APPENDIX A

FINAL SCOPING DOCUMENT

"REGREENING NORTHEAST OF BIG PINE"

IRRIGATED PASTURE
J&L LIVESTOCK--RLI-483 - BIG PINE AREA

AS AN

ENHANCEMENT/MITIGATION PROJECT

Introduction

The Technical Group has prepared this report to assist the Standing Committee in evaluating the "Regreening Northeast of Big Pine" enhancement/mitigation project.

1. Need

   To enhance the aesthetics and regreen abandoned agricultural lands northeasterly of Big Pine, and adjacent to the residential area.

2. Description

   Water will be supplied from the southwest corner of Poplar Street and U.S. Highway 395 through an existing culvert under the highway to the project area. New ditches and check structures, designed by the Department and installed by the lessee (J&L Livestock), will be used to flood irrigate up to 30 acres of new pasture.

3. Scope

   The Department will design, engineer, purchase all necessary materials, and approve of the construction of the project.

   The lessee (J&L Livestock) will be responsible for the following:

   a. Any and all clearing, cleanup or leveling of the project area.

   b. Installation of any and all water conveyance facilities on the site, including checks or control structures.

   c. Installation of all fencing materials.

   d. Prepare, seed and irrigate to germinate a suitable pasture over the parcel.

   e. Irrigate the pasture, and maintain and operate all ditches, conveyances and checks for the life of the project.

4. Water Supply

   Water for the project will come from Big Pine Creek via the proposed Big Pine Ditch System, and/or Baker Creek via the proposed Mendenhall Park Ditch, existing ditches, or some combination of the above to the southwest corner of Poplar Street and U.S. Highway 395, then under the highway through an existing culvert to a ditch or pipeline to the westerly edge of the project area. The new pasture will be supplied up to 150 acre feet annually from existing E/M well No. 375 in the Big Pine area. The method of application will be normal surface field irrigation practices (flood irrigation).

5. Effectiveness of Project

Providing water for this pasture will greatly enhance the area and mitigate the impacts caused by abandoned agriculture.

6. Impact of Project

This project will create no adverse impact to the environment, and will increase livestock grazing capacity in the area.

7. Cost

The lessee will be reimbursed for all of his expenses for development of the project. Estimated total cost: $40,000

8. CEQA Requirements

Cat. Exempt.

INYO/LOS ANGELES STANDING COMMITTEE

Dedicated to the advancement of mutual cooperation

MEMORANDUM

Date: August 27, 2010

To: Inyo/Los Angeles Standing Committee

From: Inyo/Los Angeles Technical Group

Subject: Revised Scoping Document "Regreening Northeast of Big Pine" Irrigated Pasture – Big Pine Area as an Enhancement/Mitigation Project

Background

The *Final Scoping Document "Regreening Northeast of Big Pine" Irrigated Pasture J&L Livestock—RLI-483 – Big Pine Area as an Enhancement/Mitigation Project* (1988 Final Scoping Document - attached) was completed and approved by the Standing Committee in September 1988. Revegetation of approximately 30 acres of pasture northeast of Big Pine is also included as a mitigation measure in the 1991 Environmental Impact Report on *Water from the Owens Valley to Supply the Second Los Angeles Aqueduct.*

The 1988 Final Scoping Document included brief descriptions of the need, methods, scope of work, and other information relating to the Regreening Northeast of Big Pine Project. Since the 1988 Final Scoping Document was adopted by the Standing Committee, conditions associated with the project have changed. The Technical Group recognizes that these changes in circumstance necessitate a revision to the 1988 Final Scoping Document in order to facilitate the project. The changes recommended by the Technical Group are described below and included in a Revised Final Scoping Document, Regreening Northeast of Big Pine, Irrigated Pasture – Big Pine Area, Enhancement/Mitigation Project (attached)

Key Modifications to the 1988 Final Scoping Document include:

- Changing the lessee designation from J&L Livestock to an undesignated lessee
- Revising the boundaries the project as shown on the attached map.
- Amending the water supply source and method of application identified for the project

Long-Term Water Agreement Section V.C provides that:

Certain town supply wells, irrigation supply wells, fish hatchery supply wells, enhancement/mitigation project supply wells, and other wells not affecting areas with groundwater dependent vegetation may be designated by the Technical Group as exempt from automatic turn-off.

Revised Final Scoping Document "Regreening Northeast of Big Pine"

August 27, 2010

Introduction

The Technical Group has prepared this report to assist the Standing Committee in evaluating the Regreening Northeast of Big Pine Enhancement/Mitigation Project.

1. Need

   To enhance the aesthetics and regreen abandoned agricultural lands northeasterly of Big Pine and adjacent to the residential area.

2. Description

   Project will be irrigated pasture located on up to 30 acres of land northeast of Big Pine, California (see attached map). Irrigation water will be supplied by flood irrigation using best management practices or by sprinkler irrigation. The irrigation system will be designed by LADWP and installed by LADWP or lessee.

3. Scope

   LADWP will design, engineer, purchase materials, and construct or approve construction of the project. Lessee will be responsible for: any and all clearing, cleanup, or leveling of the project area; installation, operation, and maintenance of on site water conveyances and irrigation equipment; installation of fencing; prepare, seed, and irrigate project area in order to germinate and maintain a suitable pasture.

4. Water Supply

   Water for the project will come from the Big Pine Creek via the Big Pine Ditch System or the BPIIA Ditch, or Baker Creek via the Mendenhall Park Ditch, or Baker Return Ditch, or the Big Pine Canal, or a combination of these sources. The project will be supplied with up to 150 acre-feet of water per year. Surface water supplied to the project from the above-named sources will be made up by pumping Well W375 in an amount equivalent to that supplied to the project on an annual basis.

5. Effectiveness of Project

   Providing water for this pasture will greatly enhance the area and mitigate the impacts caused by abandoned agriculture.

6. Impact of Project

   It is anticipated that this enhancement/mitigation project will have an overall beneficial impact.

7. Cost

   Cost of the project installation will be borne by LADWP. Estimated cost to be determined

8. CEQA Requirements

   LADWP will complete CEQA requirements.

AGENDA

INYO COUNTY/LOS ANGELES STANDING COMMITTEE

10:00 A.M.
August 27, 2010

Board of Supervisors Room, County Administrative Center
224 North Edwards
Independence, California

The public will be offered the opportunity to comment on each agenda item prior to any Action on the item by the Standing Committee or, in the absence of action, prior to the Committee moving to the next item on the agenda. The public will also be offered the Opportunity to address the Committee on any matter within the Committee's jurisdiction Prior to adjournment of the meeting.

1. Field trip – Blackrock Waterfowl Habitat Area and Vegetation Parcel Blackrock 94
2. Documentation of actions from May 6, 2010 meeting
3. Report on 2010-11 Operations Plan
4. **Action**: Adoption of revised scoping document for enhancement/mitigation project "Regreening Northeast of Big Pine."
5. Report on proposed revision to Green Book, Section III.C.5 Plant Recruitment Studies.
6. Report on Lower Owens River Project Seasonal Habitat Flow
7. Report on Green Book revision effort.
8. Report on the Water Agreement land releases
9. Report on the Owens Lake Groundwater Study
10. Public Comment
11. Schedule for future Standing Committee meetings
12. Adjourn

INYO/LOS ANGELES STANDING COMMITTEE

Dedicated to the advancement of mutual cooperation

MEMORANDUM

Date: November 4, 2010

To: Inyo/Los Angeles Standing Committee

From: Inyo/Los Angeles Technical Group

Subject: Revised Scoping Document "Regreening Northeast of Big Pine" Irrigated Pasture – Big Pine Area as an Enhancement/Mitigation Project

Background

The *Final Scoping Document "Regreening Northeast of Big Pine" Irrigated Pasture J&L Livestock—RLI-483 – Big Pine Area as an Enhancement/Mitigation Project* (1988 Final Scoping Document - attached) was completed and approved by the Standing Committee in September 1988. Revegetation of approximately 30 acres of pasture northeast of Big Pine is also included as a mitigation measure in the 1991 Environmental Impact Report on *Water from the Owens Valley to Supply the Second Los Angeles Aqueduct*.

The 1988 Final Scoping Document included brief descriptions of the need, methods, scope of work, and other information relating to the Regreening Northeast of Big Pine Project. Since the 1988 Final Scoping Document was adopted by the Standing Committee, conditions associated with the project have changed. The Technical Group recognizes that these changes in circumstance necessitate a revision to the 1988 Final Scoping Document in order to facilitate the project. The changes recommended by the Technical Group are described below and included in a Revised Final Scoping Document, Regreening Northeast of Big Pine, Irrigated Pasture – Big Pine Area, Enhancement/Mitigation Project (attached)

Key Modifications to the 1988 Final Scoping Document include:

- Changing the lessee designation from J&L Livestock to an undesignated lessee
- Revising the boundaries the project as shown on the attached map.
- Amending the water supply source and method of application identified for the project

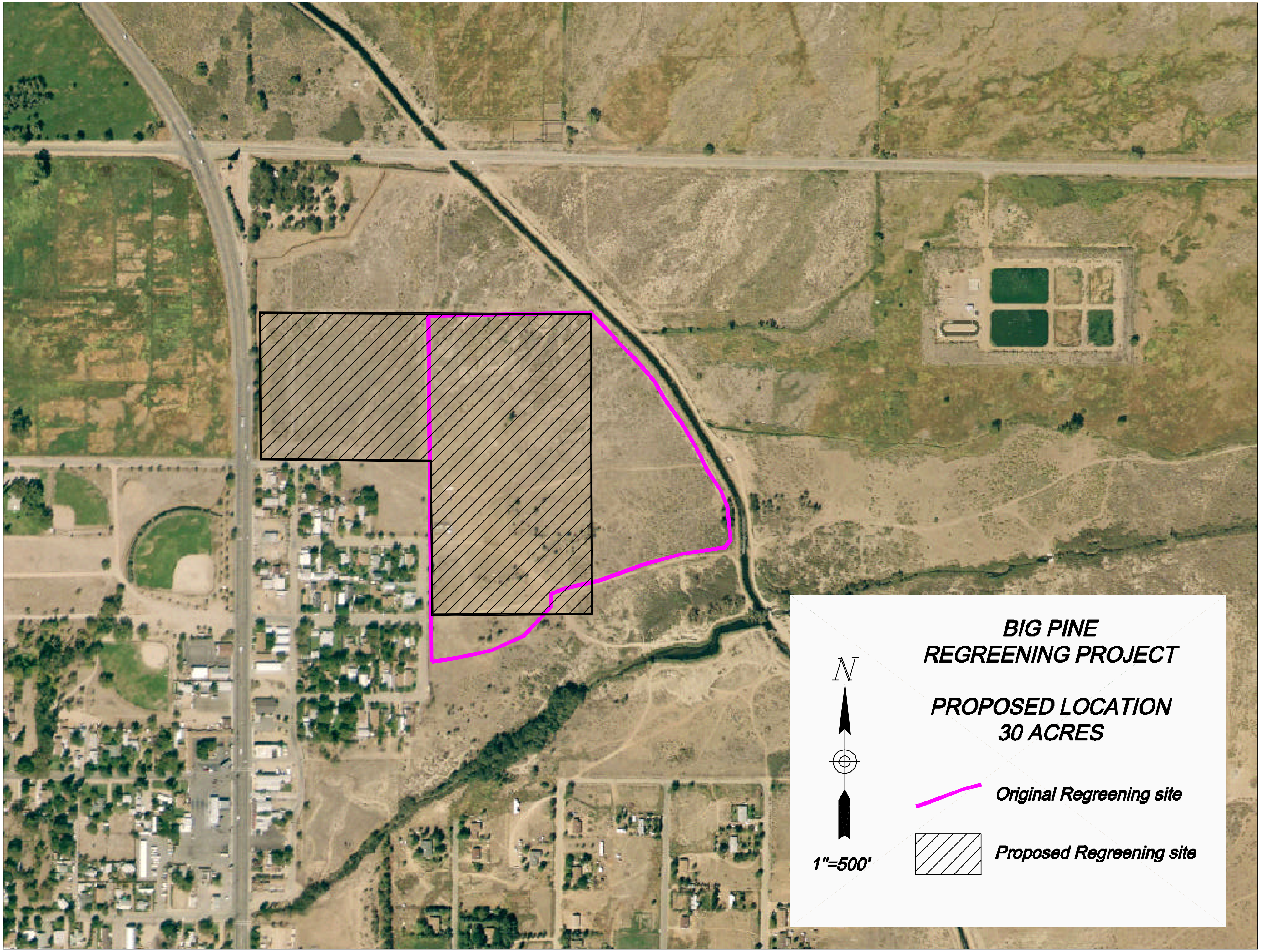
Long-Term Water Agreement Section V.C provides that:

Certain town supply wells, irrigation supply wells, fish hatchery supply wells, enhancement/mitigation project supply wells, and other wells not affecting areas with groundwater dependent vegetation may be designated by the Technical Group as exempt from automatic turn-off.

The Technical Group has analyzed the operation of Well W375 and concluded that an exemption for up to 150 acre-feet per year would have no significant impact on the environment or other well owners. The Technical Group will exempt well W375 for up to 150 acre-feet per year, not to exceed uses on the project, contingent on completion of CEQA for this project, to provide make-up water for water supplied to the project as described in the attached Revised Final Scoping Document, Regreening Northeast of Big Pine, Irrigated Pasture – Big Pine Area, Enhancement/Mitigation Project. Make-up water will be pumped on an annual basis.

Recommendation

It is recommended that the Standing Committee adopt the Revised Final Scoping Document, Regreening Northeast of Big Pine, Irrigated Pasture – Big Pine Area, Enhancement/Mitigation Project as a replacement to the 1988 Final Scoping Document.



BIG PINE
REGREENING PROJECT
PROPOSED LOCATION
30 ACRES
N
Original Regreening site
Proposed Regreening site
1"=500'

AGENDA

INYO COUNTY/LOS ANGELES STANDING COMMITTEE

1:00 P.M.
November 4, 2010

Elks Lodge
151 E. Line St.
Bishop, California

The public will be offered the opportunity to comment on each agenda item prior to any Action on the item by the Standing Committee or, in the absence of action, prior to the Committee moving to the next item on the agenda. The public will also be offered the Opportunity to address the Committee on any matter within the Committee's jurisdiction Prior to adjournment of the meeting.

1. Documentation of actions from August 27, 2010 meeting
2. **Action**: Reconsideration of adoption of modified scoping document for enhancement/mitigation project "Regreening Northeast of Big Pine."
3. Report on Green Book update
    a. Green Book Section III.C.5, Plant Recruitment Studies
    b. Green Book revision effort
4. Report on Well Exemptions
    a. Temporary exemption of W377 to supply stockwater in Laws
    b. Exempt well list
5. Report on the Water Agreement land releases
6. Report on the Owens Lake Groundwater Study
7. Owens Lakebed Master Plan process
8. Public Comment
9. Schedule for Future Standing Committee meetings
10. Adjourn

INYO/LOS ANGELES STANDING COMMITTEE

Dedicated to the advancement of mutual cooperation

MEMORANDUM

Date November 4, 2010

Subject: Agenda Item #1: Documentation of Actions Taken by Standing Committee at August 27, 2010 Meeting

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The Standing Committee's policy is to document any actions taken by the Committee in a memorandum at the subsequent meeting. The following actions were taken at the May 6, 2010 Standing Committee meeting:

Item 4. The Standing Committee adopted the Revised Final Scoping Document, Regreening Northeast of Big Pine, Irrigated Pasture – Big Pine Area, Enhancement/Mitigation Project as a replacement to the 1988 Final Scoping Document.

APPENDIX B

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P.O. Box 337
135 South Jackson Street
Independence, CA 93526

COUNTY OF INYO
WATER DEPARTMENT

July 23, 2010

TO: Los Angeles Technical Group members

FROM: Inyo County Technical Group members

SUBJECT: Effects of groundwater pumping to supply the Northeast Big Pine Regreening mitigation project

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INTRODUCTION. The Regreening Northeast of Big Pine Project was approved by the Inyo/Los Angeles Standing Committee as an enhancement/mitigation project in 1988. The project consists of irrigating 30 acres of abandoned agricultural land with the goal of enhancing the aesthetics of the area. This project was adopted as a mitigation measure in the 1991 Final Environmental Impact Report for Water From the Owens Valley to Supply the Second Aqueduct (FEIR). The scoping document approved by the Standing Committee identified the water supply for the project as coming from Big Pine Creek via the Big Pine Ditch System, Baker Creek via Mendenhall Ditch, existing ditches, or some combination thereof. The scoping document also described that the project will be supplied with up to 150 acre-feet per year (afy) from well W375. FEIR Table 4-3 allocates 750 afy to the project, but this appears to be a typographical error. Based on this description of the water supply for the project, it appears that the Standing Committee intended for the project to be supplied from surface water conveyances near the project, and that an equivalent amount of water would be pumped from W375 to make up the water supplied to the project.

The Technical Group has discussed modifications to the project described in the scoping document, including alternative locations for pumping make-up water. To evaluate the effects of different pumping locations on the water table, the USGS regional groundwater model for the Owens Valley (documented in USGS Water Supply Paper 2370-H, 1998) was used to examine the effect of project pumping on water table elevations in the Big Pine area.

