SD EForm - 1585LD V4
FORM 2: Application for uses other than irrigation
(type or print)

FILE COPY

Mail to:	(office use only)
PMB 2020 DENR - Water Rights 523 E Capitol Ave Pierre, SD 57501-3182 ph. (605) 773-3352	No. 2676-2 Hydrologic Unit 10120110 Basin Upper Cheyenne Newspaper Rapid City Journal 605 394-8300 PO Box 450 Rapid City SD 57701

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MAY - 8 2014
WATER RIGHTS PROGRAM

Application For Permit To Appropriate Water Within The State Of South Dakota

Check use(s) of water:

- [X] Municipal
- [X] Rural Water System
- [X] Domestic (over 18 gpm)
- [X] Suburban Housing
- [X] Commercial
- [X] Industrial
- [ ] Recreational
- [ ] Fish & Wildlife
- [ ] Other
- [ ] Institutional
- [ ] Geothermal Heat

Type of Application: (check one)
- [ ] **New**
- [ ] **Vested Right** (Use predates Mar 2, 1955)
- [ ] **Future Use Reservation**
- [ ] **Place to Beneficial Use Water Reserved by Future Use Permit No.** _____
- [X] **Amendment/Correction to Permit No.** 2040-2

Description of amendment/correction: (i.e. change diversion point(s), add diversion point(s), change use, etc.)
Change use and diversion points

1. Name to Appear on Water Permit City of Rapid City
   (check one) [X] Owner [ ] Tenant/lessee [ ] Owner's Legal Agent _____
   (name and complete address if different than above name)
   Mailing Address 300 Sixth Street (Address) Rapid City (City) SD (State) 57701 (Zip Code)
   Home Phone 605-394-4165 Cell _____ Email _____
2. Amount of water claimed 1.73 *CFS or _____ **GPM 277.4 ***AF
   (*Cubic Feet per Second) (**Gallons per Minute) (***Acre Feet - storage capacity of dam/dugout or annual use if applicable)
3. Source of water supply Rapid Creek (See attached Exhibit 1 for maps)
4. Location of point of diversion See attached Exhibit 2 for legal descriptions and locations County Pennington
   (example - 3 wells in SW1/4 NE1/4 section 12-T104N-R53W)
   If not a public water supply (e.g. municipal), will water be used outside of the area described above? [ ] Yes [ ] No
   If "Yes," where will water be used? _____
   (example - NW1/4 section 12-T104N-R53W)
5. County or counties where water will be used Pennington
6. Annual period during which water is to be used April 15-November 30
7. **Give a description of the project. When available include any preliminary engineering report or other reports or information that will help explain the project. (Attach sheet if more space is needed)**

   Project will divert water from Rapid Creek to the City of Rapid City water treatment plants and/or the City infiltration galleries located adjacent to Rapid Creek. Alternatively, the project will, but not simultaneously, divert water from Rapid Creek to storage in Pactola Reservoir. See the attached Exhibit 3 (Engineering Report).

Terry Wolterstorff

I, Terry Wolterstorff, Director of Public Works, the applicant, certify that I have read this application, have examined the attached map, and that the matters stated are true.

2012-09

Attachments: Attach Form 2A if diversion is from a well or dugout, or if storage of water is proposed. Also, attach map and any other technical information. (see instructions)

Form 2A
(Complete applicable portions only)

Supplemental Information

(type or print)

1. Well Information (check one or both as applicable) ☐Drilling new well(s) ☐Using existing well(s)

a) If new wells, how many ___ Have test holes been drilled ☐Yes ☐No Drilled by _____
(if yes, please provide copies of logs)

b) If existing wells, how many ___ Provide copy of log(s), if available. Drilled by _____

c) Well Depth _____ Depth to Top of Water Bearing Material _____ Depth to Water from Surface _____

d) Distance to nearest existing domestic well:

On applicant's property _____ On property owned by others _____

2. Wastewater Disposal System Information

a) Type of System (i.e. septic tank, drain field) _____

b) System Capacity (gallons) _____ Year Constructed _____

c) Connected to the City of _____ Sanitary System

3. Dugout Information

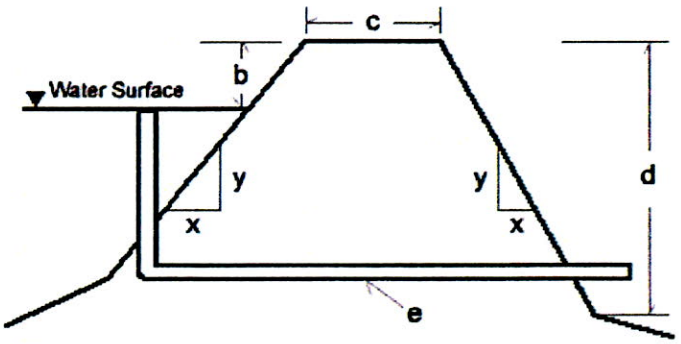
a) Surface Dimensions _____ Depth _____

b) Depth to water (ground surface to water level) _____

4. Water Storage Dams

If the proposed water use system contains one or more storage dams, please furnish the information requested below for each dam. The locations of the dams need to be shown on the map submitted with the application.

a) If a private engineering firm or government agency was involved in the design of this dam, please give their name and address:
United States Bureau of Reclamation
Department of Interior



b) Freeboard 3.3 feet

c) Crest Width 40 feet

Crest Length 5,200 feet including dykes

d) Height 245 feet

e) Primary Outlet Capacity 1,150 cfs

If pipe, diameter 2-2.75'x2.75'

f) Secondary Spillway Capacity 245,000 cfs

Spillway Width 425 feet

g) X & Y Slope (e.g. 3 to 1 is a typical slope)

Upstream 2.5:1

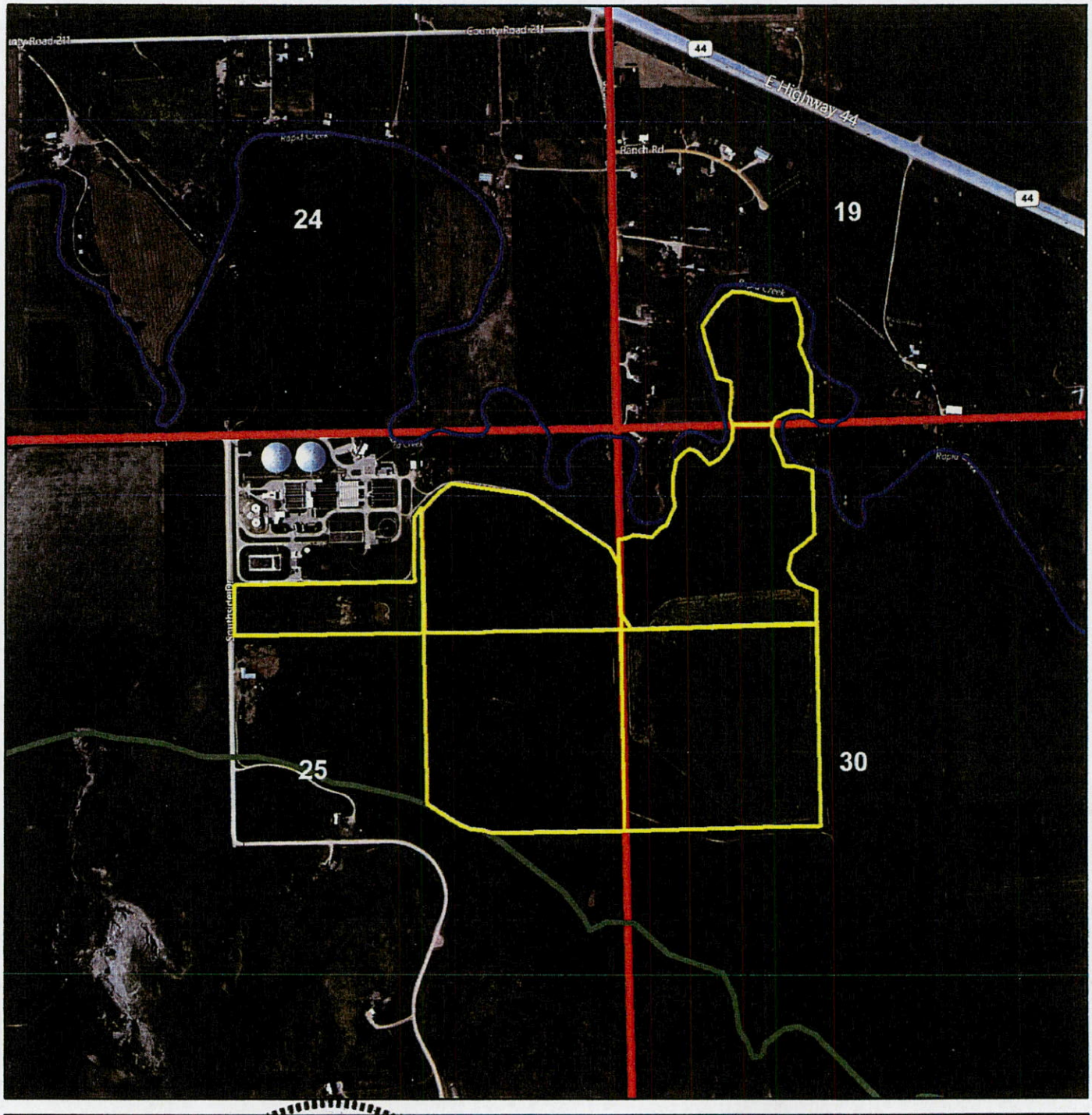
Downstream 2:1

h) Surface Area of Impoundment 1,232 acres

i) Storage 99,029.0 Acre Feet

j) Drainage Area Above Dam 319.0 Acres

EXHIBIT 1



Acres To Transfer

South Side Ditch

Sections

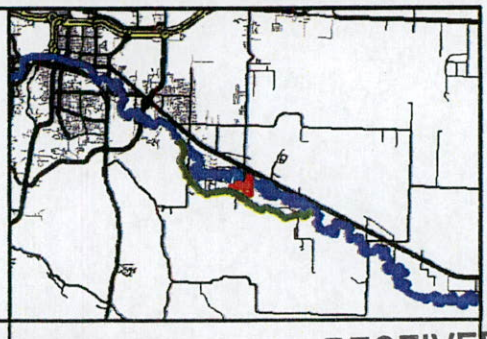
Rapid Creek

Sec 19-T1N-R8E
Sec 25-T1N-R8E
Sec 30-T1N-R8E

REGISTERED PROFESSIONAL ENGINEER
REG. NO.
10397
JARED
OSWALD
11-28-14
SOUTH DAKOTA

N

Miles
0 0.045 0.09 0.18 0.27



ESPEC
& NATURAL RESOURCES

Created By: J. Oswald
Date: 6/20/11
MXD: SouthSide.mxd

Sec 19-T1N-R9E
Sec 30-T1N-R9E
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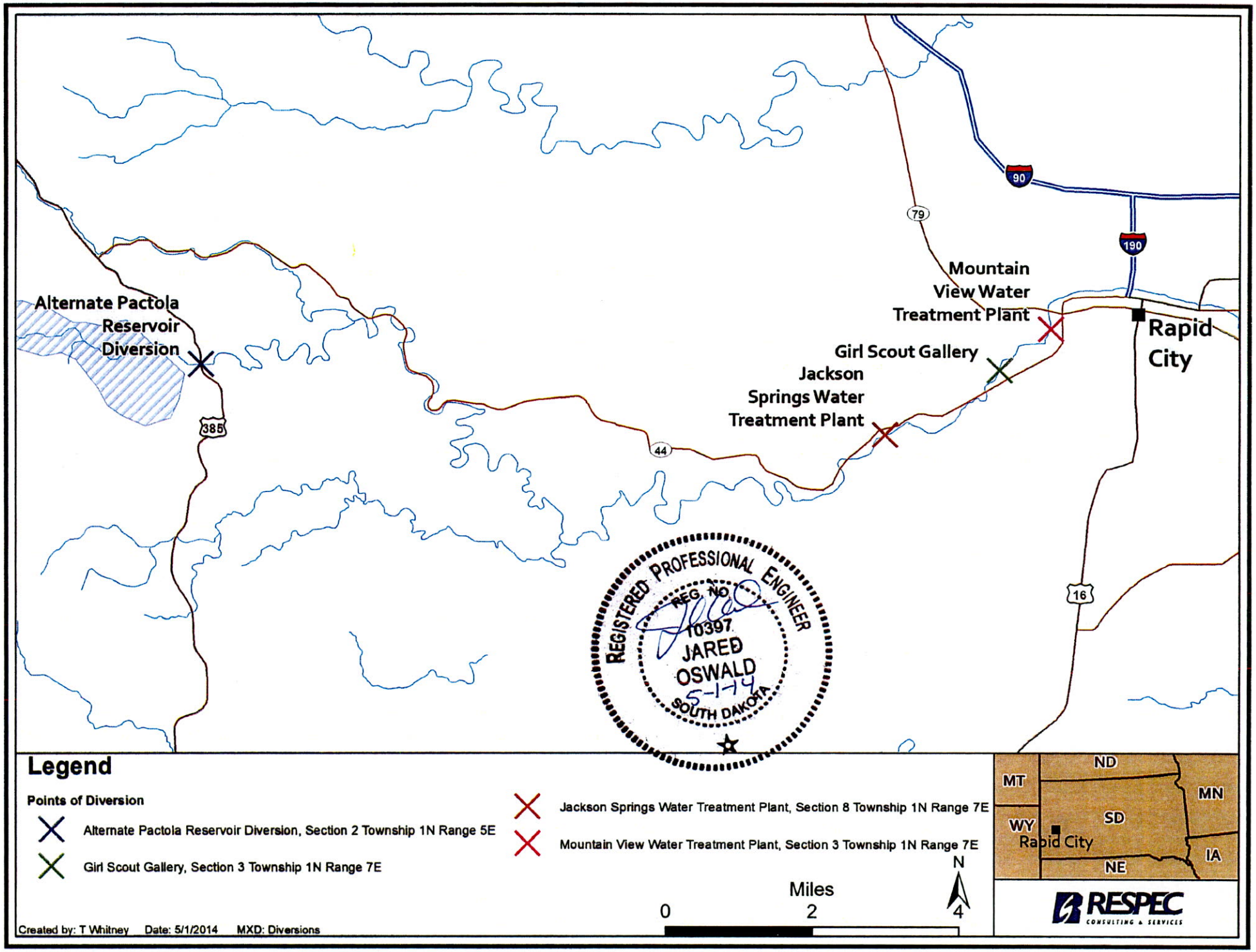
Alternate Pactola Reservoir Diversion
Mountain View Water Treatment Plant
Girl Scout Gallery
Jackson Springs Water Treatment Plant
Rapid City
90
190
79
385
44
16
REGISTERED PROFESSIONAL ENGINEER
REG. NO.
10397
JARED
OSWALD
5-14
SOUTH DAKOTA
Legend
Points of Diversion
Alternate Pactola Reservoir Diversion, Section 2 Township 1N Range 5E
Girl Scout Gallery, Section 3 Township 1N Range 7E
Jackson Springs Water Treatment Plant, Section 8 Township 1N Range 7E
Mountain View Water Treatment Plant, Section 3 Township 1N Range 7E
Miles
0
2
4
N
ND
MT
MN
SD
WY
Rapid City
NE
IA
RESPEC
CONSULTING & SERVICES
Created by: T Whitney Date: 5/1/2014 MXD: Diversions

EXHIBIT 2

EXHIBIT 2

APPLICATION FOR PERMIT TO APPROPRIATE WATER WITHIN THE STATE OF SOUTH DAKOTA

LOCATION OF POINT OF DIVERSION

Mountain View Water Treatment Plant
North 71 degrees 39 feet West, 1,205 feet from East ¼ corner of Section Three (3), Township One (1) North, Range Seven (7) East of the Black Hills Meridian.

