations are shown in Figure b.i.12. It should be noted that models are approximate representations of the physical conditions. The Taboose-Thibaut model represents the combined regional Taboose-Aberdeen and Thibaut-Sawmill Wellfields and was not developed with the fine detail needed to focus exclusively on the Blackrock Hatchery or Blackrock 94 (nor was any other available computer model). Also, the Taboose-Thibaut model was calibrated with the high water levels of 1985. As a result, any pumping scenario and resulting water levels in the shallow and deep aquifers are compared with those high water levels instead of pre-pumping water levels of the early 1970s. In effect, a model with smaller size cells near the Hatchery, greater geologic precision near Blackrock 94, and higher temporal resolution, calibrated with pre-1970 data would provide an improved tool for representation of the hydrogeology in the vicinity of Blackrock 94. Such a model would also be able to more accurately simulate the effects of short-term recharge from spreading activities west of Blackrock 94.



Sec. 5.1 Figure b.i.12. Simulation Results of Four Pumping Scenarios.

The following observations are made from the results of model simulations for water levels under permanent monitoring sites TS1 and TS2:

1. The effect of pumping and changes in runoff conditions on groundwater levels under permanent monitoring site TS1, which is closer to the alluvial fan, is more pronounced than the effect on groundwater levels under TS2, which is closer to the valley floor.
2. Groundwater levels for both TS1 and TS2 recovered from the drought and elevated pumping of the 1987-1992 period by late 1990s (Scenario 2). Since the late 1990s, 95% of all groundwater pumping in the area has been the relatively constant Hatchery supply pumping. Therefore, water level fluctuations are the result of runoff-driven recharge, including surface water spreading during periods of high runoff.
3. The "Hatchery supply pumping only" scenario showed that the relative effect of net Hatchery pumping on the water table beneath TS1 was a relatively constant suppression of about 2 feet. The relative effect of net Hatchery pumping on the water table beneath TS2 was a relatively constant suppression of about 1.5 feet. The groundwater decline coincided with the commencement of groundwater pumping to supply Blackrock Hatchery in late 1972 and stabilized during the 14 years period prior to 1986 initial vegetation inventory. Hatchery supply pumping has remained relatively stable through the current period and so has any associated groundwater level suppression beneath Blackrock 94.
4. As expected, the "no pumping scenario" simulating the effects of changes in runoff conditions, resulted in larger WTE declines under monitoring site TS1, near alluvial fans, during periods of low runoff than is observed under TS2, near the valley floor.
5. The WTE under monitoring site TS1 for all four pumping scenarios is 15 to 25 feet higher than WTE under TS2. However, because of the to higher ground elevation at TS1, the DTW under TS1 is also larger than at monitoring site TS2. This observation agrees with measured DTW on the west and particularly northwest side of the parcel compared to east side of the parcel.
6. Although the elevated pumping rates during the 1987 to 1992 drought contributed to WTE declines under monitoring sites TS1 and TS2, model results showed substantial WTE recovery under both monitoring sites by the late 1990s. The groundwater levels have remained stable since, fluctuating with variations in runoff. These results are in agreement with physical measurements of the DTW.

5.1.11. Summary and Conclusions of LADWP's evaluation of recent and historic water table changes and response to pumping as measured at the monitoring sites in Blackrock 94

The current groundwater levels near Blackrock 94 are similar or higher than groundwater levels in the early 1970s. Given the current stable levels of pumping from the area near Blackrock 94, groundwater levels under Blackrock 94 can be expected to rise to levels of the mid-1980s if successive high runoff conditions, similar to late 1970s and first half of 1980s, are repeated.

This section of the attributability analysis evaluated the effect of pumping and runoff on groundwater levels under Blackrock 94. The following is a summary of the evaluation and the resulting conclusions:

- The geohydrology of the area affects groundwater levels under Blackrock 94. Most of the area in Thibaut-Sawmill Wellfield, including Blackrock 94, is underlain by low transmissivity alluvial and fluvial formations (Figure b.i.1). The northwest area of the wellfield, including Blackrock Hatchery is underlain by a high transmissivity volcanic formation. The geology of the area near Blackrock 94 is complicated by the northern extension of Springfield Fault, a western branch of the Owens Valley Fault.
- Ground elevation in Blackrock 94 slopes upward from valley floor in the east to alluvial fans in the west, resulting an approximately 50 feet elevation difference between east and west side of the parcel (Figure b.i.3). This elevation difference has a substantial effect on DTW under Blackrock 94.
- A water balance of all flows into and out of Blackrock Hatchery was conducted (Table b.i.4). Groundwater pumping to supply Blackrock Hatchery began in October 1972 and has remained relatively stable over time. Between 1998 and 2012, of the average total pumping to supply the Hatchery was about 12,200 acre-feet per year and approximately 3,000 acre-feet of the water supplied to the Hatchery circulated back to the aquifer by seepage through Hatchery ponds. Considering that in the absence of groundwater pumping, Big Blackrock Spring flowed at about 7,000 acre-feet per year and that water came out of the aquifer and was conveyed into the LAA, the net additional groundwater extraction to supply the Hatchery averages about 2,200 acre-feet per year.
- The DTW in a number of monitoring wells in Thibaut-Sawmill and south and central Taboose-Aberdeen Wellfields, with measurements back to early 1970s, shows that runoff driven recharge and groundwater pumping are the main two factors that may affect DTW in these areas. Monitoring wells in the valley floor showed smaller fluctuations than monitoring wells near the perimeter of the valley. The hydrographs of DTW in 16 monitoring wells in Figure b.i.6 show clear correspondence of DTW fluctuations and the Owens Valley runoff as the indicator of groundwater recharge.
- Examination of hydrographs of 13 monitoring wells near Blackrock 94 (Figures b.i.7 and 8) during time periods when groundwater pumping was relatively constant shows clear response of groundwater levels to changes in runoff driven recharge. These

observations plainly demonstrate that runoff-driven recharge of the aquifer is the main factor affecting water levels beneath Blackrock 94.

- Figures b.i.7 and 8 also show that very low runoff and elevated pumping during the drought period of 1987-1992 resulted in decreases in the water table under Blackrock 94. Minimal non-Hatchery pumping since 1992 and a period of very wet hydrologic conditions between late 1994 and 1998 resulted in groundwater levels recovering by late 1990s. Since 1999, groundwater levels under Blackrock 94 have been stable with the fluctuations due to changes in runoff conditions.

- DTW under permanent monitoring sites TS1 and TS2, located near western and eastern sides of the Blackrock 94 respectively, were estimated back to early 1970s (Figure b.i.10). Table b.i.6 shows correlation coefficients of DTW under TS1 and TS2 with pumping and Owens Valley runoff. The result of this analysis shows that DTW under TS1 and TS2 has a statistically significantly correlation with Owens Valley runoff and pumping from non-Hatchery pumping wells in Thibaut-Sawmill Wellfield, which is expected because of these wells are located in the vicinity of Blackrock 94. DTW under TS1 and TS2 has no statistically significant correlation with Hatchery pumping with a 95% confidence.

- The Area-of-Influence analysis shows that production wells near Blackrock 94, such as W155 and W159, have more relative potential effect on DTW under this parcel than the more distant wells including the groundwater withdrawals for the Hatchery supply.

- Simulation of a number of pumping scenarios showed that the net Hatchery supply pumping had resulted approximately 1.5 to 2 feet of relatively constant DTW decline under permanent monitoring sites TS1 and TS2 (Figure b.i.12). The effects of Hatchery supply pumping on DTW occurred early-on after the commencement of pumping. Following successive higher than normal runoff conditions of late 1970s and first half of 1980s, the effects of Hatchery supply pumping on DTW were well stabilized by the mid-1980s. Since the mid-1980s, there has not been any additional effect of Hatchery supply pumping on DTW under Blackrock 94.

5.2. LADWP Evaluation I.C.1.b.ii – Comparison of soil water, depth to water, and degree of vegetation decrease or change at Blackrock 94 and at control sites with similar soil type and vegetation composition and cover.

5.2.1. Vegetation Cover and Composition Changes in Blackrock 94

In this section LADWP first examines whether changes in vegetation cover and composition within Blackrock 94 are attributable to changes in soil water due to changes in DTW, precipitation, surface water spreading, and other relevant factors. Then, LADWP examines whether changes in vegetation cover and composition in control parcels are attributable to change in soil moisture due to changes in DTW, precipitation, surface water spreading, and other relevant factors.

Results show that measurable changes in vegetation cover from those documented in LADWP's 1986 initial vegetation inventory within Blackrock 94 are attributable to fluctuations in the wet/dry climatic patterns of the Owens Valley and that vegetation cover was higher during wet years and lower during dry years. Two factors, precipitation and Sawmill Creek runoff, were found to strongly influence vegetation cover. Conversely, a high degree of heterogeneity of the parcel in relation to vegetation (or species) composition strongly contributed to the measurable changes in species composition from the initial inventory. The parcel should be divided into two communities: an alkali meadow community in the southeastern half and non-meadow community in the northwestern half. In the alkali meadow community, species composition has remained relatively stable since 1986, while species composition in the non-meadow community has been measurably different from the initial vegetation inventory since 1991. The northwestern half of the parcel almost certainly contained at least two non-meadow communities during the 1986 initial inventory, based on the line-point monitoring data, soil data, and vegetation communities of surrounding parcels.

The following analysis found that the observed changes in vegetation cover and composition are not attributable to changes in water table under Blackrock 94. Instead, they are results of the climatic patterns and precipitation as demonstrated in this section.

Because vegetation cover and composition are substantially affected by precipitation during the preceding fall and winter, all runoff data were summarized based on water year (October 1 to September 30) in order to reflect this relationship.

5.2.2. Changes in Water Table and Vegetation Cover

In this section, LADWP examines the potential influences of DTW from runoff, surface water spreading, and groundwater pumping on total perennial vegetation cover. The effects of soil moisture on perennial vegetation cover as well as the factors that affect soil moisture, including precipitation, spreading, DTW, and groundwater pumping, within Blackrock 94 are also evaluated.

5.2.2.1. Groundwater and Surface Water Data

In order to examine the potential effects on vegetation cover in Blackrock 94, LADWP selected two statistical methods (simple linear correlation and multiple linear regression) to evaluate five factors that were readily available, quantifiable, and relevant to changes in vegetation cover:

1) Sawmill Creek Runoff – annual runoff recorded between October 1 and September 30 measured at the Base of Mountain (STAID 0078) which utilized a five-year running average,

2) Precipitation – total precipitation measured at Independence Yard (STAID 0174) between November and June,

3) BLK094 DTW – average April DTW estimate for Blackrock 94 (Section 5.1.7 for more detail),

4) BLK094 Pumping – annual pumping from two wells (W155 and W159) located within or near the parcel Blackrock 94

5) Spreading - recorded surface water spreading volume from Sawmill Creek from 1989 to present and the estimated surface water spreading volume from Sawmill Creek in 1986 (see Appendix 5.2.2.1 for more detail).

Soil moisture has been recorded by the Inyo County Water Department (ICWD) at two permanent transect monitoring sites (TS1 and TS2) within Blackrock 94, and soil moisture readings from these two sites were considered as an input for statistical analyses; however, no reliable soil moisture readings were available for 1986 or for the period between 1991 and 1995 (see Section 5.6 for more detail). Soil moisture readings also show very high variability within the transect, particularly TS1, and between transects. Because of quality concerns with the soil moisture data prior to 1995, it was determined these readings would not adequately explain changes in vegetation cover during that crucial period and would not adequately represent the entire parcel; thus, pre-1995 soil moisture readings were not included in the overall regression analysis. Soil moisture is considered in more detail in Sections 5.2.2.4 and 5.6.

The annual runoff was summarized based on water year (October 1 to September 30) instead of runoff year (April 1 to March 31) because water year annual runoff is more relevant for vegetation monitoring data taken in June or July. The five-year running average of Sawmill Creek runoff was used to smooth out sporadic wet years. While multiple years of higher precipitation are shown to cause an increase in vegetation cover, sporadic, short term wet periods of only a year or so have less influence on vegetation cover. Precipitation data from the LADWP weather station at Independence was used because this station has the longest available data set.

The five-year running average of Sawmill Creek runoff was used to represent the influence of the runoff pattern because it has been observed that multiple high runoff years have resulted in much higher vegetation cover in past. Sawmill Creek Runoff in this and following sections represent the runoff pattern or climatic pattern.

Annual groundwater pumping from two wells located within or near Blackrock 94 (W155 and W159) was used for Blackrock 94 pumping because these wells have an immediate effect on DTW under the parcel, which in turn could influence vegetation cover when these two wells were operating. Pumping from the Blackrock Fish Hatchery wells (W351 and W356) was not considered because pumping at the Blackrock Fish Hatchery has been fairly constant since 1972, is therefore a fixed variable, and the stabilized suppression of groundwater table caused by hatchery pumping has been reflected in each vegetation survey since 1986. The total volume of surface water spreading in 1986 was estimated by a multiple linear regression analysis using three variables: 1) % Normal Runoff of Owens Valley, 2) Sawmill Creek Uses, and 3) Water Spreading between Tinemaha Reservoir and Alabama Gates (see Appendix 5.2.2.1 for more detail).

5.2.2.2. Simple Linear Correlation

A simple linear correlation is a statistical method to test how strongly two variables are related to each other, and provides a correlation coefficient (r) as the measure of strength; the closer the correlation coefficient (r) to 1 or -1, the stronger the relationship while the closer the correlation coefficient (r) to 0, the weaker the relationship. The p-value is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true. Researchers will often "reject the null hypothesis" when the p-value turns out to be less than a certain statistical significance level, often 0.05 (α=0.05). A simple linear correlation was first utilized to determine if any of the five variables described above were individually related to observed changes in vegetation cover within the parcel. LADWP used total perennial vegetation cover values based on ICWD's line-point monitoring data because it provides a longer period of record (1991-2013 compared to 2004-2013). Results of simple linear correlation analysis indicated that a statistically significant relationship existed between vegetation cover and Sawmill Creek Runoff (r = 0.63), Precipitation (r = 0.64), and Spreading (r = 0.49). The correlation was moderate or weak and statistically insignificant between vegetation cover and DTW (r = -0.39, P = 0.0619) and Pumping (r = -0.07, P = 0.7544) (Table b. ii.1). The three variables with statistically significant relationship were all runoff or climate-related variables, indicating that climatic cycles play an important role in vegetation cover change and are the primary drivers responsible for the observed changes in vegetation cover in the Blackrock 94.

Sec. 5.2 Table b.ii.1. Correlation between vegetation cover and five environmental variables; BLK094 DTW (April average DTW for Blackrock 94), Precipitation (total precipitation between November and June), Spreading (Sawmill Creek surface water spreading), Sawmill Creek Runoff (the five-year average of Sawmill Creek annual runoff), and Pumping (pumping from W155 and W159).

	Vegetation Cover		Partial Correlation	
Variable	r	*P*	r	*P*
DTW	-0.39	0.0619		
Precipitation	**0.64**	0.0007	**0.48**	0.01
Spreading	**0.49**	0.0160	-0.01	0.52
Sawmill Creek Runoff	**0.63**	0.0009	**0.62**	0.00
Pumping	-0.07	0.7544		

"r" indicates a correlation coefficient and "*P*" indicates a probability value associated with each r. Probability value indicates how likely a correlation between two values can happen just by chance; lower the probability the observed correlation is less likely to happen by chance. A partial correlation coefficient was obtained for three variables which show significant correlation (see Appendix 5.2 Section 5.2.2.2.).

5.2.2.3. Multiple Linear Regression

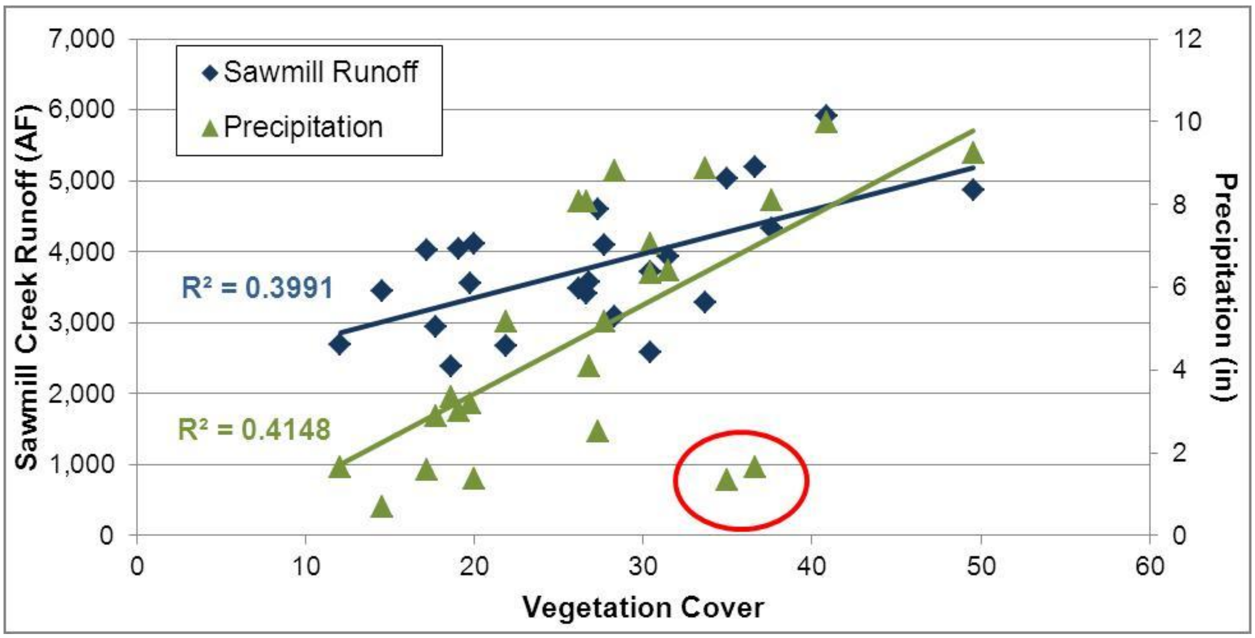
LADWP performed a multiple linear regression analysis using five variables (Sawmill Creek Runoff, Precipitation, Spreading, DTW, and Pumping) in order to investigate the combined effect of these factors on total perennial vegetation cover differences observed in Blackrock 94. A multiple linear regression produces a model which predicts vegetation cover changes with more than one environmental factor. It produces a coefficient of determination (R^2) which indicates how well environmental factors explain vegetation cover changes; closer R^2 to 1 the better the model while closer R^2 to 0, the worse the model.

The relationships of Pumping, DTW, and Spreading to vegetation cover changes were determined to not to be statistically significant while Sawmill Creek Runoff and Precipitation were statistically significant[14]. These two variables, Sawmill Creek Runoff and Precipitation, explained 73% of the observed changes in vegetation cover in Blackrock 94 since 1986 (R^2 = 0.73). The relative contribution of each variable based on partial correlations was slightly larger for Sawmill Runoff than Precipitation (Table b.ii.1). Both variables are important, but the longer-term runoff pattern is slightly more important than the annual pattern of precipitation (partial correlation coefficient in Table b.ii.1) (see Appendix 5.2 Section 5.2.2.3).

[14] Significance was declared at $\alpha = 0.05$.

Summary of Linear Correlation and Multiple Linear Regression

Combined, a simple linear correlation and multiple linear regression analyses indicate that a large portion (73%) of the observed changes in vegetation cover in Blackrock 94 can be explained by changes in precipitation and the longer-term runoff patterns as described by the regression equation ($R^2 = 0.73$). Results also suggest that the important factors driving the observed changes in vegetation cover in Blackrock 94 were related to climate as opposed to DTW or groundwater pumping. Vegetation cover is higher during periods with higher runoff and precipitation while vegetation cover is lower during periods with lower runoff and precipitation (Figure b. ii.1). The importance of the runoff pattern is also illustrated in Figure b.ii.1. Two points circled in Figure b.ii.1 are from 1999 and 2000 (higher cover despite low precipitation) and accentuate an importance of the prolonged wet years. Because of elevated residual soil moisture, vegetation was able to maintain high cover despite decreased precipitation and annual runoff.



Sec. 5.2 Figure b.ii.1. Relationships between vegetation cover and Sawmill Creek Runoff and Precipitation.

5.2.2.4. Soil Moisture and Vegetation Cover

Soil moisture readings have been collected at three or more points along two permanent transect monitoring sites (TS1 and TS2). Soil moisture readings are highly variable along the same transects, particularly TS1, due to the high spatial heterogeneity within the parcel. It was determined that TS1 and TS2 are not representative of the entire parcel (see Section 5.6 for more detail). The soil moisture readings, however, can be compared to vegetation cover recorded at two permanent transect monitoring sites, TS1 and TS2.

In this section, total soil moisture from the surface to the depth of 2 meters (m) was obtained for each site (see Appendix 5.2 Section 5.2.2.4 for more detail). A multiple linear regression analysis was used to relate the soil moisture value along with the five variables used in the previous three sections (Sawmill Creek Runoff, Precipitation, Spreading, DTW, and Pumping) to total perennial vegetation cover at each permanent transect monitoring site. In this section, the April DTW reading at T807 was used for TS1 while the April DTW reading at T806 was used for TS2 for the variable DTW. Annual pumping from Thibaut-Sawmill and Taboose-Aberdeen Wellfields was used (TS-TA Pumping from see Appendix 5.2 Section 5.2.2.4) for the variable Pumping because ground water pumping at W155 and W159 essentially stopped before 1996.

At both permanent transect monitoring sites (TS1 and TS2) soil moisture was the most important factor influencing vegetation cover among the environmental variables used in this analysis with R^2 = 0.43 and 0.33, respectively. Rising DTW was found to be correlated with reduction in vegetation cover at both monitoring sites. While this relationship was statistically significant, it was discounted because ecologically it does not make sense.

Results indicate that soil moisture is an important factor influencing vegetation cover at two permanent monitoring sites between 1996 and 2013. However, the influences of other variables are ambiguous, possibly due to confounding factors such as the 2007 Inyo Complex Fire. Changes in soil moisture within rooting zone are discussed further in Section 5.6.

5.2.2.5. Summary of Changes in DTW and Vegetation Cover

The preceding LADWP analyses illustrate that vegetation cover is strongly influenced by the runoff pattern and precipitation. The influence of surface water spreading on vegetation cover is weak, likely explained by the fact that surface water spreading is sporadic and highly localized. The influence of DTW is also weak or not significant most likely due to high topographic and soil heterogeneity of the parcel. Consequently, wet/dry climatic cycles, often chronicled as variations in runoff, are the better indicator of water availability for the parcel.

It is obvious from these analyses that precipitation and runoff, both of which are related to climatic patterns, are the best predictors of the observed changes in vegetation cover in Blackrock 94. Specifically, given wet climatic conditions, vegetation cover increases; when dry climatic conditions occur, vegetation cover decreases regardless of any groundwater pumping.

5.2.3. Vegetation Composition

In this section, LADWP first answers the question; “has there been a change in the species composition of the vegetation of Blackrock 94 since the initial inventory?” In order to answer this question, LADWP compared the relative cover from 1986 to that observed during subsequent re-inventories of the parcel conducted since 1991.

In Section 5.2.3.2 through 5.2.3.4, LADWP re-examines measurability in species composition. In Section 2.2.3.5, LADWP examines whether changes in species composition are attributable to changes in soil moisture due to changes in DTW, precipitation, surface water spreading, and other relevant factors. Because species composition data is based on many variables (each plant species contributes to vegetation cover) the analysis must incorporate all of the variables.

5.2.3.1. Definition of Vegetation Composition

Plant species that grow together form a plant community, and within a community species interact with each other and their environment. There are certain plants species that tend to grow together to form plant communities. For example, alkali sacaton (SPAI, *Sporobolus airoides*) and inland saltgrass (DISP, *Distichlis spicata*) tend to be the most common species in an alkali meadow. Other, less common species (such as Mexican rush, Nevada saltbush) are also present to form an alkali meadow, whereas shadscale (ATCO, *Atriplex confertifolia*) and greasewood (SAVE4, *Sarcobatus vermiculatus*) tend to grow together to form a shadscale scrub community (Green Book, Appendix A, page 139). These communities grow in response to many environmental variables. As a result, the occurrence and abundance of each species is related to occurrence and abundance of other species in the community and other environmental variables. Therefore, vegetation composition or species composition should reflect the inter-relationships of species, and relative cover of species represents such interrelationships. The Green Book states;

> "*Species composition is synonymous with "relative cover" and expresses the percent contribution by a species to the land surface area covered by living plants.*" (Green Book II.A.2.e, page 38)

The Green Book definition is also suitable to detect a long-term trend of species composition. Therefore, LADWP utilized this definition of species composition for this report. First species composition data (transect vs. species) was converted into "relative cover" by dividing each cover entry by the total cover of its respective transect.

5.2.3.2. Methods for Vegetation Composition Analysis

To examine the potential changes in species composition within Blackrock 94, LADWP followed the recommendations of Anderson (2001), who developed the methods utilized by the ICWD in Analysis of Conditions in Blackrock 94 (ICWD's February 2, 2011 Report). Anderson recommends using three analytical methods; 1) PERMANOVA (Permutational Multivariate Analysis of Variance, Anderson 2001, 2005) to examine statistically significant differences in species composition among years, 2) PERMDISP (Multivariate Homogeneity of Group Dispersions, Anderson 2004, 2006) to examine statistically significant differences in species composition within years and compare these differences across years, 3) NMDS (Nonmetric Multidimensional Scaling, Kruskal 1964a, b) to graphically display the relationships among and within years. Results derived from the last two analytical methods are particularly important when PERMANOVA results are statistically significant because they provide potential explanations as to why the measurable differences occurred.

A statistically significant difference detected by the PERMANOVA can be caused by;

1) differences in species composition among years and/or,

2) from large differences among transects that were run within each year.

For instance, the occurrence of various plant species and associated cover are very similar among 10 transects during the first year; thus, the first year has low within-year variability (or all transects are similar). But the next year, the occurrence of plant species and associated cover are very different among 10 transects; thus, the second year has high within-year variability (or transects are very different from each other). The difference in within-year variability between two years has been shown to contribute a statistically significant PERMANOVA result (Anderson 2001). This difference in within-year variability among all monitoring years including 1986 can be statistically tested by PERMDISP analysis. If a PERMDISP result is statistically significant, it means the parcels species composition may be variable and not necessarily that there has been a change in the composition over the years.

NMDS is an analytical method that compares vegetation transects based on their similarity (or dissimilarity) to each other. NMDS assigns a set of scores to each transect based on their similarity in species compositions. NMDS summarizes a very complex data with a few descriptors (axes). For instance, species composition among transects are different due to two factors: change in moisture availability and difference in soil types. Two numbers (site scores) or axes are, therefore, necessary to describe each transect. Site scores along each axis represent similarity or dissimilarity in species composition along each aspect of factors; one axis represents moisture availability and the other axis represents soil type difference. What each axis represents, however, is up to a researcher to determine using the knowledge of the site and characteristics of species and by comparing to the known environmental factors. NMDS was used to relate each individual transect to the rest of the transects in terms of similarity in species composition. On a graph, transects that have similar species composition are projected closer to each other, while those with dissimilar species composition are projected further away from each other. Statistical significance of all statistical tests was declared at $\alpha = 0.05$. See Appendix 5.2. Section 5.2.3.2, for detailed methods of vegetation composition analysis.

5.2.3.3. The Inyo County Water Department's Monitoring Data

The overall PERMANOVA result shows species composition was statistically different among all monitoring years including 1986. Thirteen years show statistically significant differences in species composition from 1986 (Table b.ii.2). However, the overall PERMDISP was statistically significant as well, and within year variability in 19 monitoring years were statistically different from the within year variability during the initial vegetation inventory (Table b. ii.2). It has been demonstrated by both ICWD and LADWP (LADWP's Letter to ICWD dated September 6, 2011 and ICWD's Letter to LADWP dated January 3, 2012) (Appendix 5.2 Section 5.2.6 and 5.2.7) that transects show very low variability in 1986 compared to subsequent monitoring years; thus, statistically significant PERMDISP indicates that transects during each of subsequent monitoring years are very different from each other compared to the transects during 1986. LADWP's initial inventory was conducted to characterize relatively uniform areas of most abundant plant community in parcel (Green Book Sections II.A.2.d.iii and iv) while the line-point monitoring in subsequent monitoring years was conducted to sample the entire parcel. The difference in the sampling objective has attributed to very low variability among transects measured in 1986 and to very high variability among transects measured during the subsequent monitoring years.

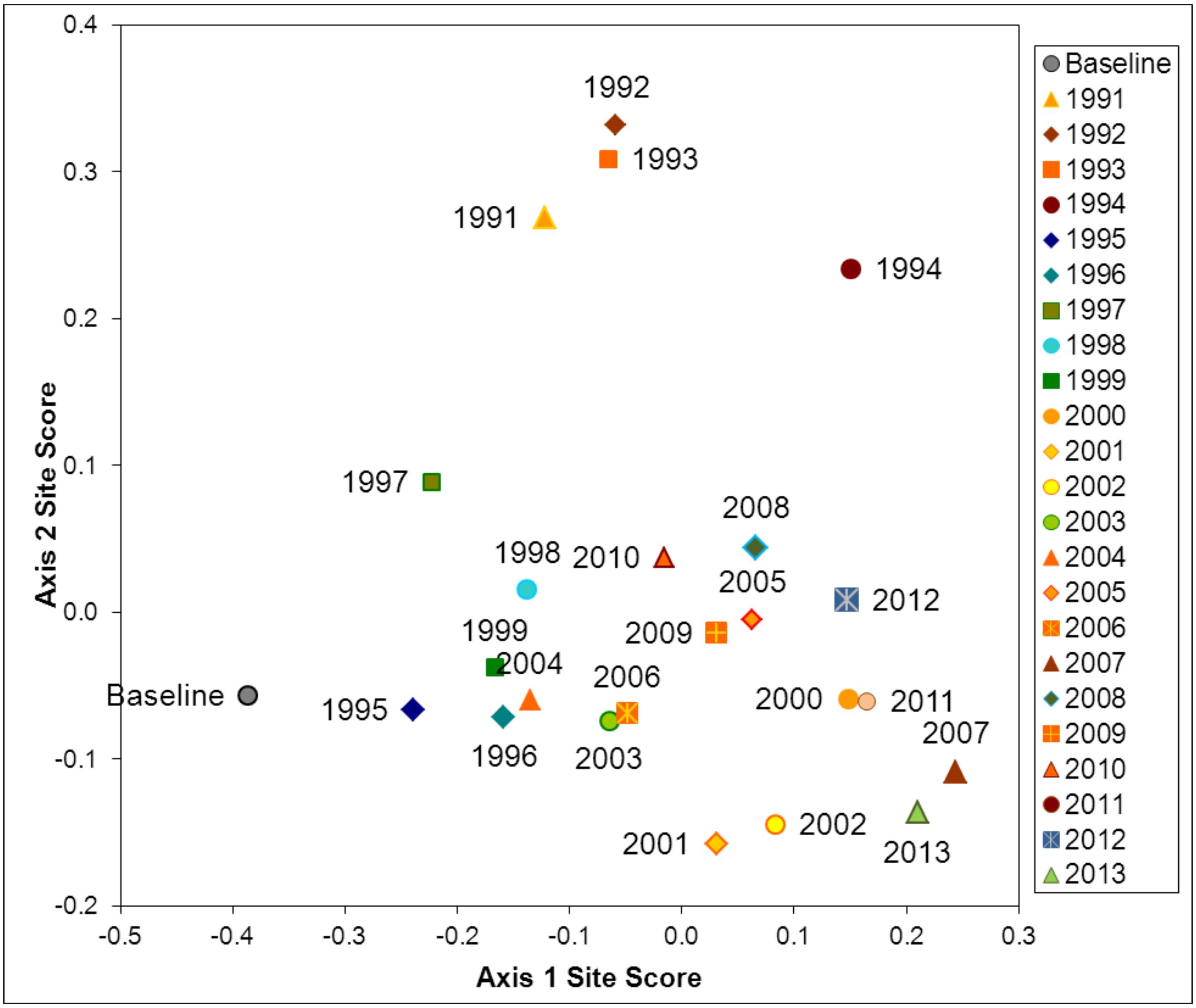
Between 1991 and 2013, thirteen years were found measurably different from the initial inventory in Blackrock 94; however, these measurable differences are mainly the results of very high variability among transects within each subsequent monitoring year. This point is further discussed in the following paragraphs.

Sec. 5.2 Table b.ii.2. Statistical comparisons of species composition between the initial inventory and subsequent monitoring years based on both ICWD's and LADWP's line-point monitoring data. The comparisons were made using PERMANOVA and PERMDISP. Red bold numbers indicate statistically significant difference at α = 0.05. Species composition (relative cover) of subsequent monitoring years was compared to that of 1986.

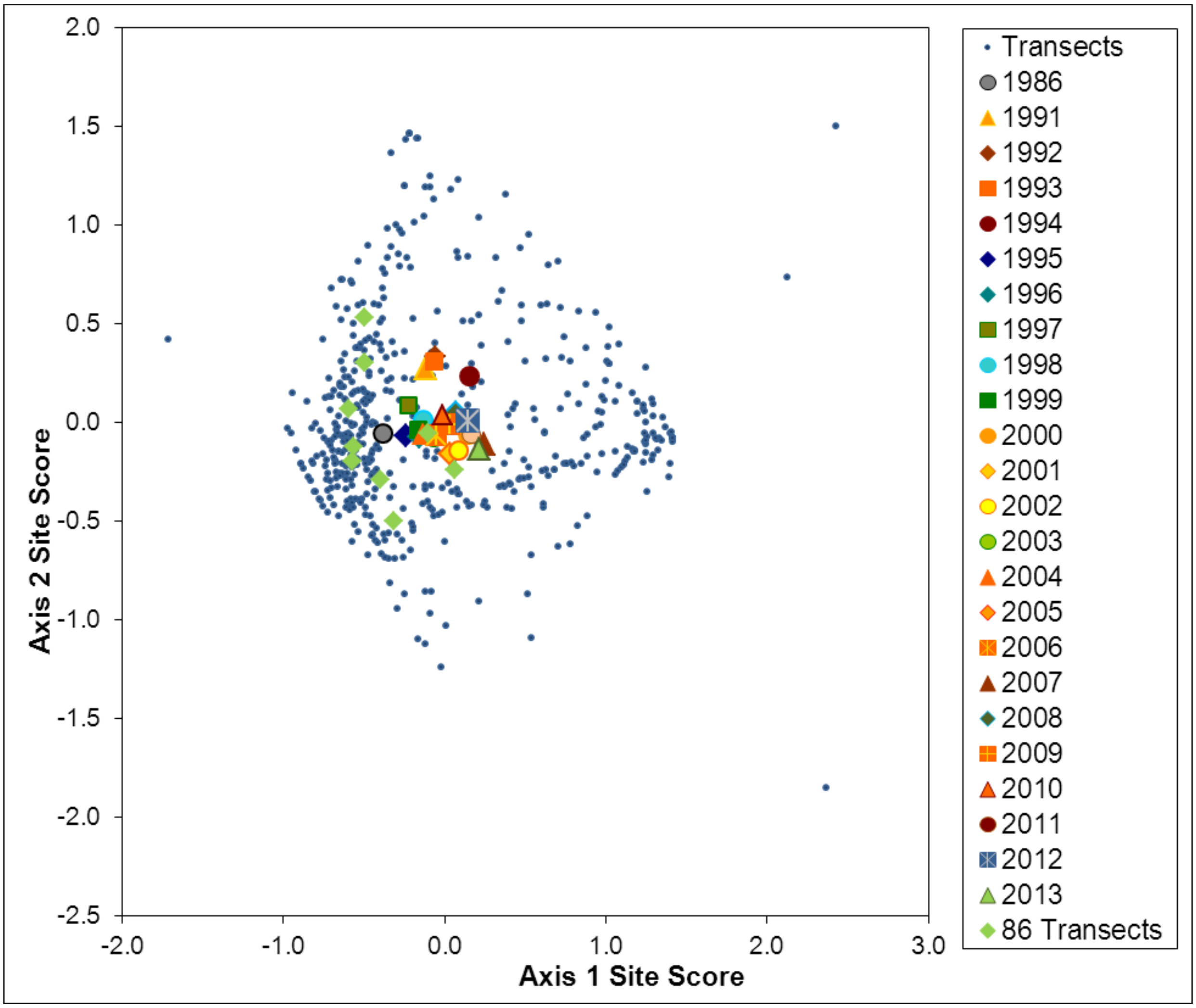
ICWD Line-Point Monitoring				LADWP Line-Point Monitoring			
	PERMANOVA		PERMDISP		PERMANOVA		PERMDISP
Year	t	*P*	*P*	Year	t	*P*	*P*
1991	1.37	0.1218	0.0553				
1992	1.68	**0.0378**	**0.0003**				
1993	1.66	**0.0426**	0.0759				
1994	1.94	**0.0126**	**0.0001**				
1995	0.93	0.5066	0.0644				
1996	1.06	0.3459	**0.0024**				
1997	0.88	0.5844	0.0718				
1998	1.01	0.4040	**0.0142**				
1999	1.06	0.3583	**0.0008**				
2000	1.67	**0.0456**	**0.0001**				
2001	1.58	0.0553	**0.0004**				
2002	1.79	**0.0253**	**0.0002**				
2003	1.42	0.1077	**0.0278**				
2004	1.44	0.0797	**0.0060**	2004	1.60	**0.0412**	**0.0083**
2005	1.73	**0.0367**	**0.0001**	2005	1.50	0.0608	**0.0018**
2006	1.79	**0.0216**	**0.0003**	2006	1.50	0.0566	**0.0054**
2007	2.13	**0.0140**	**0.0001**	2007	1.80	**0.0192**	**0.0006**
2008	1.68	**0.0301**	**0.0001**	2008	1.35	0.0979	**0.0049**
2009	1.74	**0.0358**	**0.0002**	2009	1.22	0.1695	**0.0020**
2010	1.46	0.0717	**0.0033**	2010	1.56	**0.0400**	**0.0020**
2011	1.65	**0.0338**	**0.0002**	2011	1.47	0.0514	**0.0024**
2012	1.80	**0.0191**	**0.0001**	2012	1.58	**0.0362**	**0.0021**
2013	2.05	**0.0043**	**0.0002**	2013	1.69	**0.0212**	**0.0035**
# of years	<0.05	13	19	# of years	<0.05	5	10

t indicates t-statistics, which indicates a degree of a difference between two years. The larger t-statistics indicates that the observed changes are less likely due to chance, which implies to lower probability.

Additionally, when NMDS results were examined, it was found that the average site scores for all subsequent monitoring years depart away from the initial vegetation inventory (Baseline) in Figure b.ii.2 below. However, when species composition of each transects was projected along with average site scores of monitoring years, the transects scattered across the graph. This indicates that across all monitoring years since initial inventory, the species composition was highly variable (Figure b.ii.3).



Sec. 5.2 Figure b.ii.2. Differences among monitoring years in species composition along NMDS Axis 1 and 2 based on ICWD's line-point data. Each symbol indicates the average site scores for each monitoring years along Axis 1 and 2.



Sec. 5.2 Figure b.ii.3. Differences among monitoring years in species composition along NMDS Axis 1 and 2 based on ICWD's line-point data. Each symbol indicates average site scores for each monitoring years along Axis 1 and 2. Each small blue dot indicates site scores for each transect during subsequent monitoring years. The green diamond symbols indicate scores for the initial vegetation inventory transects.

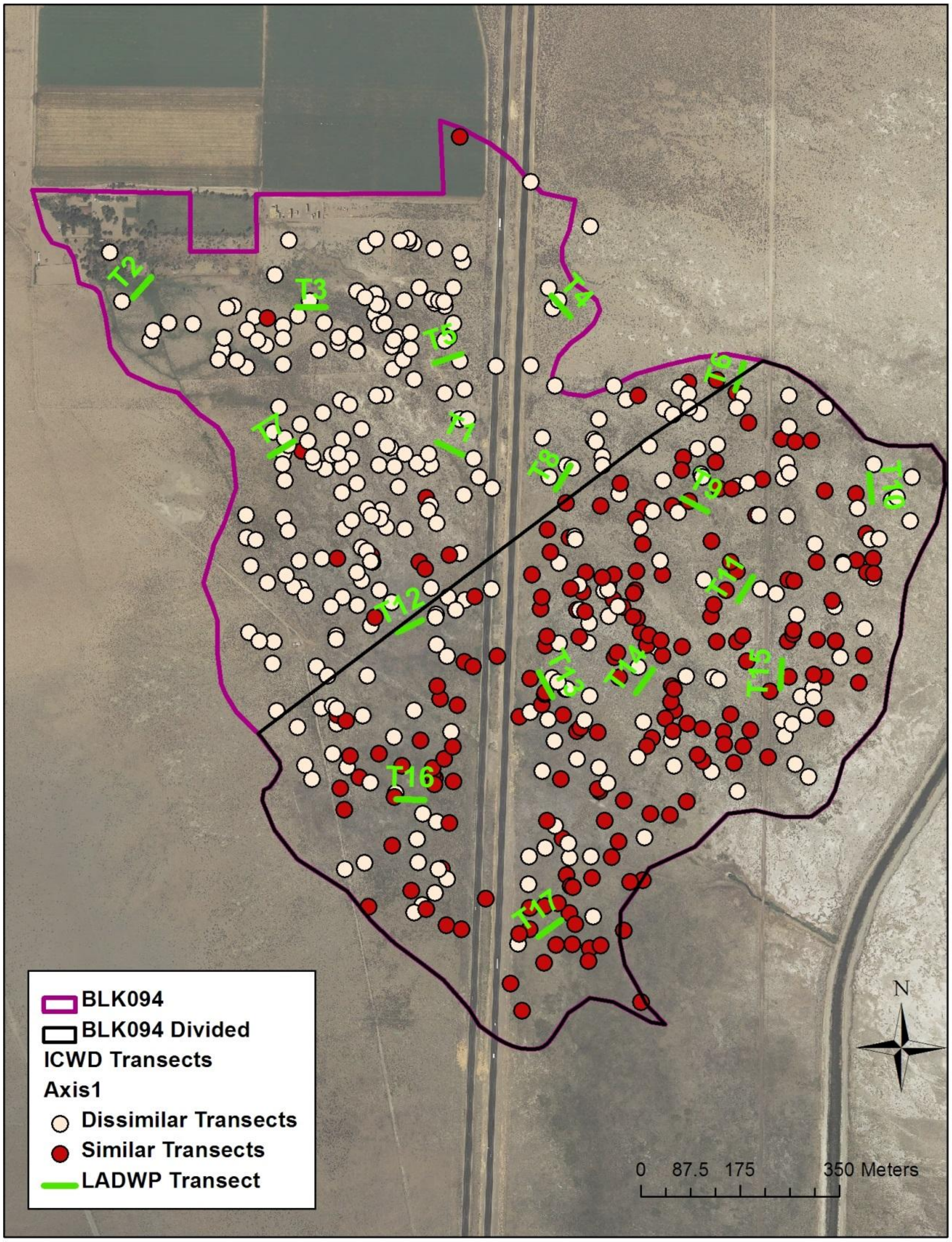
Furthermore, two species (alkali sacaton (SPAI, *Sporobolus airoides*) and Nevada saltbush (ATTO, *Atriplex torreyi*)), which are associated with an alkali meadow community (Green Book, Appendix A, page 140), are more common near the initial inventory transects (left side along the horizontal axis, r = -0.59 and -0.57 for SPAI and ATTO) while big sagebrush (ARTR2, *Artemisia tridentate*) is more common further away from the initial inventory transects (right side along the horizontal axis, r = 0.90). This indicates that differences in species composition among transects along Axis 1 (horizontal axis) are mainly due to different cover of these species. The implication is that there are at least two distinct community types in Blackrock 94, one dominated by alkali sacaton and Nevada saltbush and the other dominated by big sagebrush (see Appendix 5.2 Section 5.2.2.3 for more detail).

LADWP examined whether scattered transects form a pattern regarding time or space. A change over time is referred to as a temporal trend. For example, this trend would be shown on the graph above with transects from earlier years of the monitoring period appearing near the initial vegetation inventory (baseline) on Figure b.ii.3 with transects from later years of monitoring appearing further away from the initial inventory.

When all transects were tabulated based on similarity to the baseline in species composition, all monitoring years contained some transects that were similar to the initial inventory (Table b.ii.3). A total number of transects with species composition similar to the initial inventory remains mostly between 8 and 12. No clear temporal trend exists. When these transects were projected on a map of Blackrock 94, a clear spatial trend emerges. Nearly all of the transects that were similar to the initial inventory occur in the southeastern half of the parcel (Figure b.ii.4). It appears that changes in species composition detected for the entire parcel are mainly due to spatial heterogeneity of the parcel. The northwestern portion of the parcel has been consistently different from the initial vegetation inventory (baseline) while the southeastern portion of the parcel has remained relatively similar to the initial inventory. This point is further discussed in Section 5.2.3.5.1.

Sec. 5.2 Table b.ii.3. Species composition of each transect relative to the initial vegetation inventory (baseline) species composition. Those transects that are similar in species composition to the initial vegetation inventory (baseline) are given "Yes" while those that are not similar to the initial inventory are given "No". The similarity was based on whether transect site scores fell within three standard errors of the 1986 mean site score along Axis 1 (Figure b.ii.3). The percent of transects that were similar in species composition to the initial inventory is expressed at the bottom of the table in "% years".

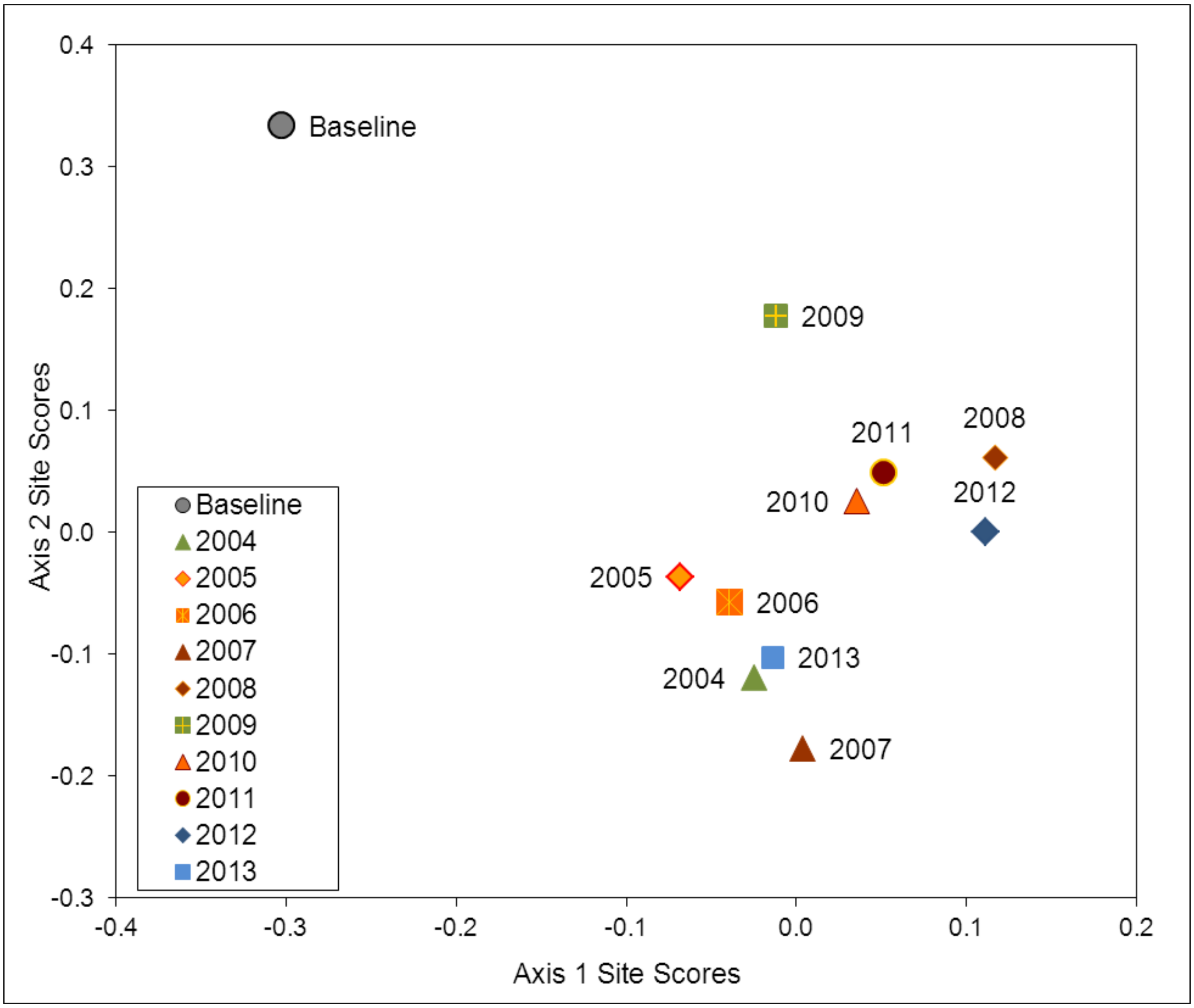
	Year																						
Transect	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
T1	Yes	Yes	No	No	No	No	Yes	No	No	No	Yes	No	No	Yes	No	No	Yes	Yes	Yes	No	No	No	No
T2	No	Yes	No	No	No	No	Yes	Yes	Yes	No	No	No	Yes	Yes	No	No	Yes	No	No	Yes	No	Yes	Yes
T3	Yes	Yes	No	No	Yes	No	No	Yes	No	No	No	No	Yes	Yes	No	No	No	Yes	No	No	No	No	Yes
T4	No	Yes	No	Yes	No	No	No	No	Yes	No	Yes	No	No	No	No	No	No	No	No	No	Yes	No	Yes
T5	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No	No	No	No	Yes	No	No	No	No	Yes	No	No	No	No
T6	No	Yes	Yes	No	No	No	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	Yes	No	No	No	No
T7	No	Yes	No	No	na	Yes	Yes	No	No	Yes	No	No	No	Yes	No	No	No	No	No	No	No	No	No
T8	No	Yes	Yes	No	No	Yes	No	Yes	Yes	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
T9	No	Yes	No	Yes	No	Yes	Yes	No	No	Yes	Yes	No	No	No	No	Yes	No	No	No	Yes	No	No	No
T10	No	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
T11	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
T12	Yes	No	Yes	No	Yes	No	No	No	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No
T13	No	No	Yes	Yes	Yes	Yes	No	No	Yes	No	No	No	No	No	No	Yes	No	No	No	Yes	No	No	No
T14	Yes	Yes	Yes	No	No	Yes	No	Yes	No	No	No	No	Yes	No	Yes	No	Yes	Yes	No	No	No	No	No
T15	Yes	Yes	Yes	No	No	Yes	No	Yes	No	No	No	No	Yes	No	No	No	Yes	No	No	Yes	Yes	Yes	No
T16	Yes	No	Yes	Yes	No	No	No	No	No	na	No	Yes	No	No	Yes	No	Yes	Yes	No	Yes	No	No	No
T17	Yes	No	Yes	Yes	No	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes	No
T18	Yes	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	No	No	No	No	Yes	No	No	No	No	Yes
T19						Yes	No	Yes	No	No	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	No	No	Yes	Yes
T20						Yes	No	No	No	No	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
T21												No	No	No	Yes	Yes	No	No	No	Yes	Yes	Yes	No
T22												Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	No	No	Yes
T23												No	No	Yes	Yes	No	No	Yes	No	No	No	Yes	Yes
T24												No	No	No	Yes	Yes	No	No	No	Yes	Yes	No	No
T25																Yes	No	Yes	Yes	Yes	Yes	No	No
T26																Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Total	10	12	9	8	6	12	8	8	9	6	8	6	8	8	8	9	8	10	9	11	8	7	9
% Years	56%	67%	50%	44%	33%	60%	40%	40%	45%	30%	40%	25%	33%	33%	33%	35%	31%	38%	35%	42%	31%	27%	35%



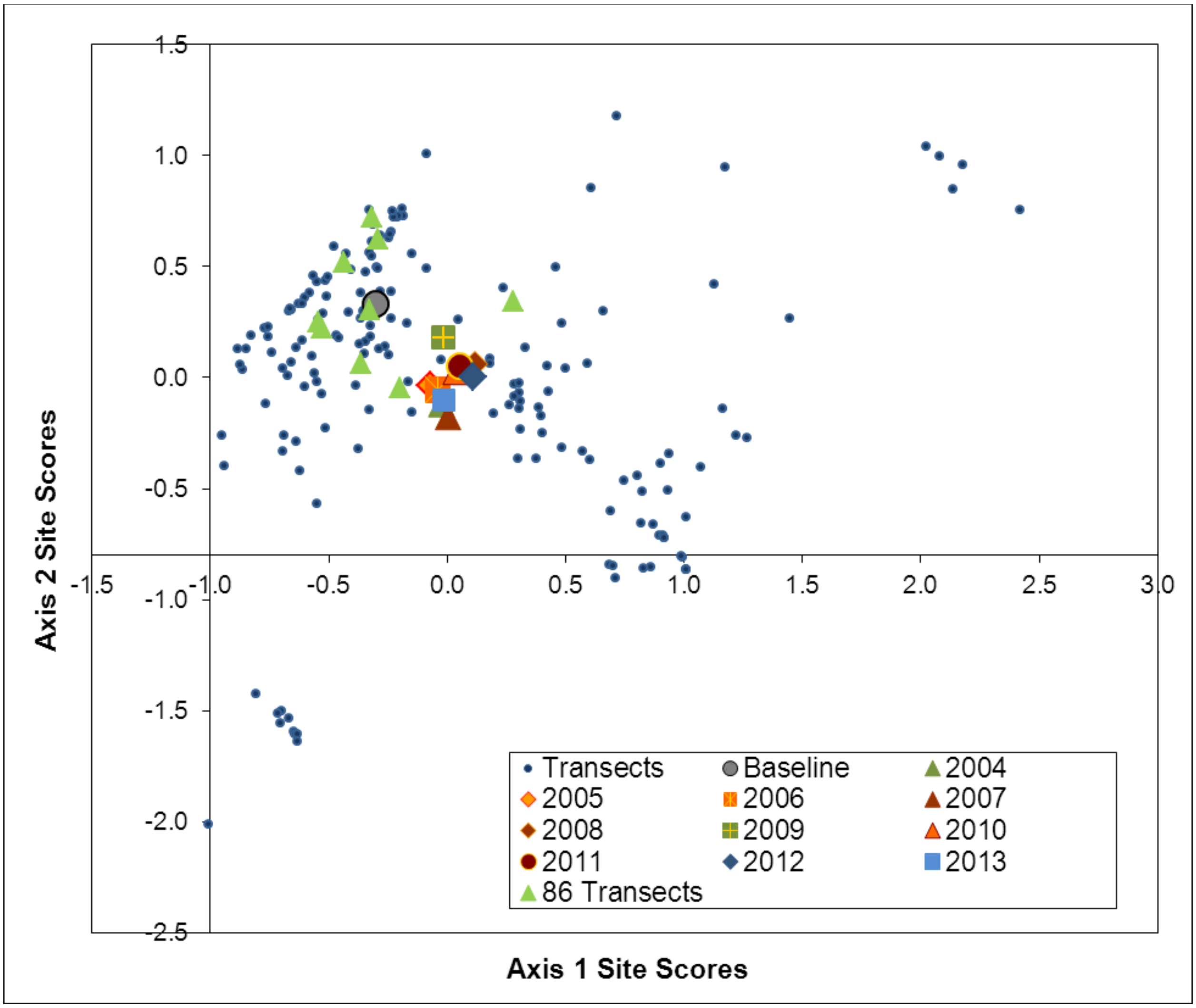
Sec. 5.2 Figure b.ii.4. Spatial pattern of transects which are similar to the initial inventory (red) and dissimilar to the initial inventory (white) based on ICWD's NMDS results (see Appendix 5.2 Section 5.2.3 for more detail). LADWP' transects were also superimposed on the figure. A straight line was tentatively drawn to demonstrate a potential boundary within Blackrock 94 between those areas that are similar to the 1986 initial vegetation inventory (baseline) and those dissimilar.

5.2.3.4. Los Angeles Department of Water and Power's Monitoring Data

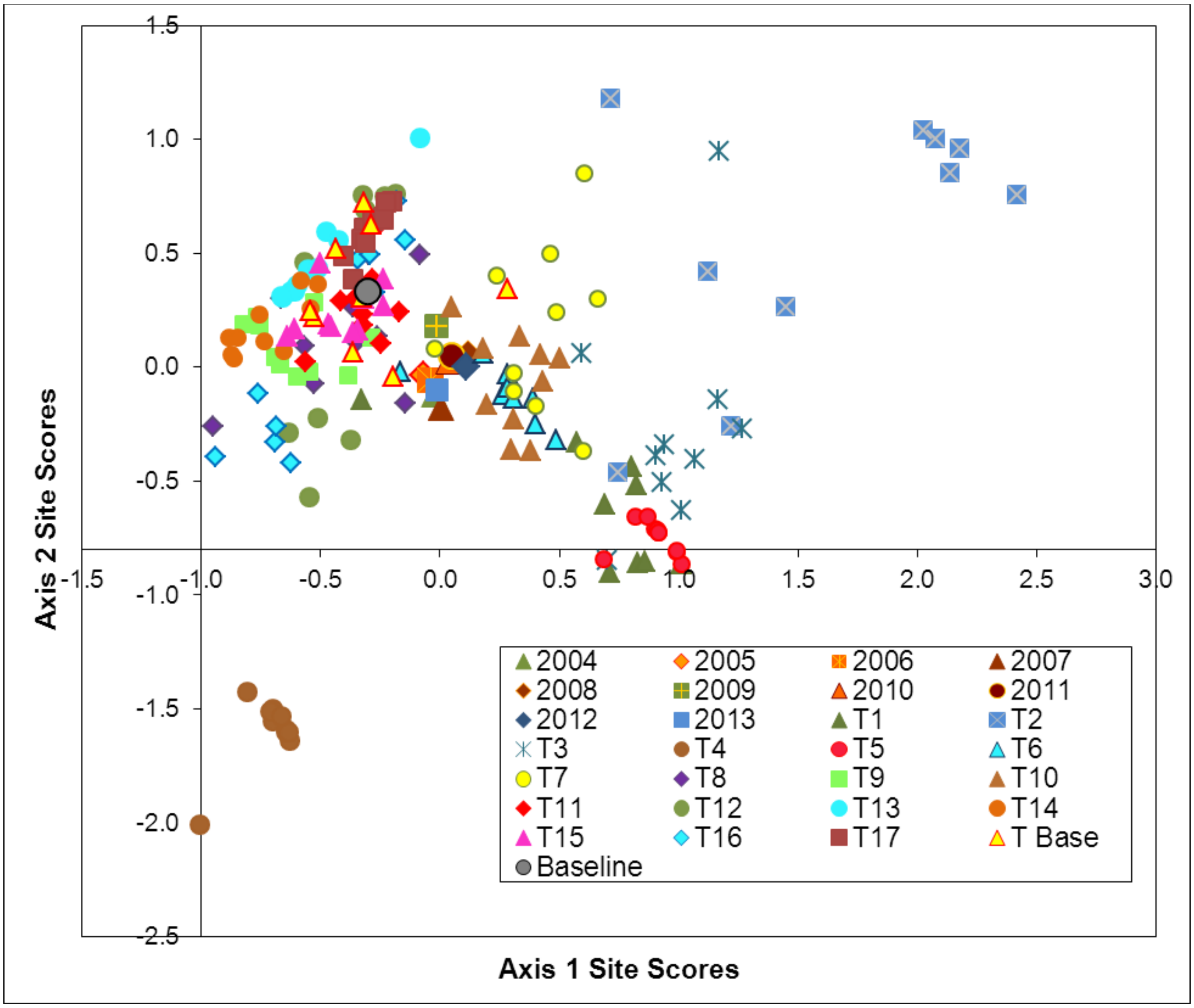
When examining LADWP's line-point monitoring data, five years showed statistically significant difference in species composition from the initial inventory (2004, 2007, 2010, 2012, and 2013, Table b. ii.2). The high variability among transects within each year was confirmed by NMDS (Figure b. ii.5 and 6). The same three species (alkali sacaton, Nevada saltbush, and big sagebrush) were found strongly related to the horizontal axis (Axis 1) (r = -0.43, -0.59, and 0.63 for sacaton, saltbush, and sagebrush, respectively), indicating differences in community types within the parcel (Appendix 5.2 Section 5.3.3). Even though five years were measurably different from the initial inventory, these measurable differences are most likely due to high variability among transects during all subsequent monitoring years. This is supported by both agencies results.



Sec. 5.2 Figure b.ii.5. Differences among monitoring years in species composition along NMDS Axis 1 and 2 based on LADWP's line-point data. Each symbol indicates the average site scores for each monitoring years along Axis 1 and 2. .



Sec. 5.2 Figure b.ii.6. Differences among monitoring years in species composition along NMDS Axis 1 and 2 based on LADWP's line-point data. Each symbol indicates average site scores for each monitoring years along Axis 1 and 2. Each small blue dot indicates site scores for each transect during subsequent monitoring years. The green diamond symbols indicate the initial inventory transects.



Sec. 5.2 Figure b.ii.7. Differences in species composition among transects along NMDS Axis 1 and 2 based on using LADWP's line-point data. Transects were grouped according to the transect number based on LADWP's line-point data between 2004 and 2013. The gray circle indicates the mean site scores for the initial vegetation inventory transects. The yellow triangle indicates the sites scores for each initial inventory transects.

When transects on Figure b.ii.6 were coded according to transect numbers (i.e. all Transect 1 between 2004 and 2013 shared the same symbol), the distribution of transects was very similar to the spatial pattern observed with ICWD's line-point data (Figure b.ii.7)[15]. The nine transects (Transects 8, 9, 11, 12, 13, 14, 15 16, and 17) consistently cluster near the initial inventory transects on the NMDS graph, and these transects were found in the southwestern half of the parcel. LADWP's nine transects show very similar species composition to the initial inventory species composition (Table b.ii.4). The remaining eight transects (T1 through T7, and T10) are

[15] Coding based on transects is only possible for LADWP's line-point data because LADWP's line-point monitoring uses permanent transects after the initial random placement of these transects; the same areas of the parcel have been monitored each year.

generally found in the northwestern area of the parcel, and species composition of these eight-observed for LADWP's and ICWD's data sets (Figure b. ii.4).
This high spatial pattern of species composition within the parcel suggest that "measurable" differences between the initial vegetation inventory (baseline) and subsequent monitoring years (2004 to 2013) are mainly driven by the existence of high spatial variability within the parcel and NOT because of differences in species composition over years. Measurable differences in species composition between 1986 and subsequent monitoring years (thirteen years) is because species composition of Blackrock 94 is very heterogeneous.

This high spatial pattern of species composition within the parcel suggest that 'measurable' differences between the initial vegetation inventory (baseline) and subsequent monitoring years (2004 to 2013) are mainly driven by the existence of high spatial variability within the parcel and NOT because of differences in species composition over years.

Sec. 5.2 Table b.ii.4. Average cover of common species between 2004 and 2013 based on LADWP's line-point data. The transects were divided into two groups depending on which side of the tentative boundary each transect fell (Figure b. ii.3).

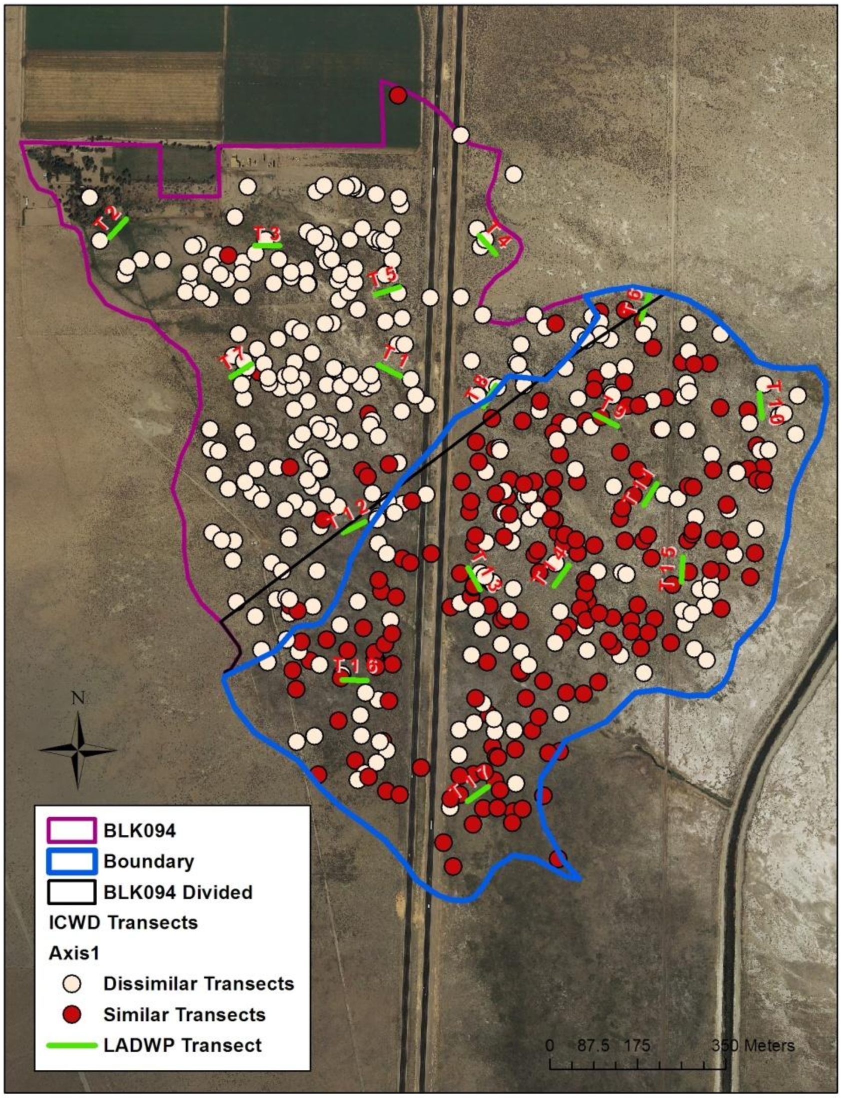
	Species				
	Saltgrass	Sacaton	Saltbush	Rabbitbrush	Sagebrush
Baseline	20%	47%	13%	8%	5%
	Dissimilar Transects				
T1	8%	5%	0%	9%	76%
T2	4%	1%	0%	0%	12%
T3	8%	3%	0%	5%	42%
T4	0%	0%	0%	17%	0%
T5	1%	3%	0%	2%	75%
T6	0%	46%	3%	2%	39%
T7	8%	39%	0%	2%	33%
T10	19%	22%	2%	9%	38%
Average	**6%**	**15%**	**1%**	**6%**	**39%**
	Similar Transects				
T8	18%	29%	33%	8%	9%
T9	4%	42%	42%	2%	7%
T11	20%	46%	5%	15%	3%
T12	34%	29%	12%	20%	3%
T13	33%	31%	35%	0%	0%
T14	15%	24%	56%	4%	0%
T15	24%	29%	25%	13%	2%
T16	10%	35%	18%	19%	1%
T17	27%	65%	5%	1%	0%
Average	**21%**	**37%**	**26%**	**9%**	**3%**

5.2.3.5. Attributability of Changes in Species Composition

Figures b.ii.3 and b.ii.4 illustrate how species composition of some transects each year have remained similar to the species composition observed during LADWP's 1986 initial vegetation inventory. These transects are mainly found in the southeastern portion of Blackrock 94 as if there is a noticeable line dividing the parcel into two distinct communities (Figure b. ii.4). In this section, LADWP utilizes a boundary delineating method in order to objectively detect and draw a boundary based on species composition (Section 5.2.3.5.1). LADWP, then, demonstrates that distinct communities exist within Blackrock 94 and how these distinct communities have resulted in measurable changes in species composition of the parcel as a whole (Section 5.2.3.5.3). See Appendix 5.2 Section 5.2.3, for more detailed methods in attributability of changes in species composition.

