2011-12 Inyo County Water Department Annual Report: Soil Water Conditions

Introduction

The Water Agreement established procedures to determine which LADWP pumping wells can be operated based on soil water and vegetation measurements. As part of the monitoring effort for the Agreement, the ICWD regularly measures depth to groundwater (DTW) and soil water content at 25 sites in wellfields and eight sites in control areas. Three of the wellfield sites are not used to determine the operational status of nearby pumping wells but are monitored to continue the data record.

The purpose for the On/Off procedures is to manage pumping to protect plant communities that require periodic access to the water table for long-term survival. Generally, the sites with On-status have wet soil and shallow water tables, and sites in Off-status have dry soil and deep water tables. Because the On/Off status is a comparison soil water and predicted transpiration, it sometimes is an unreliable indicator of whether groundwater conditions are adequate or whether water table recovery is necessary. To assist the evaluation of LADWP pumping proposals, the Water Department examined the DTW and soil water data to determine whether groundwater is accessible to plants at the permanent monitoring sites at the beginning of the 2012 growing season.

How well plants can access groundwater depends on the vegetation type. In similar soils, a shallower water table is necessary to supply groundwater to grasses than shrubs because of the shallower roots of the grasses. For management purposes in the Water Agreement, shrub-dominated sites are assigned a root zone of 4 m (13.1 ft.); grass-dominated or mixed grass and shrub assemblages are assigned a root zone of 2 m (6.6 ft.). These approximate values are not the actual rooting depth at a particular monitoring site, but they are useful to compare with the soil depth that received recharge from groundwater.

Soil water in the root zone can be supplied by infiltration from the surface (rain or irrigation) or from contact with the water table. It is usually possible to discriminate deeper soil affected by groundwater from soil near the surface affected by infiltration based on the depth and timing of the measured changes in soil water content. Water content and DTW data can provide evidence of common situations where groundwater is accessible to vegetation. Plant roots can utilize groundwater directly, and if the water table is within the root zone it is reasonable to conclude that groundwater is available. A rising water table can progressively wet the root zone from below and provide water to plants. Plant roots can also tap groundwater that is drawn into the soil above the water table by capillarity where it is held in soil pores or adsorbed to soil particles. Plant uptake during the summer depletes soil water, and when transpiration ceases in the fall, water from the moist soil above the water table will replenish the drier soil in the root zone via capillarity or through inactive plant roots even if the water table is stable or declining. This is a slow process and usually provides much less soil water recharge than a rising water table.

Results

Monitoring results for available soil water, vegetation water requirement, water table depth, and the On/Off status for all sites are presented in the figures contained in Appendix A. At the beginning of the 2011-12 runoff year, sixteen sites were in On status. Eight sites remained in On-status throughout the runoff year. Sites IO2 and SS2 went into Off status in July; sites L3, TA3, TA4, TA6, TS4, and SS3 went into Off status in October. No sites went into On status during the winter 2011-12. The eight sites in On status as of April, 2012 were L2, BP3, BP4, TA5, TS2, TS3, SS1, and BG2.

Hydrographs for the permanent monitoring sites are presented in Appendix A, and the minimum (shallowest) DTW measured during the fall and winter preceding the 2011 and 2012 growing seasons are presented in Table 1. The minimum DTW is a useful measurement because it is associated with the amount of groundwater recharge in the root zone before vegetation measurements are made. At most sites, the minimum DTW occurs in the spring. At sites BP1, 2, and 3 in Big Pine, the water table rises during the summer and reaches a minimum in the fall coinciding with the timing of diversions into the Big Pine canal for irrigation. For these three sites, the amount and depth of soil water recharge during the winter are related to the minimum water table depth in the fall.

Compared to 2011, minimum DTW in 2012 was shallower at 12 wellfield sites and deeper at 12 sites. Minimum DTW was unchanged at one wellfield site. Notable changes greater than 0.3 m (1 ft) were water table increases at BP1, TS1, and TS3 and declines at BP4, IO2, SS1, and SS2. Interestingly, the water table declined at all control sites despite the much above normal runoff in 2011-12. The control sites responded to the heavy rains during the winter of 2010-11, but this year the seasonal fluctuations were more similar to long term trends resulting in small declines from last year's peak water level. Control sites IC1 and BC3 were exceptions to this explanation. A leaky artesian well near IC1 was capped, and the water was diverted away from the site to supply a new mitigation project. The water table is still above one meter and any effects to vegetation should be local. The cause of the rather large decline at BC3 is unknown. Since 1989, the water table rose each winter, but that did not occur in 2011-12.

The monitoring sites were grouped into simple categories to summarize the connection between soil water in the root zone and the water table (Figure 1). Brief descriptions of the three categories and the results are given below:

1. Connected: Water table fluctuations resulted in soil water recharge in the top half of the root zone at most monitoring locations within a site. Seven wellfield and five control sites were placed in this category.

2. Partially connected: Water table fluctuations resulted in soil water recharge in the bottom half of the root zone at most monitoring locations within a site. Seven wellfield and three control sites occur in this category. The control sites and TS6, SS3, and BG2 have ample soil water stored in the soil profile.

3. Disconnected: No recharge from groundwater occured in the root zone. Eleven wellfield sites occur in this category. Sites L2, SS1, and TA5 had retained soil water available to plants,

but the water table at the beginning of the 2011 growing season is too deep to recharge the root zone. Soil at the other sites is dry.

At most sites it was possible to discriminate groundwater recharge from surface infiltration because of the relatively dry winter (Table 2). Infiltration and groundwater recharge overlapped at sites BC2, BC3, IC1, TS3, TS4 and IO1, all sites with a shallow water table. Even at these sites, it was possible to identify which depths were affected by groundwater before the first significant rain in January to permit classification. All of the control sites were in the connected or partially connected categories. At the beginning of the 2012 growing season, the water table was capable of supplying water to the root zone at 14 monitoring sites located in wellfields (Figure 1), one site less than in 2011. Sites BP4, TA4, and SS1 were classified in a drier category than last year. Sites BP1 and TS3 were placed in a wetter category than last year. Four sites in the disconnected category still retain soil water following water table decline (L2, BP4, SS1) or because the plant cover is low and the soil is always moist (TA5). The remaining seven sites have dry soil throughout the root zone. As in previous years, interpretations for two sites, TA5 and BG2 were difficult. Soil at these sites was moist at lower depths but relatively unchanging. Plant uptake during the summer was not evident below two meters, and soil water recovery when plant uptake ceased in the fall or related to water table fluctuations was not evident. Both sites had relatively stable DTW and low plant cover. DTW at BG2 is just below 4m (Table 2) and the capillary fringe probably intersects the root zone. The site was classified as weakly connected. The DTW at TA5 is much below the 2m root zone, and the site was classified as disconnected. The classification at both sites is unchanged from 2011.