Girl Scout Gallery
1,270 feet north 54 degrees 05 feet East of Southwest corner of Section Three (3), Township One (1) North, Range Seven (7) East of the Black Hills Meridian.

Jackson Springs Water Treatment Plant Collection Box
3,130 feet north 63 degrees and 12 minutes west of the southeast corner of Section Eight (8), Township One (1) North, Range Seven (7) East of the Black Hills Meridian.

Jackson Springs Water Treatment Plant Creek Intake
3,220 feet north 66 degrees and 18 minutes west of the southeast corner of Section Eight (8), Township One (1) North, Range Seven (7) East of the Black Hills Meridian.

Alternate Pactola Reservoir Diversion (Inlet to Service Spillway)
South 19 degrees East 3,740 feet of Northwest corner of Section Two (2), Township One (1) North, Range Five (5) East of the Black Hills Meridian.

Reservoir generally located in portions of Sections Two (2), Three (3), Four (4), Five (5), Ten (10), and Eleven (11), Township One (1) North, Range Five (5) East of the Black Hills Meridian, and portions of Sections Thirty-One (31), Thirty-Two (32), Thirty-Three (33), and Thirty-Four (34) Township One (1) North, Range Five (5) East of the Black Hills Meridian.

All of the above in Pennington County, South Dakota.

EXHIBIT 3

CITY OF RAPID CITY SOUTH SIDE

DITCH WATER RIGHTS TRANSFER

Topical Report RSI-2222
Revision 2

prepared for

City of Rapid City
300 Sixth Street
Rapid City, South Dakota 57701
Project No. W11-1933

April 2014

RESPEC
CONSULTING & SERVICES

CITY OF RAPID CITY SOUTH SIDE

DITCH WATER RIGHTS TRANSFER

Topical Report RSI-2222
Revision 2

by

Jared K. Oswald
RESPEC
P.O. Box 725
Rapid City, South Dakota 57709

prepared for

City of Rapid City
300 Sixth Street
Rapid City, South Dakota 57701
Project No. W11-1933

April 2014

FOREWORD

An engineering analysis was conducted on the property owned by the City of Rapid City near the wastewater treatment plant to determine the amount of water the property has the right to transfer to the water supply system for the City of Rapid City, South Dakota. The 154-acre parcel being assessed is located within Sections 19, 25, and 30, Township 1 North, Range 8 East, Black Hills Meridian, Pennington County, South Dakota. The property has been served irrigation water through a vested right (Water Right No. 2040-2) which allows 23.4 cubic feet per second (cfs) to be diverted from Rapid Creek into the South Side Ditch. The analysis determined that 277.4 acre-feet of water (approximately 1.8 acre-feet per acre) can be transferred annually from the property to diversion points within Rapid City from April 15–November 30 not to exceed a prorated acreage share of 1.73 cfs. A total annual volume of 138.7 acre-feet is available for transfer to Pactola Reservoir storage.

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1.0 INTRODUCTION

An engineering analysis was completed on several parcels of property owned by the City of Rapid City with irrigation rights off the South Side Ditch, which receives diversions from Rapid Creek. The property is located within: the SW ¼ SW ¼ (11 acres) of Section 19; the NW ¼ NE ¼ (10 acres), NE ¼ NE ¼ (25 acres), and SE ¼ NE ¼ (39 acres) of Section 25; and the NW ¼ NW ¼ (29 acres) and SW ¼ NW ¼ (40 acres) of Section 30. All of these sections are within the Township 1 North of Range 8 East of the Black Hills Meridian. The engineering analysis is divided into three report sections (Historic Crop Water Use, Historic Diversions, and Delivery System Losses) to comprehensively assess the volume and flow rate available for transfer to diversion points within the City of Rapid City, South Dakota. The historic irrigation requirements (demand) and diversions (supply) were compared on a monthly basis to determine if supply or demand is the limiting amount. The delivery system losses were subtracted to determine the monthly acre-feet of water available for transfer.

1.1 HISTORIC CROP WATER USE

An assessment was conducted to determine the historic crop water use and irrigation requirements of the City of Rapid City property shown in Figure 1-1. An online irrigation scheduling consultant tool, developed for individual landowners within the Belle Fourche Irrigation District (BFID) in western South Dakota, tracks the daily water balance in a field and provides a recommendation of irrigation timing and depth. Because of the proximity of the BFID to the property, the methods used to develop the tool were deemed appropriate to assess historic crop water use.

The analysis was run daily (April 1 to October 31) from 1970–2004. The inputs required to track a daily water balance are local weather and rainfall estimates, crop type, and soil water-holding capacity. Weather and rainfall data were collected from the Rapid City Regional Airport located approximately 4 miles east of the property and, therefore, deemed representative. The weather data were input into the American Society of Civil Engineers (ASCE) Penman Monteith (PM) equation (Equation 1-1) to calculate daily evapotranspiration (ET). This equation requires daily values of dew point, high temperature, low temperature, average wind speed, and solar radiation, all of which were available from the Rapid City Regional Airport weather station for the entire analysis period.

The owners indicated that during the analysis period, the field was in alfalfa/grass hay. The ASCE PM equation estimates daily evapotranspiration and references a 0.5-meter-tall crop similar to full-cover alfalfa. In other words, the PM equation uses the weather parameters required to estimate the amount of water that would be lost from full-cover alfalfa on that day.

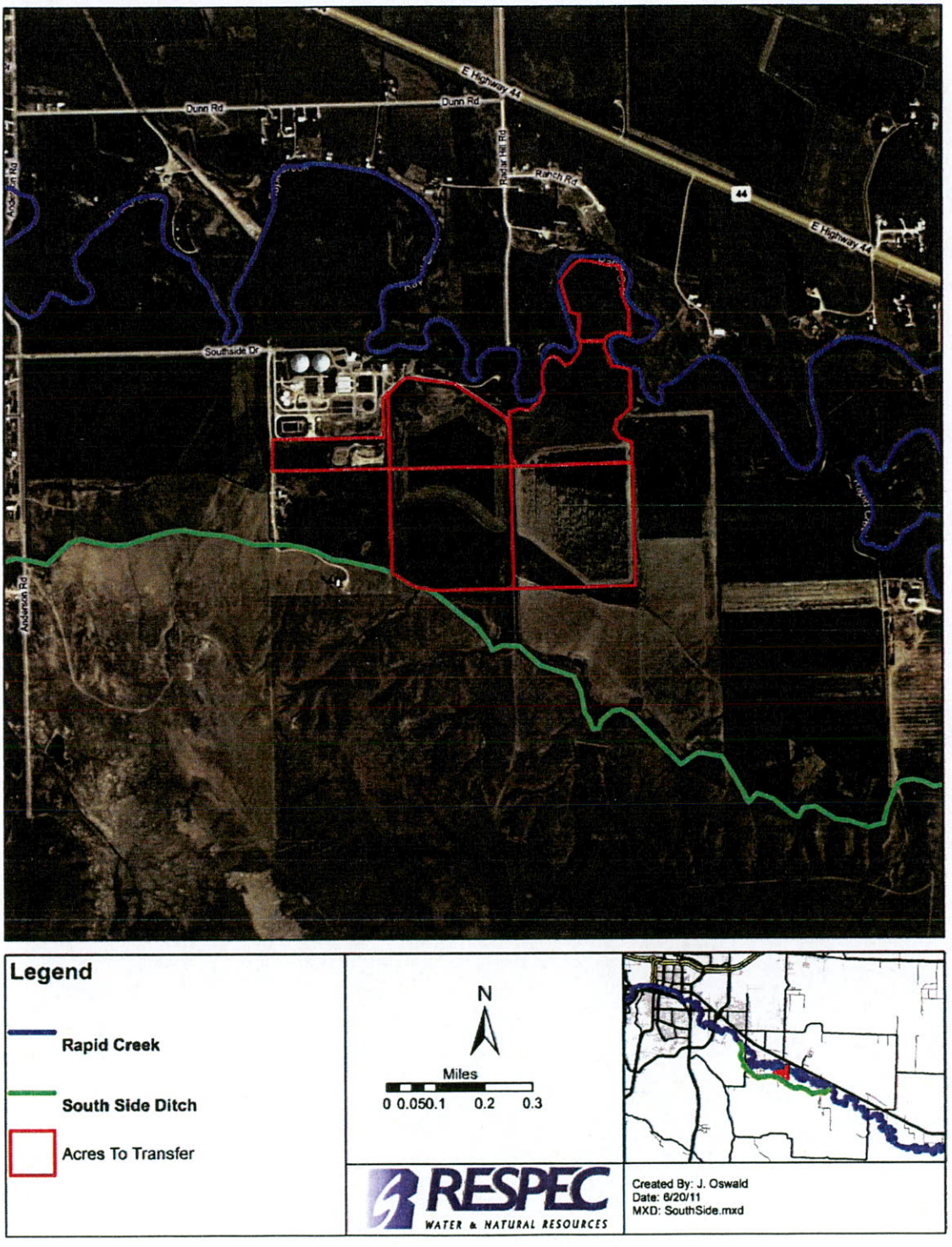

Figure 1-1. Location of the City of Rapid City Property.

This reference ET (*ETr*) estimate is multiplied by a crop coefficient (*Kc*) to adjust this value to any crop or crop stage other than full-cover alfalfa along with a plant available water coefficient (*Ka*) that adjusts for changes in soil moisture (Equation 1-1):

$$ETa = ETr \times Kc \times Ka \qquad (0\text{-}1)$$

The values for *Kc* used in this analysis are shown in Figure 1-2. It was assumed that the start of growing season, on average, begins on April 1. For alfalfa, it is assumed that the plant begins to thrive when the first 5 days of average temperature exceed 41 degrees Fahrenheit, which occurs, on average, on April 1 for this area. At this time, the *Kc* is estimated to be 0.5, or half the water used for a full-cover alfalfa crop. After the start of the season, the value steadily increases until the crop is harvested and the *Kc* drops immediately to 0.3 and the cycle repeats itself. For this analysis, based on conversations with the landowner and local knowledge, it was assumed that, on average, the alfalfa is harvested on June 2, July 12, and August 21.

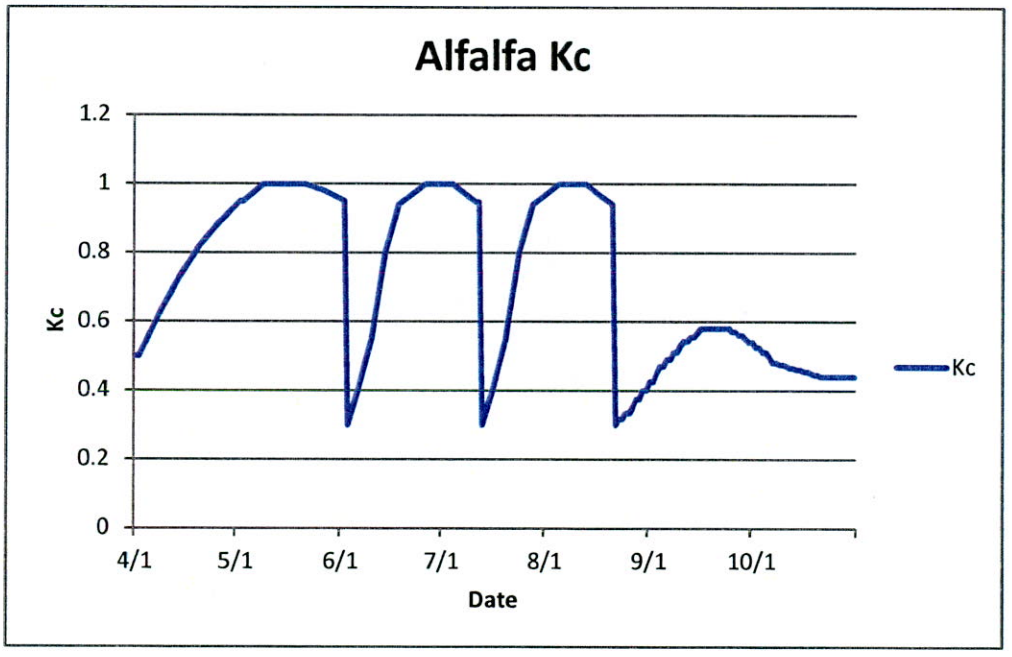

Figure 1-2. Crop Coefficient (*Kc*) Throughout the Growing Season for Alfalfa Developed Specifically for the City of Rapid City Property.

The *ETr* estimate is also multiplied by a plant available water coefficient (*Ka*) to determine the actual ET estimate (*ETa*) for the day. This value takes into account the current soil water balance. The form of the coefficient is shown in Figure 1-3. In essence, the more saturated the soil profile, the closer *Ka* gets to one, meaning the more readily available the water is to be released.

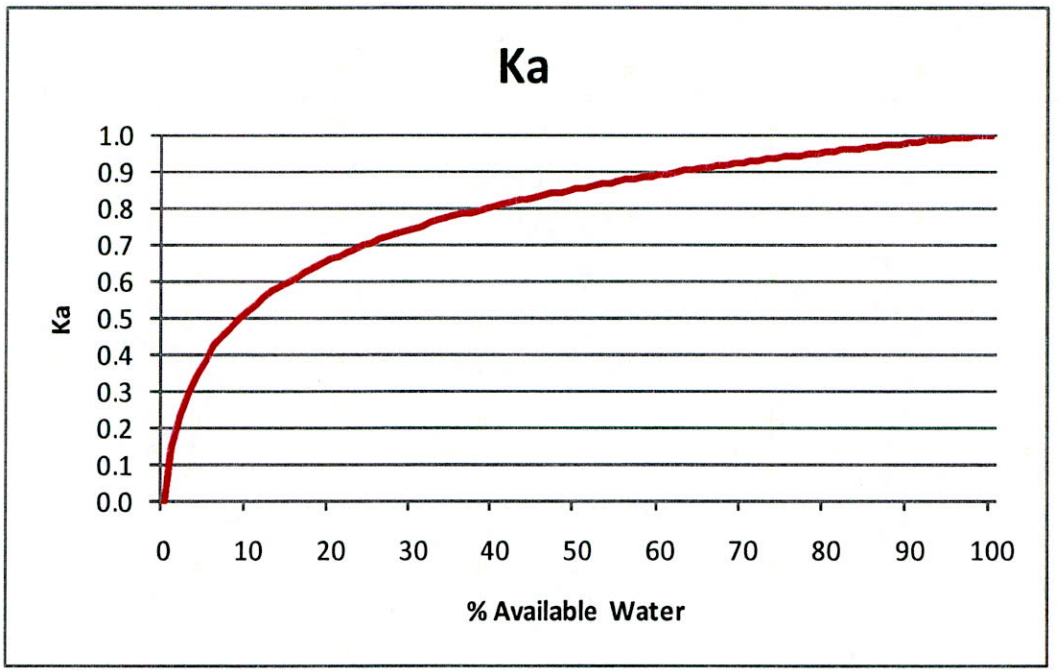

Figure 1-3. Plant Available Coefficient (*Ka*) Response to Changes in Percent of Available Water in the Soil Profile.