5.2.3.5.1. Boundary Delineation

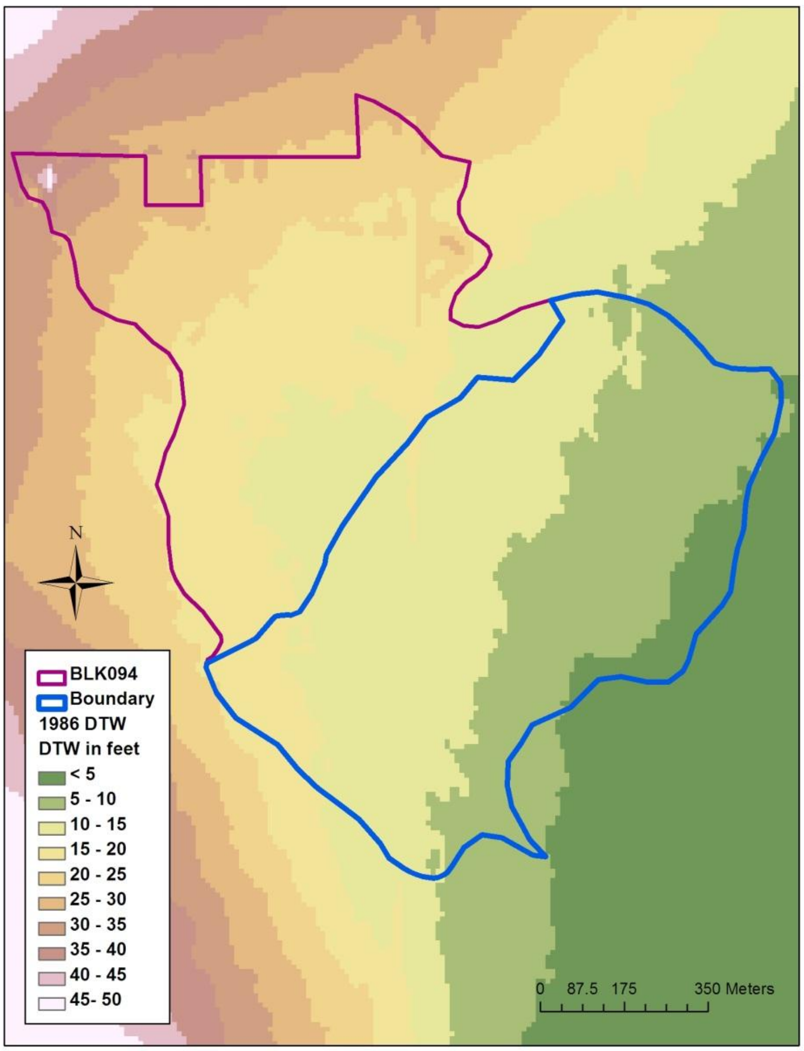
LADWP used Spatially Constrained Clustering (Legendre and Fortin 1998, Fortin and Dale 2005) to objectively delineate the species composition boundary within Blackrock 94 based on species composition data collected by ICWD since 1991. The boundary between the two largest groups was drawn based on Spatially Constrained Clustering groupings, and the resulting boundary resembled the straight boundary that was tentatively drawn and discussed in the previous section (Figure b. ii.8). LADWP acknowledges that no sharp boundary exists within the parcel, and delineation can be problematic because Highway 395 dissects the parcel. Nevertheless, this delineation was based on site knowledge, and direct observations of the vegetation community within the parcel.



Sec. 5.2 Figure b.ii.8. The boundary drawn based on Spatially Constrained Clustering using ICWD's line-point species composition NMDS results.

5.2.3.5.2. The Initial Depth-to-Water Table in the southeastern and northwestern portions of Blackrock 94

LADWP estimated April DTW for the two portions described above between 1986 and 2013 by using the estimates of the April groundwater elevation for Blackrock 94. In 1986, the average April DTW in the northwestern portion of the parcel was 19.6 feet compared to 10.3 feet in the southeastern portion of the parcel (Figure b.ii.9, Table b.ii.5). The lowest DTW (shallowest water table) in the northwestern portion of the parcel was 12.7 feet, indicating even the area where water table was shallowest appeared to have DTW greater than the effective rooting depth of many meadow species (2m or 6.6 feet). In 1986 the water table in the northwestern portion of the parcel was deep enough that there would have been very little DTW-plant interaction in the northwestern portion of the parcel. Therefore, the only way an alkali meadow community could thrive in such an area would be due to surface water spreading during very high runoff years. The alkali meadow community present in the southeastern portion of the parcel might have been supported by shallower water table conditions.



Sec. 5.2 Figure b.ii.9. DTW estimate in feet within and the surrounding area of Blackrock 94 for April 1986.

Sec. 5.2 Table b.ii.5. Estimates of the April average DTW in feet for two portions of Blackrock 94.

	Southeast			Northwest		
Year	Average	Max	Min	Average	Max	Min
1986	10.3	19.4	2.3	19.6	33.9	12.7
1991	18.4	21.2	13.6	32.2	39.9	29.4
1992	20.3	24.1	14.8	33.5	42.4	29.7
1993	20.0	24.3	14.7	33.6	42.7	29.4
1994	21.8	29.2	14.0	31.4	43.1	25.5
1995	21.9	28.8	13.6	33.4	44.5	26.7
1996	18.2	23.7	11.8	27.0	38.4	21.9
1997	15.6	20.0	10.0	23.4	34.3	19.2
1998	15.4	21.2	8.4	24.4	35.0	19.5
1999	13.9	18.5	7.8	21.6	31.4	17.2
2000	14.4	18.9	8.2	21.9	31.4	17.4
2001	14.4	20.1	7.8	23.0	35.4	17.7
2002	15.0	20.2	8.6	22.9	32.6	18.0
2003	15.5	22.4	8.0	24.7	36.5	19.0
2004	17.3	22.5	10.2	26.7	38.1	20.9
2005	16.8	22.7	9.2	26.5	37.2	20.7
2006	15.4	21.2	8.3	24.8	35.0	19.4
2007	15.1	19.8	8.6	23.6	34.2	18.3
2008	14.9	19.6	8.4	24.0	35.3	18.7
2009	15.5	20.3	8.9	25.1	36.8	20.1
2010	15.9	20.8	9.1	25.2	35.8	20.3
2011	15.6	20.9	8.5	25.5	36.4	20.3
2012	14.5	18.8	8.2	23.4	34.8	18.6
2013	15.6	20.1	8.9	24.9	35.5	20.1

5.2.3.5.3. Vegetation Characteristics in the southeastern and northwestern portions of Blackrock 94

In 1986, Blackrock 94 was classified as alkali meadow with alkali sacaton (SPAI, *Sporobolus airoides*) as the dominant species (47%), as well as inland saltgrass (DISP, *Distichlis spicata*) and Nevada saltbush (ATTO, *Atriplex torreyi*) as a sub-dominant but common species (20% and 13%, respectively) (Table b.ii.6). During subsequent monitoring years, striking differences in the cover of these species between the southwestern and northwestern portions of the parcel were found based on ICWD's line-point monitoring (Table b.ii.7). Between 1991 and 2013, the average cover of these three species in the southeastern portion of the parcel was 41%, 20% and 18% for SPAI, DISP, and ATTO, respectively, compared to 14%, 3%, and 12% in the northwestern portion. This difference was also observed in LADWP's line-point monitoring data (2004-2013). LADWP, therefore, identified the southeastern portion as an alkali meadow community and the northwestern portion of the parcel as a non-meadow community.

Sec. 5.2 Table b.ii.6. Average cover of common species during the initial inventory and subsequent monitoring years. Subsequent years were divided into a meadow community (southeastern half) and a non-meadow community (northwestern half).

	Species				
	Saltgrass	Sacaton	Saltbush	Rabbitbrush	Sagebrush
Baseline	20%	47%	13%	8%	5%
ICWD					
Meadow	18%	41%	20%	9%	4%
Non Meadow	12%	14%	3%	6%	51%
LADWP					
Meadow	17%	38%	21%	7%	10%
Non Meadow	10%	14%	6%	8%	31%

Sec. 5.2 Table b.ii.7. Cover of common species along nine transects during the initial inventory.

	Species				
Transects	Saltgrass	Sacaton	Saltbush	Rabbitbrush	Sagebrush
T1	52%	32%	14%	0%	0%
T2	24%	53%	18%	0%	0%
T3	38%	45%	10%	0%	0%
T4	9%	44%	23%	7%	0%
T5	12%	68%	0%	15%	0%
T6	9%	51%	0%	28%	0%
T7	14%	28%	22%	17%	**19%**
T8	13%	49%	28%	10%	0%
T9	7%	55%	0%	0%	**21%**
Average	20%	47%	13%	8%	5%

Big sagebrush (ARTR2, *Artemisia tridentata*) was recorded along two transects in 1986 with cover of 5% for the entire parcel. During the initial inventory, locations of transects were not recorded; the location of these two transects are unknown. In the southeastern portion of the parcel (the alkali meadow community), the baseline cover of big sagebrush has been maintained in the alkali meadow community since 1991 (4% for ICWD's line-point data and 10% since 2004 for LADWP's line-point data). However, in the northwestern portion of the parcel, big sagebrush has been a dominant species since 1991. Big sagebrush cover appears to have increased rather rapidly from 5% in 1986 to 41% in 1991 and 65% in 1992 (Table b. ii.8). However, it is highly unlikely that sagebrush, a late seral species, would invade an alkali meadow community because of the higher water tables associated with alkali meadow and the simple fact that sagebrush is not adapted to higher water tables. It is likely that sagebrush, a late seral species, was present in the northwestern portion of the parcel during the initial vegetation inventory, and big sagebrush could have been the dominant species in that portion based on high cover values recorded during the subsequent monitoring years. During the initial vegetation inventory "*transect locations were generally toward the center of the parcels in order to avoid transitional areas at the parcel edges"* (Green Book Section II.A.2.d.iv, page 38).

5.2.3.5.4. Quantitative Comparisons between Two Portions of Blackrock 94

1) Meadow Community

When species composition within this meadow community was compared to the initial vegetation inventory by using PERMANOVA, only two years (2006 and 2013) were found to be statistically significant different from the initial inventory compared to 13 years for the entire parcel based on ICWD's line-point data (Table b. ii.9). Two years are measurably different from the initial inventory in the southeastern portion of the parcel. Species composition in the southeastern portion of the parcel has remained relatively unchanged since 1986.

Sec. 5.2 Table b.ii.8. Average cover of common species in the meadow and non-meadow parts of the parcel since 1991 based on ICWD's line-point data.

	Meadow					**Non-Meadow**				
	Species					Species				
Years	Saltgrass	Sacaton	Saltbush	Rabbitbrush	Sagebrush	Saltgrass	Sacaton	Saltbush	Rabbitbrush	Sagebrush
Baseline	20%	47%	13%	8%	5%	20%	47%	13%	8%	5%
1991	30%	42%	7%	6%	3%	30%	18%	0%	2%	41%
1992	40%	35%	14%	3%	1%	16%	11%	0%	2%	65%
1993	35%	41%	4%	5%	5%	27%	29%	0%	4%	33%
1994	29%	30%	17%	3%	0%	17%	13%	3%	3%	53%
1995	16%	45%	25%	4%	1%	8%	10%	0%	21%	41%
1996	20%	44%	14%	13%	3%	16%	32%	0%	5%	29%
1997	23%	48%	15%	4%	1%	19%	31%	2%	7%	29%
1998	22%	51%	14%	6%	1%	14%	7%	1%	5%	45%
1999	19%	41%	13%	10%	3%	5%	15%	22%	1%	50%
2000	14%	41%	13%	12%	9%	8%	5%	0%	10%	60%
2001	10%	40%	27%	12%	4%	5%	23%	0%	5%	55%
2002	5%	49%	29%	10%	4%	8%	12%	0%	10%	57%
2003	10%	48%	26%	8%	4%	12%	21%	6%	4%	49%
2004	11%	42%	33%	9%	3%	20%	12%	8%	12%	35%
2005	21%	39%	24%	7%	5%	6%	12%	3%	4%	57%
2006	**18%**	**27%**	**34%**	**12%**	**4%**	6%	16%	3%	5%	62%
2007	13%	38%	23%	14%	8%	3%	0%	0%	5%	79%
2008	19%	40%	26%	5%	3%	19%	12%	1%	6%	48%
2009	14%	48%	20%	8%	7%	12%	9%	2%	1%	60%
2010	20%	38%	22%	5%	8%	2%	13%	9%	12%	50%
2011	20%	39%	21%	8%	8%	10%	16%	2%	5%	49%
2012	9%	38%	21%	11%	6%	5%	3%	4%	3%	69%
2013	**5%**	**32%**	**27%**	**22%**	**6%**	1%	5%	2%	8%	49%
Average	18%	41%	20%	9%	4%	12%	14%	3%	6%	51%

ICWD's cover values fluctuate greatly over the years, but years 2006 and 2013 tend to show lower cover of alkali sacaton (a grass species) (<40%) and saltgrass cover (>10%) with higher saltbush cover (>28%, Table b.ii.8). The 2013 year is the second year of the current dry cycle and one of the driest years in the historical record. Results of regression analysis indicate a high correlation between the cover of alkali sacaton and Sawmill Creek Runoff ($r = 0.65$, $P = 0.0006$). Three variables Sawmill Creek Runoff and Precipitation explained approximately 66% of changes in alkali sacaton cover over time (see Appendix 5.2 Section 5.2.3.5.4 for more detail).

The same trend was observed for grass cover in the meadow section; grass cover in the meadow section is strongly influenced by Sawmill Creek Runoff and Precipitation. The results of correlation and multiple linear regression analyses provides evidence that climatic patterns and precipitation patterns are related to the observed changes in species cover and composition in the southeastern portion of the parcel.

Although alkali sacaton cover is highly influenced by the climatic patterns, the low cover of alkali sacaton observed by the ICWD in 2006 was somewhat puzzling. Sacaton cover has remained relatively stable around 40% prior to 2006 and also after 2006. In spite of WY2005-06 being the second year of above normal runoff and relatively stable sacaton cover, the second lowest alkali sacaton cover since 1991 was observed (26%). The most puzzling of all, however, is that it bounced back in 2007 (39%) in spite of WY2006-07 recording only 72% of normal runoff in Sawmill Creek. The alkali sacaton cover decline in 2006 was not detected in LADWP's line-point data (Table b.ii.11)[16]. LADWP's line-point monitoring method is more suitable to compare species composition among subsequent years than ICWD's line-point method. Therefore, LADWP believes the sharp decline in 2006 was most likely the result of sampling error.

[16] LADWP's line-point data are more suitable to detect trend among years between 2004 and 2013 because the general areas have been monitored each year; thus, any notable changes in vegetation cover are mainly due to changes in vegetation cover over time.

Sec. 5.2 Table b.ii.9. Statistical differences in species composition between the initial inventory and subsequent monitoring years which were divided into the meadow and non-meadow communities based on ICWD's line-point data. Red bold numbers indicate statistical significance at α = 0.05.

	Meadow			Non Meadow		
	PERMANOVA		PERMDISP	PERMANOVA		PERMDISP
Year	F	*P*	*P*	F	*P*	*P*
1991	1.09	0.3086	0.3609	2.30	**0.0011**	0.0551
1992	1.54	0.0858	**0.0182**	3.96	**0.0003**	0.6273
1993	1.42	0.1171	0.1675	2.43	**0.0013**	0.3586
1994	1.28	0.1679	0.0631	3.50	**0.0002**	**0.0208**
1995	1.02	0.3563	0.8342	2.52	**0.0004**	**0.0047**
1996	0.62	0.8233	0.0779	2.41	**0.0008**	0.2096
1997	0.64	0.8748	0.4469	2.23	**0.0015**	0.0869
1998	0.73	0.7258	0.3933	2.73	**0.0022**	0.1176
1999	0.52	0.9057	**0.0136**	2.77	**0.0021**	0.1204
2000	0.67	0.8066	**0.0213**	3.94	**0.0002**	0.2618
2001	1.21	0.2125	**0.0119**	3.21	**0.0003**	0.2103
2002	1.41	0.1122	0.1462	4.10	**0.0001**	0.2333
2003	1.20	0.2238	0.9206	2.86	**0.0014**	0.0862
2004	1.60	0.0580	0.2689	2.26	**0.0038**	**0.0001**
2005	1.07	0.3341	**0.0302**	3.84	**0.0001**	0.3773
2006	1.87	**0.0146**	0.0541	3.72	**0.0012**	0.5337
2007	0.96	0.4532	**0.0285**	7.87	**0.0001**	0.0721
2008	0.99	0.4295	0.2855	3.28	**0.0001**	0.0602
2009	0.89	0.4952	0.0692	3.87	**0.0001**	0.4275
2010	1.07	0.3452	**0.0441**	2.99	**0.0002**	0.2183
2011	0.84	0.6056	0.0571	2.96	**0.0002**	0.0735
2012	1.03	0.3966	**0.0332**	3.99	**0.0002**	0.6654
2013	1.93	**0.0111**	**0.0387**	3.50	**0.0001**	**0.0307**
# of years	<0.05	2	9	<0.05	23	4

Sec. 5.2 Table b.ii.10. Statistical differences in species composition between the initial inventory and subsequent monitoring years that were divided into the meadow and non-meadow communities based on LADWP's line-point data. Red bold numbers indicate statistical significance at α = 0.05.

	Meadow			Non Meadow		
	PERMANOVA		PERMDISP	PERMANOVA		PERMDISP
Year	F	*P*	*P*	F	*P*	*P*
2004	0.99	0.4349	0.3670	2.46	**0.0006**	**0.0022**
2005	1.05	0.3790	0.1637	2.31	**0.0009**	**0.0023**
2006	1.00	0.4488	0.1166	2.09	**0.0013**	**0.0012**
2007	1.15	0.2775	0.1700	2.59	**0.0006**	**0.0022**
2008	0.85	0.5976	**0.0249**	1.94	**0.0065**	**0.0007**
2009	0.68	0.7775	**0.0262**	1.89	**0.0044**	**0.0001**
2010	1.11	0.3043	0.1342	2.32	**0.0011**	**0.0118**
2011	0.99	0.4290	0.0878	2.07	**0.0018**	**0.0027**
2012	0.95	0.5192	0.2808	2.32	**0.0009**	**0.0007**
2013	1.44	0.0971	0.2912	2.51	**0.0003**	**0.0057**
# of years	<0.05	0	2	<0.05	10	10

Sec. 5.2 Table b.ii.11. Average cover of common species in the meadow and non-meadow parts of the parcel since 2004 based on LADWP's line-point data.

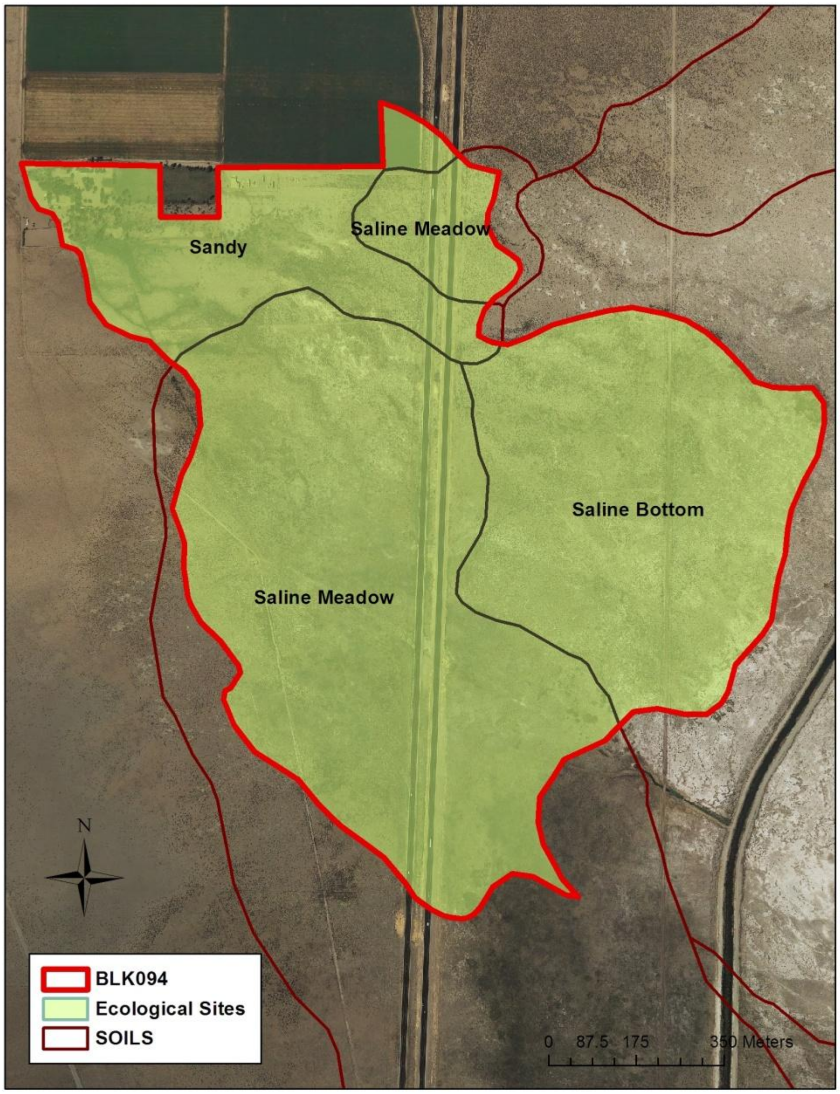
		Species				
Community	Year	Saltgrass	Sacaton	Saltbush	Rabbitbrush	Sagebrush
Baseline	1986	20%	47%	13%	8%	5%
Meadow	2004	18%	36%	19%	11%	9%
	2005	14%	40%	25%	9%	9%
	2006	24%	38%	14%	7%	13%
	2007	10%	39%	21%	13%	14%
	2008	14%	42%	21%	5%	12%
	2009	20%	39%	20%	5%	6%
	2010	19%	36%	24%	5%	9%
	2011	20%	35%	22%	6%	9%
	2012	19%	38%	18%	6%	12%
	2013	12%	37%	29%	6%	5%
Non Meadow	2004	7%	12%	3%	12%	33%
	2005	19%	10%	1%	15%	28%
	2006	3%	27%	2%	15%	25%
	2007	5%	6%	9%	9%	35%
	2008	11%	22%	3%	2%	28%
	2009	13%	17%	2%	9%	27%
	2010	12%	10%	8%	5%	36%
	2011	14%	14%	7%	2%	30%
	2012	9%	10%	9%	4%	32%
	2013	7%	8%	11%	5%	39%

In summary, the alkali meadow community in the southeastern portion of the parcel has remained relatively stable and similar to the 1986 initial vegetation inventory condition based on both ICWD's and LADWP's line-point monitoring data. Fluctuations in cover of the dominant species (alkali sacaton) closely follow the climatic pattern.

2) Non-Meadow Community

When PERMANOVA analysis was conducted for the non-meadow portion of the parcel, all years were statistically different from the initial vegetation inventory for both ICWD and LADWP line-point data (Tables b.ii.9 and b.ii.10). Since 1991, species composition in the non-meadow northwest portion of the parcel has been measurably different from what was recorded during the initial vegetation inventory. Large discrepancies in the number of measurably different years between meadow (southeast) and non-meadow communities indicates that measurable differences in species composition are mainly attributable to high spatial heterogeneity of the parcel.

As pointed out previously by LADWP (Appendix 5.2 Section 5.2.6), Blackrock 94 contains three distinct soil types and associated ecological sites (NRCS 1991, 1995) (Figure b.ii.10); Cartago gravelly loamy sand, 0 to 2 percent slopes (Sandy Ecological Site), Shondow loam, 0 to 2 percent slopes (Saline Meadow Ecological Site), and Winerton fine sandy loam, 0 to 2 percent slopes (Saline Bottom Ecological Site). The northwestern portion of the parcel contains three soil types and associated ecological sites (Figure b. ii.10), and dominant species for Sandy Ecological Site are notably different from other two sites (Table b. ii.12). However, characteristic species of Sandy Ecological Site have been recorded in a very limited portion of the parcel. LADWP has consistently recorded four-winged saltbush (ATCA, *Atriplex canescens*), Fremont's dalea (PSFRF, *Psorothamnus fremontii*) or indigobush (PSARM, *Psorothamnus arborescens*), and Mormon tea or Nevada ephedra (EPNE, *Ephedra nevadensis*) along Transect 4 (Figure b.ii.4).



Sec. 5.2 Figure b.ii.10. Three ecological sites found within Blackrock 94.

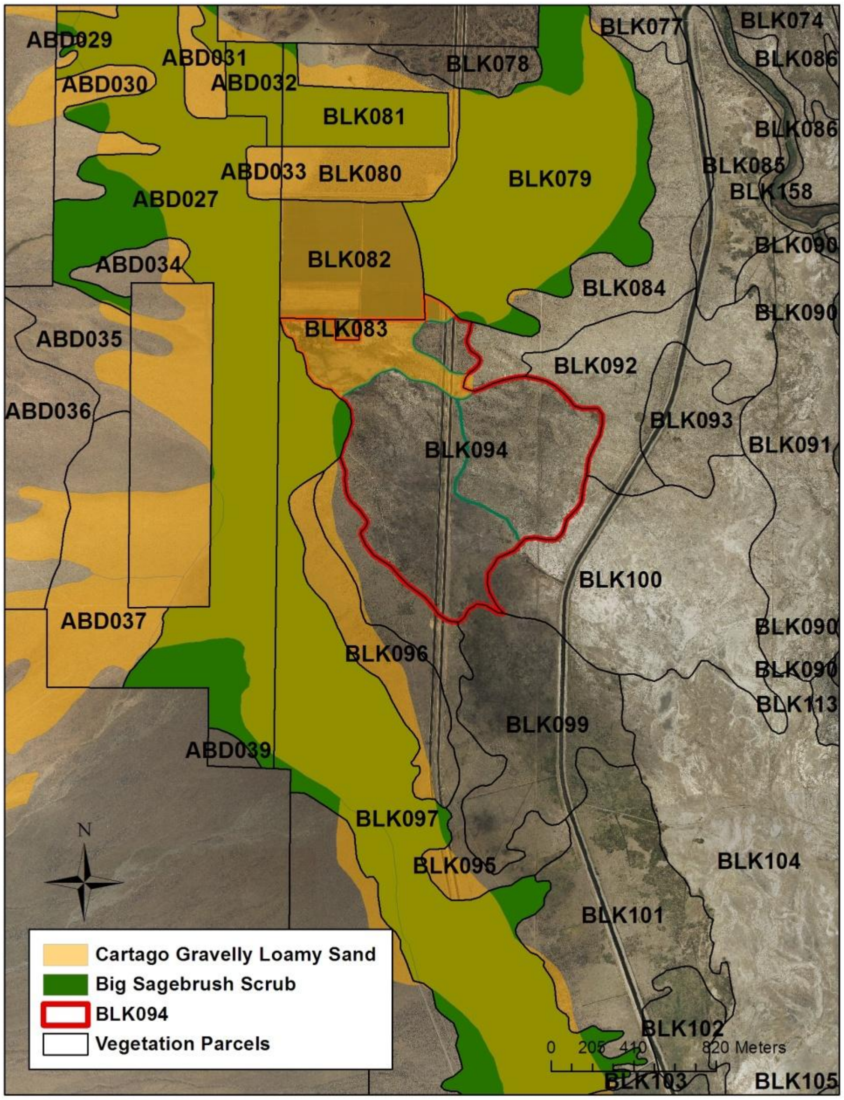
Big sagebrush which is the dominant species in the northwestern portion could be a common species in Sandy and Saline Bottom Ecological Sites, but not in Saline Meadow Ecological Sites (Table b. ii.12). During the initial inventory three surrounding parcels (ABD027, BLK079, and BLK097) with Cartago Gravelly Loamy Sand were classified as Big Sagebrush Scrub (Green Book, Appendix A, Page 137, Element Name: Big Sagebrush Scrub, Element Code: 35210, Figure b. ii.11). It is not clear why Cartago Gravelly Loamy Sand in Blackrock 94 was not included into Big Sagebrush Scrub; instead, the area was included into Blackrock 94 and classified as an alkali meadow during the initial inventory.

Big sagebrush cover was recorded in 1986 along two of nine transects (20% at T7 and 21% at T9[17]). The locations of the two transects are unknown, but they could have been located in the northwestern area of the parcel. High grass cover along T9 indicates that T9 could have been closer to surface water spreading if it were located in the northwestern portion. Grass cover at T7 was the lowest among nine transects, and the relative dominance of big sagebrush along T7 indicates T7 was most likely located in the northwestern portion of the parcel.

Furthermore, the boundary of Big Sagebrush Scrub may extend further south than the boundary of Cartago Gravelly Loamy Sand into Shondow Loam. The water-table at T807 fluctuates very rapidly in response to surface water spreading. In 1996 the rise of water-table approximately by 10 feet was observed between May 8 and June 14, but this peak dissipated quickly and the water-table went back to the pre-peak level by August 16. This response of the water table indicates the mounding of the spread water and the rapidity of the response indicates a very coarse nature of the soil. T807 is located in the western edge of the parcel within the Shondow Loam, but this peculiar behavior of the water-table at T807 indicates the soil type surrounding T807 is most likely Cartago Gravelly Loamy Sand. This soil type, therefore, most likely extends further west and south of Blackrock 94 and so is the associated plant community, Big Sagebrush Scrub.

Co-occurrences of species from different plant communities indicate the highly heterogeneous nature of the parcel, especially the northwestern non-meadow portion of the parcel.

[17] Total cover (raw cover) of big sagebrush along these two transects was 7% and 9%, respectively.



Sec. 5.2 Figure b.ii.11. Big Sagebrush Scrub parcels and Cartago Gravelly Loamy Sand soil type.

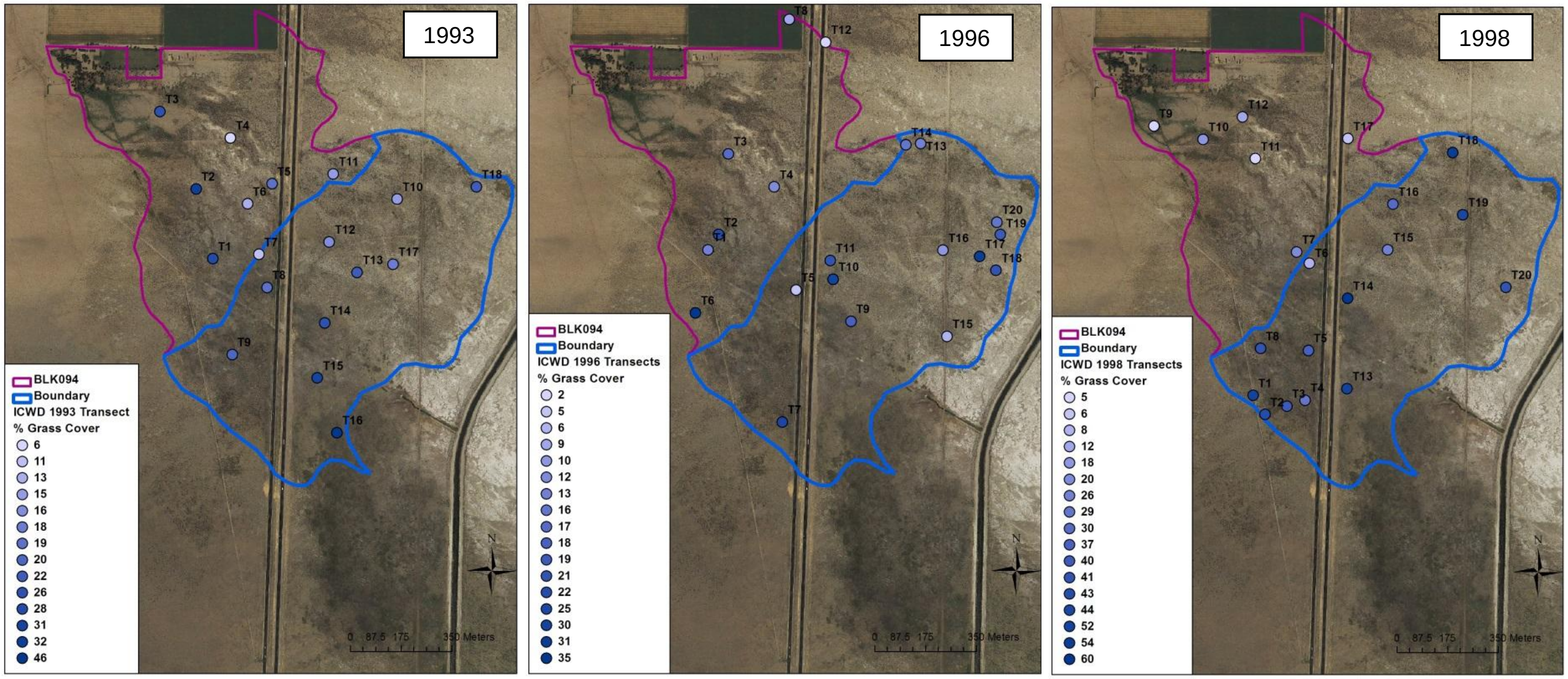
Sec. 5.2 Table b.ii.12. Soil types and associated ecological sites and common plant species found in each ecological site. The percent slope associated with soil type was omitted in the text and this table.

	Associated Species	
Soil Type/Eocological Site	Shrub	Grass
Shondow Loam/	Other shrubs	alkali sacaton
Saline Meadow	Nevada saltbush	inland saltgrass
	rabbitbrush	Mexican rush
	willow species	beardless wildrye
	woodrose	
	greasewood	
Winterton Fine Sandy Loam/	greasewood	alkali sacaton
Saline Bottom	shadescale saltbush	inland saltgrass
	Parry's saltbush	Great Basin widlrye
	Other shrubs	
	shrubby alkali aster	
	rabbitbrush	
	little horsebrush	
	watersage saltbush	
	big sagebrush	
	Mojave seablite	
Cartago Gravelly Loamy Sand/	four-wing saltbush	Indian ricegrass
Sandy	Fremont dalea	
	Nevada ephedra	
	spiny hopsage	
	winterfat	
	big sagebrush	

It is also worth noting that during wet years grass cover in the northwestern portion of the parcel can be very high depending on the surface water spreading patterns. This scenario is evident in 1993 and 1996 during which an aerial photo of the area is available. In 1993, grass cover in the non-meadow part was 20% in the area adjacent to water spreading along the western edge of the parcel (Figure b.ii.12, 1993). Three transects (T1 to T3) in particular showed high grass cover; 28%, 32%, and 26%, respectively. The same spatial pattern of grass cover was also observed in 1996 with five transects near the water spreading showing 20% grass cover (Figure b.ii.12, 1996).

Conversely, high grass cover was only observed in the southeastern portion of the parcel in 1998. Four transects (T9 through T12) were located in the area where surface water had been normally present. However, the average cover of these transects was 10%, despite the highest grass cover for the entire parcel being recorded (31%) (Figure b.ii.12, 1998). The recorded Sawmill Creek spreading for 1998 was higher than 1993 and 1996 (570 acre-feet versus

248 acre-feet and 506 acre-feet, respectively). However, surface water spreading appeared to have little effect on grass cover in the northwestern portion of the parcel in 1998. The distinct spatial pattern of high grass cover during the same wet period indicates that surface water spreading is highly variable in time and space. Surface water spreading can increase grass cover when it is present even in the non-meadow part of the parcel. Variations in the amount of surface water spreading from year to year are not an indication of a change in surface water management practices. These variations in water spreading are, however, an indication of the amount of runoff that occurred during each of the years presented in the previous discussion. For example, runoff in 1998 was 150% of average, runoff in 1993 was 107% of average, and runoff in 1996 was 136% of average. LADWP's past practice has been to spread surface water when it could not be feasibly diverted into the LAA. Spreading water during above normal runoff years is in accordance with past practices since 1970.



Sec. 5.2 Figure b.ii.12. Grass cover based on ICWD's line-point data a) in 1993, b) 1996, and c) 1998. The color variations of dot represent percent cover of grass for the transect.

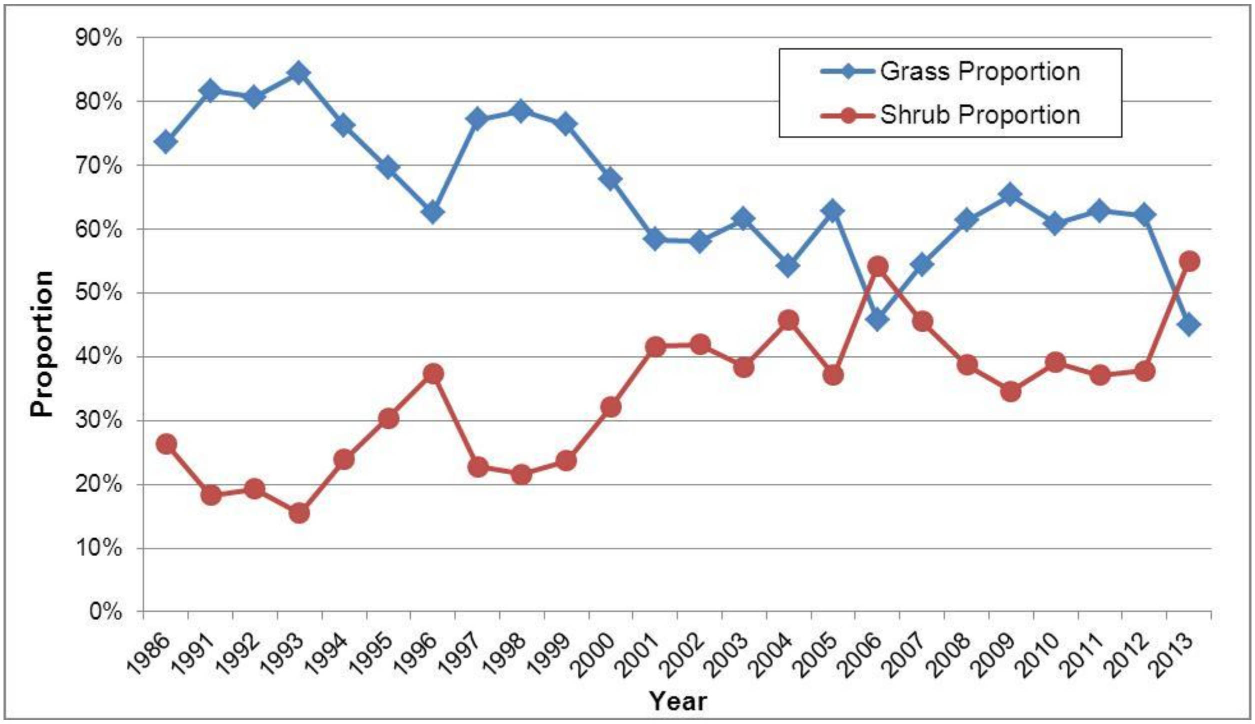
5.2.3.5.5. Grass/Shrub Proportions in the Northwestern and Southeastern Portions of the Parcel

There are distinct patterns of the grass and shrub proportions between two portions of the parcel. In the southeastern portion the grass proportion has remained fairly stable since 2000 hovering around 60% with sporadic drops in 2004, 2006, and 2013 (Figure b. ii.13). This relatively stable grass proportion began during the wet period of the late 1990s. The average grass proportion in the southeastern half during this wet period was 72%, compared to 74% in 1986. With the onset of the dry period in 1999, the grass proportion gradually decreased to around 60%. The average grass proportion between 1999 and 2013 in the southwestern half of the parcel is 60%. Shrub proportion in the southeastern portion has also been stable since 2000, except for increases in 2004, 2006, and 2013.

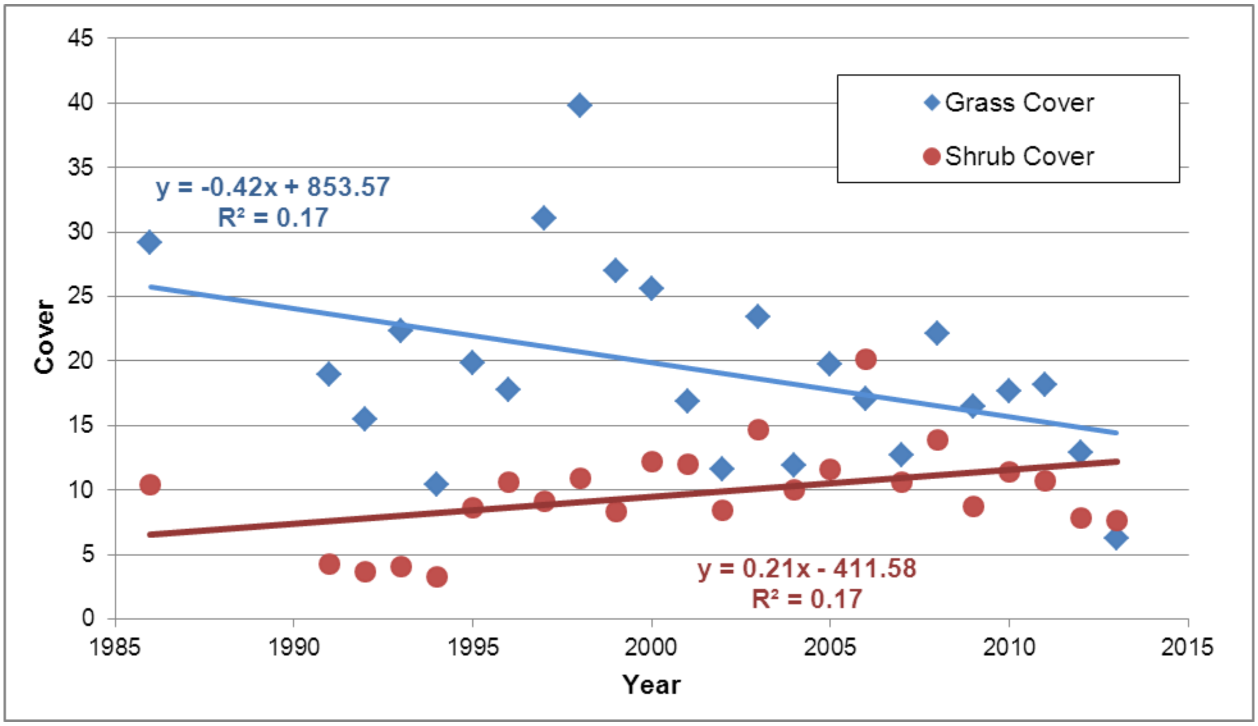
Since 1986, grass cover has decreased over time (r = -0.41 and P = 0.0445, Figure b. ii.14) in response mainly to protracted periods of low runoff and precipitation. However, this relationship was mostly derived by the record low grass cover observed in 2013 (6%). The 2013 year (WY2012-13) was the second year of the current dry trend with 59% of normal runoff for Sawmill Creek (54%[18] of normal for the Owens Valley), and was ranked the 77th driest of 81 years in terms of annual runoff for Sawmill Creek. When the grass cover values from 2013 were removed from the analysis, there was no statistically significant decrease in grass cover (r = -0.32, P = 0.1354, Figure b.ii.15).

The relative grass and shrub proportions in the alkali meadow portion of the parcel have been stable since 2000, and the type conversion has not been observed in the southeastern portion of the parcel.

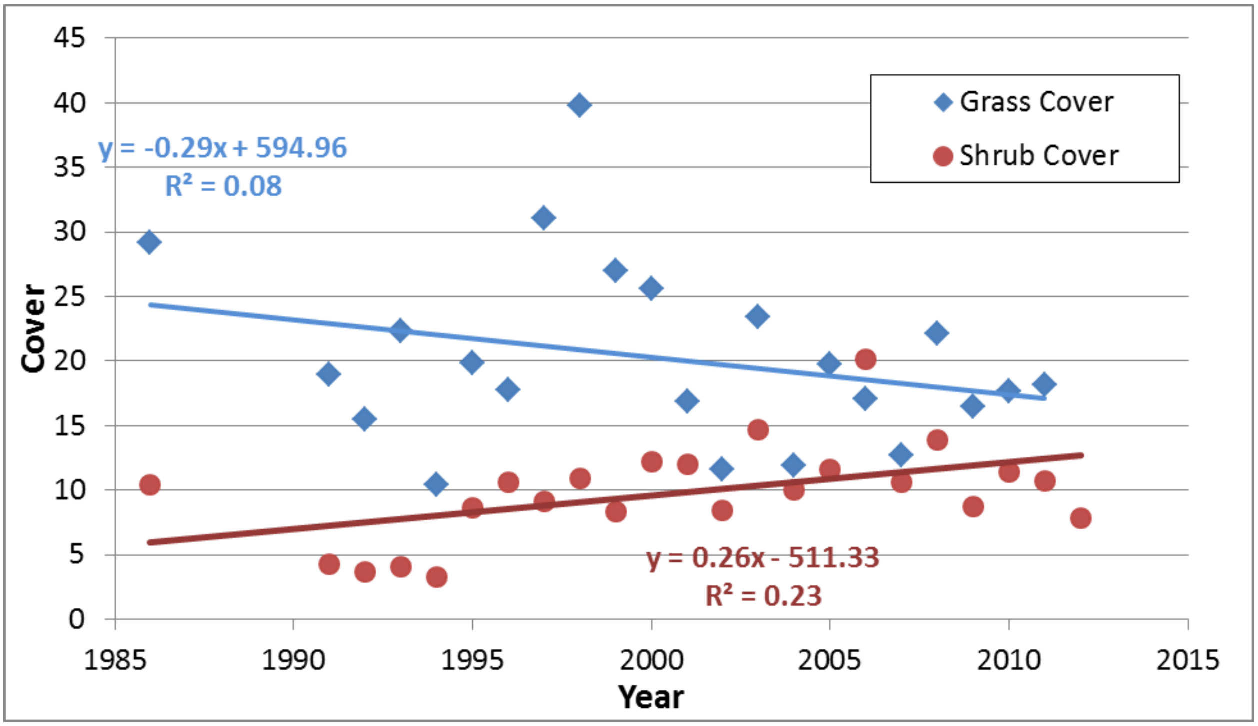
[18] The 2013 annual runoff for the Owens Valley was based on the runoff projection (54%).



Sec. 5.2 Figure b.ii.13. Changes in grass and shrub proportions over time in the meadow community.

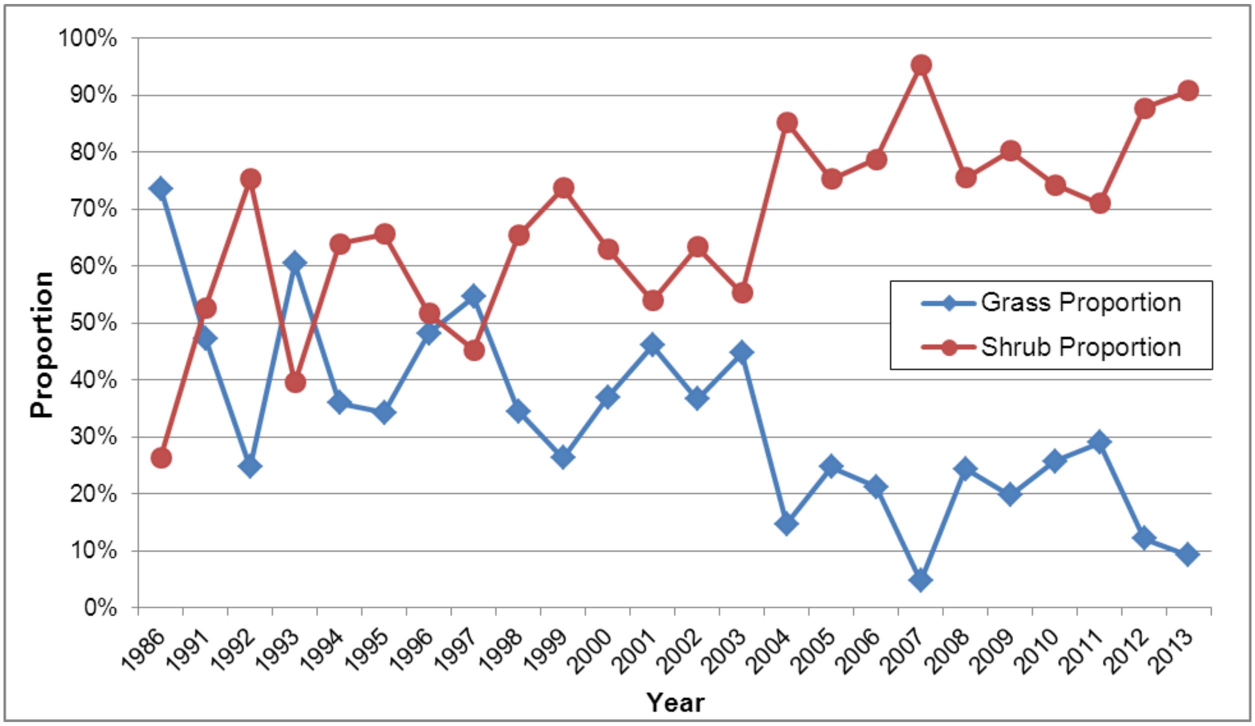


Sec. 5.2 Figure b.ii.14. Grass and shrub cover changes over time in the meadow community.

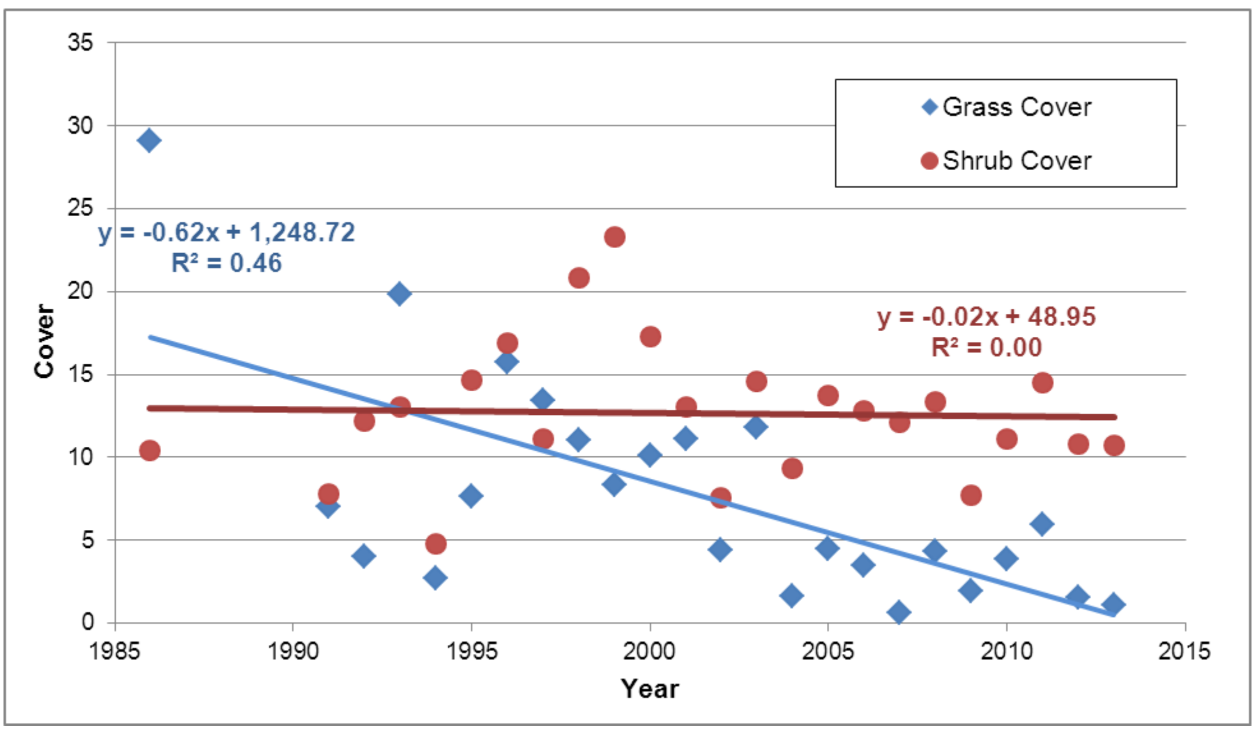


Sec. 5.2 Figure b.ii.15. Grass and shrub cover changes over time in the meadow community without 2013.

In the northwestern portion of the parcel the grass proportion has been mostly below 50% since 1986, and the grass proportion as low as 5% and 9% has been recorded in 2007 and 2013 Figure b.ii.16). Since the beginning of the monitoring in 1986, the grass proportion in the northwestern portion has exceeded 50% only three years, and grass cover has decreased significantly over time in the northwestern portion of the parcel (r = 0.68, *P* = 0.0003) while shrub cover has not changed over time (Figure b.ii.17).



Sec. 5.2 Figure b.ii.16. Grass and shrub proportions relative to total cover change over time in the non-meadow community.



Sec. 5.2 Figure b.ii.17. Grass and shrub cover changes over time in the non-meadow community.

Two portions of the parcel exhibit distinct patterns of the grass/shrub proportion changes over time. In the southeastern portion of the parcel, the grass proportion has remained at around 60% since 1998 (the end of the last wet period), and the type conversion is not occurring. Conversely, in the northwestern portion of the parcel grass proportion has exceeded 50% only three years and has been lower than 30% since 2003. Low grass proportion reflects the nature of the northwestern portion of the parcel, where there exist at least two plant communities which are very distinct from an alkali meadow.

5.2.4. Conclusion of Vegetation Cover and Composition Changes in Blackrock 94

Measurable changes from the initial inventory in vegetation cover are primarily attributable to fluctuations in wet/dry climatic patterns, the runoff pattern of Sawmill Creek (periods of wet or dry years) and annual precipitation, while changes observed with species composition from the initial vegetation inventory are mainly attributable to random sampling of this highly heterogeneous parcel.

Vegetation cover in Blackrock 94 was shown to be influenced strongly by runoff and precipitation, both of which are related to climatic patterns. This relationship is also true for grass cover, particularly alkali sacaton, in the alkali meadow community. It is apparent that with wet climatic conditions (period of wet years and high precipitation), vegetation cover increases. When dry climatic conditions (period of dry years and low precipitation) are prevalent, vegetation cover decreases, regardless of fluctuations in DTW and groundwater pumping.

Blackrock 94 can be divided into two distinct portions based on the ICWD line-point monitoring data, alkali meadow community and non-meadow community. The latter likely contains at least two distinct vegetation communities. Species composition in the non-meadow community has been measurably different from the initial inventory every year since 1991. The evidence proves that the northwestern portion of Blackrock 94 (the non-meadow community) has never resembled an alkali meadow, except during periods of repeated wet years. The amount of surface water spread, consistent with past surface water management practices, is contingent on the amount of runoff and available LAA capacity. The spatial pattern of surface water spreading is somewhat unpredictable and contingent on the condition of the spreading ditches and spreading flow rates, which in turn are dependent on the instantaneous runoff flow rates. When surface water spreading is present in the northwestern half of the parcel, high grass cover has been observed where surface water spreading is present. In comparison, the true alkali meadow community in the southeast has remained relatively stable in species composition compared to the initial vegetation inventory throughout the subsequent monitoring years.

The high heterogeneity within the parcel is the most important factor responsible for the measurable changes in species composition within Blackrock 94. However, if climatic conditions become similar to those runoff patterns prior to and during the initial inventory period or the wet period during the late 1990s, then the overall average community composition of Blackrock 94 will likely become similar to the initial inventory.

5.2.5. Vegetation Comparison (Blackrock 94 vs. Control Sites)

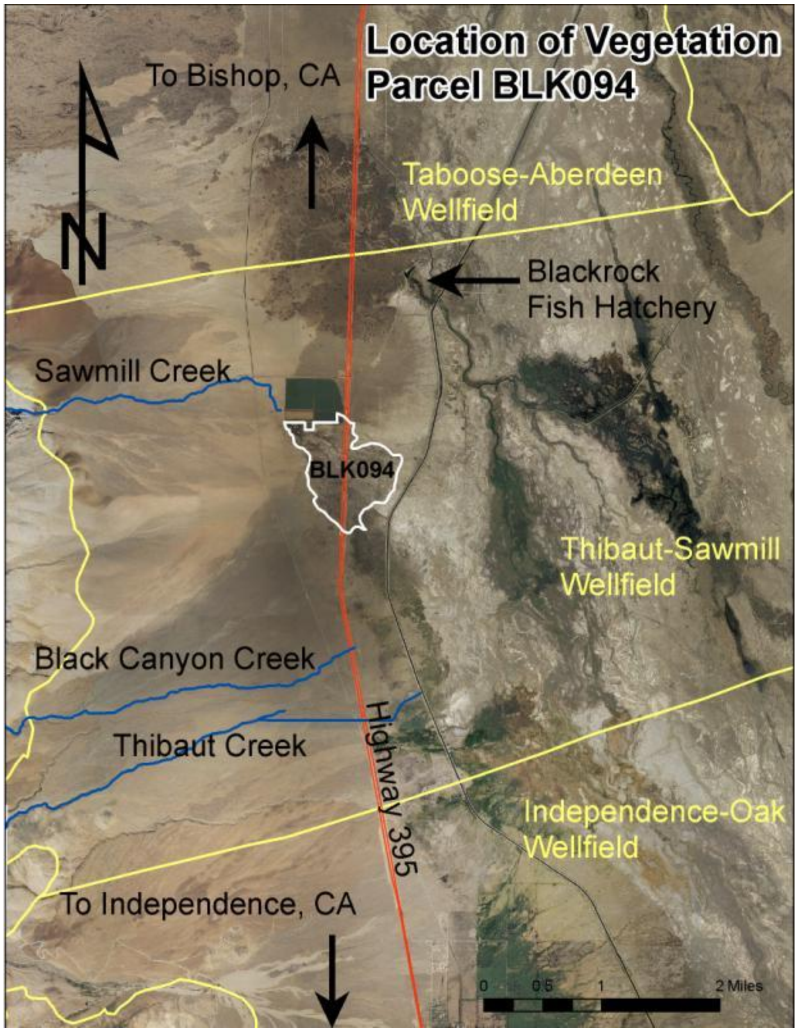
In order to determine attributability, factors such as soil water, DTW, and degree of vegetative change at the affected area must be compared to control sites that have similar precipitation, soil type, vegetation cover, and composition. Control parcels are generally defined as being parcels located outside the 10-ft drawdown contour surrounding groundwater pumping wells shown on the Water Agreement baseline maps.

5.2.5.1. Introduction to Vegetation Comparison

Three vegetative control parcels with similar soils, vegetation cover, and vegetation composition to Blackrock 94 were chosen from a list of parcels that had previously been designated as "control" sites by the ICWD. Comparisons pertaining to changes in perennial cover, perennial shrub cover, perennial grass cover, shrub and grass proportions, and vegetation composition, using ICWD and LADWP monitoring data, were made between the control parcels and Blackrock 94. Vegetation changes within the control parcels were found to be very similar to vegetation changes at Blackrock 94. Lastly, it was concluded that changes in vegetation exhibited at Blackrock 94 and at the control parcels were principally due to natural climatic variability.

5.2.5.2. Blackrock 94 (General Description)

Blackrock 94 is located approximately eight miles north of Independence and is positioned along the western flank of Owens Valley near Sawmill Creek (Figure b.ii.18). This parcel is also located in LADWP's Thibaut/Sawmill wellfield and, due to its proximity to groundwater production wells in the area, is classified as a "wellfield" parcel by the ICWD. The vegetative community within this parcel was described during the 1985-1987 initial vegetation inventory period (baseline) as a grass dominated Type C, alkali meadow. According to soil maps of the area (NRCS, 2002) Blackrock 94 contains three different soil series; *Cartago Gravelly Loamy Sand*, *Shondow Loam*, and *Winerton Fine Sandy Loam*.



Sec. 5.2 Figure b.ii.18. Location of Blackrock 94 in relationship to other significant features in Owens Valley, CA.

5.2.5.3. Wellfield vs. Control Parcels

For the purposes of this report, parcels designated by the ICWD as “control” in ICWD’s Annual Owens Valley Reports (1991-2012) were used. Method’s employed by the ICWD to define parcels as either “wellfield” or “control” are discussed below.

ICWD has developed a method that defines vegetation parcels as either wellfield or control parcels. This method is based on the 10-foot drawdown contour identified by modeling three consecutive critically dry years of maximum groundwater pumping. The 10-foot drawdown contour delineates the vegetation and wellfield management areas and is generally accepted as the boundary of areas that may be affected by groundwater pumping and areas not affected by groundwater pumping (1991 EIR pages 5-3, 10-55 through 10-57; Water Agreement Section I, page 7). Wellfield parcels are generally defined as being within the 10-foot drawdown contour. Control parcels are generally defined as being located outside of the 10-foot drawdown contour as shown on the Water Agreement vegetation and wellfield management area maps. The following was taken from the ICWD Annual Owens Valley Report (2012) and describes the ICWD method in determining wellfield vs. control in greater detail:

> “*Parcels were classified as either control or wellfield based on criteria derived from groundwater drawdown during the period of maximum pumping rate that occurred between 1987 and 1993. Two water table estimation methods were used to provide numerical criteria for these parcel classifications:*
>
> *(1) Ordinary kriging, a geostatistical approach that relies on the spatial correlation structure of the test well data for weighting in order to interpolate groundwater depth for an entire parcel, and*
>
> *(2) Groundwater-flow modeling estimates of groundwater drawdown contours shown on baseline maps (Danskin 1998, Agreement Exhibit A: Management Maps, Harrington and Howard 2000, Harrington 2003).*
>
> *Parcels were designated as either wellfield or control depending on whether drawdown estimates from both kriged test well data and groundwater modeling were above or below critical values. Parcels were assigned wellfield status if (1) kriged DTW estimates exceeded 1-m water-table drawdown and (2) they were located at sites corresponding to modeled drawdown contours greater than 10 ft. Parcels were assigned control status if (1) kriged DTW estimates were less than 1-m and (2) they were located at sites corresponding to modeled drawdown contours less than 10 ft. If the kriged DTW estimates were not reliable owing to inadequate test well coverage near vegetation parcels (Harrington 2003), then the groundwater-flow model estimate of the 10-ft drawdown contour was used as the sole criteria to designate parcels as either wellfield or control. An exception to the above criteria was applied to parcels associated with drawdown contours greater than 10-ft yet located near a surface water source (specifically, a canal, sewer pond, creek, river, or groundwater seepage source) that would mitigate potential drawdown—these parcels were classified as control. Some parcels assigned the wellfield designation currently have higher water tables than during*

> *1987 to 1993, but retain the wellfield designation because the potential for pumping-induced groundwater drawdown is present owing their proximity to pumping wells*" (ICWD Annual Owens Valley Report 2012-13).

Only those parcels designated by the ICWD using the above described method and listed as "control" in Annual Owens Valley Reports released by the ICWD were considered for potential vegetation control parcels in this report.

5.2.5.4. Control Parcel Selection (Vegetative Constraints)

In order to make vegetative comparisons, between control parcels and Blackrock 94, similar vegetation must be present within each. In this analysis, using ICWD and LADWP monitoring data, a list of potential vegetative control parcels was compiled and sorted by vegetation type. This section provides a brief description of vegetation type, as defined by the Green Book. Also, it explains why Type C vegetation was the only vegetation type considered for potential control parcels.

The vegetative community within Blackrock 94 was described during the 1985-1987 initial inventory period as a grass dominated Type C, alkali meadow. Annual vegetation monitoring data, collected by both ICWD and LADWP, were first compared to create a list of control parcels that were monitored by either of the two parties. A total of 85 parcels were identified. Of these parcels, 21 were classified as Type A, 17 were classified as Type B, 42 were classified as Type C, one was classified as Type D, and four were classified as Type E.

Type A vegetation is described as a community with a calculated evapotranspiration rate approximately equal to or less than 5.72 inches or equal to or less than the quadrangle-average precipitation (quadrangle is a map unit of approximately 50 square miles). This type of vegetation should not be negatively affected by groundwater pumping or changes in surface water management since such vegetation relies on available precipitation. Type B vegetation is described as a scrub community with an estimated average annual evapotranspiration rate greater than the quadrangle-average precipitation. This community type generally includes Rabbitbrush and Nevada Saltbush Scrub communities. Type C vegetation is described as a grass dominated community with an estimated annual evapotranspiration rate greater than the quadrangle-average precipitation. Both types B and C can be affected by groundwater pumping and/or changes in surface water management since such vegetation relies on soil moisture derived from precipitation as well as groundwater. Type D vegetation is described as a community dominated by riparian and marshland vegetation with an estimated annual average evapotranspiration greater than precipitation. Lastly, type E vegetation is described as certain lands designated under the Water Agreement as lands provided with water for agriculture, enhancement/mitigation projects, recreation areas, and wildlife habitats.

Accordingly, the selected vegetation control parcels for comparison to Blackrock 94 should be those classified as Type C. Other vegetation classifications are not appropriate for comparative purposes because: (1) Type A communities are not dependent on groundwater, (2) Type B communities are shrub dominated and will generally have deeper groundwater tables,

(3) Type D communities are functionally and structurally unique (riparian/marshland), and
(4) Type E communities are typically irrigated and actively managed with widely differing objectives based on location and land use.

5.2.5.5. Control Parcels (Soil Constraints)

In order to make vegetative comparisons, between control parcels and Blackrock 94, similar soils must also be present within each. In this section soil units contained within Blackrock 94 are identified and described. Next, an overview of the soil units contained within the potential vegetation control parcels is discussed. Lastly, after weighing several environmental factors, three vegetation control parcels were identified for comparison to Blackrock 94.

There are three different soil units contained within the bounds of Blackrock 94; *Cartago Gravelly Loamy Sand*, 0-2% slopes, *Shondow Loam*, 0-2% slopes, and *Winerton Fine Sandy Loam*, 0-2% slopes. *Cartago Gravelly Loamy Sand*s are very deep alluvium consisting mainly of gravelly loamy sands. This soil unit is somewhat excessively drained and has low available water capacity. Depth to the water table was not described in the soil survey but can be interpreted as deeper than 60 inches (depth of soil pit used in analysis) most of the year. Potential rooting depth is 60 inches or more. Typical vegetation for this soil unit is fourwing saltbush (*Atriplex canescens*), Nevada ephedra (*Ephedra nevadensis*), Fremont dalea (*Psorothamnus fremontii*), and indian ricegrass (*Achnatherum hymenoides*). Minor components of this soil unit are Goodale and Taboose soils.

Shondow Loams are very deep mixed alluvium consisting mainly of sandy clay loams and gravelly loamy sand. This soil unit is somewhat poorly drained and has a moderate to high available water capacity. Depth to the water table ranges between 24 to 36 inches from March to May. Potential rooting depth is 60 inches or more. Typical vegetation for this soil unit is alkali sacaton (*Sporobolus airoides*), inland salt grass (*Distichlis spicata*), and Baltic rush (*Juncus balticus*). Minor components of this soil unit are Dehy, Manzanar, Winnedumah, and Pokonahbe soils.

Winerton Fine Sandy Loams are moderately deep alluvium consisting mainly of fine sandy loams and sandy clay loams. A significant feature of this soil unit is a restrictive hardpan between 25 and 34 inches that can limit rooting depth of plants and slow the vertical movement of groundwater. This soil unit is moderately well drained and has a low available water capacity. Depth to the water table ranges between 40 to 60 inches from March to May. Potential rooting depth is 20 to 40 inches (dependent on location of hardpan). Typical vegetation for this soil unit is alkali sacaton, inland saltgrass, greasewood (*Sarcobatus vermiculatus*), and shadscale (*Atriplex confertifolia*). Minor components of this soil unit are Division and Numu soils.

In summation, soils at Blackrock 94 range from coarse and excessively drained materials with a deep water table, to medium to fine poorly drained materials with a shallow water table and a restrictive hardpan. It is impractical to identify a vegetation control parcel that contained the exact soil units that are contained within Blackrock 94. Soils in the Owens Valley are very dynamic and often contain, even within a single soil unit, several inclusions of differing soil types. Before identifying the soil unit or units contained within each of the 42 Type C vegetative control parcels, annual vegetative monitoring data collected by both the ICWD and the LADWP was revisited to further refine the list of potential control parcels. Of the parcels that were monitored by both the ICWD and the LADWP, only those that had complete data records beginning from at least 1992 for ICWD data and at least 2004 for LADWP data were considered. A total of nine parcels were identified that met these criteria. Soils data was summarized for each of the parcels. A total of 12 different soil units were found to be represented by the eight vegetation parcels. None of the 12 soil units exactly matched any of the three soil units identified in Blackrock 94.

Finding soils within a control parcel that exactly match those contained within Blackrock 94 is difficult due to the differing proportions of three different soil units contained within Blackrock 94. However, for this same reason, finding soils within a control parcel that are similar to one of the three or a combination of the three soil units contained within Blackrock 94 is more practicable. In this case, comparison of soils contained within Blackrock 94 and within potential control parcels becomes a many to one or many to many comparison (many-to-many when more than one soil unit is contained within a control parcel).

To select the final set of vegetation control parcels to be compared to Blackrock 94 the following factors were considered: soil unit type, soil profile descriptions, minor soil unit components, existing and baseline vegetative conditions, existence and adequacy of DTW data, annual precipitation, land management, and geographic location. After weighing each of the factors above, the following vegetation control parcels were selected by LADWP to be compared with Blackrock 94: Poleta Canyon 106 (PLC106), Lone Pine 18 (LNP018), and Union Wash (UNW029).

5.2.5.6. Selected Control Parcels (Soil Descriptions)

In this section, soil units contained within each of the selected vegetation control parcels are identified and described. Similarities between the soil units contained within the selected control parcels and Blackrock 94 are then discussed. Lastly, a cross-walk table is presented that displays similarities of all soil units identified.

There is one soil unit contained within the bounds of PLC106; Westguard-Rienhakle association, 0-2% slopes. The Westguard-Rienhakle association is a very deep alluvium consisting mainly of sandy loams and silt loams. This soil unit is moderately well drained and has a moderate to high available water capacity. DTW was not described in the soil survey, but can be interpreted as deeper than 60 inches most of the year. Potential rooting depth is 60 inches or more. Typical vegetation for this soil unit is greasewood, shadscale, alkali sacaton, and inland saltgrass. Minor soil components include Inyo and Poleta soils.

There are two different soil units contained within the bounds of LNP018; Winnedumah silt loam, 0-2% slopes, and Mazourka hard substratum-Mazourka-Eclipse complex, 0-2% slopes. Winnedumah silt loams are very deep alluvium consisting mainly of loams and sandy clay loams. This soil unit is somewhat poorly drained with a moderate to high available water holding capacity. DTW ranges from 48 to 60 inches between March and May. Potential rooting depth is 60 inches or more. Typical vegetation for this soil unit is Nevada saltbush, greasewood, alkali sacaton, and inland saltgrass. Minor soil components include Manzanar soils. The Mazourka hard substratum-Mazourka-Eclipse complex is a deep to very deep alluvium consisting mainly of sands and sandy loams. This soil unit is well drained to somewhat excessively drained with a low to moderate available water capacity. DTW was not described in the soil survey, but can be interpreted as deeper than 60 inches. Potential rooting depth ranges from 40 inches to 60 inches or more. A significant feature of this soil feature is a restrictive hardpan between 40 and 60 inches. Typical vegetation for this soil unit is shadscale, spiny meodora (*Meodora spinescens*), greasewood, and indian ricegrass. Minor soil components include Cajon soils.