Table 1. Minimum DTW during the fall and winter preceding the growing seasons in 2011 and 2012. Hydrographs for the sites are provided in Appendix A. Depths are below ground surface.

Site	2011 DTW	2012 DTW	DTW Change 2010-11†
	(m)	(m)	(m)
L1	7.00	7.09	-0.09
L2	6.89	7.05	-0.16
L3	4.93	4.80	0.13
BC1	2.87	3.02	-0.15
BC2	4.17	4.34	-0.17
BC3	1.62	2.43	-0.81
BP1	4.03	3.48	0.55
BP2	5.53	5.31	0.22
BP3	3.99	4.14	-0.15
BP4	4.70	5.15	-0.45
TA1 &2	1.96	1.80	0.16
TA3	5.41	5.23	0.18
TA4	2.53	2.61	-0.08
TA5	4.00	4.05	-0.05
TA6	3.85	3.64	0.21
TAC	0.96	1.23	-0.27
TS1	5.84	5.15	0.69
TS2	3.81	3.66	0.15
TS3	2.18	1.33	0.85
TS4	2.08	2.17	-0.09
TS6	2.98	2.86	0.12
TSC	0.95	1.12	-0.18
IO1	2.62	2.38	0.24
IO2	6.90	8.61	-1.71
IC1	0.63	0.84	-0.21
IC2	2.12	2.35	-0.13
SS1	4.15	5.08	-0.93
SS2	6.98	7.74	-0.76
SS3	3.83	4.04	-0.21
SS4	6.00	6.00	0.0
BG2	4.45	4.58	-0.13
BGC	2.07	2.32	-0.25

†: positive values denote a rise in the water table.

Table 2. Soil depth below ground surface replenished by groundwater in 2011-2012 at control sites. Values are provided for each monitoring location within a site. DTW was measured in the associated test well, and the values do no account for elevation differences between the well and monitoring site.

Site	Dominant plant species	Root Zone	Minimum DTW	Groundwater recharge depth
		(m)	(m)	(m)
BC1	rabbitbrush, saltbush, greasewood, alk. sacaton	4	3.02	2.7, 1.1, 2.5
BC2	rabbitbrush, saltgrass	2	4.34	<2.0 at all four locations †
BC3	rabbitbrush, saltgrass, saltbush	2	2.43	<1.3, <1.3, <1.1
TAC	saltbush, rye grass, saltgrass, alk. sacaton	2	1.23	1.1, 0.5, 0.9, 0.9
TSC	alk. sacaton, rabbitbrush, greasewood.	2	1.12	1.1, 0.7, 0.9
IC1	saltbush, saltgrass, rabbitbrush	2	0.84	<0.9, <0.9, <1.1
IC2	rabbitbrush, alk. sacaton	2	2.35	1.9, 1.3, 1.8
BGC	saltbush, saltgrass	4	2.32	0.7, 1.1, 1.7

†: Less than symbols (<) denote locations where both infiltration and groundwater recharge contribute to increasing soil water content above the depth indicated.

Table 3. Soil depth below ground surface replenished by groundwater in 2011-2012 at wellfield sites. Values are provided for each monitoring location within a site. Values are not provided if the identification of a specific depth was uncertain. DTW was measured in the associated test well, and the values do no account for elevation differences between the well and monitoring site.

Site	Dominant plant species	Root Zone	Minimum DTW	Groundwater recharge depth
		(m)	(m)	(m)
L1	Greasewood	4	7.09	>3.9, >3.9, 3.9
L2	alk. sacaton, greasewood, saltbush	2	7.05	>3.9 at all five locations
L3	alk. sacaton, saltgrass	2	4.80	0.9, 1.5, 1.1, 0.7, 0.9, 1.1
BP1	saltbush, greasewood	3	3.48	2.5, 1.1, 1.1, 1.5, 1.5
BP2	saltbush, rabbitbrush	4	5.31	3.7, 3.7, 3.7
BP3	greasewood, rabbitbrush	4	4.14	3.5, 3.1, 3.1
BP4	saltbush, greasewood	4	5.15	1.9, >3.9, >3.9
TA1	alk. sacaton, saltbush	2	1.80	0.9
TA2	alk. sacaton, saltbush, greasewood, rabbitbrush	2		0.9
TA3	saltbush, alk. sacaton, sagebrush	2	5.23	>3.9, >3.9, 2.5†
TA4	rabbitbrush, alk. sacaton	2	2.61	1.7, 1.1
TA5	greasewood, alk. sacaton	2	4.05	
TA6	saltbush, rabbitbrush	2	3.64	2.9, 2.7, 2.7
TS1	weeds, alk. sacaton	2	5.15	>3.9, 3.5, 3.7, 3.1, 2.9
TS2	sagebrush, saltbush, alk. sacaton	2	3.66	2.5, 2.3, 2.9
TS3	saltgrass, alk. sacaton	2	1.33	<0.9, <0.5, <0.5, <0.9, <1.1, <0.9
TS4	greasewood, alk. sacaton, saltbush, saltgrass	2	2.17	<1.0, 1.1, 0.9, 1.1
TS6	alk. sacaton, saltbush, saltgrass	2	2.86	1.3
IO1	rabbitbrush, alk. sacaton, saltbush	2	2.38	<0.9, 0.3, 0.7
IO2	Saltbush	4	8.61	>4.5, >3.9, >3.9
SS1	saltbush, greasewood	4	5.08	>5.5, >3.9, >3.9
SS2	Saltbush	4	7.74	4.7, >3.9, >3.9
SS3	Saltbush	4	4.04	2.3, 2.1, 1.9
SS4	Saltbush	4	6.00	2.3, >3.9, 2.7†
BG2	inkweed, saltbush	4	4.47	

†: Soil water content at these depths increases slightly during winter but deeper soil remains approximately constant suggesting that the recharge mechanism is not simple capillary rise above the water table.