To assess the percent available water in the soil, the water-holding capacity must be known. Figure 1-4 provides an aerial view of the City of Rapid City property with the soils overlayed. The 154 acres being assessed is comprised of 70 percent Owanka clay loam (*Ow*), 12 percent Bridgeport silt loam (*Bp*), and 18 percent Kyle Clay (*KyB*). The overall water-holding capacity of the property was determined by calculating an area weighted value. This was found by developing an estimate of water-holding capacity in inches per foot for the top 4 feet for each soil type. The top 4 feet was used because that is considered the effective rooting depth for an established alfalfa crop. The estimated water-holding capacity of the individual soil types is then multiplied by the percent of area they comprise of the property. The calculated area weighted water-holding capacity for the property is shown in Table 1-1.

The daily water balance is found by adding the daily rainfall and simulated irrigation amounts and subtracting the *ETa* calculated using Equation 1-2. Irrigation events were simulated and assumed to occur when the calculated balance reached 50 percent of the water-holding capacity (also often referred to as field capacity). Irrigation amounts fully replenished any soil water deficit at the time.

$$\text{Available Water} = \text{Previous Day Available Water} - ETa + \text{Rainfall} + \text{Irrigation} \qquad (0\text{-}2)$$

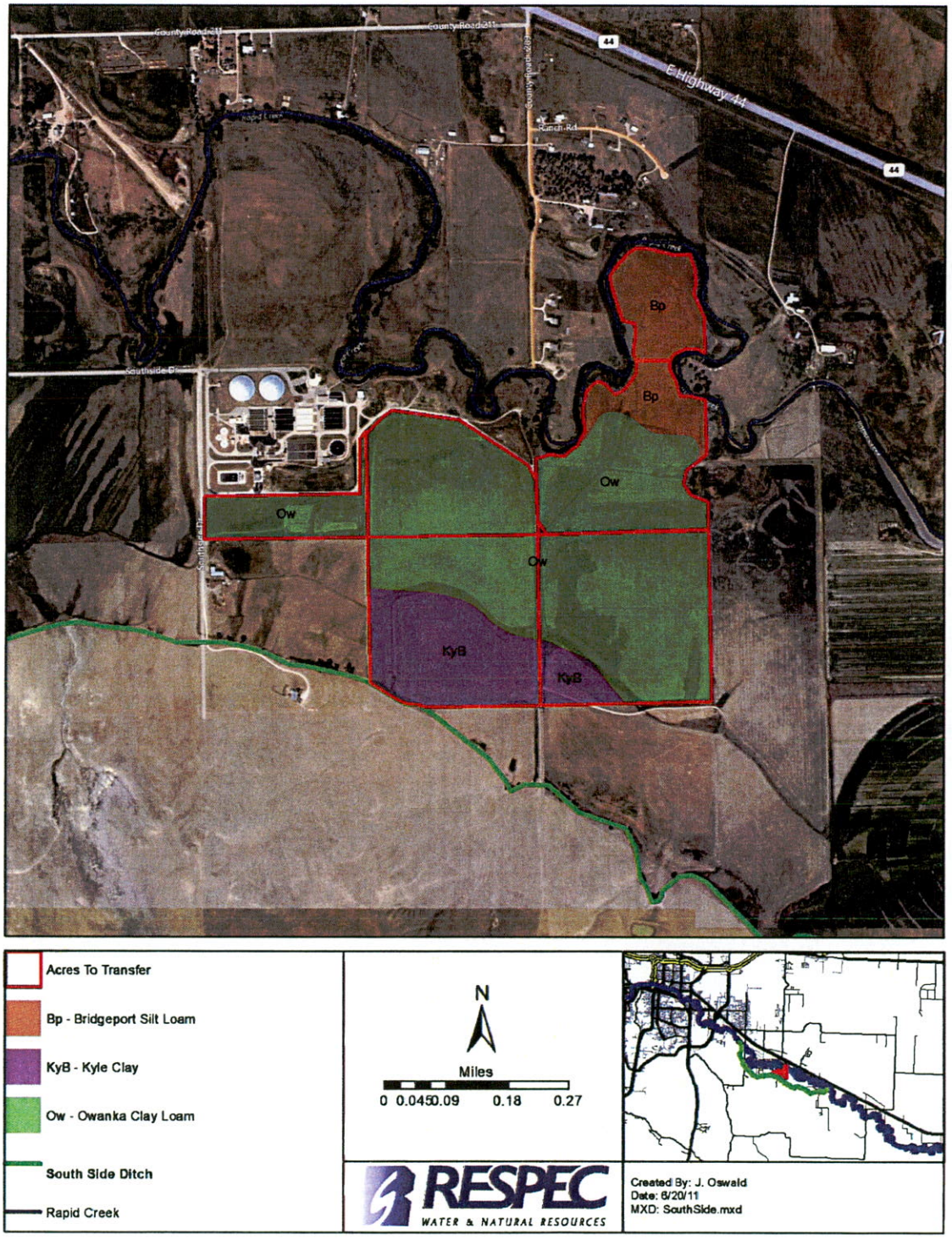

Figure 1-4. Location of the City of Rapid City Property With Soils Overlayed.

Table 1-1. Calculated Weighted Water-Holding Capacity for the City of Rapid City Property

Depth (ft)	Water-Holding Capacity (in/ft)
1	1.86
2	1.71
3	1.71
4	1.63
Total	**6.91**

Figure 1-5 provides a graphical representation of the estimated water balance from 1970 using the methods described above. During the irrigation season (April 15–October 31), the field received 11.39 inches of rainfall and had 40.41 inches of *ETa* deficit, which induced 25.83 inches of irrigation. The graphs from the remaining years are displayed in Appendix A. Figure 1-6 displays the total yearly values for reference rainfall, irrigation, reference ET (*ETr*), and actual ET (*ETa*) throughout the period of analysis. On average, there was 56.83 inches of *ETr*, 40.08 inches of *ETa*, 12.66 inches of rainfall, and 24.62 inches of irrigation simulated. The greatest irrigation amount simulated (36.92 inches) occurred in 1988, which was in response to receiving only 8.58 inches of rain and having 50.67 inches of *ETa*.

According to the City of Rapid City, the property has been surface irrigated throughout its existence. Irrigation efficiency was therefore assumed to be 50 percent. Table 1-2 displays the water available to be transferred from the City of Rapid City property by month based on the analysis of historic crop water use. According to this analysis, the crop demands an average of 632.0 acre-feet during the irrigation season with monthly delivery rates needed to supply this demand varying from 0.54 cubic feet per second (cfs) in October to 2.39 cfs in August.

1.2 HISTORIC DIVERSIONS

Diversion records were collected by the Bureau of Reclamation for the South Side Ditch on a monthly basis over a 13-year period and are included in Table 1-3 (Reclamation Rapid Valley Project Histories 1963–1968 and 1972–1978). These historic diversion estimates to the ditch were then multiplied by the fraction of land (pro rata share) that the City of Rapid City property encompasses within the water rights minus estimated delivery losses to determine the historic monthly delivery amount to the field (Equation 1-3). The water right (2040-2) identifies that the 154-acre property is approximately 8 percent of the 1,877 acres that were originally designated as irrigable under this right. Table 1-3 shows the amount of water available for transfer using this method of analysis.

RSI-1948-10-004

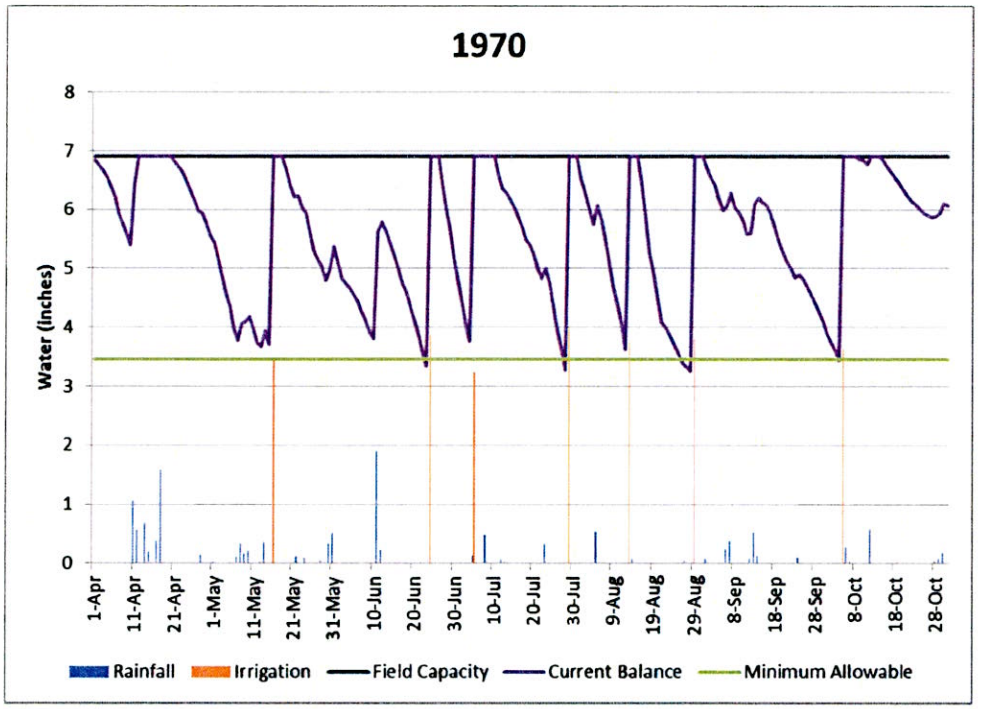

Figure 1-5. Water Balance Tracking for 1970 Irrigation Season.

RSI-1948-10-005

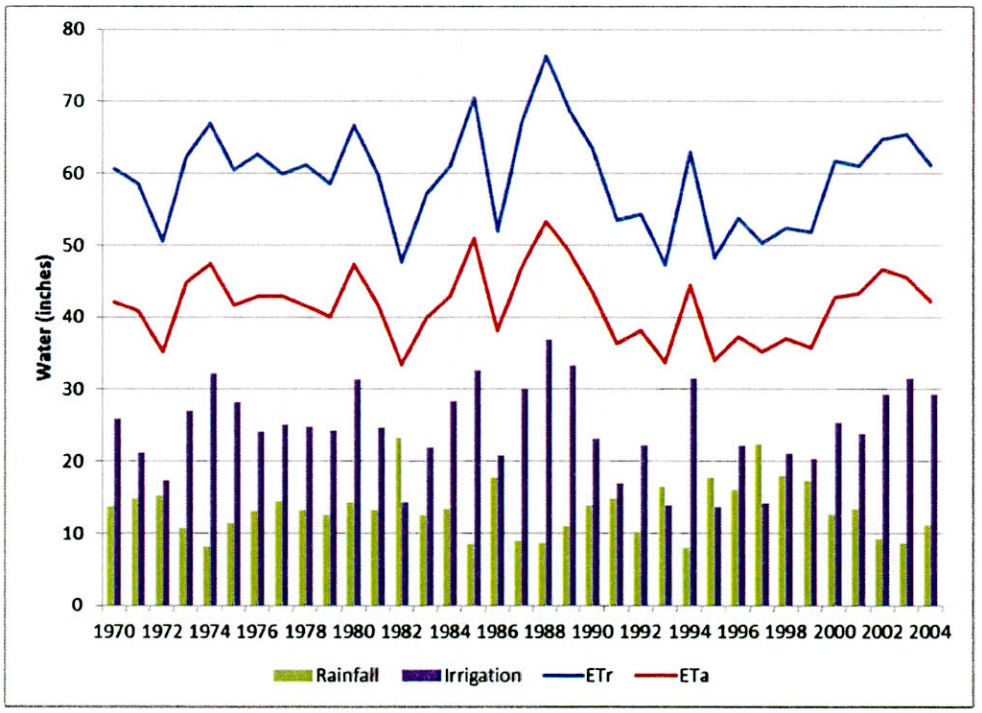

Figure 1-6. Total Values of Rainfall, Irrigation, Reference Evapotranspiration, and Actual Evapotranspiration During the Analysis Period of 1970–2004.

$$\text{Monthly Pro Rata Share} = \text{Monthly Historic Diversion} \times \frac{154}{1{,}877} - \text{Delivery Losses (9.8\%)} \quad (0\text{-}3)$$

Table 1-2. Amount of Irrigation Demand Based on Historic Crop Water Use Analysis

	April	May	June	July	August	September	October	Total
Crop Demand (inches)	1.26	3.89	4.06	5.29	5.71	3.11	1.30	24.62
Crop Demand at 50% Application Efficiency (inches)	2.53	7.78	8.11	10.58	11.43	6.22	2.60	49.24
Acre-Feet/Acre Crop Demand	0.21	0.65	0.68	0.88	0.95	0.52	0.22	
Number of Acres	154	154	154	154	154	154	154	
Acre-Feet of Crop Demand	32.5	99.8	104.1	135.7	146.7	79.9	33.3	632.0
Days of Delivery	15.0	31.0	30.0	31.0	31.0	30.0	31.0	199.0
CFS Equivalent	1.09	1.62	1.75	2.21	2.39	1.34	0.54	

Table 1-3. Historic Diversions and Monthly Pro Rata Share Available for Transfer From the City of Rapid City Property Based on Historic Diversion Records

	April	May	June	July	August	September	October	Total
Historic Diversions To Ditch (Acre-Feet)		350	532	638	808	532		2,860.0
Pro Rata Share of Historic Diversions Minus Ditch Loss (Acre-Feet)	0	25.9	39.4	47.2	59.8	39.4	0	211.7

1.3 DELIVERY SYSTEM LOSSES

Delivery system losses were estimated in a Bureau of Reclamation 1989 study to be 9.8 percent. This number has been consistently referenced in all previous transfers from the South Side Ditch.

2.0 WATER RIGHTS AVAILABLE FOR TRANSFER

An engineering analysis was completed to determine the water rights that were available for transfer from the City of Rapid City property located within Sections 19, 25, and 30, Township 1 North, Range 8 East, Black Hills Meridian, Pennington County, South Dakota. To complete this analysis, the historic crop water use for the 154-acre parcel as well as historic diversion records to the South Side Ditch were assessed. Table 2-1 provides a monthly summary of the findings in acre-feet, subtracting out the 9.8 percent delivery losses, as well as the irrigation rights available for transfer in acre-feet and cfs. The irrigation rights to be transferred was found by taking the lesser of the two analyses (crop water use or diversions) except in April and October where the crop water use amount was used because no historic delivery records were available.

The analysis determined that 277.4 acre-feet of water (approximately 1.8 acre-feet per acre) can be transferred annually from the property to diversion points within Rapid City (Table 2-1) from April 15–November 30 not to exceed a prorated acreage share of 1.73 cfs. A total annual volume of 138.7 acre-feet is available for transfer to Pactola Reservoir storage.