There is one soil unit contained within the bounds of UNW029; Reinhakle sand, 0-2% slopes. Reinhakle sands are very deep alluvium consisting mainly of sands and sandy clay loams. This soil unit is somewhat poorly drained with a moderate to high available water capacity. DTW ranges from 40 to 60 inches from March to May. Potential rooting depth is 60 inches or more. Typical vegetation for this soil unit is alkali sacaton, inland saltgrass, greasewood, and shadscale. Minor soil components include Manzanar, Winnedumah, and Pokonahbe soils.

In summary, key similarities exist between the soils contained within the three selected vegetation control parcels and the soils contained within Blackrock 94 (Table b.ii.13). The primary similarities include soil texture, soil drainage, available water capacity, depth-to-water table, typical vegetation, and minor soil components. A secondary similarity that is also important but is not exhibited by all sites is the presence of a restrictive layer. This layer is present in the Winerton soil unit in Blackrock 94 as well as in the Mazourka hard substratum unit present in LNP018.

Sec. 5.2 Table b.ii.13. Comparison of soil attributes between the three soil units contained within Blackrock 94 and those contained within each of the three selected vegetation control parcels.

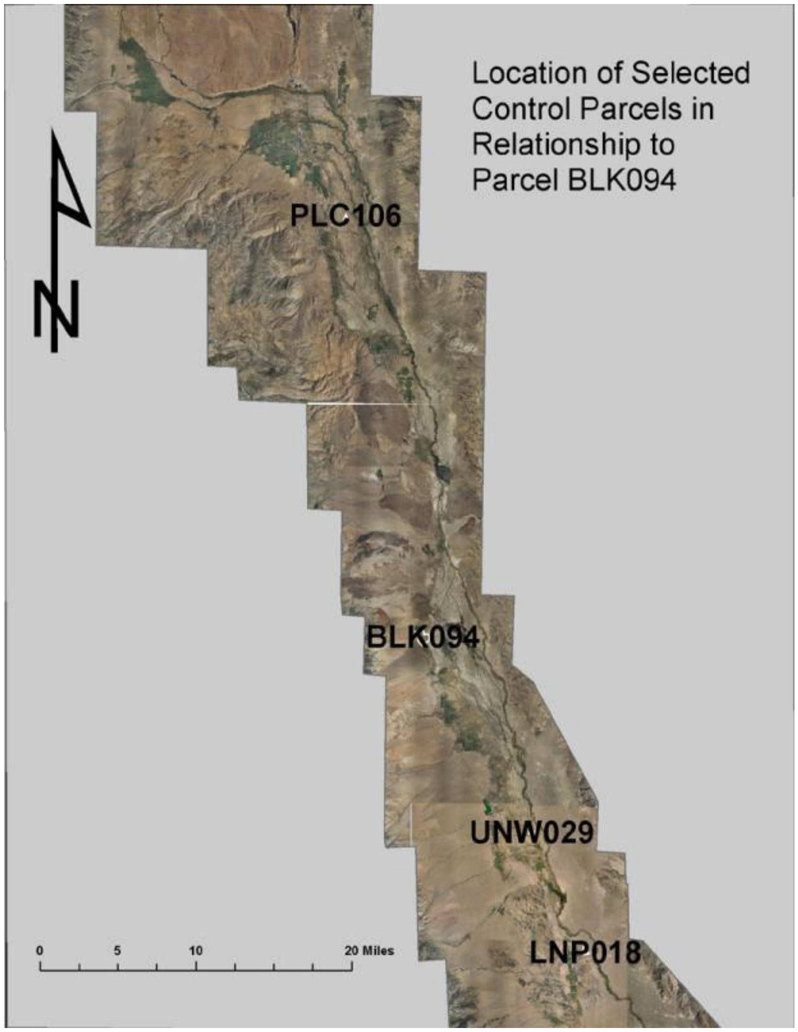
Vegetation Parcel →	BLK094			PLC106 (Control)	LNP018 (Control)		UNW029 (Control)
↓ Soil Attributes	Cartago	Shondow	Winerton	Westguard-Rienhakle	Winnedumah	Mazourka hard substratum mazourka-Eclipse	Rienhakle
Parent Material	Alluvium	Alluvium	Alluvium	Alluvium	Alluvium	Alluvium	Alluvium
Soil Texture	Gravelly loamy sand	Sandy clay loam to gravelly loamy sand	Fine sandy loam to sandy clay loam	Sandy loam to silt loam	Loam to sandy clay loam	Sand to sandy loams	Sands to sandy clay loam
Soil Drainage	Somewhat excessively drained	Somewhat poorly drained	Well Drained	Moderately well drained	Somewhat poorly drained	Well drained to somewhat excessive	Somewhat poorly drained
Available Water Capacity	Low	Moderate to High	Low	Moderate to high	Moderate to high	Low to moderate	Moderate to high
Depth to Groundwater	> 60 inches	24 to 36 inches	40 to 60 inches	> 60 inches	48 to 60 inches	> 60 inches	40 to 60 inches
Restrictive Soil Layer Yes/No	No	No	Yes between 25 & 34 inches	No	No	Yes between 40 & 60 inches	No
Typical Dominate Vegetation	ATCA, EPNE, PSFR, ACHY	SPAI, DISP	SPAI, DISP, SAVE, ATCO	SPAI, DISP, SAVE, ATCO	SPAI, DISP, ATTO, SAVE	ATCO, MESP, SAVE, ACHY	SPAI, DISP, SAVE, ATCO
Minor Soil Components	Goodale, Taboose	Dehy, Manzanar, Winnedumah, Pokonahbe	Division, Numu	Inyo, Poleta	Manzanar	Cajon	Manzanar, Winnedumah, Pokonahbe

ATCA = Fourwing Saltbush, EPNE = Nevada joitfir, PSFR = Fremont's dalea, ACHY = Indian ricegrass, SPAI = Alkali sacaton, DISP = Inland saltgrass, ATCO = Shadscale, MESP = Spiny menodora

5.2.5.7. Selected Control Parcels (General Descriptions)

In this section, to show the distribution of the three selected control parcels, the general location of each in relationship to Blackrock 94, is discussed. Then, each parcel was described in detail with information such as total acreage, distance to significant water bodies, vegetation type, and community type. Lastly, each control parcel was assessed for LADWP water spreading/irrigation using aerial imagery taken in 1944, 1968, 1981, 1993, 1996, 2000, 2005, and 2009, and the results of this assessment are presented.

The general location of the three remaining vegetation control parcels is best described, in relation to Blackrock 94, as a northern parcel and a southern pair. The northern parcel, control parcel PLC106, lies to the north of Blackrock 94 and is located west of the Owens River near Bishop, CA (Figure b.ii.19). The southern pair, control parcel LNP018 and control parcel UNW029, lie to the south of Blackrock 94 and are both located west of the Owens River between Independence and Lone Pine.

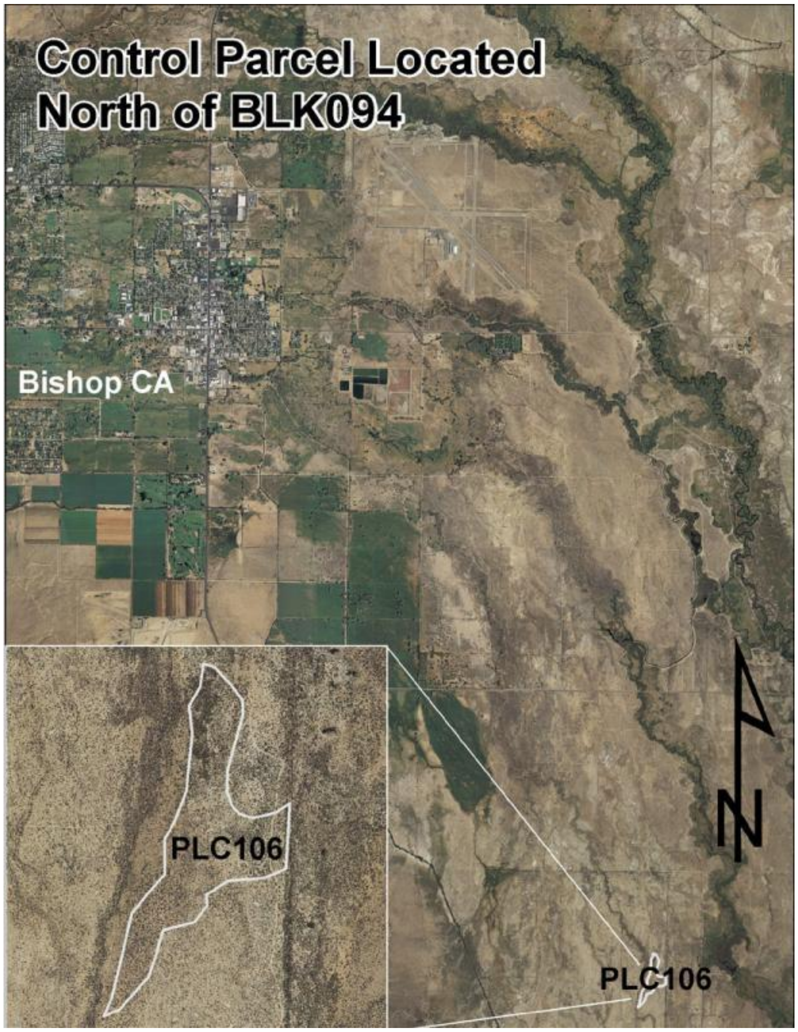


Sec. 5.2 Figure b.ii.19. General location of selected vegetation control parcels in relationship to Blackrock 94

5.2.5.7.1. PLC106 (Control)

This parcel is 14 acres in size and is located approximately five miles south of Bishop, CA (Figure b.ii.20). This parcel is positioned on the desert floor approximately 1.5 miles west of the Owens River. Warm Springs Road lies to the north of this parcel and Collins Road lies to the south. The vegetative community within this parcel was described during the 1985-1987 initial inventory period (baseline) as a Type C, rabbitbrush meadow.

This vegetation control parcel is 0.5 miles east of Saunders pond which is the closest significant water feature to this parcel. Due to the distance between the two, water from this pond should have very little influence on the vegetation within this parcel. Also, aerial imagery taken in 1944, 1968, 1981, 1993, 1996, 2000, 2005, and 2009 indicates that this parcel receives only a nominal amount of water from LADWP water spreading operations.



Sec. 5.2 Figure b.ii.20. Location of the northern control parcel PLC106.

5.2.5.7.2. LNP018 (Control)

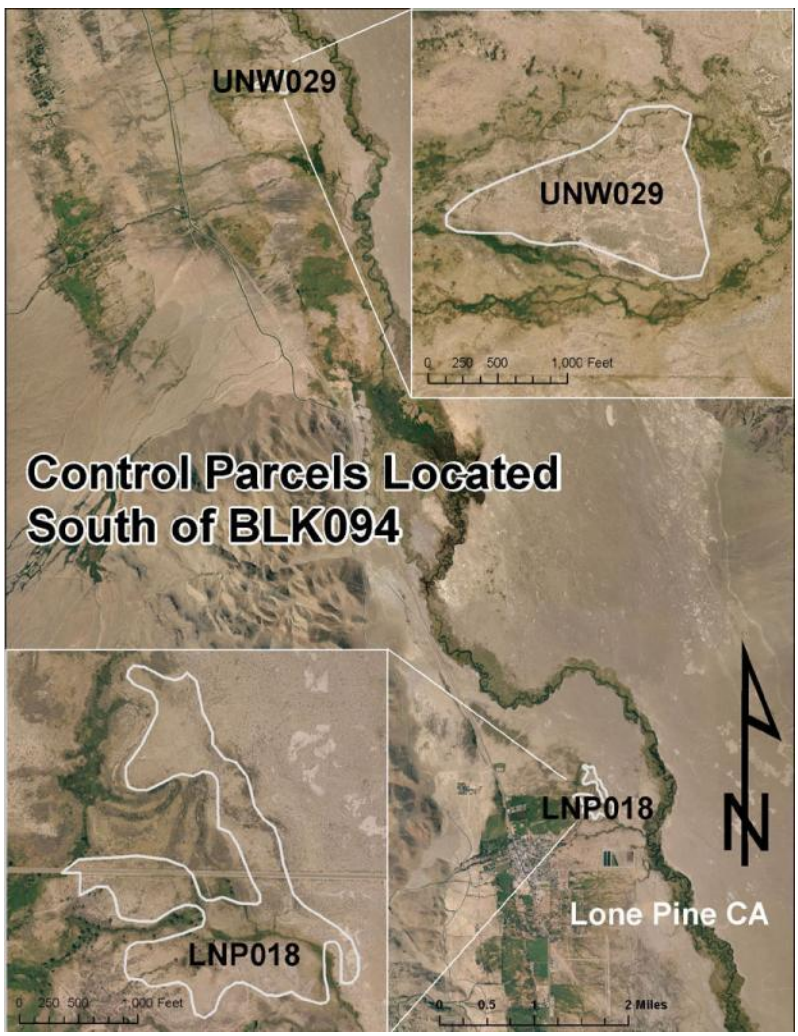
This parcel is 57 acres in size and is located approximately 0.5 miles northeast of Lone Pine, CA (Figure b.ii.21). This parcel is positioned on the desert floor approximately 0.5 miles west of the Owens River and is bisected by Narrow Gage Road. The vegetative community within this parcel was described during the 1985-1987 initial inventory period (baseline) as a grass dominated Type C, alkali meadow.

Vegetation control parcel LNP018 is located 0.5 miles west of the Owens River. Due to the distance between the two, the river should have very little influence over the vegetation within the parcel. LADWP hydrographic records and aerial imagery taken in 1944, 1968, 1981, 1993, 1996, 2000, 2005, and 2009 indicate that this parcel receives more water during average to above average runoff years.

5.2.5.7.3. UNW029 (Control)

This parcel is 29 acres in size and is located approximately seven miles south of Independence, CA (Figure b.ii.21). This parcel is positioned on the desert floor approximately 0.5 miles west of the Owens River and approximately one mile south of Manzanar Reward Road. The vegetative community within this parcel was described during the 1985-1987 initial inventory period (baseline) as a grass dominated Type C, alkali meadow.

This vegetation control parcel is located 0.5 miles west of the Owens River. Due to the distance between the two, the river should have very little influence over the vegetation within this parcel. Aerial imagery taken in 1944, 1968, 1981, 1993, 1996, 2000, 2005, and 2009 indicates that this parcel does receive water from LADWP water spreading operations during average to above average runoff years. However, according to the same imagery, water that is spread does not seem to flow directly through the parcel but rather around it to the north and to the south.



Sec. 5.2 Figure b.ii.21. Location of the southern pair of control parcels LNP018 and UNW029.

5.2.5.8. Vegetative Cover at Control Parcels and Blackrock 94

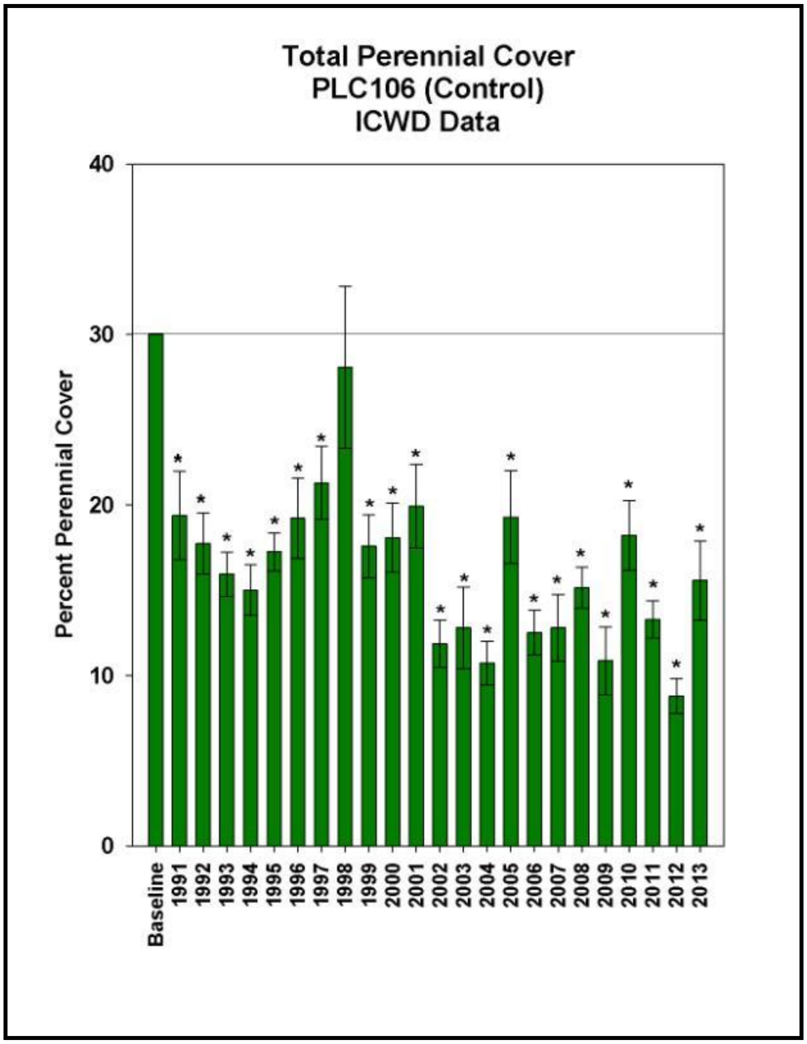
Vegetation cover within the control parcels and within Blackrock 94 is analyzed using ICWD data. Next, vegetation cover within the control parcels and within Blackrock 94 is analyzed using LADWP data. Perennial cover and perennial grass cover within the three control parcels and within Blackrock 94 generally increased from 1991 to approximately 2000. From 2000 to 2013 perennial cover and perennial grass cover generally declined in the evaluated control parcels and Blackrock 94. Perennial shrub cover within the three control parcels and within Blackrock 94 did not show any discernible trend over time. Results of this analysis are presented herein.

5.2.5.8.1. PLC106 (Control) ICWD Data

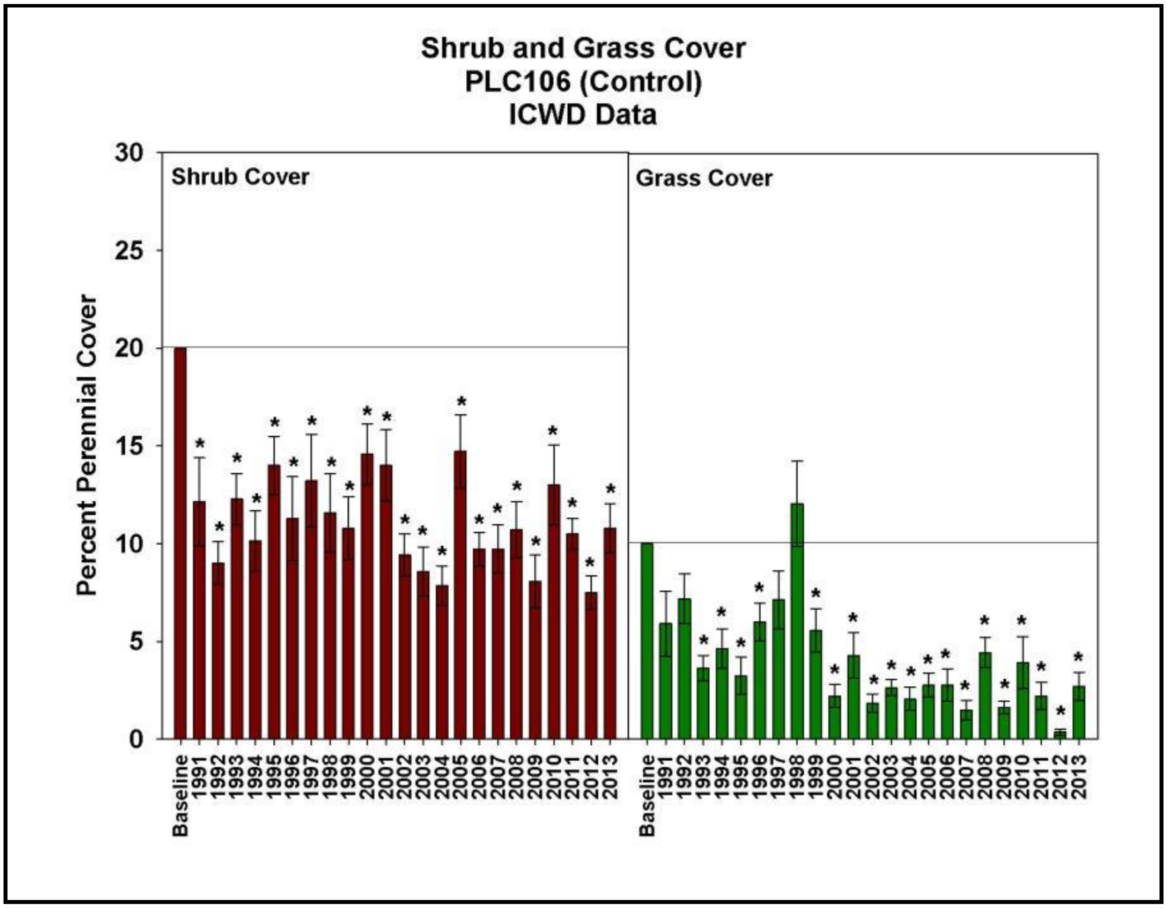
Total perennial cover within PCL106 during the baseline period was 30% (Figure b.ii.22). Total perennial cover decreased from 30% in 1991 to 15% in 1994. From 1994 to 1998 total perennial cover increased from 15% to 28%. After 1998, total perennial cover steadily declined through 2013 to 16%. Of the 23-year monitoring period, 22 years were found to be statistically below the initial vegetation inventory ($P < 0.05$). The only year that total perennial cover was statistically within the initial vegetation inventory (baseline) was 1998, with a cover value of 28%.

Perennial shrub cover within PLC106 during the baseline period was 20% (Figure b.ii.23). Perennial shrub cover showed a slight increase in cover from 12% in 1991 to 15% in 2000. From 2000 to 2013 perennial shrub cover generally declined. Perennial shrub cover was found to be statistically lower than the initial vegetation inventory (baseline) for all 23 monitoring years ($P < 0.05$). From 1991 through 2013 perennial shrub cover was on average 50% less than the initial vegetation inventory (baseline).

Perennial grass cover within PLC106 during the baseline period was 10% (Figure b.ii.23). On average, perennial grass cover at PLC106 increased from 6% in 1991 to 12% 1998. From 1998 to 2013 perennial cover generally declined. Perennial grass cover in 2013 was 3%. Perennial grass cover was found to be statistically lower than baseline for 19 out of 23 monitoring years ($P < 0.05$). The only years found to have total perennial cover that was statistically within the initial vegetation inventory (baseline) were 1991, 1992, 1997, and 1998. Average cover during these years was 8%.



Sec. 5.2 Figure b.ii.22. Total perennial cover within vegetation control parcel PLC106 using ICWD data. Black asterisks denote years that were statistically lower than the initial vegetation inventory (baseline). The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.



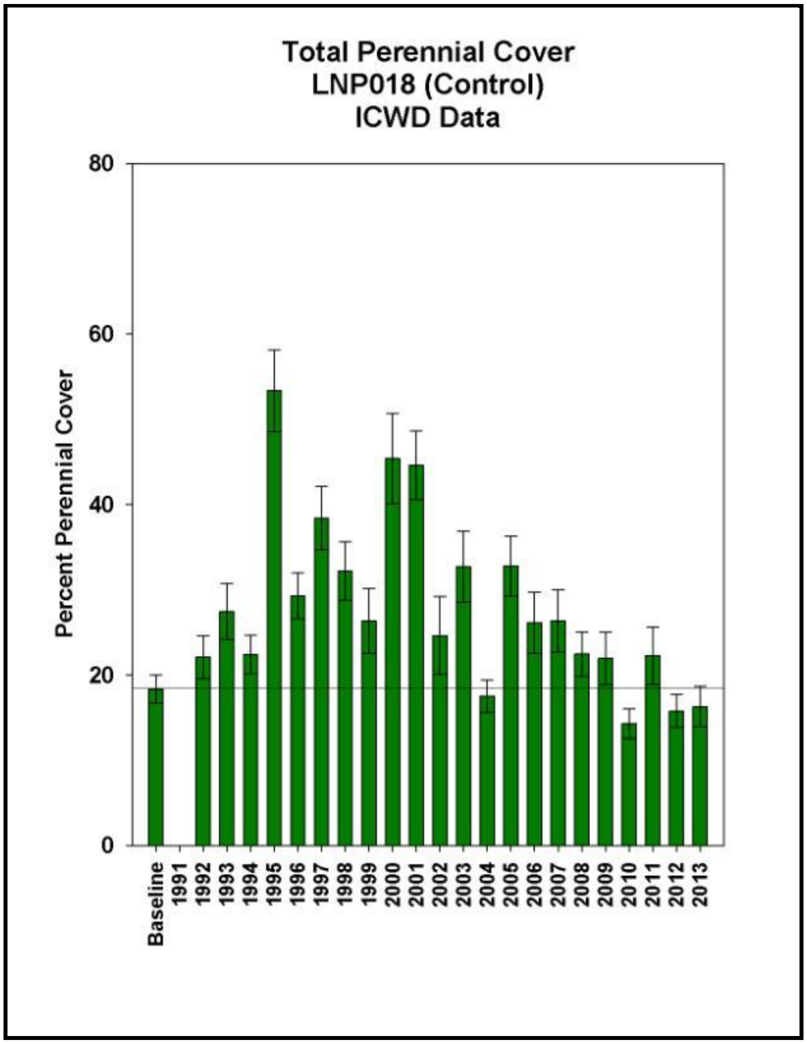
Sec. 5.2 Figure b.ii.23. Perennial shrub and grass cover within vegetation control parcel PLC106 using ICWD data. Black asterisks denote years that were statistically lower than baseline.

5.2.5.8.2. LNP018 (Control) ICWD Data

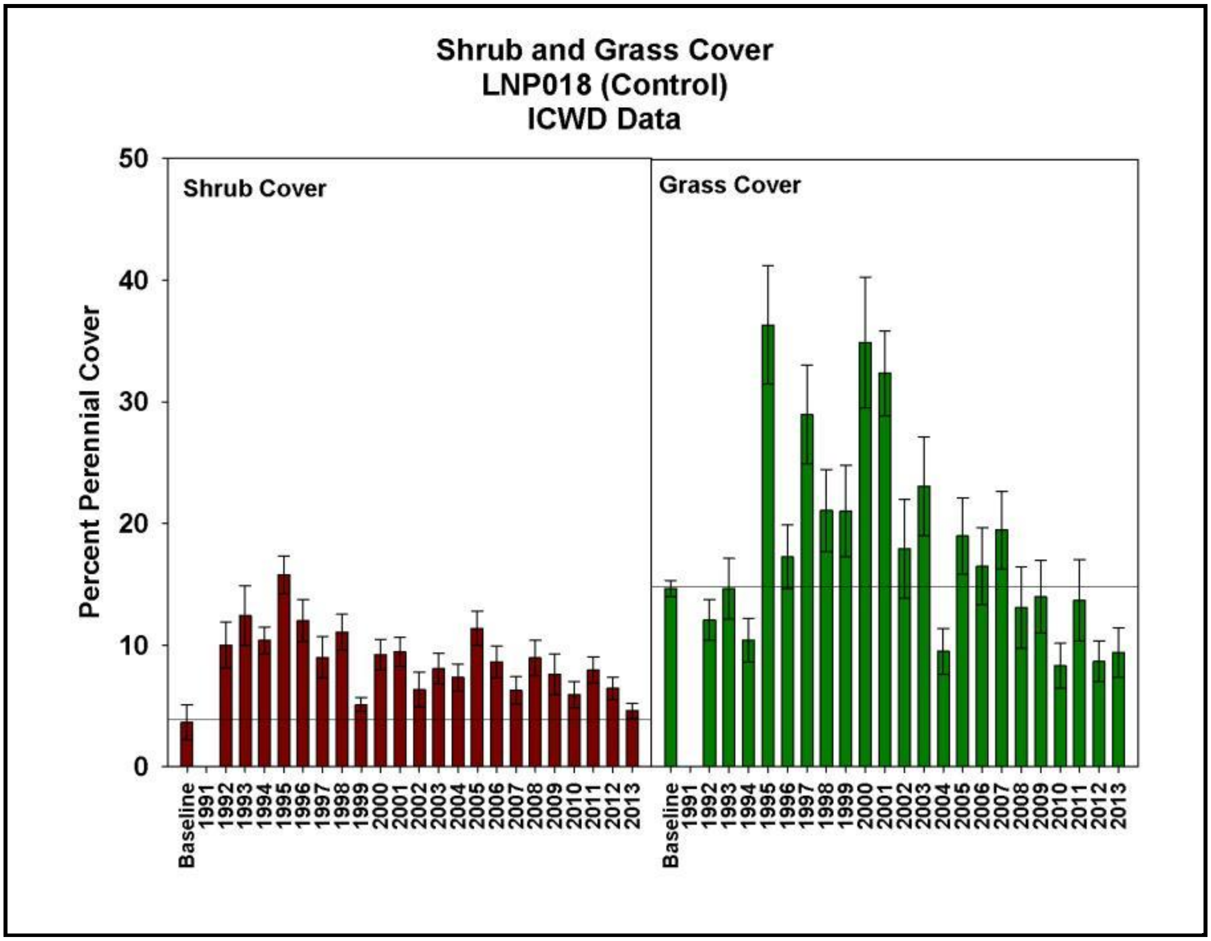
Total perennial cover within LNP018 during baseline was 18% (Figure b.ii.24). Total perennial cover increased from 22% in 1992 to 45% in 2000. After 2000, total perennial cover steadily declined through 2013 to 16%. During the 23-year monitoring period no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest total perennial cover years occurred in 2004, 2010, 2012, and 2013.

Perennial shrub cover within LNP018 during baseline was 4% (Figure b.ii.25). On average, perennial shrub cover exhibited a general downward trend from 10% in 1992 to 5% in 2013. During the 23-year monitoring period no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest cover years occurred in 1999, 2002, 2007, 2010, and 2013.

Perennial grass cover within LNP018 during the baseline period was 15% (Figure b.ii.25). Perennial grass cover increased from 12% in 1992 to 35% in 2000. After 2000 perennial grass cover steadily declined to 9% in 2013. During the 23-year monitoring period no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest cover years occurred in 1994, 2004, 2010, 2012 and 2013.



Sec. 5.2 Figure b.ii.24. Total perennial cover within vegetation control parcel LNP018 using ICWD data. The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.



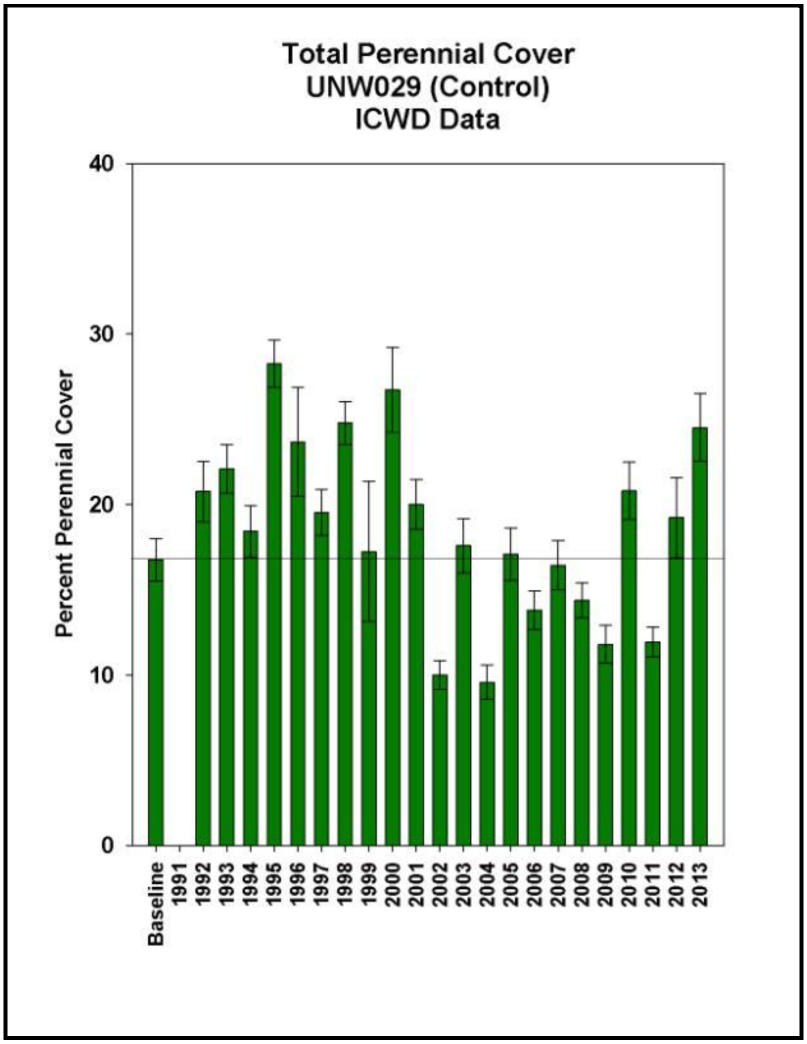
Sec. 5.2 Figure b.ii.25. Perennial shrub and grass cover within vegetation control parcel LNP018 using ICWD data.

5.2.5.8.3. UNW029 (Control) ICWD Data

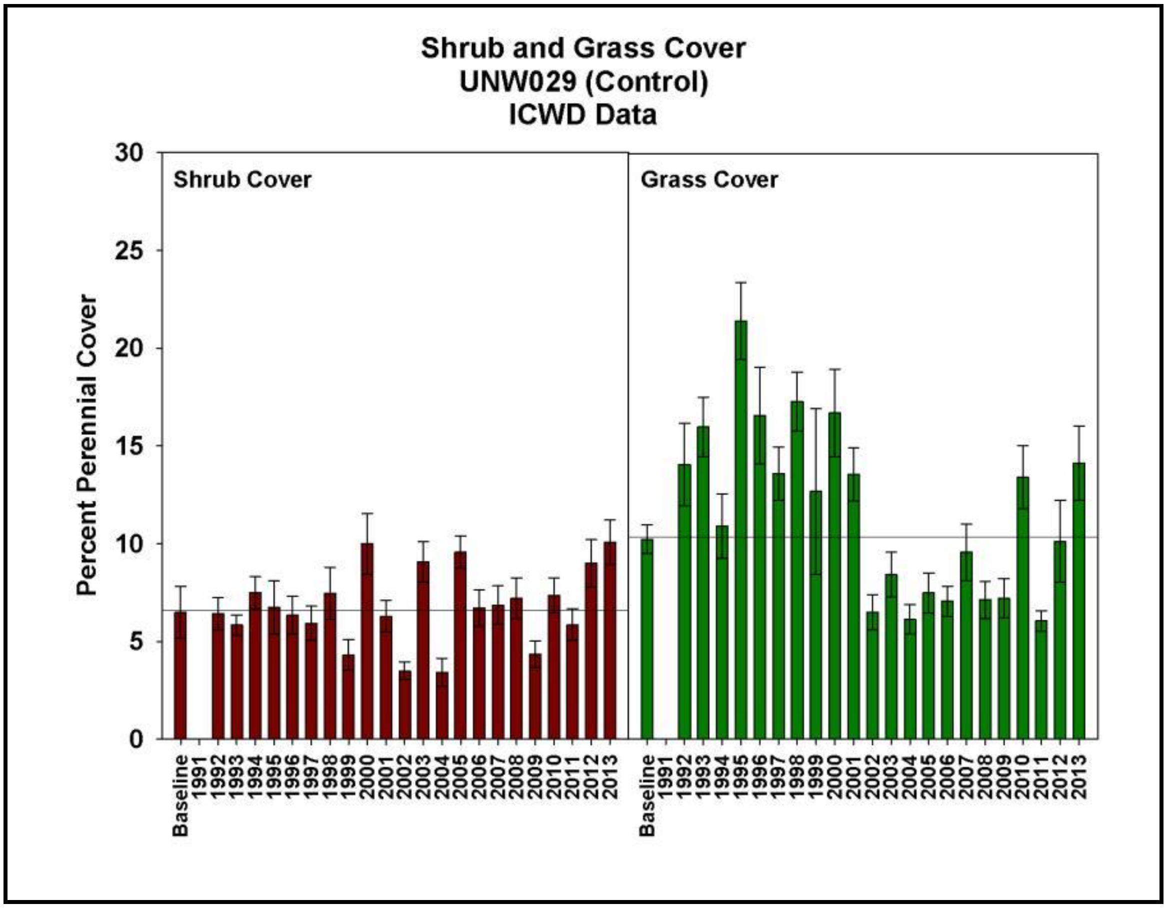
Total perennial cover within UNW029 during baseline was 17% (Figure b.ii.26). Total perennial cover increased from 21% in 1992 to 27% in 2000. After 2000, perennial cover steadily declined to 10% in 2004. There was a general increase in cover from 2004 to 2013, with the average value for this time period being 16 percent. During the 23-year monitoring period, no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest cover years occurred in 2002, 2004, 2009, and 2011.

Perennial shrub cover within UNW029 during the initial vegetation inventory (baseline) period was 7% (Figure b.ii.27). Perennial shrub cover did not show a discernible trend other than perhaps a slight decrease in cover in 2002 and 2004. Between 1992 and 2013, shrub cover ranged between 4% and 10%. During the 23-year monitoring period, no years were found to be statistically lower than baseline.

Perennial grass cover within UNW029 during the baseline period was 10% (Figure b.ii.27). Perennial grass cover increased from 14% in 1992 to 17% in 2000. From 2001 to 2002 grass cover dropped from 14% to 7% and remained around this value until 2009. During the 23-year monitoring period no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest cover years occurred in 2002, 2003, 2004, 2005, 2006, 2008, 2009, and 2011.



Sec. 5.2 Figure b.ii.26. Total perennial cover within vegetation control parcel UNW029 using ICWD data. The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.



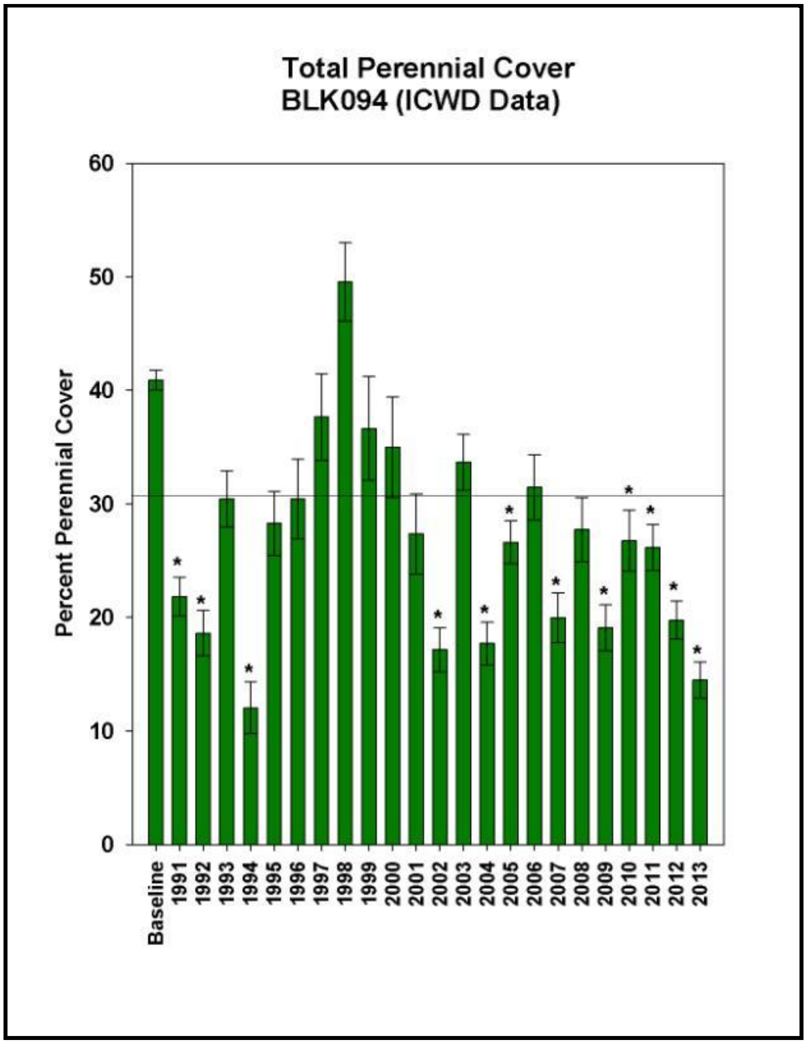
Sec. 5.2 Figure b.ii. 27. Perennial shrub and grass cover within vegetation control parcel UNW029 using ICWD data.

5.2.5.8.4. Blackrock 94 (Wellfield) ICWD Data

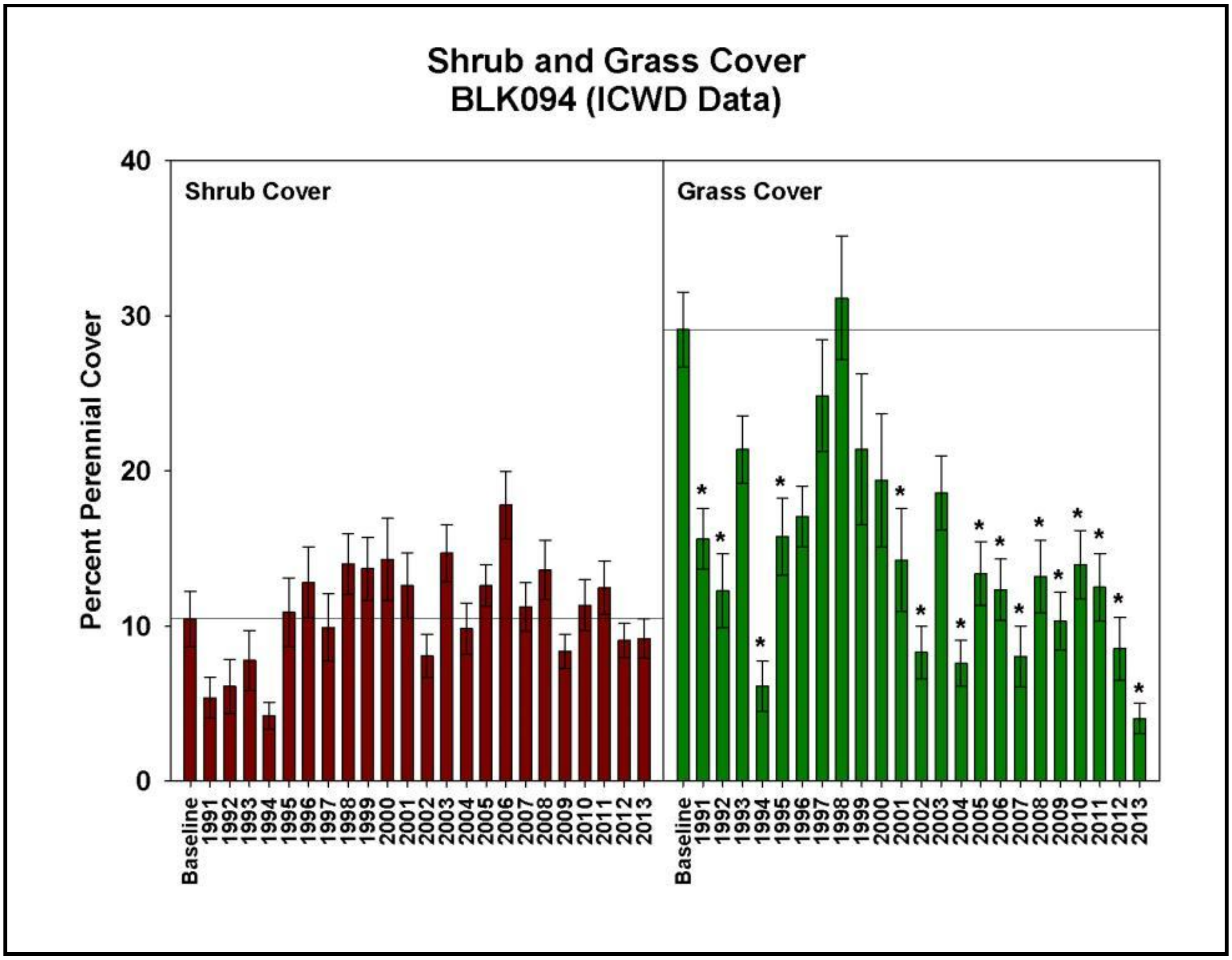
Total perennial cover within Blackrock 94 during the initial vegetation inventory (baseline) period was 41% (Figure b.ii.28). In general, total perennial cover increased from 22% in 1991 to 50% in 1998. After 1998, total perennial cover steadily declined to 17% in 2002. From 2002 to 2013, average total perennial cover was 23%. Perennial cover increased from 17% in 2002 to 27% in 2005. In 2006, total perennial cover was 32%. Total perennial cover values then declined to 19% in 2009, after which it increased to 27% in 2010 and remained at this value through 2011. In 2013, total perennial cover values declined to 15%. Of the 23-year monitoring period, 12 years were found to be statistically lower than baseline ($P < 0.05$): 1991, 1992, 1994, 2002, 2004, 2005, 2007, 2009, 2010, 2011, 2012, and 2013.

Perennial shrub cover within Blackrock 94 during the baseline period was 10% (Figure b.ii.29). Perennial shrub cover increased from 6% in 1991 to 14% in 2000. Of the 23-year monitoring period, no years were found to be statistically lower than baseline. Although not statistically significant, the lowest cover value of 4% occurred in 1994.

Perennial grass cover within Blackrock 94 during the initial inventory (baseline) period was 29% (Figure b.ii.29). Perennial grass cover, on average, increased from 16% in 1991 to 31% in 1998. After 1998 perennial grass cover steadily declined to 8% in 2002. There was a sharp increase in 2003 however, by 2004 cover returned to the 2002 level. From 2004 to 2013 perennial grass cover ranged between four and 14%. Of the 23-year monitoring period, 16 years were found to be statistically lower than baseline (*P* < 0.05): 1991, 1992, 1994, 1995, 2001, 2002, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, and 2013.



Sec. 5.2 Figure b.ii.28. Total perennial cover within Blackrock 94 using ICWD data. Black asterisks denote years that were statistically lower than the initial vegetation inventory (baseline). The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.



Sec. 5.2 Figure b.ii.29. Perennial shrub and grass cover within Blackrock 94 using ICWD data. Black asterisks denote years that were statistically lower than the initial vegetation inventory (baseline).

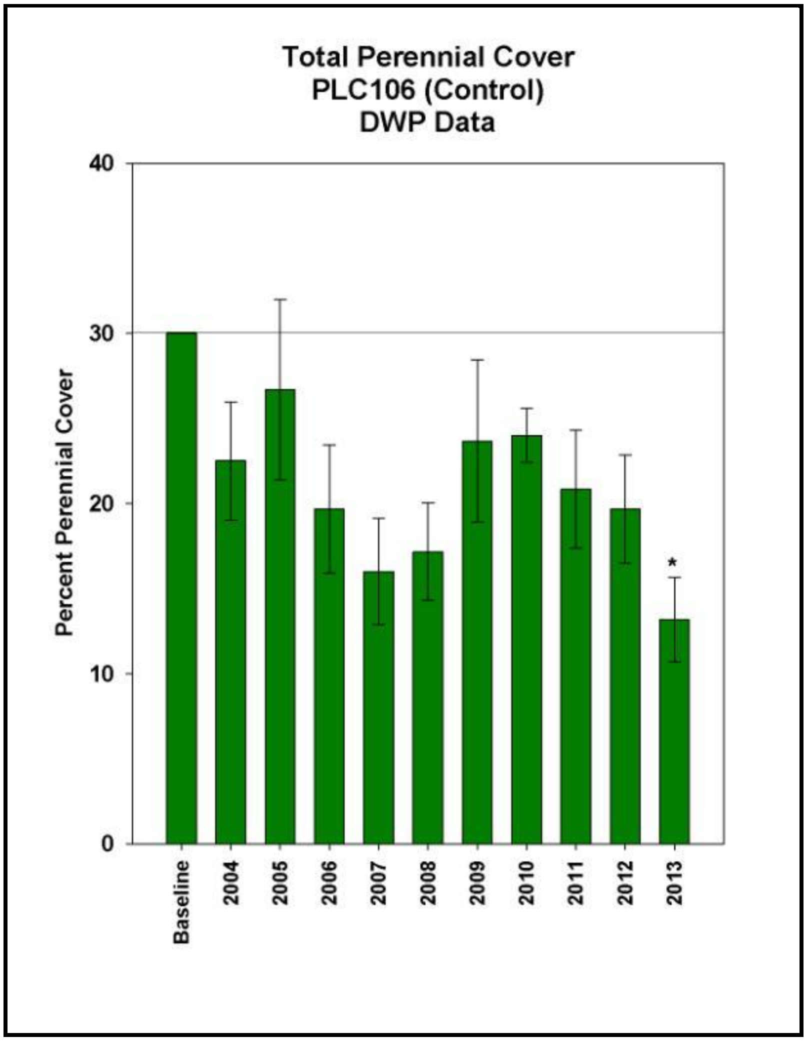
The initial vegetation inventory values used in the ICWD data are exactly the same as the initial inventory values used in the LADWP data that follows. It is important to note however, that the LADWP vegetation monitoring program did not begin until 2004. The LADWP data presented below represents a much shorter monitoring period (ten years) as compared to the ICWD's vegetation monitoring data (23 years).

5.2.5.8.5. PLC106 (Control) LADWP Data

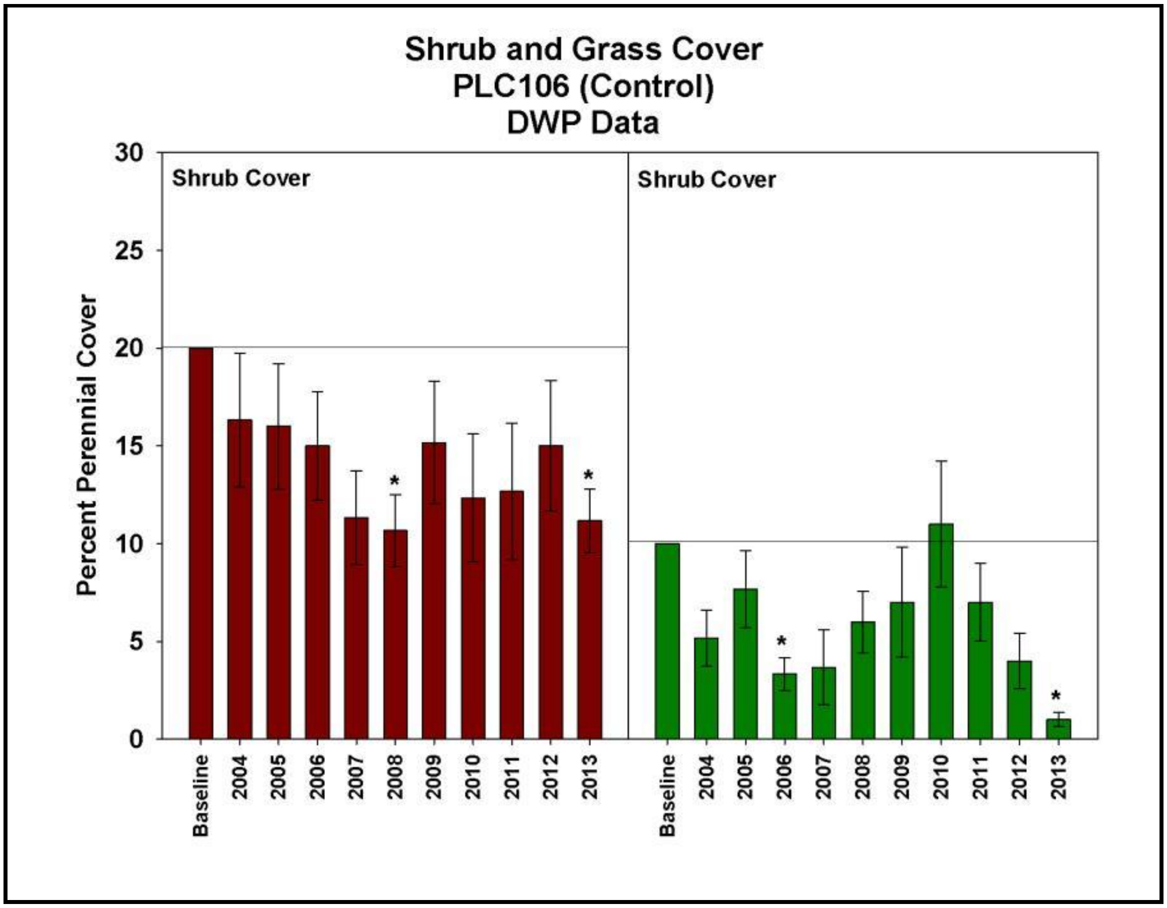
Total perennial cover within PLC106 ranged between 13 and 27% from 2004 to 2013 (Figure b.ii.30). During the 10-year monitoring period 2013 was the only year found to be statistically below the initial vegetation inventory (baseline) with a value of 13% ($P < 0.05$). Although not statistically significant, other notable years with low total perennial cover include 2007 and 2008.

Perennial shrub cover within PLC106 ranged between 11 and 16 % from 2004 to 2013 (Figure b.ii.31). During the 10-year monitoring period 2008 and 2013 were found to be significantly below baseline (*P* < 0.05). Although not statistically significant, one notable year with low shrub cover includes 2007.

Perennial grass cover within PLC106 ranged between one and 11 % from 2004 to 2013 (Figure b.ii.31). During the 10 year monitoring period 2006 and 2013, perennial grass cover was found to be significantly below the initial vegetation inventory with values of three and one percent respectively (*P* < 0.05). Although not statistically significant, other notable years with low grass cover include 2007 and 2012.



Sec. 5.2 Figure b.ii.30. Total perennial cover within vegetation control parcel PLC106 using LADWP data. Black asterisks denote years that were statistically below the initial vegetation inventory (baseline). The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.



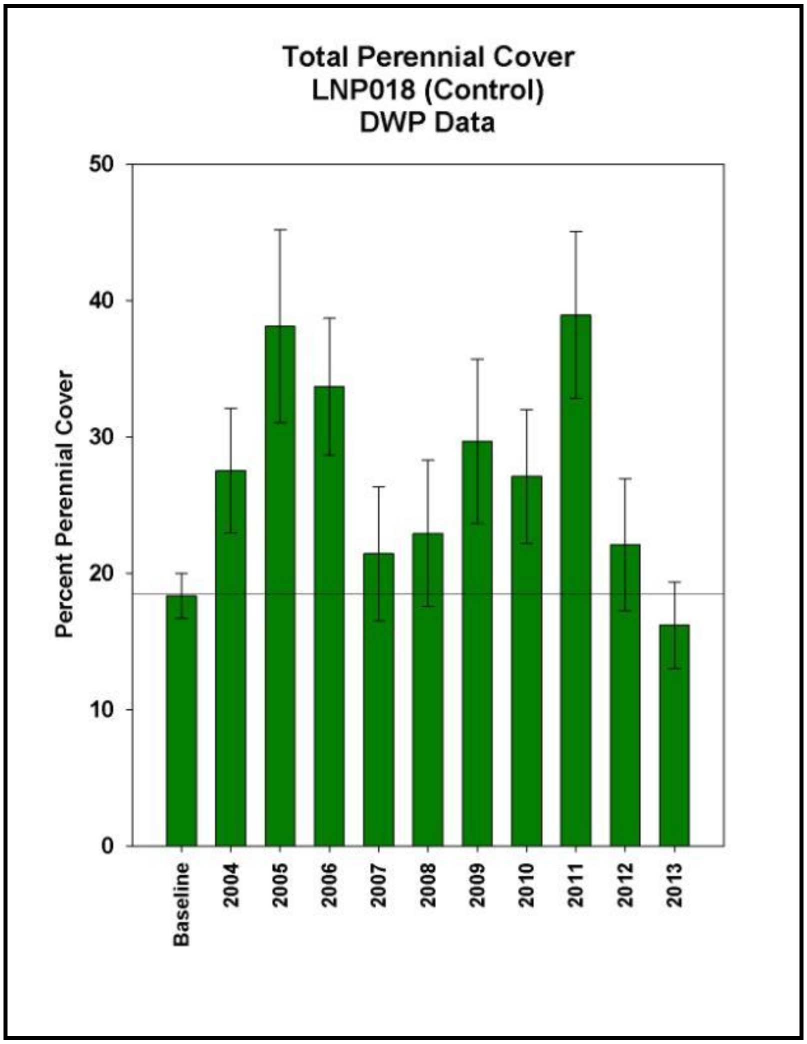
Sec. 5.2 Figure b.ii.31. Perennial shrub and grass cover within vegetation control parcel PLC106 using LADWP data. Black asterisk denote years that are statistically below the initial vegetation inventory.

5.2.5.8.6. LNP018 (Control) LADWP Data

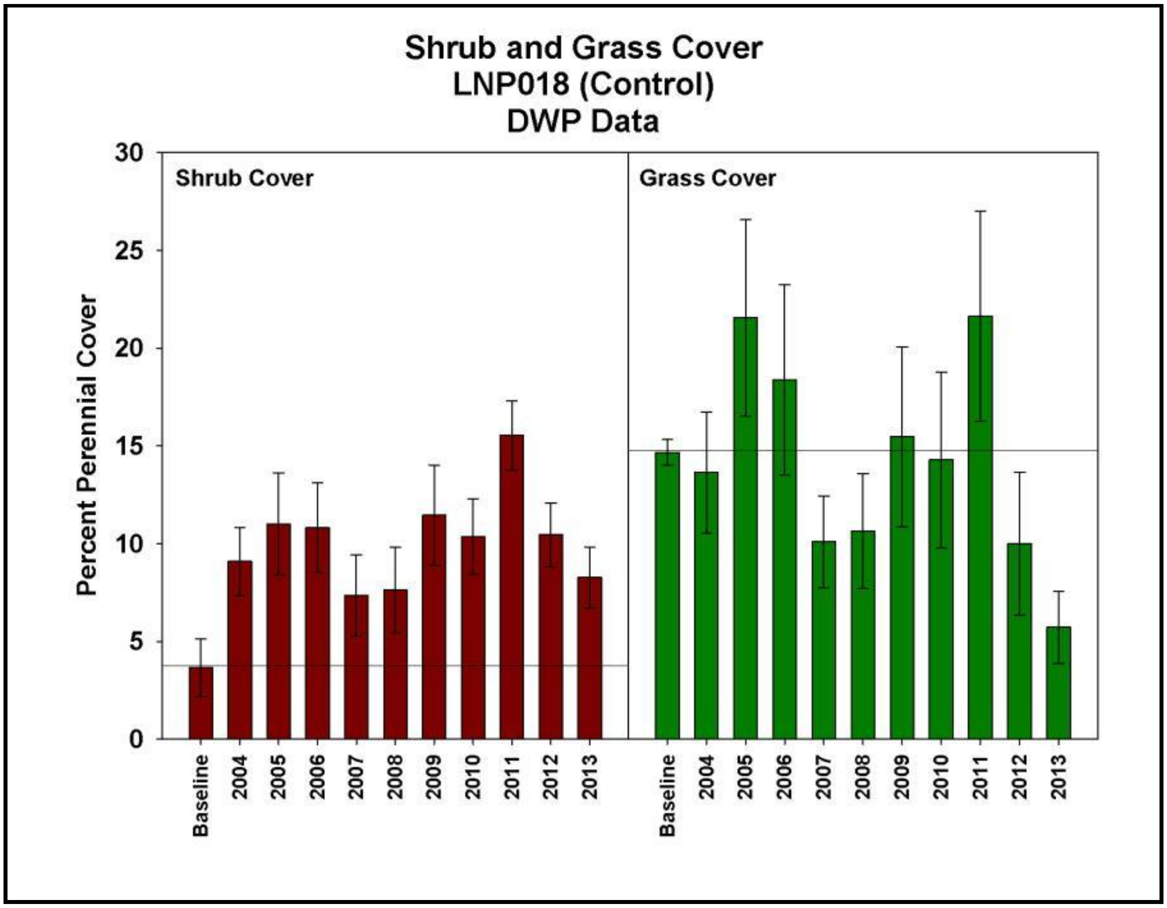
Total perennial cover within LNP018 ranged between 16 to 39% from 2004 to 2013 (Figure b.ii.32). During the 10-year monitoring period no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest total perennial cover was recorded at 16 % in 2013.

Perennial shrub cover within LNP018 ranged between seven to 16 % from 2004 to 2013 (Figure b.ii.33). During the 10-year monitoring period no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest shrub cover was recorded at 7% in 2007.

Perennial grass cover within LNP018 ranged between six to 26% from 2004 to 2013 (Figure b.ii.33). During the 10-year monitoring period no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest grass cover was recorded at 6% in 2013.



Sec. 5.2 Figure b.ii.32. Total perennial cover within vegetation control parcel LNP018 using LADWP data. The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.



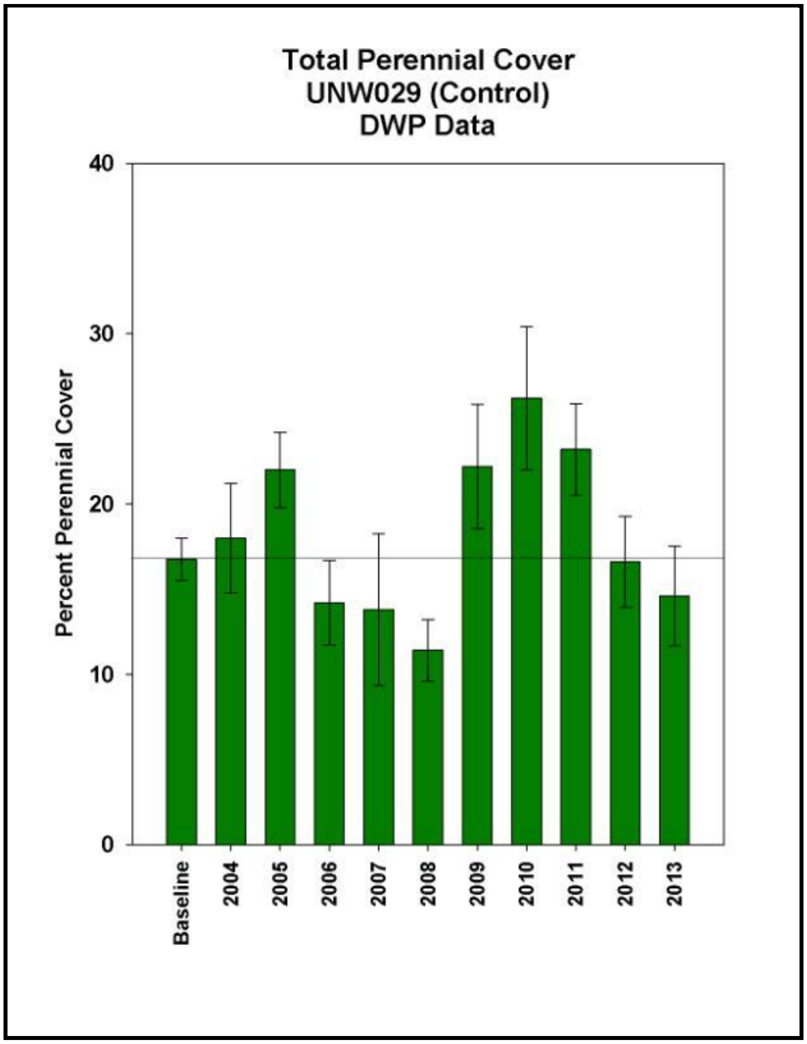
Sec. 5.2 Figure b.ii.33. Perennial shrub and grass cover within vegetation control parcel LNP018 using LADWP data.

5.2.5.8.7. UNW029 (Control) LADWP Data

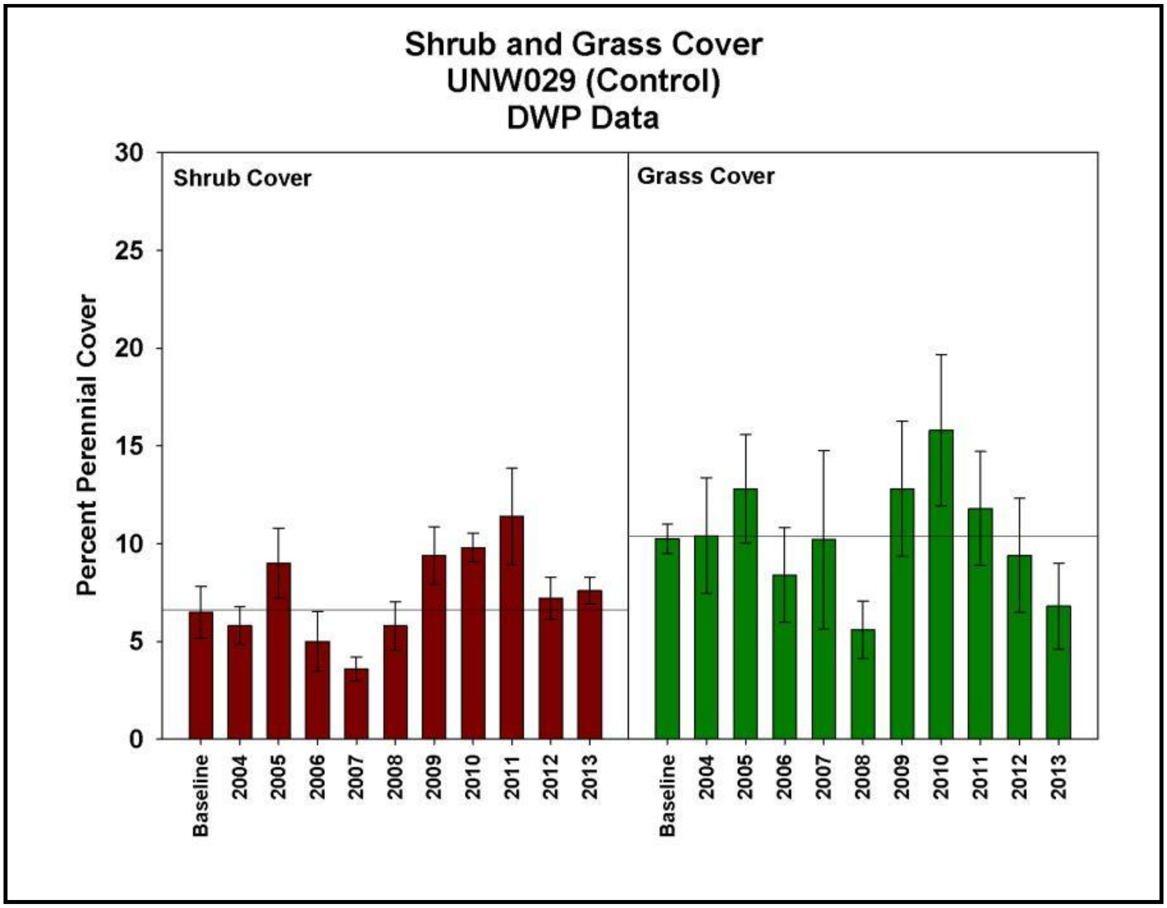
Total perennial cover within UNW029 ranged between 11 and 26 % from 2004 to 2013 (Figure b.ii.34). During the 10-year monitoring period no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest total perennial cover was recorded at 11% in 2008.

Perennial shrub cover within UNW029 ranged between four and 11 % from 2004 to 2013 (Figure b.ii.35. During the 10-year monitoring period no years were found to be statistically lower than baseline. However, of these values the lowest shrub cover was recorded at 4% in 2007.

Perennial grass cover within UNW029 ranged between six and 16 % from 2004 to 2013 (Figure b.ii.35). During the 10-year monitoring period no years were found to be statistically lower than the initial vegetation inventory (baseline). However, of these values the lowest grass cover was recorded at 6% in 2008.



Sec. 5.2 Figure b.ii.34. Total perennial cover within vegetation control parcel UNW029 using LADWP data. The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.



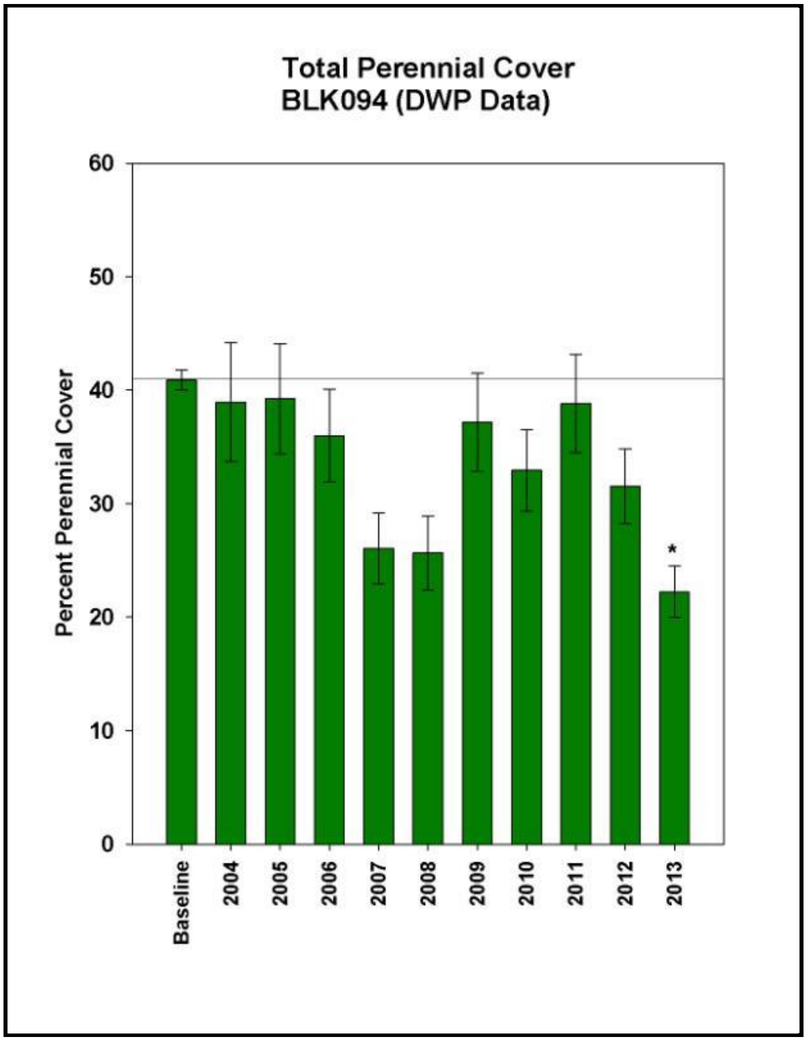
Sec. 5.2 Figure b.ii.35. Perennial shrub and grass cover within vegetation control parcel UNW029 using LADWP data.