††: Less than symbols (<) denote locations where both infiltration and groundwater recharge contribute to increasing soil water content above the depth indicated.

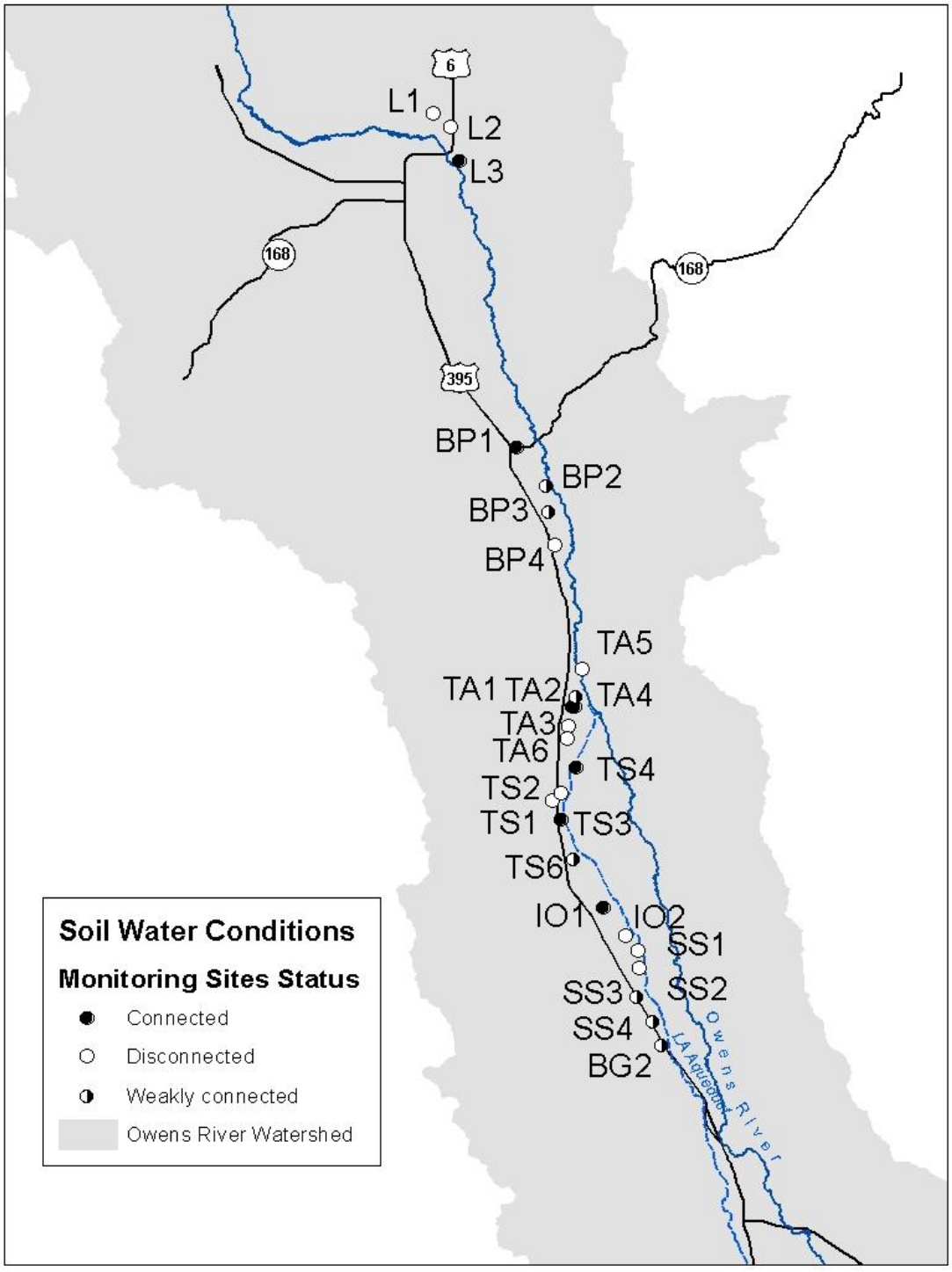


Figure 1. Owens Valley permanent wellfield monitoring sites and groundwater recharge classes.

Appendix A. Soil-plant water balance and groundwater data and July 1 and October 1 On/Off calculation tables for the permanent monitoring sites.

June 2011 monitoring site status and July 1, 2011 soil/vegetation water balance calculations according to Green Book, Section III.

Site	June, 2011 Status	July, 2011 Veg. Water Req./ Soil AWC for turn-on	July 2011 soil AWC	July 2011Status	Soil AWC required. for well turn-on
		(cm)	(cm)		(cm)
L1	OFF	8.1/15.6	7.2	OFF	15.6, OFF 7-10
L2	ON	6.7/NA	28.1	ON	NA
L3	ON	13.7/NA	13.9	ON	NA
BP1	OFF	11.6/22.9	8.2	OFF	22.9†, OFF 10-97
BP2	OFF	15.0/28.4	5.6	OFF	28.4, OFF 7-98
BP3	ON	9.2/NA	16.2	ON	NA
BP4	ON	8.9/NA	63.8	ON	NA
TA3	ON	13.8/NA	16.9	ON	NA
TA4	ON	12.4/NA	16.9	ON	NA
TA5	ON	4.8/NA	26.9	ON	NA
TA6	ON	9.4/NA	17.1	ON	NA
TS1	OFF	4.4/20.4	6.6	OFF	20.4†, OFF 10-96
TS2	ON	7.5/NA	14.1	ON	NA
TS3	ON	16.5/NA	25.1	ON	NA
TS4	ON	30.9/NA	43.9	ON	NA
IO1	OFF	30.0/42.2	37.1	OFF	42.2, OFF 10-98
IO2	ON	10.1/NA	8.0	OFF	18.9, OFF 7-11
SS1	ON	15.0/NA	38.3	ON	NA
SS2	ON	13.8/NA	4.8	OFF	25.6, OFF 7-11
SS3	ON	18.1/NA	28.4	ON	NA
SS4	OFF	12.3/15.9	6.3	OFF	15.9, OFF 7-05
BG2	ON	11.6/NA	31.9	ON	NA

†: These values of soil water required for well turn-on were derived using calculations based on % cover that were routinely performed in the past. The values have not been updated to conform to the Green Book equations in section III.D.2, p. 57-59.