Table 2-1. Irrigation Amounts Available for Transfer From the City of Rapid City Property

Row	Description	April	May	June	July	August	September	October	Total
A	Historic Diversions to Ditch (Acre-Feet)		350	532	638	808	532		2,860.0
B	Pro Rata Share of Historic Diversions Minus Ditch Loss (Acre-Feet)	0	25.9	39.4	47.2	59.8	39.4	0	211.7
C	Crop Demand Minus Ditch Loss (Acre-Feet)	32.5	99.8	104.1	135.7	146.7	79.9	33.3	632.0
D	Irrigation Right to Be Transferred to Diversion Points in Rapid City Minus Upstream Return Flows (Acre=Feet)	32.5	25.9	39.4	47.2	59.8	39.4	33.3	277.4
E	Irrigation Right to Be Transferred to Pactola Reservoir (Acre-Feet)	16.2	13.0	19.7	23.6	29.9	19.7	16.7	138.7
F	Irrigation Right to Be Transferred to Diversion Points in Rapid City (cfs)	1.09	0.42	0.66	0.77	0.97	0.66	0.54	

Row A - taken from previous South Side Ditch water rights transfers outlined in Section 1.2.

Row B - calculated by multiplying Row A by the ratio of acres to be transferred to the total irrigated acres validated.

Row C - calculated using an online irrigation scheduling tool outlined in Section 1.1.

Row D - The lesser of Row B and C except in the months of April and October when no diversion data were available.

Row E - Multiply Row D by assumed irrigation efficiency of 50 percent.

Row F - Multiply Row D by conversion factor.

Table 2-2. Approximate Locations of City of Rapid City Intake Galleries

Location Name	Location
Girl Scout Gallery	SW¼ SW¼ Section 3
Mountain View Water Treatment Plant	SE¼ NE¼ Section 3
Jackson Springs Gallery	NW¼ SE¼ Section 8

APPENDIX A

HISTORIC CROP WATER USE BY YEAR

RSI-1948-10-007

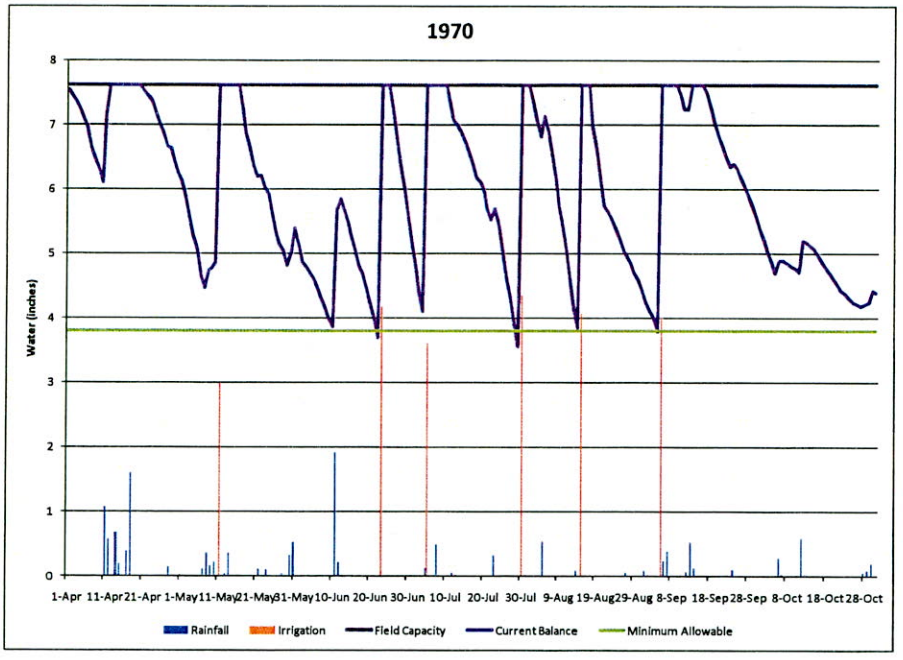

Figure A-1. Crop Water Use Calculation for Year 1970.

RSI-1948-10-008

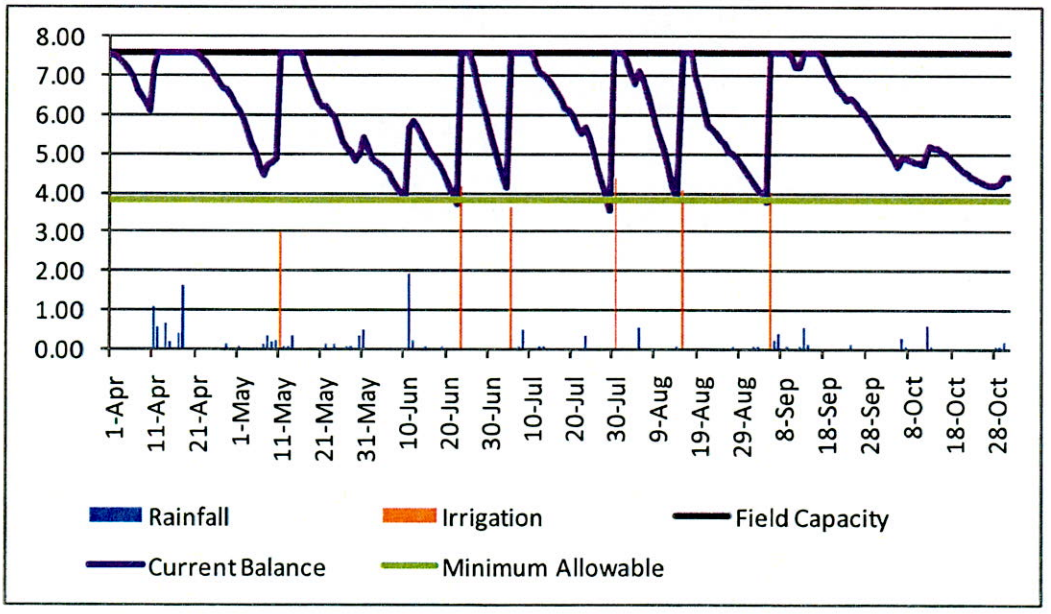

Figure A-2. Crop Water Use Calculation for Year 1971.

RSI-1948-10-009

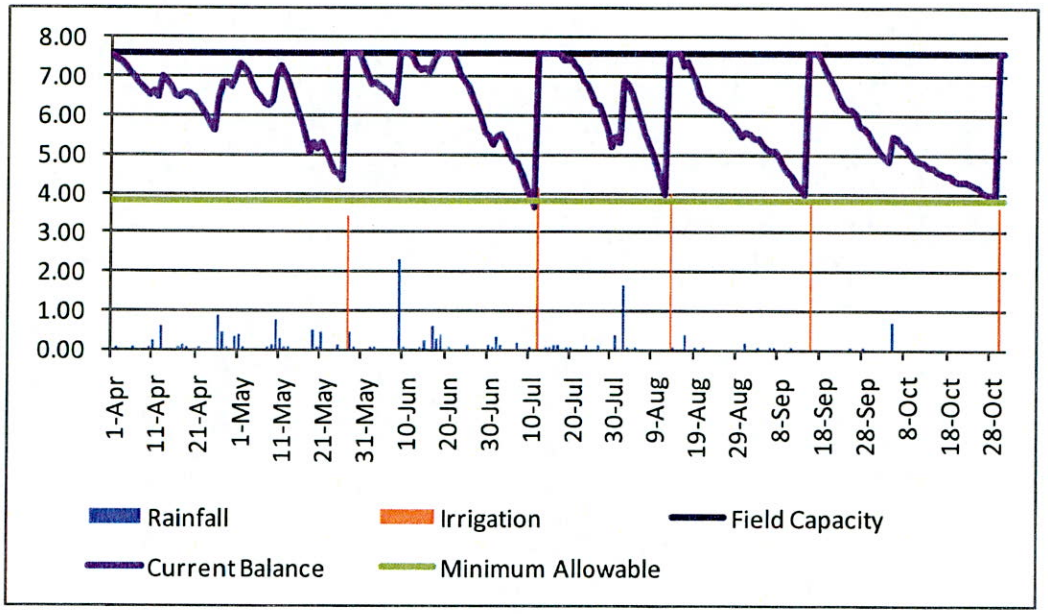

Figure A-3. Crop Water Use Calculation for Year 1972.

RSI-1948-10-010

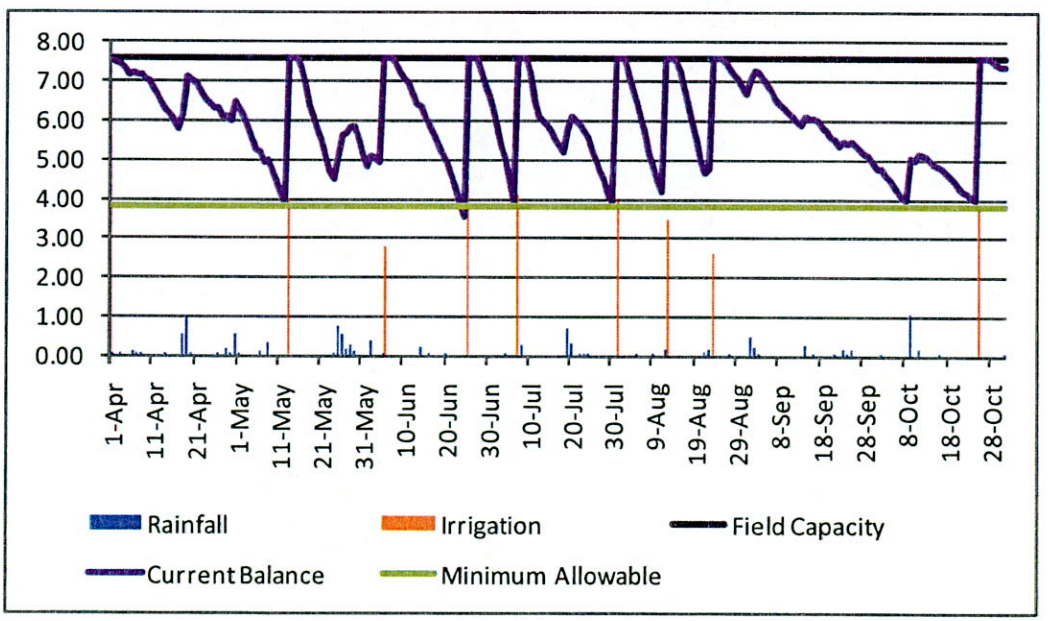

Figure A-4. Crop Water Use Calculation for Year 1973.

RSI-1948-10-011

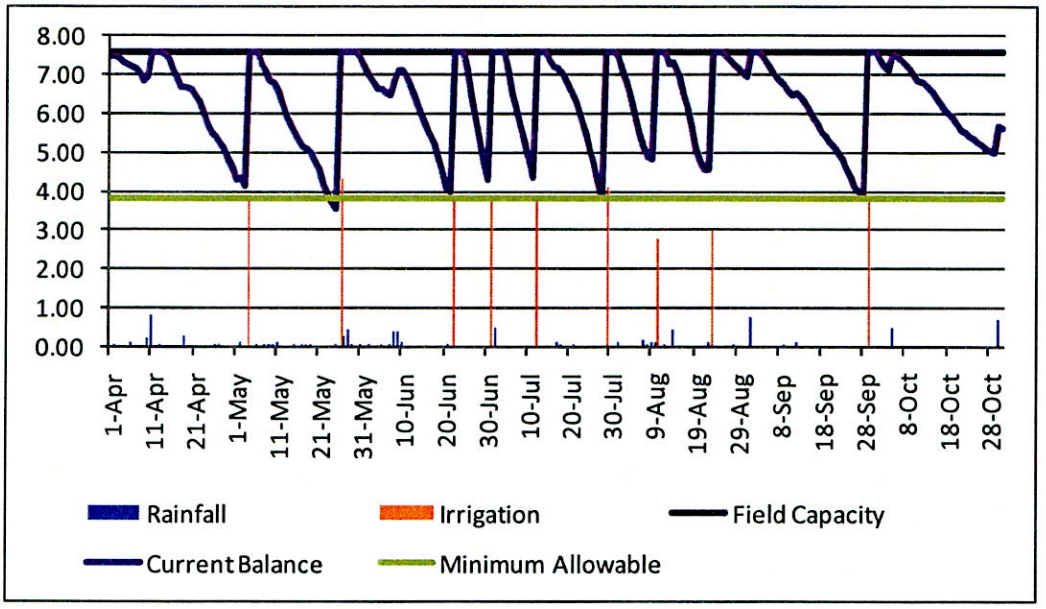

Figure A-5. Crop Water Use Calculation for Year 1974.

RSI-1948-10-012

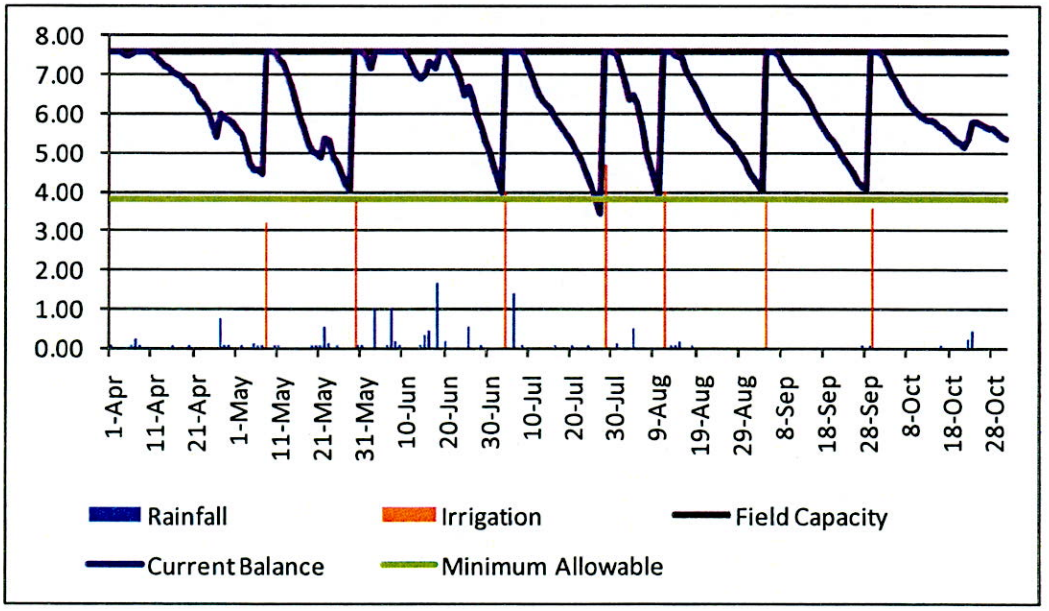

Figure A-6. Crop Water Use Calculation for Year 1975.