METHOD. Pumping was simulated from three different locations: the regreening project site, the town supply well, and Well W375 (Figure 1). For each location, drawdown resulting from ten years of project operation was simulated, holding all other inputs to the model constant. During each year, 150 acre-feet were withdrawn over a six-month period, followed by six months of recovery. 150 acre-feet of pumping over a six-month period is equal to a pumping rate of 0.4148 cubic-feet per second (cfs). In reality, pumping rates would vary over the course of the irrigation season; for example, W375 could pump 150 acre-feet in about two weeks if operated at full capacity. Although pumping schedules may vary from the schedule simulated, the overall effect of withdrawing 150 afy would be similar to the simulated effect. Simulations were initiated from a steady-state condition based on 2008 pumping rates and average recharge. Pumping at the project site and from the town supply well was apportioned between the upper and lower model layers based on aquifer transmissivity. This resulted in 90% of pumpage being withdrawn from the lower layer at the project site, and 60% of pumpage being withdrawn from the lower aquifer at the town supply well. 100% of pumpage from W375 was withdrawn from the lower model layer, because W375 is screened from 260 to 440 feet below ground surface and sealed above the well screen. Hydrographs were simulated for each well location, and for the Big Pine Paiute Tribe Reservation (BPPTR).

RESULTS. Figure 2 shows simulated drawdown at the regreening project site and the BPPTR resulting from pumping from a well at the regreening project site. Simulated drawdown does not exceed 0.4 ft at the BPPTR, and does not exceed 1.0 ft at the project site. Drawdown at monitoring site BP1 would be similar to the project site. Figure 1 shows that native phreatophytic vegetation is adjacent to the project site, therefore, the maximum drawdown such vegetation would be subjected to would be 1.0 ft with seasonal recovery to less than 0.5 ft of drawdown. Approximately eight years after pumping begins, simulated drawdown equilibrates (i.e., the annual decline ceases). Operation of well W210 has been discussed by the Technical Group as an alternative source of water for the project. W210 would produce a drawdown pattern similar to a well located at the project site.

Figure 3 shows simulated drawdown resulting from using the town supply well, W341, to supply the town system with 150 afy of additional water. Maximum simulated drawdown at the town well site is less than 4.3 ft, and maximum simulated drawdown at the BPPTR is less than 0.3 ft. A replacement for W341 has been constructed nearby. It is not known that either W341 or the replacement well (W415) has sufficient additional capacity to accommodate supplying the regreening project. Approximately eight years after pumping begins, simulated drawdown equilibrates.

Figure 4 shows simulated drawdown resulting from pumping W375 to provide make-up water for the water supplied to the project. The hydrographs in Figure 4 appear angular because the groundwater model output has a maximum resolution of 0.01 ft. Maximum simulated water table drawdown at W375 is less than 0.2 ft, and maximum simulated drawdown at BPPTR is less than 0.25 ft. Approximately eight years after pumping begins, drawdown equilibrates. After two years, water table drawdown at the BPPTR exceeds drawdown at W375. This results from W375 withdrawing water from the deeper aquifer and a high degree of aquifer confinement at W375. Operational testing conducted on W375, in which the well was pumped continuously for several months, did not induce measureable drawdown in the shallow aquifer, consistent with these model results.

DISCUSSION AND RECOMMENDATION. The regional groundwater model that these results are based on has a coarse spatial resolution, generalized hydraulic parameters, and simplified hydrologic processes. The results presented here are approximations, and the response of the actual system will likely be different by an unknown amount. The effect of stream capture by pumping wells and the effect of irrigation return flow to the shallow aquifer were not simulated. If these effects were included in the model, predicted drawdown would be reduced. Reducing the irrigation duty for the project from 150 afy to 90 afy, as has been discussed by the Technical Group, would proportionally reduce pumping and resultant drawdown. It is not clear that such a reduction would provide adequate water for the project to succeed. Pumping effects from other wells not simulated here are additive to the effects resulting from regreening project pumping.

Among the water supply options considered, the least likely to have an adverse impact is pumping from W375. This option produced the least drawdown at BPPTR and will have negligible effect on riparian areas west of Big Pine. Drawdown induced by pumping W341 (Figure 3) could potentially affect groundwater dependent vegetation growing along stream channels and fault scarps west of Big Pine. Drawdown induced by a well at the regreening project site indicates that a well located at the site poses little risk to phreatophytic vegetation, but slightly higher drawdown is predicted than for W375. The predicted drawdown from W375 is too small to measurably affect the phreatophytic communities in the vicinity of the well (Figure 4), and is therefore considered insignificant. The Water Department recommends that W375 be exempt to provide up to 150 afy as make up water for water supplied to the regreening project.

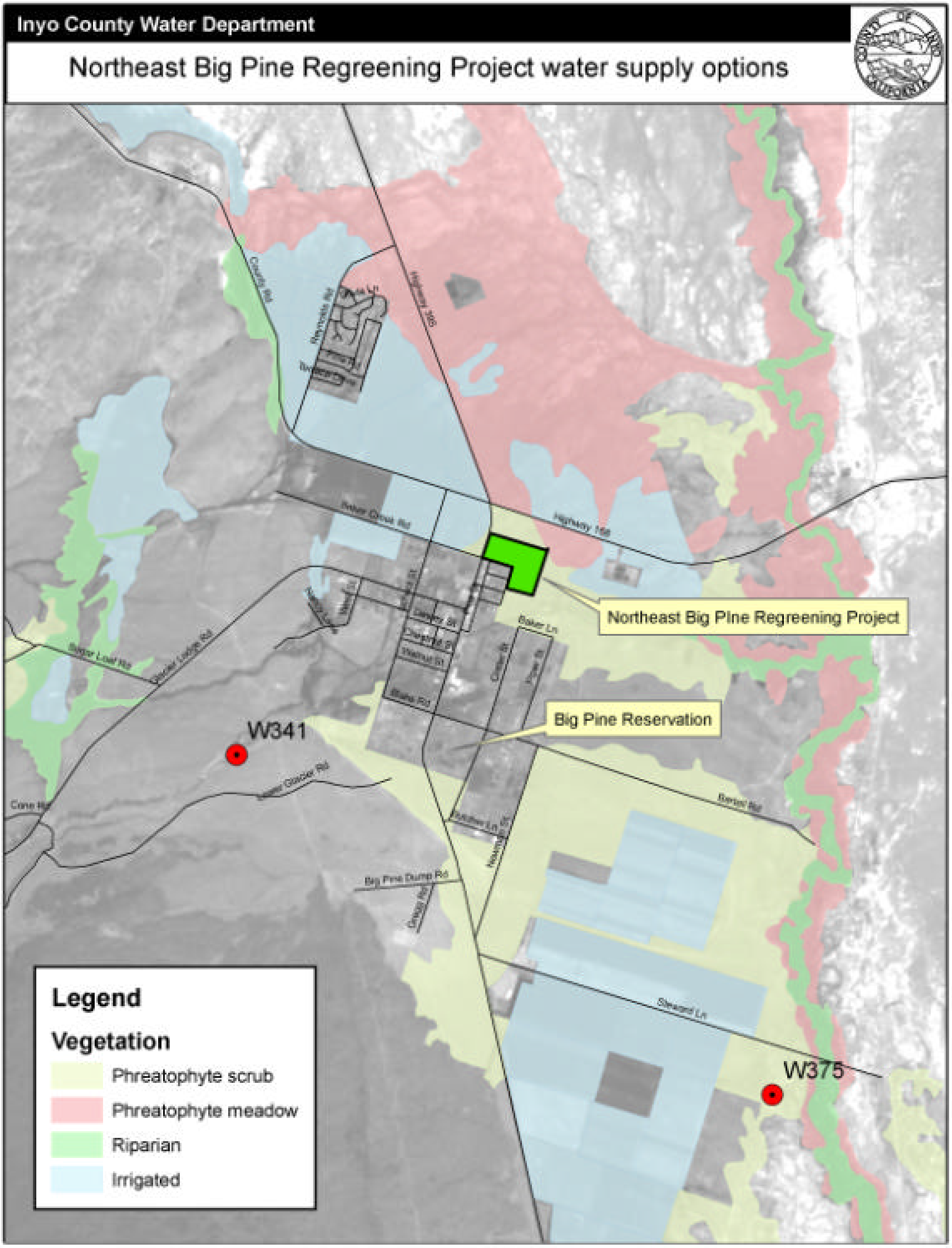
Inyo County Water Department
Northeast Big Pine Regreening Project water supply options
Northeast Big Pine Regreening Project
Big Pine Reservation
W341
W375
Highway 395
Highway 168
Baker Ln
Steward Ln
Big Pine Dump Rd
Legend
Vegetation
Phreatophyte scrub
Phreatophyte meadow
Riparian
Irrigated

Figure 1. Location map. Existing wells W375 and W341 are shown. Vegetation map is for LADWP lands only.

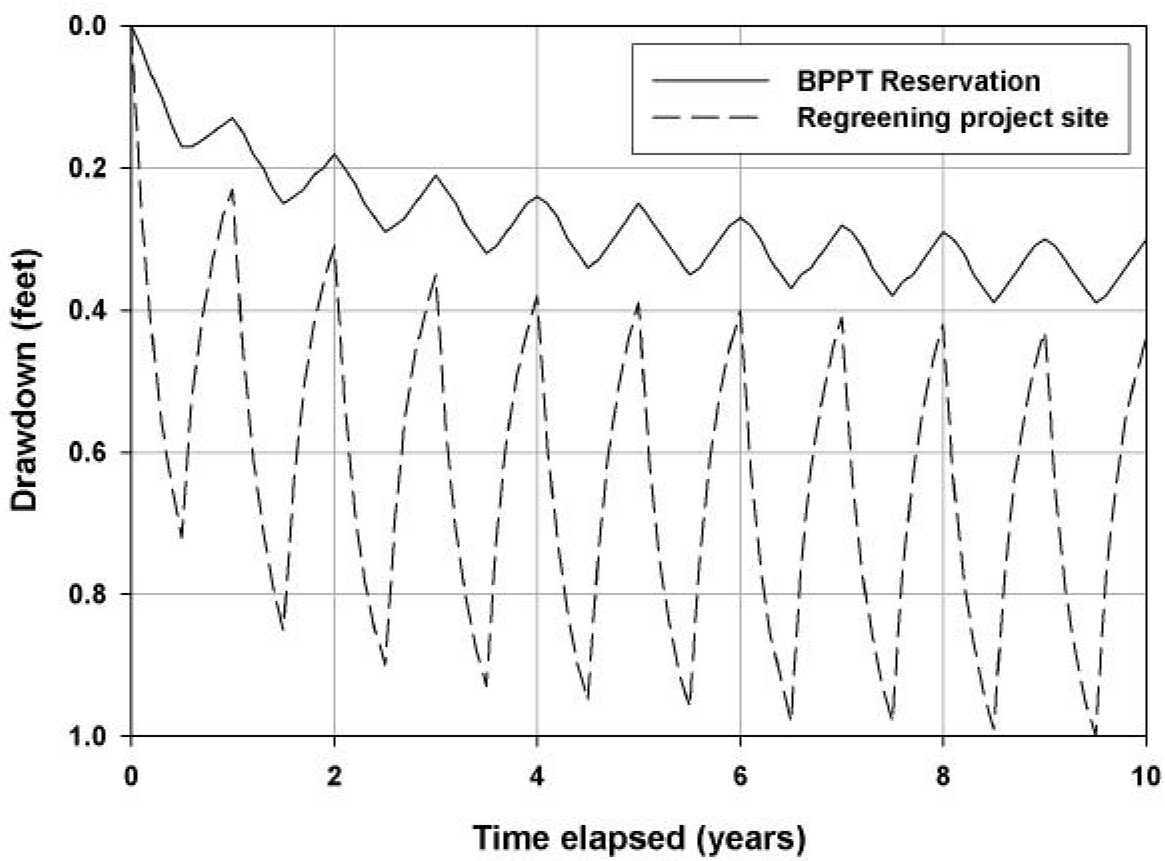

Figure 2. Simulated drawdown resulting from a well located at regreening project site.

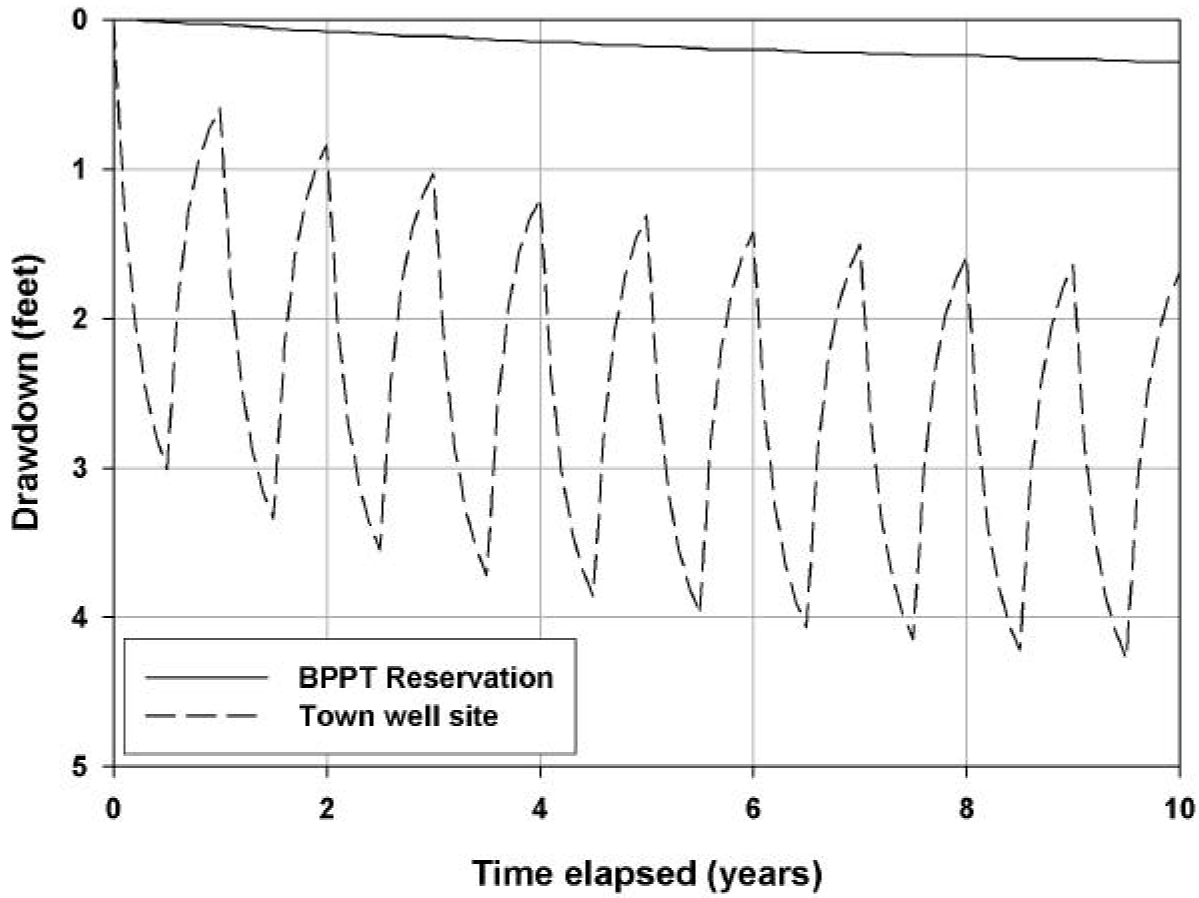

Figure 3. Simulated drawdown resulting from using town supply well to supply project.