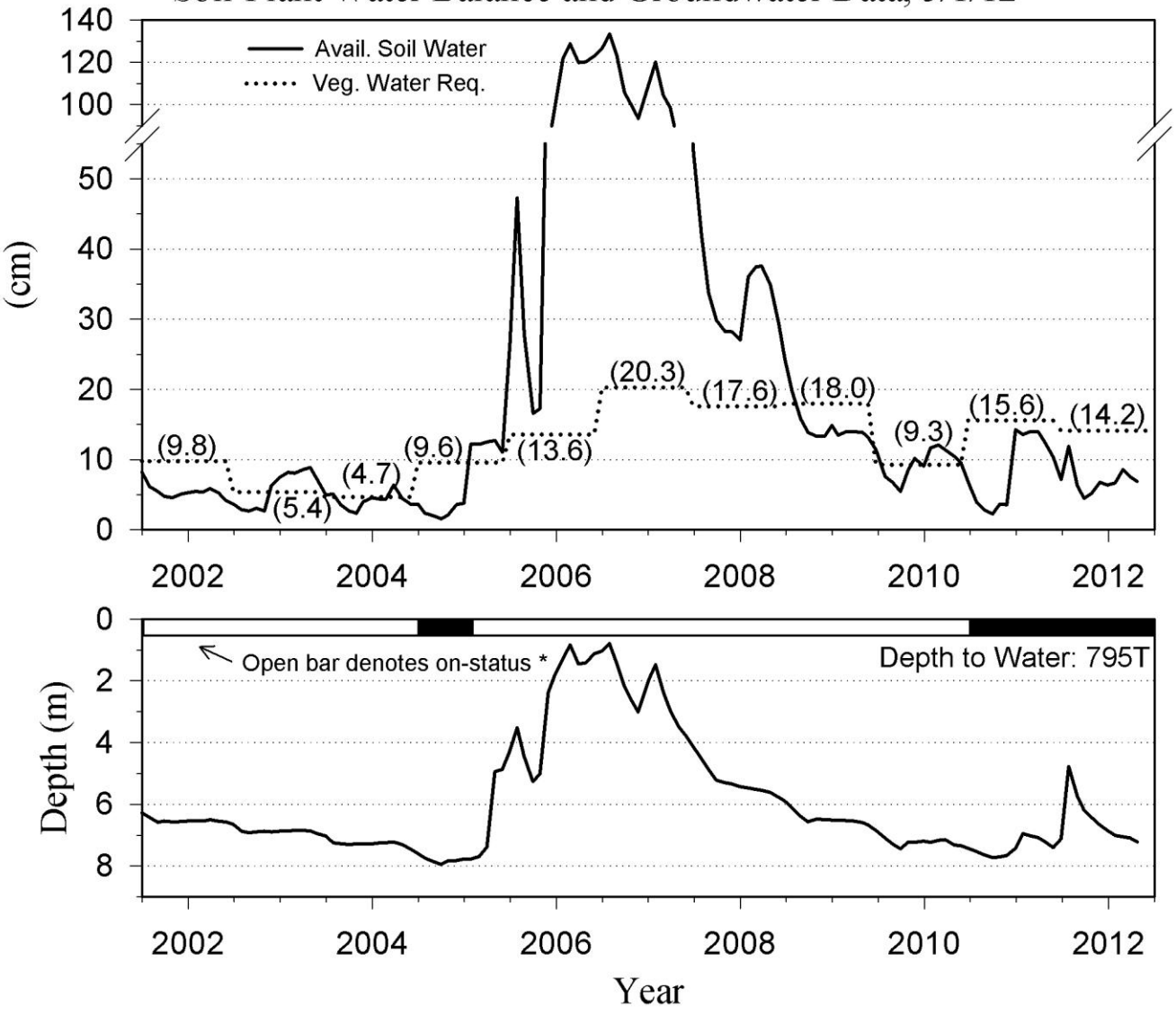
Monitoring site status and soil/vegetation water balance calculations for October 1, 2011 according to Green Book, Section III.

Site	July 1, 2011 Status	October, 2011 Veg. Water Req./Soil AWC for turn-on	October 2011 soil AWC	+50% annual ppt.	October 1 2011 Status	Soil AWC req. for well turn-on
		(cm)	(cm)	(cm)		(cm)
L1	OFF	14.2/15.6	4.5	NA	OFF	15.6, OFF 7-10
L2	ON	12.1/NA	23.4	23.4 + 7.9 = 31.3	ON	NA
L3	ON	25.2/NA	7.4	7.4 + 7.9 = 15.3	OFF	25.2, OFF 10-11
BP1	OFF	21.3/22.9	10.3	NA	OFF	22.9†, OFF 10-97
BP2	OFF	27.7/28.4	2.2	NA	OFF	28.4, OFF 7-98
BP3	ON	16.4/NA	15.2	15.2 + 7.6 = 22.8	ON	NA
BP4	ON	16.0/NA	58.2	58.2 + 8.2 = 66.4	ON	NA
TA3	ON	26.0/NA	9.8	9.8 + 7.3 = 17.1	OFF	26.0, OFF 10-11
TA4	ON	23.3/NA	15.1	15.1 + 7.3 = 22.4	OFF	23.3, OFF 10-11
TA5	ON	8.8/NA	22.6	22.6 + 8.2 = 30.8	ON	NA
TA6	ON	17.6/NA	10.2	10.2 + 7.3 = 17.5	OFF	17.6, OFF 10-11
TS1	OFF	8.2/20.4	1.6	NA	OFF	20.4†, OFF 10-96
TS2	ON	13.8/NA	8.7	8.7 + 7.3 = 16.0	ON	NA
TS3	ON	30.3/NA	25.1	25.1 + 7.3 = 32.4	ON	NA
TS4	ON	55.9/NA	35.5	35.5 + 7.3 = 42.8	OFF	55.9, OFF 10-11
IO1	OFF	55.9/42.2	30.9	NA	OFF	42.2, OFF 10-98
IO2	OFF	18.9/18.9	5.0	NA	OFF	18.9, OFF 7-11
SS1	ON	27.2/NA	34.1	34.1 + 6.5 = 40.6	ON	NA
SS2	OFF	25.6/25.6	4.0	NA	OFF	25.6, OFF 7-11
SS3	ON	33.8/NA	23.4	23.4 + 6.5 = 29.9	OFF	33.8, OFF 10-11
SS4	OFF	23.0/15.9	3.4	NA	OFF	15.9, OFF 7-05
BG2	ON	21.3/NA	30.2	30.2 + 6.6 = 36.8	ON	NA

†: These values of soil water required for well turn-on were derived using calculations based on percent cover that were routinely performed in the past. The values have not been updated to conform with the Greenbook equations in section III.D.2, p. 57-59.