RSI-1948-10-013

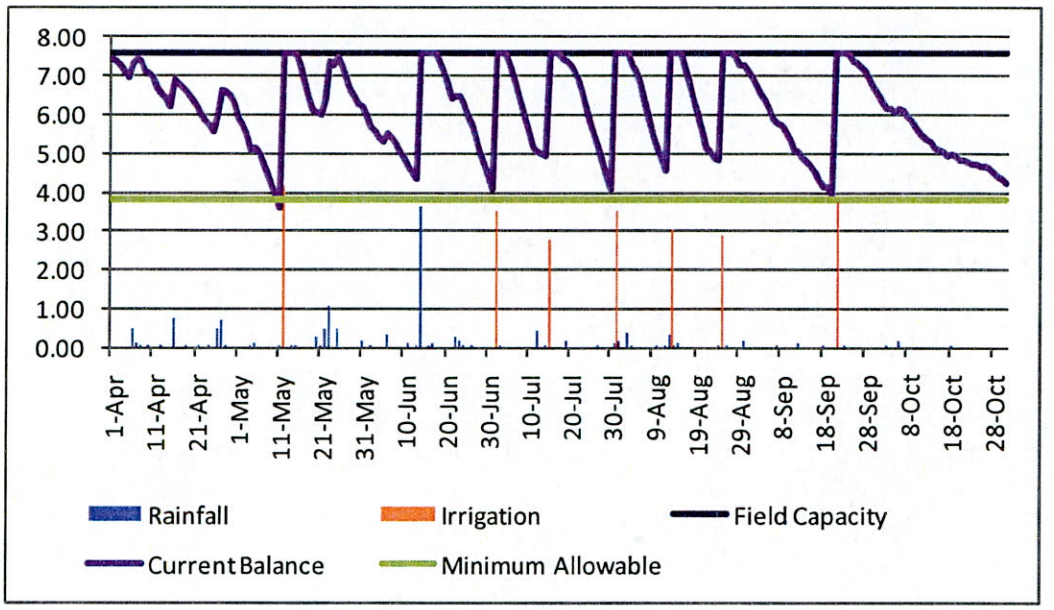

Figure A-7. Crop Water Use Calculation for Year 1976.

RSI-1948-10-014

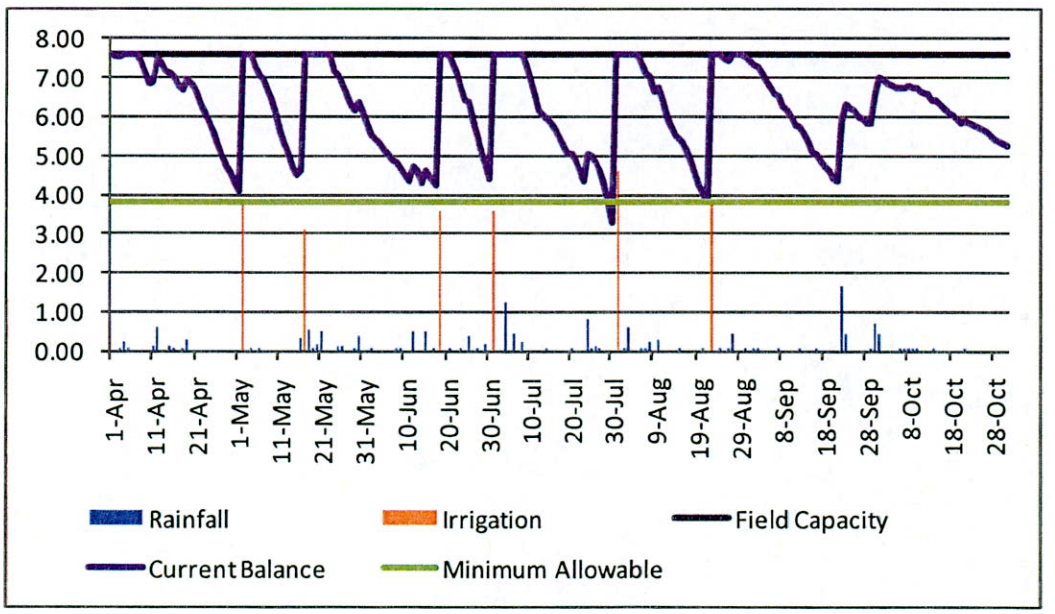

Figure A-8. Crop Water Use Calculation for Year 1977.

RSI-1948-10-015

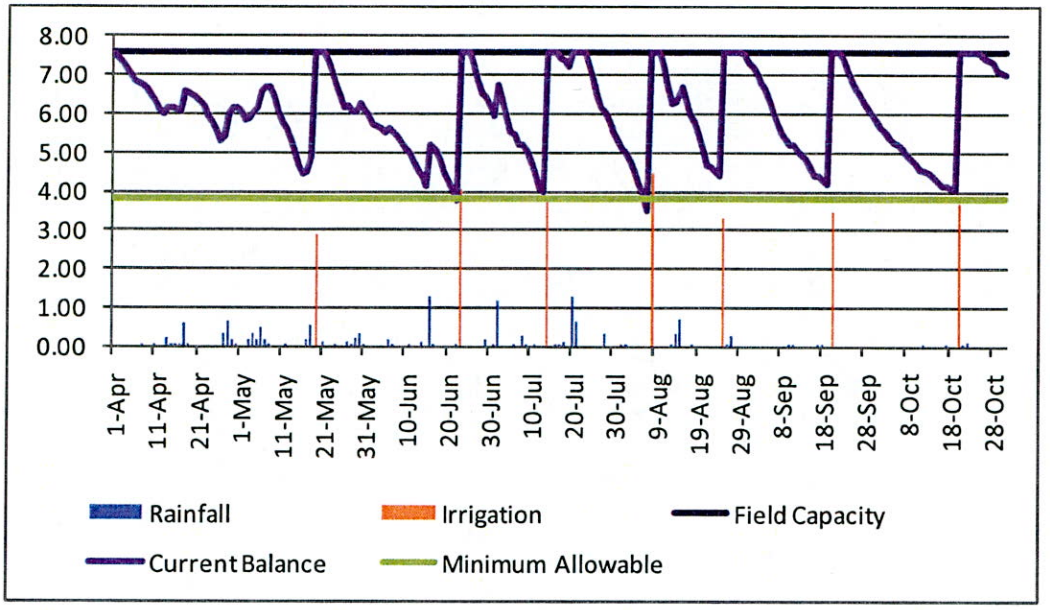

Figure A-9. Crop Water Use Calculation for Year 1978.

RSI-1948-10-016

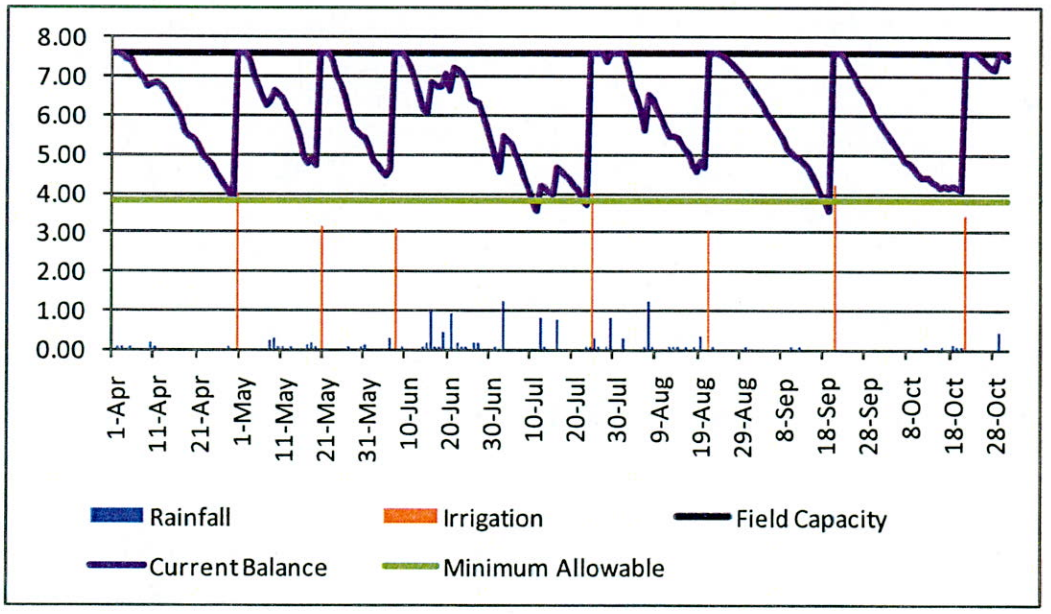

Figure A-10. Crop Water Use Calculation for Year 1979.

RSI-1948-10-017

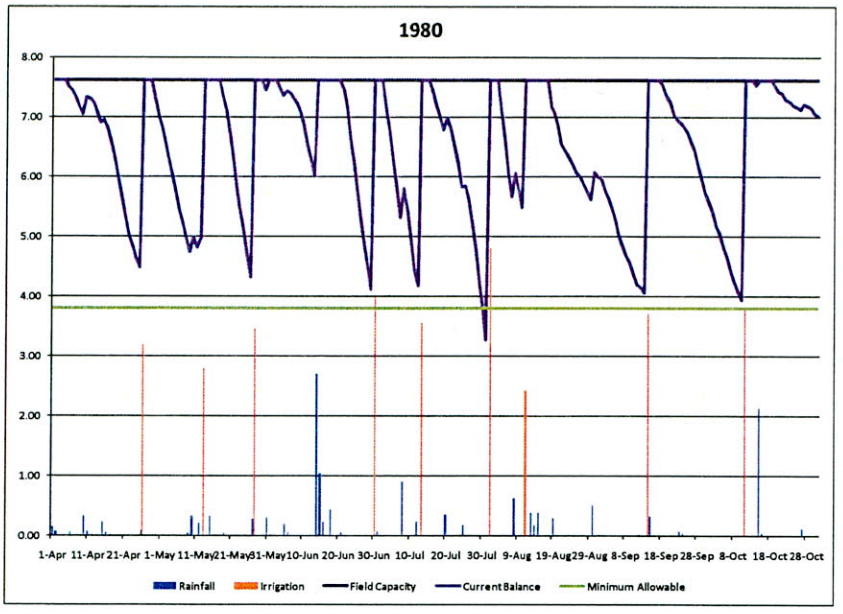

Figure A-11. Crop Water Use Calculation for Year 1980.

RSI-1948-10-018

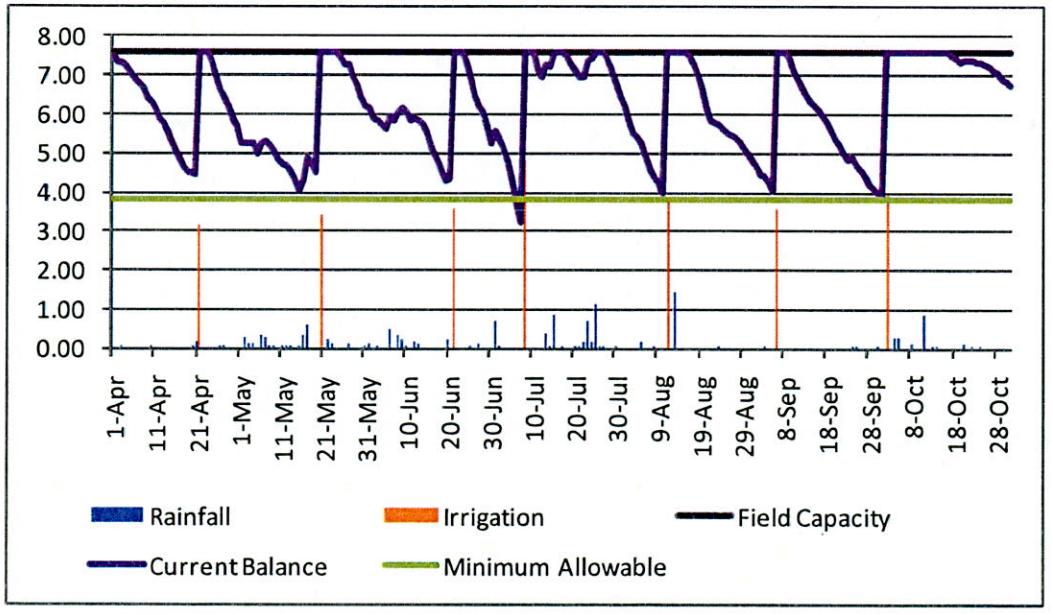

Figure A-12. Crop Water Use Calculation for Year 1981.

RSI-1948-10-019

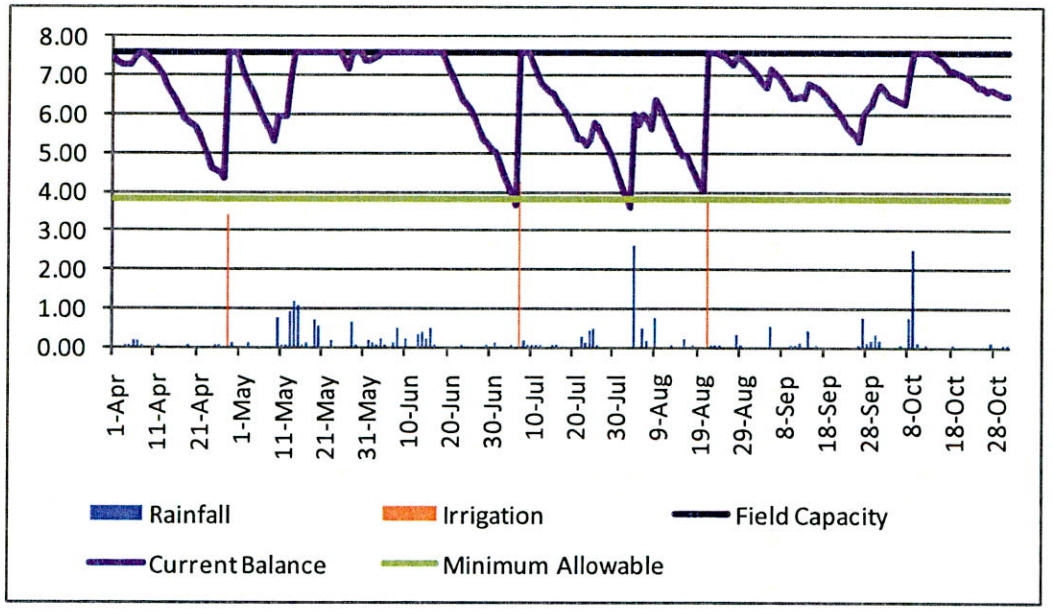

Figure A-13. Crop Water Use Calculation for Year 1982.

RSI-1948-10-020

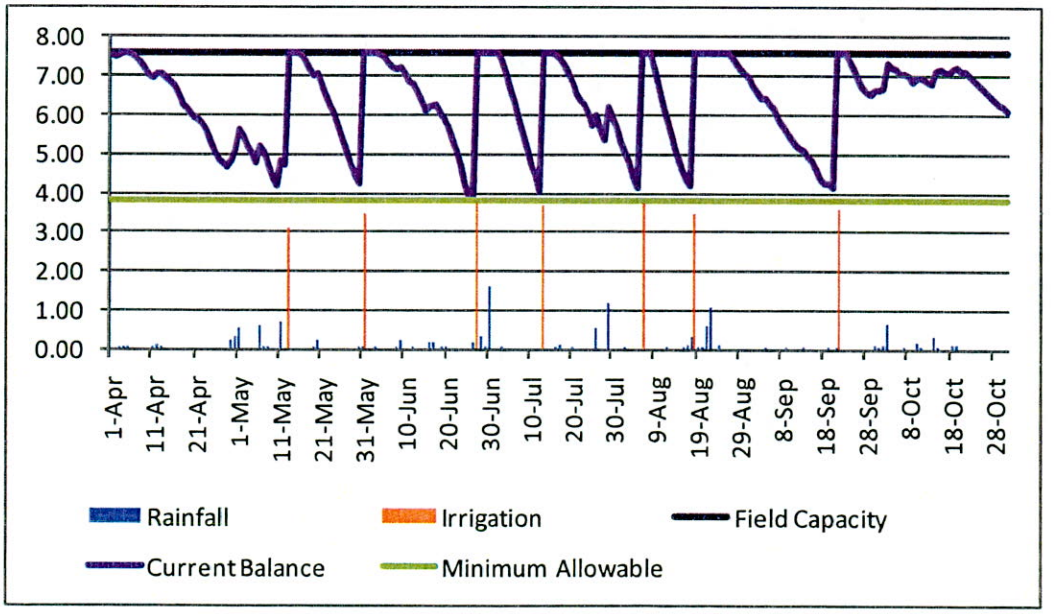

Figure A-14. Crop Water Use Calculation for Year 1983.