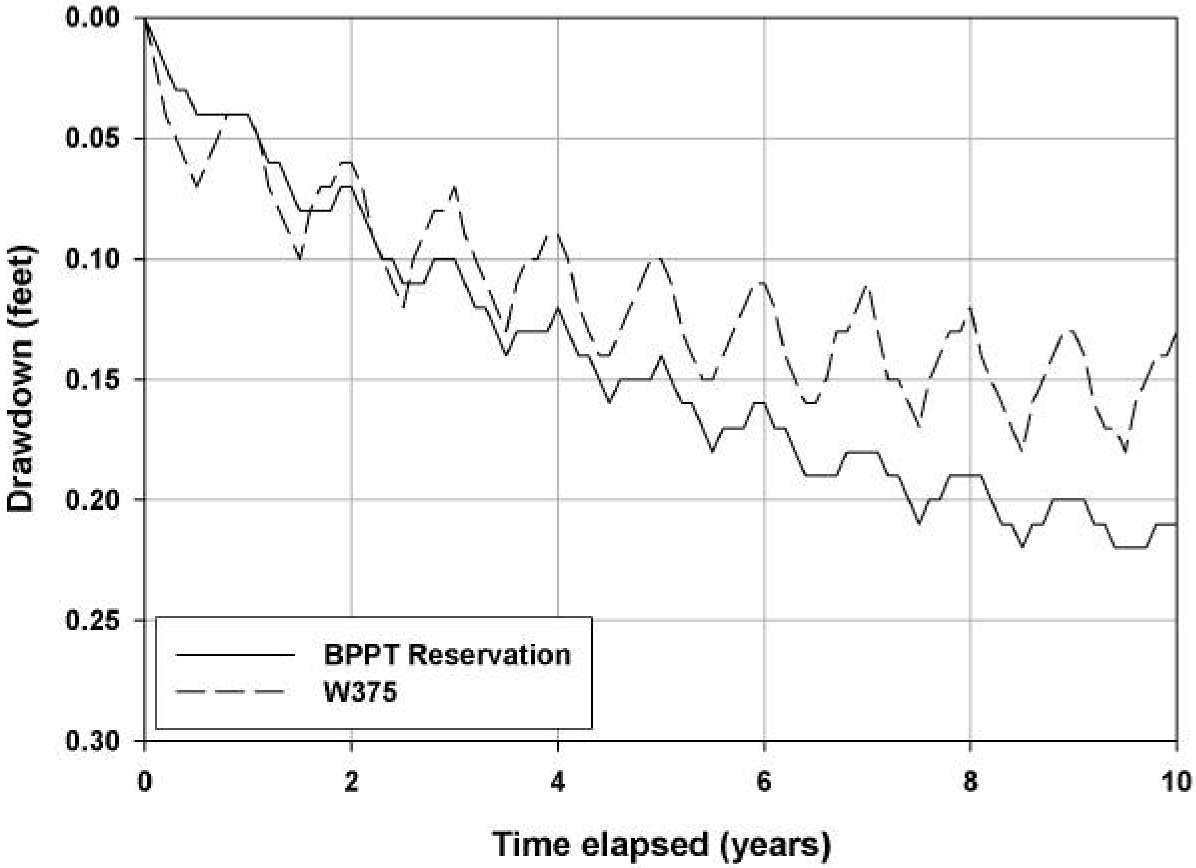

Figure 4. Simulated drawdown resulting from pumping W375 to provide make-up water.

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P.O. Box 337
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COUNTY OF INYO
WATER DEPARTMENT

August 30, 2011

TO: Los Angeles Department of Water and Power
Environmental Assessment and Planning
Attention: Ms. Nancy Chung
111 North Hope Street, Room 1050
Los Angeles, CA 90012

FROM: Bob Harrington, Water Director
County of Inyo

SUBJECT: Comments on CEQA Initial Study and Negative Declaration for Big Pine Northeast Regreening Project

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Thank you for the opportunity to comment on the environmental analysis for this project. Regarding Initial Study Section 2.3.9, Hydrology and Water Quality, we raise two points:

1. The Initial Study concludes that groundwater pumping for the project will have no significant impacts based on a groundwater modeling analysis done by the Inyo County Water Department. It should be understood that the amount of drawdown is likely overestimated in the Water Department's work, because the effect of stream capture by the pumping well and the effect of irrigation return flow to the shallow aquifer were not simulated. If these effects were included in the model, predicted drawdown would be reduced. Additionally, the Water Department's analysis assumed that the maximum allotment provided for the project would be used each year. Reducing the irrigation duty for the project from 150 acre-feet per year to 90 acre-feet per year through more efficient irrigation practices, as has been discussed by the Technical Group, would proportionally reduce pumping and resultant drawdown.

2. We have examined additional information pertaining to potential impacts of pumping Well 375. In 1997 and 1998, an operational test of Well 375 was conducted jointly by LADWP and the Inyo County Water Department, where the well was pumped continuously for 196 days, producing 2170 acre-feet of water, or nearly 15 times the amount of pumping that is proposed annually for the Big Pine Northeast Regreening

Project. Twenty shallow wells and twelve deep wells in the vicinity of Well 375 were monitored during the test. Observations from this test showed that there were no more than a few inches of drawdown in shallow wells in the Big Pine area. This is consistent with, and strengthens, the Initial Study's conclusion that the proposed pumping for this project will have no negative impacts.

Robert F. Harrington
Curriculum Vitae

Contact:
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Employment

County of Inyo Water Department, 2007-present
Water Director – Responsible for directing the Inyo County Water Department, which is charged with implementation of Inyo County water policies. These policies stem primarily from the County's interactions with the City of Los Angeles's water export activities in Inyo County, and from the County's regulation of groundwater transfers. The Water Department's activities include monitoring hydrologic conditions, monitoring vegetation conditions potentially affected by water management activities, assessing potential effects of proposed groundwater pumping, developing and implementing mitigation measures for adverse impacts due to groundwater pumping, monitoring mitigation activities, integrated regional water management planning, invasive species control, and informing and educating the public regarding county water issues.

County of Inyo Water Department, 1997-2007
Hydrologist – Responsible for collecting, analyzing, and reporting on hydrologic conditions as related to Inyo County water policies. Tasks include data collection and interpretation, groundwater model development and review, monitoring network design, development of monitoring and mitigation plans aimed at mitigating impacts of groundwater pumping, and multidisciplinary teamwork to assess effects of hydrologic changes on biological resources.

University of Arizona, 1991-1997
Department of Hydrology and Water Resources, Research Assistant.

Desert Research Institute, 1989-1991
Water Resources Center, Research Assistant.

Education

University of Arizona
PhD in hydrology with minor in remote sensing, 1997. Dissertation title: The release of meltwater and ionic solute from melting snow.

University of Nevada-Reno
MSc in hydrology/hydrogeology, 1991. Thesis title: The amount and fate of acid deposition in the Sierra Nevada, California.

University of Nevada-Reno

BS in geophysics with minor in mathematics, 1988.

Professional Registrations

California Registered Geologist #8285

Professional Affiliations

American Geophysical Union
American Water Resources Association
Geological Society of America
Groundwater Resources Association of California
National Ground Water Association

Peer-reviewed Publications

Steinwand, A.L., R.F. Harrington, and D. Or, Water balance for Great Basin phreatophytes derived from eddy covariance, soil water and water table measurements, Journal of Hydrology, 329(3-4), 595-605, 2006.

Steinwand, A.L., R.F. Harrington, and D. Or, Comment on "The inappropriate use of crop transpiration coefficients (Kc) to estimate evapotranspiration in arid ecosystems: A review" by Mata-Gonzáles et al. Vol. 19: 285–295. (2005)," Arid Land Research and Management, 20(2), 177-179, 2006.

Steinwand A.L., R.F. Harrington, and D.P. Groeneveld, Transpiration coefficients for three Great Basin shrubs, Journal of Arid Environments, 49(3), 555-567, 2001.

Harrington, R.F., R. C. Bales, Modeling ionic solute transport in melting snow, Water Resources Research, 34(7), 1727-1736, 1998.

Harrington, R., R. C. Bales, Interannual, seasonal, and spatial patterns of meltwater and solute fluxes in a seasonal snowpack, Water Resources Research, 34(4), 823-832, 1998.

Harrington, R.F., R.C. Bales, and P. Wagnon, Variability of melt-water and solute fluxes from homogeneous melting snow at the laboratory scale, Hydrological Processes, 10, 945-953, 1996.

Bales, R.C., and R.F. Harrington, Recent progress in snow hydrology, Reviews of Geophysics, Supplement, U.S. National Report to the IUGG, 1011-1020, 1995.

Harrington, R.F., K. Elder, and R.C. Bales, Distributed snow melt modeling using a clustering algorithm, *in* IAHS Pub. 228, Biogeochemistry of Seasonally Snow Covered Catchments, 1995.

Harrington, R.F., A.W. Gertler, D. Grosjean, and P. Amar, Formic acid and acetic acid in the Western Sierra Nevada, California, Atmospheric Environment, 27A(12), 1843-1849, 1993.

Conference Presentations and Published Abstracts

Harrington, R.F., Challenges of monitoring and mitigating adverse impacts of groundwater pumping, Great Basin Water Forum, Sparks Nevada, October 2010. *(Invited oral presentation)*

Harrington, R.F., Groundwater management in the Owens Valley under the Inyo/Los Angeles Long-Term Water Agreement, Sierra Nevada Alliance 15th Annual Conference, September 2008. *(Invited oral presentation)*

Harrington, R.F., A.L. Steinwand, and D. Or, Vadose zone water balance for Great Basin phreatophytes, Fall 2005 Meeting of the American Geophysical Union, San Francisco, California, December 2005. *(Invited oral presentation)*

Harrington and Steinwand, Evaptranspiration from groundwater dependent plant communities, Owens Valley, California, 2004 Evapotranspiration Symposium, Nevada Water Resources Association, November 15, 2004, Las Vegas, Nevada. *(Invited oral presentation)*

Harrington, R.F., Hydrology and water extraction from Owens Valley, in Impacts of Climate Change on Landscapes of the Eastern Sierra Nevada and Western Great Basin, USGS Open File Report 01-202, 2001. *(Invited oral presentation, published abstract)*

Harrington, R.F. and A. Steinwand, Regional groundwater discharge estimated using micrometeorological measurements, plot-scale measurements of vegetation cover, and remotely-sensed vegetation cover, Fall 2002 Meeting of the American Geophysical Union, San Francisco, California, December 2002. *(Poster presentation)*

Harrington, R.F., Regression modeling of water table fluctuations for management of groundwater pumping in phreatophytic vegetation, Fall 1999 Meeting of the American Geophysical Union, San Francisco, California, December 1999. *(Poster presentation)*

Manning, S. and R.F. Harrington, Effects of water table fluctuations on phreatophytic plant communities in the Owens Valley, California, Fall 1999 Meeting of the American Geophysical Union, San Francisco, California, Fall 1999. *(Oral presentation)*

Colee, M., R. Harrington, T. Painter, and J. Dozier, A high-resolution distributed snowmelt model in an alpine catchment, *in* International Conference on Snow Hydrology: The Integration of Physical, Chemical, and Biological Systems, J. Hardy, M. Albert, and P. Marsh, eds., p. 93 USACE Cold Regions Research and Engineering Laboratory Special Report 98-10, 1998. *(Published abstract)*

Harrington, R.F., R. Jordan, and D. Tarboton, A comparison between two physically based snow models, Fall Meeting of the American Geophysical Union, San Francisco, California, 1995. *(Oral presentation)*

Kattelman, R., and R.F. Harrington, Daily melt waves through an alpine snowpack, Fall Meeting of the American Geophysical Union, San Francisco, 1995. *(Poster presentation)*

Harrington, R.F., and R.C. Bales, Spatial variability of snowmelt and ion release from a seasonal snowpack, Mammoth Lakes, California, Fall Meeting of the American Geophysical Union, 1993. *(Poster presentation)*

Harrington, R.F., R. Galarraga-Sanchez, and R.C. Bales, Predicting the release of ionic solute from alpine snowpacks using coupled snowmelt and digital elevation models, 23rd Annual Meeting of the American Water Resources Assoc., Reno, Nevada, 1992. *(Oral presentation)*

Harrington, R.F., and R.C. Bales, Laboratory experiments as a model for field-scale variability in water and solute release from melting snow, Fall Meeting of the American Geophysical Union, 1992. *(Poster presentation)*

Harrington, R.F., A.W. Gertler, and P. Amar, Network operations and preliminary monitoring results for the receptor modeling of acidic air pollutants to forested regions of the Sierra Nevada study, 84th Annual Meeting and Exhibition of the Air and Waste Management Assoc., Vancouver, British Columbia, Canada, 1991. *(Oral presentation)*

Harrington, R.F., and A.W. Gertler, Modeling the fate of atomospheric dry deposition in Sierra Nevada soils, 84th Annual Meeting and Exhibition of the Air and Waste Management Assoc., Vancouver, British Columbia, Canada, 1991. *(Oral presentation)*

APPENDIX C

Operational tests of wells 375W, 380W, 381W, and 382W: results from previous tests and recommendations for future tests and management

Robert Harrington
Hydrologist
Inyo County Water Department

June, 2001

Report to The Inyo County/Los Angeles Technical Group

Introduction

Most LADWP production wells in the Owens Valley are screened throughout the saturated aquifer; however, in an effort to minimize the effect of groundwater extraction on water levels in the shallow aquifer, several newer wells were screened only in the deep aquifer and sealed throughout confining layers and the shallow aquifer. Because these wells were constructed so as to reduce their effect on the shallow aquifer, it may be feasible and advantageous to develop alternatives to the soil water and plant water requirement based management methods described in the Green Book to govern operation of these wells. "Operational tests" were conducted on four of these sealed wells during which the wells were pumped for extended periods of time and water levels in the deep and shallow aquifers were monitored within a two-mile radius of the production wells. These tests were conducted on well 375W in the Big Pine wellfield (Figure 1), and wells 380W, 381W, and 382W in the Thibaut-Sawmill wellfield (Figures 2 and 3) with the purpose of evaluating the saturated hydraulic linkage between the wells and their associated vegetation and soil water monitoring sites.

During the development of the Annual Operations Plan for 2000-2001, LADWP proposed operating wells 374W, 375W, 380W, and 381W on the basis that these wells had "no impact on [the] shallow aquifer during 1997-1998 pump test" (G. Coufal letter to G. James, April 20, 2000). Inyo County protested that these wells were in "off" status and had not been formally exempted by the Standing Committee (G. James letter to G. Coufal, May 1, 2000). In its response to Inyo County's comments, LADWP recast the operation of these wells as an operational test (G. Coufal letter to G. James, May 26, 2000). Inyo County agreed that the wells could be operated as part of a test if the Standing Committee approved a proposal for such a test (G. James letter to G. Coufal, July 28, 2000); however, the Standing Committee did not agree to conduct a test due to unresolved differences between LADWP and Inyo County staff about how the test should proceed. It was the opinion of Inyo Count staff that one of the preliminary steps in developing a viable proposal for further testing of these wells was that the data from previous tests be examined and used to assess the need for and guide the design of any further tests. Examination of data from the previous test was hampered by the absence of any kind of report from the previous test, and, at the September 14 2000 Standing Committee meeting, efforts to incorporate an operational test into the 2000-2001 Annual Operations Plan were abandoned. At that meeting, Inyo County committed to provide LADWP with a more detailed document regarding the County's views and concerns regarding operational testing of these wells. This report is that document.

The purpose of this report is to assess the need for additional operational tests, and to initiate development of alternative management for these wells. To accomplish this, data from the operational tests were examined to ascertain if any effect of the test pumping could be detected in the hydrographs of shallow and deep wells monitored during the operational tests. The proposal for the previous operational tests specified several analyses such as analytical modeling and development of drawdown contours which are not conducted here. The present report is meant only to fulfill the commitment Inyo County made to the Standing Committee to examine the data from the previous tests provide an assessment of the need for further operational testing of these wells. This report should not be construed as a final report for the operational tests conducted in 1996-1998.

Methods

Many factors cause water level fluctuations in wells at a variety of time scales. To correctly assess the effect of test pumping, fluctuations unrelated to test pumping must be identified and accounted for (Freeze and Cherry, 1979). During the operational tests, fluctuations in recharge, surface water stage, evapotranspiration (ET), water spreading, or non-test pumping may have influenced water levels in observation wells, masking the effect of the test pumping. To account for these external influences, the hydrograph for each observation well was examined and assessed qualitatively to determine the relative magnitude of test-pumping induced fluctuations versus externally-induced fluctuations.

Data. Construction details for wells 375W, 380W, 381W, and 382W and periods of test pumping are given in Table 1. Daily average flow rates for the four production wells, the

Big Pine Canal, and the Owens River are given in Figures 4 and 5. Pumping rates for wells 330W, 332W, 341W, 351W, 356W, and 409W are not given, because their monthly production rates remained fairly constant throughout the period of the operational tests. Table 2 lists the depths of observation wells monitored during the operational tests. Hydrographs for the wells listed in Table 2 are given in Figures 6 through 35. In order to assess background trends at each well, the hydrographs span the period 1996 through 2001. Though the data presented here provide a large amount of information about groundwater fluctuations during the operational tests, there are further data that could be included in a complete analysis of these tests: data from several wells that were equipped with continuous recorders are not included, and only a few of LADWP's numerous surface water measuring stations are included. Nevertheless, the data are sufficient for the qualitative and preliminary analysis undertaken here.

Table 1. Construction details and test periods for pumped wells. Capacities are from City of Los Angeles and County of Inyo, Table 9-10 (1990).