LAWS MONITORING SITE #1

Soil-Plant Water Balance and Groundwater Data, 5/1/12



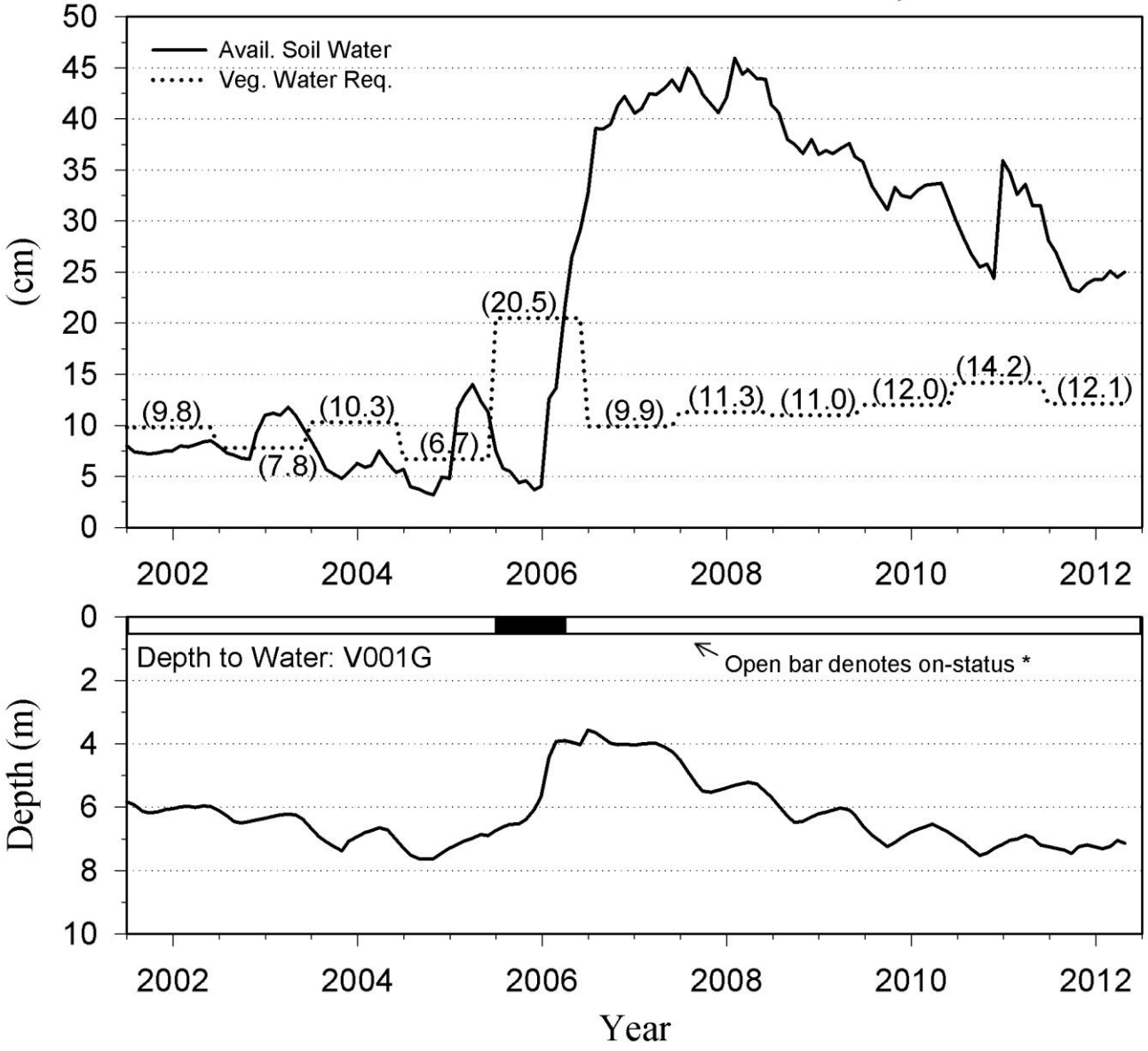
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping wells- 247, 248, 249, 398

Soil water required for turn on (15.6 cm)