RSI-1948-10-021

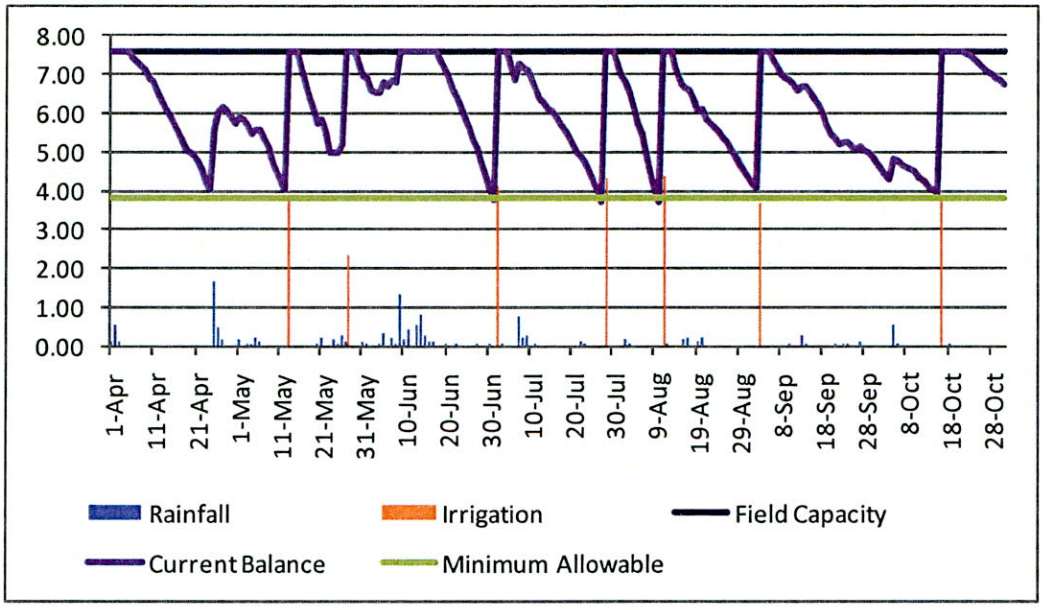

Figure A-15. Crop Water Use Calculation for Year 1984.

RSI-1948-10-022

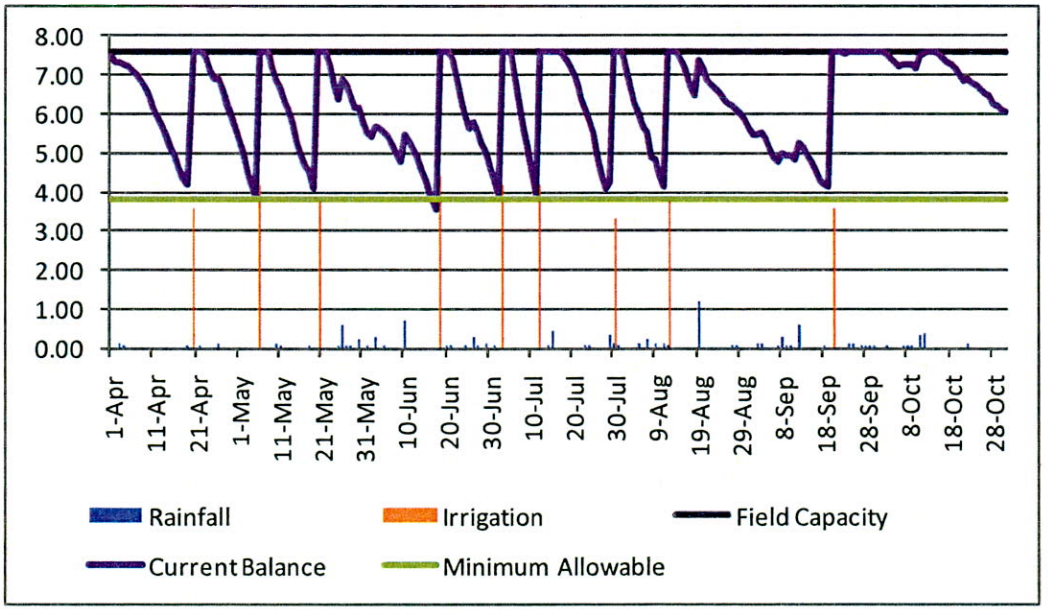

Figure A-16. Crop Water Use Calculation for Year 1985.

RSI-1948-10-023

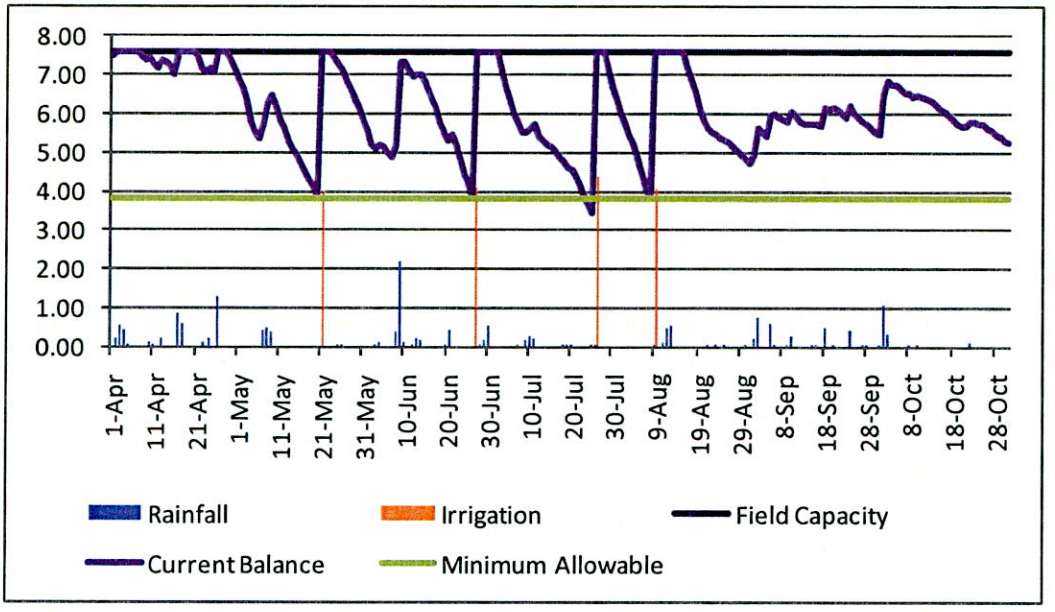

Figure A-17. Crop Water Use Calculation for Year 1986.

RSI-1948-10-024

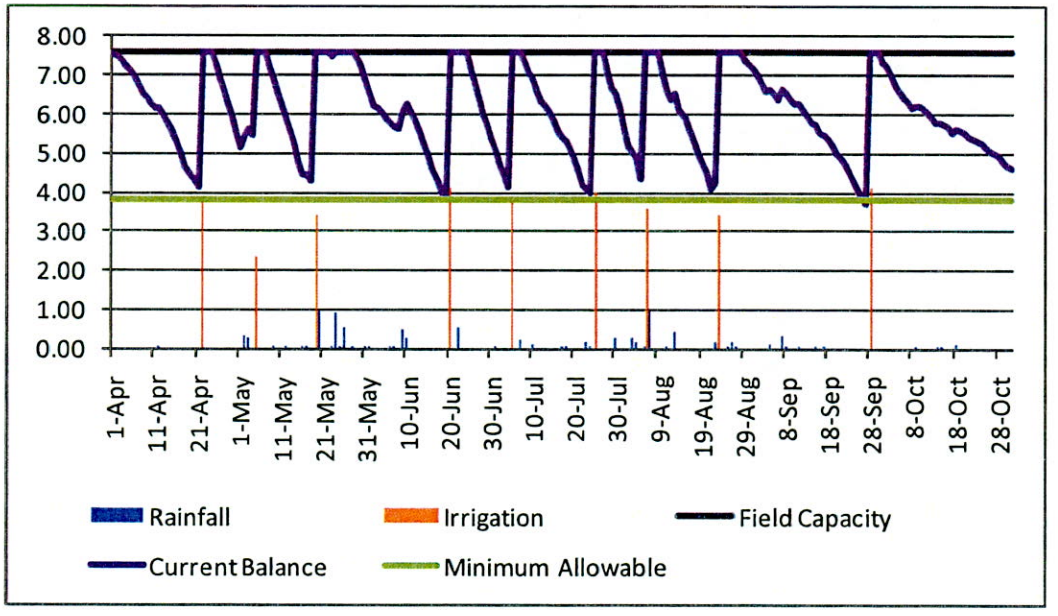

Figure A-18. Crop Water Use Calculation for Year 1987.

RSI-1948-10-025

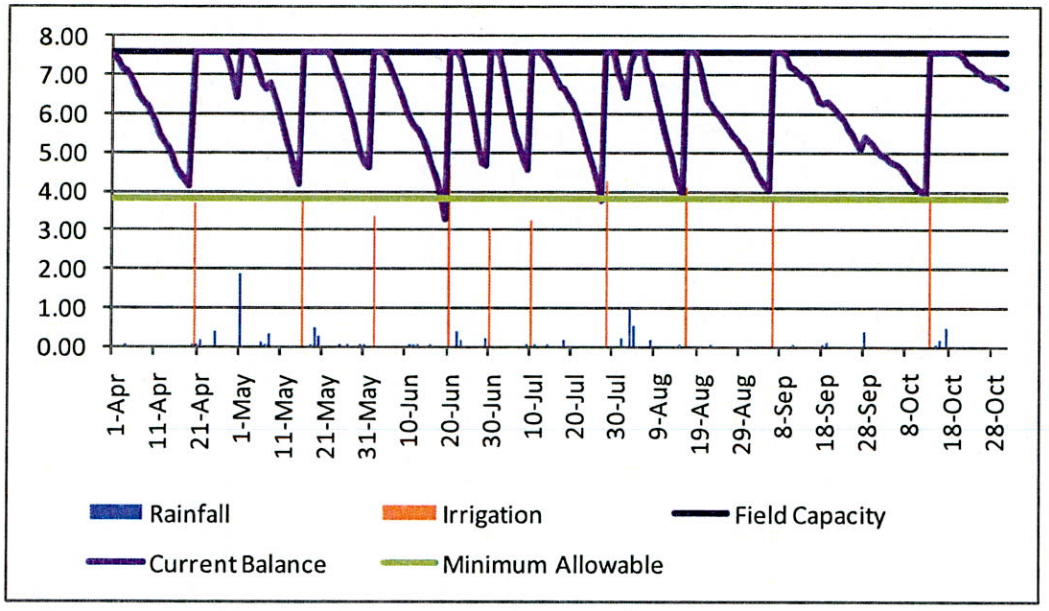

Figure A-19. Crop Water Use Calculation for Year 1988.

RSI-1948-10-026

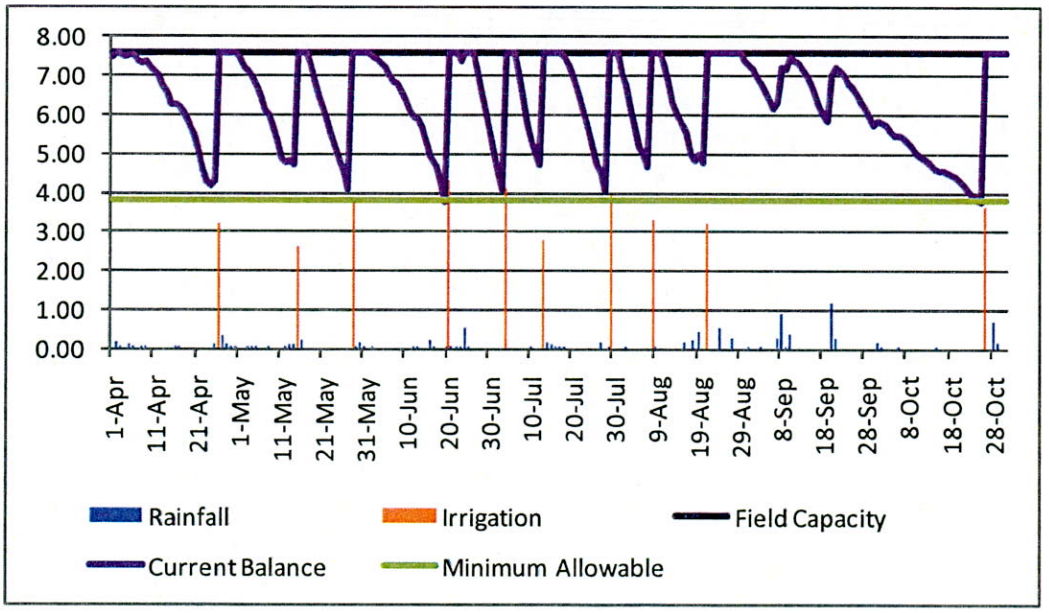

Figure A-20. Crop Water Use Calculation for Year 1989.

RSI-1948-10-027

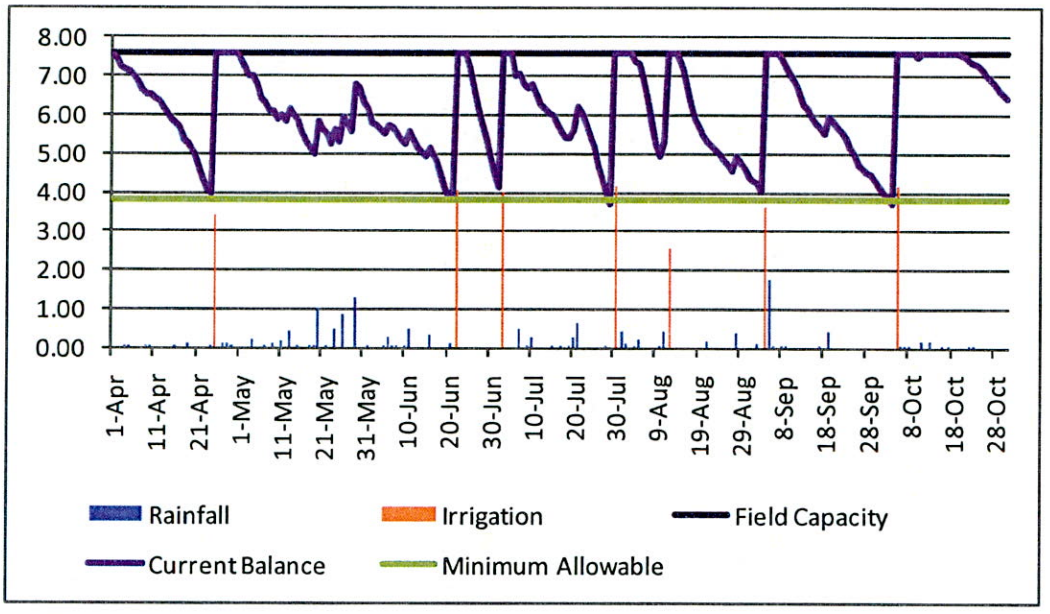

Figure A-21. Crop Water Use Calculation for Year 1990.