Well	Casing size (inches)	Depth (feet)	Screened interval (feet)	Seal depth (feet)	Capacity (cfs)	Test period
375W	18	450	260-440	240	5.6	11/3/97-6/16/98
380W	18	730	250-690	230	3.2	10/1/96-1/29/97; 4/6/97-4/21/98
381W	20	700	250-690	230	3.4	10/1/96-1/29/97; 4/6/97-4/21/98
382W	20	625	275-615	232	1.8	11/3/98-4/21/98

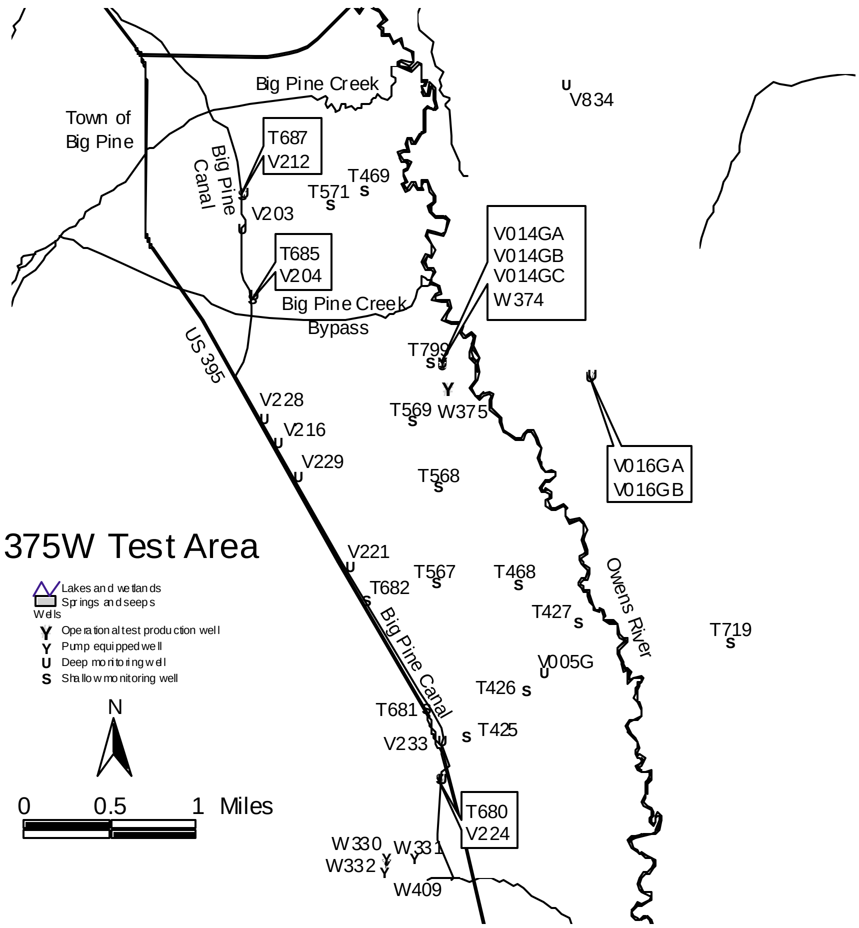

Figure 1. Map of 375W area, Big Pine wellfield.

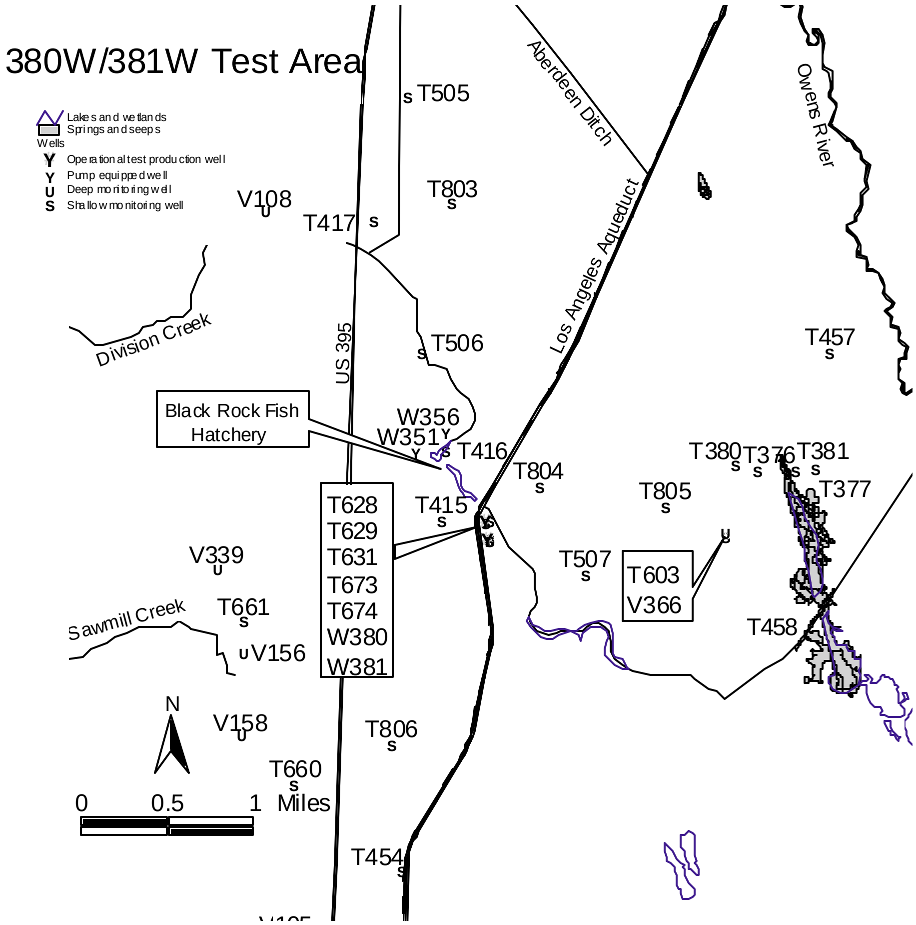

Figure 2. Map of 380W/381W area, Thibaut Sawmill wellfield.

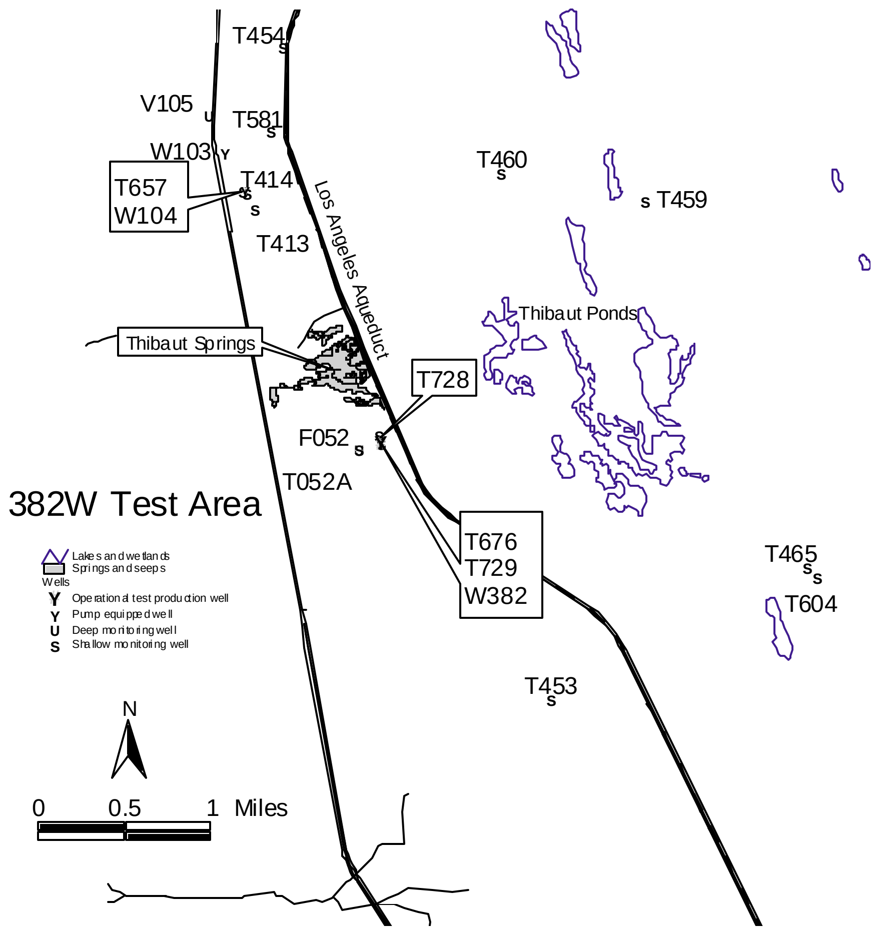

Figure 3. Map of 382W area, Thibaut Sawmill area.

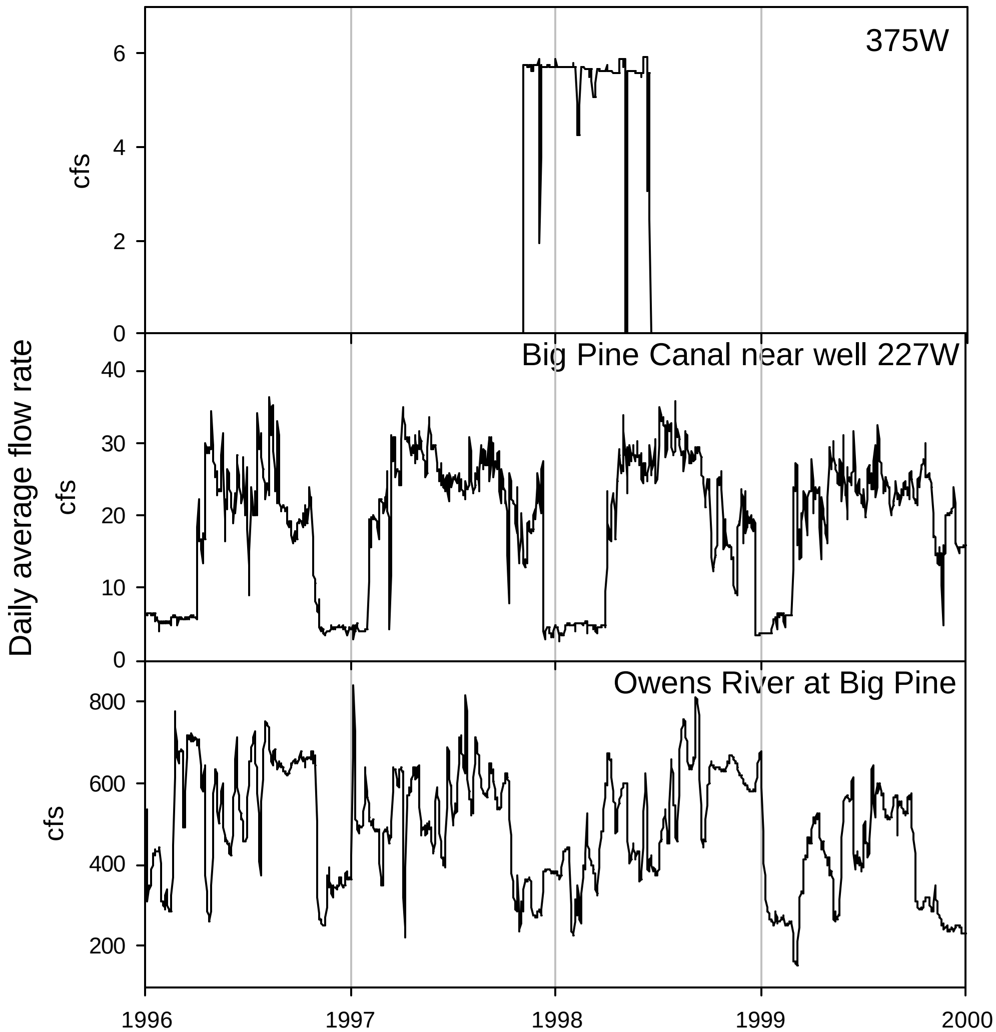

Figure 4. Daily average flow rates for well 375W and surface water conveyances near Big Pine during the operational test.

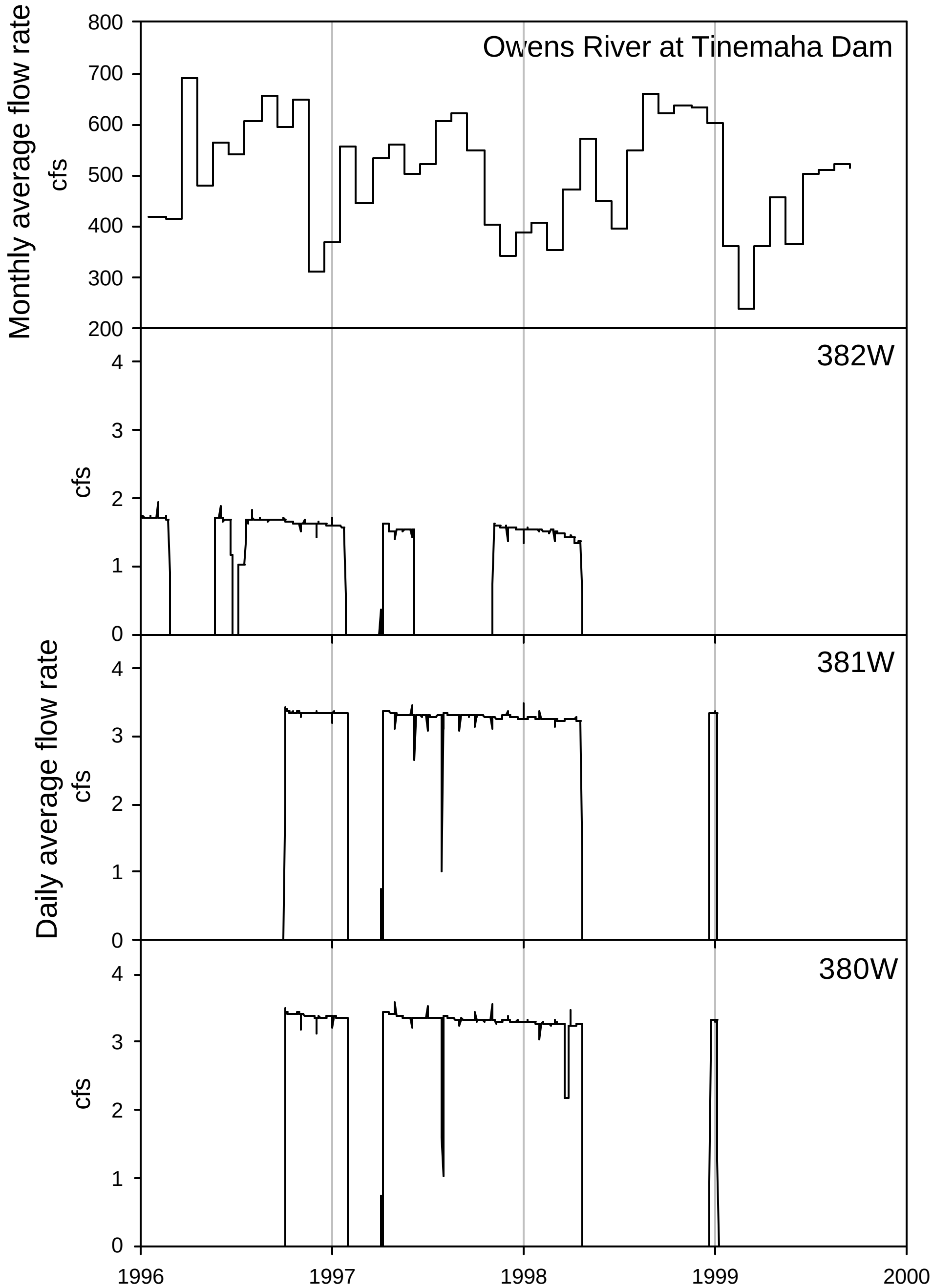

Figure 5. Daily average flow rates for wells 380W, 381W, and 382W; monthly average flow rate for Owens River at Tinemaha Dam.

Table 2. Wells monitored during operational tests.

Well	Depth (feet)	Well	Depth (feet)	Well	Depth (feet)	Well	Depth (feet)
375W test							
Shallow wells				Deep wells			
425T	20.9	681T	33.1	203V	200+	228V	100.0
426T	19.7	682T	58.9	204V	137.6	229V	131.0
427T	19.3	685T	----	212V	200+	233V	149.0
468T	19.6	687T	53.0	216V	101.0	834V	----
469T	21.0	719T	20.7	221V	79.4	V014GA	315.0
567T	29.5	799T	29.3	224V	322.0	V016GA	----
568T	32.0	V005G	----				
569T	42.3	V014GB	166.0*				
571T	39.4	V014GC	41.0				
680T	41.0	V016GB	31.3				
380/381 test							
Shallow wells				Deep wells			
376T	63.5	507T	52.0	108V	128.9	366V	210.0
377T	52.6	603T	19.8	156V	----	628T	----
380T	41.8	630T	----	158V	173.0	629T	----
381T	52.4	660T	31.7	339V	140.0	631T	----
415T	42.3	661T	79.8				
416T	23.3	673T	19.7				
417T	63.0	674T	----				
454T	21.7	803T	29.0				
457T	31.6	804T	28.8				
458T	19.4	805T	27.0				
505T	52.8	806T	26.5				
506T	42.3						
382W test							
Shallow wells				Deep wells			
052AT	20.0	460T	42.1	728T	156.6	105V	206.9
413T	42.3	465T	20.2	729T	202.9	052F	----
414T	20.2	581T	11.0				
453T	21.0	604T	13.4				
454T	21.7	657T	20.7				
459T	20.1	676T	17.3				

*V014GB's depth suggests it should be considered a deep well, but its hydrograph more closely resembles V014GC, a shallow well at the site, than it resembles V014GA.