LAWS MONITORING SITE #2

Soil-Plant Water Balance and Groundwater Data, 5/1/12



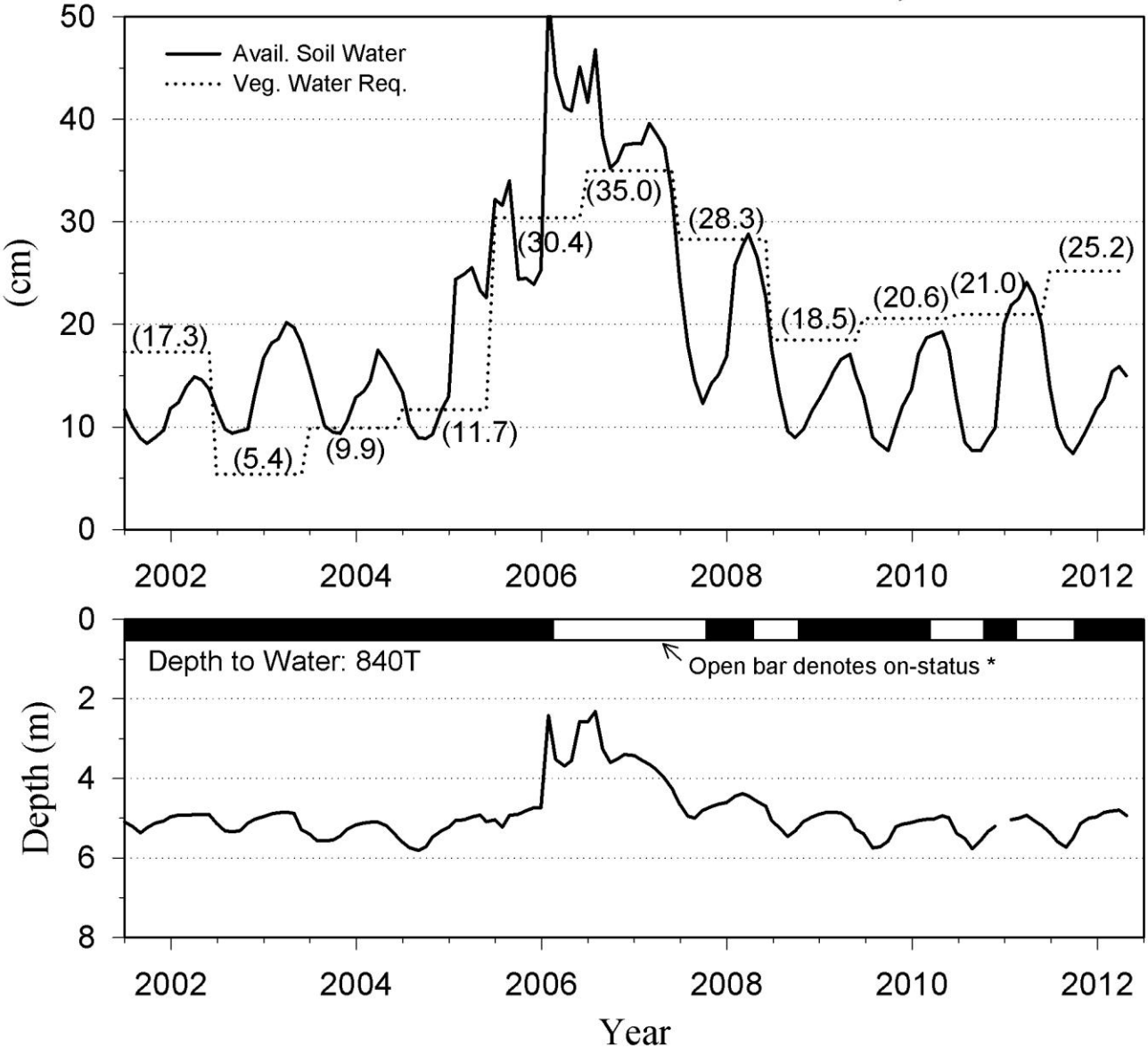
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping wells - 236, 239, 243, 244

Soil water required for turn on (--)

LAWS MONITORING SITE #3

Soil-Plant Water Balance and Groundwater Data, 5/1/12



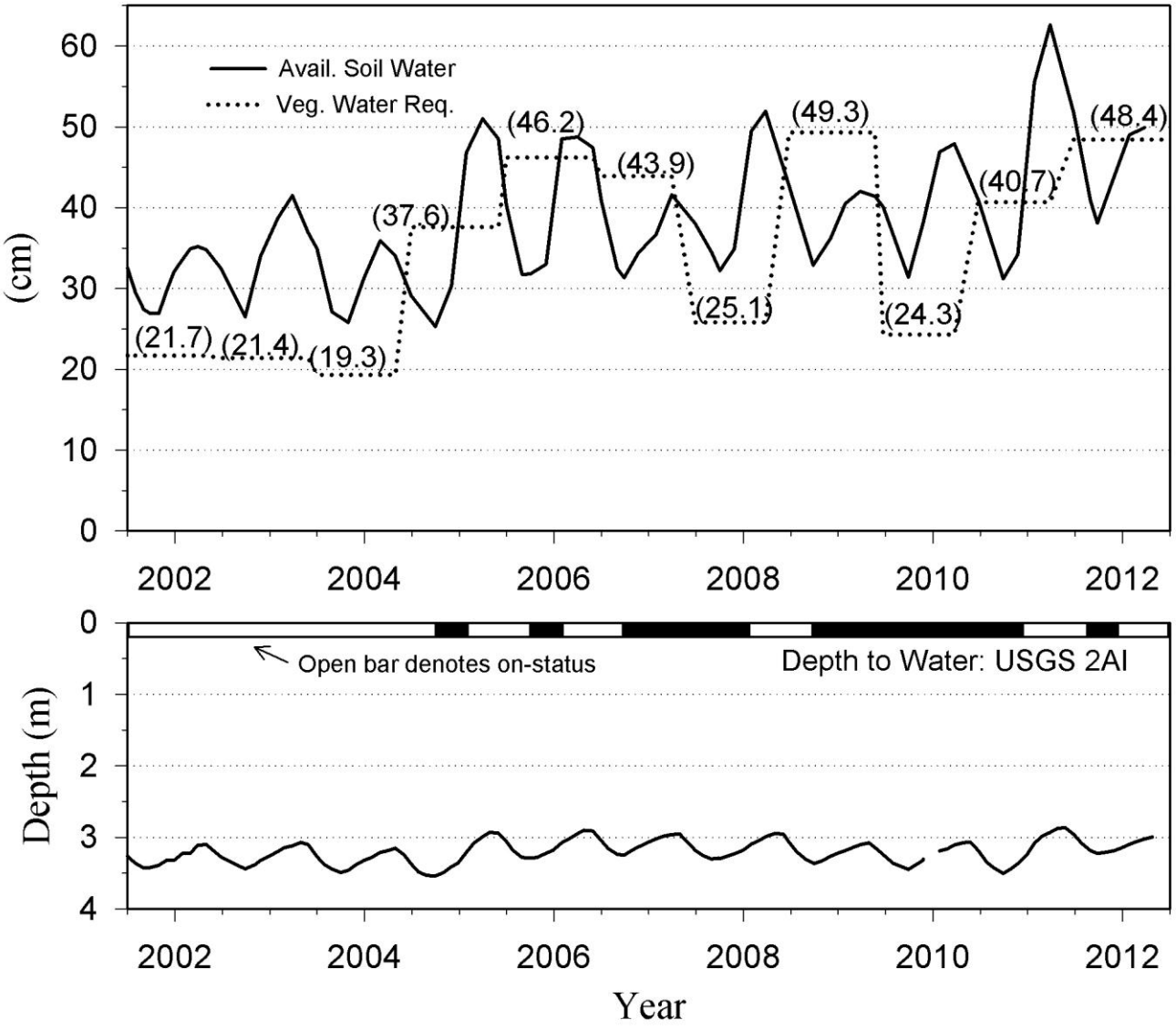
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping wells - 240, 241, 399, 376, 377