RSI-1948-10-028

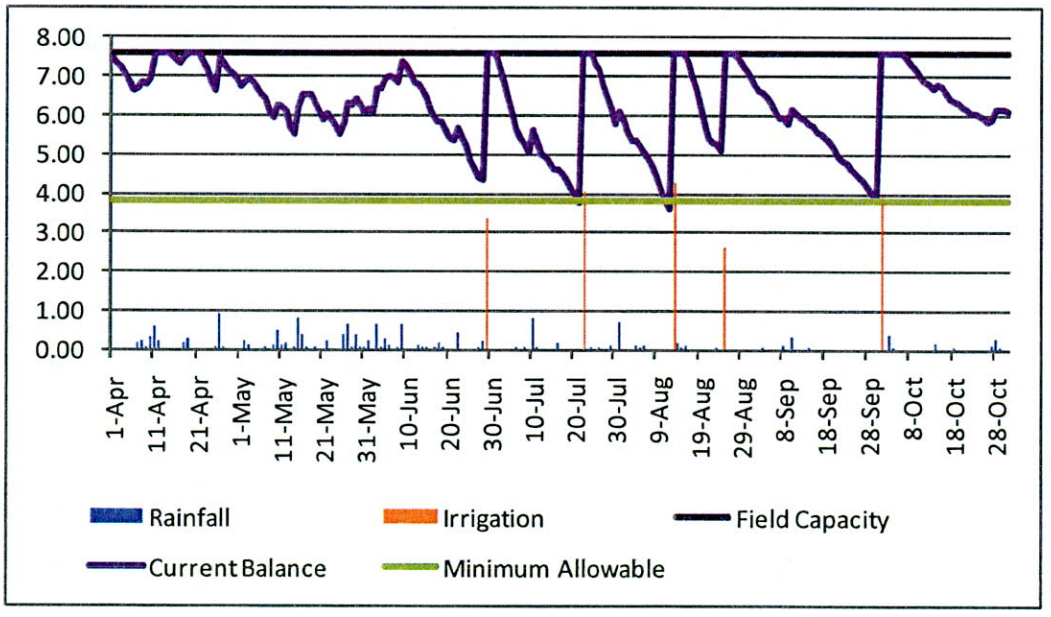

Figure A-22. Crop Water Use Calculation for Year 1991.

RSI-1948-10-029

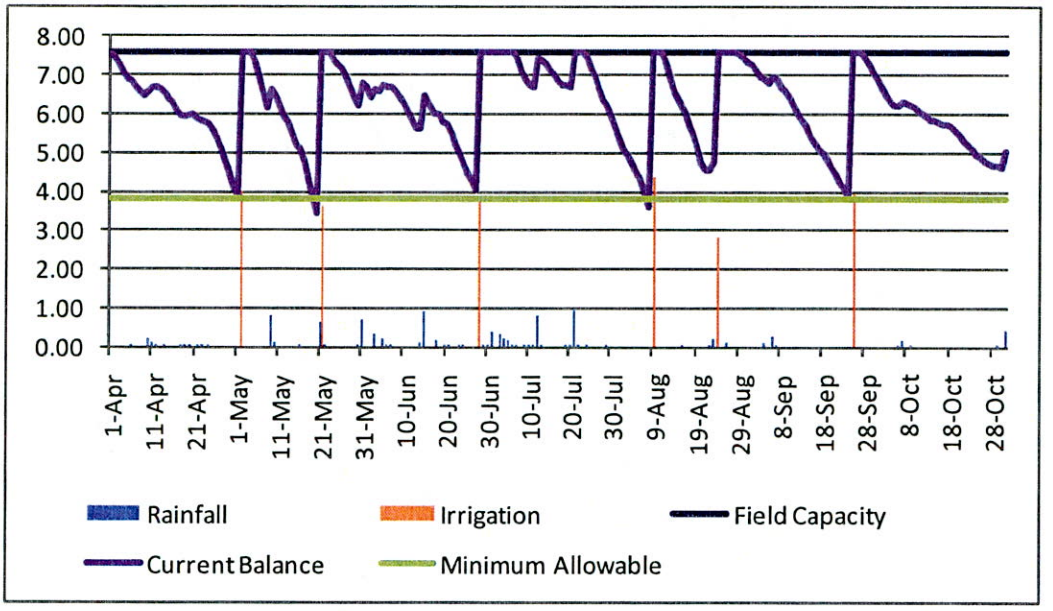

Figure A-23. Crop Water Use Calculation for Year 1992.

RSI-1948-10-030

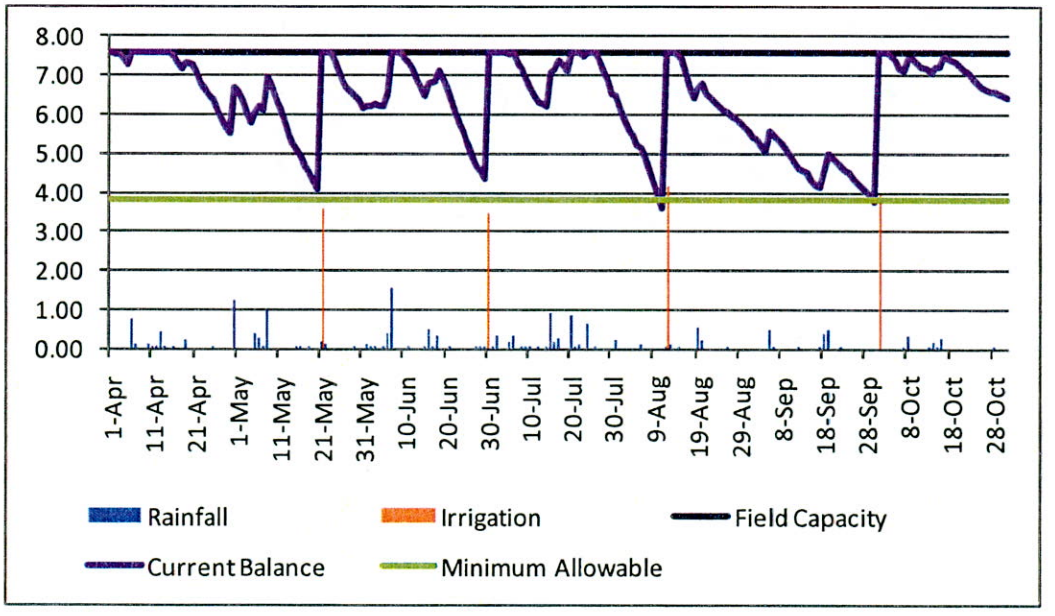

Figure A-24. Crop Water Use Calculation for Year 1993.

RSI-1948-10-031

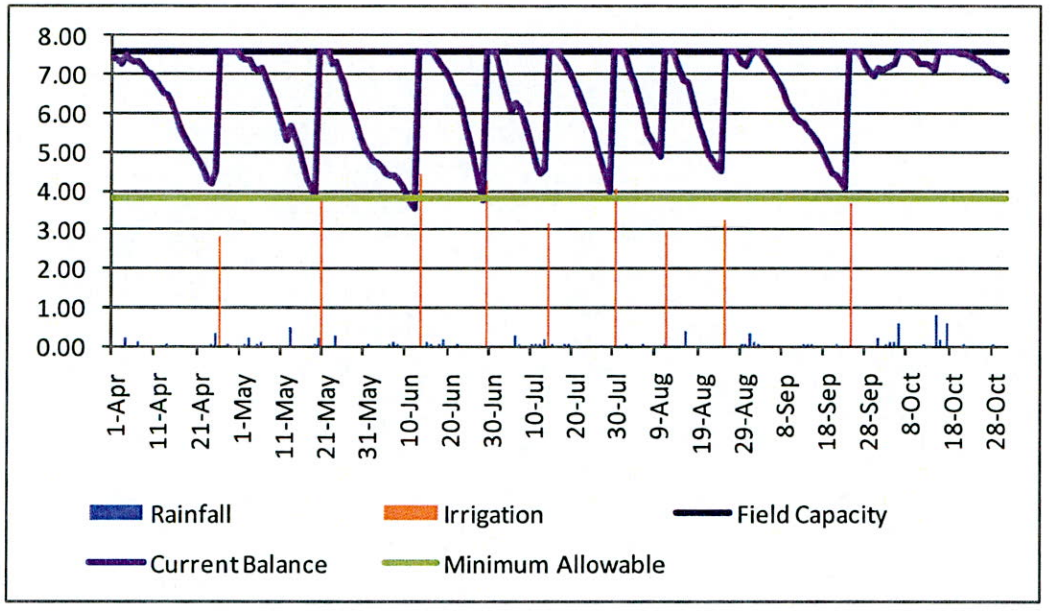

Figure A-25. Crop Water Use Calculation for Year 1994.

RSI-1948-10-032

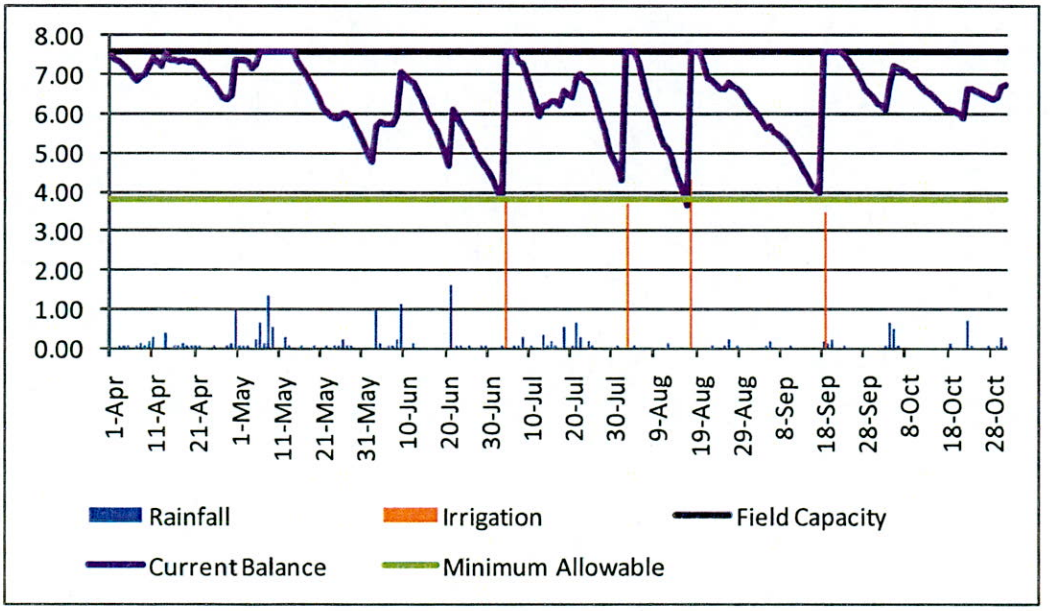

Figure A-26. Crop Water Use Calculation for Year 1995.

RSI-1948-10-033

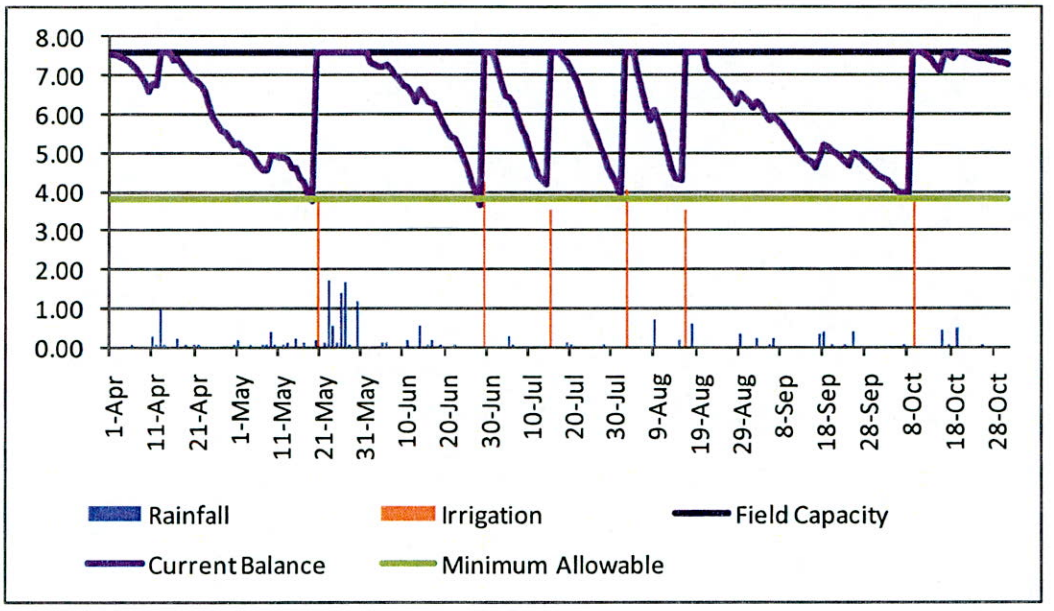

Figure A-27. Crop Water Use Calculation for Year 1996.

RSI-1948-10-034

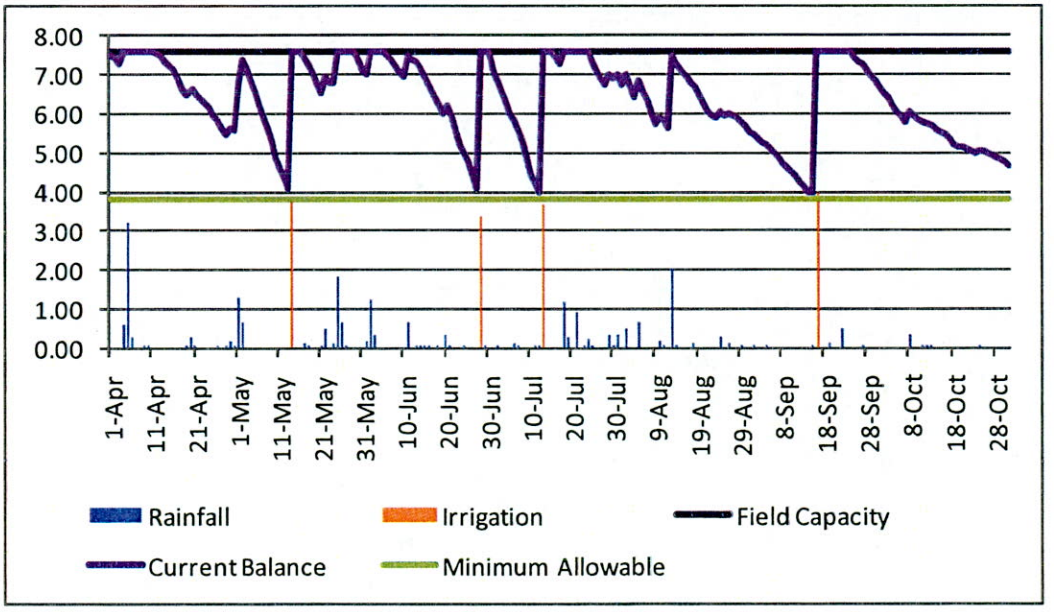

Figure A-28. Crop Water Use Calculation for Year 1997.