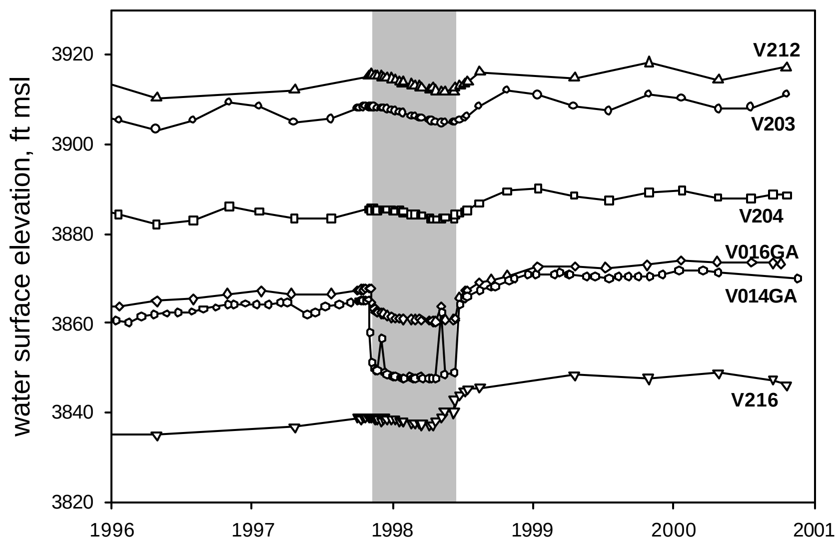

Figure 6. Deep wells near 375W. Gray indicates when 375W was on.

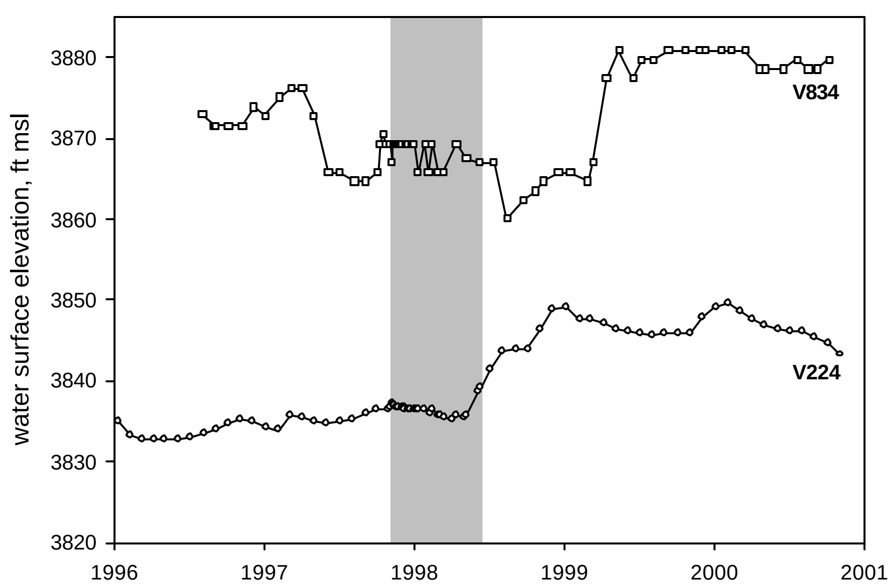

Figure 7. Deep wells near 375W. Gray indicates when 375W was on.

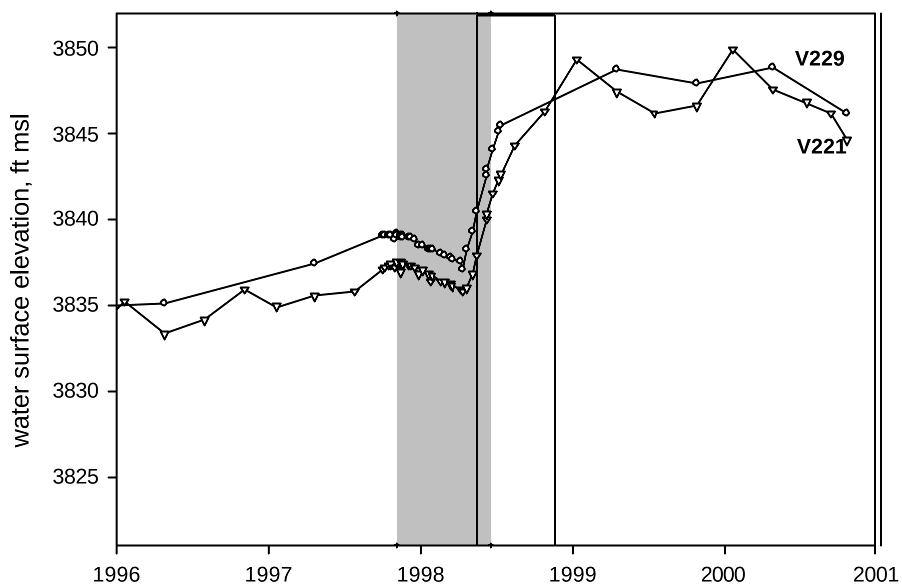

Figure 8. Deep wells near 375W. Gray indicates when 375W was on.

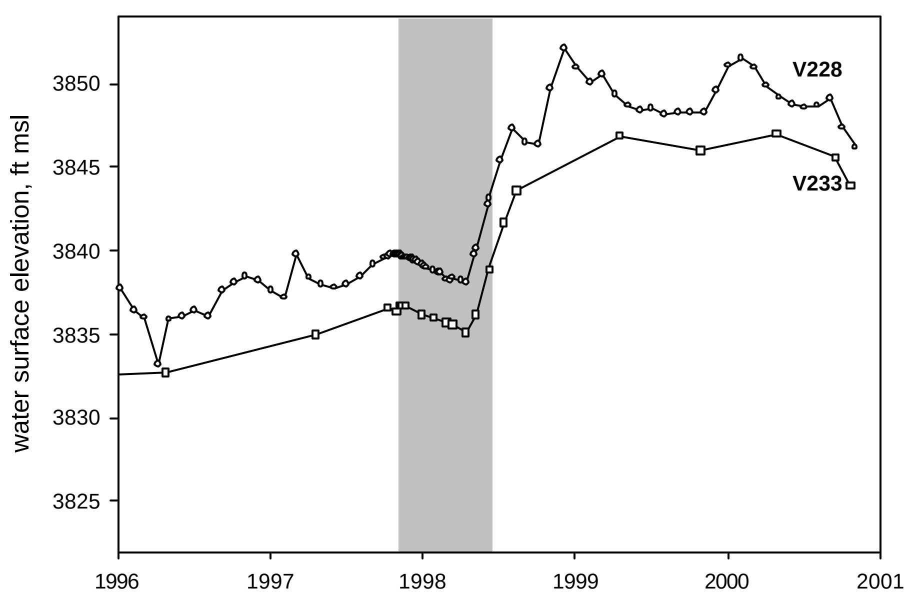

Figure 9. Deep wells near 375W. Gray indicates when 375W was on.

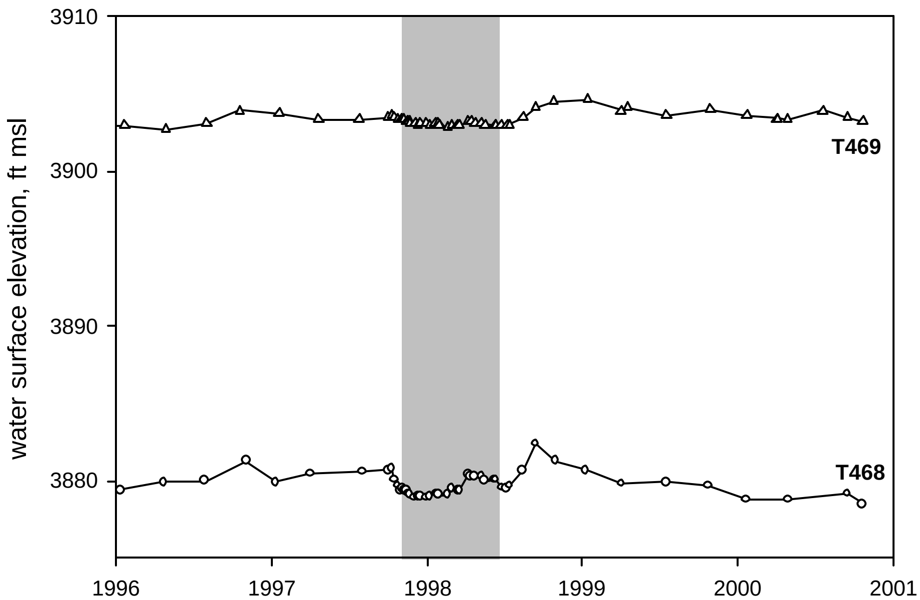

Figure 10. Shallow wells near 375W. Gray indicates when 375W was on.

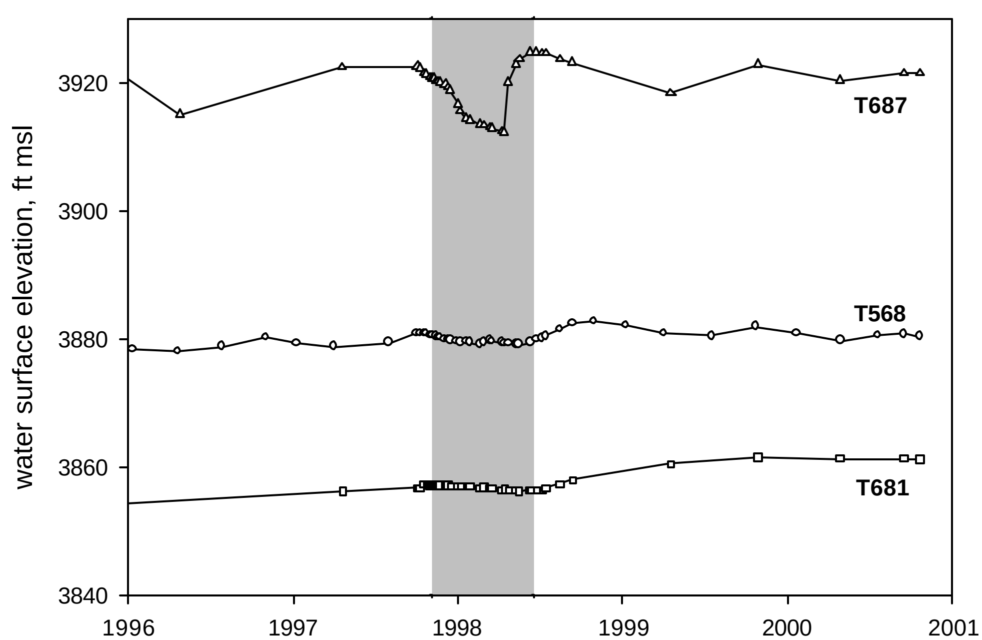

Figure 11. Shallow wells near 375W. Gray indicates when 375W was on

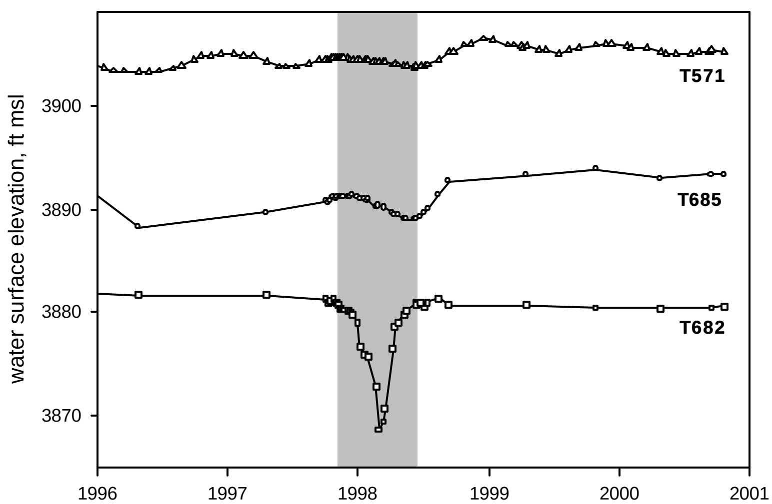

Figure 12. Shallow wells near 375W. Gray indicates when 375W was on.

Figure 13. Shallow wells near 375W. Gray indicates when 375W was on.

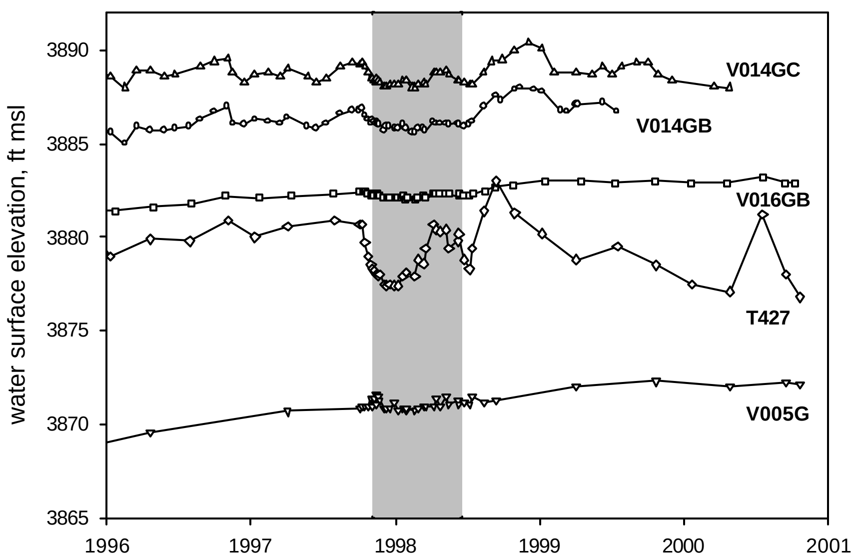

Figure 14. Shallow wells near 375W. Gray indicates when 375W was on.

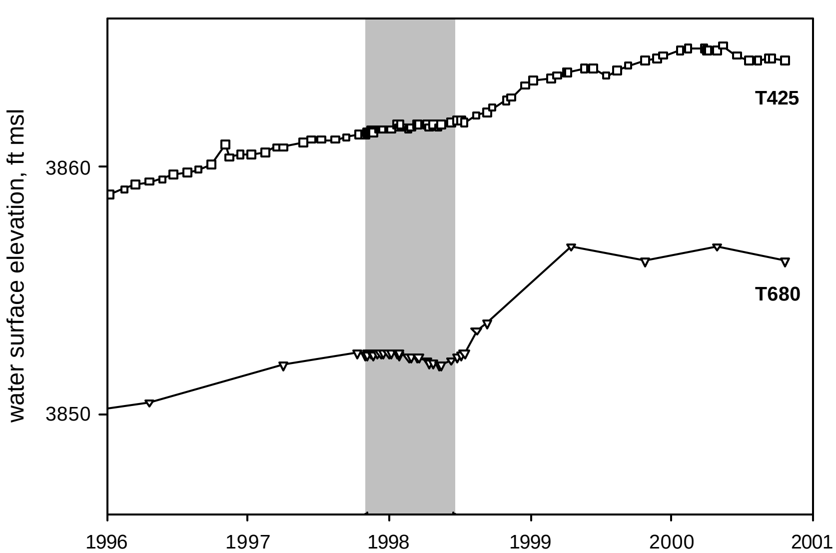

Figure 15. Shallow wells near 375W. Gray indicates when 375W was on.

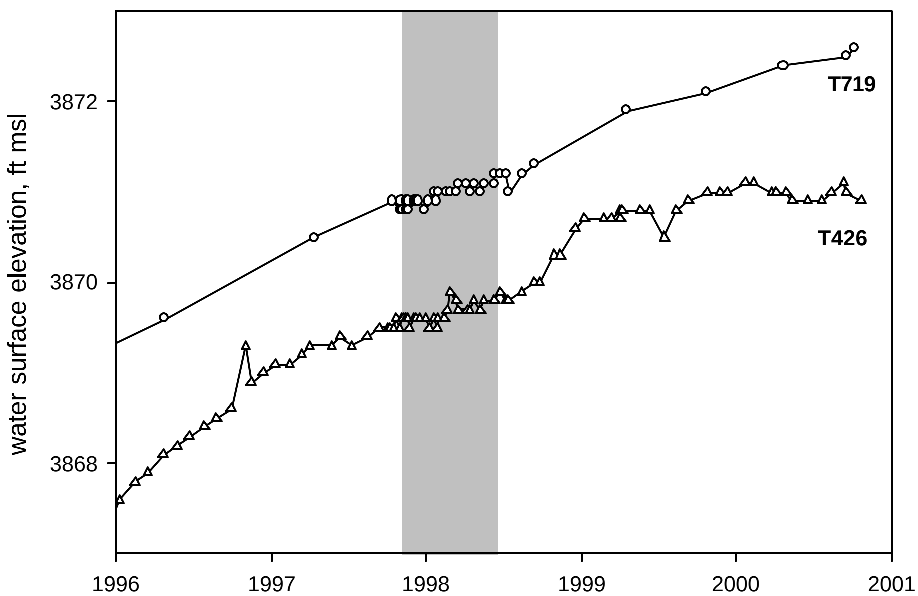

Figure 16. Shallow wells near 375W. Gray indicates when well was on.