5.2.5.8.8. Blackrock 94 (Wellfield) LADWP Data

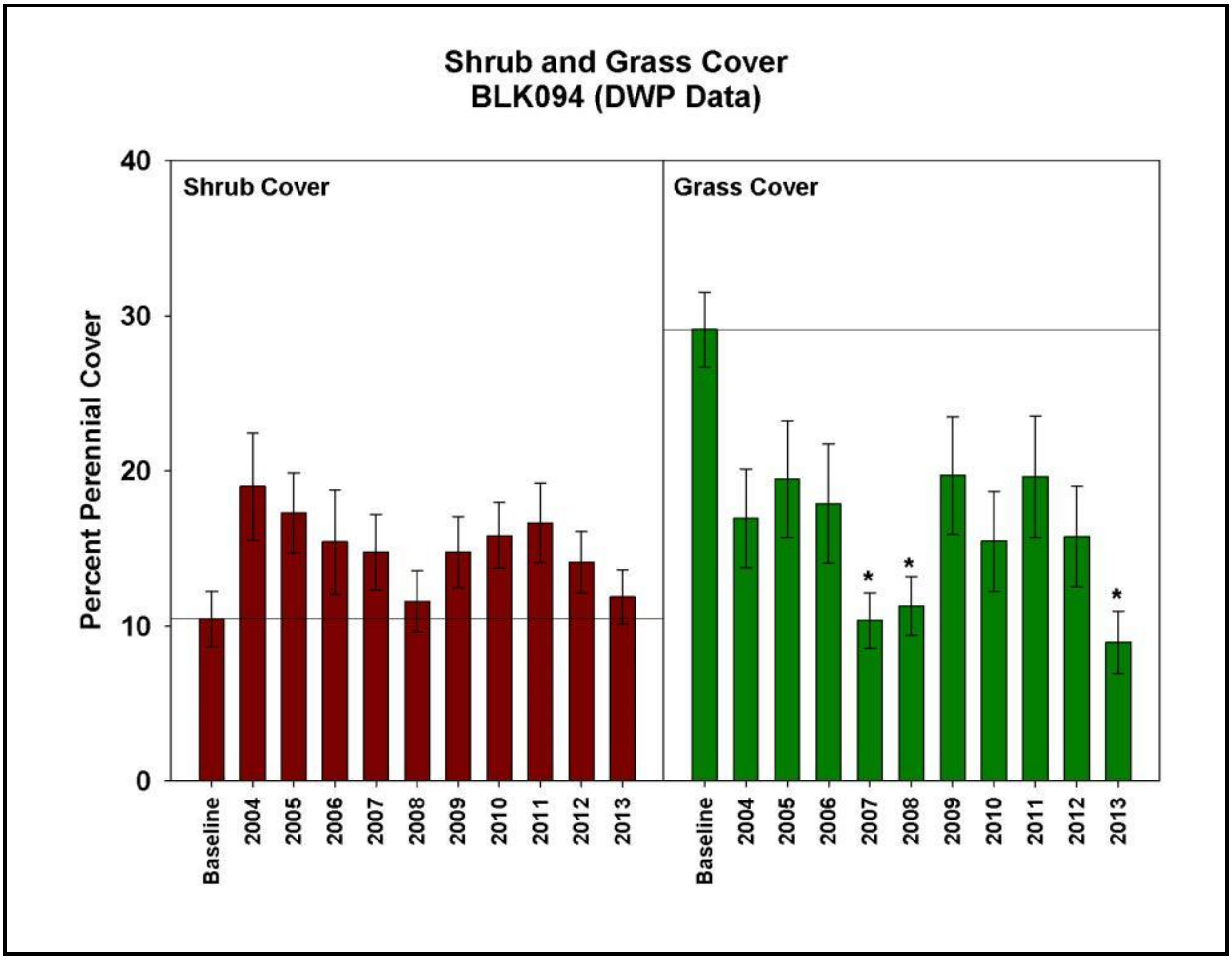
Total perennial cover within Blackrock 94 ranged between 22 to 39 % from 2004 to 2013 (Figure b.ii.36). Total perennial cover showed, on average, a decrease in cover from 2004 to 2013. Of the 10-year monitoring period 2013 was the only year to be found statistically lower than the initial vegetation inventory ($P < 0.05$). Although not statistically significant, other notable years with low total perennial cover were 2007 and 2008.

Perennial shrub cover within Blackrock 94 ranged between 12 and 19% from 2004 to 2013 (Figure b.ii.37). Perennial shrub cover did not show any discernible trend over time other than a general decrease from 2004 to 2013. Of the 10-year monitoring period no years were found to be statistically lower than baseline ($P < 0.05$). Although not statistically significant the lowest shrub cover value of 12% occurred in 2008 and in 2013.

Perennial grass cover within Blackrock 94 ranged between nine and 20% from 2004 to 2013 (Figure b.ii.37). Perennial grass cover did not show any discernible trend over time other than a decrease in grass cover during 2007, 2008, and 2013. Of the 10-year monitoring period 2007, 2008, and 2013 were found to be statistically lower than the initial vegetation inventory ($P < 0.05$). Average grass cover during these three years was 10%.



Sec. 5.2 Figure b.ii.36. Total perennial cover within Blackrock 94 using LADWP data. Black asterisks denote years that were statistically lower than the initial vegetation inventory (baseline). The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.

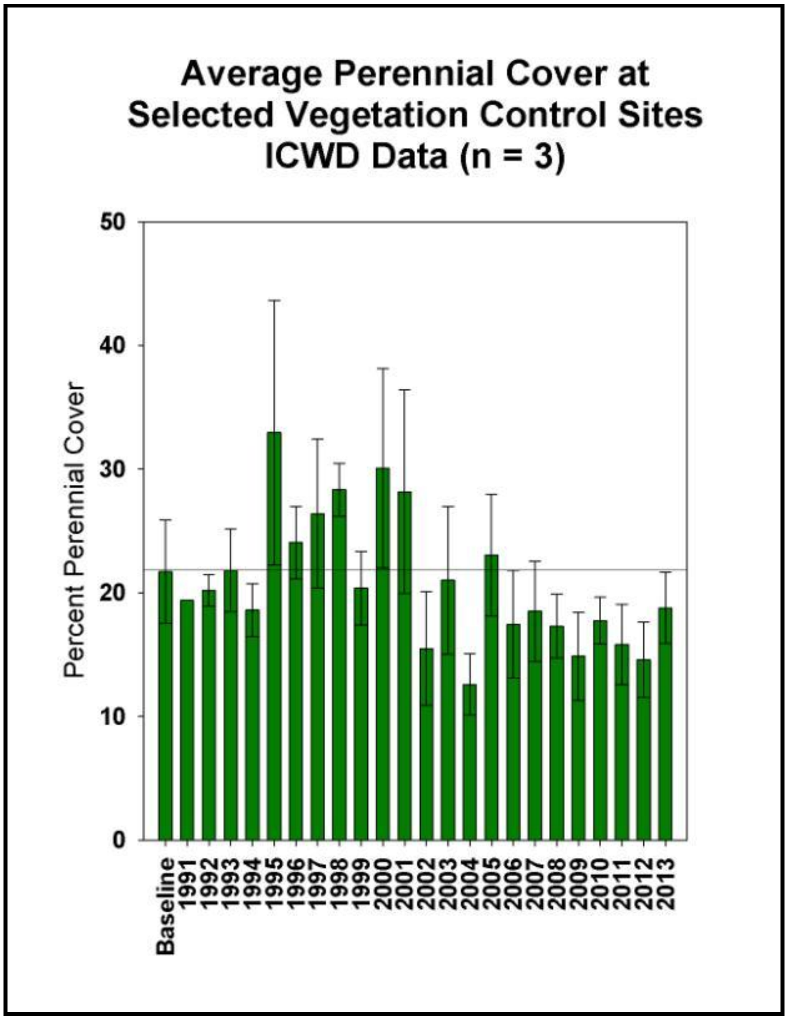


Sec. 5.2 Figure b.ii.37. Perennial shrub and grass cover within vegetation control parcel Blackrock 94 using LADWP data. Black asterisks denote years that were statistically lower than the initial vegetation inventory (baseline).

5.2.5.9. Vegetative Trend (Selected Control Parcels) ICWD Data

Average vegetation cover across all three control parcels was analyzed using ICWD data. Total perennial cover and perennial grass cover across all three control parcels generally increased from 1991 to approximately 2000. From 2000 to 2013 perennial cover and perennial grass cover generally declined. Perennial shrub cover across all three control parcels did not show any discernible trend over time.

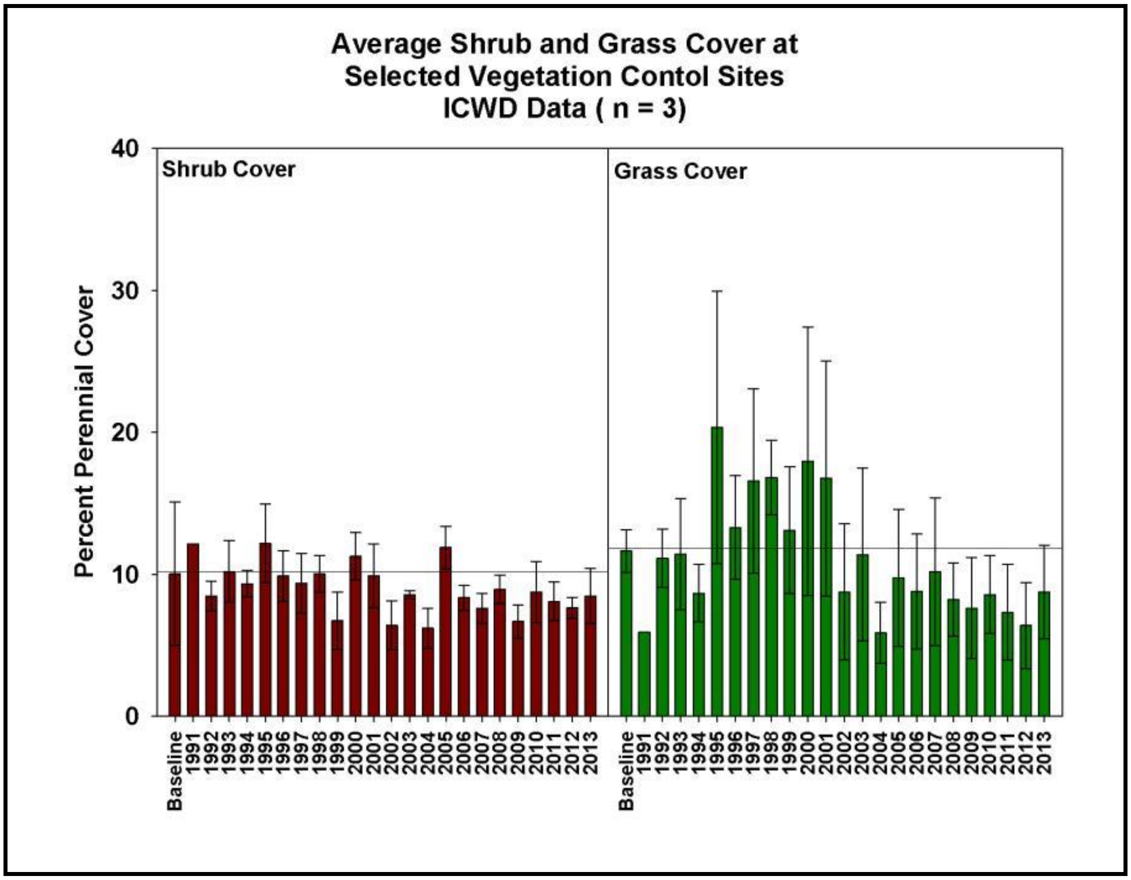
Average total perennial cover across all three selected control parcels during baseline was 22% (Figure b.ii.38). Average control parcel total perennial cover generally increased from 1991 to approximately 2001. In 2002 there was a fairly sharp drop in total perennial cover that lasted through 2013. Although not statistically significant, average control parcel perennial cover was below the initial vegetation inventory (baseline) average for a total of 15 years during the entire 23 monitoring years. Of those 15 years the lowest average values occurred in 2002, 2004, 2009, and 2012.



Sec. 5.2 Figure b.ii.38. Average perennial cover within selected vegetation control parcels using ICWD data (PLC106, LNP018, UNW029). The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.

Average perennial shrub cover across all three selected control parcels during the initial vegetation inventory (baseline) period was 10% (Figure b.ii.39). Average control parcel perennial shrub cover did not show a discernible trend other than perhaps a slight decrease in cover across all years after 2001. Of the 23 monitoring years average control parcel perennial shrub cover was generally within three percent of baseline.

Average perennial grass cover across all three selected control parcels during the initial vegetation inventory (baseline) period was 12% (Figure b.ii.39). Average control parcel perennial grass cover generally increased from 1991 to approximately 2001. In 2002 there was a fairly sharp drop in grass cover that lasted through 2013. Although not statistically significant, average control parcel perennial grass cover was below baseline a total of 16 years out the 23-year monitoring period. Of those years the lowest grass cover occurred in 1991, 2004, 2009, 2011, and 2012.



Sec. 5.2 Figure b.ii.39. Average shrub and grass cover within selected vegetation control parcels using ICWD data (PLC106, LNP018, UNW029).

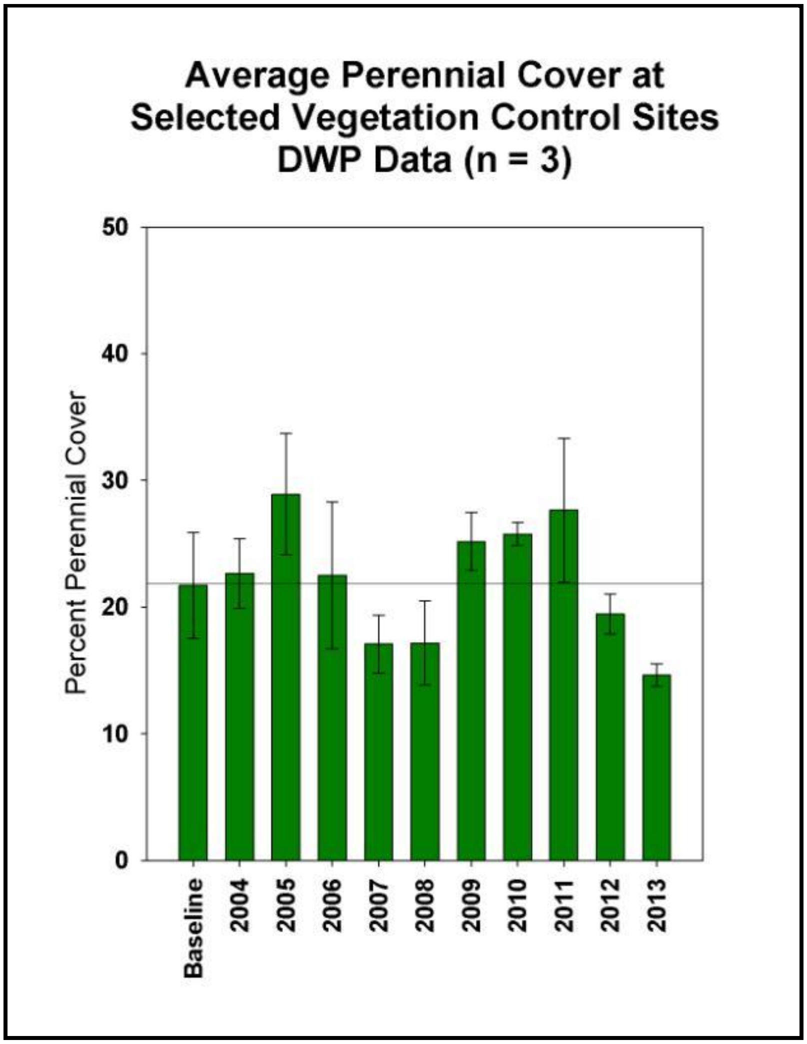
5.2.5.10. Vegetative Trend (Selected Control Parcels) LADWP Data

Average vegetation cover across all three control parcels was analyzed using LADWP data. Due to the truncated nature of this data set as compared to the ICWD data set, minimal trends in all perennial cover types are exhibited. LADWP data did show a decrease in all perennial cover types in 2007, 2008, 2012, and 2013.

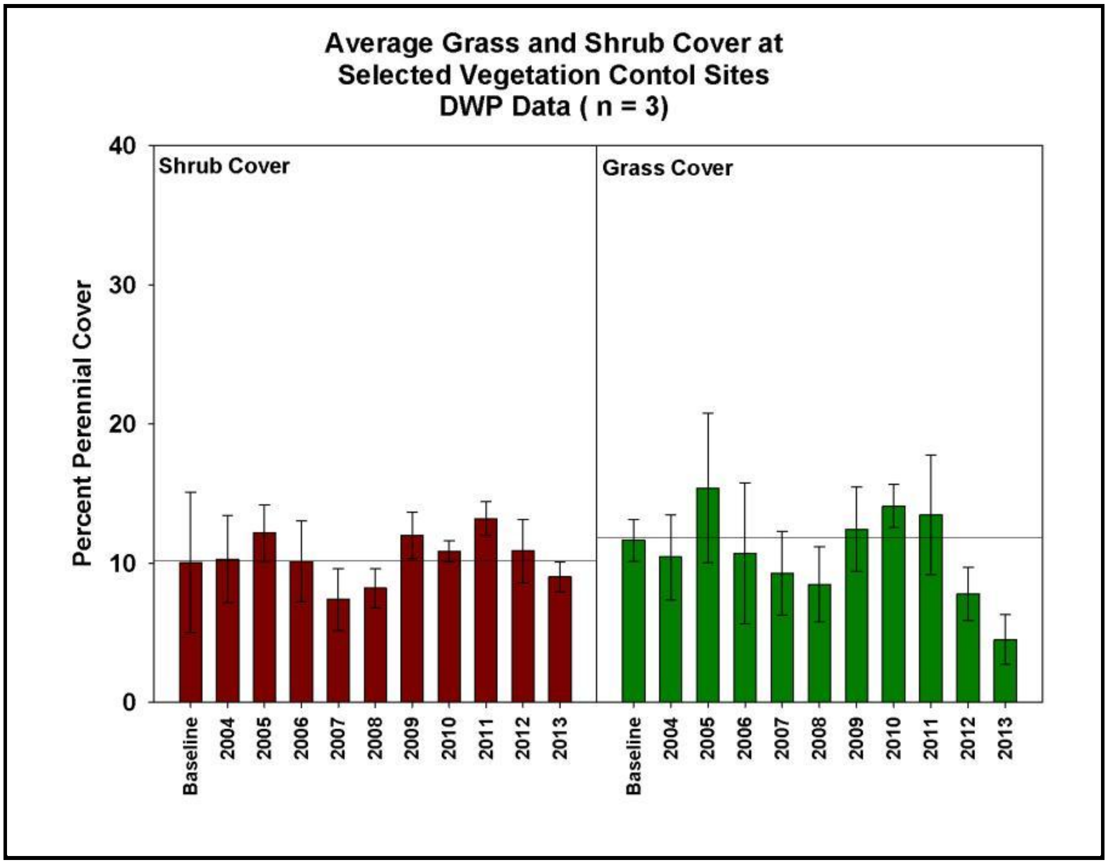
Average perennial cover across all three selected control parcels from 2004 to 2013 ranged from 15 to 29% (Figure b.ii.40). Although not statistically significant, average control parcel total perennial cover was below the initial vegetation inventory (baseline) value of 22% a total of four years out of the 10-year monitoring period. Of those years, the lowest total perennial cover of 15% occurred in 2013.

Average perennial shrub cover across all three selected control parcels from 2004 to 2013 ranged from seven to 13% (Figure b.ii.41). Although not statistically significant, average control parcel perennial shrub cover was below the baseline value of 10% for a total of three years out of the 10-year monitoring period. Of those years, the lowest shrub cover occurred in 2007 and 2008.

Average perennial grass cover across all three selected control parcels from 2004 to 2013 ranged from five to 15% (Figure b.ii.41). Although not statistically significant, control parcel perennial grass cover was below the initial vegetation inventory value of 12% a total of six years out of the 10-year monitoring period. Of those years the lowest grass cover occurred in 2007, 2008, 2012, and 2013.



Sec. 5.2 Figure b.ii.40. Average perennial cover within selected vegetation control parcels using LADWP data (PLC106, LNP018, UNW029). The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.

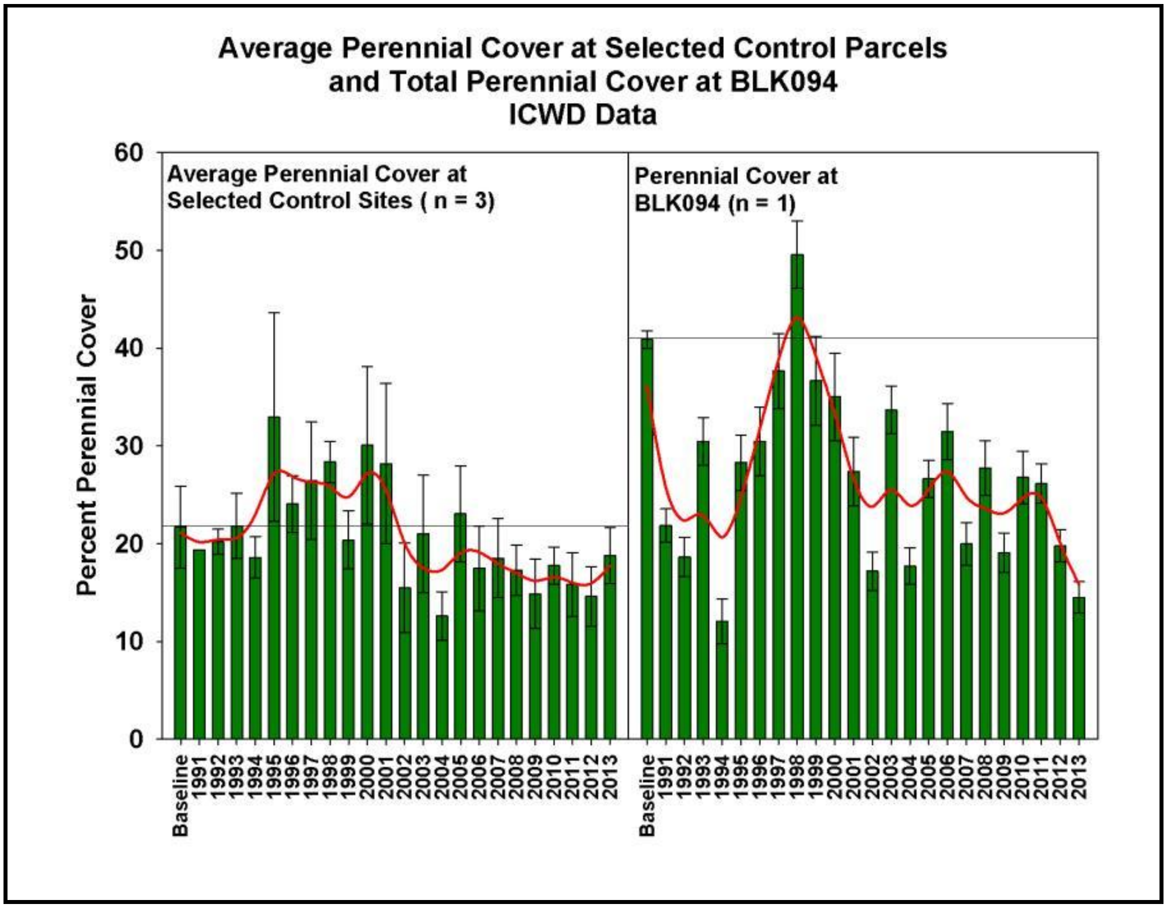


Sec. 5.2 Figure b.ii.41. Average perennial shrub and grass cover within selected vegetation control parcels using LADWP data (PLC106, LNP018, UNW029). N = 3 indicates values are average values of 3 parcels.

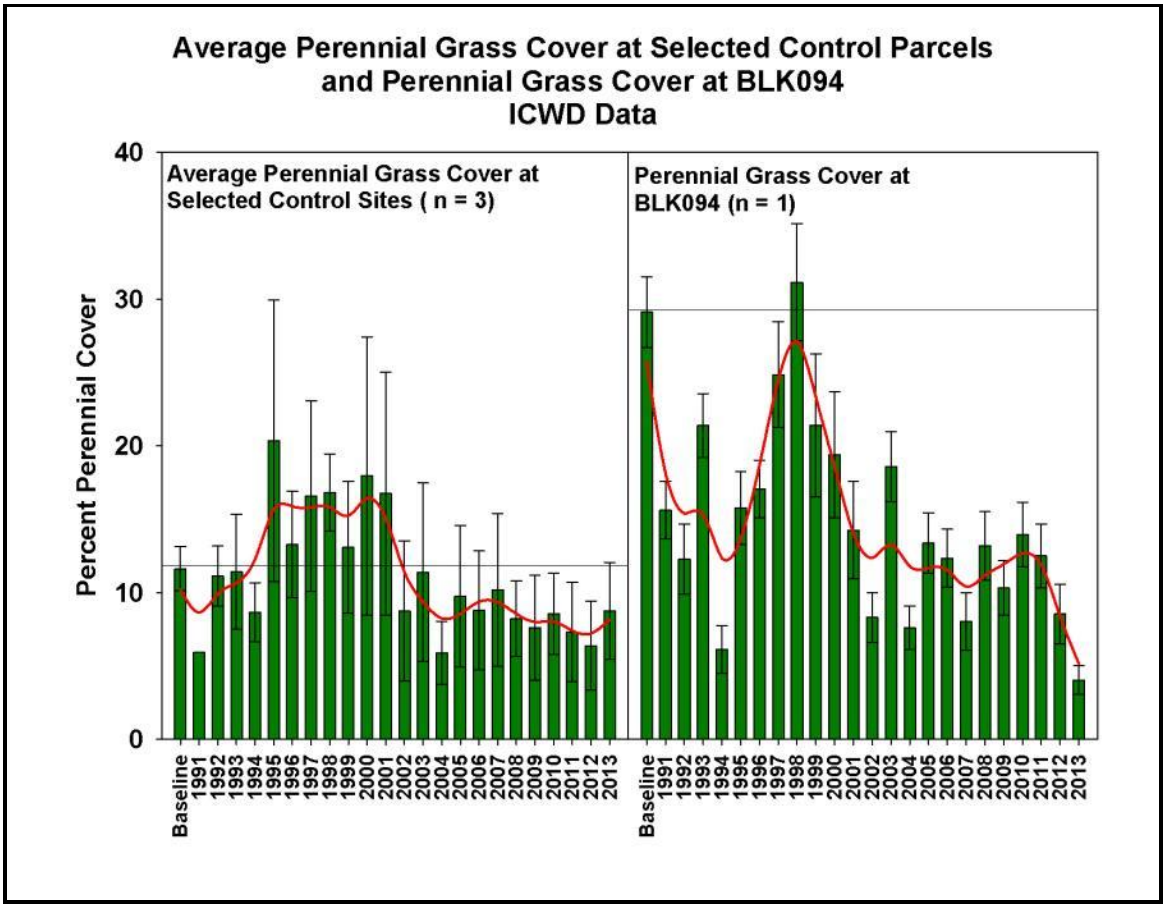
5.2.5.11. Vegetative Cover (Control Parcels vs. Blackrock 94)

Total perennial cover within the control parcels each exhibited, with varying degrees, a general increase in cover from 1991 to about 2000 and a general decline in cover through the mid- to late 2000s. On average, perennial shrub cover did not show any discernible trend during the entire monitoring period. This means that this trend was primarily driven by changes in grass cover over time. Some of the control parcels were influenced by surface water spreading. More specifically LNP018 received tail-water from irrigation directly west of the parcel during average or above average runoff years. Control parcel UNW029 was influenced by irrigation tail-water but this water flowed around the parcel to the north and sound during average or above average runoff years. Control parcel PLC106 was relatively unaffected by water spreading. The effect of “extra” water was reflected in the total perennial cover at each parcel. On average, during the entire 23-year monitoring period, total perennial cover was higher at LNP018 than at UNW029, and perennial cover at UNW029 was higher than at PLC106. Even though these differences existed, it was the similar trends in total perennial cover and perennial grass cover exhibited at all control parcels that were important. On average, this trend was characterized by a general rise in both total perennial cover and perennial grass cover from the early 1990s to approximately the early 2000s. After 2000 to 2001 a general decline in both total perennial cover and perennial grass cover was observed through 2013.

This same pattern was seen at Blackrock 94 for total perennial cover and perennial grass cover. Shrub cover at Blackrock 94 also did not show any discernible trend over time. Since total perennial cover is comprised of perennial shrubs and grasses, this means that trend in total perennial cover at Blackrock 94 was also primarily driven by changes in its grass cover component over time. To compare total perennial cover and perennial grass cover trends over time a running two year average of the values was used. For simplicity, average control parcel perennial cover and average control parcel perennial grass cover was used for comparison with perennial cover and perennial grass cover at Blackrock 94. A trend line was generated for each data set and plotted (Figures b.ii.42 & b.ii.43).



Sec. 5.2 Figure b.ii.42. Average perennial cover within selected vegetation control parcels vs. perennial cover within Blackrock 94 using ICWD data. Red lines denote general trend of each data set.



Sec. 5.2 Figure b.ii.43. Average perennial grass cover within selected vegetation control parcels vs. perennial grass cover within Blackrock 94 using ICWD data. Red lines denote general trend of each data set.

Correlation analysis for both perennial cover and perennial grass cover between the control parcels and Blackrock 94 revealed moderately strong relationships. Average perennial cover at the control parcels was statistically (P = 0.001) related to total perennial cover at Blackrock 94 (positive correlation coefficient of 0.58). Average perennial grass cover at the control parcels was also statistically (P = 0.002) related to perennial grass cover at Blackrock 94 (positive correlation coefficient of 0.59).

All years that were statistically below initial inventory cover values, in regards to total perennial cover and perennial grass cover, for each of the three control sites and Blackrock 94 were tallied using ICWD data results (Tables b.ii.14 and b.ii.15). All years that were notably low on average, in regard to total perennial cover and perennial grass cover, were also tallied using ICWD data results (Tables b.ii.14 and b.ii.15). The following two tables display the similarities in vegetation change over time between the three control parcels and Blackrock 94. Of the 12 years where total perennial cover was statistically below the initial vegetation inventory values at Blackrock 94, control parcel PLC106 also experienced significantly low cover for each of the same years. Of the 16 years where perennial grass cover was found to be statistically below the initial vegetation inventory (baseline) at Blackrock 94 control parcel PLC106 also experienced statistically low cover for 14 out of 16 years. When other notable low cover years are considered it becomes even more apparent that change in perennial vegetation cover and perennial grass cover over time at the control parcels is very similar to the change in vegetation cover over time at Blackrock 94.

Sec. 5.2 Table b.ii.14. Tally of statistically low and notably low total perennial cover by year for all four vegetation control parcels and Blackrock 94 using ICWD data. Red x's denote statistically significant years. Black x's denote notable low cover years.

Perennial Cover	Statistically Lower Than Baseline/Noteably Low Cover																						
Vegetation Parcel	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
BLK094	x	x		x								x		x	x		x		x	x	x	x	x
PLC106	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
LNP018														x						x		x	x
UNW029												x		x					x		x		
Sum of Statistically Significant Years	2	2	1	2	1	1	1	0	1	1	1	2	1	2	2	1	2	1	2	2	2	2	2
Sum of Notable years	0	0	0	1	0	0	0	0	0	0	0	1	0	2	0	0	0	0	1	1	1	1	1
Sum of All Low Years	**2**	**2**	**1**	**3**	**1**	**1**	**1**	**0**	**1**	**1**	**1**	**3**	**1**	**4**	**2**	**1**	**2**	**1**	**3**	**3**	**3**	**3**	**3**

Sec. 5.2 Table b.ii.15. Tally of statistically low and notably low perennial grass cover by year for all four vegetation control parcels and Blackrock 94 using ICWD data. Red x's denote statistically significant years. Black x's denote notable low cover years.

Perennial Grass Cover	Statistically Lower Than Baseline/Noteably Low Cover																						
Vegetation Parcel	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
BLK094	x	x		x	x						x	x		x	x	x	x	x	x	x	x	x	x
PLC106			x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
LNP018				x										x						x		x	x
UNW029												x	x	x	x	x		x	x		x		
Sum of Statistically Significant Years	1	1	1	2	2	1	0	0	1	1	2	2	1	2	2	2	2	2	2	2	2	2	2
Sum of Notable years	0	0	0	1	0	0	0	0	0	0	0	1	1	2	1	1	0	1	1	1	1	1	1
Sum of All Low Years	**1**	**1**	**1**	**3**	**2**	**1**	**0**	**0**	**1**	**1**	**2**	**3**	**2**	**4**	**3**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

5.2.5.12. Type Class Analysis (Control Parcels vs. Blackrock 94)

ICWD data was analyzed to determine if a vegetation type change (from a grass dominated community to shrub dominated community) had occurred at any of the three control parcels and/or at Blackrock 94 between 1991 and 2013. Regression analysis was used to predict if vegetation at any of the three control parcels and/or Blackrock 94 was trending toward a type conversion. Control parcel PLC106 exhibited a type conversion in four out of the 23 monitoring years. Regression analysis indicated that two out of three control parcels (PLC106 and

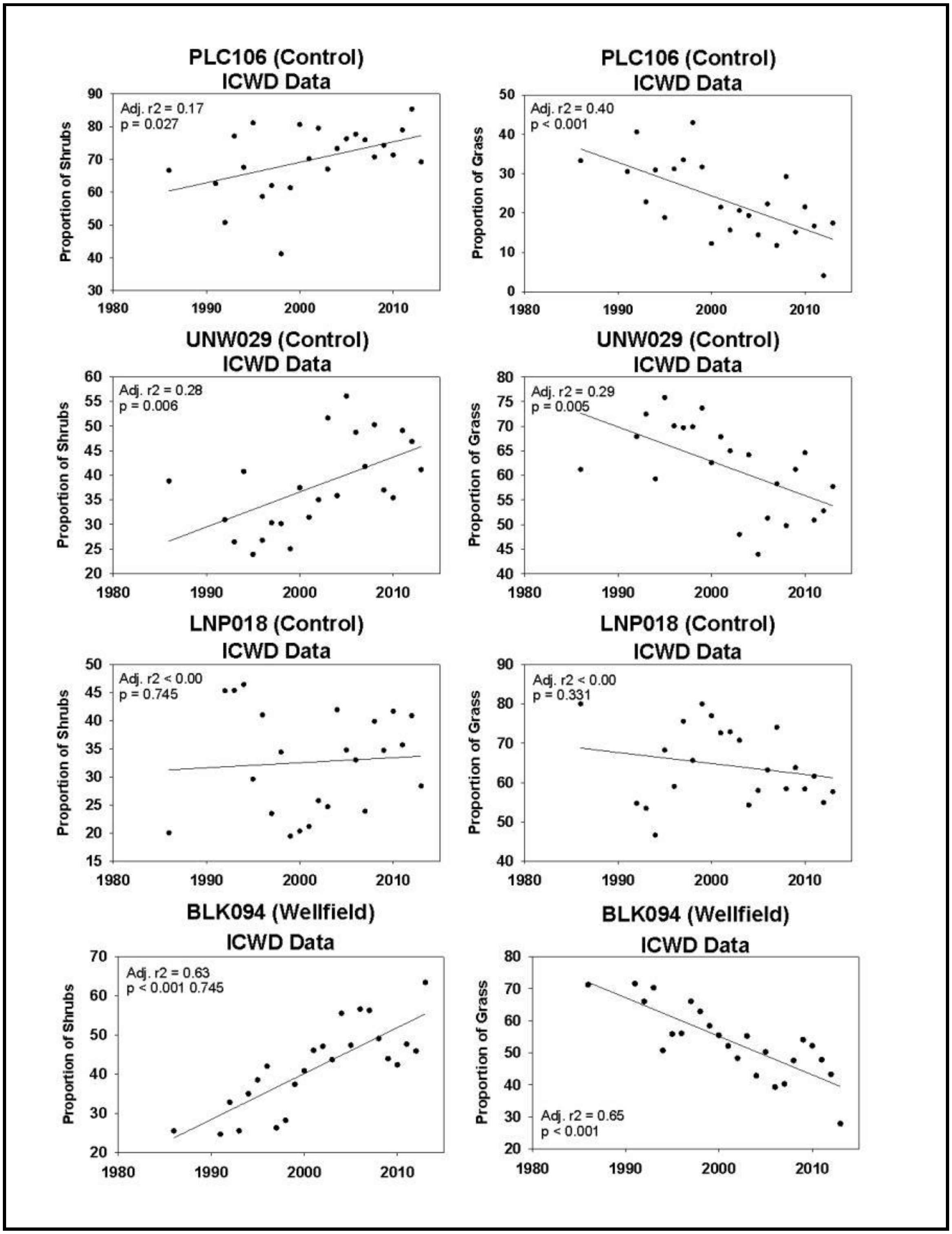
UNW029) and Blackrock 94 were trending toward a vegetation type conversion. Control parcel LNP018 was not trending towards a vegetation type conversion and it was determined that this may be in part due to irrigation water that this parcel received during average and above average runoff years.

Type C vegetation communities, as defined by the Green Book, are grass dominated. Type B vegetation communities are shrub dominated. Because conversion of community type from Type C to Type B is contrary to the Water Agreement goals it is important to analyze changes in shrub and grass proportions. ICWD (2006) analyzed the initial vegetation inventory data to determine a quantitative threshold between Type C and B vegetation classes and provided an opinion that vegetation parcels were classified as Type B when shrubs comprised 80% or more of the existing vegetation.

All three of the selected control parcels as well as Blackrock 94 were classified as Type C plant communities during the initial vegetation inventory period. To determine if a type conversion had occurred at any of the five parcels during the 23-year monitoring period, the annual shrub proportion was calculated for each of the four parcels (Example: Shrub Cover/Perennial Cover = Shrub Proportion) (Table b.ii.16). Using the ICWD data a total of 23 data points were calculated for each parcel. To determine if any of the four parcels were trending in the direction of a type conversion the annual shrub proportion for each parcel was regressed against year and plotted (Figure b.ii.44). Next, to determine the trend in grass proportion the annual grass proportion for each of the five parcels was also regressed against year and plotted (Figures b.ii.44).

Sec. 5.2 Table b.ii.16. Proportion of shrub cover from 1986 to 2013 for each of the three vegetation control parcels and Blackrock 94 using ICWD data. Values are expressed as a percent. Values highlighted in pink are years in which a Type conversion (Type C to Type B) vegetation had occurred.

Year	PLC106	LNP018	UNW029	BLK094
1986	67	20	39	26
1991	63			25
1992	51	45	31	33
1993	77	45	26	26
1994	68	46	41	35
1995	81	30	24	39
1996	59	41	27	42
1997	62	23	30	26
1998	41	34	30	28
1999	61	19	25	37
2000	81	20	37	41
2001	70	21	31	46
2002	80	26	35	47
2003	67	25	52	44
2004	73	42	36	56
2005	76	35	56	47
2006	78	33	49	57
2007	76	24	42	56
2008	71	40	50	49
2009	74	35	37	44
2010	71	42	35	42
2011	79	36	49	48
2012	85	41	47	46
2013	69	28	41	63



Sec. 5.2 Figure b.ii.44. Scatterplots of shrub and grass proportions at each of the four vegetation control parcels and at Blackrock 94 using ICWD data. Regression lines denote trend over time.

During the 23-year monitoring period, the proportion of shrubs has remained under 80% for all parcels except for vegetation control parcel PLC106. The proportion of shrubs in this parcel ranged between 41% and 85% for the entire monitoring period and was at or above 80% in 1995, 2000, 2002, and 2012. Shrub proportion at Blackrock 94 ranged between 25% and 63% for the 23-year monitoring period (Table b.ii.16).

Regression analysis showed a general increase in shrub proportion and decrease in grass proportion for all three vegetation control parcels as well as Blackrock 94 (Figure b.ii.44). This trend was statistically significant ($P < 0.05$) in vegetation control parcels PLC106 and UNW029 for both shrubs and grasses. The same trend in both shrub and grass proportions was also exhibited in Blackrock 94 (Figure b.ii.44). Although a type conversion has not occurred at Blackrock 94 the increase in shrub proportion and decrease in grass proportion over time was statistically significant ($P < 0.05$).

The proportion of shrubs and grasses over time at both the control parcels and at Blackrock 94 were changing in a similar manner; shrub proportion was increasing and grass proportion was decreasing. This change was significant at PLC106, UNW029, and Blackrock 94. The change was not significant at LNP018, and this may be due to the irrigation tail-water that was received by LNP018. This parcel seemed to be buffered from drought conditions by the addition of irrigation water. The change in shrub and grass proportions at the two dryer control parcels PLC106 and UNW029 are more indicative of the natural climate regime in the Owens Valley.

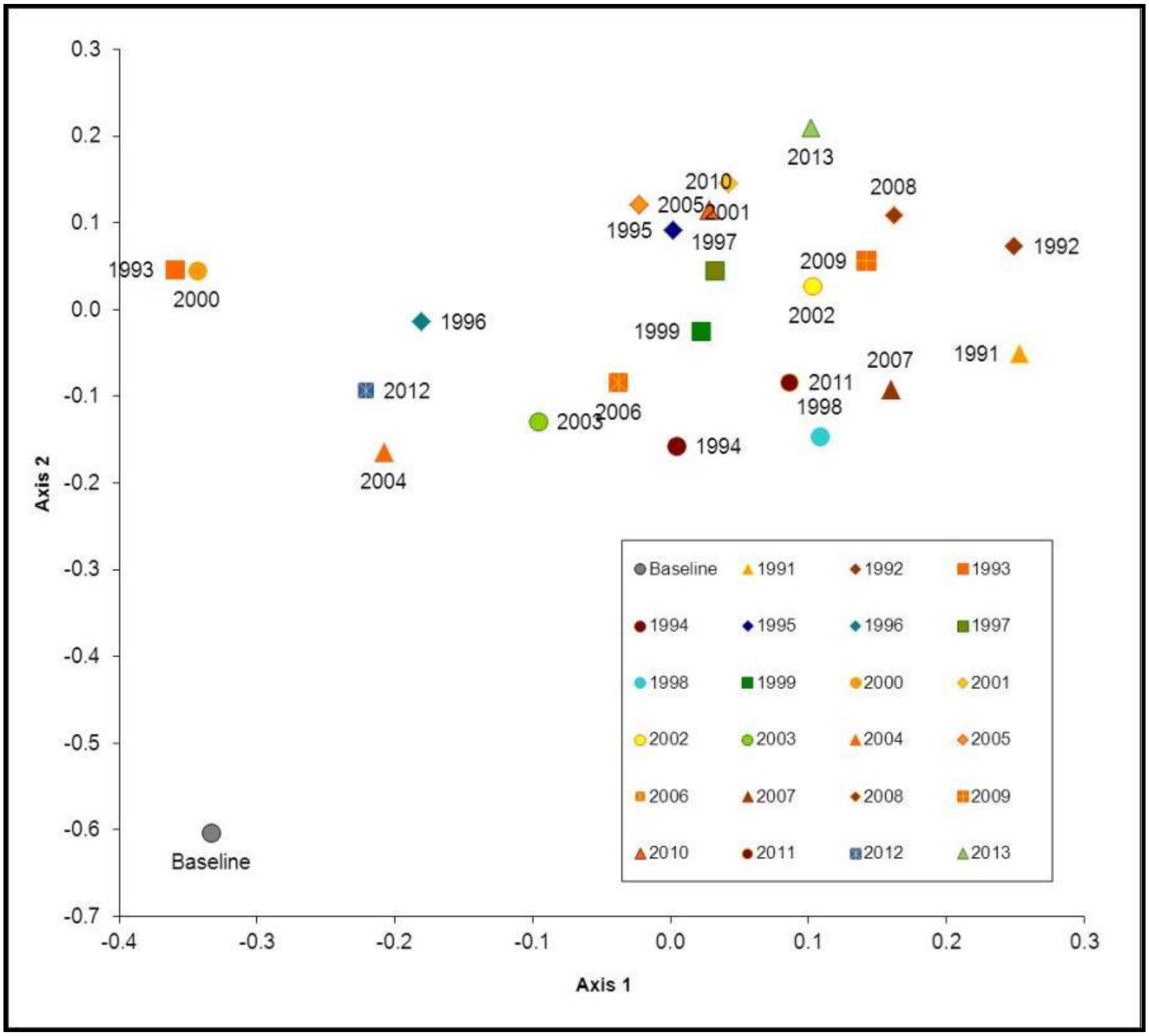
5.2.5.13. Vegetative Composition (Control Parcels vs. Blackrock 94)

In this section vegetation composition using ICWD data is analyzed to determine if composition at the three control parcels and/or at Blackrock 94 had changed between 1991 and 2013. Vegetation composition was found to be significantly different in one or more years in all three control parcels and at Blackrock 94. In conclusion, change in vegetation composition at the control parcels was found to be very similar to the change in composition at Blackrock 94.

Vegetation species composition for each of the three selected control parcels, using ICWD data, was analyzed using PERMANOVA and non-metric multidimensional scaling (NMDS). This analysis graphically shows, and significantly tests, for changes in species composition over time. Graphically, in this analysis, species composition is spatially plotted for each monitoring year using NMDS. Years that plot closer to the symbol labeled “baseline”, are similar to the species composition that occurred during the initial vegetation inventory (baseline). As years plot further and further away from the baseline symbol the more dissimilar they are in species composition. Statistical differences using PERMANOVA were declared a $P < 0.05$.

5.2.5.13.1. PLC106 (Control)

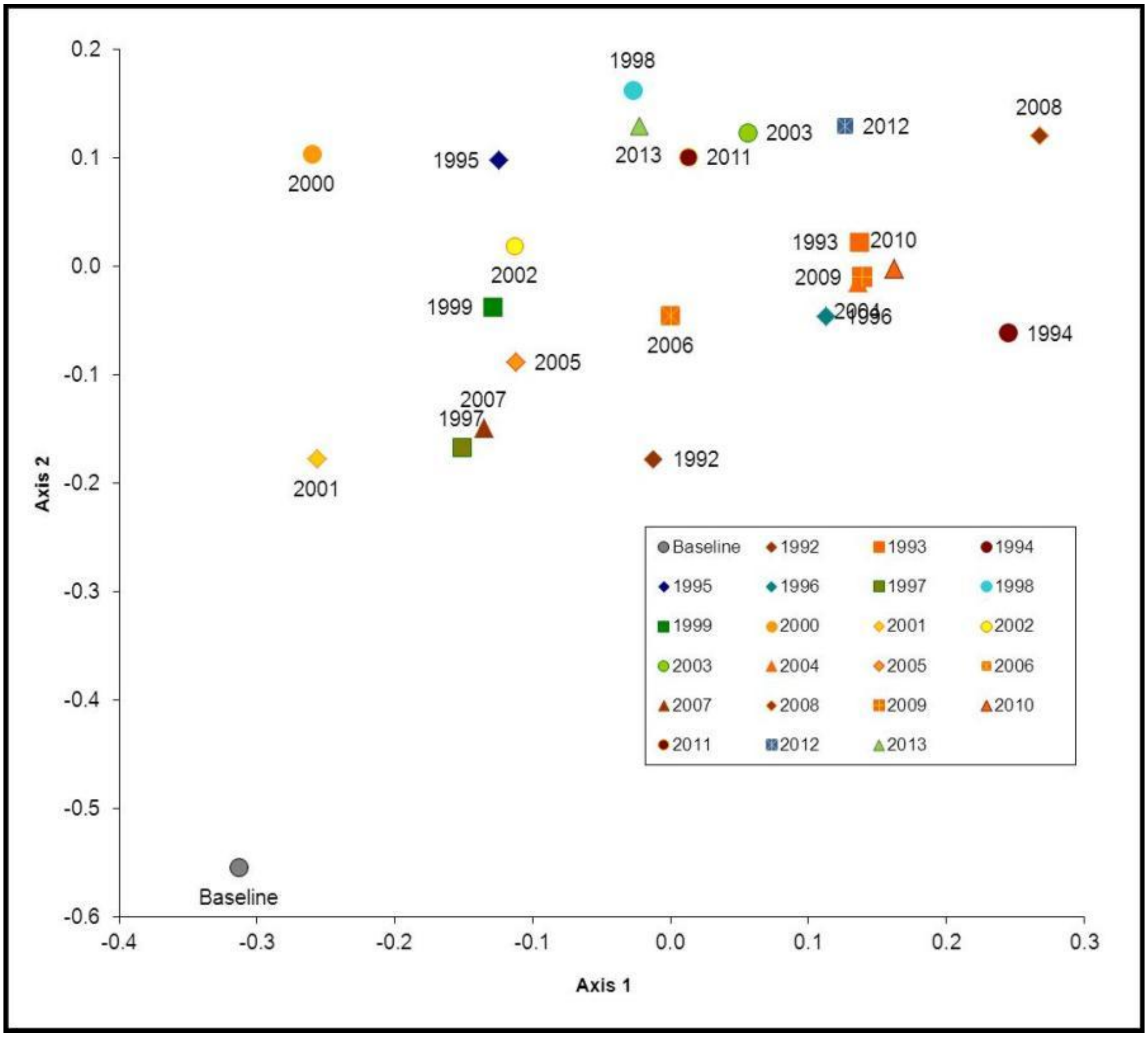
Species composition at control parcel PLC106 was found to be statistically different from the initial vegetation inventory in one or more of the 23 monitoring years (Figure b.ii.45). Due to the fact that only one vegetation transect was used during initial vegetation inventory of the parcel, a pairwise comparison could not be conducted using PERMANOVA. However, judging from the graph very little similarity in species composition exists between the initial vegetation inventory and all subsequent sample years.



Sec. 5.2 Figure b.ii.45. Spatial representation of species composition at vegetation control parcel PLC106 using ICWD data.

5.2.5.13.2. LNP018 (Control)

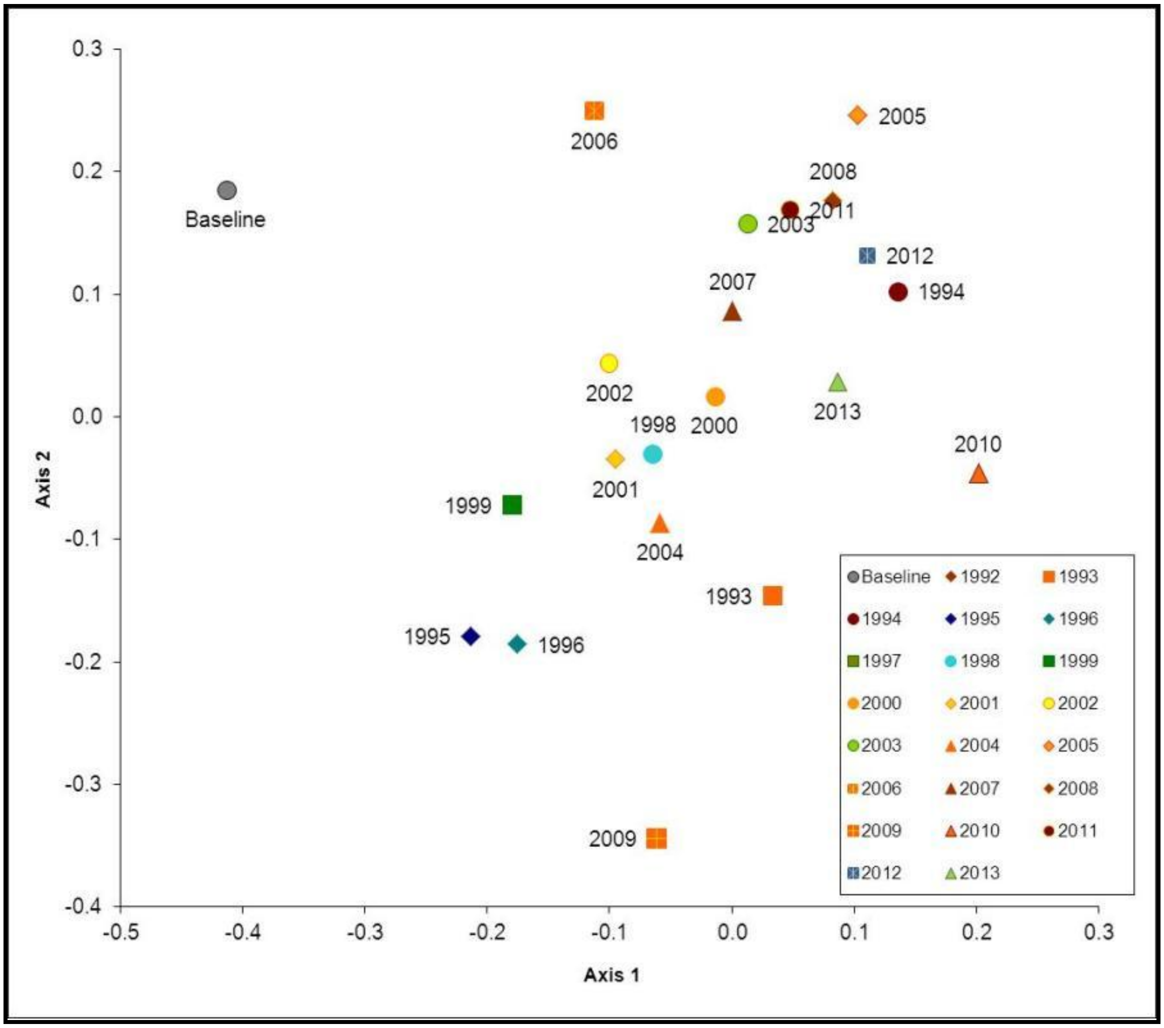
Species composition at control parcel LNP018 was found to be statistically different than the initial vegetation inventory in six out of 23 monitoring years (Figure b.ii.46). Statistically different years include: 1994, 1998, 2000, 2006, 2008, and 2012.



Sec. 5.2 Figure b.ii.46. Spatial representation of species composition at vegetation control parcel LNP018 using ICWD data.

5.2.5.13.3. UNW029 (Control)

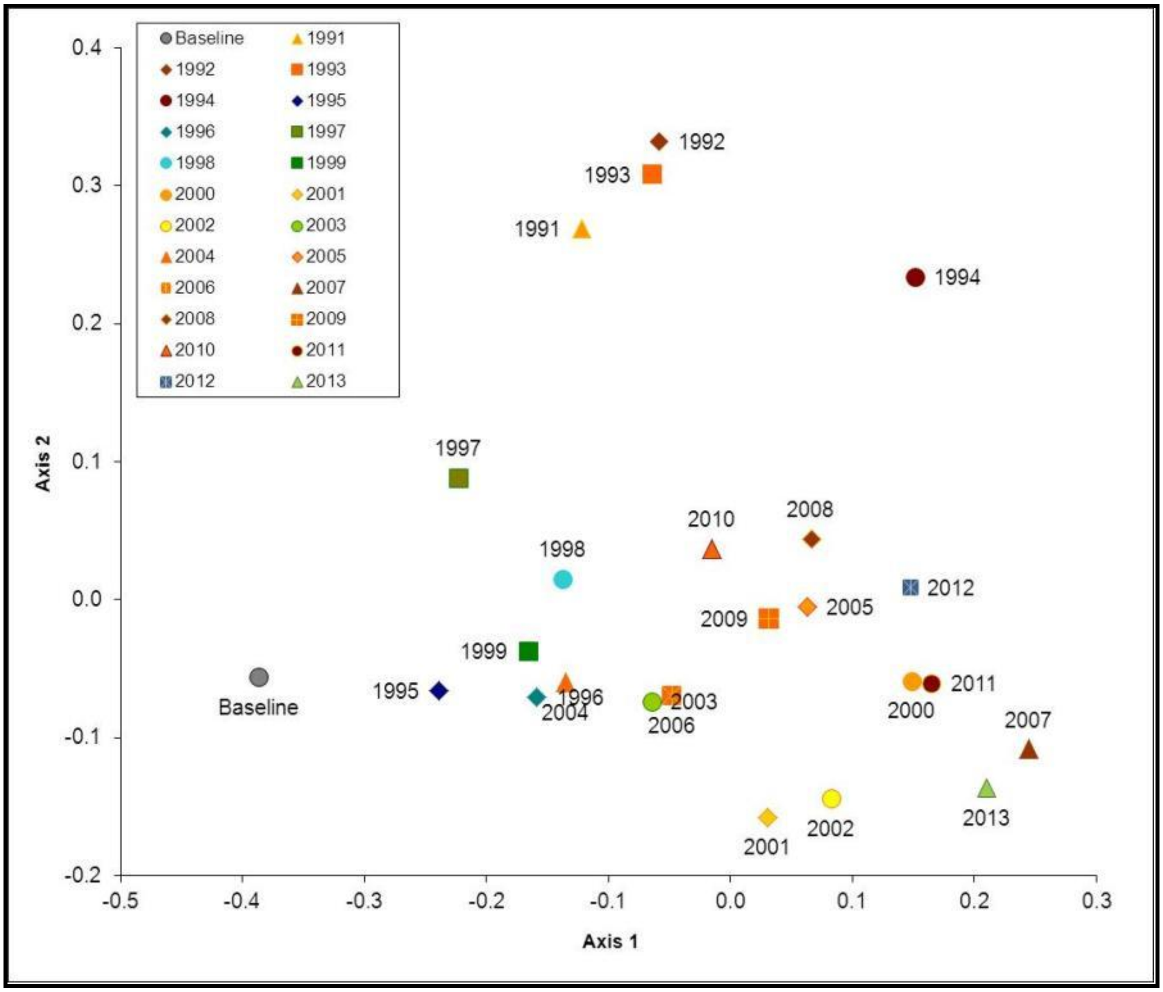
Species composition at control parcel UNW029 was found to be statistically different than the initial vegetation inventory in 10 out of 23 monitoring years (Figure b.ii.47). Statistically different years include: 1992, 1993, 1995, 1997, 2004, 2005, 2008, 2009, 2010, and 2011.



Sec. 5.2 Figure b.ii.47. Spatial representation of species composition at vegetation control parcel LNP018 using ICWD data.

5.2.5.13.4. Blackrock 94 (Wellfield)

Species composition at parcel Blackrock 94 was found to be statistically different than the 1986 initial vegetation inventory in 13 out of 23 monitoring years (Figure b.ii.48). Statistically different years include: 1992, 1993, 1994, 2000, 2002, 2005, 2006, 2007, 2008, 2009, 2011, 2012, and 2013.



Sec. 5.2 Figure b.ii.48. Spatial representation of species composition at Blackrock 94 using ICWD data.

Species composition was found to be statistically different than the initial vegetation inventory in one or more monitoring years at PLC106. Species composition at was found to be statistically different a total of six monitoring years at LNP018. Species composition at UNW029 was found to be statistically different a total of 10 monitoring years. Species composition at Blackrock 94 was found to be statistically different than the initial vegetation inventory a total of 13 out of the 23 monitoring years. Change in species composition in magnitude of years at the control parcels was very similar as compared to Blackrock 94. Of the 13 years to be found statistically different in species composition, 10 of those years were also found to be statistically different in one or more vegetation control parcels (Table b.ii.17).

Due to the strong relationships exhibited between the control parcels and Blackrock 94 in regard to changes in total perennial cover, changes in perennial grass cover, changes in shrub and grass proportions, and changes in species composition over time, and the fact that the control parcels are not affected by groundwater pumping, it can be easily inferred that these vegetative changes are driven by environmental factors other than groundwater pumping.

Sec. 5.2 Table b.ii.17. Tally of statistically different years in species composition at all three vegetation control parcels and at Blackrock 94. Statistical significance was found in PLC106 however, exact years were not able to be determined.

Species	Statistically Lower Than Baseline																						
Vegetation Parcel	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
BLK094		x	x	x						x		x			x	x	x	x	x		x	x	x
PLC106	Statistical Difference Detected, Mean Separation Not Possible																						
LNP018				x				x		x						x		x				x	
UNW029		x	x		x		x							x	x			x	x	x	x		
Sum of Statistically Significant Years	**0**	**2**	**2**	**2**	**1**	**0**	**1**	**1**	**0**	**2**	**0**	**1**	**0**	**1**	**2**	**2**	**1**	**3**	**2**	**1**	**2**	**2**	**1**

Due to the strong relationships exhibited between the control parcels and Blackrock 94 in regard to changes in total perennial cover, changes in perennial grass cover, changes in shrub and grass proportions, and changes in species composition over time, and the fact that the control parcels are not affected by groundwater pumping, it can be easily inferred that these vegetative changes are driven by environmental factors other than groundwater pumping.

5.2.5.14. Effects of Environmental Factors on Vegetative Conditions

Multiple linear regression analysis was used to determine the primary factors that influence vegetation change at the three control parcels and at Blackrock 94. Factors analyzed included: annual runoff, winter precipitation, and depth to groundwater. On average, annual runoff was found to consistently influence vegetation cover at all three control sites and at Blackrock 94.

Multiple linear regression analysis was used to determine the factors that influence total perennial cover, perennial shrub cover, and perennial grass cover at all three control parcels and at Blackrock 94. The variables used in this analysis were Owens Valley runoff (5-year running average), November to June precipitation, and average annual DTW under each vegetation parcel. Owens Valley runoff was chosen due to the wide dispersion of vegetation control parcels about the valley. Runoff values were converted into 5-year running average values prior to being applied to the analysis. This method mutes the minimum and maximum values associated with this type of data and allows for more meaningful relationships between variables to be extracted. Due to the truncated nature of LADWP's vegetation data (10 years), the longer ICWD vegetation data set (23 years) was used for this analysis. Coefficient of determination (r^2) values given below indicates how well the combination of variables fit each analysis. Values closer to 1 indicate a good fit whereas values closer to zero indicate a poor fit.

5.2.5.14.1. PLC106 (Control)

Total perennial cover at PLC106 was positively influenced by precipitation ($P = 0.030$), runoff ($P = 0.003$) and DTW ($P = 0.049$). The r^2 value for this analysis was 0.48. Perennial grass cover at this parcel was positively influenced by runoff ($P = 0.052$). Precipitation and DTW were also used in this analysis but were not statistically significant. The r^2 for this analysis was 0.29. Perennial shrub cover at this parcel was positively influenced by precipitation ($P = 0.017$)

and runoff (P = 0.046). DTW was used in this analysis but was not statistically significant. The r^2 value for this analysis was 0.45.

The positive relationship between DTW and perennial cover suggests that as DTW becomes greater, perennial cover increases. Ecologically this does not make sense and should be disregarded.

5.2.5.14.2. LNP018 (Control)

Total perennial cover and perennial grass cover were both not statistically influenced by any of the variables used. Perennial shrub cover was negatively influenced by runoff (P = 0.046). Precipitation and depth to water were also used in this analysis but were not statistically significant. The R^2 value for this analysis was 0.41.

The negative relationship between perennial shrub cover and runoff suggests that as runoff increases perennial shrub cover decreases. Due to periodic water spreading in this parcel, it is likely that inundation from flooding is causing the reduction in shrub cover.

5.2.5.14.3. UNW029 (Control)

Total perennial cover, perennial shrub cover, and perennial grass cover at UNW029 were all not statistically influenced by any of the variables used.

5.2.5.14.4. Blackrock 94 (Wellfield)

Perennial cover at Blackrock 94 was positively influenced by runoff ($P < 0.001$) and precipitation ($P < 0.001$). DTW was also used in this analysis but was not statistically significant. The R^2 value for this analysis was 0.74. Perennial grass cover was positively influenced by runoff ($P <$ 0.001) and precipitation ($P < 0.001$). DTW was also used in this analysis but was not statistically significant. The R^2 value for this analysis was 0.67. Perennial shrub cover was not statistically related to any of the variables used.

On average, vegetation was positively influenced by both annual runoff and precipitation at control parcel PLC106 and at Blackrock 94. Relationships ranged in strength from $R^2 = 0.28$ to $R^2 = 0.74$ with the majority being greater than 0.45. Correlation coefficients between 0.45 and 0.74 can be viewed as moderate to moderately strong. No meaningful relationships were found using DTW as a variable. This suggests that vegetation at control parcel PLC106 and at Blackrock 94 is primarily influenced by runoff and precipitation.

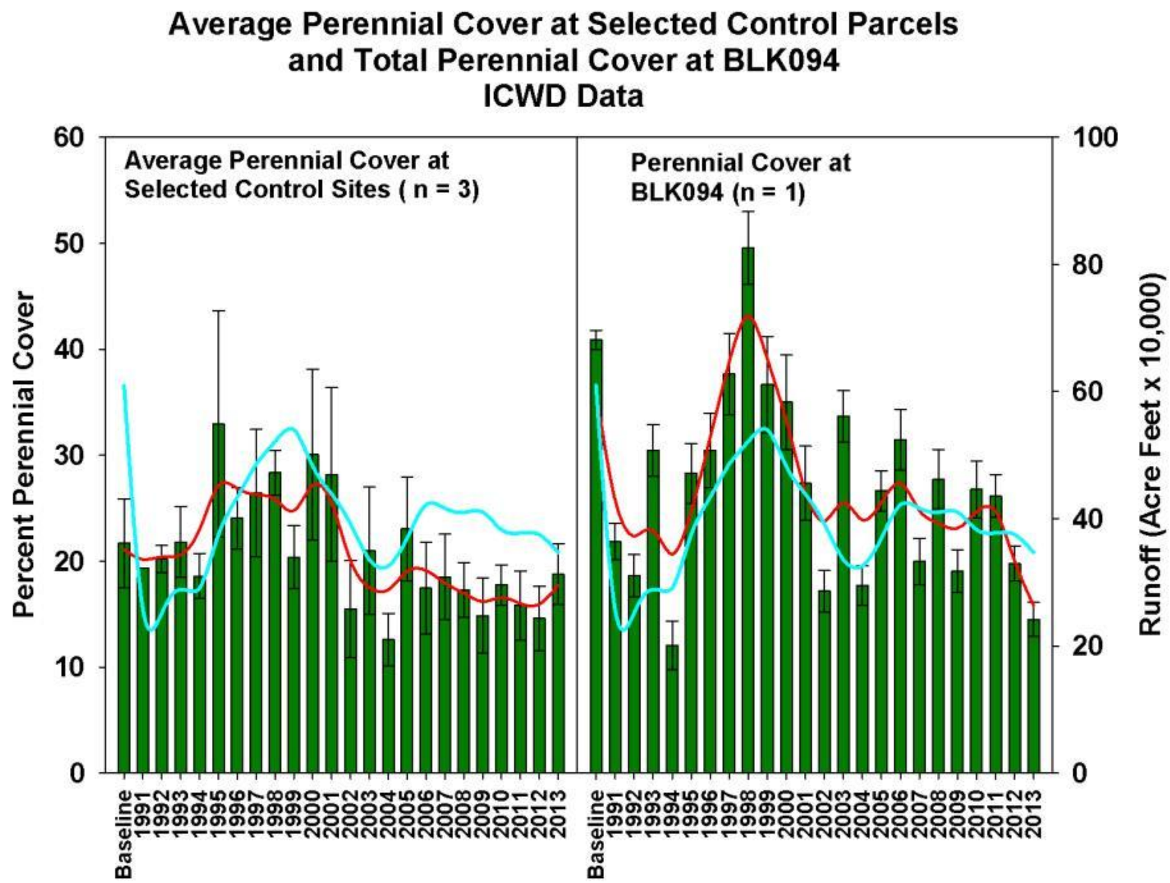
Meaningful relationships were found for vegetation at control parcel PLC106 but were not found at control parcels LNP018 and UNW029. This may be the result of the tests used and/or the need for more data. It is important to note however, that just because statistically significant relationships were not detected at these control parcels does not mean that the vegetation within these parcels reacted differently as compared to PLC106 and Blackrock 94 in response to climatic variability. Changes within LNP018 and UNW029 in regards to vegetation cover, vegetation type conversion, and vegetation composition presented earlier in this report were similar to the changes within PLC106 and Blackrock 94.

5.2.5.15. Vegetative Conditions Summary

The measureable change in vegetation at Blackrock 94 is comparable to change in vegetation measured at the three selected vegetation control parcels. Analytical results indicate that this change is primarily driven by wet and dry climatic cycles. Trends in total perennial cover at both the control parcels and at Blackrock 94 display this pattern. Total perennial cover increases during wet years and decreases during dry years. Wet/dry cycles can be represented using Owens Valley runoff (Figure b.ii.49).