RSI-1948-10-035

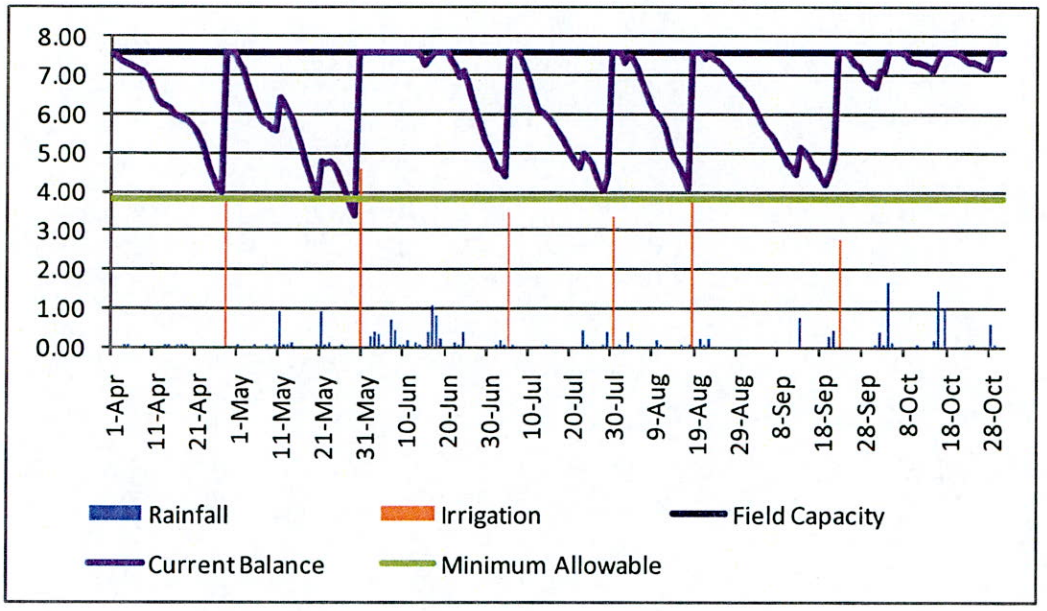

Figure A-29. Crop Water Use Calculation for Year 1998.

RSI-1948-10-036

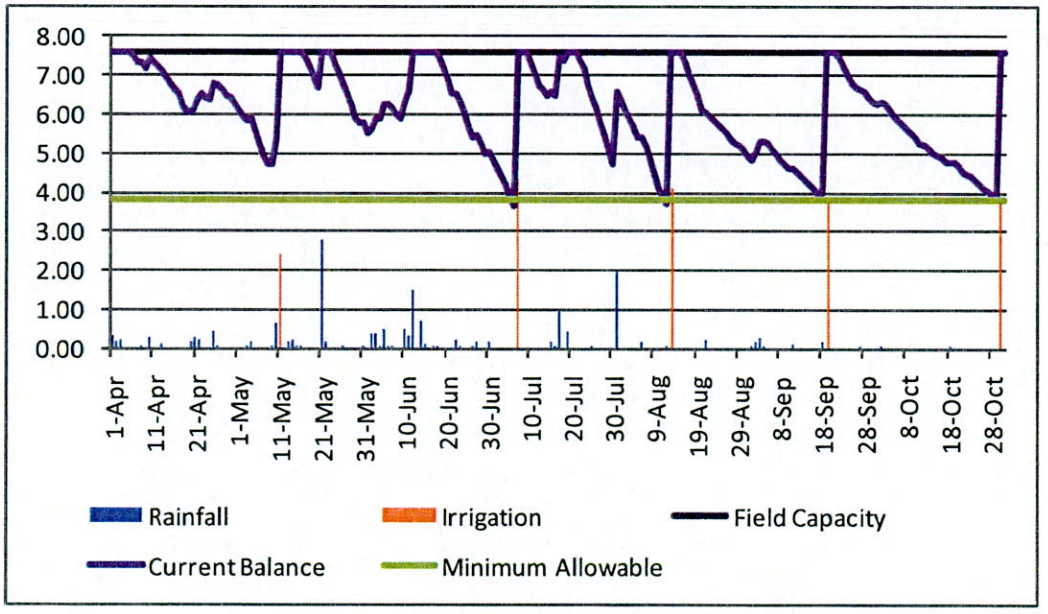

Figure A-30. Crop Water Use Calculation for Year 1999.

RSI-1948-10-037

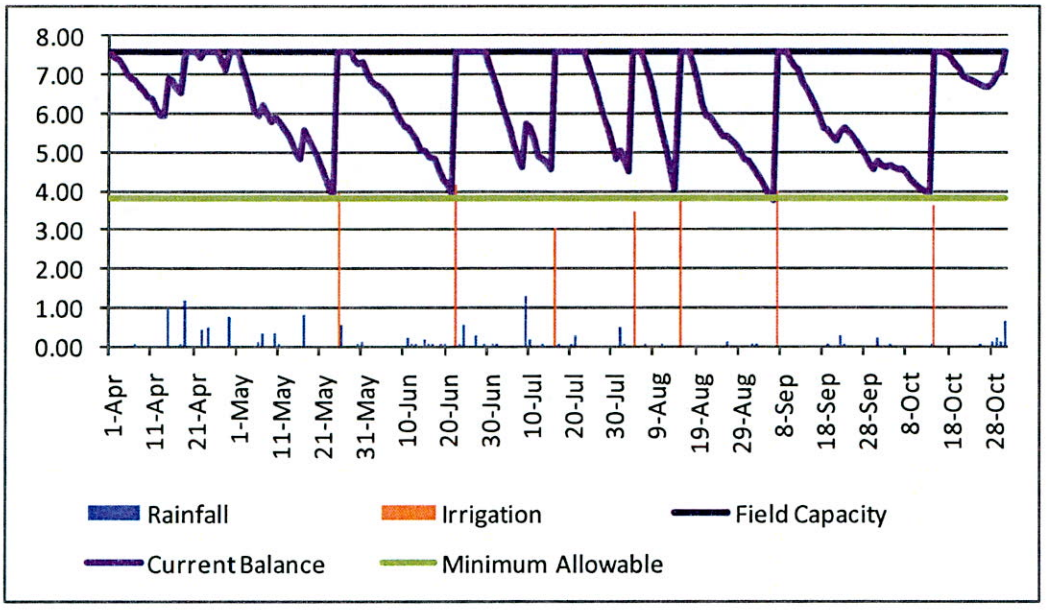

Figure A-31. Crop Water Use Calculation for Year 2000.

RSI-1948-10-038

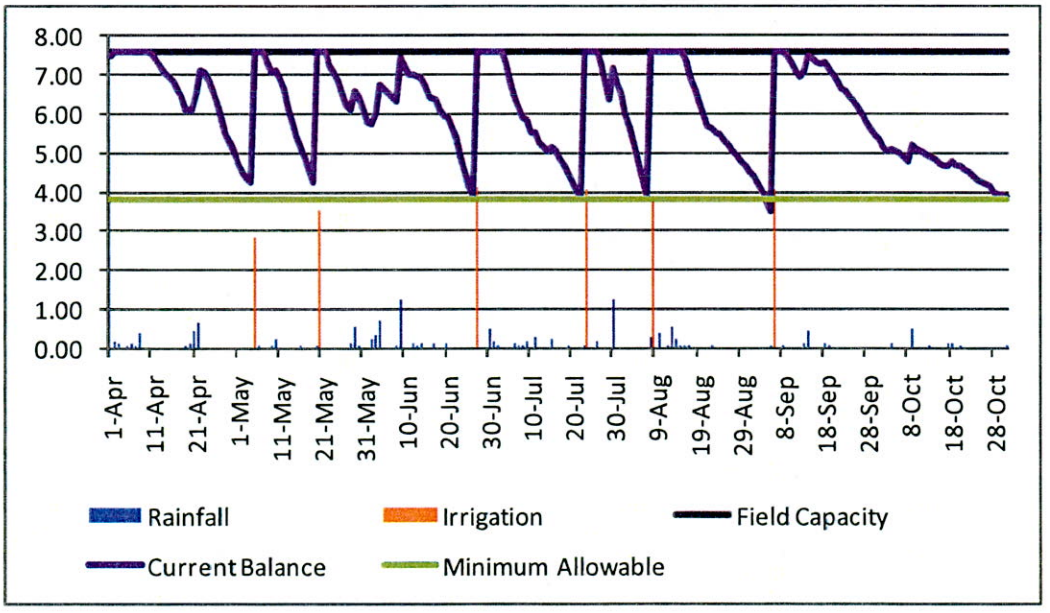

Figure A-32. Crop Water Use Calculation for Year 2001.

RSI-1948-10-039

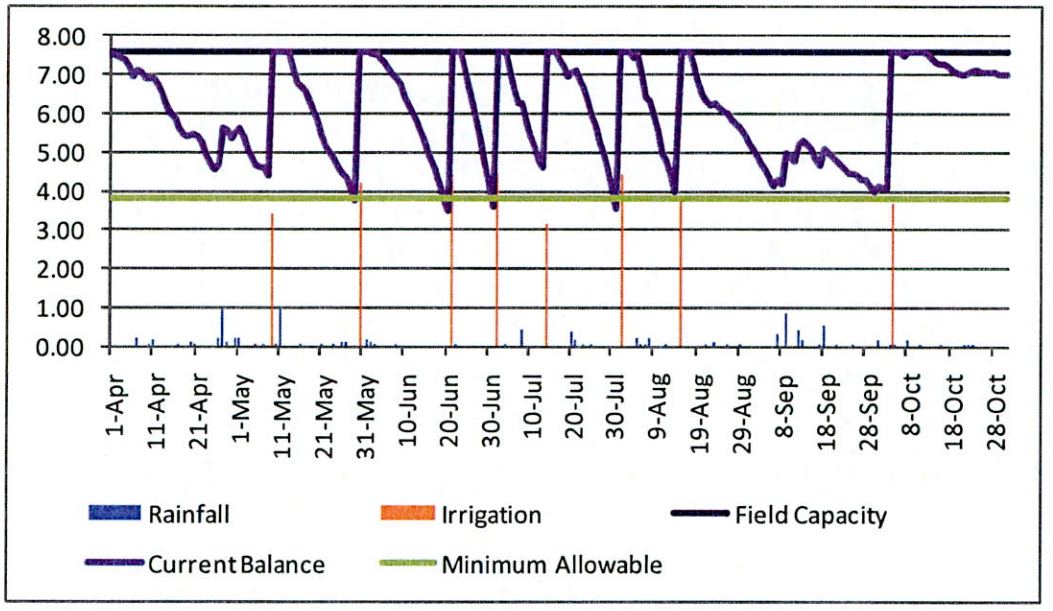

Figure A-33. Crop Water Use Calculation for Year 2002.

RSI-1948-10-040

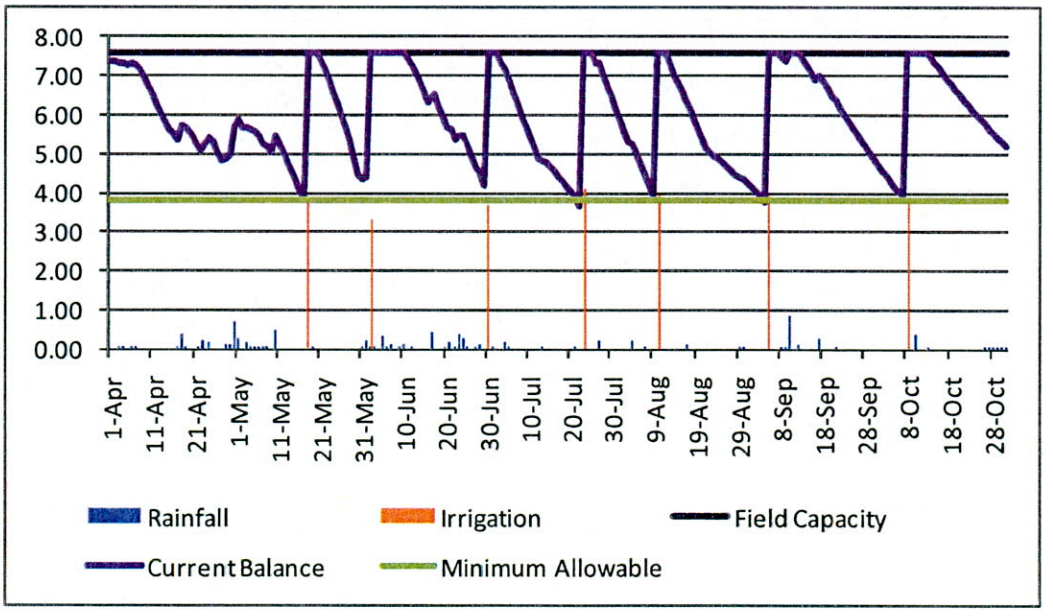

Figure A-34. Crop Water Use Calculation for Year 2003.

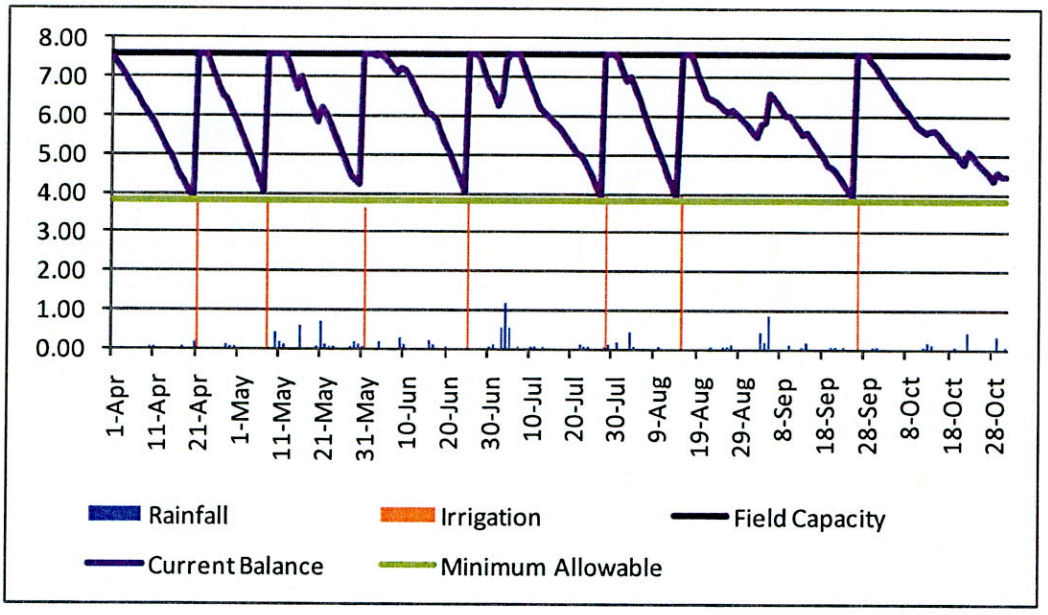

Figure A-35. Crop Water Use Calculation for Year 2004.