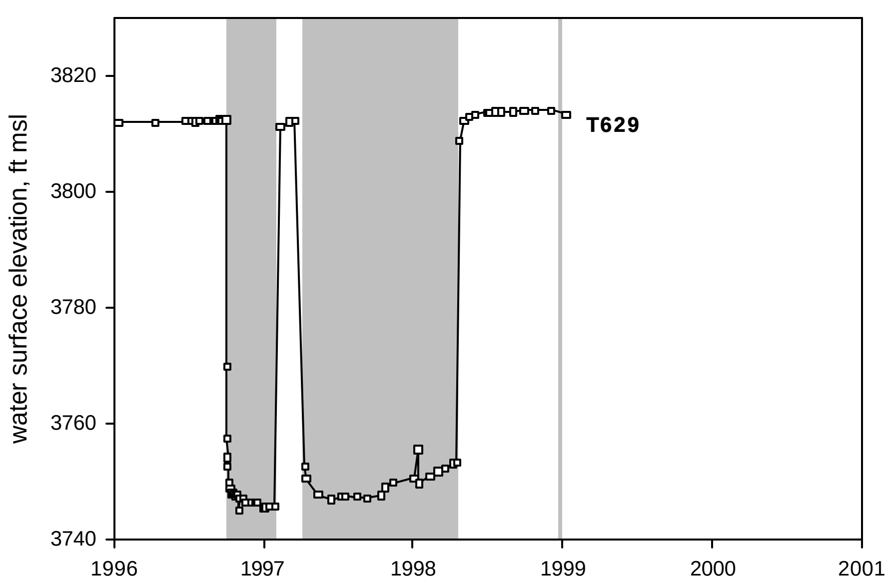

Figure 17. Deep well near 380W and 381W. Gray indicates when wells were on.

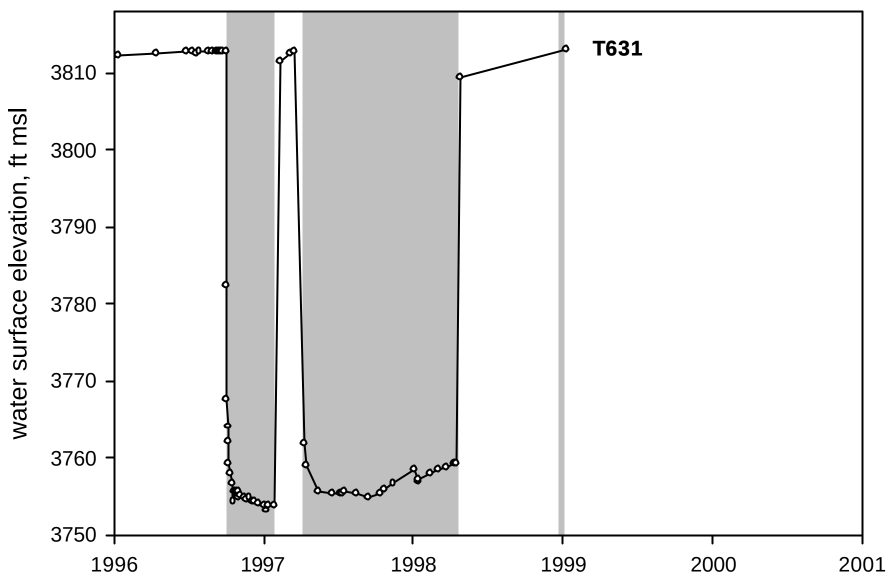

Figure 18. Deep well near 380W and 381W. Gray indicates when wells were on.

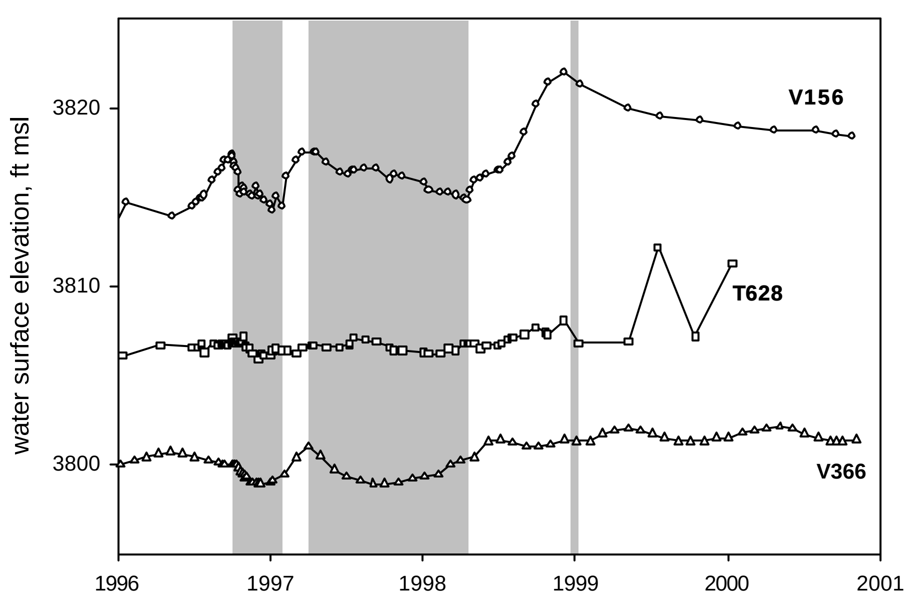

Figure 19. Deep wells near 380W and 381W. Gray indicates when wells were on.

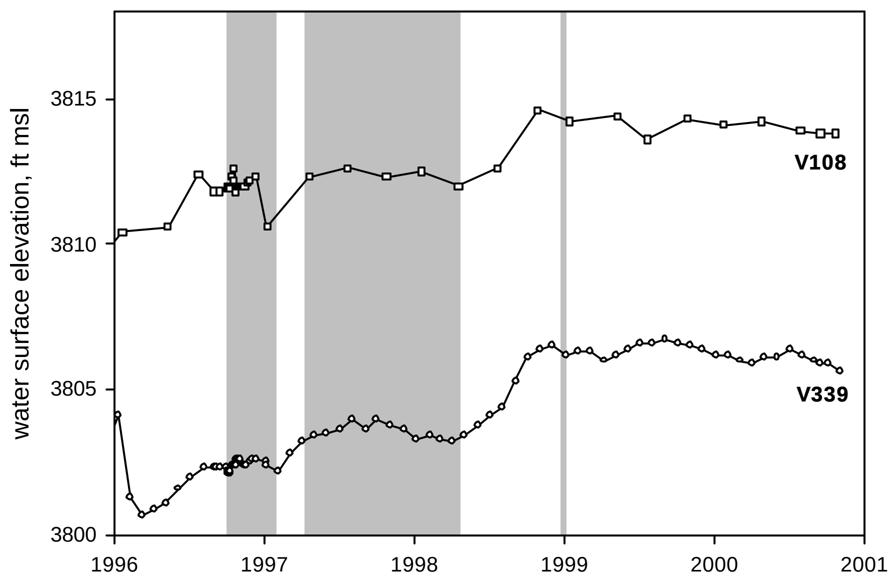

Figure 20. Deep wells near 380W and 381W. Gray indicates when wells were on.

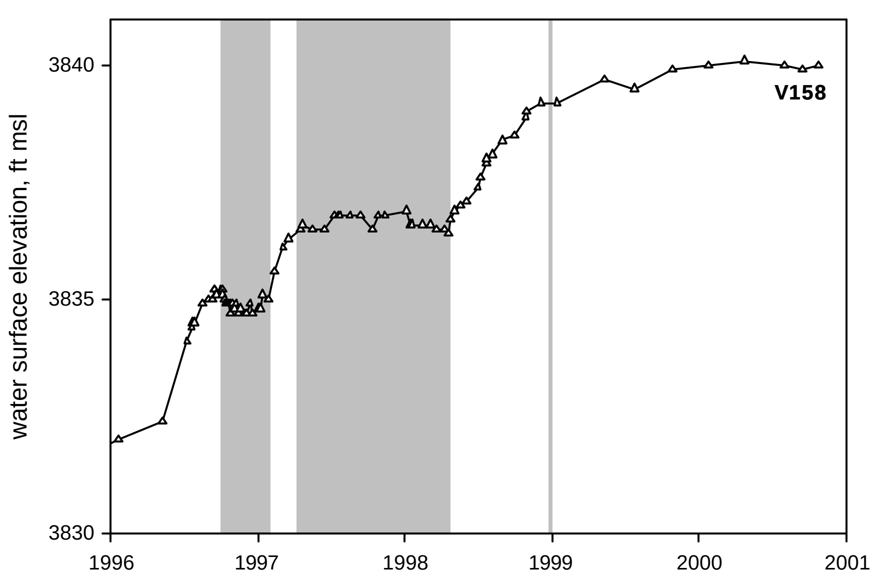

Figure 21. Deep well near 380W and 381W. Gray indicates when wells were on.

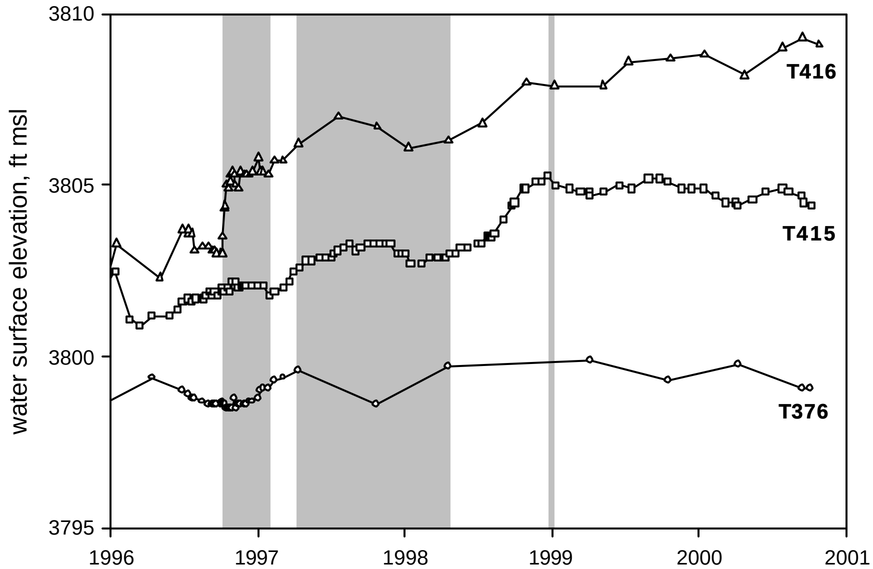

Figure 22. Shallow wells near 380W and 381W. Gray indicates when wells were on.

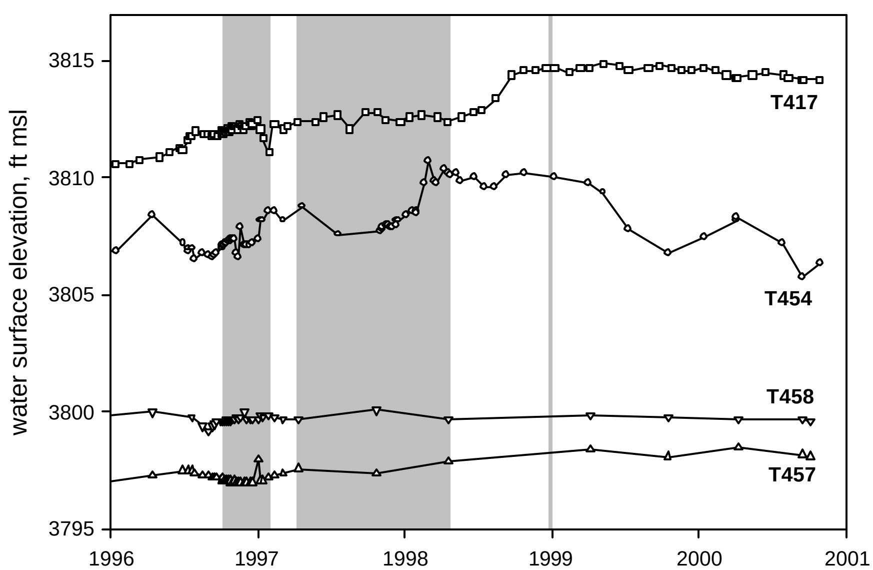

Figure 23. Shallow wells near 380W and 381W. Gray indicates when wells were on.

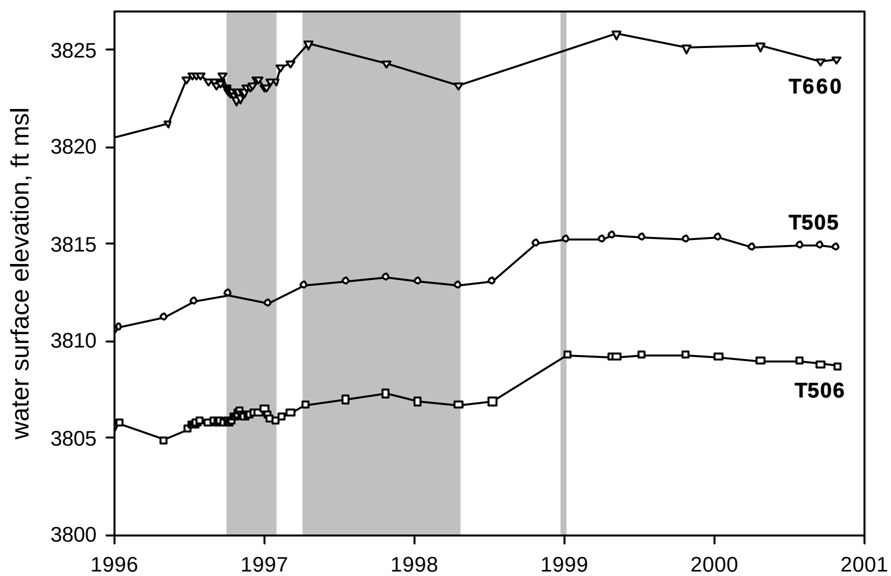

Figure 24. Shallow wells near 380W and 381W. Gray indicates when wells were on.

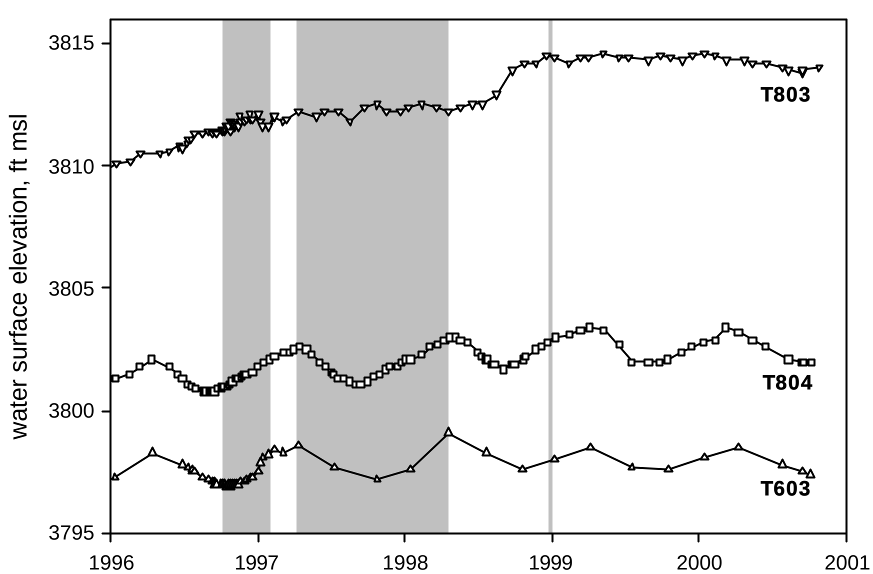

Figure 25. Shallow wells near 380W and 381W. Gray indicates when wells were on.

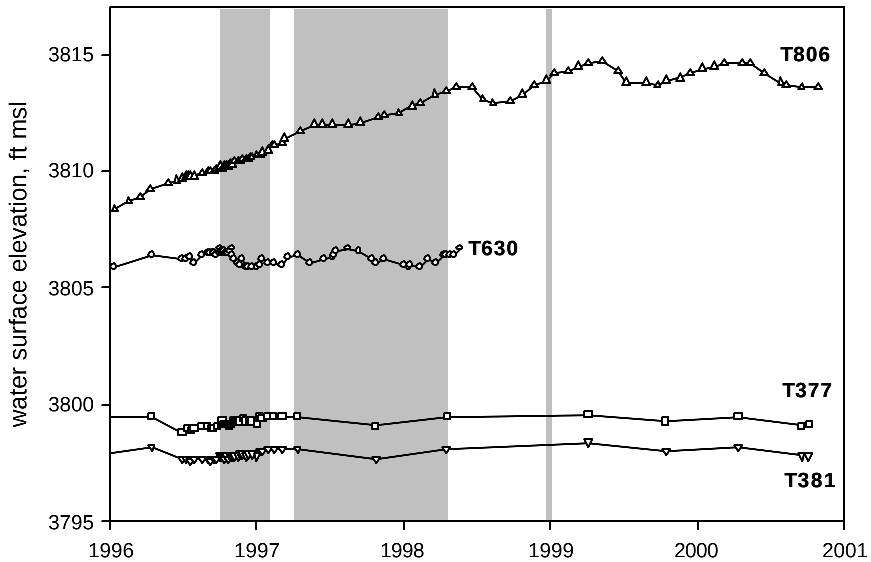

Figure 26. Shallow wells near 380W and 381W. Gray indicates when wells were on.