The Owens Valley runoff hydrograph very closely follows the trends exhibited in perennial cover for both the vegetation control parcels and for Blackrock 94. This change in cover is even more pronounced in perennial grass cover at both the control parcels and at Blackrock 94 due to the fact that grasses are more sensitive to wet/dry cycles than shrubs.

During dry years above ground biomass can all but disappear for grasses whereas shrubs remain largely intact. During wet years grasses can quickly re-sprout from dormancy caused by a preceding dry year. If a dry cycle is prolonged, grass root mass can be reduced. It is the length of the dry cycle that indicates how much of the root mass is lost. Upon return to a wet cycle, grasses will first replace lost root mass prior to increasing vegetative mass or producing reproductive features. This phenomenon is referred to as a lag effect in vegetative growth, and it is seen in both the vegetation control parcels and at Blackrock 94. After a prolonged dry cycle, grass cover can take several years of average or above average runoff to recover to its average cover. This process takes place in all plants including shrubs and trees, however because they are structurally different, change in shrub and tree cover during wet/dry cycles is much slower and shown to a lesser degree as compared to grasses. Therefore it is reasonable to assume that grass cover within Blackrock 94 will return to 1986 initial vegetation inventory values if hydrologic conditions similar to those during the 1978-1986 or 1995-1998 periods reoccur.



Sec. 5.2 Figure b.ii.49. Average perennial cover at selected control parcels and perennial cover at Blackrock 94 using ICWD data. Red line represents vegetative trend over time. Blue line represents Owens Valley runoff (5 year running average). The reference "n = 3" denotes the average of the three control parcels. The evaluation of this parcel indicates that total perennial cover increases in wet years and decreases in dry years.

Changes in the proportion of shrubs and grasses over time at the vegetation control parcels are also comparable to the change in proportion of shrubs and grasses over time at Blackrock 94. The similarity of these changes between control parcels and Blackrock 94 are because wet/dry cycles in the Owens Valley tend to have an effect on the entire valley.

Changes in the proportion of shrubs and grasses over time at the vegetation control parcels are also comparable to the change in proportion of shrubs and grasses over time at Blackrock 94. The similarity of these changes between control parcels and Blackrock 94 are because wet/dry cycles in the Owens Valley tend to have an effect on the entire valley.

Due to differences in root structure between shrubs and grasses, shrubs are able to utilize deeper sources of water during drought, giving shrubs a competitive advantage over grasses during drought conditions. This pattern is seen at LNP018 and is due in part to the irrigation tail-water it receives. This “extra” water allows the grasses to compete with shrubs during dry cycles which results in static or nearly static shrub and grass proportions over time. The more xeric parcels, PLC106 and UNW029 more closely follow the trend in shrub and grass proportions that is shown at Blackrock 94. This trend is more reflective of the natural wet/dry cycles in the Owens Valley.

Lastly, change in species composition at both the vegetation control parcels and at Blackrock 94 is also comparable. Of the 13 years found to be statistically different in species composition at Blackrock 94, 10 of those years were also found to be statistically different in one or more vegetation control parcels. This pattern is mostly due to a combination of two factors: (1) how the baseline transects were initially set up during the initial vegetation inventory (baseline) period of 1985 to 1987, and (2) wet/dry cycles. Vegetation transects during the 1985 to 1987 initial vegetation inventory period were spatially biased to characterize the dominate vegetation in as few transects as possible (Green Book Section II.A.2.d). When calculating species composition in Blackrock 94 using the 1986 initial vegetation inventory data, a very distinct community is represented. Subsequent monitoring employs many more transects as compared to the 1986 initial vegetation inventory. These transects are also dispersed about the entire vegetation parcel to characterize the plant community of the entire parcel each year. These transects do not always capture the same proportions of species as compared to the 1986 vegetation inventory and this difference is represented in the analysis as a difference in species composition. When this monitoring issue is coupled with the fluctuations in vegetation cover due to variations in wet/dry cycles, these monitoring methods may produce more pronounced differences from the 1986 initial vegetation inventory than have actually occurred. Lastly, and more likely the case, species composition, in varying degrees, is changing at the control parcels and at Blackrock 94, spatial bias within baseline transects are causing type I errors when determining species composition using subsequent monitoring years data, and fluctuations in wet and dry cycles are adding additional noise to the analysis. In this scenario, the ability to detect change in species composition becomes very difficult.

In conclusion, measured changes in vegetative conditions at Blackrock 94 have been shown to closely follow the natural climactic patterns of the Owens Valley, as demonstrated by both site specific and pooled control parcel data. Changes in total perennial cover, perennial grass cover, shrub and grass proportions, and species composition were found to be very similar between the control parcels and at Blackrock 94. These types of similarities show that the changes in vegetation at Blackrock 94 are not occurring in isolation; comparable changes in vegetation cover and composition are occurring throughout the Owens Valley. Furthermore, because groundwater pumping does not affect vegetation at the control parcels, these changes are occurring in the absence of groundwater pumping.

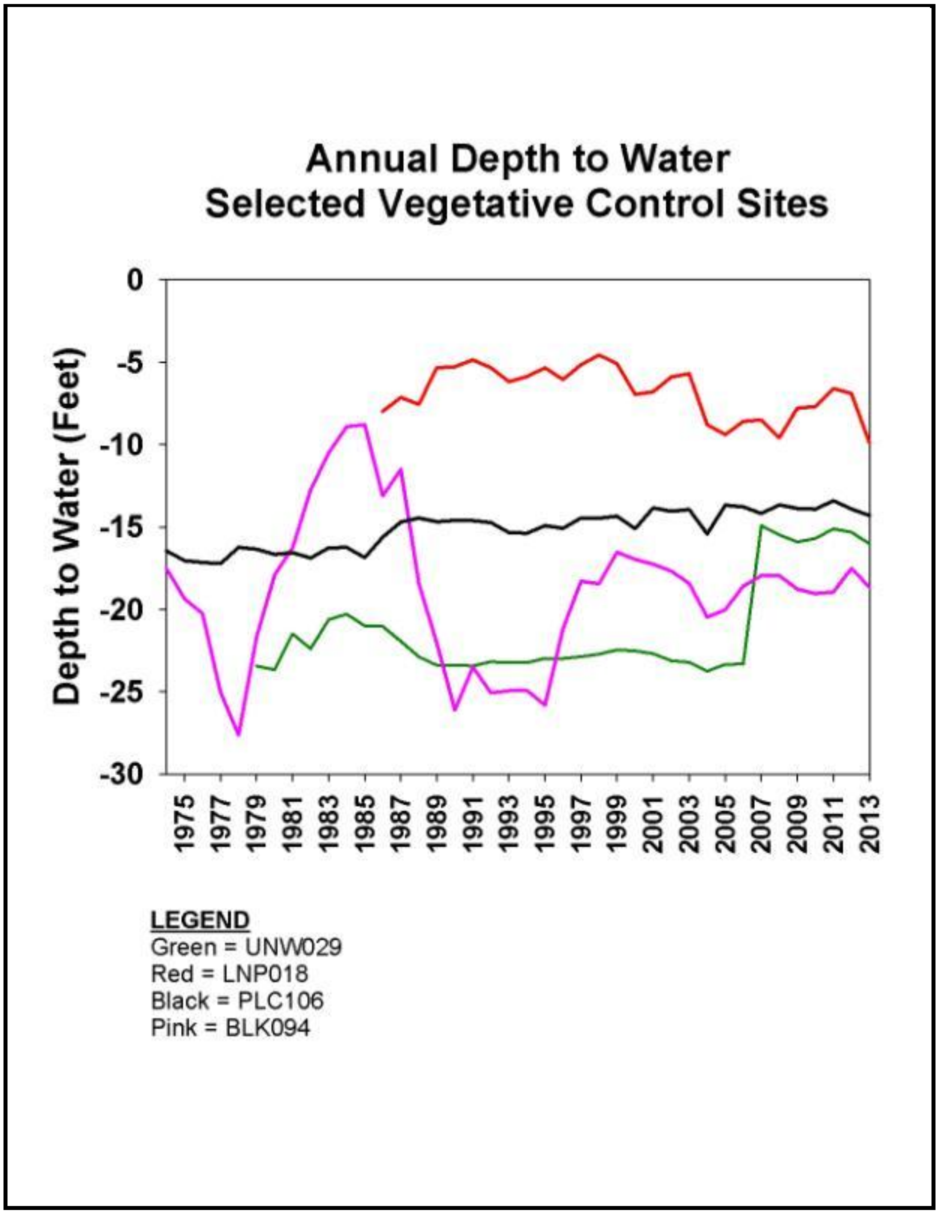
Furthermore, because groundwater pumping does not affect vegetation at the control parcels, these changes are occurring in the absence of groundwater pumping

Lastly, as was documented during the wet periods of the early 1980s and mid-1990s, grass cover and by extension total perennial cover, is expected to increase during multiple years of high precipitation and runoff. If precipitation and runoff conditions similar to those experienced in the early 1980s or mid-1990s reoccur, vegetation cover and composition within Blackrock 94 is expected to become similar to that documented during LADWP's 1986 initial vegetation inventory.

5.3. LADWP Evaluation I.C.1.b.iii – Comparison of water table depths in Blackrock 94 with water table depths in the general region with soils, vegetation cover, and vegetation composition comparable to Blackrock 94.

5.3.1. Depth-to-Water

Average annual DTW was calculated for each of the three selected control parcels and for Blackrock 94 using available monitoring well data associated with each vegetation parcel. The methods for calculating these values can be found in Section 5.1of this report. The parcels have varying periods of DTW data; however, all four sites have DTW data between 1986 and 2013 (Figure b.iii.1). DTW is not affected by groundwater pumping at any of the three selected vegetation control parcels, as shown on the hydrographs. One notable detail, however, is at control parcel UNW029 between 2006 and 2007 groundwater increased by 8.4 feet. This steep increase in groundwater is most likely attributable to the re-watering of the Lower Owens River by LADWP in 2006. Since 2006, the formerly dry river reach began receiving approximately 40,000 acre-feet annually. This rise in groundwater was noted at several other locations along the river following the initial water release. Information about the Lower Owens River Project (LORP) can be found in jointly produced LORP annual reports by the LADWP and the ICWD. Lastly, the effects of groundwater pumping can be seen at BLK094 with increases in depth to groundwater in both the late 1970s and again in the late 1990’s (Figure b.iii.1).

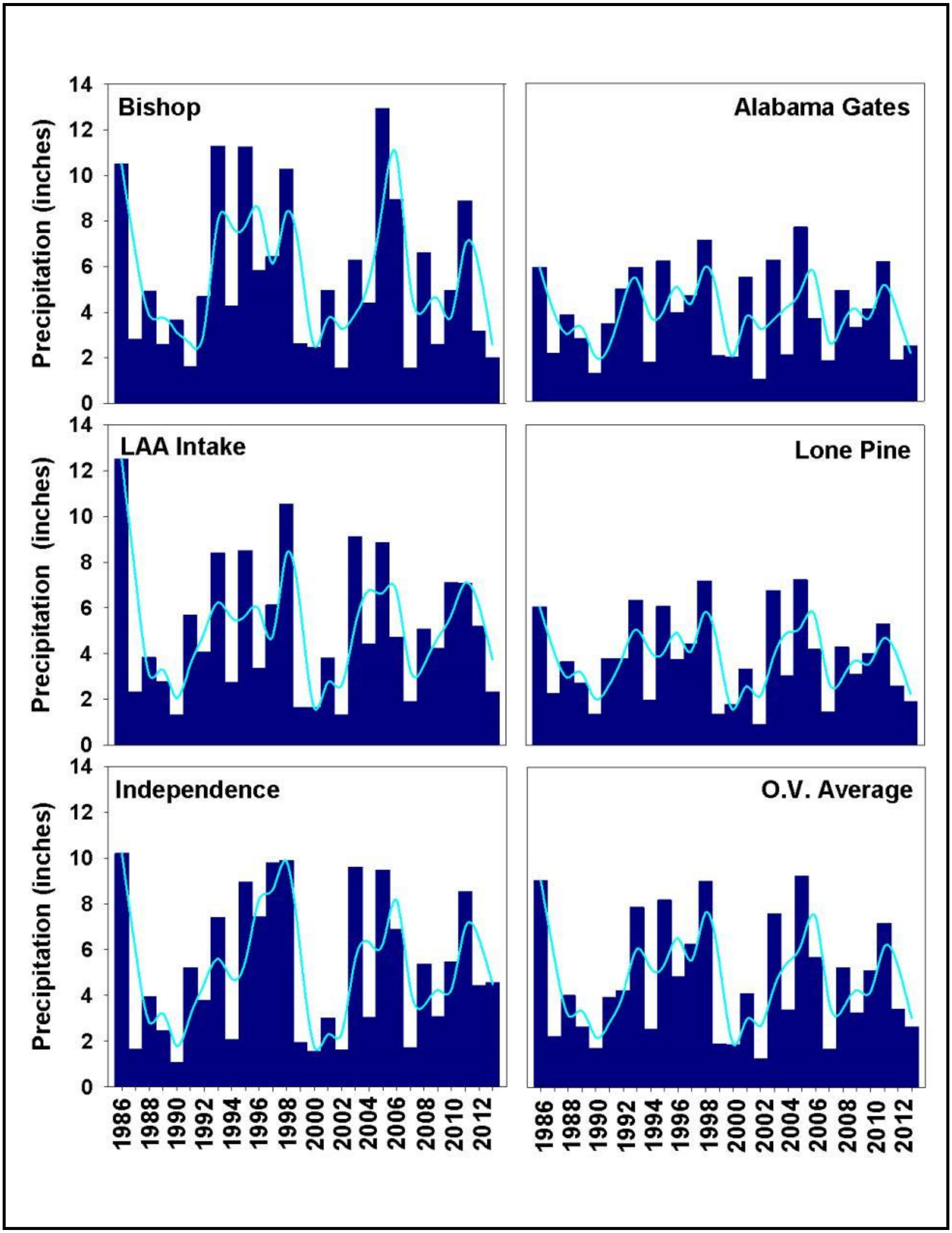


Sec. 5.3 Figure b.iii.1. Average annual DTW for the three selected vegetation control parcels and at BLK094.

5.4. LADWP Evaluation I.C.1.b.iv – Evaluation of Rainfall differences that may exist between control sites and Blackrock 94.

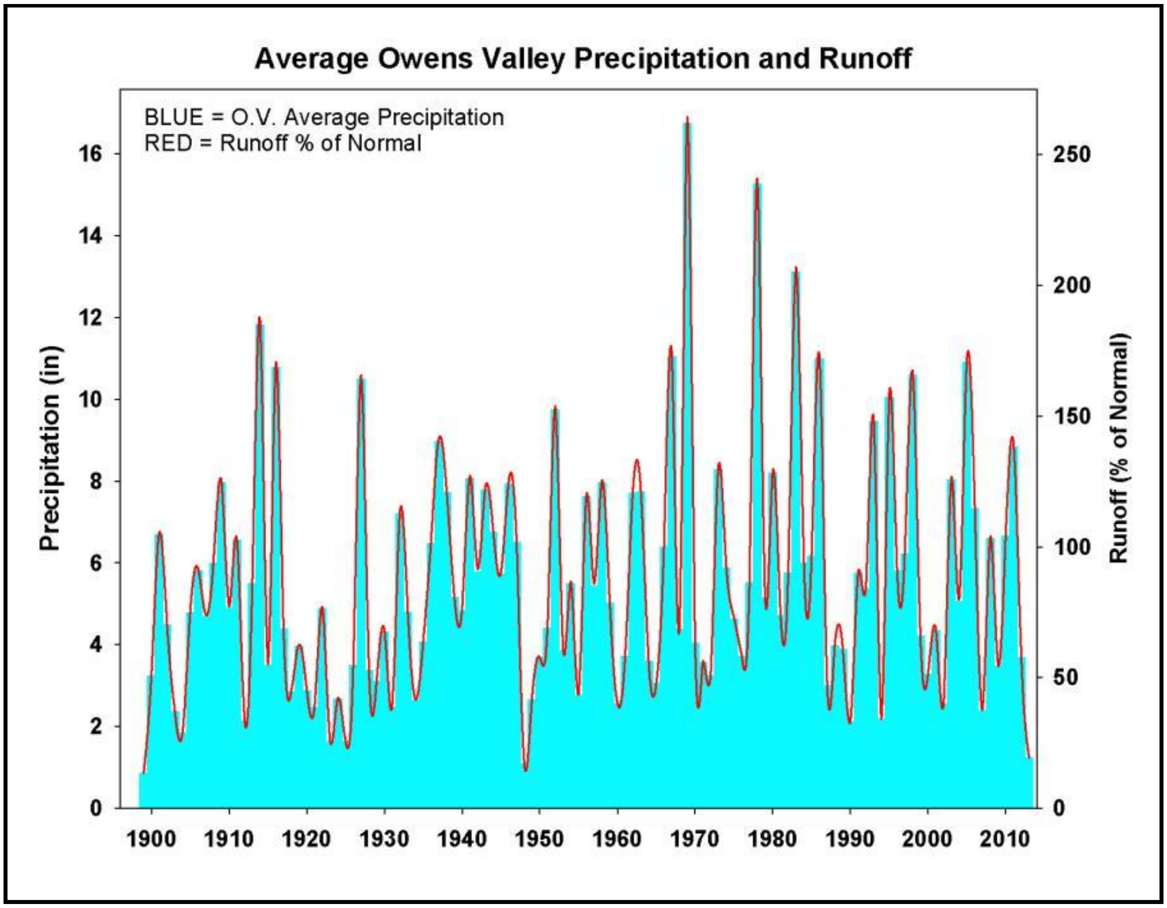
5.4.1. Precipitation

Annual precipitation (October through September) as well as winter precipitation (November through June) totals were organized for the following LADWP weather stations: Bishop, LAA Intake, Independence, Alabama Gates, and Lone Pine (Appendix 4.2). Annual precipitation amounts are very similar between all five weather stations (Figure b.iv.1). Between 1985 and 2013 the average amounts of precipitation at Bishop, LAA Intake, Independence, Alabama Gates, and Lone Pine was 5.5 inches, 5.0 inches, 5.1 inches, 3.8 inches and 3.7 inches, respectively. Differences in timing and duration of precipitation however, do exist between all five weather stations. Therefore, these differences can be expected to occur at each of the four selected control parcels and at Blackrock 94. To accurately represent precipitation at each of the three control sites and at Blackrock 94, during various analyses throughout this document, precipitation data was always taken from the nearest weather station.



Sec. 5.4 Figure b.iv.1. Annual precipitation amounts for five weather stations maintained by LADWP. Owens Valley average is located in the lower right hand corner

It is important to note that Owens Valley average annual precipitation and annual runoff are highly correlated (Figure b.iv.2). The relationship demonstrates that during wet years, available moisture for vegetation growth, across the entire valley occurs as both precipitation on the valley floor and as snowpack in the mountains. Wet and dry cycles of this type can have a profound effect of vegetation cover as described in Section 5.2.



Sec. 5.4 Figure b.iv.2. Average precipitation and percent of normal runoff for the Owens Valley.

5.5. LADWP Evaluation I.C.1.b.v – Evaluation of the extent to which other factors unrelated to the effects of groundwater pumping may have contributed to the measurable vegetation change or decrease.

5.5.1. The Role of Other Factors on Vegetation Change or Decrease within Blackrock 94

The annual Owens Valley and Sawmill Creek runoff is summarized in this section based on the water year (WY), which is defined as being October 1st through September 30th. This is because fall and winter precipitation substantially affect vegetation cover during the following June or July. By conducting year-to-year comparisons using the WY, fall and winter precipitation and affected vegetation cover are all evaluated in a single year. For example, the vegetation cover measured in June of 1994 has been directly affected by fall precipitation at the end of 1993 and winter precipitation during the beginning of 1994. Comparisons using the WY are useful because the fall of 1993, the winter of 1994, and June 1994 are all captured by WY1993-94.

5.5.1.1. Drought

> The most severe period of drought began in WY1986-87 and ended in WY1993-94, with seven of these eight years experiencing below average runoff of *68% of the long-term average*.

LADWP has recorded periods of drought in the Owens Valley since it first began recording stream flows in the valley (Figure b.v.1). A period of drought in this section is defined as an extended period of below average runoff years. Since 1986, 19 of the last 27 years experienced below average runoff, and these low runoff years have formed two prolonged periods of drought (Table b.v.1). During these two drought periods, runoff was 82% of the long-term average. The most severe period of drought began in WY1986-87 and ended in WY1993-94, with seven of these eight years experiencing below average runoff of 68% of the long-term average. Beginning in WY1998-99, 12 of the last 15 years have had below average runoff. The average runoff during this period was 89% of normal. When the three wetter years (WY2004-05, WY2005-06, and WY 2010-11) are excluded, the average runoff since WY1997-98 is 76% of the long-term average. Annual vegetation monitoring pursuant to the Water Agreement began in 1991, therefore vegetation monitoring has been conducted during two prolonged drought periods.

It cannot be overstated that the initial inventory was conducted toward the end of the longest and wettest period on record, with eight years of runoff averaging 133% of the long-term average and that vegetation monitoring years since that time has been conducted mostly under drought conditions. The first period of drought, since the initial vegetation inventory, persisted for eight years between WY1986-87 and WY 1993-94, and this current combination of drought and extended periods of very low runoff, which began in WY 1998-99, has now lasted for 15 years. The average vegetation cover during the first and second periods of drought and extended periods low runoff was 21% and 25%, respectively; compared to 41% in 1986 when the initial inventory was conducted. Vegetation cover has generally decreased since 2006 except for small increases in 2010 (RY2009-10), slightly below average runoff year, and in 2011 (WY2010-11), an above average runoff year. Total perennial vegetation cover in Blackrock 94 during the past two years (WY2011-12 and WY2012-13) was 20% and 15%, respectively.

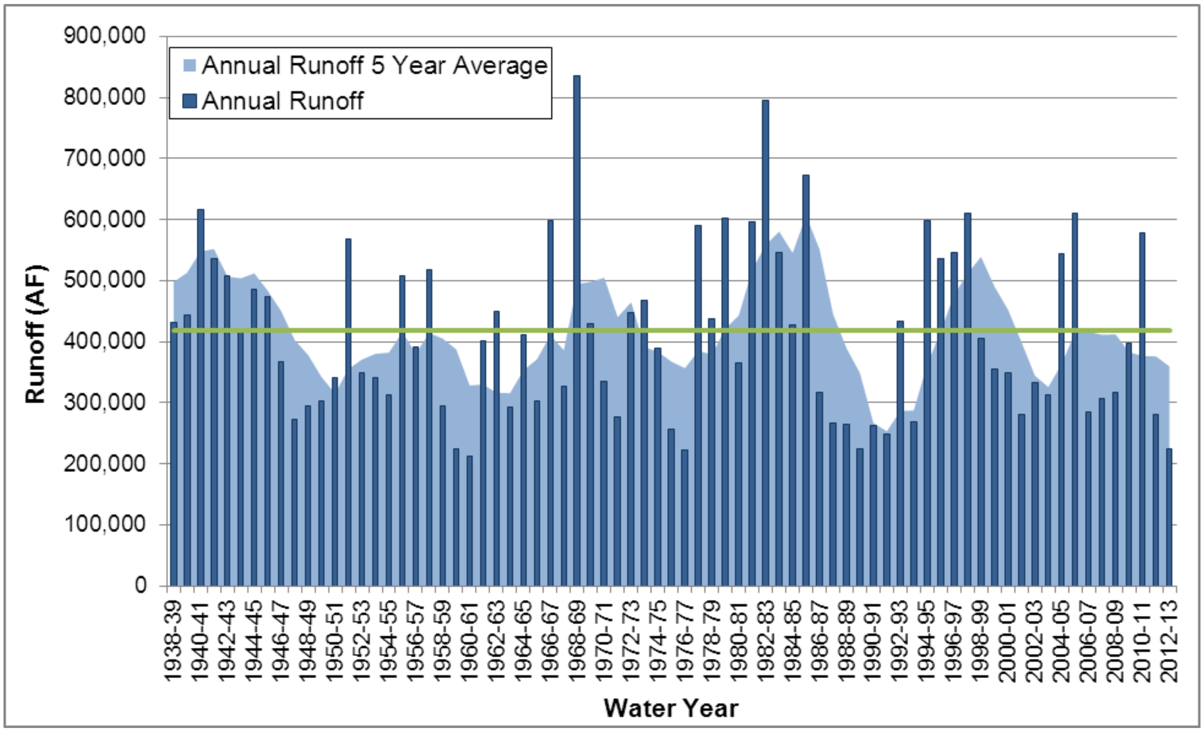
Runoff in WY2011-12 and WY2012-13 was 58% and 51% of the long-term average respectively. While runoff in WY2009-10 (95% based on WY but 102% based on runoff year) and above average runoff in WY2004-05, WY2005-06, and WY2010-11 had associated increases in vegetation cover, the current vegetation conditions in the parcel are not unexpected considering the fact that the present period of drought and prolonged low runoff is entering its 16th year.

5.5.2. Wet/Dry Climatic Cycles

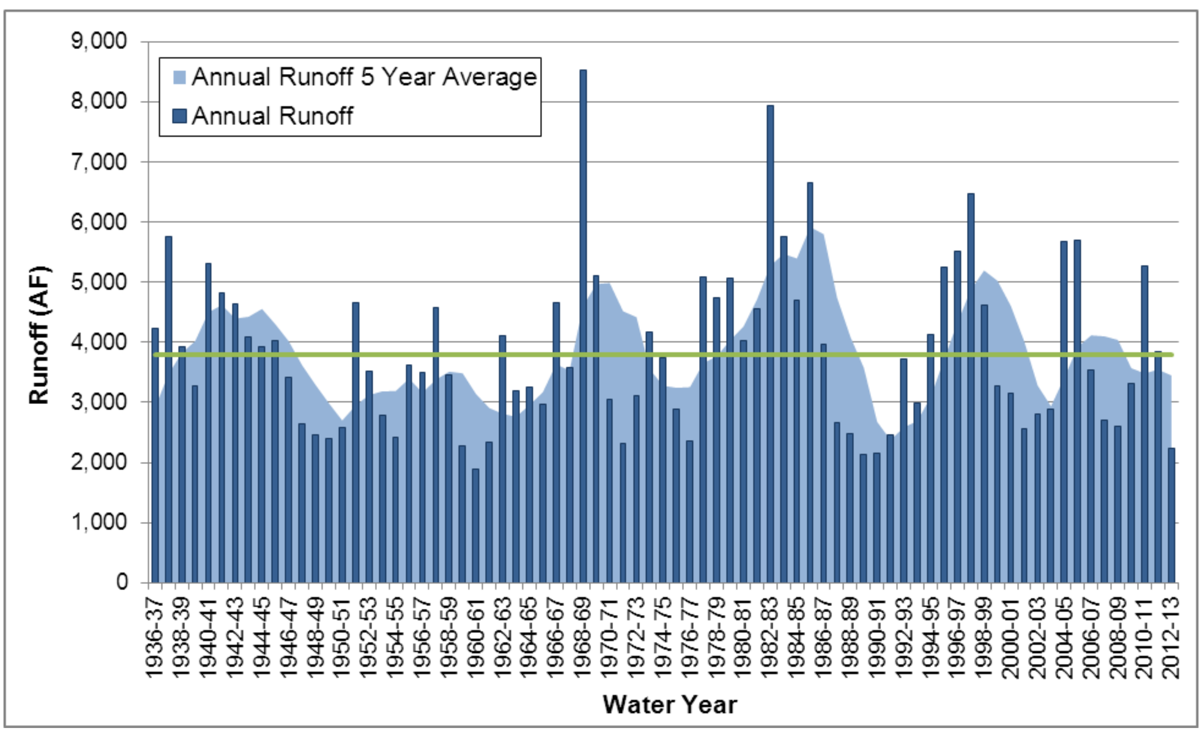
5.5.2.1. The Climatic Pattern

The pattern of annual runoff of Sawmill Creek forms a series of wet and dry cycles, and this pattern becomes much clearer when the five-year running average is used (Figure b.v.2, Table b.v. 1 and 2). The annual runoff pattern of Sawmill Creek is very similar to the annual runoff pattern of the Owens Valley[19] (Figure b.v.1, Table b.v.1 and 2). As noted above, the initial inventory of vegetation cover in Blackrock 94 was conducted in 1986, the last year of the nine-year wet period, between WY1977-78 and WY1985-86. The average runoff during this period was 133% of the long-term average. The WY1985-86 also experienced the fourth highest annual runoff on record (672,030 AF or 160% of the long-term average). The initial vegetation inventory data sheet for Blackrock 94 notes that the parcel was wet in some locations, indicating the presence of surface water spreading in 1986 (Appendix 5.5.1).

[19] Runoff and precipitation values may differ slightly between sections because the water year (October 1 to September 30) is used for much of the vegetation analysis and runoff year (April 1 to March 31) is used for much of the hydrologic analysis.



Sec. 5.5 Figure b.v.1. Annual runoff in acre-feet (AF) based on water year and five-year average for the Owens Valley based on water years. A green line indicates the long-term Owens Valley runoff (418,589 acre-feet).



Sec. 5.5 Figure b.v.2. Annual runoff in acre-feet (AF) based on water year and five-year average at Sawmill Creek based on water. A green line indicates the long-term Sawmill Creek runoff (3,785 acre-feet).

Sec. 5.5 Table b.v.1. Sawmill Creek and Owens Valley annual runoff in acre-feet based on water year (October 1 to September 30) and vegetation and grass cover within Blackrock 94. Rank is where each year falls in the period of record.

				Annual Runoff			
		Vegetation Cover (%)		Sawmill Runoff		Owens Valley	
Year	WY	Perennial	Grass	% Normal	Rank	% Normal	Rank
1971	1970-71			81%	52	80%	51
1972	1971-72			61%	74	66%	67
1973	1972-73			82%	51	107%	28
1974	1973-74			110%	26	112%	26
1975	1974-75			99%	36	93%	42
1976	1975-76			76%	57	61%	73
1977	1976-77			63%	72	53%	78
1978	1977-78			135%	14	141%	12
1979	1978-79			125%	17	104%	31
1980	1979-80			134%	15	144%	8
1981	1980-81			107%	30	87%	45
1982	1981-82			121%	24	142%	11
1983	1982-83			210%	2	190%	2
1984	1983-84			152%	6	130%	16
1985	1984-85			124%	18	102%	35
1986	1985-86	40.9	29.1	176%	3	160%	4
1987	1986-87			105%	32	76%	54
1988	1987-88			70%	62	64%	70
1989	1988-89			66%	67	63%	71
1990	1989-90			56%	80	54%	76
1991	1990-91	**21.8**	15.6	57%	79	63%	72
1992	1991-92	**18.6**	12.3	65%	68	60%	74
1993	1992-93	30.4	21.4	99%	37	103%	32
1994	1993-94	**12.1**	6.1	79%	53	64%	69
1995	1994-95	**28.3**	15.8	109%	27	143%	10
1996	1995-96	30.5	17.1	139%	12	128%	18
1997	1996-97	37.7	24.9	146%	9	130%	15
1998	1997-98	49.6	31.2	171%	4	146%	7
1999	1998-99	36.7	21.4	122%	22	97%	38
2000	1999-00	35.0	19.4	87%	47	85%	46
2001	2000-01	27.4	14.3	83%	50	83%	48
2002	2001-02	**17.2**	8.3	68%	66	67%	65
2003	2002-03	33.7	18.6	74%	59	79%	52
2004	2003-04	**17.7**	7.6	76%	58	74%	57
2005	2004-05	**26.6**	13.4	150%	8	130%	17
2006	2005-06	31.5	12.3	151%	7	146%	6
2007	2006-07	**20.0**	8.0	93%	40	68%	64
2008	2007-08	27.7	13.2	72%	61	73%	58
2009	2008-09	**19.1**	10.3	69%	64	76%	55
2010	2009-10	**26.8**	14.0	88%	45	95%	40
2011	2010-11	**26.2**	12.5	139%	11	138%	13
2012	2011-12	**19.8**	8.5	102%	35	67%	66
2013	2012-13	**14.5**	4.0	59%	77	54%	75

Bold red numbers for perennial vegetation cover indicate years with statistically different vegetation cover from the initial inventory. Red numbers for annual runoff and five-year averages indicate below normal runoff (<100% of the long-term average) while blue numbers indicate above normal runoff (>100% of the long-term average).

Sec. 5.5 Table b.v.2. Sawmill Creek and Owens Valley annual runoff five-year average in acre-feet based on water year (October 1 to September 30) and vegetation and grass cover within Blackrock 94. Rank is where each year falls in the period of record.

				5-Year Average Runoff			
		Vegetation Cover (%)		Sawmill Runoff		Owens Valley	
Year	WY	Perennial	Grass	% Normal	Rank	% Normal	Rank
1971	1970-71			130%	8	121%	14
1972	1971-72			118%	17	105%	27
1973	1972-73			116%	20	111%	22
1974	1973-74			93%	42	94%	40
1975	1974-75			86%	55	92%	45
1976	1975-76			85%	57	88%	56
1977	1976-77			85%	56	85%	60
1978	1977-78			96%	37	92%	44
1979	1978-79			98%	35	91%	50
1980	1979-80			105%	29	101%	28
1981	1980-81			111%	24	106%	26
1982	1981-82			123%	12	124%	9
1983	1982-83			138%	5	134%	3
1984	1983-84			143%	3	139%	2
1985	1984-85			141%	4	131%	7
1986	1985-86	40.9	29.1	155%	1	145%	1
1987	1986-87			152%	2	132%	5
1988	1987-88			124%	11	107%	25
1989	1988-89			107%	27	93%	41
1990	1989-90			94%	40	84%	63
1991	1990-91	**21.8**	15.6	70%	75	64%	74
1992	1991-92	**18.6**	12.3	62%	77	61%	75
1993	1992-93	30.4	21.4	68%	76	69%	73
1994	1993-94	**12.1**	6.1	70%	74	69%	72
1995	1994-95	**28.3**	15.8	81%	64	87%	58
1996	1995-96	30.5	17.1	97%	36	100%	29
1997	1996-97	37.7	24.9	113%	22	114%	21
1998	1997-98	49.6	31.2	127%	10	123%	12
1999	1998-99	36.7	21.4	136%	6	129%	8
2000	1999-00	35.0	19.4	131%	7	117%	19
2001	2000-01	27.4	14.3	120%	14	108%	23
2002	2001-02	**17.2**	8.3	105%	32	96%	39
2003	2002-03	33.7	18.6	86%	54	82%	64
2004	2003-04	**17.7**	7.6	77%	68	78%	68
2005	2004-05	**26.6**	13.4	89%	50	87%	57
2006	2005-06	31.5	12.3	103%	33	100%	31
2007	2006-07	**20.0**	8.0	108%	25	100%	30
2008	2007-08	27.7	13.2	107%	26	99%	35
2009	2008-09	**19.1**	10.3	106%	28	99%	34
2010	2009-10	**26.8**	14.0	93%	41	92%	46
2011	2010-11	**26.2**	12.5	91%	47	90%	52
2012	2011-12	**19.8**	8.5	93%	43	90%	53
2013	2012-13	**14.5**	4.0	90%	49	86%	59

Bold red numbers for perennial vegetation cover indicate years with statistically different vegetation cover from the initial inventory. Red numbers for annual runoff and five-year averages indicate below normal runoff (<100% of the long-term average) while blue numbers indicate above normal runoff (>100% of the long-term average).

The extreme wet period between WY1977-78 and WY1985-86 was followed by the longest and driest period on record starting in WY1986-87 and ending in WY1993-94; the average annual runoff during this period was 68% with only one above average runoff year recorded during this period (WY1992-93.

Since WY1997-98, there has not been a wet period lasting longer than two years.

The extreme dry period between WY1986-87 and WY1993-94 was followed by the four-year wet period between WY1994-95 and WY1997-98. The average runoff during this wet period was 137% of the long-term average. In WY1998-99, however, Sawmill Creek recorded above average runoff (122%); thus, the wet climatic condition persisted little longer in the Sawmill Creek Watershed, and WY1998-99 marks the last year of the wet period at Sawmill Creek. Since WY1997-98, there has not been a wet period lasting longer than two years. The average runoff between WY1998-99 and WY2012-13 was 89% of the long-term average. The five-year running average since WY2000-01 has never exceeded 100% of the long-term average since WY1999-00.

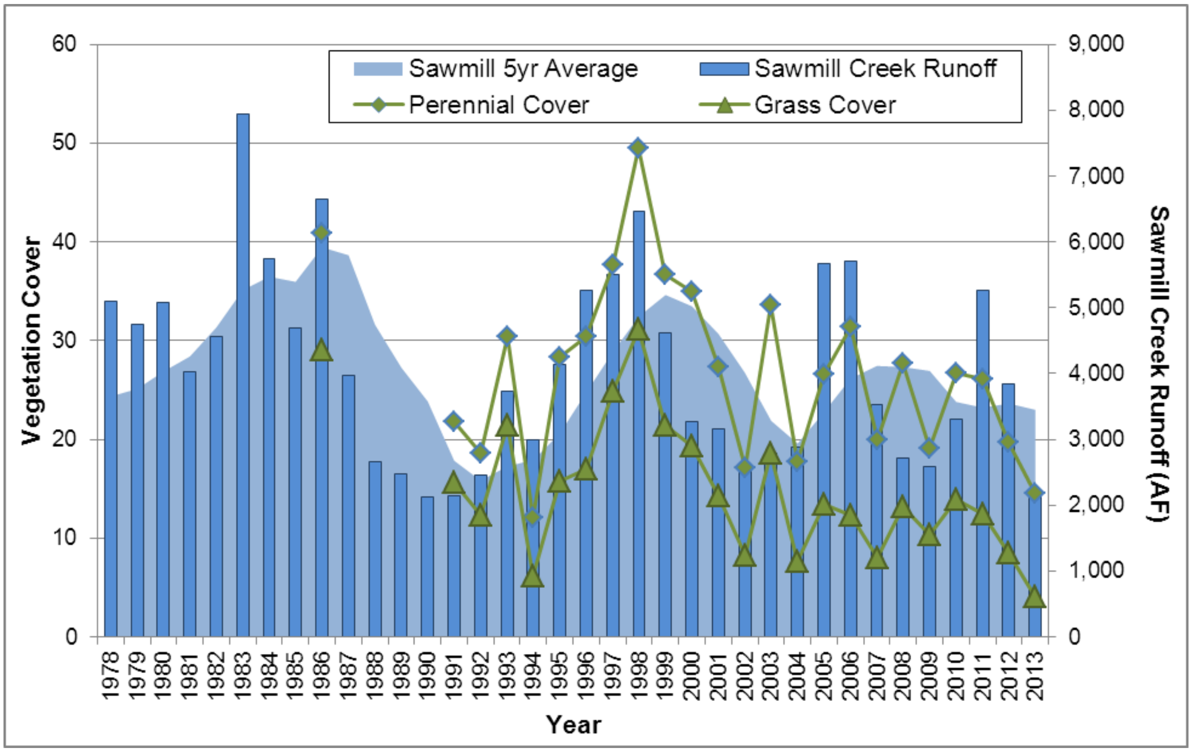
5.5.2.2. Vegetation Cover and the Climatic Cycles

Vegetation cover of the parcel fluctuates very closely with the annual runoff from Sawmill Creek (Figure b.v.3). The initial inventory taken in 1986 (the last year of a nine-year wet period) showed vegetation cover at 40.8%, which was higher than all monitoring years but one (1998). Grass cover was also the second highest on record in 1986 at 29%.

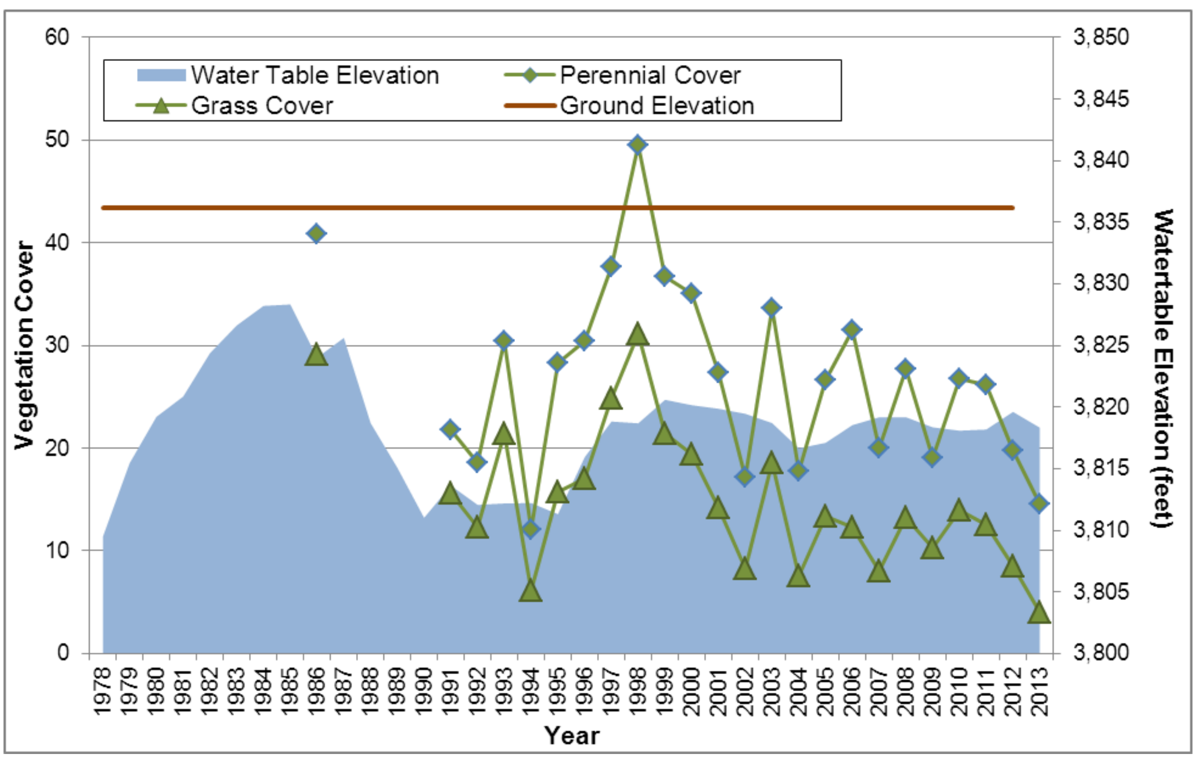
In 1991, with the onset of the eight-year dry period, vegetation cover declined to 15.6% and hit the lowest cover on record in 1994 (12%), the last year of the eight-year dry period. Grass cover was second lowest on record in 1994 (6%). Vegetation rebounded in 1995 with the onset of a four-year wet period that lasted through WY1997-98 (WY1998-99 for Sawmill Creek) The average annual runoff during this period was 137% of the long-term average.

Total perennial vegetation cover in Blackrock 94 increased each year between 1995 and 1998 during the wet period (RY1994-95 and RY1997-98) and reached highest on record in 1998, at 50%; which was 121% of the initial vegetation inventory cover. The cover ever recorded in Blackrock 94 was measured concurrently with DTW similar to that measured between 1998 and 2013 (Figure b.v.2b).

A very similar pattern was found for grass cover changes. In 1998 the grass cover *had recovered* to 31.2%; surpassing the baseline level of 29.1% despite having April DTW, which was deeper than the maximum depth of “grass root zone” (6.6ft or 2m). Importance of the wet period cannot be understated. Vegetation cover was not statistically different from the 1986 initial vegetation inventory baseline for two more years after the end of the wet period in 1998.



Sec. 5.5 Figure b.v.3. Relationships between total perennial cover (vegetation cover, diamond)/grass cover (triangle) and Sawmill Creek annual runoff/five-year average annual runoff.



Sec.5.5 Figure b.v. 4. Relationships between total perennial cover (diamond)/grass cover (triangle) and average April Water Table Elevation under Blackrock 94

The water table reached the highest level (DTW = 16.5 feet) in 1999 since the initial vegetation inventory years (1984-1987), and has remained relatively stable since then, ranging from 16.5 feet to 20.5 feet (Figure b.v.5). Despite this stable DTW condition, vegetation cover has declined after reaching its peak in 1998, which was the end of the wet period. Since the end of wet period in the late 1990s, the climate has been characterized by a prolonged dry period with sporadic wet years. Vegetation cover has not been able to respond as robustly to sporadic and short-term wet years (WY2004-05, WY2005-06, and WY2010-11); vegetation cover has increased during these years, but sustained high cover has not been observed. The second and fourth lowest vegetation cover was recorded in past two years (2011-12 and 2012-13), which marked one of the lowest annual runoff periods for a two consecutive years (60% of the long-term average for the Owens Valley).

LADWP previously reported that vegetation cover during eleven subsequent monitoring years was measurably different from the initial vegetation inventory cover based on ICWD's line-point data (Appendix 5.5.2). When LADWP reanalyzed the same data including 2012 and 2013 data, these two additional years were found measurably different from the initial inventory. In total, 13 years were found measurably different from the initial vegetation inventory (see Appendix 5.2 Section *Measurability* for more detail). When these 13 years were compared to the wet/dry climatic cycles, ten of these years coincided with dry years (Tables b.v.1 and b.v.2). The remaining four years (1995, 2005, 2011, and 2012) coincided with wet years, but three of the four years (1995, 2005, and 2011) were the first year of higher runoff after a dry period. The monitoring year 2012 follows the wet year (WY2010-11), but this was only a single year of above average runoff. As a result, vegetation cover did not substantially benefit from this one wet year.

5.5.2.3. Historical Vegetation Community

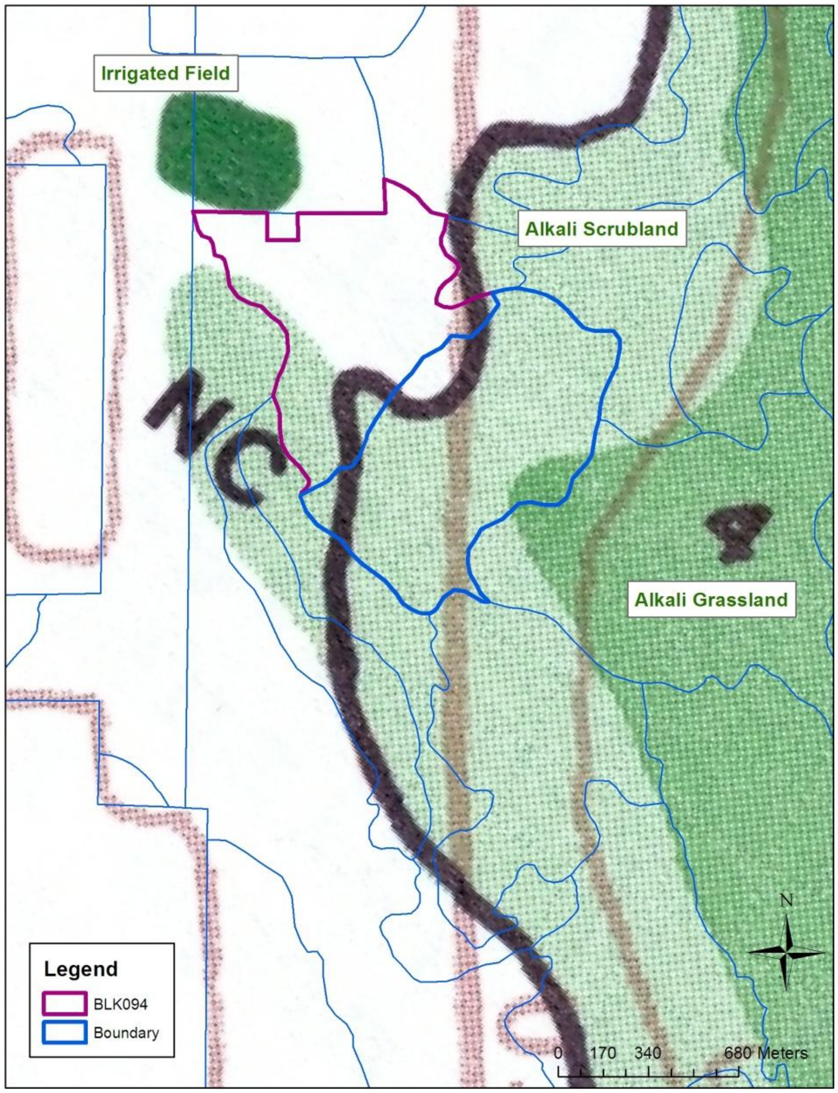
Prior to 1986, the majority of Blackrock 94 was classified as alkali scrubland (light green colored zone) in 1976 (revised 1976 Draft EIR) (Figure b.v.5). According to the report, the alkali scrubland represents a combination of the grassland (alkali sacaton-saltgrass) and shrubby species, which includes rabbitbrush, Nevada saltbush, greasewood, and shadscale with slightly higher cover of shrub. It also states:

> "*Shruby species generally cover close to one-third of the ground surface and the grasses average slightly smaller percentage. Total ground coverage varies greatly from as little as 10 to 15 percent to as much as 150 percent.*"

The actual vegetation survey was conducted in 1973 and 1974. WY1972-73 and WY1973-74 had 107% and 112% of the long-term average runoff for the Owens Valley, respectively). The five-year average runoff prior to WY1972-73 (between WY1966-67 and WY1971-72) was 120% of the long-term average, due to one extremely wet year in WY1968-69. WY1968-69 was the wettest year ever recorded at Sawmill Creek and for the Owens Valley. Therefore, the survey was conducted during a period with elevated residual soil moisture conditions.

The revised 1976 Draft EIR describes the alkali scrubland having that the shrub proportion equal to or higher than 50% and the grass proportion equal to or lower than 50% (1976 revised Draft EIR). Since the beginning of the line-point monitoring in 1991, the grass proportion averaged 54% for the entire parcel while the shrub proportion averaged 41%. The shrub proportion was recorded higher than the grass cover in six of 23 years. As discussed previously, the grass/shrub proportions for the entire parcel are exaggerated due to high heterogeneity of the parcel, yet these exaggerated proportions still fall within the expectation of the vegetation community of the area described in the revised 1976 Draft EIR.

It should be also noted that most of the northwestern half of the parcel was classified as neither alkali scrubland nor alkali grassland indicating that these plant communities were absent in the northwestern half of the parcel. The southeastern half was mostly classified as alkali scrubland, and only a very small portion of the parcel was classified as alkali grassland. In 1986, however, the entire parcel was classified as an alkali meadow. Considering the upland location and very coarse soils of the northwestern half of the Blackrock 94, the classification of this area as an alkali meadow is likely due to repeated years of surface water spreading in this northwestern area during the wet period between WY1977-78 and WY1985-86. It has been LADWP's past surface water management practice to spread water when surface runoff exceeded the capacity of the LAA as was often the case between WY1977-78 and WY1985-86. As determined in Section 5.7, LADWP's surface water management practices have not changed since 1970.



Sec.5.5 Figure b.v.5. The Flora Impact Map from the Revised 1976 Draft EIR of the area around Blackrock 94.

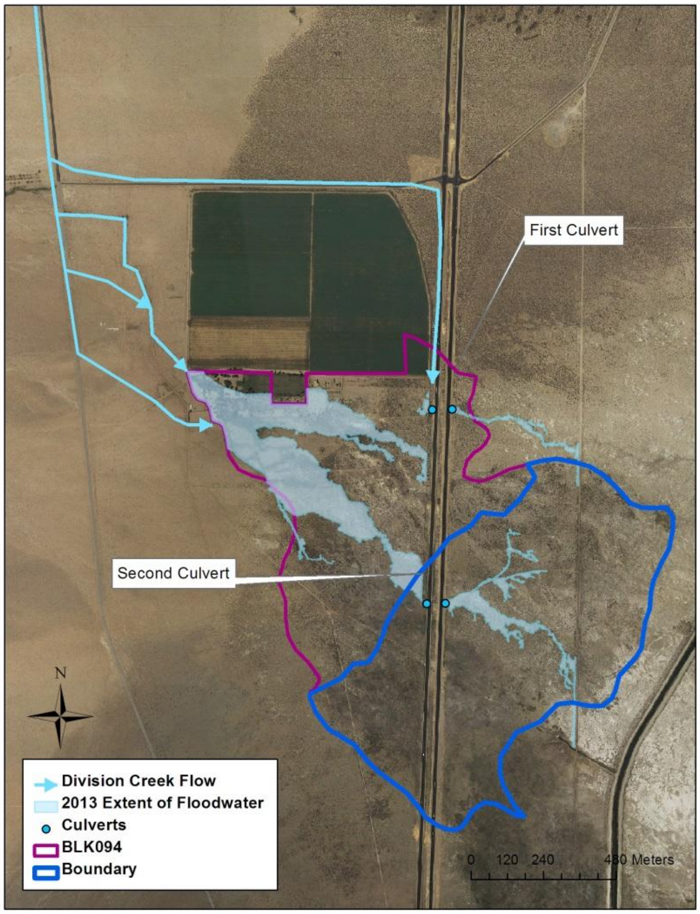
5.5.2.3.1. Summary of Wet/Dry Climatic Cycles

Vegetation cover in Blackrock 94 is strongly related to the runoff patterns and climatic dry/wet cycles. Vegetation cover tends to be lower during dry periods or drought, and tends to be higher during wet periods. A four year wet period, between WY1994-95 and WY1997-98, brought vegetation cover and grass cover from lows experience during the drought between the late 80's to the mid 90's to 120% of the initial inventory level. This rebound occurred despite DTW being deeper than the 1986 DTW. However, there has not been a wet period lasting over two years since WY1997-98. As a result, vegetation cover and grass cover have been declining in Blackrock 94 from its peak 1998 cover level. If Blackrock 94 experiences a wet period similar to 1978-1986 or 1995-1998, total perennial cover and composition in the parcel are expected to be similar to that observed in the initial inventory.

5.5.3. Flooding

On July 23, 2013, the Division Creek watershed experienced an intensive thunderstorm event that caused portions of Division Creek to flow south toward Blackrock 94 (Figure b.v.6 through 9). The northwestern corner of the parcel was mostly flooded, and the floodwater eventually reached the east side of Highway 395, through the second culvert. On the east side, the old ditch structure has enhanced the transportation of water further toward TS2, but most of water followed the topographic relief spreading floodwater toward the southeast. The floodwater followed the Sawmill Creek Road and turned south. Once it hit Highway 395, it started flowing along the west side of the highway. This water, then, entered the east side of Blackrock 94 through the first culvert.

When LADWP staff visited the area on July 25, the extent of flooding was evident, but in most parts surface water was absent especially in the east side of the parcel. A stockwater release from the 8-Mile Ranch into the area was higher than normal (0.5 cfs), which flooded the parcel. The surface water spreading can be the major factor for recharging soil moisture and vegetation cover especially in the northeastern part of the parcel where soils are coarse and water-table has been deeper.



Sec. 5.5 Figure b.v.6. Flood extent of Division Creek flash flood in July 23, 2013 within Blackrock 94. The extent was mapped by LADWP staff in July 25 and 29 by walking along the edge of water. The floodwater extent includes dry areas within the edges of flood extent.

Sec. 5.5 Figure b.v.7. Flood water still flowing in south of the 8-Mile Ranch taken in July 25, 2013.

Sec. 5.5 Figure b.v.8. Flood water in the northwestern half of Blackrock 94 taken in July 25, 2013.

Sec. 5.5 Figure b.v.9. Flood water in the southeastern half of Blackrock 94 taken in July 29, 2013.

5.5.4. Fungal Blight and Other Infestations

There has been no indication of fungal blight in Blackrock 094. However, LADWP has made observation of Atriplex leaf beetles in some areas of the Owens Valley. The infestation could negatively affect shrub species cover, especially *Atriplex torreyi* (Nevada saltbush). However, presence of Atriplex leaf beetles has not been observed in Blackrock 094.

5.5.5. Range Management Practices

5.5.5.1. Ecological Sites within Blackrock 94

In order to fully understand the effects of grazing on the Blackrock 94 landscape, a discussion on ecological sites must first be provided. An ecological site is a land classification system consisting of distinctive units that describe ecological dynamics and potentials for a given area. Ecological sites stratify land units in accordance with their potential vegetation and responses to disturbances such as fire, livestock grazing, soil erosion, etc. The Ecological Site Description (ESD) tool was developed and is currently used by the USDA Natural Resource Conservation Service (NRCS), the Agricultural Research Service (ARS), the Bureau of Land Management (BLM), and numerous universities and non-governmental organizations to assist in land management decisions and assessment of resource condition. Ecological site descriptions are represented spatially as soil map units, developed from soil and vegetation survey data. Soil surveys in the Owens Valley were conducted by NRCS and the final data can be found in the Soil Survey of Benton-Owens Valley Area, California, Parts of Inyo and Mono Counties (USDA NRCS, 2002). Vegetation data for the Owens Valley were collected by LADWP from 1984 to 1987. This vegetation data is also referred to as “a baseline” in the Green Book.

Ecological site descriptions include the expected production (pounds per acre) for each soil map unit based on growing conditions (normal, favorable, unfavorable). Yearly growing conditions are based on annual precipitation data (October 1 through September 30). The ecological site description describes the potential plant community by percent composition by dried weight of the major plant species. The potential plant community information does not set a specific percent composition for each species, but specifies an expected range of abundance of each of the major plant species by ecological site. These potential plant communities are typically assumed to be sites in excellent ecological condition and are used as a reference to evaluate a given location's ecological condition.

There are three distinct ecological sites inside of the Blackrock 94 parcel: 1) sandy ecological site, 2) saline bottom ecological site, and 3) the saline meadow ecological site (Figure b.v.10)

Sec.5.5 Figure b.v.10. Ecological sites and corresponding soil units contained within Blackrock 94.

Sandy Ecological Site

The sandy ecological site corresponds to the *Cartago Gravelly Loamy Sand*, 0-2% slopes soil unit. This is a deep, well-drained soil with effective rooting depths exceeding 60 inches. This soil typically occurs at the toe slope of alluvial fans. The sandy ecological site that is found on the northwest corner of Blackrock 94 is a shrub dominated site dependent upon precipitation and associated runoff. In excellent ecological condition this site is dominated by four-wing saltbush, Fremont dalea, and Indian ricegrass. Typical vegetation composition is approximately 55% shrubs, 30% perennial bunchgrasses, and 15% forbs. Perennial grasses are cool season bunch grasses. Total annual production can range between 300 - 700 lbs/acre depending upon the year. This site is very sensitive to heavy grazing and browsing and will result in a decrease in perennial bunchgrass and palatable shrub species such as four-wing saltbush and winterfat. The site is prone to invasion of Russian thistle. Big sagebrush can dominate drainages on this site.

Saline Bottom Ecological Site

The saline bottom ecological site occupies the eastern portion of Blackrock 94. *Winerton Fine Sandy Loam*, 0-2% slopes is the soil unit inside the parcel that corresponds to the saline bottom ecological site. The typical landforms associated with saline bottom ecological sites are ancient lacustrine and stream terraces. Soils are formed from mixed alluvium and lacustrine sediments, soil surface textures are sandy, sandy loams, loamy sands and loams. Typical vegetation composition is 65% grasses (alkali sacaton, saltgrass), 25% shrubs (primarily greasewood and shadscale), and 10% forbs. Total annual production can range between 300 – 700 lbs/acre depending upon the year. Continuous, year-long heavy grazing will lead to the ecological deterioration of this site, perennial grasses will be replaced with greasewood, shadscale and rubber rabbitbrush.

Saline Meadow Ecological Site

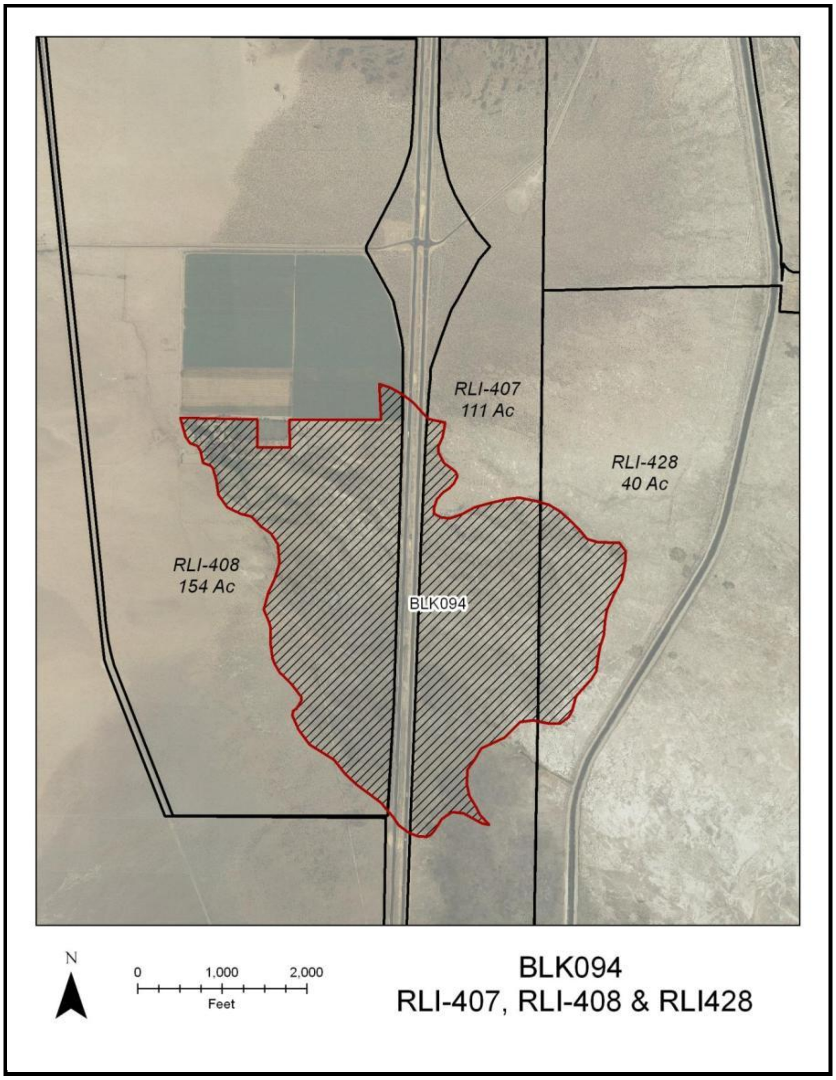
The saline meadow ecological site is located in the southern, central and western portion of Blackrock 94. The *Shondow Loam*, 0-2% slopes is the soil unit on Blackrock 94 that corresponds to the saline meadow ecological site. These sites occur on fan, stream, and lacustrine terraces as well as axial stream floodplains. The *Shondow Loam* soil is very deep with potential rooting depths exceeding 60 inches. The typical vegetation composition is approximately 80% grasses (alkali sacaton and saltgrass), 15% shrubs and trees (predominantly Nevada saltbush, rubber rabbitbrush, willow spp., wood rose, and greasewood), and 5% forbs. Production on saline meadow sites can range between 1000 – 3300 lbs/acre depending upon the year. Sustained heavy grazing will increase Nevada saltbush and a decline in perennial grasses.

In summary, each of the three ecological sites found Blackrock 94 are unique in regards to expected plant communities, production potentials, soils, and resiliency to grazing pressure. From west to east, across Blackrock 94, the plant community changes from shrub dominated to grass dominated, soils change from coarse and well drained material, to fine and poorly drained materials. Plant production potential changes from low potential to very high potential.

Along with these environmental gradients is the gradient in which the landscape responds to livestock grazing. From west to east, across Blackrock 94, the resiliency of the landscape to receive and rebound from livestock grazing pressure changes from low or not resilient to highly resilient. In practical terms, the western side of Blackrock 94 can be annually grazed but special attention must be placed on timing and intensity to prevent impacts. This area is most sensitive to overgrazing. The middle section of Blackrock 94 is more resistant to livestock grazing as compared to the western edge but again, special attention must also be placed on timing and intensity to prevent impacts. The eastern side of Blackrock 94 can handle a much higher grazing pressure as compared to the rest of the parcel. Nevertheless, no landscape is beyond the effects of overstocking and poorly timed grazing regimes. This side of the parcel however, could endure the longest under poor grazing management practices before negative impacts were seen.

5.5.5.2. Rangeland Management History of Blackrock 94

Three different grazing leases encompass the grazing activities on Blackrock 94: 8-Mile Ranch (RLI-408), Coloseum Ranch (RLI-407), and Blackrock Ranch (RLI-428) leases (Figure b.v.11). Each lease is managed differently with varying stocking rates, classes of livestock, and duration of grazing. Prior to the implementation of the Owens Valley Land Management Plan (OVLMP) in 2010 all grazing leases were managed at the lessee’s discretion and ocular estimates were made by LADWP Watershed Resources staff to assess forage utilization. As a part of the OVLMP, grazing management plans were developed for all LADWP ranch leases to manage livestock grazing on City of Los Angeles lands, including Blackrock 94. All of the grazing plans are specifically designed for each lease; however, all specify grazing utilization prescriptions of no more than 40% in riparian areas and 65% in upland areas. The Blackrock 94 parcel is an upland area and therefore all leases are now managed under the grazing utilization prescription of 65%.



Sec.5.5 Figure b.v.11. Location of the three grazing leases on Blackrock 94.

The 8-Mile Ranch Lease (RLI-408) contains the largest portion of the Blackrock 94 parcel, encompassing approximately 154 acres. This lease is used to farm 103 acres of alfalfa during the summer; and in the winter, pack stock (mules and horses) are released to graze the post harvested field. In the early 1980s the 8-Mile Ranch Lease was operated by John Ketchum. During this time there was only 12 acres of irrigated alfalfa and 80 to 100 head of pack stock grazed the lease, which was estimated to provide approximately 47 animal unit months. Management at that time entailed using Sawmill Creek to flood-irrigate the alfalfa pasture and allowed the remainder of the creek-flow to irrigate the South Field (southwest portion of Blackrock 94). Grazing pressure on the lease was high during this time period because of the small size of the irrigated alfalfa field and the high stocking rates of pack stock (80-100 head).

In 1984, the lessee expanded the alfalfa operation to 103 acres. Much of this land had been in agriculture production in the 1940s but was allowed to convert back to native vegetation since that time. In order to expand the alfalfa operation a gravity sprinkler system was installed. This system requires the greatest proportion of allotted water during the spring and summer months. Remaining water is used for stock water or sent to the LAA.

In 1988 a new lessee, Lee Roeser, began to take over the lease. During this time John Ketchum still operated the farming and irrigation portion of the lease, which included spreading any available water from spring runoff. Runoff water usually came from Black Canyon located to the southwest of the lease. In the early 1980s, runoff from Black Canyon used to flow directly east over the alluvial fan. During that time a flash flood washed out a historical diversion and the channel changed course and began flowing northeast, providing additional water for spreading onto the South Field of Blackrock 94 for a period of time. At times water was so abundant in this area that a berm was constructed, which diverted water around the permanent monitoring site TS-1. Black Canyon Creek was returned to its earlier stream course in the early 1990's.

Also during this time the new lessee, Lee Roeser, began to reduce stocking rates in all of the fields on the lease in order to allow recovery from the previous heavy grazing practices. In order to reduce stocking rates, Lee Roeser constructed one new field called the Willow Field and a feed lot. Both lie directly north of the South Field and are used to feed pack stock until the alfalfa stubble is available for grazing in the winter. In the early 1990s Lee Roeser took over the entire lease. The new grazing management strategy called for only fall or spring grazing by pack stock in all fields depending on forage conditions. If forage conditions were not adequate, grazing would not occur and pack stock would be fed in the feed lot prior to being turned out on alfalfa stubble for the winter. Stocking rates were also decreased to 40 to 45 head of pack stock. Much of the lease went un-grazed each year prior to Inyo Complex Fire in 2007.

After this grazing management change, the lessee noticed forage conditions did not recover. Furthermore a die-off of shrubs located to the west, on parcel ABD027, was observed by the lessee prior to 2007. The 2007 Inyo Complex Fire effectively burned 90% of the leases native forage including a large portion of the South Field and almost burned down the lessee's residence. At that time grazing was suspended on the lease for 2 years.

In 2009, forage conditions were evaluated by LADWP Watershed Resources staff, and it was determined that the South Field was the only field that recovered enough for grazing. Recovery in this area is most likely due to the fact that only the south western portion of the field burned and vegetation in this area is Alkali Meadow, having a large amount of perennial grasses that respond well to burn events. Since 2007, grazing has not resumed in any other field on the lease because of poor recovery. There have been no changes in grazing management or to lease operations since 2009. Only spring or fall grazing occurs in the South Field.