Soil water required for turn on (25.2 cm)

BISHOP CONTROL SITE #1

Soil-Plant Water Balance and Groundwater Data, 5/1/12

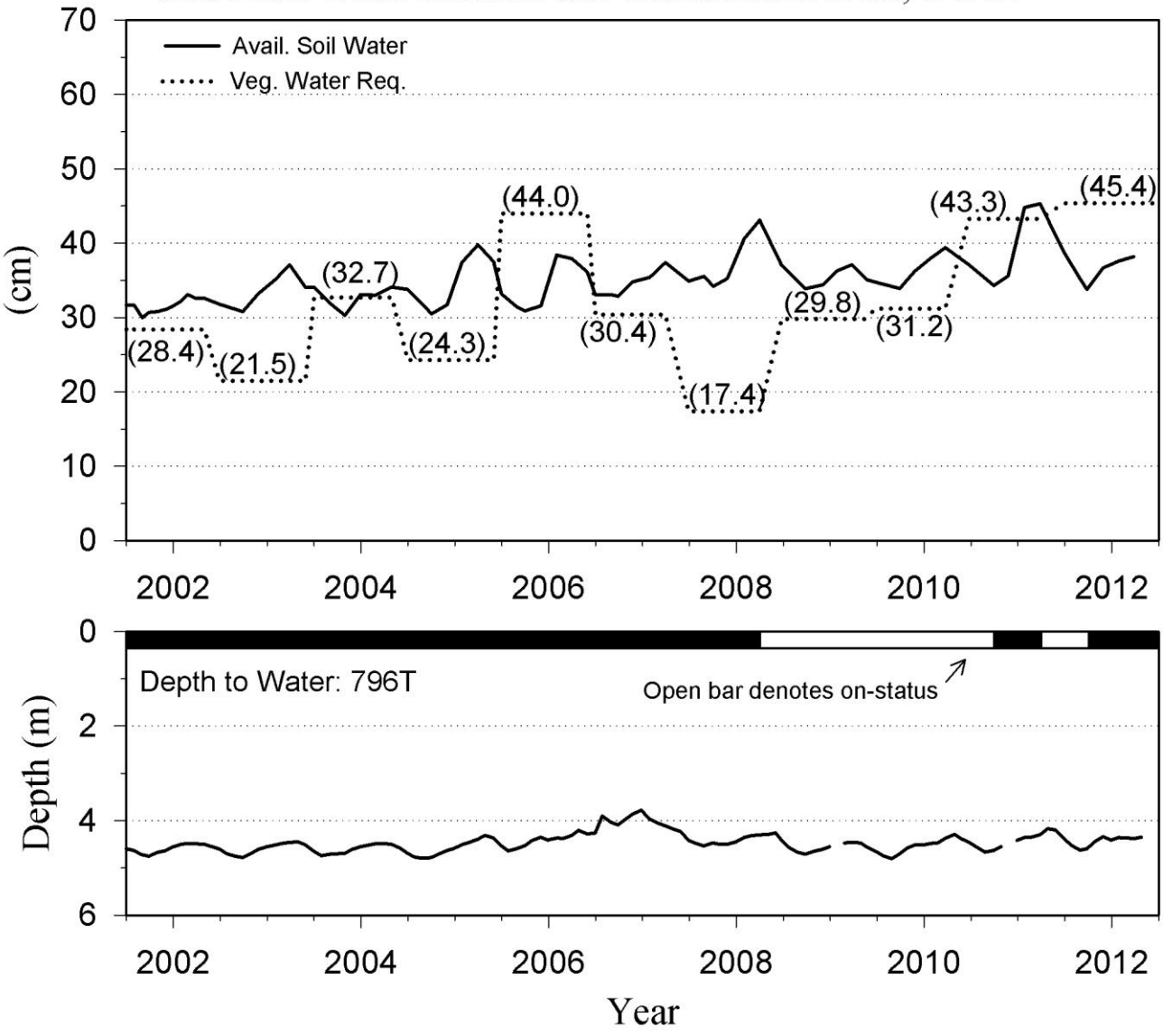


*On/off according to the Green Book Section III values for Veg. Water Req.

Soil water required for turn on (--)