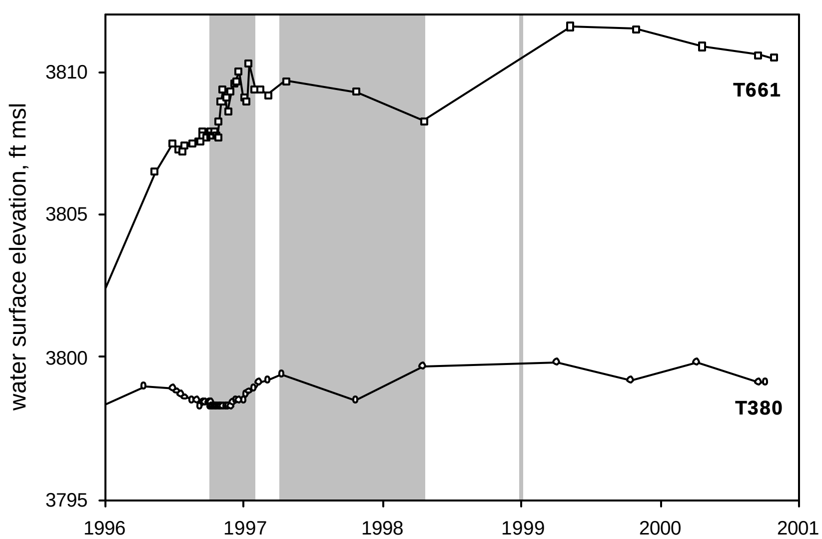

Figure 27. Shallow wells near 380W and 381W. Gray indicates when wells were on.

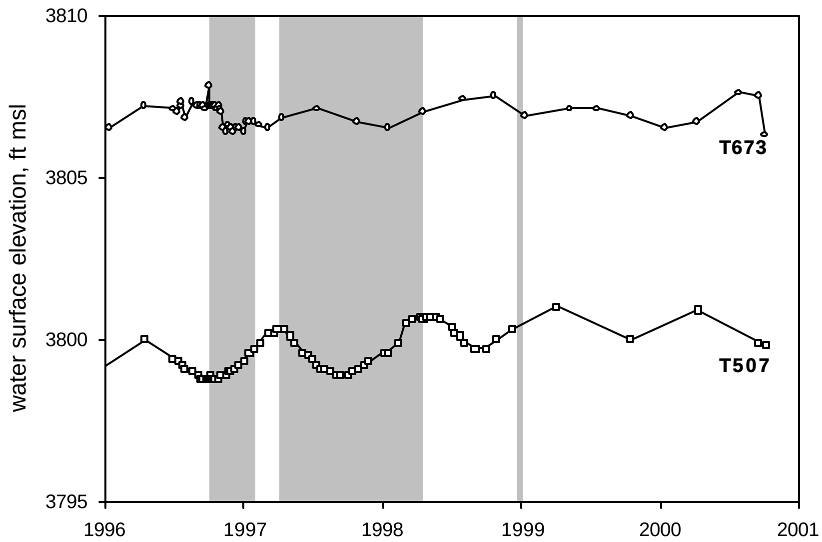

Figure 28. Shallow wells near 380W and 381W. Gray indicates when wells were on.

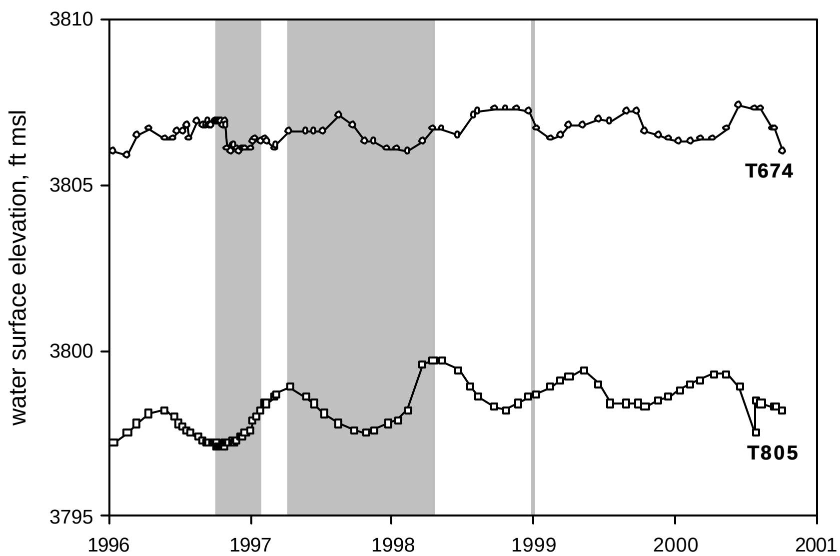

Figure 29. Shallow wells near 380W and 381W. Gray indicates when wells were on.

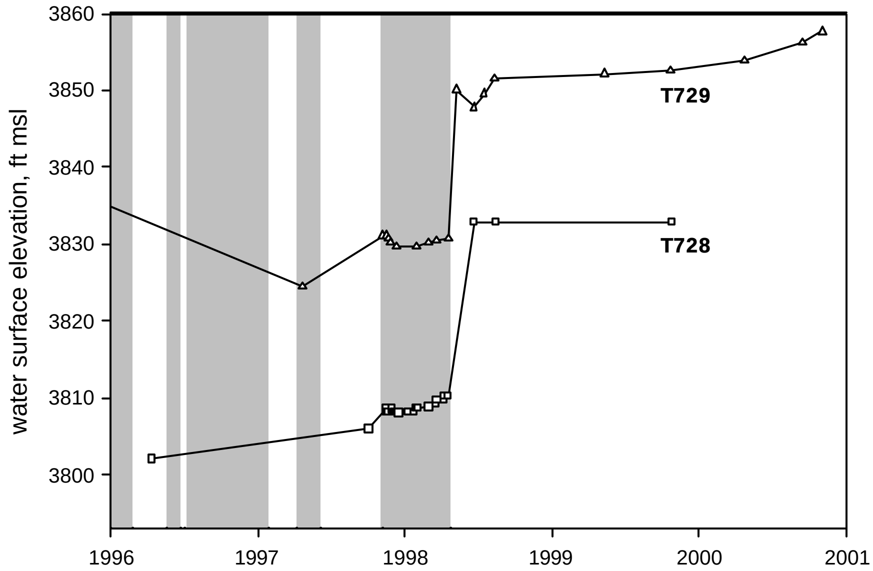

Figure 30. Deep wells near 382W. Gray indicates when 382W was on.

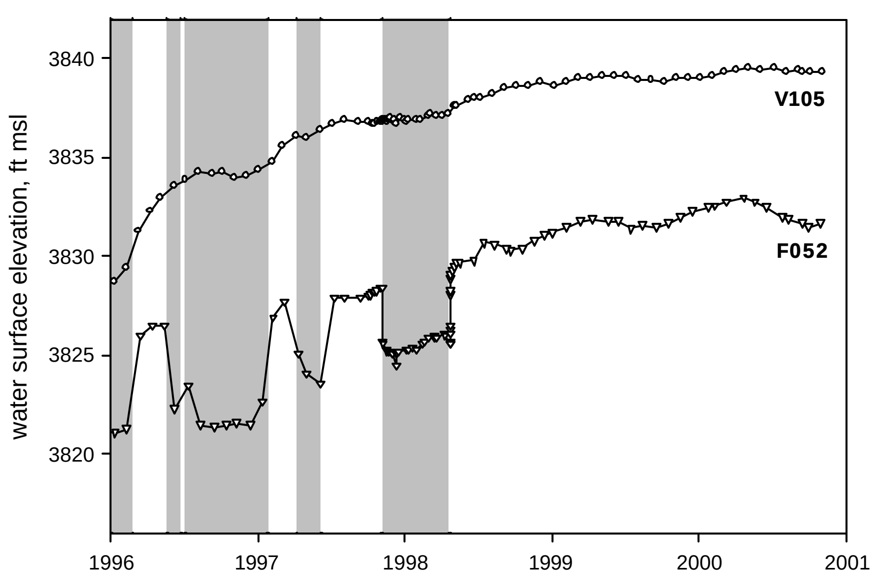

Figure 31. Deep wells near 382W. Gray indicates when 382W was on.

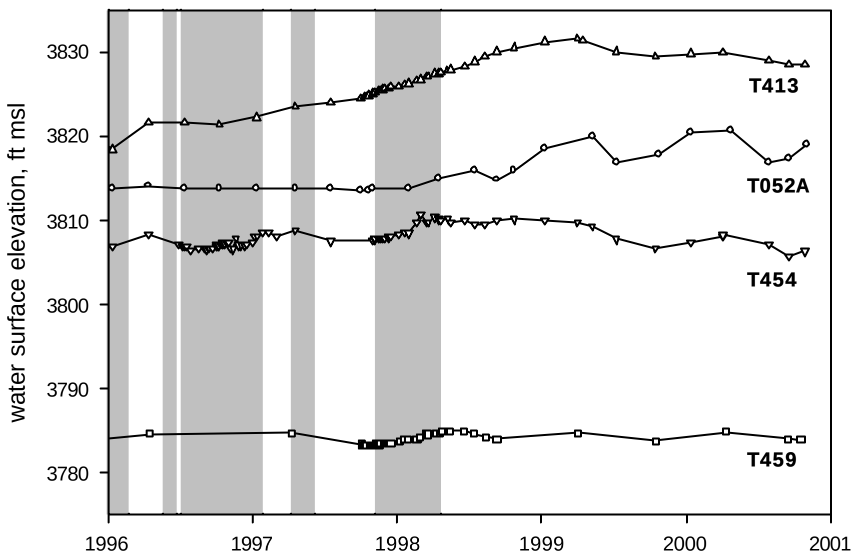

Figure 32. Shallow wells near 382W. Gray indicates when 382W was on.

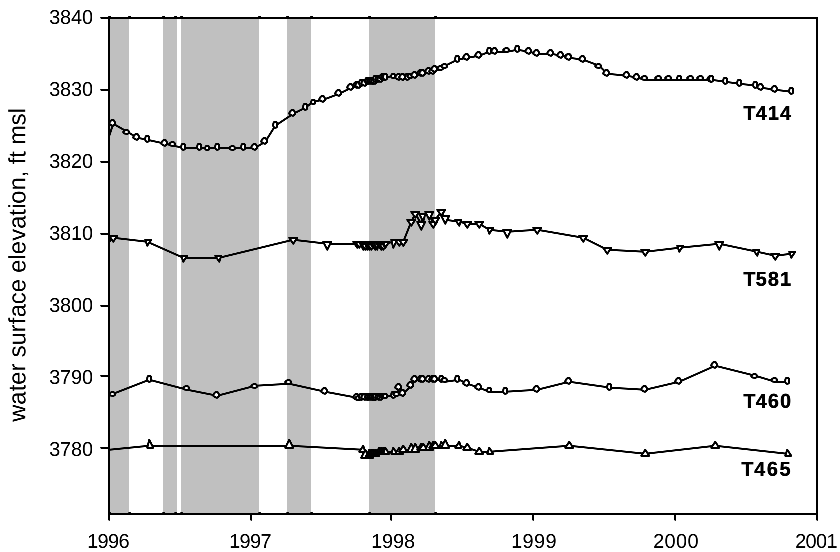

Figure 33. Shallow wells near 382W. Gray indicates when 382W was on.

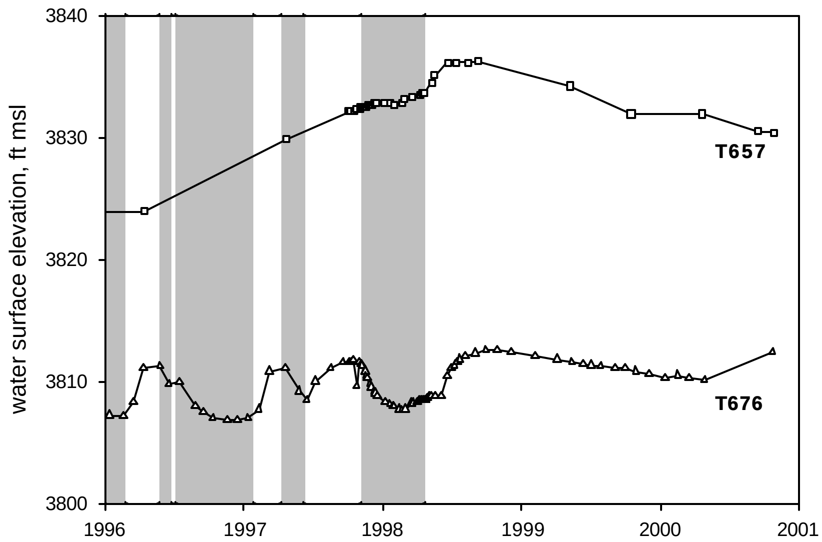

Figure 34. Shallow wells near 382W. Gray indicates when 382W was on.

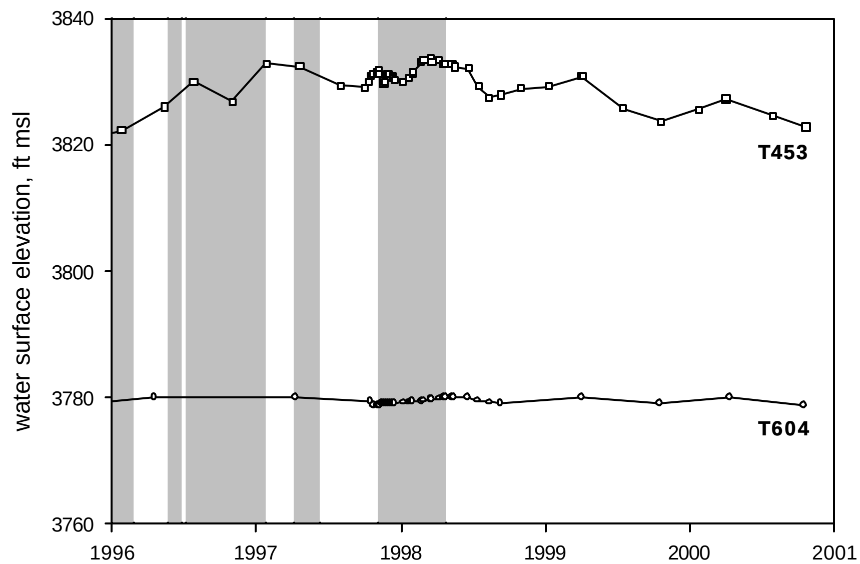

Figure 35. Shallow wells near 382W. Gray indicates when 382W was on.

Analysis. The timing of changes in water levels in observation wells monitored during the operational tests was compared to changes in hydrologic variables such as canal and aqueduct operation, river flows, and test pumping to get a qualitative sense of what variables influenced each observation well. By looking for contemporaneous changes in water level and external variables, the relative importance of various hydrological stresses was assessed. In a few cases (e.g., 631T, Figure 18), the effect due to test pumping is of far greater magnitude than other effects. In most cases, any effect of pumping is overprinted on background fluctuations of greater magnitude than the effect of pumping.

There are two general strategies for assessing background effects during aquifer tests. One is based on the assumption of spatially uniform background trends, the other based on temporally uniform background trends (Kruseman and de Ridder, 2000). If an observation well is distant enough from the pumped well that it is unaffected by the pumping, it can be used to define the background trend for wells closer to the pumped well. This requires that the well used to define the background trend be influenced by the same hydrologic variables as the pumping-affected wells nearer to the production well. In other words, the background trend must be spatially uniform, or at least is a simple function of location. Because of the extended period of time that the pumping wells were run during these tests, a large area encompassing a variety of local sources and sinks was potentially influenced by the test pumping; therefore, the assumption of a spatially uniform background trend is not met in these tests. An alternative is to observe trends in wells before and after the pump test and to interpolate the background trend through the period of the pump test. In this case, it is assumed that the background trend at each well is temporally uniform. Background trends observed during these tests were variable between wells, consisting of linear and nonlinear trends, periodic signals driven by seasonally varying recharge and discharge, step changes caused by stage changes in surface water conveyances, or combinations of these patterns. The complex form and uncertain cause of these background patterns renders all but a few of the records unsuitable for aquifer parameter estimation and no attempt was made here to estimate parameters. If one was to attempt to estimate parameters from these data, using the hydrograph before and after the test would be the more tenable way of discriminating pumping effects from background effects.

Results

375W test deep wells. Deep wells in the Big Pine area showed three distinct patterns. Wells 203V, 204V, and 212V (Figure 6) showed smooth annual periodic fluctuations with maxima in the late fall and minima in the late spring. Wells 216V, 221V, 224V, 228V, 229V, and 233V (Figures 6, 7, 8, and 9) showed an abrupt increase in spring of 1998 during the operational test. Wells V014GA and V016GA (Figure 6) increased steadily except for a clear effect due to the test pumping. The first two patterns appear to be related to operation of the Big Pine Canal (cf. Figure 4). Wells that penetrate volcanic rocks responded with abrupt increases when the canal flows increased in the spring of 1998 (Figure 4); however, it is not clear why the rise in water levels in 1998 was larger than during previous or subsequent years. 1998 was a heavy runoff year, and spreading operations west of Highway 395 may have contributed to the rise in water levels, but no records exist to confirm this. Conversely, wells 203V, 204V, and 212V responded gradually to the increase in canal stage although they are immediately adjacent to the canal. These three wells do not penetrate volcanic rocks. Wells V014GA and V016GA (Figure 6) were not affected by fluctuations in the Big Pine Canal. Aquifer parameters could be derived from the hydrographs for these two wells. Well 834V (Figure 7), at Steward Ranch, does not follow a pattern similar to any of the three described above, presumably because its fluctuations are largely governed by pumping for irrigation on the ranch and its source of recharge is primarily from the Wacoubi Embayment rather than from the Sierran range front.