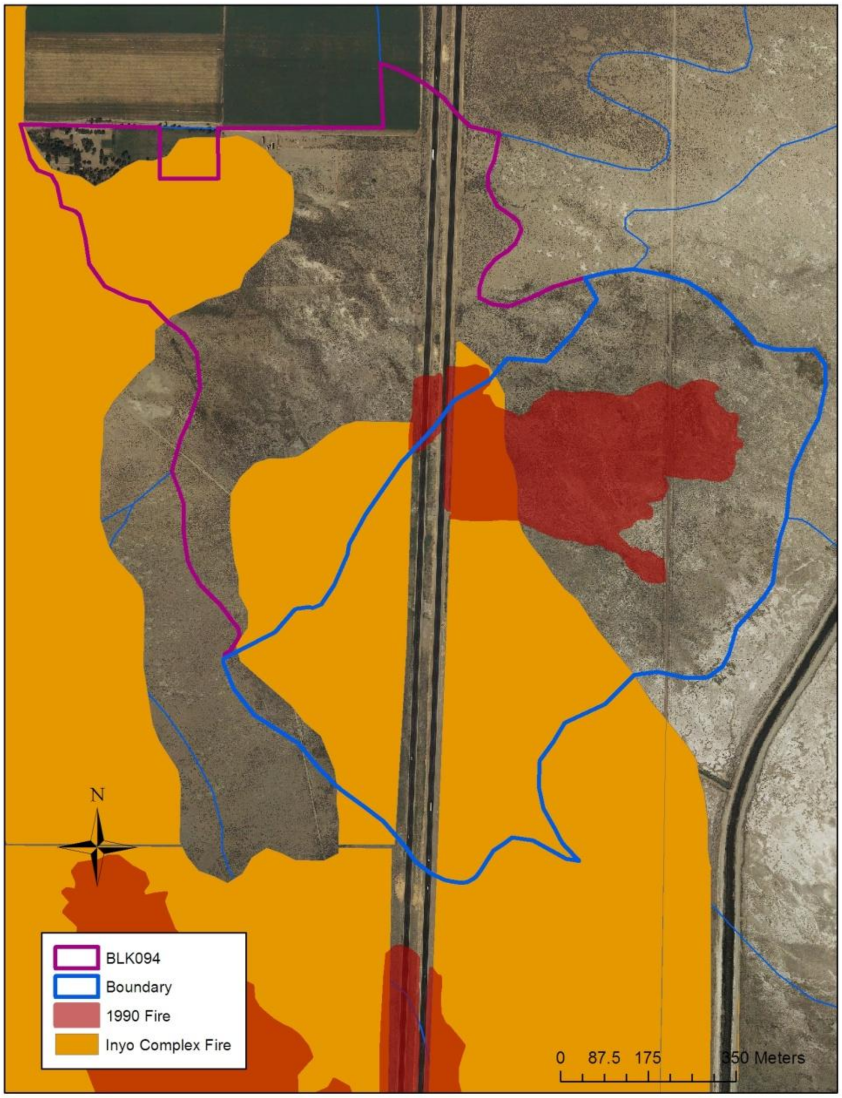
The Coloseum Ranch Lease (RLI-407) contains approximately 111 acres of the Blackrock 94 parcel as part of its grazing operation. Ownership of this lease has not changed in over 30 years and the only management changes on the lease have been made in compliance with the utilization prescriptions imposed by the OVLMP. Stocking rates are adjusted seasonally by the lessee to match available forage. The lessee spreads water on normal to above normal runoff years when water is available to increase forage production. Cattle primarily graze this lease during the fall and winter until utilization standards are met. Supplemental feeding of hay is also used by the lessee to extend the duration of grazing during the winter. If the cattle meet the upland utilization standard, then they are then moved to private property or federal grazing allotments. Since 2006 there have been several occasions where utilization has been met and the lessee has had to move livestock prior to the spring. After the 2007 Inyo Complex Fire, utilization rates were reduced to 50% instead of 65%, and the allowable stocking rate was reduced to 25-30 cattle. This reduction lasted for two years. Since the northern portion of the field had not burned the lessee wanted to continue grazing in this area. With permission from LADWP, a cross fence was constructed by the lessee. The construction of this fence split the northern and southern portions of the fields and also allowed the lessee to better control grazing intensity and duration.

The Blackrock Ranch Lease (RLI-428) contains the smallest portion of the Blackrock 94 parcel. This lease has been under the same ownership for over 30 years. This lease is approximately 40 acres and is referred to as the North Thibaut Field. The portion of grazing acreage within Blackrock 94 is relatively small as compared to the entire lease. Management on this lease has only changed to comply with 2010 OVLMP. Stocking rates are adjusted seasonally by the lessee to match available forage. The lessee spreads water on normal to above normal runoff years when water is available to increase forage production. Cattle graze in Long Valley on RLM-469, a Mono County LADWP lease, during the summer and on the Blackrock lease during the winter and spring. The North Thibaut Field is typically grazed for two weeks in late fall, and then cattle are moved to the South Thibaut Field for the duration of the winter. In early spring cattle are gathered and moved back to the North Thibaut Field, in preparation for branding. Once branding is completed the cattle are then moved back to the South Thibaut Field if utilization rates have not been met. If utilization has been met, then cattle are moved to a different portion of the lease. Prior to 1997 the lessee would graze mules and horses in the North Thibaut Field during the winter.

In conclusion, having limited quantitative grazing data prior to 2006 and considering recent grazing management practices, it is the opinion of LADWP that grazing activities on the Blackrock 94 parcel are probably not a main factor causing change in total perennial vegetation cover across the entire parcel. However, overstocking and heavy grazing that occurred within the northwestern corner of Blackrock 94 during the 1980s may have caused changes in vegetation that have yet to fully recover. This area, being particularly sensitive (sandy ecological site) to disturbance, may require a substantial amount of time to fully recover.

5.5.6. Wildfire

There have been two wildfires that have burned parts of Blackrock 94 since 1986. The fire in 1990 burned approximately 37 acres of Blackrock 94 (Figure b.v.12, 13, and 14). The burned area was delineated mainly based upon the portions of the fire line visible on the 1990 aerial photo, not on the actual burn area. Therefore, the actual extent may have been greater than 37 acres. The parcel was burned again in 2007 as a result of the Inyo Complex Fire, which was a particularly intense and hot fire. The Inyo Complex Fire burned 45% of Blackrock 94, primarily the southeastern alkali meadow community and the northwestern corner of the parcel (Figure b.v.12).



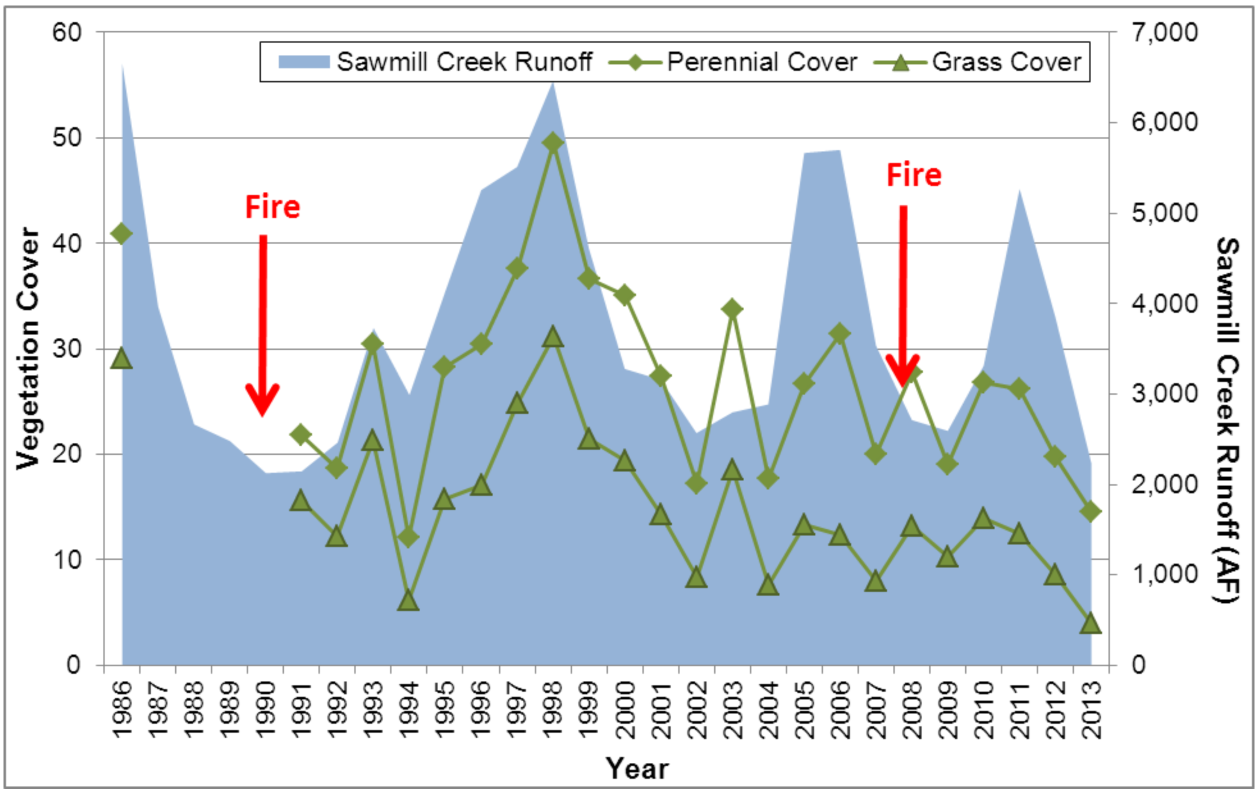
Sec.5.5 Figure b.v.12. Extent of 1990 Fire and Inyo Complex Fire in 2007.

The first year of ICWD's line-point monitoring was conducted in 1991, one year after the 1990 fire. Vegetation cover was measurably lower than the 1986 initial vegetation inventory baseline level in three of four years (1991, 1992, and 1994) prior to the 1995-1998 wet period (WY1994-95 and WY1997-98) (Figure b.v.15). The recovery period after the 1990 fire occurred during the eight-year drought period beginning in 1987. The reduced runoff, in turn, coincided with increased pumping in the late 1980's in Thibaut-Sawmill and Taboose-Aberdeen Wellfields, resulting in the lowest water table between 1986 and present, occurring in 1993. In time and with the onset of the 1995-1998 wet period, total perennial vegetation cover rebounded from the impacts of the 1990 fire to 121% of the initial vegetation inventory baseline.

Sec.5.5 Figure b.v.13. The 1990 Fire. The picture was taken on May 14, 1990, by a LADWP staff, looking northwest. The fireline is visible in the middle of the picture.

Sec.5.5 Figure b.v. 14. The 1990 Fire. The picture was taken on May 14, 1990, by a LADWP staff, looking southwest.

Conversely, vegetation cover has not fully recovered from the Inyo Complex Fire in 2007. This fire was particularly hot. A hot summer fire can destroy the basal crowns of perennial grasses. The recovery time period following this fire also coincided with an extended period of state-wide drought. Sawmill Creek runoff after the Inyo Complex Fire was 88% of the long-term average runoff[20], with five out six years of below normal runoff since the fire (Table b.v.1 and 2).[21] There has been only one year (WY 2010-11) with above average runoff. In Blackrock 94, the second and fourth lowest vegetation cover was recorded in 2012 and 2013, which were two consecutive dry years. Under the current dry climatic conditions, vegetation recovery from the 2007 very intense Inyo Complex Fire is impeded. However, following multiple years of elevated precipitation and runoff similar to the wet period between WY1978-WY1986 or WY1994-95-WY1997-98, vegetation conditions are expected to be similar to that observed in 1986 or 1998.



Sec.5.5 Figure b.v.15. Relationship between vegetation cover (perennial cover, diamond)/grass cover (triangle) and, two fires that burned the part of Blackrock 94, and Sawmill Creek annual runoff. (acre-feet or AF).

Two fires in past 25 years indicate that wildfire is fairly common in Blackrock 94. It took four consecutive wet years to recover from the relatively small 1990 fire, but recovery since the 2007

[20] The annual runoff of Sawmill Creek was based on water year (October 1 to September 30).
[21] The year 2012 was considered as below Normal because without the elevated baseflows in fall and winter due to 2013, the total runoff would have been close to 78%.

Inyo Complex Fire has not occurred, partially due to the severity of the fire, but primarily due to the persistent drought conditions after the fire. The climatic pattern following a fire has a very strong influence on how long it takes for vegetation cover to recover.

The fire could be severe enough to alter a plant community, and recovery after the fire is strongly affected by the following climatic pattern. A plant community conversion due to a fire has not been observed in Blackrock 94 as the southeastern half of the parcel has remained relatively similar to the conditions observed during the initial inventory while the northwestern half of the parcel has contained at least two plant communities which are distinct from the initial inventory condition. The recovery after the fire is slow in Blackrock 94 and likely will require a wet period lasting at least three or more years.

5.5.7. Off-Road Vehicles and Highway 395 Expansion

Close comparison of imagery taken in 1981 and in 2009 revealed no sign of newly created roads or impacts caused by off road vehicles within the bounds of Blackrock 94. However, there are new trails present on the 2009 landscape as compared to the 1981 landscape. These new trails are most likely animal paths caused by livestock with the majority of the paths leading to common areas, watering holes or along fence lines. The lack of new roads being created by off road vehicles is to be expected due to the fact that a fair amount of the parcel is located between the LAA and the Highway 395 and the entire parcel is well fenced for livestock management.

The only disturbance caused by vehicles within Blackrock 94 was the expansion of Highway 395. Figure b.v.16 displays the expansion of Highway 395 as it bisects BLK094. This section of highway expansion was completed in 2008. Imagery taken in 1981 shows that the California Department of Transportation (CALTRANS) had not fully occupied its right of way within the highway corridor. Based on the imagery, it appears that the right of way was already fenced off. A discernible fence line contrast between un-grazed areas (inside the right of way) and grazed areas (outside of the fenced right of way) can be seen in the 1981 imagery. The polygon depicted on the 1981 imagery shows the fenced-off CALTRANS right of way. Within this right of way, approximately 11.4 acres are directly impacted from Highway 395 while leaving the rest of the area and vegetation inside the right of way intact. The polygon shown on the 2009 imagery shows the full extent of Highway 395 expansion after completion. Expansion obviously impacted the large majority of the previously undisturbed area inside the right of way. The total area in the right of way in 2009 was 34 acres, increasing the potential area affected by the highway construction by 22.6 acres (6.8% of the total parcel area).

In conclusion, there was a substantial loss of vegetation within the bounds of Blackrock 94 due to the expansion of Highway 395. Vegetation cover within highway corridors is generally elevated due to extra soil moisture caused by runoff from the highway surface during precipitation events. This area can also be assumed to have higher vegetation cover as compared to surrounding vegetation because the highway has been fenced off from cattle grazing since it was created (between 1944 and 1968).

It appears that this area was re-inventoried by ICWD in 1991 (2 transects), 1992 (1 transect), 1995 (3 transects), and 2001 (1 transect). Therefore, it can be inferred that this area could have been sampled during any year following the highway expansion and due to the loss of this higher cover vegetation, sampling years after the highway expansion could yield lower average perennial cover values. Therefore, expansion of Highway 395 in 2008 may, in part, be attributable to the change in vegetation at Blackrock 94.

Sec.5.5 Figure b.v.16. Imagery from 1981 and 2009 showing the expansion of Highway 395 in 2008

5.5.8. Summary

Vegetation cover in Blackrock 94 has been influenced by many environmental factors within Blackrock 094. As demonstrated repeatedly, the climatic patterns expressed as the five-year pattern of snowmelt runoff and annual pattern of winter-spring precipitation are two of the most important factors for vegetation cover. Periods of dry and wet years have significant and lasting impacts on vegetation cover. During multiple wet years, vegetation cover and grass rebounds to the record high level while absent of such a period reduces vegetation cover and grass cover to the record low level. Vegetation cover and grass cover responds to sporadic wet years, but the overall trend is set by presence or absence of a wet period lasting longer than three years.

Grazing, fire, and the expansion of Highway 398 had substantial and lasting impact on vegetation cover in Blackrock 94; however, LADWP believes grazing, fire, and Highway 395 are not the major factors attributable for vegetation cover changes in Blackrock 94. A 2013 flash flood resulted in additional water flowing over areas of the parcel, which should provide a temporary benefit for cover in the parcel. But repeated years of high runoff and precipitation are more important factors for vegetation in the northwestern half of the parcel where soils are coarse and water table has been deeper.

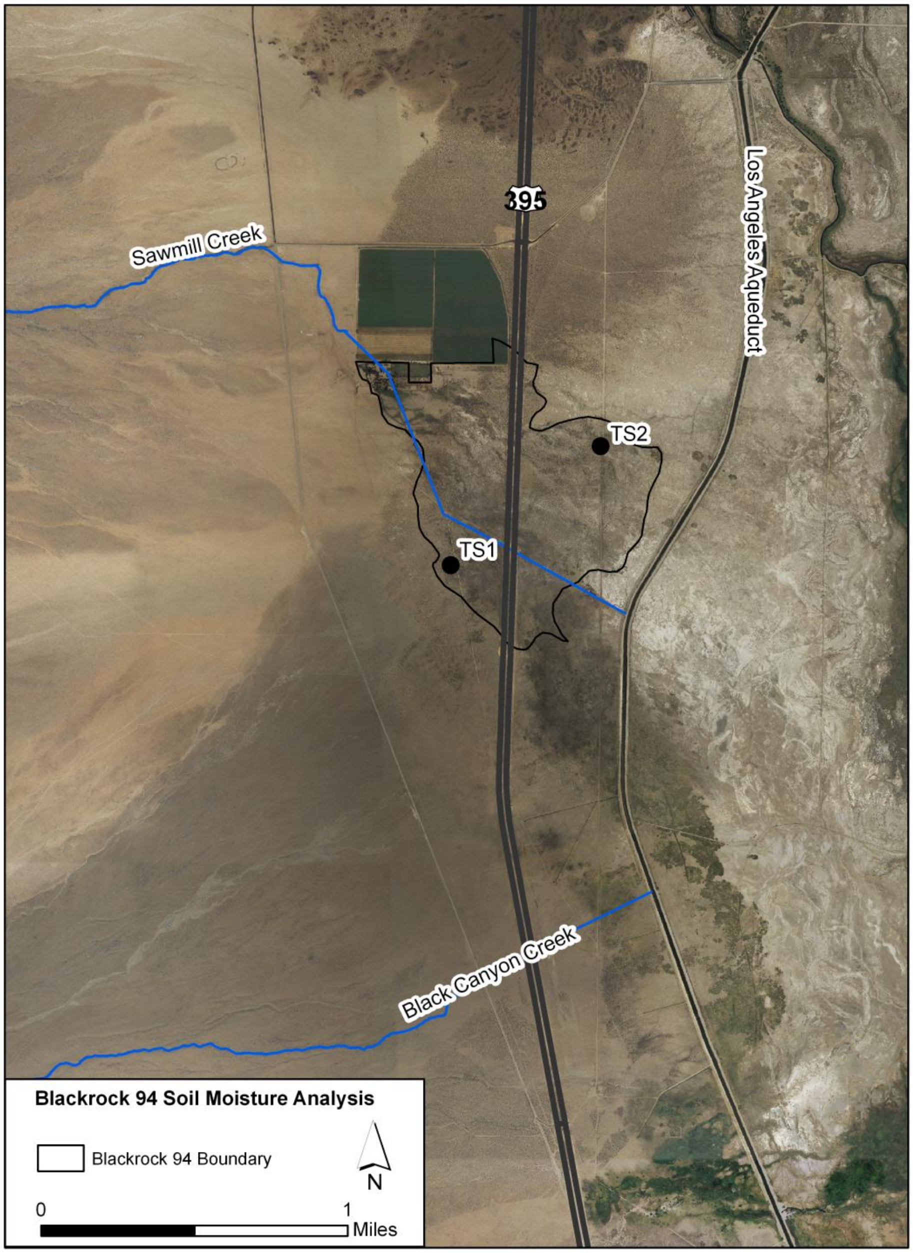
5.6. LADWP Evaluation I.C.1.b.vi – Evaluation of change in soil water within root zone caused by a pumping-induced change in the water table.

5.6.1. Soil Moisture

This section provides an evaluation of changes in soil moisture within the root zone at the Blackrock 94 parcel as required by the Green Book. In particular, it examines both the amount and the trend of moisture content in the soil during the growing season (April-September) from WY's 1996 to 2012. Additionally, it provides statistical analysis on the primary variables that affect soil moisture: precipitation, surface-water spreading practices and DTW. The trends and analysis find that precipitation primarily is responsible for soil moisture levels, in the upper portions of the soil column, and that surface-water spreading and DTW are of a lesser importance.

5.6.2. Methods and Data

In conducting the analysis the WY's of 1996-2012 were examined to compare how differing stream-flow runoff amounts influence soil moisture and DTW. Soil moisture data were provided by the ICWD for monitoring sites TS1 and TS2 (Figure b.vi.1). TS1 is on the higher southwestern margins of the parcel and TS2 is on the northeastern.



Sec. 5.6 Figure b.vi.1. Location of TS1 and TS2 Soil Moisture Monitoring Sites at Blackrock 94

Both monitoring site TS1 and TS2 have a linear set of permanent soil-moisture monitoring tubes that are relatively evenly spaced and moisture content is measured at each tube at vertical intervals of 7.9 inches starting 11.8 inches below the surface and is measured to a depth of 12.8 feet. TS1 has five monitoring tubes spread over 330 feet and TS2 has three tubes spanning 280 feet. Soil moisture data exists from 1991 to present. However, prior to 1996 the data are incomplete as soil moisture was collected only 3 to 4 times a year at the TS1 site and only at one tube. Starting in 1996, soil moisture was measured monthly at both sites and at all tubes. Because of the continuous record existing from 1996 onwards, the data from 1996 to 2012 are used in this analysis. Additionally, each site has a groundwater monitoring well associated with it and DTW is measured monthly. In examining the soil moisture data, individual moisture readings were grouped at 31.5 inch intervals (with exception to the shallowest interval which comprises the uppermost 23.6 inches) and averaged to obtain monthly values; (Tables b.vi.1 and 2). Furthermore, the analysis focused on soil moisture levels during the growing season (April to September). To ease comparison when referencing the four depth classes, they are numbered 1 through 4, with 1 being the shallowest and 4 being the deepest.

To examine the effect surface water spreading has on soil moisture; the annual total stream flow was compared to the long-term annual average, using the water year convention (October 1 to September 30), of 1933-2013 for Sawmill Creek as no stream gage exists on Black Canyon Creek (Table b.vi.3). Surface water spreading occurs along the lower portions of the alluvial fans of both Sawmill and Black Canyon Creeks during most years when runoff is greater than average (Table b.vi.3) (for further discussion on surface-water management activities at Blackrock 94 see Section 5.7.2). Lastly, local precipitation was also examined to deduce the affect it has on soil moisture, the rain gage for Independence was used (Figure b.vi.2).

Sec. 5.6 Table b.vi. 1. Site TS1 April to September Average Percent of Soil Moisture at each depth intervals and average depth to groundwater for the same time period. Shading indicates runoff year type: blue = wet, red = dry, no color = normal.

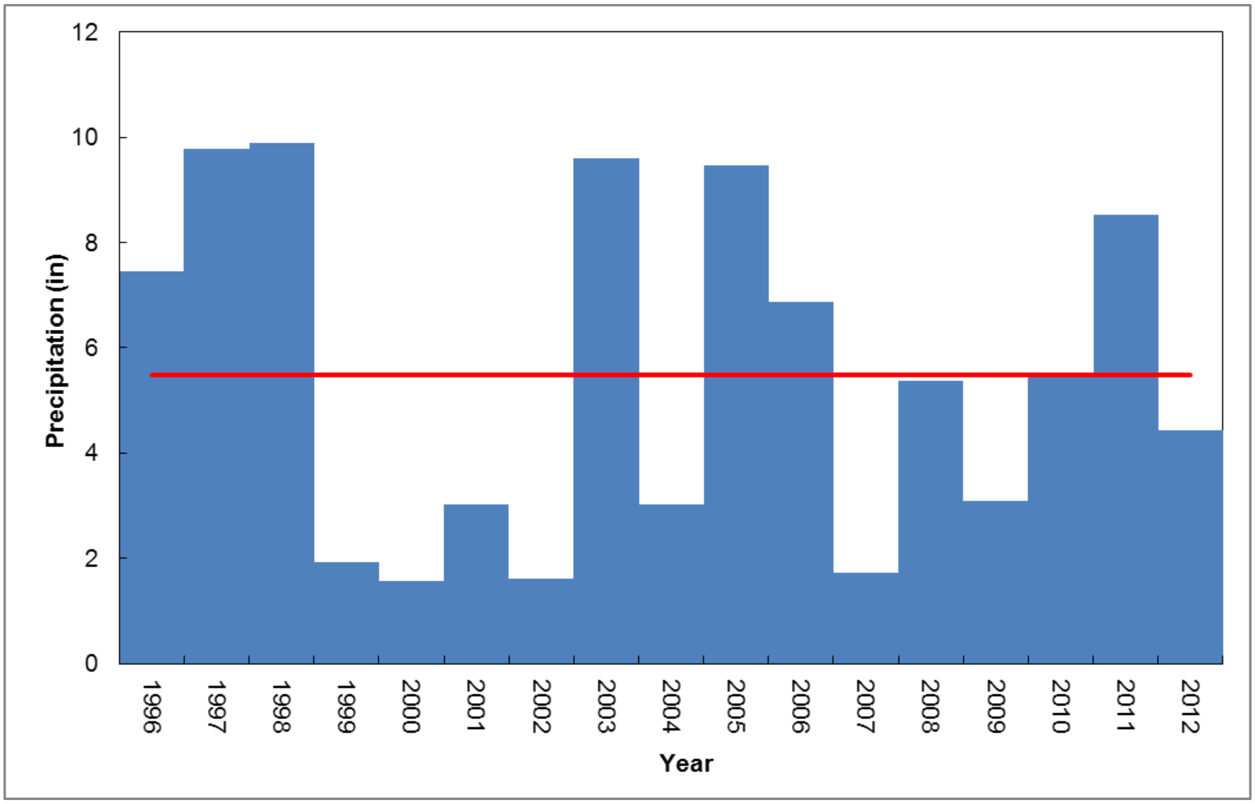
		Soil Depth Class			
Water Year (Oct 1 - Sep 30)	Avg. depth to groundwater Apr - Sep (ft.)	Class 1. (11.8-35.4 in.)	Class 2. (43.3-74.8 in.)	Class 3. (82.7-114.2 in.)	Class 4. (122.0-153.5 in.)
		Avg. Percent of Soil Moisture Content (Apr - Sep)			
1995-1996	15.6	12.6	16.3	23.4	23.2
1996-1997	17.3	12.1	14.3	17.2	15.3
1997-1998	17.8	12.8	12.7	14.0	12.4
1998-1999	16.4	9.6	11.3	13.2	13.7
1999-2000	16.8	9.0	10.9	13.3	13.2
2000-2001	17.1	9.1	10.9	13.5	12.4
2001-2002	18.0	8.7	10.7	13.4	11.0
2002-2003	19.5	10.9	11.4	13.1	8.8
2003-2004	21.1	8.0	9.3	11.9	7.9
2004-2005	20.1	10.0	9.6	12.5	8.0
2005-2006	19.0	9.7	9.2	12.0	7.6
2006-2007	18.2	7.5	9.3	12.3	8.1
2007-2008	17.8	11.5	10.0	13.0	9.8
2008-2009	18.9	9.2	10.0	13.6	11.7
2009-2010	19.2	9.6	9.8	13.7	11.4
2010-2011	18.4	13.9	10.5	14.0	11.1
2011-2012	17.5	9.8	10.1	14.1	12.5

Sec. 5.6 Table b.vi.2. Site TS2 April to September Average Percent of Soil Moisture at each depth interval and average depth to groundwater for the same time period. Shading indicates runoff year type: blue = wet, red = dry, no color = normal.

		Soil Depth Class			
Water Year (Oct 1 - Sep 30)	Avg. depth to groundwater Apr - Sep (ft.)	Class 1. (11.8-35.4 in.)	Class 2. (43.3-74.8 in.)	Class 3. (82.7-114.2 in.)	Class 4. (122.0-153.5 in.)
		Avg. Percent of Soil Moisture Content (Apr - Sep)			
1995-1996	16.7	8.2	6.2	8.9	10.9
1996-1997	14.4	9.1	5.9	11.0	18.5
1997-1998	13.1	11.2	8.3	12.8	24.2
1998-1999	12.2	7.7	8.7	17.1	28.8
1999-2000	12.3	7.7	9.4	17.6	28.9
2000-2001	12.6	8.0	8.8	16.8	28.1
2001-2002	12.9	7.8	8.3	15.8	27.5
2002-2003	13.2	11.2	10.1	15.2	27.0
2003-2004	14.6	9.8	8.3	13.4	22.2
2004-2005	14.4	10.9	9.3	12.4	20.9
2005-2006	13.5	11.6	9.7	13.0	23.4
2006-2007	13.5	9.5	9.2	14.0	25.2
2007-2008	13.4	11.3	9.7	14.5	26.5
2008-2009	13.8	10.1	9.2	14.4	25.3
2009-2010	14.0	10.4	8.7	13.8	24.1
2010-2011	13.1	13.8	12.1	15.0	26.7
2011-2012	13.2	11.1	10.5	16.6	29.1

Sec. 5.6 Table b.vi.3. Percent of Annual Stream Flow as compared to the long-term annual stream flow average (1933-2012), runoff type and volume of surface-water spreading from Sawmill Creek.

Water Year (Oct 1 - Sep 30)	Percent of Normal	Runoff Type	Spreading (acre-feet)
1995-1996	139%	wet	506
1996-1997	146%	wet	234
1997-1998	171%	wet	570
1998-1999	122%	wet	0
1999-2000	87%	dry	0
2000-2001	83%	dry	0
2001-2002	68%	dry	0
2002-2003	74%	dry	0
2003-2004	76%	dry	0
2004-2005	150%	wet	802
2005-2006	151%	wet	729
2006-2007	93%	dry	0
2007-2008	72%	dry	0
2008-2009	69%	dry	0
2009-2010	88%	dry	0
2010-2011	139%	wet	808
2011-2012	102%	normal	0

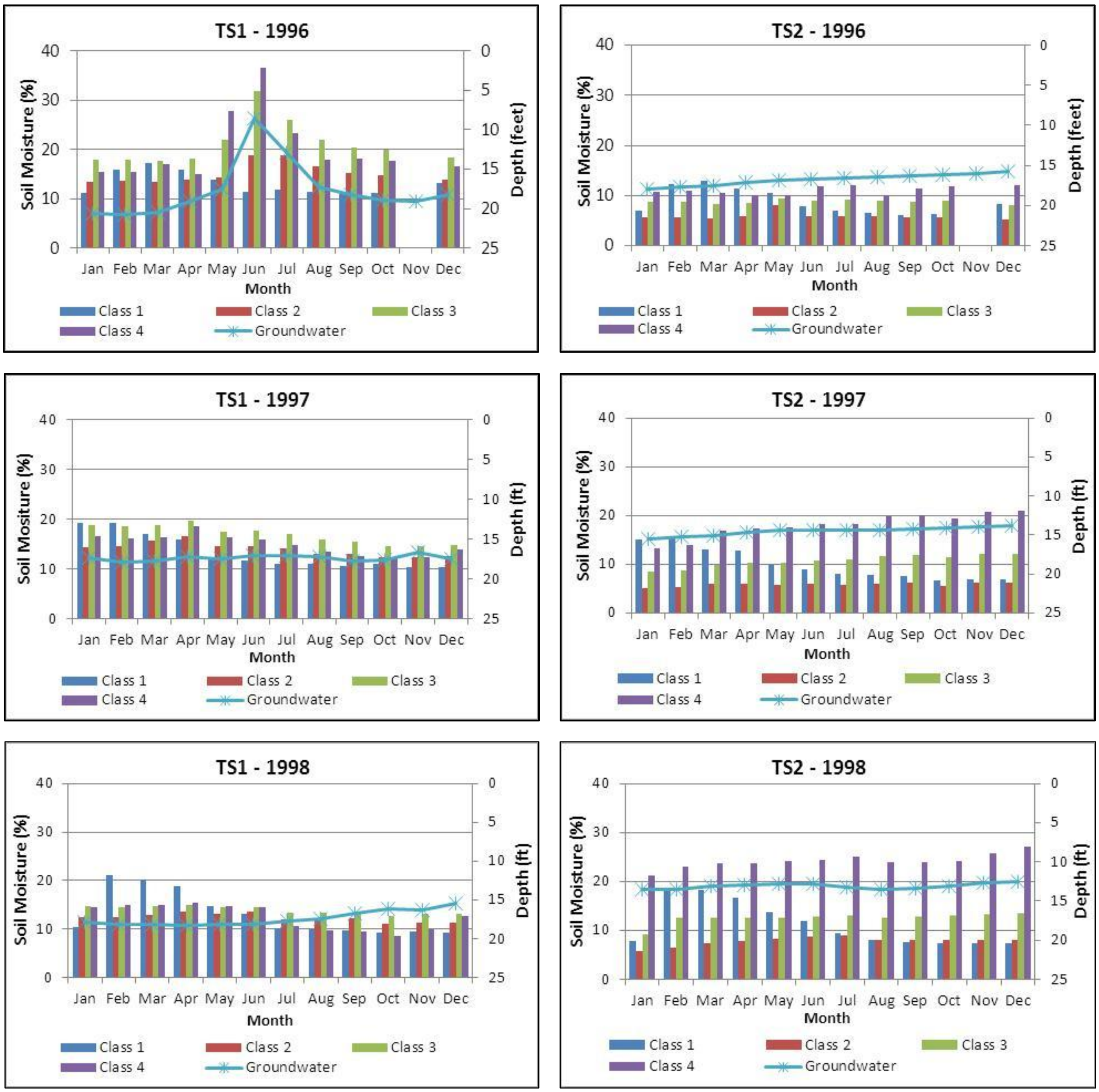


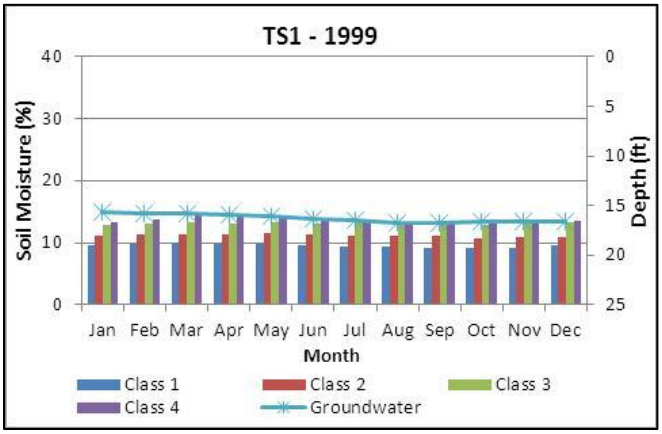
Sec. 5.6 Figure b.vi.2. Annual precipitation at Independence, CA. The red line is the long-term average (5.49 inches) at this site from 1961 to 2012.

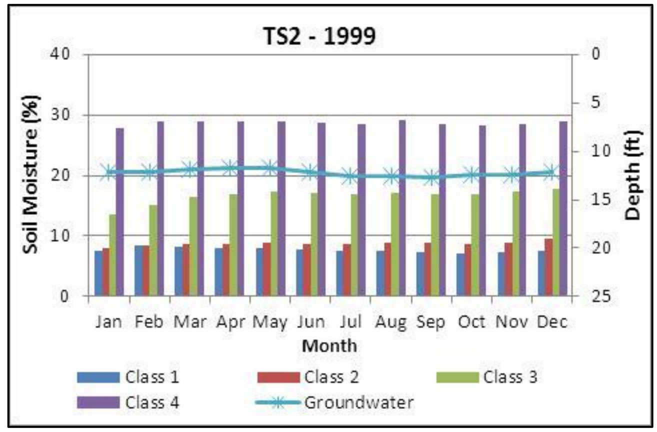
5.6.3. Results and Analysis (Attachment b.vi.1)

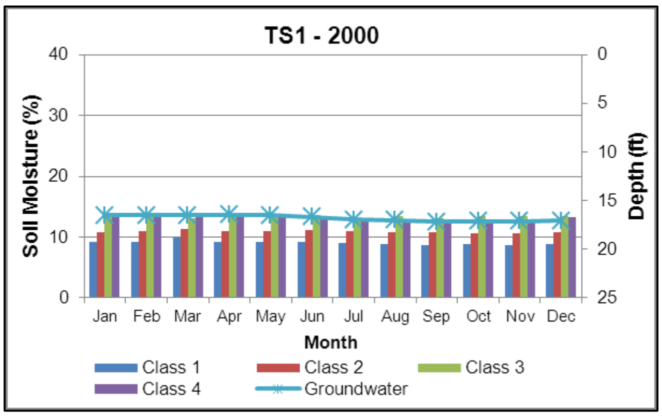
Soil moisture levels are highly variable from year to year and differ between the TS1 and TS2 sites. At the TS1 site, when examining all soil depths, the average soil-moisture content varied between 0.1% and 15.3% and at TS2 it varied from 0% to 18% for WY's 1996 to 2012 (Tables b.vi.1 and 2). This variability is because of decreases in DTW associated with water-surface spreading practices and above average local precipitation. In WY 1996-1997, 506 acre-feet of water were spread from Sawmill Creek (Table b.vi.3) and at the TS1 site, the DTW rose 10 feet between April and June (Figure b.vi.3). Resulting from the higher DTW soil moisture levels (except class 1) increased rapidly and peaked at values between 18.9% and 36.7% (Figure b.vi.3). However, despite the surface-water spreading in 1996, TS2 displayed a much different trend. Depth-to-water rose only a 1 foot from April to September and soil moisture remained relatively constant (Figure b.vi.3). These differences in response between TS1 and TS2 in 1996 are because surface water spreading occurred near TS1. In subsequent years, when spreading occurred (1997, 1998, 2005, 2006 and 2011), it happened outside the areas of TS1 and TS2 as supported by the relatively constant DTW (Figure b.vi.3).

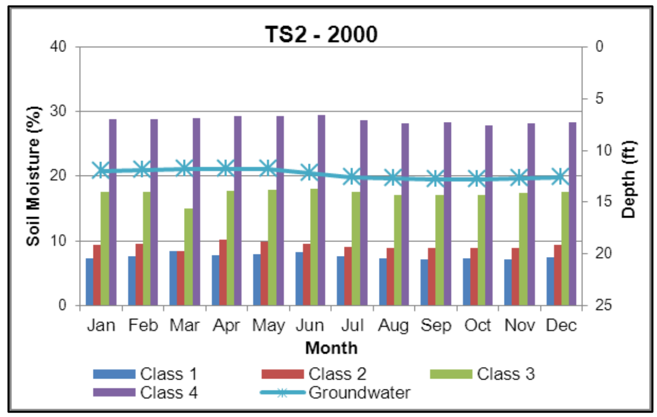
Sec. 5.6 Figures b.vi.3. Soil moisture percentages for depth classes 1-4 and groundwater levels for select years (for all years see Appendix 5.6.2). Classes 1-4 represent increasing soil depth intervals at which moisture was measured; with 1 = 11.8-35.4 inches, 2 = 43.3-74.8 inches, 3 = 82.7-114.2 inches and 4 = 122.0-153.5 inches.

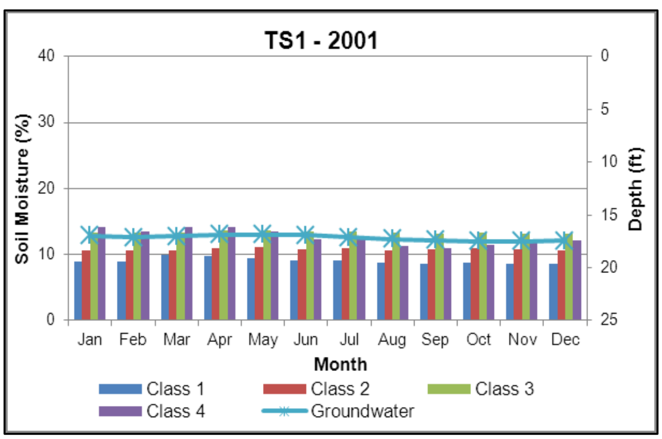


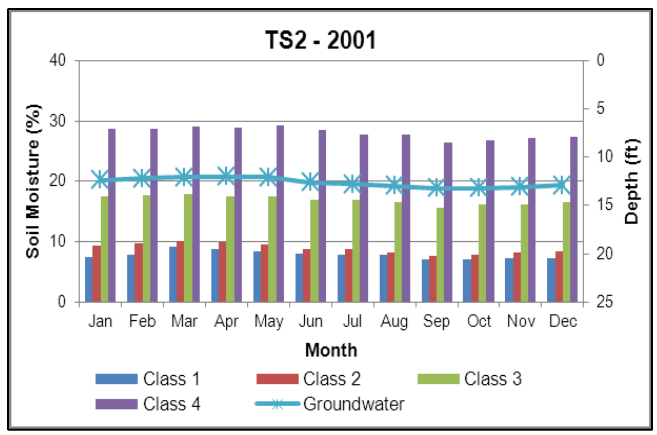

TS1 - 1999
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

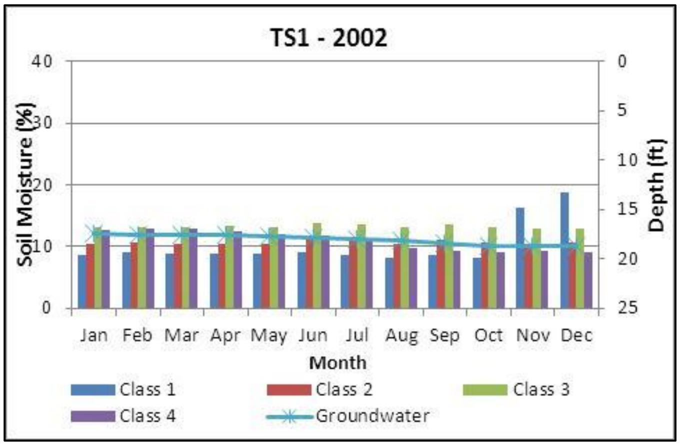

TS2 - 1999
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

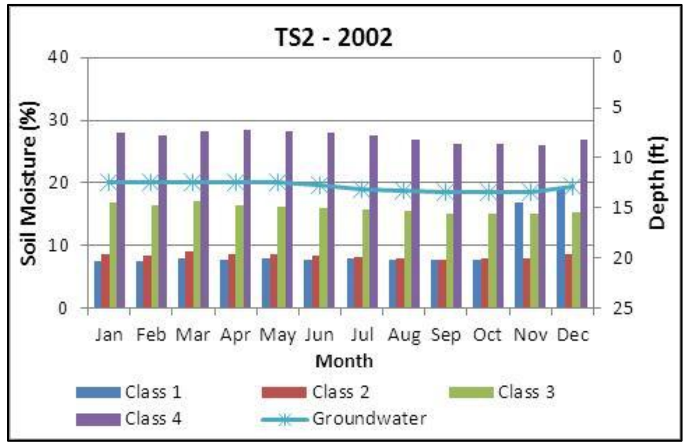

TS1 - 2000
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

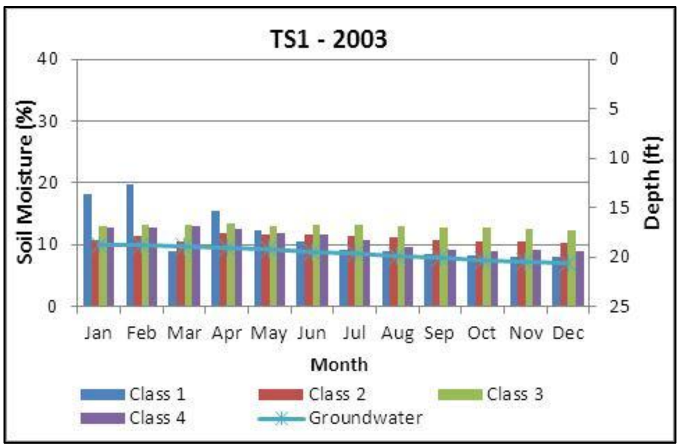

TS2 - 2000
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

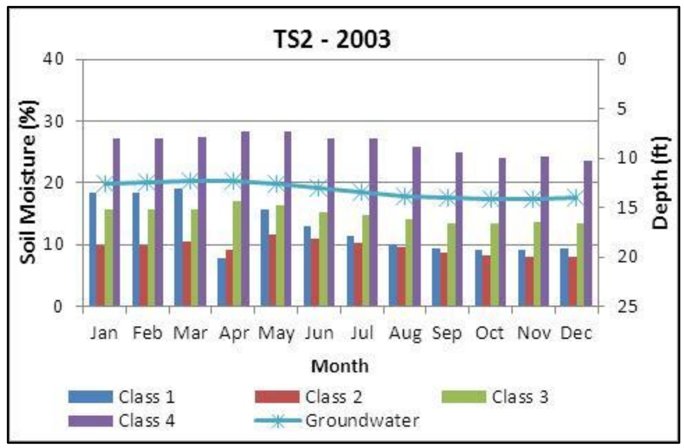

TS1 - 2001
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

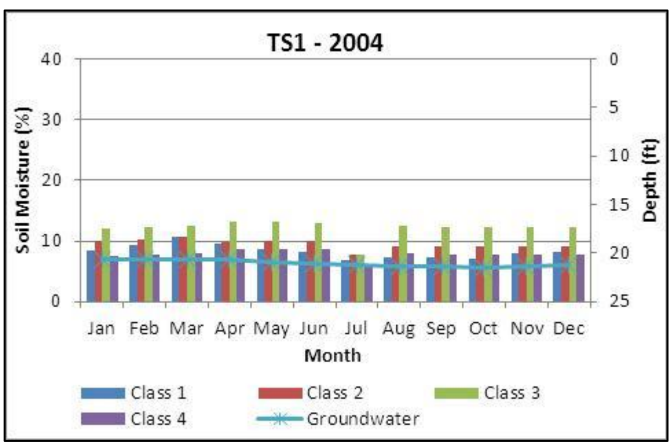

TS2 - 2001
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

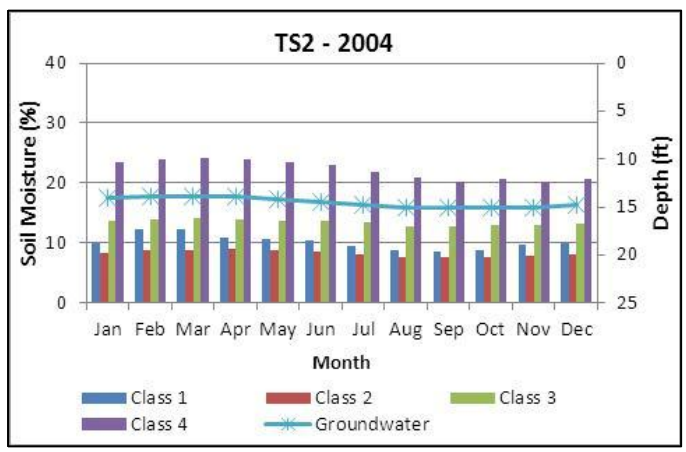

TS1 - 2002
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

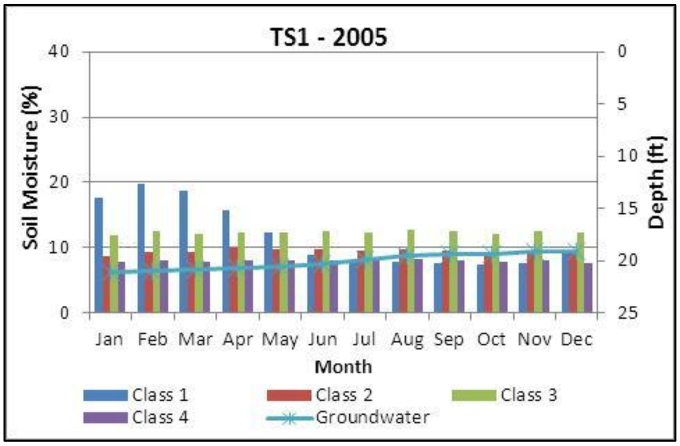

TS2 - 2002
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

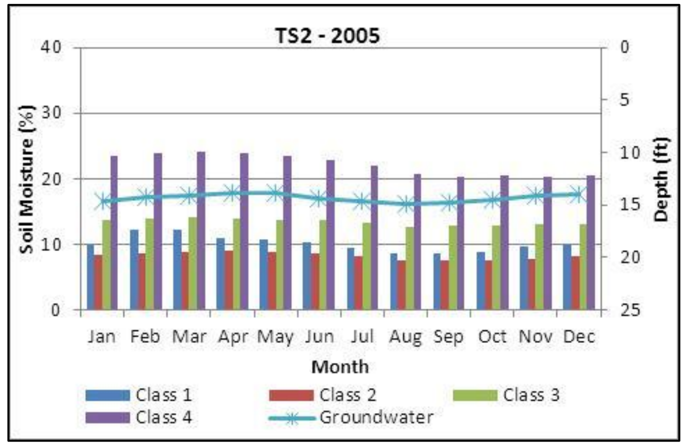

TS1 - 2003
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

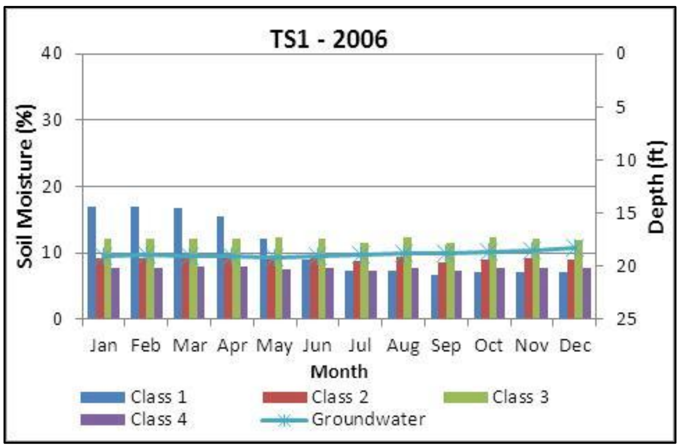

TS2 - 2003
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

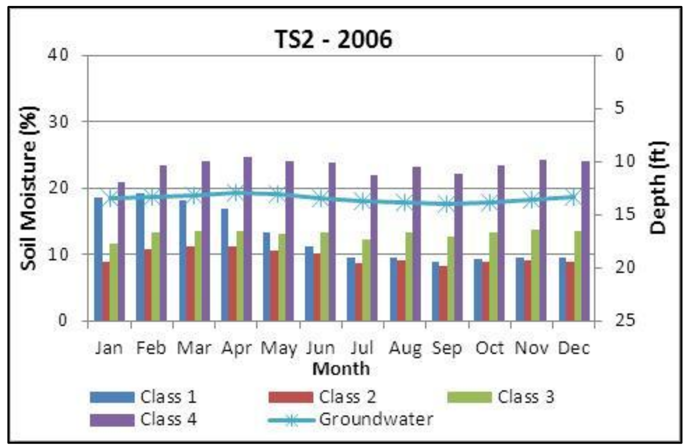

TS1 - 2004
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

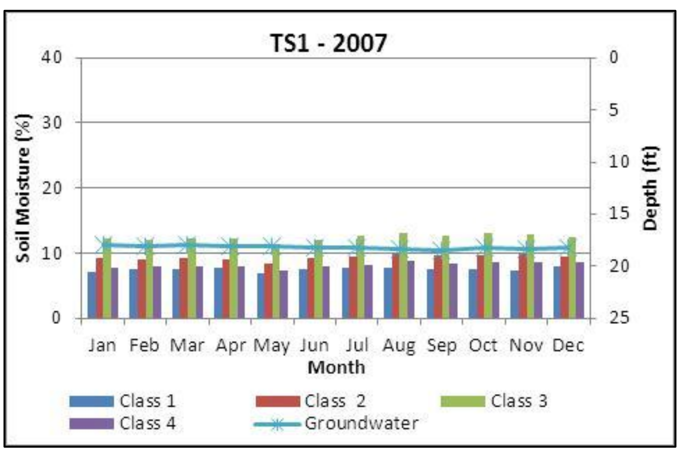

TS2 - 2004
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

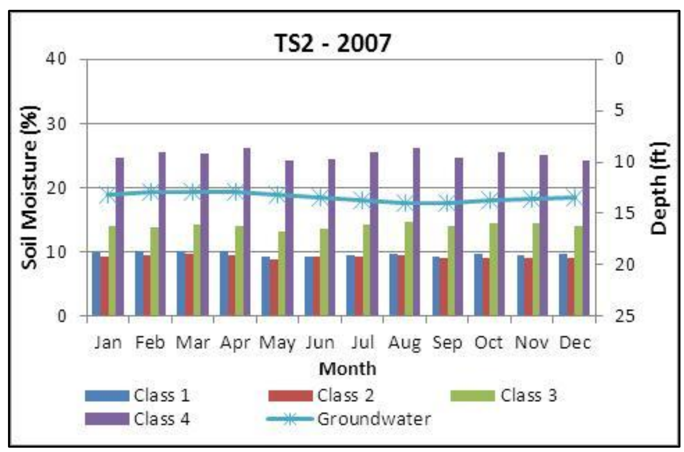

TS1 - 2005
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

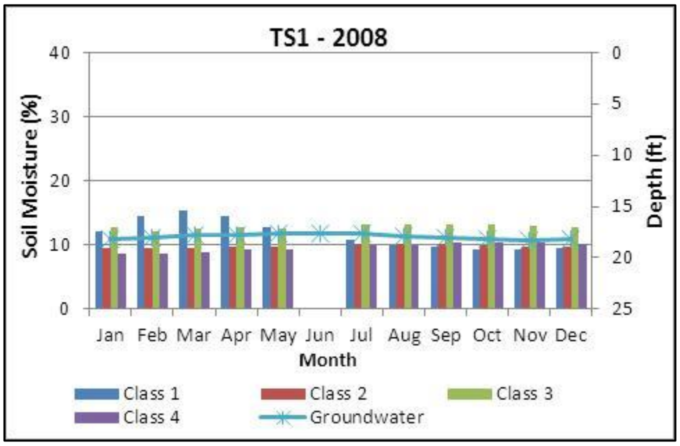

TS2 - 2005
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

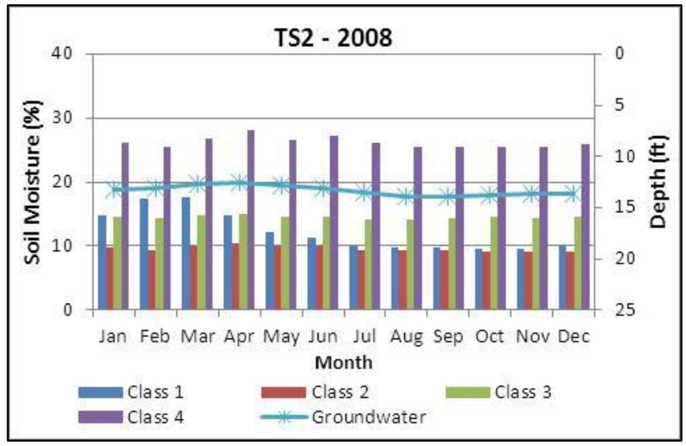

TS1 - 2006
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

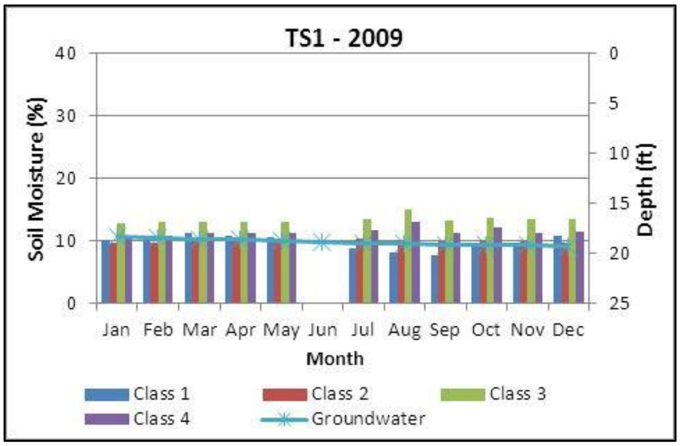

TS2 - 2006
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

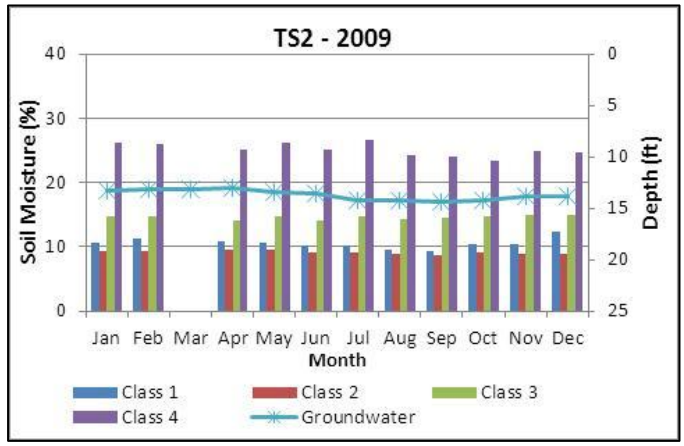

TS1 - 2007
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

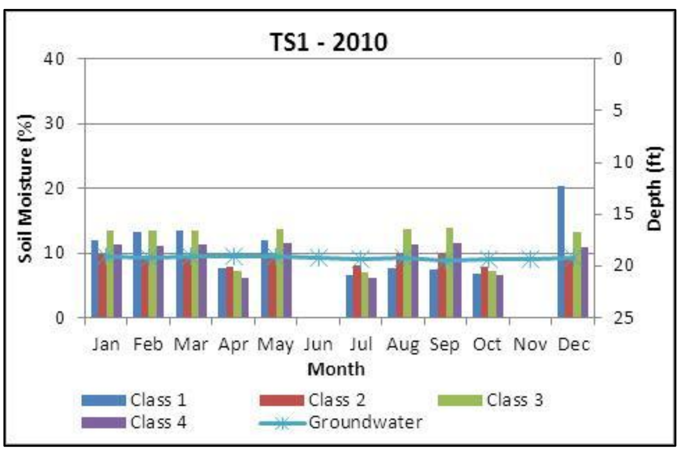

TS2 - 2007
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

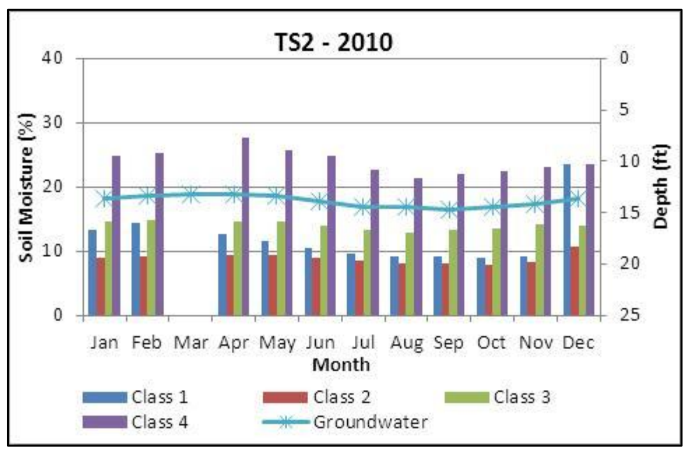

TS1 - 2008
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

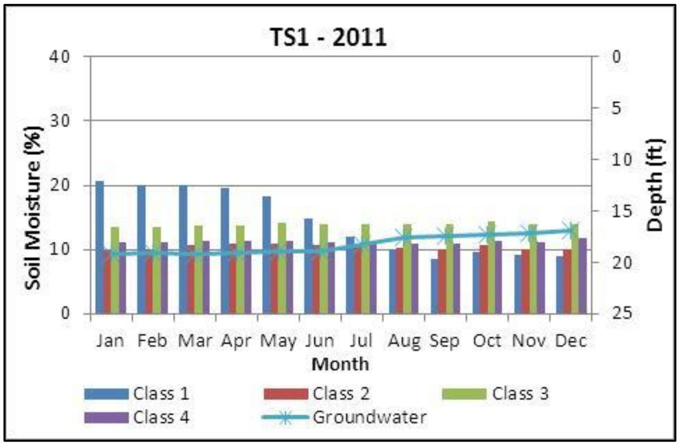

TS2 - 2008
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

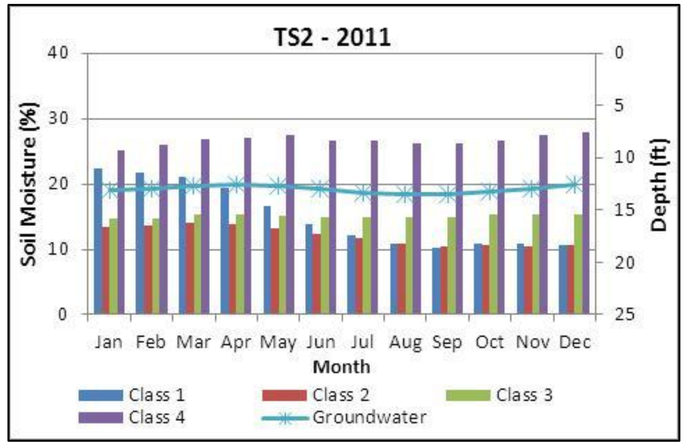

TS1 - 2009
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

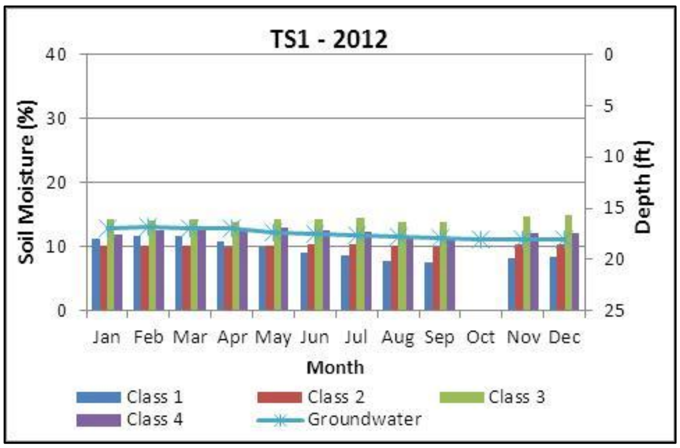

TS2 - 2009
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater

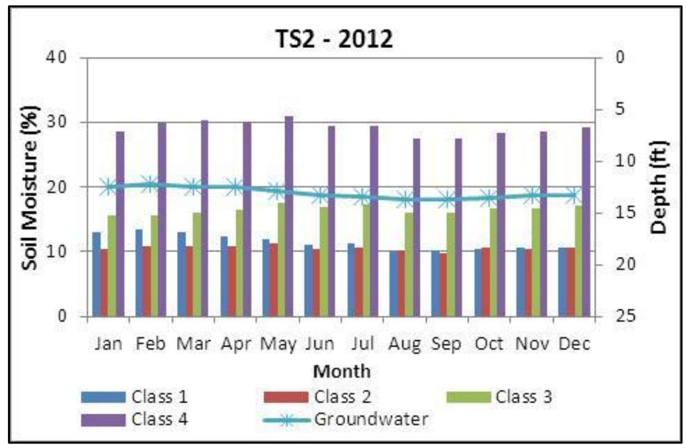

TS1 - 2010
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater


TS2 - 2010
Soil Moisture (%)
Depth (ft)
Month
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Class 1
Class 2
Class 3
Class 4
Groundwater


TS1 - 2011
Soil Moisture (%)
Depth (ft)
Month
Class 1
Class 2
Class 3
Class 4
Groundwater


TS2 - 2011
Soil Moisture (%)
Depth (ft)
Month
Class 1
Class 2
Class 3
Class 4
Groundwater


TS1 - 2012
Soil Moisture (%)
Depth (ft)
Month
Class 1
Class 2
Class 3
Class 4
Groundwater


TS2 - 2012
Soil Moisture (%)
Depth (ft)
Month
Class 1
Class 2
Class 3
Class 4
Groundwater

Precipitation, however, exerts more influence on soil-moisture at the sites than either surface-water spreading or DTW. During the years 1996, 1997, 1998, 2003, 2005, 2006, 2008, and 2011, precipitation at the Independence rain gage was above the long-term average of 5.49 inches and ranged from 6.9 to 10 inches (Figure b.vi.2). In response to the higher than normal precipitation, soil moisture levels in the uppermost layer (Class 1), at the start of growing season, at both TS1 and TS2 ranged from 15.5% to 19.7% and 11% to 17%, respectively (Figure b.vi.3). In comparison, in years with average to below average precipitation soil moisture, at the start of the growing season, in the uppermost layer (Class 1) ranged from 7% to 11% at TS1 and 8% to 13% at TS2 (Appendix 5.6.2). The use of simple linear-correlation statistics further supports the greater influence of precipitation on soil moisture (Appendix 5.6.3). When performing the correlation, soil moisture in the uppermost layer (11.8-35.4 in) was found to be most dependent on November to June precipitation as it explained 68.0% of the variability at TS1 and 27.3% at TS2 (Table b.vi.4). Conversely, DTW was the poorest predictor of soil moisture at TS1 as it explained only 2.2% of the variability; while at the TS2 site, 17.1%. Lastly, runoff from Sawmill Creek explained 37.3% and 5.8% of the variability in soil moisture at TS1 and TS2, respectively (Table b.vi.4).

Sec. 5.6 Table b.vi.4. Simple linear correlation results for the variables determining soil moisture content in the upper 35 inches of soil for both TS1 and TS2.

Simple Linear-Correlation				
	Site			
	TS1		TS2	
	r value	unadjusted r^2 value	r value	unadjusted r^2 value
Variable				
Precipitation Nov - Jun	0.82	0.68	0.52	0.27
Depth to Water	0.15	0.02	0.41	0.17
Runoff	0.61	0.37	0.24	0.06

5.6.1. Summary

Soil moisture levels vary throughout the analysis period of WY's 1996 to 2012 and between the TS1 and TS2 sites. The variability is because of surface water spreading and precipitation. Surface water spreading occurred in 6 of the 17 years of the analysis; however, only one year (WY 1995-1996) was there a response in soil moisture. During this year, water was spread in the vicinity of TS1 but not TS2. Subsequently the DTW decreased and soil moisture increased at TS1; however at TS2 both DTW and soil moisture remained approximately constant. In all other years, spreading occurred in outlying areas of TS1 and TS2 and there was no increase in soil moisture at either site. Trends in precipitation showed that greater soil moisture is found in the upper portions of the soil column (<36 inches) (where the majority of a plant's roots are found, particularly grasses) at the onset of the growing season during years with above average precipitation. Further, when examining the statistical relationship between the variables influencing soil moisture (stream runoff, precipitation and DTW), precipitation falling between November and June was a significantly better predictor than either stream-flow runoff or DTW in determining soil moisture content at both sites. Results reported by MWH Americas, Inc. (Appendix b.i.5.1.2) at the TS1 and TS2 sites from the years 1995-2001, found that the main factor controlling shallow soil-moisture was precipitation. Stemming from these two analyses (LADWP and MWH Americas, Inc.), it can be concluded that precipitation is the primary mechanism driving shallow soil-moisture levels at Blackrock 94.

5.7. LADWP Evaluation I.C.1.b.vii – Review surface water operations to determine if changes from past surface water management practices contributed to vegetation change.

This section provides a background and overview of the Los Angeles Aqueduct (LAA) operations and an analysis of surface water practices that may affect Blackrock 94.

The following background and overview portion of this section describes some of the history of the LAA as well as the principles and guidelines LADWP follows while operating the LAA. It is shown that surface water operations are influenced by numerous legal obligations, maintenance requirements, and runoff volume. It is also shown that LADWP's surface water management practices are consistent with those required by, the Water Agreement, and that LADWP has continued to manage its surface water management practices in a manner congruent to those surface management practices of between 1970 and 1990.

To determine if a change in past surface water management practices since 1970 has occurred, the analysis portion of this section evaluates the following parameters for surface water management practices in the area of Blackrock 94:

1) surface water management practices between 1970 and 1990,

2) surface water management practices since 1990, and

3) a comparison of surface water management practices between 1970 and 1990 to surface water management practices since 1990 to determine if there has been a change in surface water management practices.

Review of this data indicates that there has been no significant change in surface water management practices in the area of Blackrock 94 since 1970.

5.7.1. Background and Overview of LADWP's LAA Operations

5.7.1.1. The Los Angeles Aqueduct

The LAA is a collection of facilities that are used to gather and transport water from the Eastern Sierra to the City of Los Angles (City) in order to serve approximately four million people. Facilities include reservoirs, dams, spillways, tunnels, large pipe, earth- and concrete-lined channels, canals, ditches, and hydropower plants. LADWP operates numerous facilities on the LAA system, including flow control and diversion facilities along the Owens River and tributary streams, and groundwater wells that discharge into the LAA system. These facilities are located throughout the Mono Basin, Long Valley, and Owens Valley, extending more than 300 miles south to Los Angeles. The LAA Filtration Plant, located in Sylmar, California, is at the southern terminus of the LAA and receives the delivered water. Along the way, facilities are used to distribute water within the Owens Valley to meet "in-Owens Valley" needs. In-Owens Valley uses consist of water for irrigation, stock water, Enhancement/Mitigation (E/M) projects, town supplies, fish hatcheries, and other in-Owens Valley uses. Water is also diverted from the LAA system during periods of high snowpack runoff (runoff) for the protection of the LAA and for groundwater recharge.

The LAA was first completed in 1913. At that time the Owens River was diverted to an earth-lined channel that transitioned to a concrete-lined channel and transported diverted water to Haiwee Reservoir, and then through closed conduits to Los Angeles. For operational purposes, the part of the Owens River upstream of the diversion point is also considered part of the LAA. The second LAA was completed in 1970, which parallels the original alignment, in order to increase the capacity of the LAA system from Haiwee Reservoir to the City.

5.7.1.2. LAA Operations

The overall purpose of managing LAA operations is to:

(1) capture water as permitted by the City's water rights,

(2) transport the water to Los Angeles, and

(3) convey water to uses within Mono and Inyo Counties.

In doing so, there are numerous decisions that must be made that translate to operational actions. When operating the LAA, LADWP's operators must decide how much flow to allow in the various components of the LAA in order to transport the water as efficiently as possible. Efficient transport and operation serves to prevent unregulated releases and to avoid damaging the LAA or the environment. Operational decisions are made by the Operations Dispatcher, after coordination with other personnel. Field personnel, working out of facilities located along the LAA, execute these decisions by operating appropriate flow control and diversion facilities.

5.7.1.3. Operational Principles of the LAA

The primary guiding principles of LAA operations are to provide reasonable annual deliveries of water to the City and to meet in-Owens Valley uses within the context of the Water Agreement. To achieve that, a schedule of expected deliveries is prepared at the beginning of each runoff year (a runoff year is the period of time from April 1 of a year until March 31 of the following year). The schedule is prepared so that the LADWP sources of supply (water from the LAA, water from the San Fernando and other local Los Angeles groundwater basins, and water purchases from the Metropolitan Water District) can be coordinated to meet the City's expected demands. Because water from the LAA is typically the highest quality of all these sources, LADWP endeavors to use this high-quality source to the extent practicable within the context of the Water Agreement.

Many factors have a role in shaping the Los Angeles deliveries schedule: (1) the pattern and magnitude of City demands, (2) availability and pricing of various supplies, (3) availability of runoff and groundwater from the Eastern Sierra region, (4) environmental conditions, (5) LAA capacity, (6) obligations and mandated in-Owens Valley uses, (7) maintenance activities at the LAA Filtration Plant, and (8) maintenance activities on the LAA. In planning its LAA deliveries, LADWP employees and managers, who are involved with the various sources of supply, come together to prepare the schedule during the months of March and April when the expected snowpack can be reasonably estimated and runoff volume and timing becomes more predictable.

Historically (and currently) during periods of high runoff, the amount of water spread is based upon the amount of runoff and LAA capacity.

The peak runoff period (May-June-July) is the critical time for LAA operations. As snowpack begins to melt, flow in the streams (and inflow to the LAA) increases dramatically. Channels, particularly earth-lined channels, can be damaged if they receive more water than they are designed to carry. Damage is in the form of erosion that can lead to blow-outs and complete failures of the channel. The Operations Dispatcher monitors all inflows to avoid damaging the LAA, and to ensure that there is room for the predicted flows in the near future.

If a large amount of snowpack runoff is forecast, the Operations Dispatcher will work to reduce the amount of water in storage reservoirs at the beginning of the runoff season in order to make room for the anticipated high stream flows. The goal is to reduce reservoir storage in a planned and deliberate way, thereby preventing damage that could be caused by the inability to store water (which restrains water flow in the LAA) had the reservoirs been full.

5.7.1.4. Factors that Guiding Water Spreading

The primary factor influencing water spreading is the ability or anticipated ability of the LAA to convey water. Factors that influence the ability of the LAA to convey water include LAA design parameters, maintenance activities on the LAA or the LAA Filtration Plant, condition of the LAA, the amount or anticipated amount of runoff, and other factors that limit the ability of the LAA to receive additional water.

During years with especially large snowpacks, water is sometimes spread in spreading areas in the northern end of the Owens Valley in advance of a period of expected high runoff volumes. The purpose of water spreading when high runoff is expected is to maximize available reservoir storage and make room for any sudden increases in tributary stream flows. This is an extremely important concept: surface water management practices have historically been, and continue to be, dependent on runoff volumes. During most years with larger than normal snowpacks, water in excess of the LAA's capacity is typically spread concurrently with the spring runoff. These practices are intended to prevent runoff volumes in excess of the LAA's capacity from damaging or overtopping the LAA. Large volumes of unanticipated runoff, which may be due to a sudden increase in ambient temperature or a "rain on snow event"[22], may also be spread regardless of the existing snowpack amounts. Occasionally, high turbidity water will also be spread for water quality reasons.

While water spreading is often performed to reduce peak flows from the water courses that are tributary to the LAA and which could possibly fill the LAA beyond its capacity, water spreading during periods of high runoff also serves to recharge the groundwater basin. Water that is spread

[22] A rain on snow event is simply described as a rain storm on the mountain snowpack. Depending on the characteristics of the storm, a rain on snow event may cause a sizeable and sudden melting of the snowpack, resulting in a rapid increase in snowpack runoff.

may later be partially recovered by groundwater pumping. Most streams, including Hogback, Georges, Bairs, Shepard, Symmes, Pinyon, Independence, Oak, Thibaut, Sawmill, Black Canyon, Taboose, Goodale, and Division that feed into the LAA may have their flow diverted into unlined channels that allow the water to percolate into the ground, preventing it from reaching the LAA during periods of high runoff.

LAA spillgates and release gates may also be used to release water directly from the LAA if necessary. In such instances, released water flows into canals and drainage ditches in the Owens Valley, carrying it away from the LAA.

While many factors influence the timing and amount of water spreading, fundamentally more water is spread during those years with large snowpacks (and associated large volumes of runoff) than in years with small snowpacks (and relatively smaller volumes of runoff). An exception to this general rule would be a year with an above-normal snowpack and a cooler spring period extending into the summer. This condition would provide for a more gradual runoff that could result in a greatly reduced (or absence of) need for water spreading.

5.7.1.5. State Laws Affecting the Surface Water Operations and the Spreading of Water

LADWP's surface water management practices include water diversions into the LAA for municipal uses, irrigation and other "in-Owens Valley" uses, and water spreading. These management practices must be conducted in accordance with California state law.

Article X, Section 2 of the California Constitution requires water resources to be put to "beneficial use to the fullest extent of which they are capable":

> "*It is hereby declared that because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such waters is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare*."

The requirement that water resources be put to the fullest extent of which they are capable (sometimes referred to as "the highest and best use") and that the "waste or unreasonable use or unreasonable method of use of water be prevented" is also reflected in California State Water Code Section 100:

> "*It is hereby declared that because of the conditions prevailing in this State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such water is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare. The right to water or to the use or flow of water in or from any natural stream or watercourse in this State is and shall be limited to such water as shall be reasonably required for the beneficial use to be served, and such right does not and shall not*

extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water."

Accordingly, LADWP's surface water operations are managed to meet the City's obligations within the context of the Water Agreement while striving at all times to put its water resources to the highest and best use possible and to avoid the waste of water. The current highest and best use of water resources is generally recognized as being municipal, domestic, or industrial uses, followed by irrigation. Equally important among these uses are public trust and environmental uses that present challenging and evolving regulations/policies that require compliance.

The California Fish and Game Code provides one such environmental regulation and LADWP's surface water operations must be accomplished in conformance with provisions of the California Fish and Game Code. California Fish and Game Code 5937 that requires:

"*The owner of any dam shall allow sufficient water at all times to pass through a fishway, or in the absence of a fishway, allow sufficient water to pass over, around or through the dam, to keep in good condition any fish that may be planted or exist below the dam.*".

Fish and Game Code 5900 defines a "dam" to include "all artificial obstructions." Moreover, California Fish and Game Code 5901 makes it unlawful to construct or maintain in any stream in District 4 ½, which includes the Owens Valley, "*any device or contrivance which prevents, impedes, or tends to prevent or impede, the passing of fish up and down stream".*

Accordingly, LADWP's surface water management practices are conducted to both keep fish in good condition and to neither prevent nor impede the passing of fish up and down natural stream courses. This means that LADWP conducts its surface water operations in a manner that maintains sufficient base flows within the natural stream courses for these purposes and LADWP cannot divert so much out of the creeks that insufficient base flows, needed to keep fish in good condition, remain.

5.7.1.6. Other Factors Affecting Surface Water Management Practices

Water is also provided by LADWP for other uses within Mono and Inyo Counties. Operations for in-Owens Valley uses in Inyo County are coordinated from the LADWP Bishop office by LADWP's Watermaster. These uses are either year-round uses (fish hatcheries, stock water, town supplies), or seasonal uses (irrigation, certain enhancement/mitigation projects), and are supplied with surface water from natural stream courses on which the City has water rights or from the LAA or with pumped groundwater. General planning relative to what source to use for in-Owens Valley uses are made during the spring of each year, and depend on the expected stream flows, the anticipated amount of groundwater that may be extracted by groundwater wells, and the individual constraints of the in-Owens Valley uses (for example, town potable water systems must be supplied with groundwater).

Groundwater is also a source of supply to the LAA and one that has a direct effect on LAA operations. Groundwater production is managed in accordance with the provisions of the Water

Agreement and the Green Book. In conformance with the Water Agreement, LADWP prepares an Annual Operations Plan that describes how water is projected to be pumped during the upcoming year. According to the Water Agreement, wells in a given wellfield may be operated if monitoring shows that there is adequate soil moisture to protect vegetation within the Vegetation and Wellfield Management Area associated with the well field. Groundwater pumping is typically reduced during periods of high runoff and water spreading.

The major factors for operating the LAA in terms of facilities are: storage at Long Valley, Tinemaha, Haiwee and Bouquet Reservoirs; the preceding year's runoff volume and distribution; the timing of the pending runoff (typically streams toward the south experience runoff earlier than streams in the north), its peak magnitude, distribution along the LAA (sometimes, due to variations in snowpack or for other reasons, streams in the north may carry proportionately more water than streams to the south, and vice versa), and total volume and flow in the various components of the LAA. These factors are in addition to both scheduled and unscheduled maintenance activities of the LAA and the LAA Filtration Plant.

Another consideration that affects operations of the LAA is power generation. LAA water is used to generate hydroelectric power at twelve power plants along the LAA. This aspect of the operation is not described extensively and is only briefly mentioned to give the reader an understanding of the complexity of the LAA and its operation.

5.7.1.7. Provisions of the 1991 EIR, Water Agreement, and Green Book that affect LADWP's surface water management practices.

As required by the 1991 EIR, Water Agreement, and Green Book, LADWP manages its surface water operations in a manner consistent with its surface water management practices from between 1970 and 1990.

The 1991 EIR identifies the Water Agreement requirement to manage its surface water operations in accordance with past practices since 1970:

> "*Ditches and Canals - Agreement*
> *Under the provisions of the Agreement, LADWP will continue to operate canals in accordance with its practices from 1970 (past practices have included taking canals out of service for maintenance and for operational purposes)*" (1991 EIR, page 9-56, paragraph 2).

The 1991 EIR also refers to the Water Agreement's requirement that measurable changes in vegetation may only be considered to be significant, pursuant to the impact determination procedures of Water Agreement Section IV.B or Green Book Section I.C, if it has been determined that a measurable change in vegetation is attributable to groundwater pumping or changes in LADWP's past surface water management practices:

> "*Decreases and changes in vegetation and other environmental effects will be considered to be attributable to groundwater pumping, or to a* ***change in surface water management practices****, if vegetation decrease, change, or environmental effect would*

not have occurred but for groundwater pumping and/or a ***change in past surface water management practices***" (1991 EIR, page 10-72, paragraph 4, emphasis added).

Similarly, the 1991 EIR cites the Water Agreement's requirement that the Technical Group must consider how changes in surface water management practices have contributed to the significance of a measurable change in vegetation:

"Decreases and changes in vegetation…shall be considered "attributable to groundwater pumping or a change in surface water management practices", if the decrease, change, or effect would not have occurred but for groundwater pumping and/or a change in past surface water management practices" Water Agreement Section IV.B).

"*Whether effects of the vegetation decrease, change, or environmental effect are limited, but the incremental effects are substantial when viewed in connection with vegetation decreases or changes in other areas that are attributable to groundwater pumping or* ***to changes in surface water management practices by LADWP***" (1991 EIR, page 10-73, paragraph 2, emphasis added).

The Water Agreement's vegetation management provisions for *Type B, C, and D Vegetation Classifications* contains additional language addressing changes in surface water management practices:

"*The Department shall continue to operate canals in accordance with its practices from 1970 (past practices have included taking canals out of service for maintenance and for operational purposes)*" (Water Agreement Section IV.A, page 16, paragraph 3).

Water Agreement Section IV.B, *Determination of "Significant" and "Significant Effect on the Environment"* bears out the analysis of the 1991 EIR requiring that measurable changes in vegetation will be considered to be *attributable* only if the effect would not have occurred *but for groundwater pumping and/or a change in past surface water management practices*:

"*Decreases and changes in vegetation and other environmental effects shall be considered "attributable to groundwater pumping, or to a* ***change in surface water management practices****", if the decrease, change, or effect would not have occurred but for groundwater pumping and/or* ***a change in past surface water management practices***" (Water Agreement, Section IV.B, page 18, paragraph 4, emphasis added).

Water Agreement Section IV.B also requires consideration of *changes* in surface water management practices prior to determining a measurable change in vegetation or the environment to be significant. The Water Agreement requires the Technical Group to consider:

"*Whether effects of the decrease, change, or effect are limited, but the incremental effects are substantial when viewed in connection with decreases or changes in other areas that are attributable to groundwater pumping or to* ***changes in surface water management practices by the Department***" (Water Agreement Section IV.B, page 19, paragraph 2, emphasis added).

Green Book Section I describes the methods for meeting the goals and principles of vegetation management under the Water Agreement:

> *"I. VEGETATION MANAGEMENT*
> *This Green Book section describes methods for achieving the goals and principles for vegetation management of the Agreement. Unless otherwise specified, determinations, decisions, or actions called for in this section will be made by the Technical Group.* ***When reference is made to changes in surface water management practices, changes will be determined in comparison with past practices since 1970***[23]*.*
>
> *A. Management Goals*
> *The overall goal of managing the water resources within Inyo County is to avoid certain described decreases and changes in vegetation and to cause no significant effect on the environment which cannot be acceptably mitigated while providing a reliable supply of water for export to Los Angeles and for use in Inyo County. This means that groundwater pumping and* ***changes in surface water management practices*** *will be managed with the goal of avoiding significant decreases and changes in Owens Valley vegetation from conditions documented in 1984 to 1987, and of avoiding other significant environmental impacts"* (Green Book, page 1, paragraphs 1 and 2, emphasis added).

Green Book Section I.C provides the following standards for determining attributability:

> "*Determining Attributability*
> *Once it has been determined that there has been a measurable vegetation decrease or change, it must be determined whether the impact is attributable to groundwater pumping or to* ***changes in surface water management practices***.
>
> *A determination of whether the impact is attributable to groundwater pumping or* ***changes in surface water management practices*** *will be based on evaluation and consideration of relevant factors…*" (Green Book page 23, paragraphs 2 and 3, emphasis added).

In summary, the 1991 EIR, Water Agreement, and Green Book are consistent in requiring that LADWP continue its surface water management practices in a manner commensurate with those surface management practices since 1970. These documents require that any "…*changes in the surface water management practices will be managed with the goal of avoiding significant decreases and changes in Owens Valley vegetation*" (Green Book, page 1, paragraph 2). If a suspected change in surface water management practices is alleged to have caused a significant impact to vegetation, then the Technical Group is obligated to investigate the suspected change following the procedures of Water Agreement Section IV.B and Green Book Section I.C. However, Water Agreement Section IV.B and Green Book Section I.C require the determinations of attributability and significance to be wholly contingent on "whether the impact is attributable to

[23] The Green Book was published in June 1990.

groundwater pumping or to **changes in surface water management practices**" (Green Book, page 23, paragraph 3). Accordingly, in addition to evaluating groundwater pumping, it is necessary to determine if LADWP has changed its surface water management practices from those conducted between 1970 and 1990[24] and, if so, did a change in surface water management practices result in a significant adverse change in vegetation or the environment.

5.7.1.8. Water Accounting

LADWP has managed surface water in the Owens Valley for as long as it has held water rights in the valley. During its early years, LADWP maintained only a general accounting of its surface water uses. However, beginning in the late 1960's LADWP began a more detailed tracking of the amounts of water used and the spatial location of those uses for various purposes within the Owens Valley as a tool to aid its surface water management. LADWP refers to its water use tracking as "water accounting".

The earlier water accounting reports were effective in expressing how much water was put to various purposes, but were only summarized as totals used within broad areas of the Owens Valley. As the years passed, the water use accounting summaries became more detailed, focusing on the operational practices of specific stream courses. As a result, some of the detailed water accounting use data is available for the last 5, 10, or 20 years, but is not available prior to when more detailed records began being kept.

In LADWP's water use accounting system, water uses are divided into categories that describe the distinct purposes for the use of the water. These purposes are: Irrigation, Stock Water, Enhancement & Mitigation (E&M), Recreation & Wildlife, Indian Land Uses, Operations, Spreading (also called groundwater recharge), Lower Owens River Project, 1,600 Acre-Feet Projects, and Owens Lake Dust Mitigation.

For the purposes of the analysis of Blackrock 94, only the water accounting use categories of Irrigation, Stock Water, Operations, and Spreading apply. Uses that fall into the other categories occur far from Blackrock 94, and do not affect the parcel; therefore, they are not relevant to this analysis. The relevant categories are described below:

> Irrigation – Water supplied from water rights maintained by LADWP and delivered to lands owned by LADWP in the Owens Valley for use as irrigation. Typically, the LADWP-owned land is managed by a lessee. Once water is delivered to the lease the lessee manages the distribution of the water upon the lease.
>
> Stock Water – Water delivered to lessees for the purpose of drinking water for stock such as cattle and horses.

[24] Green Book Section I provides "*when reference is made to changes in surface water management practices, changes will be determined in comparison with past practices since 1970*." Since the Green Book was published in 1990, LADWP's analysis of changes in surface water management practices compares surface water management practices between 1970 and 1990 in the area of Blackrock 94 to surface water management practices since 1991.

Spreading – For the purposes of the analysis of Blackrock 94, this is water diverted from surface water sources during periods of high runoff into spreading diversions to allow the water to infiltrate into the ground. Diversion is normally done to relieve high flows in the LAA in order to avoid uncontrolled spillage and possible catastrophic failure of the LAA.

Operations –The operations category is intended to track water released due to maintenance of LADWP infrastructure, but can also be for other reasons. The accounting can be for an area or a lease. An exception to this is if water is released for operations to an area designated as a spreading area, then it is accounted for as a spreading use instead of as operations.

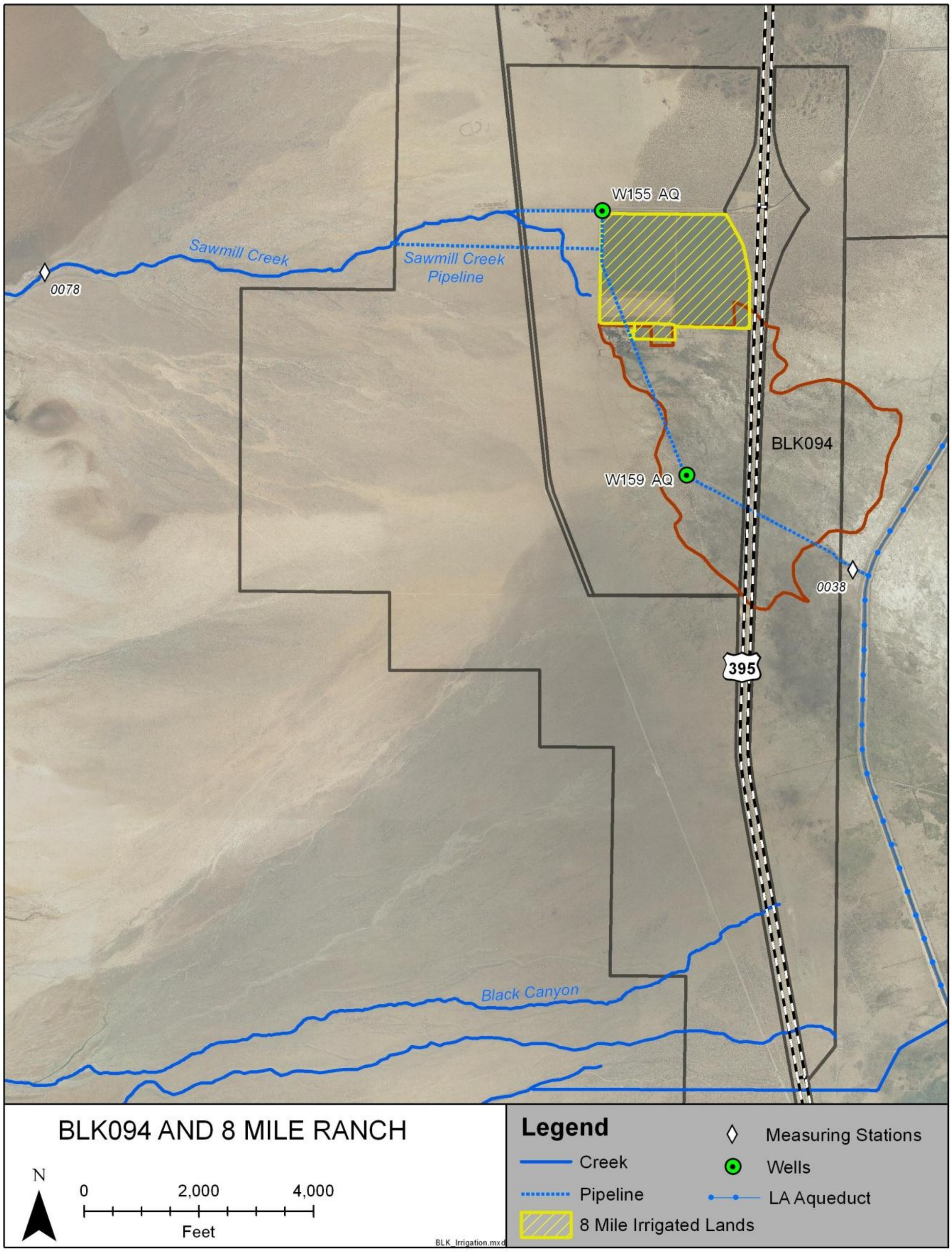
5.7.2. Analysis of LADWP's Surface Water Management Practices effecting Blackrock 94

5.7.2.1. Surface Water Management Practices in the Area of Blackrock 94

As shown in Figure b.vii.1, Blackrock 94 sits directly south of Sawmill Creek and to the north of Black Canyon Creek. The surface water management practices of these two creeks have the greatest potential of affecting vegetation conditions at Blackrock 94.

On Sawmill Creek, water is diverted annually for use as irrigation and stock water. Occasionally, water is also diverted for operations or spreading from this creek. On the other hand, Black Canyon Creek is an intermittent stream that typically only reaches the LAA during peak runoff or in above normal runoff years when the LAA is usually full. LADWP does not record permanent data for Black Canyon Creek and diverts water from it for spreading purposes during high runoff years. Due to the lack of data at Black Canyon Creek and because Sawmill Creek has much larger runoff flows and use diversions, the following analysis focuses on surface water management practices off of Sawmill Creek when discussing detailed surface water management practices which may affect Blackrock 94.

LADWP's surface water management practices for Sawmill Creek in the area affecting Blackrock 94 can be grouped into two categories: lease water uses and spreading. The lease water uses consist primarily of irrigation, stock water, and operations water delivered to the 8-Mile Ranch just to the north of Blackrock 94 (see figure b.vii.1). Spreading takes place off of diversions well upstream of Blackrock 94, where water is diverted out of the stream for groundwater recharge. Lease use water is provided to the 8-Mile Ranch consistent with the requirements of the Water Agreement and lease provisions. Because of the location of Sawmill Creek in the LAA system, as well as the characteristics of the stream itself, the past principles guiding LADWP's water spreading practices on Sawmill Creek (and Black Canyon Creek) have been relatively straightforward: If there has been no available capacity in the LAA to receive additional water from Sawmill Creek (or Black Canyon Creek), then water from these creeks has been spread; if the LAA has had available capacity, then water has not been diverted for spreading.



Sec. 5.7 Figure b.vii.1. Location of Blackrock 94, 8-Mile Ranch, and Sawmill and Black Canyon Creeks.

5.7.2.2. There has Been No Change in Lease Water Uses in the Area of Blackrock 94

To determine if a change in past surface water management practices since 1970 has occurred, the following analysis of surface water management practices evaluates the following parameters: 1) surface water management practices between 1970 and 1990, 2) surface water management practices since 1990, and 3) a comparison of surface water management practices between 1970 and 1990 to surface water management practices since 1990 to determine if there has been a change.

As specified in Green Book Section I (page 1, paragraph 1), when considering if changes in LADWP's surface water management have occurred, these "…changes will be determined in comparison with past practices from 1970." Given the Green Book was published in June 1990, surface water management practices from the period between 1970 and 1990 are compared to those between 1991 and the present.

The 8-Mile Ranch is the one lease that uses Sawmill Creek water that could potentially have an effect on Blackrock 94 as no other leases use water supplied by Sawmill Creek. LADWP has lease water use data recorded for 8-Mile Ranch dating back to 1970 for total uses on the lease, which include irrigation, stock water, and operations. The historical water use record is shown in Table B.VII.1.

Sec. 5.7 Table b.vii.1. - Total Water Use by Runoff Year for 8-Mile Ranch

Runoff Year	Acre-Feet Total Use	Runoff Year	Acre-Feet Total Use
1970-71	700	1991-92	758
1971-72	630	1992-93	804
1972-73	569	1993-94	780
1973-74	969	1994-95	805
1974-75	1087	1995-96	891
1975-76	815	1996-97	898
1976-77	626	1997-98	828
1977-78	426	1998-99	817
1978-79	415	1999-00	908
1979-80	487	2000-01	880
1980-81	294	2001-02	839
1981-82	730	2002-03	871
1982-83	1228	2003-04	910
1983-84	516	2004-05	797
1984-85	1109	2005-06	847
1985-86	1208	2006-07	958
1986-87	1220	2007-08	864
1987-88	1299	2008-09	813
1988-89	1193	2009-10	963
1989-90	1124	2010-11	986
1990-91	932	2011-12	1009
		2012-13	1034
1970-1990 Average:	837	1991-2013 Average:	875

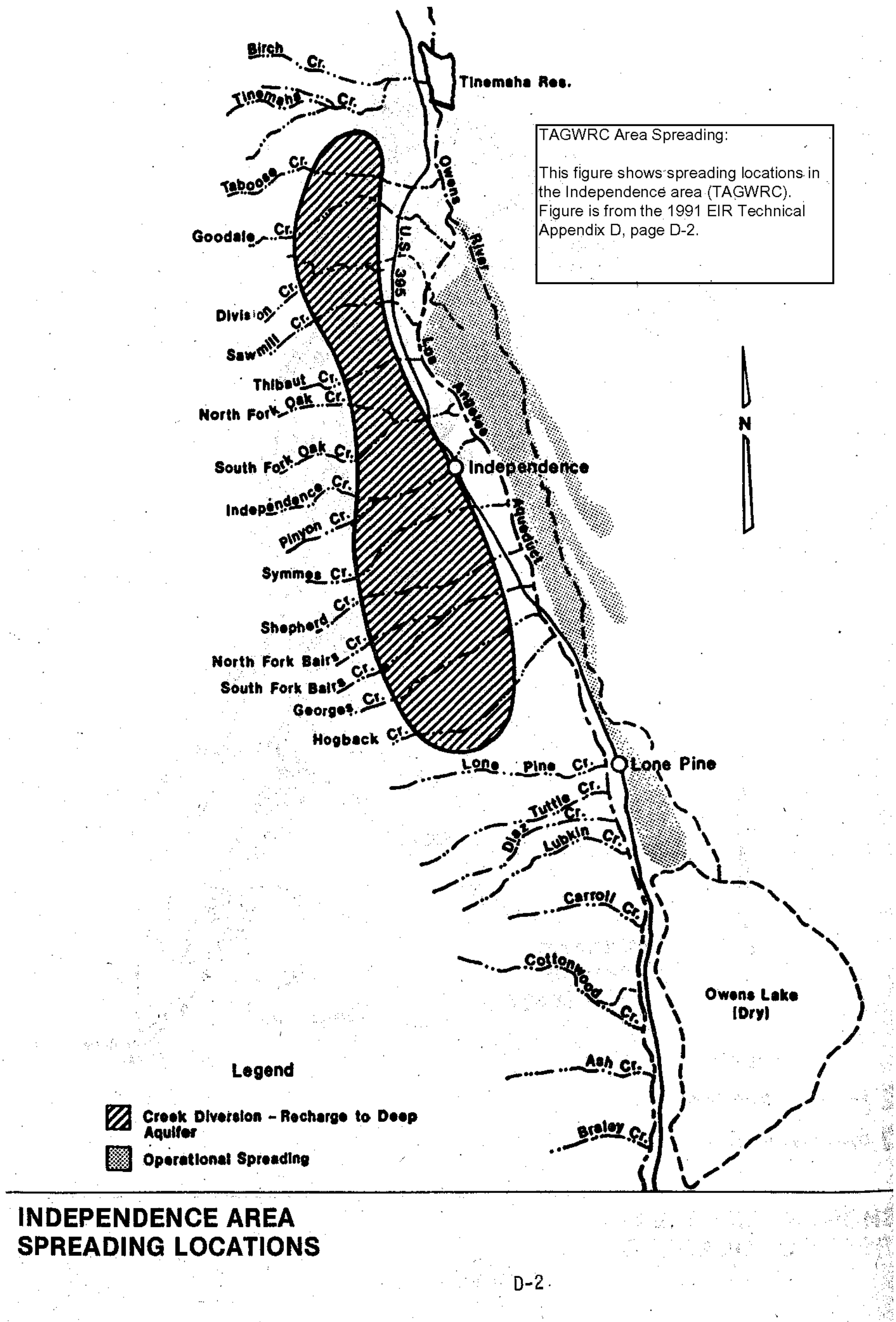
As shown on Table B.VII.1, total water uses for 8-Mile Ranch is similar for the period between 1970 and 1990, with an average annual use of 837 acre-feet, and the period between 1991 and 2013 having an average annual use of 875 acre-feet. A Mann-Whitney Rank Sum Test (P=0.62) comparing the periods 1970-1990 and 1991-2013 confirms that there is not a statistically significant difference in the water uses between the two time periods[25]. It is a clear conclusion from this data that no significant changes have been made to the lease use water deliveries off of Sawmill Creek.

5.7.2.3. There Has Been No Change in Water Spreading in the area of Blackrock 94.

Precise analysis of water spreading practices on Sawmill Creek is somewhat more challenging than analysis of the lease water uses because direct water accounting data for spreading on Sawmill Creek has only been available from 1989 through the present. However, other data is available that can be used to analyze the spreading practices on Sawmill Creek and determine whether a change in spreading practices has occurred.

The first set of data that can be used in the analysis is the spreading data for a larger area that encompasses Sawmill Creek spreading. Prior to 1989, water accounting methods kept track of bundles of individual creeks and water spreading amounts, which were tallied into total spreading values for larger areas. In this particular case, Sawmill Creek spreading is included in a total spreading area called “Tinemaha to Alabama Gates Groundwater Recharge” (TAGWRC). The area covered by TAGWRC is shown in Figure B.VII.2. Water account records for the total spreading in the TAGWRC area extends back to 1970, covers an area from 10 miles north of Sawmill Creek to 17 miles south of Sawmill Creek and includes all spreading that occurred from the streams in this area. The historical spreading numbers for TAGWRC are shown in Table B.VII.2.

[25] The Mann-Whitney Rank Sum Test is a non-parametric t-test used to determine whether two sets of data are different or similar. A non-parametric test was utilized because the dataset was not normally distributed. A P value result of 0.05 or less on these tests would have indicated that the two sets of data came from different populations.



Sec. 5.7 Figure b.vii.2. TAGWRC Spreading Locations

Sec. 5.7 Table b.vii.2. – Tinemaha to Alabama Gates Groundwater Recharge (TAGWRC)

Runoff Year	% Normal Runoff	Acre-Feet Spread	Runoff Year	% Normal Runoff	Acre-Feet Spread
1970-71	91%	578	1991-92	64%	0
1971-72	77%	0	1992-93	61%	0
1972-73	66%	0	1993-94	105%	4227
1973-74	111%	9868	1994-95	66%	418
1974-75	111%	2723	1995-96	152%	22406
1975-76	90%	412	1996-97	134%	2367
1976-77	60%	548	1997-98	123%	2925
1977-78	52%	0	1998-99	148%	16561
1978-79	155%	22581	1999-00	88%	0
1979-80	98%	0	2000-01	83%	135
1980-81	146%	31950	2001-02	82%	0
1981-82	84%	420	2002-03	67%	0
1982-83	159%	18023	2003-04	81%	0
1983-84	189%	58800	2004-05	77%	0
1984-85	120%	1725	2005-06	135%	11573
1985-86	102%	2341	2006-07	145%	21515
1986-87	157%	52267	2007-08	60%	0
1987-88	67%	0	2008-09	73%	2682
1988-89	62%	8	2009-10	77%	344
1989-90	62%	0	2010-11	102%	2538
1990-91	51%	0	2011-12	139%	10262
			2012-13	57%	0
1970-1990 Correlation			1991-2013 Correlation		
of Runoff to Spreading:		r=0.84	of Runoff to Spreading:		r=0.84

It might be noted that the total volume of water spread during the 1991-2013 period was less than during the 1970-1990 period. The reason for this is that the total volume of water flowing in Sawmill Creek was less during the 1991-2013 period than the 1970-1990 period and the 1970-1990 period included more very high runoff years in which large amounts of water were spread. Over half of all spreading for the 1970-1990 period occurred during two extremely high runoff years: 1983-84, a 189% of average runoff year and 1986-87, a 157% of average runoff year. Moreover, the 1991-2013 period was drier overall than the 1970-1990 period: 96% of average runoff between 1991 and 2013 vs. 100% of average runoff between 1970 and 1990.

There is a strong correlation between percent of normal runoff and spreading that indicates LADWP's practice of spreading pre-Water Agreement and post-Water Agreement has not changed.

In general, it has been LADWP's practice to spread water in years when runoff is high and not to spread in years when runoff is low. For the TAGWRC area, there is a relationship between high runoff and water spreading, which is supported by a coefficient of correlation between percent of normal runoff and spreading for the period between 1970 and 1990 of 0.84 (indicating a strong correlation)[26]. For the 1991 to 2013 period, the correlation coefficient between runoff and spreading in the TAGWRC area is also 0.84, again showing a strong correlation. This correlation indicates that LADWP's practice of spreading pre-Water Agreement and post-Water Agreement is consistent when looking at the area that encompasses Sawmill Creek.

An Analysis of Covariance of the regression of percent of normal runoff verses TAGWRC water spreading for the time periods 1970-1990 and 1991-2013 provides a P value in ANCOVA summary of 0.11[27], this further indicates that there is no difference in spreading patterns between those water spreading practices between 1970 and 1990 and those of 1991 and 2013 (Zar 1999).

Sawmill Creek Spreading for the available period of record (1989 to 2013) is provided in Table B.VII.3. A correlation between water spreading practices on Sawmill Creek and those spreading practices for the entire TAGWRC area provide a coefficient of 0.83, indicating a strong correlation between the two. This correlation demonstrates that LADWP has remained consistent in its water spreading practices when comparing those on Sawmill Creek to those within the entire TAGWRC area.

[26] The coefficient of correlation (or "simple correlation coefficient", also called "r") is a measure of intensity of association between two variables (Zar, 1999). All r values are between -1.0 and 1.0, with values close to 1.0 indicating a strong positive correlation, values close to -1.0 indicated a strong negative correlation, and values close to zero indicating a very weak correlation. Generally, statistical references accept values above 0.8 as indicating strong correlation and values below 0.5 as a weak correlation.

[27] An Analysis of Covariance using ANCOVA is a method of statistical analysis to test whether two sets of linear regression are the same. In this case it is used because two regression for each set of data are being compared (% normal runoff and TAGWRC spreading). P value results of .05 or less on the ANCOVA summary would have indicated that the two sets of data came from different populations.

Sec. 5.7 Table b.vii.3. Sawmill Creek Spreading

Runoff Year	Owens Valley Runoff % Normal	Sawmill Creek Spreading (AF)
1989-90	62%	0
1990-91	51%	0
1991-92	64%	0
1992-93	61%	0
1993-94	105%	248
1994-95	66%	0
1995-96	152%	516
1996-97	134%	506
1997-98	123%	234
1998-99	148%	570
1999-00	88%	0
2000-01	83%	0
2001-02	82%	0
2002-03	67%	0
2003-04	81%	0
2004-05	77%	0
2005-06	135%	802
2006-07	145%	729
2007-08	60%	0
2008-09	73%	0
2009-10	77%	0
2010-11	102%	0
2011-12	139%	808
2012-13	57%	0

Because water spreading in the area described by TAGWRC between 1970 and 2013 has been demonstrated to be correlated with the percent of normal Owens Valley runoff (r=0.84), and spreading practices at Sawmill Creek have also been shown to be correlated with spreading practices within the TAGWRC area (r=0.83), it can be reasonably inferred that spreading at Sawmill Creek is also correlated to percent of normal Owens Valley runoff for the period of 1970 to 2013.

Additionally, when a correlation between percent of Owens Valley runoff and Sawmill Creek Spreading is conducted, a correlation coefficient of 0.90 results, showing that Spreading on Sawmill Creek itself is highly correlated with runoff just as it is within TAGWRC area. Therefore, spreading at Sawmill Creek and spreading at TAGWRC follow the same pattern and the consistent management practice is that water is spread in these areas when runoff is high and it is not spread when runoff is low.

The question of Sawmill Creek spreading practices can also be approached from a different direction by using a simplistic water balance model, similar to the model used to investigate surface water history on page 32 of the Inyo County Water Department's February 2, 2011 report: *Analysis of Conditions in Vegetation Parcel Blackrock 94*. However, the model is modified to include the available ranch lease water use records.

As water in Sawmill Creek flows out of the mountains, it is measured at a station called "Sawmill Creek at Base of Mountains" (station ID 0078), as shown in Figure b.vii.1. At various points after the base of mountains measurement, the water may be diverted for various uses including spreading, irrigation, stock water, and operations. Also, both wells W155 and W159 may add pumped water to the creek flow, potentially adding to the total stream flow prior to its diversion into the LAA. Along the way, water is lost to evaporation, plant transpiration, and infiltration (losses). At the termination of the creek, the remaining water in Sawmill Creek is diverted into the LAA and is measured at that point by a flow measurement station called "Sawmill Creek at LAA" (station ID 0038).

Records are available for most of the variables used in the accounting of Sawmill Creek flows back to 1970 to allow a water balance formula to be set up to solve for the sum of the two unknowns:

SPREADING AND LOSSES = (STAID 0078 + W155 + W159) – (LEASE USES + STAID 0038) (1)

The results of the calculations for the 'SPREADING + LOSSES' term is shown in Table b.vii.4. When the 'SPREADING AND LOSSES' term is correlated against percent of normal runoff, there is a resulting coefficient of correlation(r) of 0.88 for the 1972 to 1990 pre-Water Agreement period (1970 and 1971 were omitted because well pumping data is unavailable for those 2 years). For the period between 1991 and 2013, there is an r of 0.87 when comparing runoff to "SPREADING + LOSSES" term. Again, these correlation coefficients indicate that there is consistency in surface water management practices because the correlation between runoff and spreading is nearly identical for the two time periods.

An Analysis of Covariance of the regressions of Owens Valley runoff verses calculated water spreading and losses from Sawmill Creek for the time periods 1970-1990 and 1991-2013 resulted in a P value in the ANCOVA summary of 1.00[28], this reliably indicates that there is no difference in spreading patterns between those water spreading practices between 1970 and 1990 and those of 1991 and 2013 (Zar 1999). Both are based on the amount of runoff in a given year, not the total amount of spreading in a particular period.

[28] P value results of .05 or less on the ANCOVA summary would have indicated that the two sets of data came from different populations. A 1.00 result is the highest P value possible.

Sec. 5.7 Table b.vii.4. Sawmill Creek Water Balance

		INFLOWS			USES + OUTFLOW		
Runoff Year	Owens Valley Runoff % Normal	Station 0078	Well W159	Well W155	8-MILE RANCH LEASE USE	Station 0038	CALCULATED SPREADING AND LOSSES
1970-71	91%	3769	na	na	700	3201	na
1971-72	77%	2631	na	na	630	4069	na
1972-73	66%	2184	1343	1341	569	3647	653
1973-74	111%	3731	615	405	969	2876	906
1974-75	111%	4322	272	110	1087	2630	987
1975-76	90%	3383	187	0	815	2105	650
1976-77	60%	2631	203	303	626	1914	597
1977-78	52%	2598	625	480	426	2241	1036
1978-79	155%	6008	13	0	415	2652	2954
1979-80	98%	4140	0	0	487	1858	1795
1980-81	146%	5536	0	0	294	2583	2659
1981-82	84%	3311	1	377	730	1729	1230
1982-83	159%	5713	54	39	1228	2712	1866
1983-84	189%	8163	1	0	516	3079	4569
1984-85	120%	5101	0	0	1109	2506	1486
1985-86	102%	4610	7	17	1208	2777	649
1986-87	157%	6948	213	189	1220	3363	2767
1987-88	67%	2874	890	304	1299	2890	-121
1988-89	62%	2562	362	434	1193	1802	363
1989-90	62%	2362	29	649	1124	1593	323
1990-91	51%	1997	0	162	932	701	526
1991-92	64%	2262	0	163	758	969	698
1992-93	61%	2673	0	0	804	956	913
1993-94	105%	4134	0	0	780	1934	1420
1994-95	66%	2550	0	391	805	1346	790
1995-96	152%	5160	0	47	891	2144	2172
1996-97	134%	5502	0	0	898	2628	1976
1997-98	123%	5146	0	0	828	3290	1028
1998-99	148%	6847	0	0	817	3849	2181
1999-00	88%	3705	0	0	908	2119	678
2000-01	83%	3073	18	0	880	1108	1103
2001-02	82%	3068	0	0	839	1330	899
2002-03	67%	2486	0	0	871	898	717
2003-04	81%	2902	0	0	910	1062	930
2004-05	77%	3115	0	0	797	1049	1269
2005-06	135%	6462	0	0	847	3398	2217
2006-07	145%	5351	0	0	958	2601	1792
2007-08	60%	2750	0	0	864	801	1085
2008-09	73%	2686	0	0	813	869	1004
2009-10	77%	2662	0	0	963	896	803
2010-11	102%	3657	0	0	986	1991	680
2011-12	139%	5972	0	0	1009	2622	2341
2012-13	57%	2687	0	0	1034	1274	379

Note: Well data was not recorded for 1970 and 1971

5.7.2.4. Analysis of Surface Water Management Practices Using Equation 2 from Inyo County Water Department's February 2, 2011 report: Analysis of Conditions in Vegetation Parcel Blackrock 94.

Inyo County Water Department analyzed LADWP's surface water management practices in their report dated February 2, 2011: *Analysis of Conditions in Vegetation Parcel Blackrock 94*. In the analysis (page 32 of the report) the term "Uses and Losses" is very similar to the "Spreading and Losses" term from Equation (1) except LADWP Equation 1 also includes the lease uses. As Inyo County described it "Uses and Losses" is "*surface water that is used for irrigation, water spreading, or percolates into the subsurface through stream channels and conveyances*." LADWP would describe the "Uses and Losses" term as surface water that is used for irrigation, stockwater, operations, water spreading, and losses due to evaporation, transpiration, and infiltration. However, this method of analysis is a valid one, albeit simplistic, so it is presented here as well, except LADWP performs the analysis using all of the relevant data available (1972 to 2013) instead of hand selecting a few specific years for the analysis as was done in the ICWD report. The equation is:

$$\text{Uses and losses} = (\text{STAID 78} + \text{W155} + \text{W159}) - \text{STAID 38} \qquad (2)$$

The results of the equation are presented in Table B.VII.5. The average "Uses and Losses" amount for the 1972 to 1990 period was 2,218 ac-ft/year. The average "Uses and Losses" for the 1991 to 2013 period was 2,106 ac-ft/year (a drop of 5%). Correspondingly, the average percent of normal Owens Valley runoff for the 1972 to 1990 period was 102% while the average percent of normal runoff for the 1991 to 2013 period was 96% (a drop of 6%). So, while the average "Uses and Losses" did drop 5% when comparing pre- and post- Water Agreement periods, the amount of runoff also dropped by a very similar amount of 6%.

When the "Uses and Losses" is correlated to percent of normal runoff, there is a coefficient of correlation of 0.94 for the 1972 to 1990 period and a coefficient of correlation of 0.89 for the 1991 to 2013 period. Both time periods have very strong correlations between "Uses and Losses" and percent of normal runoff. Because losses (evaporation, transpiration, and infiltration) have remained relatively stable over time, the year-to-year fluctuations in the "Uses and Losses" term can reasonably be inferred to be solely due to fluctuations in Sawmill Creek uses, which have not changed since 1972 and are highly correlated with runoff.

Sec. 5.7 Table b.vii.5. Sawmill Creek Water Balance using Inyo County's Analysis Methods

Inyo County Method - Sawmill Creek Water Balance						
		INFLOWS			OUTFLOW	
Runoff Year	**Owens Valley Runoff% Normal**	Station 0078	Well W159	Well W155	Station 0038	**CALCULATED USES ANDLOSSES**
1970-71	91%	3769	na	na	3201	na
1971-72	77%	2631	na	na	4069	na
1972-73	66%	2184	1343	1341	3647	1221
1973-74	111%	3731	615	405	2876	1875
1974-75	111%	4322	272	110	2630	2074
1975-76	90%	3383	187	0	2105	1465
1976-77	60%	2631	203	303	1914	1223
1977-78	52%	2598	625	480	2241	1462
1978-79	155%	6008	13	0	2652	3369
1979-80	98%	4140	0	0	1858	2282
1980-81	146%	5536	0	0	2583	2953
1981-82	84%	3311	1	377	1729	1960
1982-83	159%	5713	54	39	2712	3094
1983-84	189%	8163	1	0	3079	5085
1984-85	120%	5101	0	0	2506	2595
1985-86	102%	4610	7	17	2777	1857
1986-87	157%	6948	213	189	3363	3987
1987-88	67%	2874	890	304	2890	1178
1988-89	62%	2562	362	434	1802	1556
1989-90	62%	2362	29	649	1593	1447
1990-91	51%	1997	0	162	701	1458
1991-92	64%	2262	0	163	969	1456
1992-93	61%	2673	0	0	956	1717
1993-94	105%	4134	0	0	1934	2200
1994-95	66%	2550	0	391	1346	1595
1995-96	152%	5160	0	47	2144	3063
1996-97	134%	5502	0	0	2628	2874
1997-98	123%	5146	0	0	3290	1856
1998-99	148%	6847	0	0	3849	2998
1999-00	88%	3705	0	0	2119	1586
2000-01	83%	3073	18	0	1108	1983

Sec. 5.7 Table b.vii.5, continued

Inyo County Method - Sawmill Creek Water Balance						
		INFLOWS			**OUTFLOW**	
Runoff Year	**Owens Valley Runoff% Normal**	Station 0078	Well W159	Well W155	Station 0038	**CALCULATED USES ANDLOSSES**
2001-02	82%	3068	0	0	1330	1738
2002-03	67%	2486	0	0	898	1588
2003-04	81%	2902	0	0	1062	1840
2004-05	77%	3115	0	0	1049	2066
2005-06	135%	6462	0	0	3398	3064
2006-07	145%	5351	0	0	2601	2750
2007-08	60%	2750	0	0	801	1949
2008-09	73%	2686	0	0	869	1817
2009-10	77%	2662	0	0	896	1766
2010-11	102%	3657	0	0	1991	1666
2011-12	139%	5972	0	0	2622	3350
2012-13	57%	2687	0	0	1274	1413

5.7.2.5. There has Been No Change in Sawmill Creek Diversion to the LAA

Runoff water in Sawmill Creek has been analyzed for changes in surface water management practices for lease uses and for spreading, so the last remaining piece to analyze is the diversions from Sawmill Creek to the LAA (or acre-feet of water diverted to the LAA). Table b.vii.6 shows the Sawmill Creek LAA diversions (measured at station ID 0038 and subtracting out the pumped groundwater contribution from wells W155 and W159 to station ID 0038):

Sec. 5.7 Table b.vii.6. Sawmill Creek Diversions to the Los Angeles Aqueduct (with the contribution from groundwater from wells W155 and W159 water subtracted).

Runoff Year	Acre-Feet Diverted	Runoff Year	Acre-Feet Diverted
1970-71	na	1991-92	806
1971-72	na	1992-93	956
1972-73	963	1993-94	1934
1973-74	1856	1994-95	955
1974-75	2248	1995-96	2097
1975-76	1918	1996-97	2628
1976-77	1408	1997-98	3290
1977-78	1136	1998-99	3849
1978-79	2639	1999-00	2119
1979-80	1858	2000-01	1090
1980-81	2583	2001-02	1330
1981-82	1351	2002-03	898
1982-83	2619	2003-04	1062
1983-84	3078	2004-05	1049
1984-85	2506	2005-06	3398
1985-86	2753	2006-07	2601
1986-87	2961	2007-08	801
1987-88	1696	2008-09	869
1988-89	1006	2009-10	896
1989-90	915	2010-11	1991
1990-91	539	2011-12	2622
		2012-13	1274
1972-1990 Average:	1896	1991-2013 Average:	1751

Table b.vii.6 assumes that any pumped water from W155 and W159 remained in the creek when the water was measured at “Sawmill Creek at LAA” (station ID 0038), so it has been subtracted out of the diversion total. In reality, not all of the pumped water would reach the LAA as some would be lost to evaporation, transpiration, or infiltration. Nevertheless, assuming that all pumped groundwater reaches the LAA diversion is a conservative approach to the diversion analysis; therefore, full diversion of pumped water was assumed.

The average amount of water diverted from Sawmill Creek to the LAA between 1972 and 1990 was 1,896 acre-feet. From 1991 to 2013, the average diversion was 1,751 acre-feet. Less water has been diverted from Sawmill Creek to the LAA since 1991, but the difference is not statistically significant, demonstrating that LADWP's surface water management practices have remained consistent and unchanged since 1970.

5.7.3. Summary of LADWP's Analysis Regarding Changes in LADWP Surface Water Management Practices – There has Been No Change in LADWP's Surface Water Management Practices in the Area of Blackrock 94 Since 1970

Green Book Section I.C.1.b, *Determining Attributability*, requires the Technical Group to determine if a measurable change in vegetation cover or composition or other effect on the environment "*is attributable to groundwater pumping or to **changes in surface water management practices**"* (Green Book page 23, paragraph 2, emphasis added).

Green Book Section I.C.1.b further defines several factors that must be considered prior to determining "*whether the impact is attributable to groundwater pumping or **changes in surface water management practices***" (Green Book page 23, paragraph 3, emphasis added). One of the relevant factors the Technical Group is required to consider is listed under Green Book Section I.C.1.b.vii, which states that the Technical Group shall consider a "*review of surface water management operations to determine if **changes from past practices** contributed to vegetation change"* (Green Book, page 24, paragraph 6, emphasis added).

To satisfy this requirement, this section has provided an overview of LADWP's surface water system and its operation, including a description of the various elements of the system. A description of LADWP's surface water management practices including its practical, contractual, and legal considerations in operating its surface water system have also been included. Finally a detailed analysis of LADWP's surface water management practices on Sawmill Creek since 1970 has been provided.

In conducting its analysis to determine the extent of changes in surface water management practices in the Blackrock 94 area, LADWP first conducted a "lease water use" evaluation that considered changes in the amount of water diverted from Sawmill Creek, the principal surface water source in the Blackrock 94 area, to the 8-mile Ranch, the only agricultural recipient of Sawmill Creek water that could have an effect on Blackrock 94. The lease water use analysis considered irrigation, stock water, and operational uses supplied to the 8-mile Ranch during the 1970 to 1990 period and compared these uses to surface water supplied during the 1990 to 2013 period. Multiple statistical approaches confirmed that there is no difference in surface water uses between the two time periods.

Next, an analysis was performed that compared historical spreading over the area that includes Sawmill Creek and Blackrock 94, known as the Tinemaha to Alabama Gates Groundwater Recharge area or the TAGWRC. A very strong correlation was shown to exist between runoff and surface water spreading in the TAGWRC area. Surface water spreading practices were then compared in the TAGWRC area for the periods from 1970 to 1990 and between 1991 and 2013. It was determined that there were strong correlations between runoff and spreading in the TAGWRC area when comparing data for the period between 1970 to 1990 and the period between 1991 to 2013 and that the correlation between the two was identical. LADWP's surface water spreading operations in the TAGWRC area have followed the same management practices since 1970: if there has been available capacity in the aqueduct, then water was diverted to the LAA; if the available aqueduct capacity was such that it could not receive additional water, then water was spread for groundwater recharge.

LADWP then compared the water spreading practices on Sawmill Creek for the period of which water spreading records were maintained specifically on Sawmill Creek water spreading (1989 to 2013) to the water spreading practices for the TAGWRC area (Table b.vii.2). The resulting correlation coefficient value of 0.83 along with an analysis of covariance ANCOVA P value of 0.11 indicates a strong correlation between the surface water spreading practices on Sawmill Creek and water spreading practices for the TAGWRC area. Since the water spreading practices for the TAGWRC area have been shown to have remained consistent since 1970, it can reasonably be inferred that water spreading practices on Sawmill Creek have also remained consistent since 1970.

The Owens Valley runoff record was also compared to Sawmill Creek spreading record. The resulting correlation indicates that water spreading practices on Sawmill Creek are highly correlated with years of high Owens Valley runoff and confirm that water spreading on Sawmill Creek is conducted in years of high runoff, just as it is with the TAGWRC area.

A spreading analysis was also performed using a simple water balance model. The model calculated water spreading and losses on Sawmill Creek for the period of between 1972 and 2013. The results of the water balance model were then analyzed to determine the correlation between percent of normal runoff and water spreading and losses on Sawmill Creek for the periods of 1972-1990 and 1991-2013. The analysis found both strong correlations between runoff and Sawmill Creek water spreading and further found no change in spreading practices since 1972.

A second simple water balance analysis of Sawmill Creek surface water management practices was conducted using Equation 2 from Inyo County Water Department's February 2, 2011 report: *Analysis of Conditions in Vegetation Parcel Blackrock 94*. However instead of hand selecting data for the analysis as was done in the report, all available data was used. The analysis found strong correlations between runoff and "Uses and Loses" on Sawmill Creek and "Uses and Losses" for the periods of 1972-1990 and 1991-2013 and further found no change in water management practices since 1972

An analysis of the regressions of Owens Valley runoff verses calculated water spreading and losses from Sawmill Creek for the time periods 1972-1990 and 1991-2013 resulted statistical values indicating that there is no difference in spreading patterns between those water spreading practices between 1972 and 1990 and those of 1991 and 2013.

Finally, an analysis was performed on surface water diversions from Sawmill Creek to the LAA for the 1972-1990 period and compared to diversions for the 1991-2013 period. Although the the analysis found that amount of water diverted into the LAA from Sawmill Creek decreased from an average of 1,896 acre-feet per year during the 1970-1990 period to an average of 1,791 acre-feet per year during the 1991-2013 period, the difference is not statistically significant. Results show that LADWP has remained consistent in its water diversions from Sawmill Creek into the LAA and that LADWP has not changed surface water management practices since 1972.

5.7.3.1. LADWP has not changed its surface water management practices in the Blackrock 94 area since 1970.

LADWP has provided an overview of its surface water operations and conducted numerous analyses using all available hydrologic data for both for the overall area surrounding Blackrock 94 and for Sawmill Creek, the principle water source that could affect Blackrock 94. These analyses examined LADWP's surface water management practices in the area of Blackrock 94 for the period between 1970 and 2013 for the purpose of evaluating the overall relationships of LADWP's surface water management practices in the area of Blackrock 94 and to determine if there has been a change in surface water management practices since 1970. The analyses conducted by LADWP used various approaches in determining if surface water management practices have changed in the area of Blackrock 94 and the conclusions of each of these methods were vetted using standard scientific analytical methods. The results of all of the analysis concluded that:

1. Water supply practices to the 8-mile Ranch, which include water for irrigation, stock water, and operational uses, have not changed since 1970.
2. LADWP's water spreading practices both in the general area of Blackrock 94 and on Sawmill Creek, which is adjacent to Blackrock 94, are highly correlated with runoff. Water is reliably spread during periods of high runoff and not spread during periods of low runoff.
3. LADWP's water spreading practices both in the general area of Blackrock 94 and on Sawmill Creek have not changed since 1970.
4. LADWP's water management practices related to diversions from Sawmill Creek into the LAA have not changed since 1970.

Based upon the preceding analysis of the overlying facts and relevant data using numerous different analytical methods, it is unambiguously concluded that surface water management practices have not changed in the area of Blackrock 94 since 1970.

5.8. LADWP Evaluation I.C.1.b.viii – Springs and Flowing Wells in the Area of Blackrock 94

As part of the attributability analysis, the effect of pumping on flowing well and spring flows in the area of Blackrock 94 was evaluated. The flow records of Big Black Spring and nine flowing wells were evaluated in relation to groundwater pumping from wells in south and central Taboose-Aberdeen and Thibaut-Sawmill Wellfields and Owens Valley runoff. Correlation analysis indicated that flow from non-hatchery flowing wells was not correlated with hatchery supply pumping but was correlated with Owens Valley runoff and pumping from non-hatchery supply wells that were screened to the deep aquifer within the Thibaut-Sawmill Wellfield.

Springs

Typical springs and seeps within the Owens Valley exist because of the Owens Valley fault or fault branches. Groundwater flows from the alluvial fans of the Eastern Sierra Nevada and Inyo and White Mountains, toward the Owens River. The Owens Valley fault, which lies between the Eastern Sierra Nevada's and the Owens River, creates a groundwater barrier. Once groundwater reaches the fault barrier, it rises to ground surface either through seeps and springs, or through flowing wells.

Big Blackrock Spring itself is fundamentally different from other springs adjacent to Owens Valley Fault. This spring is located atop a volcanic formation with shallow depth and high conductivity, which extends mainly north and west of the Blackrock Fish Hatchery. Big Blackrock Spring is where the groundwater from the shallow volcanic aquifer flows to the surface due to the lower ground elevation at the spring as compared to the rest of the volcanic formation.

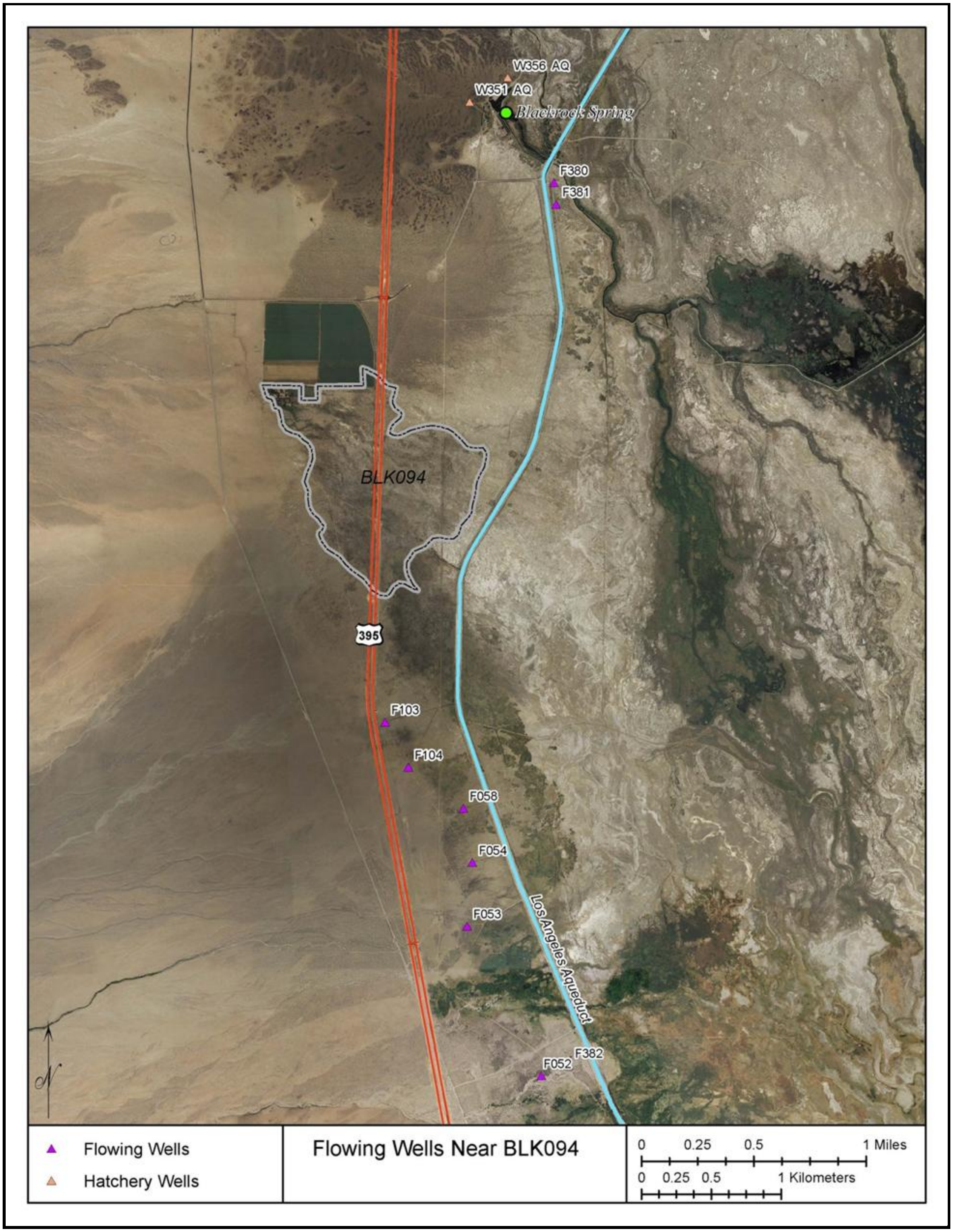
The two pumping wells that supply Blackrock Hatchery, W351 and W356, are screened within the same volcanic formation as the source of Big Blackrock Spring. When pumping for hatchery supply began in October of 1972 at a rate greater than the long-term potential spring flow, spring flow at Big Blackrock Spring ceased. The effects of groundwater pumping to supply the Blackrock Hatchery on associated meadow and riparian vegetation were identified and mitigated in the 1991 EIR (mitigation measure 10-14).

Flowing Wells

A number of pumping/flowing wells exist in Thibaut-Sawmill Wellfield, although there are no flowing wells in Blackrock 94. Flowing wells are typically drilled and screened below a confining layer that separates shallow and deep aquifers. As a result of the artesian pressure in the deeper aquifer, these wells to flow when they are not being pumped.

The pumping/flowing wells in the Thibaut-Sawmill Wellfield include: W380, W381, W103, W104, and W382 (Figure b.viii.1). When these wells are not being pumped, they are designated as “F” wells. Separate records are maintained for the periods these wells are operated as a “W” (pumping wells) and when they are not operated as “F” (flowing wells).

Flowing wells that are not operated as pumping wells in the Thibaut-Sawmill Wellfield include F052, F053, F054, and F058. Figure b.viii.1 shows the location of flowing wells in relation to Blackrock 94 and the Blackrock Hatchery.



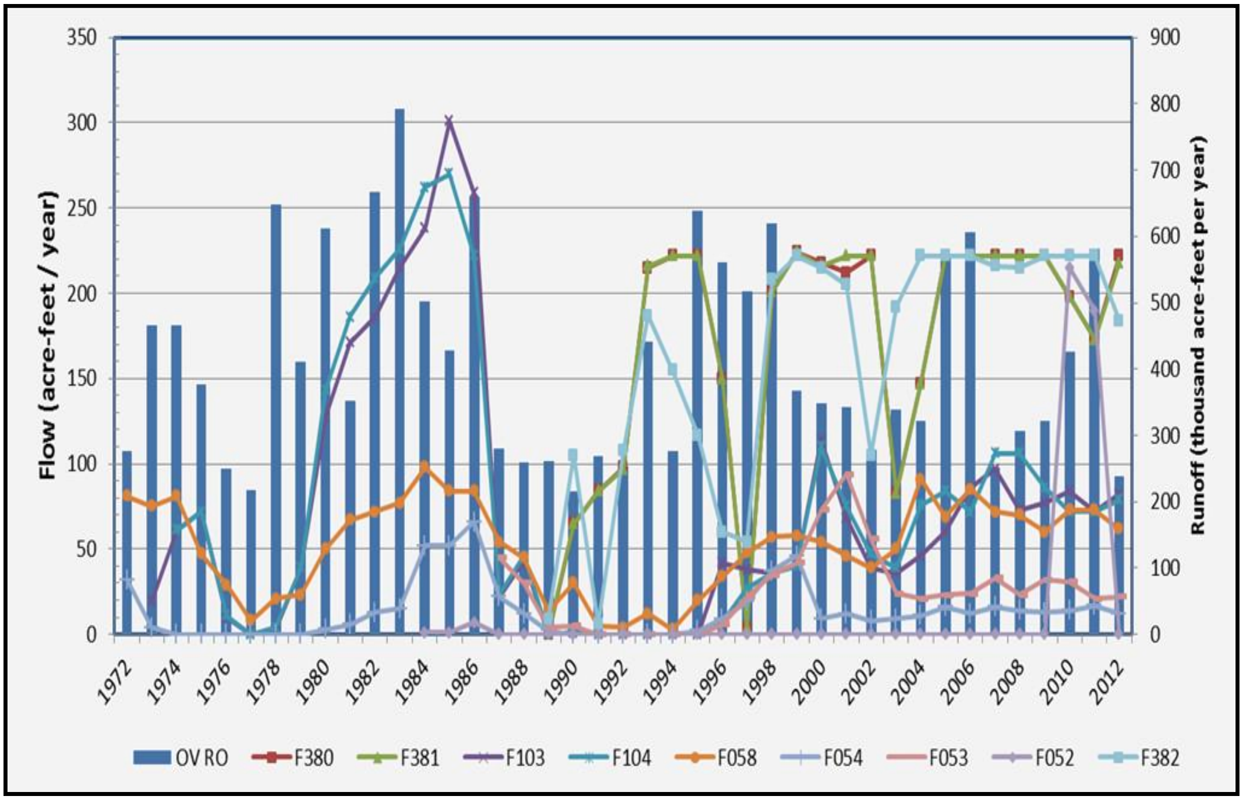
Sec. 5.8 Figure b.viii.1. Location of the Blackrock Fish Hatchery and groundwater wells (pumping and flowing) in relationship to Vegetation Parcel Blackrock 94.

Analysis (Flowing Wells)

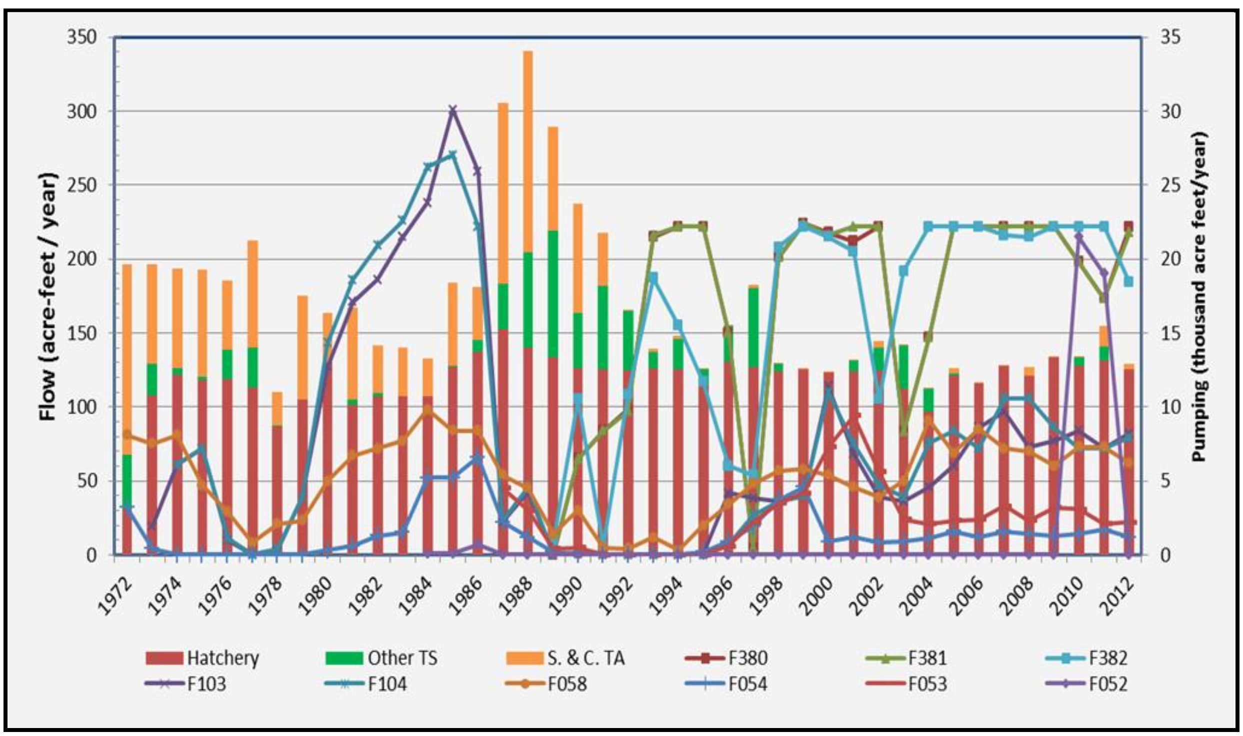
The record of flow from all flowing wells within the Thibaut-Sawmill Wellfield is shown in Table b.viii.1. This table also shows total pumping from hatchery supply wells, pumping from wells in Thibaut-Sawmill Wellfield, pumping from wells in south and central Taboose-Aberdeen Wellfield, and Owens Valley runoff. Flow data from flowing wells in relationship to groundwater pumping and Owens Valley runoff are presented in Figure b.viii.2 and Figure b.vii.3. It must be noted that pump-equipped flowing wells (W380, W381, W103, W104, and W382) do not free-flow when being pumped. In effect, no well can be pumped in excess of its natural flow rate and flow at the same time.