375W test shallow wells. Patterns in shallow wells in the Big Pine area are more varied than patterns in deep wells. Wells 427T, 468T, 568T, 687T, V014GC, and V014GB (Figures 10, 11, and 14) began declining prior to the start of the test and recovered subsequent to the test, making it impossible to assess how much, if any, of the drawdown observed in these wells was attributable to test pumping. The declines prior to the start of the test were probably due either to reductions in Big Pine Canal or Owens River flows (Figure 1) or cessation of irrigation in the Steward Lane area in the early fall of 1997. Many wells (567T, 568T, 569T, 571T, and 685T; Figures 11, 12, and 13) show an annual cycle that peaks in the fall. Precipitation, irrigation, canal operations, pumpage, ET, stream flow, water spreading, and other natural and man-caused factors also exhibit quasiperiodic annual cycles, thus the relative importance of these sources of the annual fluctuations in these wells is difficult to identify and probably is influenced by multiple factors. It is likely that operation of the Big Pine Canal, stage of the Owens River, and irrigation influenced these hydrographs. For example, the abrupt rise in 687T (Figure 11) appears attributable to increased flow in the Big Pine Canal. Wells 427T, 799T, V014GC, and V014GB (Figures 12, 13, and 14) show less well-defined annual cycles, but are seasonally variable. The patterns in these four wells during the test are similar, but the amplitude of fluctuations in 427T is greater, probably in response to changes in stage of the Owens River (Figure 1). Wells 425T, 426T, 680T, 681T, 719T, V005G, and V016GB (Figures 11, 14, 15, and 16) have smoothly increasing trends with possibly a few inches of drawdown during the test superimposed upon the trend.

Pumping-induced drawdown from 375W. Deep wells V014GA and V016GA show clear responses to test pumping of 375W (Figure 6). Other deep wells may have been affected by test pumping, but the effect was not detectable because of fluctuations due to changes in recharge conditions. Shallow wells with smooth hydrographs show a slight deflection in the slope of the hydrograph during the test (425T, 426T, 719T, V005G, and V016GB). These wells are in the east and south part of the test area. Even with the relatively smooth background trends in these wells it is difficult to quantify the exact amount of pumping-induced drawdown in these shallow wells, because the effect of pumping appears to amount to at most a few inches of drawdown. However, the possibility of pumping induced drawdown of the shallow aquifer cannot be ruled out based on the results of these tests. Other shallow wells may have had similar or greater amounts of pumping induced drawdown than those identified above; however, the few inches of drawdown attributable to the test pumping may not have been discernable against the larger background fluctuations that were prevalent in the western and northern part of the test area. Wells 680T and 681T also show slight changes in slope during the test, but it is not clear whether this is part of a seasonal cycle or due to test pumping. It cannot be determined whether or not wells with large seasonal fluctuations or changes due to river stage were affected by test pumping.

380W/381W deep wells. Wells 629T and 631T (Figures 17 and 18), each within 100 ft of one of the pumping wells, showed clear responses to the test pumping of 380W and 381W. Several deep wells more distant from the pumping wells show more subdued, but clear, drawdown due to the test pumping (156V, V158, 339V, and 366V; Figures 19, 20, and 21). Other wells do not show a clear response to the test pumping (628T and 108V; Figures 19 and 20).

380W/381W shallow wells. Most shallow wells near wells 380W and 381W follow one of three patterns: (1) irregular hydrographs due to surface water fluctuations (415T, 416T, 417T, 454T, 460T, 630T, 661T, 673T, and 674T; Figures 22, 23, 26, 27, and 33); (2) smooth quasi-sinusoidal hydrographs with an annual period peaking in the springtime (376T, 377T, 380T, 381T, 457T, 458T, 507T, 603T, 804T, 805T, and 806T; Figures 22, 23, 25, 26, 27, 28, and 29), apparently due to the seasonality of plant transpiration; or (3) relatively smooth hydrographs (505T, 506T, and 803T; Figures 24 and 25). The shallow wells nearest the pumping wells fall into the first category, suggesting that water levels in the LA Aqueduct, the Blackrock Ditch, and the ponds at the Blackrock Fish Hatchery maintain the water table in this area. Wells displaying quasi-sinusoidal hydrographs lie east of the LA Aqueduct in areas of shallow groundwater, suggesting a linkage to climatological stresses.

Pumping-induced drawdown from 380W and 381W. Deep wells 629T and 631T near 380W and 381W showed about sixty feet of drawdown when the wells were operated. Deep wells more distant from the production wells also showed drawdown of up to a few feet of response (156V, 158V, 339V, and 366V). Pumping effects could not be detected in any shallow wells, either because effects were buffered by surface water, masked by other variations, or no pumping effects propagated to the shallow aquifer.

382W deep wells. Two deep wells within 200 ft of well 382W (728T and 729T; Figure 30) showed slight drawdown at the beginning of the test and abrupt recovery following the end of the test. These two wells were artesian before the test began and resumed flowing after 382W was shut off. No pressure data are available to quantify the head in these wells prior to the start of the test, but the cessation of flow was clearly related to operation of 382W. Well 052F (Figure 31) showed a clear response to pumping. Well 105V (Figure 31) possibly showed some drawdown due to test pumping of 382W, but the deflection of its hydrograph began before test pumping of 382W started. Interpretation of this hydrograph is complicated by effects due to pumping of 103W and 104W in late-1995 and test pumping from 380W and 381W. 105V is approximately equidistant from 382W and wells 380W and 381W.

382 shallow wells. Well 676T (Figure 34), about 50 ft from 382W, clearly showed drawdown due to operation of the well, but it is unclear whether this was due to leakage through the well seal, leakage through the aquitard, or cessation of artesian flow in nearby artesian wells. During the period of test pumping, abundant runoff and water spreading affected several shallow wells near 382W (453T, 454T, 460T, and 581T; Figures 32, 33, and 35). Wells 414T and 657T (Figures 33 and 34) showed slight deflections in their hydrographs that may be related to the test pumping. Wells 459T, 465T, and 604T (Figures 32, 33, and 35) showed smoothly varying hydrographs, apparently unaffected by test pumping or surface water spreading.

Pumping-induced drawdown from 382W. Artesian flow ceased in wells 728T and 729T when 382W was turned on and resumed when it was turned off. Well 052F showed a clear response to pumping and may be suitable for parameter estimation. 676T showed a clear response to operation of 382W, but as discussed above, the pathway by which this effect propagated to the shallow aquifer is unclear.

Conclusions and Recommendations

Operational tests. The two main conclusions to be drawn from these tests are: (1) that the problem of separating the effects of test pumping from effects of other factors severely hampers observation of pumping affects in the shallow aquifer, and (2) that operational testing as conducted in these tests to assess the effects of these wells is unlikely to provide a useful assessment of the long-term operation of these wells. In all but a few wells monitored during these tests, the assessment of pumping effects was inconclusive because of the large amount of external noise in the hydrographs compared to the modest signal due to pumping. Danskin (1998) states that, though confining pumping to the deep aquifer may reduce impacts to the shallow aquifer, sustained pumping of such wells will eventually affect groundwater dependent vegetation by propagation of drawdown around the margins of confining clay layers. Were this to occur, impacts would be far progressed before they were detectable in the shallow aquifer. Regarding the original goal of the tests, they were successful in showing that the hydraulic linkage between the production wells and their associated monitoring sites is not a reliable management strategy. In cases where effects of test pumping were qualitatively detectable, in most cases the background effects appeared sufficiently complex that any attempt at parameter derivation by standard aquifer test analysis techniques would be subject to large errors. Furthermore, conducting operational tests by operating these wells and monitoring for drawdown, even for longer than a year as done for 380W and 381W, does not provide a clear assessment of the long-term effects of operation of these wells. A more viable strategy would be to design and conduct aquifer tests so that they support a modeling effort directed at assessing pumping impacts, thereby accounting for the many factors contributing to each hydrograph and providing the capability to simulate long periods of well operation.

In the area of 375W, these tests suggested that drawdown may be propagating through or around confining layers east and south of 375W. Further work should be aimed at confirming or refuting this hypothesis by quantifying the aquifer confinement in the area. The linkage between the stage of surface water conveyances and hydraulic head in aquifer systems should be determined, because this linkage appeared to control many of the hydrographs during the test. Further, the linkage between various local hydrostratigraphic units should be determined, in particular, the linkage between volcanic rocks related to Crater Mountain and the fluviolacustrine deposits of the valley floor appeared to control the response to recharge from the Big Pine Canal. Any further operational testing should be aimed at establishing hydraulic parameters, extent of confinement, and hydrostratigraphic and structural relationships to support a numerical model of the Big Pine area.

In the 380W/381W area, testing suggested that surface water buffered pumping effects near the wells, but effects propagated long distances from the wells. Surface water buffering southeast of wells 380W and 381W will probably increase in the future as the Blackrock Waterfowl Management Area is intermittently inundated as part of the Lower Owens River Project. Drawdown was observed in deep wells near the alluvial fans west of 380W/381W, indicating that the mechanism identified by Danskin is probably active in this area. Further operational testing of 380W/381W is unlikely to yield any additional information unless aimed at supporting a modeling effort, e.g., aquifer testing to determine confining layer characteristics. An observation well was drilled in 2000 into the confining layer near wells 380W and 381W for the purpose of evaluating confining layer properties. An aquifer test should be designed and conducted using this well as part of the confining layer cooperative study.

During the 382W test, drawdown related to the test was observed in shallow well 676T near the pumping well. It remains unclear how drawdown propagated from the deep aquifer to 676T. Possible pathways by which drawdown in the deep aquifer might have been communicated to the shallow aquifer are propagation through the confining layer by Darcian flow, flow through natural breaches in the confining layer such as faults or fractures, propagation around confining layers where they pinch out or grade into more permeable material, propagation through abandoned wells that are completed in both the deep and shallow zones, leakage past the seal in the pumping well, or propagation through artesian wells. The role played by the artesian flows in maintaining the water table could be investigated by temporarily sealing the artesian wells and observing the response of well 676T, however, it is not necessary to answer this question before a monitoring program could be developed. Well 382W differs from 375W, 380W, and 381W in that there are clearly identifiable groundwater dependent resources near the well. Extensive spring and seep areas and areas of phreatophytic vegetation in the Thibaut Springs area are within 0.5 miles of 382W (Ecosystems Sciences, 2000), as well as rare plant populations east of the LA Aqueduct. Monitoring should be installed to observe any affects of 382W on these areas.

Future management of wells sealed to deep aquifers. Wells 375W, 380W, 381W, and 382W withdraw water only from the deep aquifer, and as a consequence the cones of depression of these wells affects a greater area than would be affected if an equivalent amount of water was withdrawn from both the deep and shallow aquifers. When wells extract water directly from the shallow aquifer, it can be expected that the impact on water levels in the shallow aquifer will be a function of distance from the pumping well; however, when extraction is limited to the deep confined zone, impacts to the shallow aquifer will depend on the properties and extent of the confining layer.

Of particular concern is the possible impact of these wells on spring, seep, wetland, or riparian resources that occur where groundwater emerges due to structural or stratigraphic controls on groundwater flow (e.g., faults that allow upward flow through confining layers, or facies changes that terminate confining layers). Existing knowledge of the characteristics of the confining layers is insufficient to predict when and where effects will reach the shallow aquifer system; therefore, it is recommended that management for these wells be focused on identification of areas within the radius of influence of these wells that might be impacted and developing monitoring for those areas. Section I.V.3 of the Green Book (City of Los Angeles and Inyo County, 1990) notes that Type D vegetation is more sensitive to water deficits than Types A, B, or C, and specifies that the effectiveness of existing management methods will be evaluated and appropriate monitoring and management methods developed. It should further be recognized that the delineation of Type D as defined by the management maps appended to the Agreement may be insufficient to fully identify all the riparian and marshland areas within the radius of influence of these wells. For example, the Thibaut Springs area near well 382W is identified by Ecosystem Science (2000) as spring area (DWP 11), but is designated as Type C on the Agreement management maps.

A study is identified in Section V.B.8 of the Green Book (City of Los Angeles and Inyo County, 1990) aimed at developing effective monitoring for riparian and marshland vegetation. LADWP is currently developing this study. It is recommended that monitoring for spring, seep, and riparian areas within the radius of influence of wells sealed to the deep aquifer be incorporated into this study.

LADWP and Inyo County are currently engaged in two other cooperative studies that should prove useful in designing management for these wells. One cooperative study is aimed at evaluating the hydraulic properties of confining layers; the other is aimed at improving hydrological modeling tools. Together, these studies should provide tools for assessing the radius of influence of these wells, and provide information about the timing and location of drawdown propagating from the deep to the shallow zones. It is recommended that development of alternative management of these wells be addressed within the scope of these studies, and that data from the tests be incorporated into these studies. If in the course of these studies data gaps are identified, LADWP and Inyo County should seek joint funding for research to address them.

The following steps are a suggested outline for the development of a management program for these wells:

1. *Identify the radius of influence of these wells.* This task consists of developing and using groundwater models to delineate the area within which groundwater dependent resources might be impacted due to pumping from the wells.

2. *Identify groundwater dependent resources within the radius of influence of these wells.* Likely areas to be impacted are spring and seep areas, where groundwater

emerges along faults or through artesian wells, or areas where confining layers are inferred to grade into more permeable material (for example, at the toe of an alluvial fan). It should also be recognized that Type B and C vegetation may be impacted if drawdown propagates to the shallow aquifer.

3. *Identify the allowable fluctuation in measurable hydrological variables at the identified resources.* Ecosystem water requirements should be estimated and the water source identified for the resources identified in the second step.

4. *Identify a monitoring program for the identified resources.* Management should be based on monitoring of hydrologic conditions (surface water and groundwater levels, hydraulic gradients, and flow rates) rather than vegetation or soil water conditions, because once a measurable decline in vegetation has been observed, impacts may be irreversible or expensive and difficult to mitigate. Monitoring and management based on hydrologic conditions will identify pumping-induced changes earlier than either vegetation or soil water monitoring. In addition, once water level or flow measurement devices are installed, hydrological monitoring is easier and more certain than vegetation or soil water measurements. This monitoring program should be designed to identify baseline hydrologic and biologic conditions, provide data to verify modeling results, monitor conditions during well operation, provide management triggers to govern well operation, and monitor recovery in the event that triggers are exceeded. Monitoring may be at the identified resource, or at trigger locations between the production well and the resource. Hydrological monitoring may consist of surface water levels; spring discharge; groundwater levels in spring, seep, or phreatophyte areas; groundwater levels at intervening trigger locations; and/or vertical gradients in hydraulic head. Trigger locations intermediate between the production well and the resource may be preferable if the resource is so sensitive that no fluctuation is allowable, or if measurement at the resource is impractical. The monitoring program should also identify a sampling schedule and schedule for reporting to the Technical Group. This program should recognize that spring, seep,

and wetland vegetation is more immediately sensitive to water deficits than groundwater dependent scrub and alkali meadow communities.

5. *Define operational rules for a well management program based on the monitoring program.* Required components of this program are definitions of monitoring components and trigger points that direct changes in well management, actions that occur when trigger points are exceeded, means of determining when resources or triggers have recovered, and decision-making mechanisms that implement management of well operations.

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APPENDIX D

Appendix D

Vegetation Inventory for Big Pine NE Regreening Project Area

Surveys performed by Lori Gillem, Lori Dermody. Watershed Resources Specialist, City of Los Angeles Department of Water and Power

A vegetation inventory was performed for the Big Pine NE Regreening Project area during the spring and summer of 2011 (March 21, 2011 through September 15, 2011). The site visits occurred during late spring, summer and early fall to determine if any special status plant species occur on the project site. None of the special status species listed on the Big Pine quadrangle map were found within the 30 acre project area.

Plant species found during site surveys include:

SATR12	*Salsola tragus*
AMTE	*Amsinckia tessellata*
DISP	*Distichlis spicata*
BAHY	*Bassia hyssopifolia*
SAVE4	*Sarcobatus vermiculatus*
ERNA10	*Ericameria nauseosa*
ATTO	*Atriplex torreyi*
DEPIP3	*Descurainia pinnata*
GLLE3	*Glycyrrhiza lepidota*
ROPS	*Robinia pseudoacacia*
ROWO	*Rosa woodsii*
BRTE	*Bromus tectorum*

The site surveys included walking the project area and documenting the species found. No transects were ran as percent cover of the existing site is estimated at 20% and the dominant species documented were SATR12, and BRTE which are non-native species.