Sec. 5.8 Table b.viii 1. Flow record of pumping/flowing wells and Owens Valley runoff.

RO Yr	F380	F381	F103	F104	F058	F054	F053	F052	F382	Hatchery	Other TS	S&C TA	OV RO
1972					81	32				3,104	3,664	12,909	276,882
1973			19		75	4				10,787	2,142	6,738	466,516
1974			61	61	81	0				12,179	428	6,718	465,125
1975			72	72	47	0				11,818	187	7,247	377,308
1976			10	11	29	0				11,873	1,992	4,672	249,678
1977			0	0	8	0				11,314	2,692	7,280	216,567
1978			3	4	21	0				8,689	74	2,209	648,737
1979			39	39	23	0				10,518	0	6,989	411,287
1980			127	143	50	3				13,084	3	3,235	611,023
1981			171	186	67	6				10,133	378	6,170	351,412
1982			186	209	72	13				10,743	185	3,259	667,114
1983			215	226	77	15				10,696	2	3,286	792,511
1984			238	262	98	52		1		10,705	0	2,545	502,366
1985			301	270	84	52		1		12,654	90	5,628	428,046
1986			259	222	84	66		7		13,731	791	3,571	658,839
1987			22	23	54	22	45	0		15,275	3,045	12,195	280,785
1988			43	46	45	12	30	0		14,030	6,447	13,581	258,845
1989	0	1	0	0	14	2	4	0	9	13,334	8,598	6,979	261,425
1990	65	65	1	1	30	0	5	0	105	12,590	3,754	7,407	215,375
1991	84	84	0	0	5	0	0	0	6	12,511	5,645	3,577	267,858
1992	98	97	0	0	4	0	0	0	108	12,491	4,035	76	254,358
1993	215	216	0	0	12	0	0	0	187	12,640	1,099	192	441,306
1994	222	222	0	0	3	0	0	0	155	12,579	2,026	186	275,497
1995	222	222	0	0	20	2	0	0	117	11,512	1,028	51	638,036
1996	150	150	42	7	34	9	6	0	60	13,078	2,362	105	560,366
1997	4	4	38	27	48	19	22	0	54	12,724	5,322	205	516,225
1998	201	201	36	36	57	37	35	0	208	12,428	512	5	618,668
1999	224	224	40	40	58	46	42	0	222	12,525	0	34	368,000
2000	218	216	114	110	54	9	73	0	215	12,318	18	7	348,698
2001	212	222	68	75	46	12	94	0	205	12,432	708	1	343,340
2002	222	222	39	47	39	8	56	0	105	12,469	1,532	415	278,750
2003	83	83	36	39	50	9	24	0	192	11,206	2,962	1	338,416
2004	147	147	46	76	91	11	21	0	222	9,670	1,548	9	321,253
2005	222	222	60	84	69	16	23	0	222	12,115	133	337	565,593
2006	222	222	86	72	85	12	24	0	222	11,590	26	75	606,508
2007	222	222	97	106	72	16	33	0	216	12,732	0	16	251,628
2008	222	222	73	106	70	14	23	0	215	12,126	0	579	307,425
2009	222	222	77	86	60	13	32	0	222	13,354	0	102	321,786
2010	198	198	84	72	73	14	31	215	222	12,764	552	63	426,874
2011	173	173	72	72	73	17	21	190	222	13,118	946	1,401	581,758
2012	222	218	82	79	62	12	22	0	184	12,520	0	372	237,719
Averge	**170**	**170**	**71**	**75**	**52**	**14**	**26**	**14**	**162**	**11,906**	**1,584**	**3,181**	**414,876**



Sec. 5.8 Figure b.viii.2. Flowing well discharge rates in Thibaut-Sawmill wellfield and Owens Valley runoff.



Sec. 5.8 Figure b.viii.3. Flowing well discharge rates in Thibaut-Sawmill wellfield and groundwater pumping totals.

As illustrated in Table b.viii.2, variations in flow from flowing wells do not correlate with pumping for Fish Hatchery supply. This is because pumping for the Blackrock Fish Hatchery has been relatively constant and occurs from the shallow volcanic aquifer. Flow from flowing wells has the highest negative correlation with pumping from other wells in Thibaut-Sawmill Wellfield. This is because, as mentioned earlier, when these wells are pumped, they cannot free-flow. However, after pump-equipped flowing wells cease pumping, water flow resumes at the same rate as that prior to being pumped. Therefore, it can be inferred that pumping does not have any long-term effect on flow from these wells.

Sec. 5.8 Table b.viii.2. Correlation of flowing wells with pumping and Owens Valley runoff. Values closer to zero indicate little to no correlation whereas values closer to 1 or -1indicate a strong relationship.

Variable	F380	F381	F103	F104	F058	F054	F053	F052	F382	Average
Hatchery Supply Pumping	-0.08	-0.07	-0.07	-0.16	-0.19	0.00	0.10	0.11	-0.29	**-0.07**
Pumping from other TS wells	-0.92	-0.92	-0.46	-0.49	-0.47	-0.22	-0.38	-0.14	-0.87	**-0.54**
Pumping from wells in S. & C. TA	-0.62	-0.62	0.01	0.02	0.00	-0.01	-0.05	-0.10	-0.56	**-0.22**
Owens Valley Runoff	0.20	0.20	0.42	0.40	0.33	0.26	-0.08	0.21	0.17	**0.23**

As expected, flow from the flowing wells in the Thibaut-Sawmill Wellfield is also correlated with pumping from other Thibaut-Sawmill (non-Hatchery) wells screened to the deep aquifer. This is because prolonged pumping from a well screened to the deep aquifer tends reduce the overall piezometric head in the aquifer, and will tend to temporarily reduce the flow rates of adjacent flowing wells screened to the same deep aquifer.

The correlation coefficient of flow from flowing wells with pumping from other wells in Thibaut-Sawmill Wellfield was more than two times greater than the correlation with wells in south and central Taboose-Aberdeen Wellfield. This is because groundwater pumping from the Taboose-Aberdeen wellfield occurs further away than pumping from the Thibaut-Sawmill wellfield in relationship to the flowing wells. This is also because pumping, within the south and central Taboose-Aberdeen Wellfield, is mainly within the shallow volcanic aquifer.

Flowing wells have a positive correlation with Owens Valley runoff. This means that flow from these wells is higher when annual runoff within the Owens Valley is higher. This is an expected conclusion because runoff driven recharge to the aquifer increases the piezometric head within the deep aquifer. As the piezometric head increases, discharge from flowing wells also increases.

Conclusion

In response to groundwater pumping to supply the Blackrock Fish Hatchery, Big Blackrock spring stopped flowing. This was mainly due to the very close proximity of the pumping in relationship to the spring and the shallow and high conductivity of the aquifer in that area. The effects of groundwater pumping to supply the Blackrock Hatchery on associated meadow and riparian vegetation were identified and mitigated in the 1991 EIR (mitigation measure 10-14).

Correlation analysis indicated that flow from non-hatchery flowing wells was not correlated with hatchery supply pumping but was correlated with Owens Valley runoff and pumping from non-hatchery supply wells within the Thibaut-Sawmill wellfield.

In regards to flowing wells that are periodically pumped, it was found that once these pump-equipped wells ceased pumping, the flow from flowing wells return to about the same rates as what had occurred prior to pumping. Therefore, pumping from these wells does not have any long-term effect on flow from the flowing wells. The pumping from non-Hatchery wells in Thibaut-Sawmill Wellfield has been less than 9% of wellfield pumping since 1992.

Lastly, it was found that pumping within the Thibaut-Sawmill and Taboose-Aberdeen Wellfields could reduce flow of flowing wells within the Thibaut-Sawmill Wellfield. However, the effects of pumping on flowing wells are not permanent and flowing wells return to previous flow rates as observed prior to pumping. The overarching long-term driver of flow in these flowing wells is the annual Owens Valley runoff patterns.

5.9. Summary of LADWP's Attributability Analysis

The Green Book Section I.C.1.b. describes that once it has been determined that there has been a measurable change in vegetation:

> "…*it must be determined whether the impact is attributable to groundwater pumping or changes in surface water management practices.*
>
> *A determination of whether the impact is attributable to groundwater pumping or changes in surface water management practices will be based on evaluation and consideration of relevant factors*…" (Green Book, page 23, paragraphs 2 and 3, emphasis added).

Green Book Section I provides:

> "*When reference is made to changes in surface water management practices, changes will be determined in comparison with past practices since 1970*" (Green Book, page 1, paragraph 1).

In determining whether a measurable change in vegetation within Blackrock 94 is attributable to groundwater pumping, changes in surface water management practices, or to factors unrelated to the effects of groundwater pumping or changes in surface water management practices, LADWP evaluated the relevant factors that could have caused vegetation change within the parcel.

An evaluation of all relevant factors found variations in grass cover to be the primary reason for fluctuations in vegetation cover and composition within Blackrock 94. The principle driver of measurable changes in grass cover, and by extension vegetation cover and composition within Blackrock 94 was determined to be variations in precipitation and snowpack runoff resulting from fluctuations in wet/dry climactic cycles. During the "wet" periods of increased precipitation and snowpack runoff between 1978-1986 and 1994-1998, vegetation cover in Blackrock 94 increased substantially. During the "dry" periods of lower precipitation and decreased runoff, specifically the years between 1987 and 1994 and the years since 1999, vegetation cover has tended to decrease. During the few years since 1999 when precipitation and runoff were considerably above average (2004, 2005, and 2011), vegetation cover has increased or remained stable. During the dry periods since 1999 (1999-2004, 2007-2009, and the historically low runoff years of 2012 and 2013), vegetation cover has decreased within the parcel. Since 1986, 19 of the last 27 years experienced below average runoff, and these low runoff years have formed two prolonged periods of drought that resulted in vegetation decreases within the parcel.

An evaluation of ICWD-designated control parcels within the Owens Valley that have similar vegetation, precipitation, and soil types as Blackrock 94, substantiated the conclusion that vegetation cover increases substantially during wet periods and decreases during dry periods throughout the Owens Valley, regardless of groundwater pumping.

Other factors including periods of excessive grazing within Blackrock 94 prior to 2006, wildfires in 1990 and 2007, and the expansion of Highway 395 in 2008, have all had substantial influence on reductions in vegetation cover since LADWP's 1986 initial vegetation inventory. Blackrock 94 has not recovered from the 2007 Inyo Complex Fire, which was a particularly hot summer fire during the 2000-2009 drought, and will likely not recover until multiple years of high precipitation and runoff reoccur. However, the evidence demonstrates that the reductions in precipitation and runoff during dry periods as the predominant factor resulting in measurable reductions in vegetation cover during "dry" periods. Vegetation cover has also been shown rebound in the parcel during multiple years of wet conditions.

5.10. Summary of LADWP's Findings Regarding the Attributability of Groundwater Pumping on Measurable Changes in Vegetation within Blackrock 94

Analysis of the relevant hydrologic data, including changes in precipitation, snowpack runoff, and groundwater pumping in the Thibaut-Sawmill and Taboose-Aberdeen Wellfields, found that variations groundwater recharge caused by variations in snowpack runoff to be the principle factor driving water table changes beneath Blackrock 94. Water spreading practices in the area of Blackrock 94 were determined to have remained unchanged since 1970.

While a major drought between 1987 and 1994, combined with increased groundwater pumping in the Thibaut-Sawmill and south and central Taboose-Aberdeen Wellfields between 1987 and 1992, did effect groundwater levels beneath Blackrock 94; groundwater pumping in these wellfields, other than Blackrock Hatchery supply pumping, was significantly curtailed in 1992 and has remained minimal since that time. The combination of minimal groundwater pumping and a four-year period of very high runoff between 1995 and 1998, allowed for water table recovery under Blackrock 94 by the late 1990s.

Since 1998, Blackrock Fish Hatchery pumping accounts for 95 percent of all groundwater pumping in the Thibaut-Sawmill Wellfield. Since 1998, the effects of groundwater pumping prior to 1992 have not been a factor affecting the water table beneath Blackrock 94. The water table beneath Blackrock 94 has remained stable since 1998, fluctuating with annual changes in runoff. Groundwater pumping for the Blackrock Fish Hatchery has persisted, constant and steady since 1972. Any water table suppression beneath Blackrock 94, due to groundwater pumping to supply the Blackrock Hatchery was in place and stable when LADWP conducted its 1986 vegetation inventory of the parcel and has been equally superimposed on every vegetation inventory since. There is no correlation between groundwater table fluctuations beneath Blackrock 94 and Blackrock Hatchery pumping during the time period between LADWP's 1986 initial vegetation inventory baseline and 2013. Other wells in the Thibaut-Sawmill and south and central Taboose-Aberdeen Wellfields have been only operated infrequently since 1992 and are not attributable to groundwater suppression beneath the Blackrock 94.

5.11. Summary of LADWP's Findings Regarding Attributability of Changes in Surface Water Management Practices on Measurable Changes in Vegetation within Blackrock 94

LADWP has provided an overview of its surface water operations since 1970 and conducted numerous analyses using all available hydrologic data for both the overall area surrounding Blackrock 94 and for Sawmill Creek, the principle water source that could have an effect on Blackrock 94. These analyses examined LADWP's surface water management practices in the area of Blackrock 94 for the period between 1970 and 2013, for the purpose of evaluating the overall relationships of LADWP's surface water management practices in the area of Blackrock 94 and to determine if there has been a change in surface water management practices since 1970. The analyses conducted by LADWP used numerous approaches in determining if surface water management practices have changed in the area of Blackrock 94 since 1970 and the conclusions of the individual analytical approaches were vetted and confirmed using standard scientific analytical methods. The results of all of the analysis overwhelmingly concluded that:

1. Water management practices pertaining to agricultural supply have not changed since 1970. Water supply practices to the 8-Mile Ranch include water for irrigation, stock water, and operational uses.
2. LADWP's water spreading practices both in the overall area surrounding Blackrock 94 and on Sawmill Creek, which is adjacent to Blackrock 94, are highly correlated with runoff. Water is reliably spread during periods of high runoff and not spread during periods of low runoff.
3. LADWP's water spreading practices both in the general area of Blackrock 94 and on Sawmill Creek have not changed since 1970.
4. LADWP's water management practices related to diversions from Sawmill Creek into the Los Angeles Aqueduct have not changed since 1970.

5.12. Conclusions of LADWP's Attributability Analysis

> The primary driver of decreases in vegetation cover are periods of decreased precipitation and runoff, which limit the amount of water available for grasses within the parcel.

An analysis of variations in vegetation cover and composition within Blackrock 94 found these fluctuations to be primarily the result of fluctuations in grass cover within the parcel. Variations in grass cover within the parcel are predominantly the result of fluctuations in wet/dry climatic cycles. Factors including grazing, wildfire, and the expansion of Highway 395 have adversely affected vegetation cover within the parcel. However, the primary driver of decreases in vegetation cover are periods of decreased precipitation and runoff, which limit the amount of water available for grasses within the parcel. Grass cover within the parcel has also been shown to rebound during multiple years of increased precipitation and runoff.

Groundwater pumping in the area of Blackrock 94 has for all intents and purposes been limited to groundwater pumping to supply the Blackrock Fish Hatchery since 1992. While other wells in the area have operated since 1992, the amount of pumping from these other wells has been minimal, only a few percent of the total pumping in the Thibaut-Sawmill and central and southern Taboose-Aberdeen Wellfields, so as not to be attributable to vegetation changes since that time. While the effects of a major drought between 1987 and 1994 combined with increased groundwater pumping between 1987 and 1992 resulted in decreases in the groundwater table beneath Blackrock 94, a four-year period of increased precipitation and 140% of average snowpack runoff between 1995 and 1998, in combination with reduced groundwater pumping, resulted in total perennial vegetation cover within Blackrock 94, by 1999, to be 21.3% higher and grass cover to 7.2% higher than that observed during LADWP’s 1986 initial vegetation inventory.

The principal source of groundwater pumping in the Blackrock area, pumping for the Blackrock Fish Hatchery, has been persistent and relatively constant since 1972. Any suppression on the water table caused by Blackrock Fish Hatchery supply pumping was in place and had stabilized during the 14 years prior to LADWP’s 1986 initial vegetation inventory and any effect on vegetation cover and composition caused by hatchery pumping was reflected in the 1986 inventory. Moreover, Blackrock Fish Hatchery supply pumping has caused no further suppression or fluctuations in the groundwater table since the 1986 initial vegetation inventory, therefore Blackrock Fish Hatchery pumping is not attributable to vegetation changes since that time.

Using numerous analytical methods, it has been conclusively demonstrated that LADWP has not changed its surface water management practices since 1970, either in the overall area of Blackrock 94 or on Sawmill Creek, the principle creek that could affect Blackrock 94. Therefore, changes in LADWP’s surface water management practices are not attributable for measurable changes in vegetation within Blackrock 94. LADWP’s water spreading practices both in the overall area surrounding Blackrock 94 and on Sawmill Creek, which is adjacent to Blackrock 94, are highly correlated with runoff. Water is reliably spread during wet periods of high runoff and not spread during periods of low runoff.

> LADWP’s water spreading practices both in the overall area surrounding Blackrock 94 and on Sawmill Creek, which is adjacent to Blackrock 94, are highly correlated with runoff. Water is reliably spread during periods of high runoff and not spread during periods of low runoff.

6.0 Section I.C.1.c – Determining Degree of Significance

Water Agreement Section IV.B provides:

> "*If the decrease, change, or effect is determined to be attributable to groundwater pumping or to changes in past surface water management practices, the Technical Group shall then determine whether the decrease, change, or effect is significant* (Water Agreement, page 19, paragraph 2).

ICWD concluded in its February 2, 2011, *Analysis of Conditions in Vegetation Parcel Blackrock 94*:

> "*Pumping induced declines in the water table 1987-1990 corresponded to decreases vegetation cover and a change in species composition. In Blackrock 94, where pumping has withdrawn the water table from the grass root zone, grass cover has diminished"* (ICWD *Analysis of Conditions in Vegetation Parcel Blackrock 94,* February 2, 2011, page 56, paragraph 3).

ICWD further concluded that:

> "…data indicate *a measurable change in vegetation has occurred in Blackrock 94… These changes occurred between baseline and 1991 and have persisted in time*" (ICWD, *Analysis of Conditions in Vegetation Parcel Blackrock 94*, February 2, 2011, page 66, paragraph 2).

However, both groundwater pumping and changes in past surface water management practices were found not to be the driver of vegetation change within Blackrock 94. LADWP's analysis of attributability concluded that variations in precipitation and runoff, caused by natural variations in wet/dry climactic cycles, are the primary drivers of variations in grass cover and total perennial cover within Blackrock 94. Moreover, LADWP refuted the ICWD's conclusion that decreases in vegetation cover "*have persisted in time"* through an examination of the ICWD's own vegetation data. The evaluation contained herein, establishes that, despite decreases in grass cover that occurred concurrently with an eight-year drought between 1987 and 1994, both grasses and total perennial cover were essentially equal to the 1986 initial vegetation inventory baseline by 1997 and over 20% higher than baseline cover values by 1998.

The following analysis of significance is conducted pursuant to the October 21, 2013, Interim Order requiring LADWP to conduct this analysis. LADWP's analysis of significance is hereby submitted in conformance with the Interim Order. This analysis of significance does not suggest that a determination of attributability was made by the Technical Group or through the dispute resolution process.

Green Book Section I.C.1.c requires the Technical Group to evaluate the following in determining whether or not a measurable change in vegetation, which has been determined to be attributable to LADWP's groundwater pumping or a change in LADWP's surface water management practices since 1970, is significant.

6.1. LADWP Evaluation I.C.1.c.i – The size, location, and use of the area that has been affected.

As discussed in Section 5.2.3.5, there are two distinct plant communities within Blackrock 94 that can be easily delineated. The southeastern portion has remained relatively unchanged as an alkali meadow as was recorded during the 1986 initial vegetation inventory. The alkali meadow has existed in the southeastern portion because of finer soil types and lower elevation. The upland northwestern portion has very distinct plant communities from the alkali meadow because of coarser soil types and higher elevation. Vegetation cover and composition in the two areas have been affected by the wet/dry climatic cycles differently.

Water Agreement Section I, *Management Areas*, requires the Technical Group to monitor vegetation and groundwater conditions in the context of the "management area". The Water Agreement provides:

> *"The vegetation and groundwater conditions within the management areas will be carefully monitored by the Technical Group to assure that the goals and principles of this groundwater management plan are met"* (Water Agreement, Section I.B, *Management Area*s, page 7, paragraph 3)
>
> *"It is recognized that vegetation composition and density varies for reasons other than groundwater pumping, from period to period, depending on weather, precipitation, surface water spreading, and other factors"* (Water Agreement Section I.D, page 8, *Management Areas*, paragraph 2).

Blackrock 94 lies within the *Blackrock Vegetation and Wellfield Management Area*, which is 6,763 acres in size (Water Agreement Exhibit A, page 2 of 14; 1991 EIR, Volume II, Appendix B). When viewed in the context of the Blackrock Vegetation and Wellfield Management Area, the 149 acre area showing relative cover that is dissimilar from the initial inventory within Blackrock 94 represents approximately 2% of the total Management Area. In the context of the Blackrock Vegetation and Wellfield Management Area a temporary decrease in vegetation of 2% is not significant, especially that the decrease is attributable to natural wet/dry climatic cycles.

6.2. LADWP Evaluation I.C.1.c.ii – Evaluation of the degree of the decrease, change, or effect within the affected area.

Between 1991 and 2013, 13 of 23 years showed measurable vegetation cover decreases from that measured during LADWP's 1986 vegetation inventory of Blackrock 94 (Table b.v.1). The vegetation cover in 1986 was 41% compared to the average cover of 26% between 1991 and 2013. These decreases occurred during relatively extended periods of low runoff and precipitation. During the protracted drought between 1987 and1994, vegetation cover decreased from 41% to 12%, subsequently recovering to 50% following a four-year wet period. Vegetation within the parcel then fell to 18% in 2004, following a six-year dry period that averaged 81% of normal runoff. While vegetation cover did increase to 32% following high runoff years in 2005 and 2006, a state-wide drought that significantly affected the Owens Valley resulted in vegetation cover declining to 19% by 2009. While better than average runoff conditions in 2010 and 2011 resulted in vegetation cover increasing to 27%, back-to-back years of 58% of average runoff in 2012 and 50% of average runoff in 2013, have resulted in vegetation cover decreasing to 15%.

These observed decreases in vegetation cover are not significant because:

1. These decreases were a result of drought or dry climatic cycles.
2. Vegetation cover has shown a very close relationship with the runoff patterns whereby vegetation cover decreases during drought and dry climatic cycles, and rebounds during wet periods,
3. The parcel contains at least two plant communities which are distinct from the alkali meadow (see Section 5.2.3.5.). The upland northwestern portion of the parcel only resembles an alkali meadow during wet periods.

Since the 1986 initial vegetation inventory, Owens Valley runoff has varied by over 300%, from 658,839 acre-feet in 1986 to a low of approximately 210,264 acre-feet in 2013. As shown in Section 5.2.2.2, and Section 5.5.2, the amount of vegetation cover within Blackrock 94 correlates with the amount of runoff. Vegetation cover naturally decreases during dry periods and increases during wet periods. The degree of vegetation decrease during these dry periods cannot be considered significant because vegetation has the natural ability to rebound during wet periods.

6.3. LADWP Evaluation I.C.1.c.iii – Evaluation of the permanency of the decrease, change, or effect.

Observed decreases in vegetation cover within Blackrock 94 are not permanent. As demonstrated in Section 5.2.2., vegetation cover within the parcel is strongly influenced by runoff and precipitation. The amount of vegetation cover within the parcel (and elsewhere in the valley) convincingly correlates with precipitation and snowpack runoff. As was shown throughout this report, vegetation cover increases during wet climatic cycles, periods of high runoff, and elevated precipitation. Correspondingly, vegetation cover also declines during periods of drought and dry climatic cycles.

Similar to the initial inventory year of 1986, the wet period between 1995 and 1998, the high runoff years of 2004 and 2005, and even the single average runoff year in 2010 (in which vegetation cover increased from 19% to 27% in response to a single year of 103% of average runoff), vegetation cover clearly increases during wet periods. Based upon the available data, current decreases in vegetation cover in Blackrock 94 are due to the current low runoff and precipitation conditions. Vegetation cover is fully anticipated to increase following a period of higher precipitation and runoff. If previous wet hydrologic conditions (i.e. 1978-1986 or 1995-1998) repeat themselves, then vegetation cover is fully expected to meet or exceed that measured during LADWP's initial inventory. Therefore, the current changes are not permanent and not significant in the context of the Water Agreement.

6.4. LADWP Evaluation I.C.1.c.iv – Evaluation as to whether the decrease, change, or effect causes a violation of air quality standards.

There are no data available that suggests air quality has been negatively impacted at Blackrock 94.

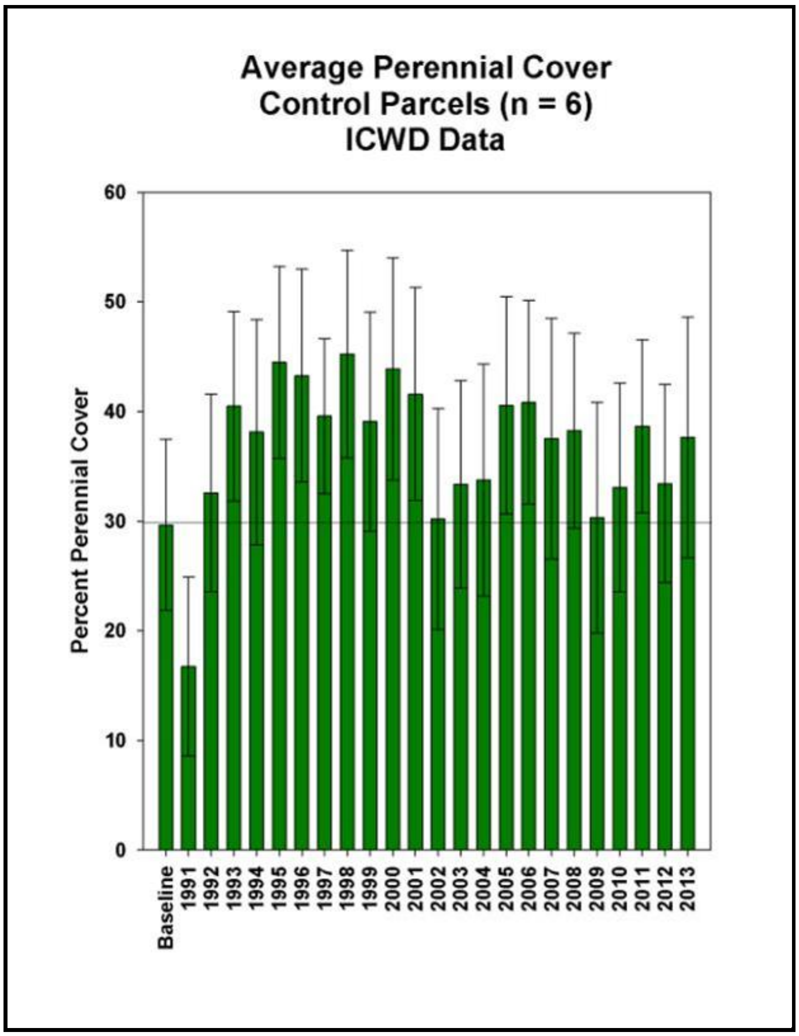
6.5. LADWP Evaluation I.C.1.c.v – Evaluation of the cumulative effect of the impact when judged in relation to all such areas on the Owens Valley.

No significant adverse effects to vegetation or the environment have been determined by the Technical Group (or through dispute resolution) since the 1991 EIR was certified or the Water Agreement signed. The measureable changes to vegetation at Blackrock 94 have not been determined to be attributable to groundwater pumping or changes in surface water management practices by the Technical Group (or through dispute resolution). A thorough analysis conducted by LADWP finds measurable changes to vegetation in Blackrock 94 to be attributable to fluctuations in wet/dry climatic cycles. Therefore, there are no significant effects to vegetation due to groundwater pumping or changes in surface water management practices to evaluate as part of an analysis of the cumulative effect of the measureable vegetation changes at Blackrock 94 "to all such areas of the Owens Valley." The accumulation of measurable, attributable, and significant adverse effects is therefore zero.

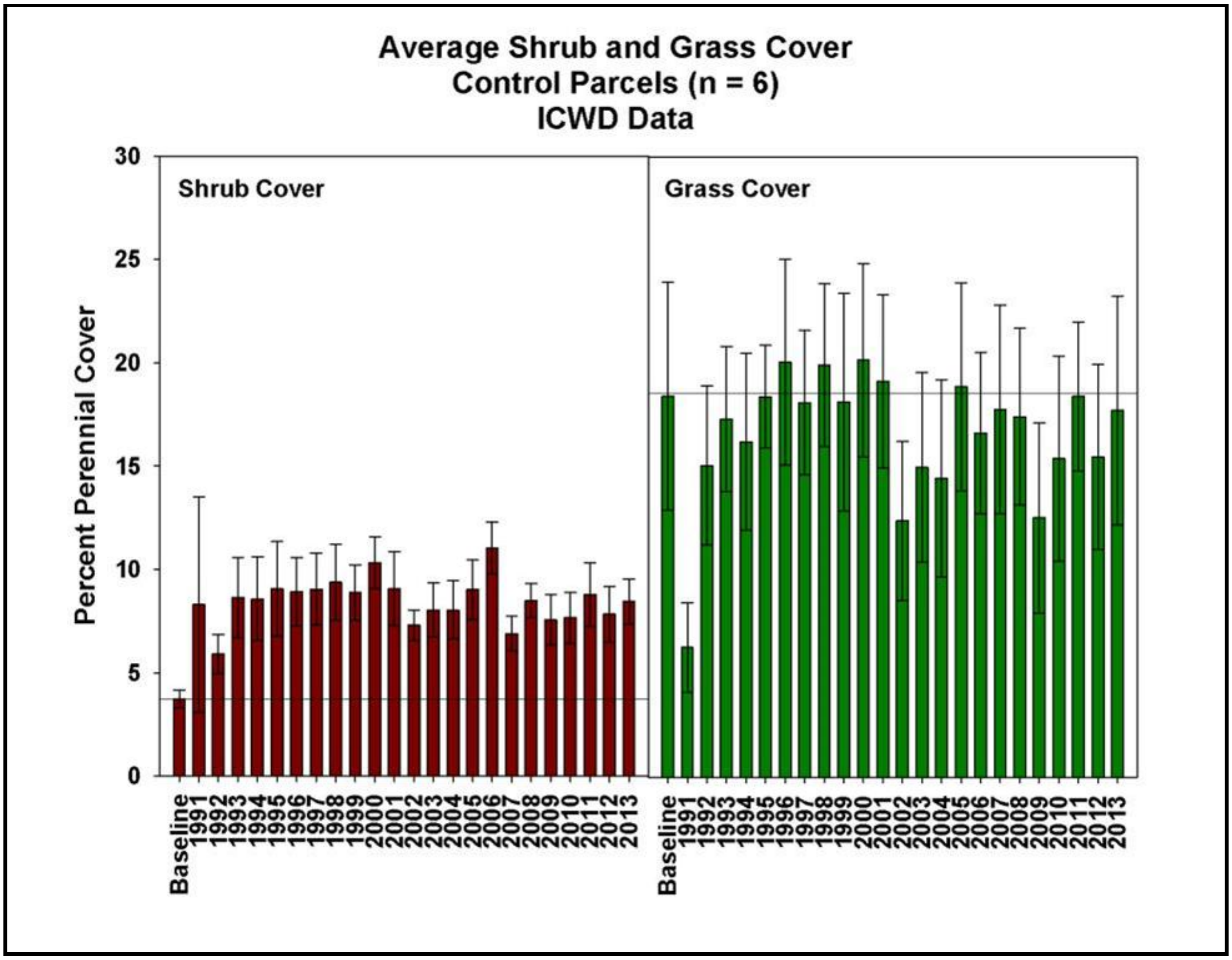
A consideration of vegetation changes in other areas of the Owens Valley is provided in section 5.2.5 of the LADWP attributability analysis. LADWP compared vegetation changes within Blackrock 94 to vegetation changes within three vegetation parcels that have been identified as "control parcels" by the ICWD, with similar soil types, similar average annual precipitation, and similar vegetation type. Changes in perennial cover, perennial shrub cover, perennial grass cover, shrub and grass proportions, and composition were found to be very similar between the control parcels and Blackrock 94. Because vegetation cover increases in both the control parcels and Blackrock 94 coincided with wet periods, and vegetation decreases coincided with dry periods and during periods of stable groundwater levels, it was concluded that changes in vegetation that were exhibited at Blackrock 94 and at the control parcels were primarily due to wet/dry climatic variability. Therefore, it can reasonably be inferred that, in general, vegetation cover within other areas of the Owens Valley decreases during periods of drought and increases during wet periods.

Below is a brief analysis that compares an additional six Type C vegetation control parcels to Blackrock 94. Using ICWD data the following parcels were identified for comparison: BGP031, IND163, MAN060, PLC024, PLC121, and PLC223. These six parcels are located throughout the Owens Valley from Bishop, CA to Lone Pine, CA (See Section 5.2.5.4 for a discussion of Type C vegetation).

On average, total perennial cover and perennial grass cover increased from 1991 to 2000 (Figures c.v.1 and c.v.2). From 2000 to 2002 cover declined for both perennial cover and perennial grass cover. In 2005 and 2006, both cover types increased again and then declined through 2013. Because average control parcel perennial shrub cover did not show any discernible trend over time, changes in total perennial cover were primarily driven by changes in grass cover (Figure c.v.2).



Sec. 6 Figure c.v.1. Average perennial cover within six additional vegetation control parcels using ICWD data. The reference "n = 6" denotes the average of six control parcels.



Sec. 6 Figure c.v.2. Average perennial shrub and grass cover within six additional control vegetation control parcels using ICWD data. The reference "n = 6" denotes the average of six control parcels.

This same trend was exhibited within the three similar vegetation control parcels compared to Blackrock 94 in attributability section of this report (section 5.2.5). Total perennial cover and perennial grass cover increased through 2000 and generally decreased from 2000 to 2013 and very closely follow Owens Valley annual runoff patterns.

6.6. LADWP Evaluation I.C.1.c.vi – Evaluation of the value of existing enhancement and mitigation projects addressing the environmental consequences of similar impacts.

The purpose of this section is to evaluate the value of existing enhancement and mitigation projects that are in place to mitigate for the impacts from groundwater pumping for the Blackrock Fish Hatchery and from other wells in the Taboose-Aberdeen and Thibaut-Sawmill Wellfields. The following projects were implemented by LADWP to enhance the environment in the vicinity of Blackrock 94.

The Lower Owens River Project (LORP) was identified in the 1991 EIR as compensatory mitigation for impacts that were considered difficult to quantify or mitigate directly. The LORP was specifically identified as mitigation for impacts to riparian and meadow vegetation resulting from groundwater pumping to supply the Blackrock Fish Hatchery (1991 EIR, mitigation measure 10-14). Monitoring and analysis results indicate that the LORP is attaining many of the goals identified in the Memorandum of Understanding (1997). The LORP supports a healthy warm-water fishery in all reaches. Habitat for all indicator species continues to develop. Biodiversity in wetlands and riverine habitats has increased. Some threatened and endangered species are using the restored habitat. Through implementation of the LORP there has been an increase in water and wet meadow habitat types of approximately 600 acres and a reduction in upland/shrub habitats of approximately 600 acres.

The Owens Valley Land Management Plan (OVLMP) was developed by LADWP in 2007 to provide management direction for all resources on approximately 250,000 acres of Los Angeles owned lands in Inyo County. The OVLMP goals and objectives are reflected in the plans to supply water to the City, better manage livestock grazing, reduce recreation impacts yet allow for continued and sustainable recreation and other resource uses while enhancing ecosystem health, biodiversity, and threatened and endangered species habitat. These goals are achieved using a multitude of land management tools and activities of which include but are not limited to:

- prescribed fire,
- rangeland utilization monitoring,
- vegetation cover monitoring,
- fisheries surveys,
- avian surveys, and habitat management, and
- threatened and endangered species monitoring and management.

A major land management activity conducted through the OVLMP and utilized by LADWP to improve environmental conditions of the City's land is prescribed fire. Fire effectively suppresses and eliminates most woody plants within the burned area while encouraging grass and forb growth. This practice is beneficial for the landscape in many ways as it increases available forage for wild and domestic ungulates and small mammals including elk, cattle, Owens Valley Vole, and etc., increases species diversity that in-turn increases the resiliency of the landscape to resist natural and anthropomorphic disturbances, and increases the overall health of the landscape by removing senescent vegetation and associated deadfall.

Since 2009, LADWP has burned approximately 1,800 acres. Areas that are planned for burning generally have a shrub cover of between 60 and 70 percent with a subdominant grass component. The presence of the subdominant grass component is one of the most important factors to consider when determining if a prescribed burn will have the desired effect of replacing the shrub scrub meadow community with a grass dominated community. For burns conducted by LADWP there has been a return of predominantly grassy meadows with grass cover of between 60 and 100 percent with just traces of shrubs remaining over the entire 1,800 acres. These efforts therefore, have an effect of increasing the amount of alkali meadow habitats similar those described for Blackrock 94 during the initial inventory.

Additional Mitigation Projects (AMP) includes: 1) LADWP's commitment to supply 1,600 acre-feet of water per year at eight projects located throughout the Owens Valley as a mitigation measure for impacts identified in the 1991 EIR at Hines Springs, and 2) the implementation of on- and/or off-site mitigation for impacts identified in the 1991 EIR at Fish Springs, Big and Little Blackrock Springs, and Big and Little Seely Springs.

With the goal of identifying reasonable and feasible measures that would provide the most environmental benefits that can be achieved with the 1,600 acre feet allotted as mitigation for impacts to Hines Springs, eight sites were identified: Freeman Creek (215 acre-feet/year), Hines Spring Well 355 (240 acre-feet/year), Hines Spring Aberdeen Ditch (145 acre-feet/year), North of Mazourka Canyon Road (300 acre-feet/year), Homestead (300 acre-feet/year), Well 368 (150 acre-feet/year), Diaz Lake (up to 250 acre-feet/year), and Warren Lake (to be determined annually to balance the 1,600 acre-feet/year commitment). Five of these projects, Hines Spring Well 355 (240 acre-feet/year), Hines Spring Aberdeen Ditch (145 acre-feet/year), North of Mazourka Canyon Road (300 acre-feet/year), Homestead (300 acre-feet/year), and Well 368 (150 acre-feet/year) are in the general vicinity of Blackrock 94. Through distribution of allocated water at each site, the AMPs are enhancing and creating riparian, aquatic, wetland and/or spring habitats. The most recent estimate found that there has been approximately 19 acres of flooded area.

Additional enhancement or mitigation projects in Taboose-Aberdeen and Thibaut-Sawmill Wellfields are:

- Blackrock Fish Hatchery,
- Seely Spring (via Well 349), and
- Little Blackrock Spring (via Blackrock Ditch)

The California Department of Fish and Wildlife (CDFW) fish hatchery at Big Blackrock Springs serves as mitigation of a compensatory nature by producing fish that are stocked throughout Inyo County (1991 EIR, mitigation measure 10-14). The hatchery serves a dual role as both a production and brood stock hatchery. Currently, around 170,000 pounds of catchable rainbow trout are produced, along with 90,000 sub-catchable Lahontan cutthroat trout per annum; 300,000 Kamloops rainbow and 100,000 brown trout eggs are taken each year on site and then immediately transferred to Mount Whitney Hatchery for incubation and shipment.

In the area of Big and Little Seely Springs, LADWP Well 349 discharges water into a pond approximately one acre in size (1991 EIR, mitigation measure 10-14). This pond provides a temporary resting place for waterfowl and shorebirds when the pump is operating or Big Seely Spring is flowing. This water passes through the pond to the Owens River. Riparian vegetation has established around this pond. Based on mapping from aerial imagery collected in 2009, there is approximately 5.5 acres of riparian, wetland, and meadow associated with this project.

LADWP will continue to supply water from Division Creek to the site of the former pond at Little Blackrock Springs (1991 EIR, mitigation measure 10-14). The marsh vegetation at this site will thus be maintained. Based on mapping from aerial imagery collected in 2009, there is approximately 0.5 acres of riparian, wetland, and meadow associated with this project.

In conclusion, LADWP has provided mitigation for the direct impacts on riparian and meadow vegetation caused by groundwater pumping to supply the Blackrock Fish Hatchery. Mitigation has been accomplished by:

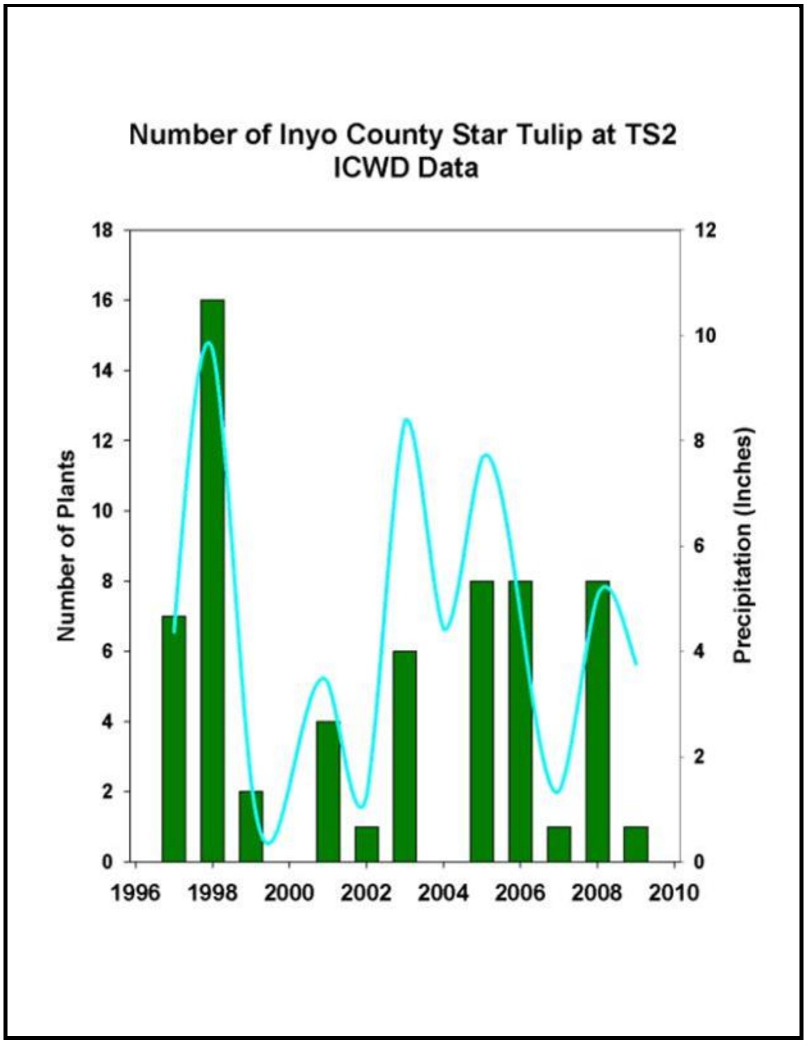
1. Implementing the LORP, which restored over 60 miles of the Owens River and resulted in hundreds of acres of new meadow areas.
2. Additional mitigation prescribed through 1991 EIR mitigation measure 10-14 are LADWP's cooperative efforts with the CDFW through which a considerable amount of fish are produced at the Blackrock Hatchery that contribute to the local economy via enhanced recreational opportunities.
3. LADWP has completed eight enhancement and/or mitigation projects in the vicinity of Blackrock 94. These projects have been implemented to offset adverse environmental effects associated with LADWP's water gathering activities and to provide significant environmental benefits through the creation and/or conversion of more than 2,400 acres of shrubland into aquatic, wetland, or grassland habitats.

6.7. LADWP Evaluation I.C.1.c.vii – Evaluation as to the impact, if any, on rare or endangered species and on other vegetation of concern.

To determine if there has been an effect within Blackrock 94 on any rare, threatened, endangered, or species of special concern, a review of available rare plant data was performed for the parcel. LADWP's review found that there is significant relationship between precipitation and numbers of rare plants in Blackrock 94. Simple linear regression revealed a significant positive relationship between precipitation and numbers of rare plants at permanent monitoring site TS2. No relationship was found between DTW and the number of rare plants at TS2, indicating that fluctuations in DTW do not influence this population.

The California Natural Diversity Database (CNDDB), LADWP databases and files, and the ICWD rare plant data were utilized to search for species of special concern, threatened or endangered species, and rare communities within Blackrock 94. The results of the search indicated the presence of Inyo County star tulip (*Calochortus excavatus*) within the parcel. Inyo County star tulip is not listed as a state or federally threatened or endangered species.

Simple linear regression was used to determine which of the following variables, winter precipitation, annual Owens Valley runoff, and DTW, were influencing the number of plants from year to year at monitoring site TS2. Analysis indicated a moderately strong relationship (r^2=0.63, $P < 0.001$) was exhibited between precipitation and number of plants at TS2 (Figure c.vi.1). No significant relationship was exhibited between DTW and number of plants at the monitoring site.



Sec. 6 Figure c.vii.1. Number of Inyo County star tulip using ICWD data. The blue line denotes annual precipitation from November to June. Precipitation data was taken from a LADWP weather station located at the LAA Intake.

The variability exhibited within this rare plant population is explained by winter precipitation. No relationship was found between DTW and number of plants at this population. No relationship was found between water spreading and the number of plants at this population. This further indicates that ground water pumping, changes in DTW, or surface water spreading are not the primary influences affecting this population.

6.8. LADWP Evaluation I.C.1.c.viii – Evaluation as to whether the decrease, change, or effect affects human health.

There are no data available that suggests human health has been affected by vegetation changes at Blackrock 94.

6.9. Summary of LADWP's Significance Analysis

Analysis of variations in vegetation cover and composition within Blackrock 94 determined that these variations are attributable to fluctuations in wet/dry climatic cycles. While other factors including grazing, wildfire, and the expansion of Highway 395 have adversely affected vegetation cover within the parcel, the primary driver of decreases in vegetation cover are periods of drought, reduced precipitation, and low snowpack runoff. All of which limit the amount of soil water available for vegetation. It has been further established that vegetation cover within the parcel has rebounded during multiple years of increased precipitation and runoff. This pattern can be expected with reasonable certainty to repeat itself in the future, whereby during extended periods of drought, vegetation cover in Blackrock 94 will tend to decrease and during multiple years of average and above average precipitation and runoff, vegetation cover will increase within the parcel. Groundwater pumping and changes in surface water management practices were found not to be factors driving vegetation change within Blackrock 94.

Water Agreement Section IV.B requires:

> "*Decreases and changes in vegetation and other environmental effects shall be considered attributable to groundwater pumping, or to a change in surface water management practices," if the decrease, change, or effect would not have occurred* ***but for*** *groundwater pumping and/or a change in past surface water management practices*" (Water Agreement, page 18, paragraph 4, emphasis added).
>
> *"If the decrease, change, or effect is determined to be attributable to groundwater pumping or to changes in surface water management practices, the Technical Group then shall determine whether the decrease, change, or effect is significant*" (Water Agreement, page 19, paragraph 2).

LADWP has completed an analysis of significance in conformance with the Arbitrator's October 21, 2013 Interim Order. LADWP's analysis followed the provisions of Green Book Section I.C.1.c and, based upon the factors presented herein, the available vegetation and hydrologic data, and the body of evidence, it was found that measureable changes in vegetation cover and composition in Blackrock 94 are not significant because:

- Measurable changes in vegetation cover are not attributable to groundwater pumping or to changes in LADWP's past surface water management practices since 1970.
- Measurable changes in vegetation cover were attributable to periods of drought and fluctuations in wet/dry climatic cycles.

- Vegetation cover trends that were observed at Blackrock 94 were also observed in control parcels located in other areas of the Owens Valley.
- The size of measurably different vegetation cover within the Blackrock 94 parcel is only about 2% of the Blackrock Vegetation and Wellfield Management Area.
- Because measurable changes in vegetation fluctuate widely commensurate with the amount of runoff and precipitation, the degree of change is not significant (an example of this is vegetation cover increased over 400%, from 12% to 50%, between 1994 and 1998, during a period of 140% of average runoff).
- Measurable changes in vegetation are not permanent and clearly fluctuate with available runoff and precipitation.
- There is no indication of an effect on air quality.
- The cumulative effect of adverse vegetation change since the Water Agreement was signed is zero because there has never been a determination pursuant to the provisions of the Water Agreement that a significant change in vegetation that is attributable to groundwater pumping or to changes in surface water management practices.
- Existing enhancement/mitigation projects provide significant environmental benefits through the creation and/or conversion of more than 2,400 acres of meadow area.
- Changes in rare plants within Blackrock 94 are driven by changes in precipitation and not significant.
- There is no indication of an effect on air quality or human health.

7.0 Summary and Conclusions

Summary and Conclusions of LADWP's Analysis of Attributability and Significance of Measurable Changes in Blackrock 94

LADWP has completed its analysis of measurable changes in vegetation within Blackrock 94 pursuant to the provisions of Water Agreement Section IV.B, Green Book Section I.C, and in conformance with the Arbitrators October 21, 2013 Interim Order. After analysis and consideration of the available evidence, LADWP has made the following findings:

Conclusions Regarding Groundwater Pumping

In 1972, groundwater pumping for the Blackrock Fish Hatchery began and has continued persistently at an average flow rate of 12,200 acre-feet per year ever since. By 1986, groundwater pumping for the Blackrock Fish Hatchery had continued unabated for 14 years and the effects of hatchery pumping on the water table beneath Blackrock 94 had thoroughly stabilized by the time LADWP's 1986 initial vegetation baseline inventory was conducted. Because any water table suppression caused by hatchery pumping had been well established when LADWP's 1986 initial vegetation baseline inventory was conducted, the effects of Blackrock Fish Hatchery pumping on vegetation within Blackrock 94 are reflected in the 1986 data.

An eight-year drought began in 1987. This resulted in multiple years of substantially decreased snowpack runoff and increased groundwater pumping. Low runoff conditions brought about by the 1987-1994 drought, combined with groundwater pumping caused the water table in the area of Blackrock 94 to decline. Vegetation cover also declined during this drought period. However, following the signing of the Water Agreement groundwater pumping in the area was considerably reduced and a wet period between 1994 and 1998 resulted in substantial increases in the water table and vegetation cover within the parcel. By 1997, vegetation cover in Blackrock 94 was similar to that of the 1986 initial inventory, by 1998, vegetation cover within the parcel was 120% of that measured by the 1986 inventory.

Since 1998, Blackrock Fish Hatchery pumping has accounted for about 95% of all of the groundwater pumping in the Thibaut-Sawmill Wellfield and 78% of the remaining 5% of the groundwater pumping is from wells screened to a deeper aquifer and without direct effect on the shallow water table beneath Blackrock 94. Blackrock Hatchery pumping has accounted for 90% of the combined pumping of all wells in the Thibaut-Sawmill and southern Taboose-Aberdeen Wellfields since 1992 (the Water Agreement was signed on October 18, 1991). Moreover, the 13,000 acre-feet of combined annual average pumping of all wells in the Thibaut-Sawmill and southern Taboose-Aberdeen Wellfields since 1998 is substantially less than the 16,300 acre-feet of average annual pumping from these wells during the ten years prior to the 1986 initial vegetation inventory baseline survey.

In consideration of the following:

- Groundwater pumping for the Blackrock Fish Hatchery has been relatively steady-state between 1972 and the present, and
- The effects of hatchery pumping on the Blackrock 94 water table were well stabilized by 1986, and
- Any effects on vegetation caused by suppression of the water table due to hatchery pumping were reflected in LADWP's 1986 vegetation inventory of Blackrock 94 (and every vegetation inventory since), and
- Vegetation conditions following a wet period between 1994 and 1998 rebounded to 120% of those measured during the 1986 vegetation inventory, and
- Blackrock Fish Hatchery pumping accounts for 90% of all groundwater pumping in the Thibaut-Sawmill and southern Taboose-Aberdeen Wellfields since 1992, and
- Blackrock Fish Hatchery pumping accounts for 95% of all groundwater pumping in the Thibaut-Sawmill Wellfield since 1998, and
- Of the remaining 5% of pumping in the Thibaut-Sawmill Wellfield, 78% of that pumping is from wells screened to the deep aquifer and with a limited direct effect on the shallow water table beneath Blackrock 94, and
- Combined groundwater pumping from all wells in the Thibaut-Sawmill and the southern Taboose-Aberdeen Wellfields is now 3000 acre-feet per year less than groundwater pumping from those same wells during the years prior to the 1986 vegetation inventory,

It is concluded that fluctuations in vegetation cover within Blackrock 94 or a decrease in vegetation cover from that measured in 1986, are not attributable groundwater pumping for the Blackrock Fish Hatchery or groundwater pumping from other wells in the Thibaut-Sawmill and Taboose-Aberdeen Wellfields.

Conclusions Regarding Changes in Surface Water Management Practices

Green Book Section I.C.1.b, *Determining Attributability*, requires:

> "*Once it has been determined that there has been a measurable vegetation decrease or change, it must be determined whether the impact is attributable to groundwater pumping or to **changes in surface water management practices**"* (Green Book, page 23, paragraph 2, emphasis added).

Green Book Section I requires:

> "*When reference is made to changes in surface water management practices, changes will be determined in comparison with past practices since 1970*" (Green Book, page 1, paragraph 1).

Accordingly, LADWP evaluated whether changes in its surface water management practices since 1970 may have resulted in vegetation changes in Blackrock 94. To determine if changes in surface management practices have occurred, LADWP employed numerous approaches and conducted numerous analyses of its surface water management practices in the general area of Blackrock 94 and on Sawmill Creek, which is adjacent to Blackrock 94. LADWP conducted analyses to find if changes in water supplied to agriculture, changes in water spreading practices, and changes in water diversions to the LAA had occurred since 1970. Each analysis conclusively found that LADWP's surface water management practices have not changed since 1970. LADWP's year-to-year surface water management practices are contingent on the amount of available snowpack runoff and surface water management practices regarding water supplied to for agricultural uses, water diverted for groundwater recharge, and water diverted into the LAA have remained consistent since 1970.

With regard to LADWP's surface water management practices pertaining to water spreading, LADWP's standard practice since 1970 has been to spread water when the LAA didn't have the capacity to take additional water. This practice results in water typically being spread during periods of high snowpack runoff. Water is spread during high runoff periods and even more water is spread during particularly high periods of runoff. This surface water management practice has not changed since 1970.

It has been conclusively determined that LADWP's surface water management practices in the area of Blackrock 94 have not changed since 1970, for that reason changes in Blackrock 94 cannot be attributed to "*a change in past surface water management practices.*"

Vegetation Changes in Blackrock 94 are Attributable to Periods of Drought and Fluctuations in Wet/Dry Climatic Cycles

The Green Book requires the Technical Group to consider "…*the extent to which other factors unrelated to the effects of groundwater pumping may have contributed to the vegetation change or decrease. Such factors include drought, wet/dry climatic cycles,* " (Green Book, Section I.C.1.b.v, page 24). Accordingly, LADWP conducted a thorough evaluation of the extent to which other factors unrelated to groundwater pumping may have effected vegetation in Blackrock 94. Through its analysis LADWP determined that vegetation within the parcel has changed due to range management practices, wildfire, and the expansion of U.S. Highway 395 within the parcel; but the primary driver of vegetation change within Blackrock 94 is due to periods of drought and fluctuations in wet/dry climatic cycles.

Total perennial cover within Blackrock 94 is largely made up of perennial shrubs and grasses. LADWP has established that shrub cover within Blackrock 94 has remained relatively stable since the 1986 and changes in total perennial cover in the parcel are primarily caused by fluctuations in grass cover. It has also been established that grass cover strongly correlates with fluctuations in wet/dry cycles. Annual plant species cover follows a similar pattern as grasses.

During multiple years of average and above average precipitation and runoff, soil moisture within Blackrock 94 increases. During periods of elevated runoff LADWP's past surface water management practice has been to spread water in excess of the LAA's capacity. These periods result in periods of increased soil moisture which produce increases in grass cover and by extension increases in total perennial vegetation cover within Blackrock 94. This correlation between increases in total perennial vegetation cover and periods of increased precipitation and runoff can be seen in the 1986 initial vegetation inventory of Blackrock 94, in which 41% cover was measured following an eight-year period of 135% of average runoff; the 1998 vegetation inventory, in which vegetation cover increased over 400 percent, from 12% to 50% total perennial cover, following a four year period 140% of average runoff; and the 2006 vegetation inventory, in which total perennial cover increased 180% following a two year period of 142% of average runoff.

The converse is also true, during periods of drought, decreased precipitation, and low runoff conditions, soil moisture within Blackrock 94 decreases. These periods of decreased soil moisture result in declines in grass cover and by extension decreases in total perennial vegetation cover within Blackrock 94. The correlation between decreases in total perennial vegetation cover and periods of decreases in precipitation and runoff in Blackrock 94 can be seen in the 2004 vegetation inventory, in which vegetation cover fell from 37% to 18% following a six-year period of 81% of average runoff; the 2009 inventory, in which vegetation cover fell from 31% to 19% during a period of state-wide drought, which was most pronounced in the Owens Valley between 2007 and 2009 (snowpack runoff average 71%); and the current drought, in which vegetation cover fell from 26% to 15% during a period of back-to-back runoff years of approximately 58% of average in 2012 and 51% of average in 2013.

Fluctuations in vegetation cover due to periods of wet/dry cycles are not confined to Blackrock 94. LADWP has examined vegetation within control parcels throughout the Owens Valley with groundwater tables not influenced by groundwater pumping and found the same trend: during periods of high precipitation and snowpack runoff, grass cover increases, resulting in overall increases in perennial cover; during periods of low precipitation and snowpack runoff, grass cover decreases resulting in overall decreases in perennial cover.

Final Conclusions

A thorough evaluation of the available evidence finds measureable changes in Blackrock 94 to be attributable to periods of drought and fluctuations in wet/dry climatic cycles. Fluctuations in vegetation cover within Blackrock 94 were determined not to be attributable to groundwater pumping in the Thibaut-Sawmill and central and southern Taboose-Aberdeen Wellfields or to LADWP's surface water management practices. It was conclusively demonstrated that LADWP's surface water management practices have not changed since 1970. Changes in vegetation cover and composition from that measured in LADWP's 1986 initial vegetation inventory are attributable to fluctuations in wet/dry climatic cycles and not attributable to groundwater pumping or to changes in past surface water management practices.

Water Agreement Section IV.B sets the criteria for determining that measurable changes in vegetation are attributable to groundwater pumping or changes in surface water management practices:

> "*Decreases and changes in vegetation and other environmental effects shall be considered "attributable to groundwater pumping, or to a change in surface water management practices," if the decrease, change, or effect would not have occurred* ***but for*** *groundwater pumping and/or a change in past surface water management practices"* (Water Agreement, page 18, paragraph 4, emphasis added).

In the evaluation of Blackrock 94 that criteria has clearly not been met. Water Agreement Section IV.B allows for the evaluation of significance only after it has been determined that measurable changes are attributable to groundwater pumping or changes in surface water management:

> "*If the decrease, change, or effect is determined to be attributable to groundwater pumping or to changes in surface water management practices, the Technical Group then shall determine whether the decrease, change, or effect is significant*" (Water Agreement, page 19, paragraph 2).

Therefore, pursuant to the terms of the Water Agreement, a determination of significance cannot be made. However, pursuant to the Arbitrator's October 21, 2013 Interim Order, LADWP evaluated the significance of vegetation change in Blackrock 94 and, following the provisions of Green Book Section I.C.1.c, found the factors requiring a determination of significant to not have been met. Fluctuations in vegetation cover in response to wet periods and periods of drought are part of a natural process that happens throughout the Great Basin Desert. Decreases in vegetation during periods of drought or low precipitation and snowpack runoff occur throughout the Owens Valley and during protracted periods of low runoff vegetation cover and composition may be affected substantially. While these decreases may be disconcerting, they cannot be considered to be significant pursuant to the provisions of the Water Agreement.

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9.0 Glossary

Acre-Foot: A unit of volume equal to the volume of a sheet of water one acre in area and one foot in depth; 43,560 cubic feet. One acre-foot of water is approximately 325,851 gallons.

Alkali Meadow: Dense to fairly open growth of perennial grasses and sedges. Dominant species are: alkali meadow (*Sporobolus airoides*), inland saltgrass (*Distchlis spicata*), and Mexican sedge (*Juncus balticus*).

Alluvium: Unconsolidated soil or sediment which has been eroded reshaped by water in some form and re-deposited.

Animal Unit Months: The amount of forage needed by an "animal unit" for one month. The quantity of forage needed is based on the cow's metabolic weight, and the "animal unit" is defines as one mature 1,000 pound cow and her suckling calf. One cow nursing a calf consumes 11 kg or 26 pound of forage (dry matter) per day.

Available water capacity: The portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

Class 1: Uppermost layer of the soil profile (less than 1 meter in depth).

Class 2: Soil layer located between 1 meter and 2 meters in depth.

Class 3: Soil layer located between 2 meter and 3 meters in depth.

Class 4: Soil layer located between 3 meter and 4 meters in depth.

Common plant species appeared in the analysis: Alkali sacaton (SPAI, *Sporobolus airoides*)**,** Big sagebrush (ARTR2, *Artemisia tridentata*)**,** Inland saltgrass (DISP, *Distichlis spicata*)**,** Nevada saltbush (ATTO, *Atriplex torreyi*)**,** Rubber rabbitbrush (ERNA10, *Ericameria nauseosa*)

Depth-to-Water: The distance from the ground surface to the groundwater table. Depth-to-water is referred to as DTW.

Drought: Period of years with below normal precipitation and runoff.

Evapotranspiration: The amount of water lost from an area through plant transpiration and evaporation from soil and plant surface (as a result of interception).

Excessively Drained: Water is removed from the soil very rapidly. Internal free water commonly is very deep or very rare. The soils are commonly coarse textured and have very high saturated hydraulic conductivity or are very shallow.

fmsl: feet above mean sea level.

Flowing Wells – F: Synonymous to artesian wells. Groundwater flows out of the well because the piezometric head pressure is higher than the ground level of the well.

Fluvial: Produced by the action of a river or stream.

Hardpan: Soil layer that is restrictive to the vertical movement of water and/or roots within a soil profile.

Hydraulic conductivity: A coefficient of proportionality describing the rate at which water can move through a permeable medium.

Indicator species: A species whose presence, absence, or relative well-being in a given environment is indicative of the health of its ecosystem as a whole.

Initial Inventory: Also referred to as LADWP's initial vegetation inventory, baseline inventory, or baseline. This monitoring effort was conducted by the LADWP between 1985 and 1987. Vegetation cover was quantified by vegetation parcel throughout the Owens Valley using the line point intercept method.

Late Seral Species: A plant species which occurs in a later stage of succession to form a climax community.

NMDS: Nonmetric Multidimensional Scaling. An ordination method to reduce or summarize a complex data set into fewer descriptors (dimensions or axes). For instance, species composition among transects are different due to two factors: change in moisture availability and difference in soil types. Two numbers (site scores) or axes are, therefore, necessary to describe each transect. Site scores along each axis represent similarity or dissimilarity in species composition along each aspect of factors; one axis represents moisture availability and the other axis represents soil type difference. What each axis represents, however, is up to a researcher to determine using the knowledge of the site and characteristics of species and by comparing to the known environmental factors.

Moderately Well Drained: Water is removed from the soil somewhat slowly during some periods of the year. Internal free water commonly is moderately deep and may be transitory or permanent. The soil is wet for only a short time within the rooting depth during the growing season but is wet lone enough that most mesophytic crops are affected. The soil commonly has a moderately low or lower saturated hydraulic conductivity class within one meter of the surface, periodically receives high rainfall, or both.

Multiple Linear Regression: A regression analysis to test relationships and interrelationships among three or more variables (one dependent variable and two or more independent variables). It calculates a coefficient of determination (R^2) which indicates how much of variation in a dependent variable is explained by a combination of independent variables. Closer R^2 is to 1 the better the model while closer R^2 is to 0, the worse the model.

Pack Stock: Animals such as horses, mules, donkeys, etc. use to carry equipment where vehicular travel is not usually permitted.

Partial Linear Correlation: A statistical method to test how strongly two variables are related to each other by removing the effect of a third variable. Often two environmental variables (i.e. surface water spreading and runoff) show very similar patterns of fluctuations over time. In order to test a "true" effect of spreading on vegetation, the effect of runoff must be removed prior to testing a relationship between spreading and vegetation. When a partial correlation coefficient becomes statistically insignificant, then the relationship between two variables (spreading and vegetation) is spurious.

PERMANOVA: Permutational Multivariate Analysis of Variance. A statistical method, developed by M.J. Anderson, to test difference between two variables and among three or more variables based on multivariate data. Multivariate means there are more than one dependent variable. The interpretation of the result is analogues to Analysis of Variance (ANOVA). This method was used to test difference in species composition among monitoring years.

PERMDISP: Multivariate Homogeneity of Group Dispersion (Variance). A statistical method, developed by M.J. Anderson, to test difference in variance structure between two variables and among three or more variables based on multivariate data. For instance, the occurrence of various plant species and associated cover are very similar among 10 transects during the first year; thus, the first year has low within-year variability (or all transects are similar). But the next year, the occurrence of plant species and associated cover are very different among 10 transects; thus, the second year has high within-year variability (or transects are very different from each other). PERMDISP statistically test this difference in within-year variability between two or more years.

Piezometric head: A specific measurement of liquid pressure above a geodetic datum. It is usually measured as a liquid surface elevation, expressed in units of length, at the entrance (or bottom) of a piezometer. In an aquifer, it can be calculated from the depth to water in a piezometric well (a specialized water well), and given information of the piezometer's elevation and screen depth. Hydraulic head can similarly be measured in a column of water using a standpipe piezometer by measuring the height of the water surface in the tube relative to a common datum. The hydraulic head can be used to determine a hydraulic gradient between two or more points.

Poorly Drained: The soil is wet at shallow depths periodically during the growing season or remains wet for long periods. Internal free water is shallow or very shallow and common or persistent. Unless the soil is artificially drained, most mesophytic crops cannot be grown. The soil, however, is not continuously wet directly below plow depth. The water table is commonly the result of a low or very low saturated hydraulic conductivity class or persistent rainfall or a combination of these factors.

Pumping Wells – W: Wells which actively pump groundwater from unconfined and/or confined aquifers.

Restrictive layer: A nearly continuous layer that has one or more physical, chemical, or thermal properties that significantly impede the movement of water and air through the soil or that restricts roots or otherwise provide an unfavorable root environment.

Riparian: Is the interface between land and a river or a stream. Plant habitats and communities along the river margins and banks are called riparian vegetation.

Simple Linear Correlation: A statistical method to test how strongly two variables are related to each other. It calculates a correlation coefficient (r) or Pearson's product moment correlation coefficient as the measure of strength; the closer the correlation coefficient (r) to 1 or -1, the stronger the relationship while the closer the correlation coefficient (r) to 0, the weaker the relationship. The p-value is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true. Researchers will often "reject the null hypothesis" when the p-value turns out to be less than a certain statistical significance level, often 0.05 (α=0.05).

Soil series: A subdivision of a family and consists of soils that are similar in all major profile characteristics. Soil series is the lowest and most detailed classification of soil.

Soil Unit: An area consisting of one or more major soil or miscellaneous types and inclusions of minor types.

Somewhat Excessively Drained: Water is removed from the soil rapidly. Internal free water commonly is very deep or very rare. The soils are commonly coarse textured and have high saturated hydraulic conductivity or are very shallow.

Somewhat Poorly Drained: The soil is wet at a shallow depth for significant periods during the growing season. Internal free water is commonly shallow or moderately deep and transitory or permanent. Unless the soil is artificially drained, the growth of most mesophytic plants is markedly restricted. The soil commonly has a low or very low saturated hydraulic conductivity class or a high water table, receives water from lateral flow or persistent rainfall, or is affected by some combination of these factors.

Statistical significance: This term refers to a statistically significant test result. In this report statistical significance was declared at $\alpha = 0.05$.

Temporal: Relating to measured time.

Transpiration: The passage of water through a plant from the roots through the vascular system to the atmosphere.

Transmissivity: The rate at which water of a prevailing density and viscosity is transmitted through a unit width of an aquifer or confining bed under a unit hydraulic gradient. It is a function of properties of the liquid, the porous media, and the thickness of the porous media.

Upland: Ground elevated above lowlands.

Tail water: Excess water draining from an irrigated field.

Heterogeneity: Consisting of dissimilar elements or parts.

High spatial heterogeneity: In this document, this term refers to co-occurrences of different plant communities or soil types within the parcel.

Vegetation Composition: Species composition which is "*synonymous with "relative cover" and expresses the percent contribution by a species to the land surface area covered by living plants.*"

Vegetation Cover: For the purposes of this report vegetation cover is total perennial vegetation cover.

Water Spreading: Water that is diverted from natural streams, creeks, or rivers to recharge the groundwater basin. LADWP typically spreads water during periods of high runoff when stream-flow is in excess of LAA capacity. LADWP also spreads water for maintenance and other operational purposes.

Water Table Elevation (WTE): Measurement of the groundwater surface above sea level.

Water Year: A hydrological year used to summarize hydrological data. A water year starts in October 1 and ends in September 30.

Well Drained: Water is removed from the soil readily but not rapidly. Internal free water commonly is deep or very deep; annual duration is not specified. Water is available to plants in humid regions during much of the growing season. Wetness does not inhibit growth of roots for significant periods during most growing seasons.

Xeric: Environment of habitat containing little moisture, very dry.