BISHOP CONTROL SITE #2

Soil-Plant Water Balance and Groundwater Data, 5/1/12

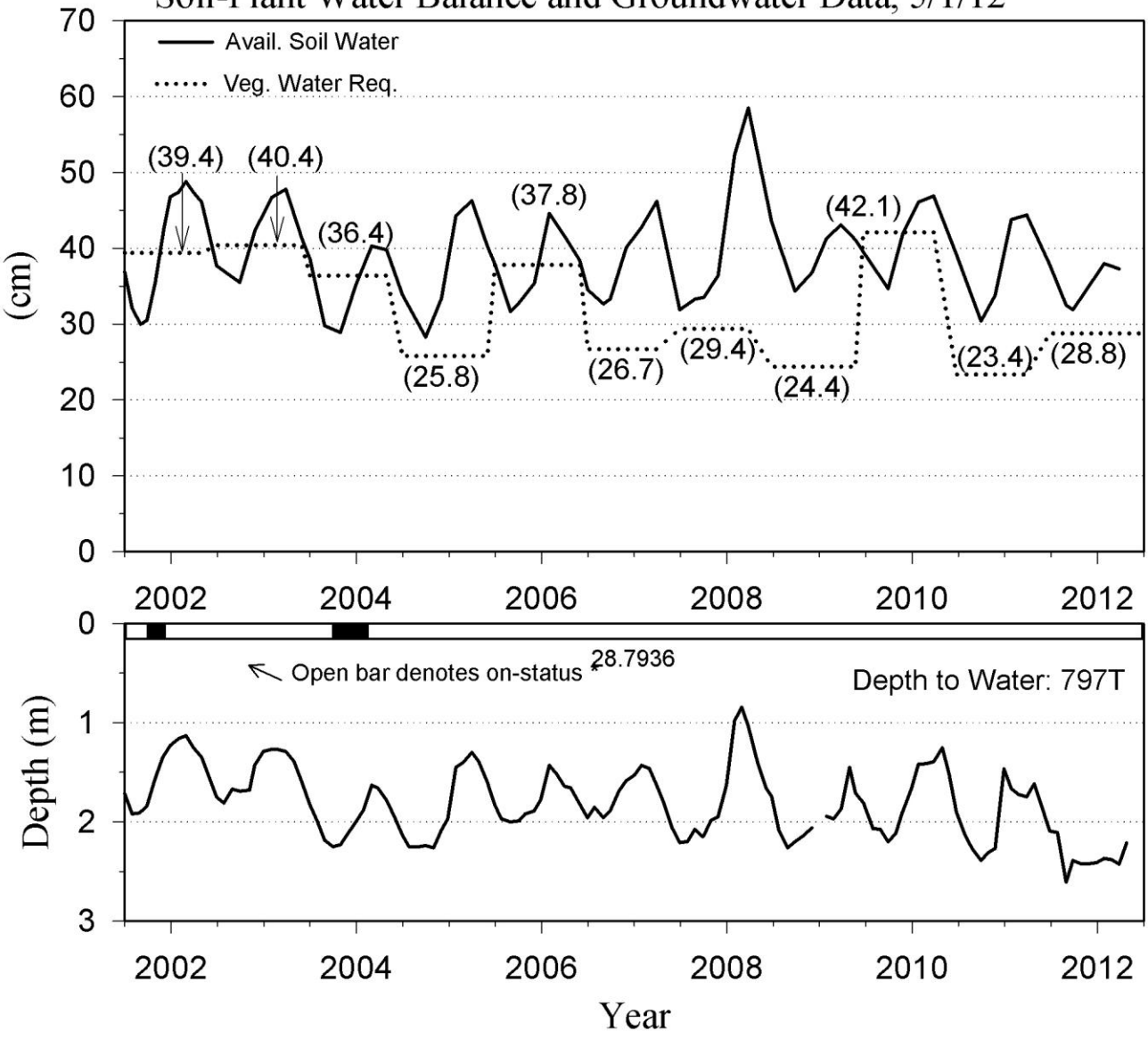


*On/off according to the Green Book Section III values for Veg. Water Req.

Soil water required for turn on (--)

BISHOP CONTROL SITE #3

Soil-Plant Water Balance and Groundwater Data, 5/1/12

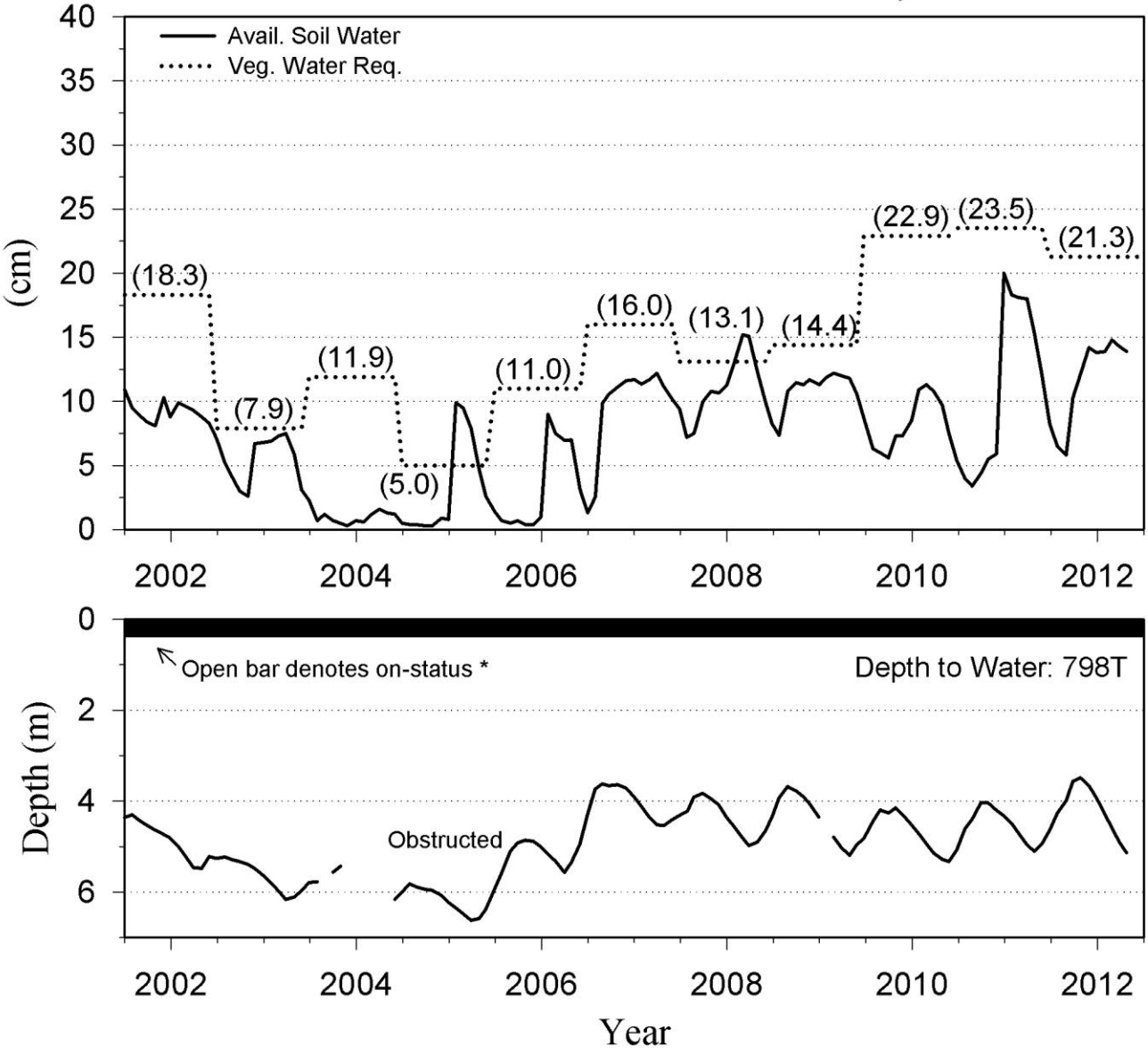


*On/off according to the Green Book Section III values for Veg. Water Req.

Soil water required for turn on (--)

BIG PINE MONITORING SITE #1

Soil-Plant Water Balance and Groundwater Data, 5/1/12



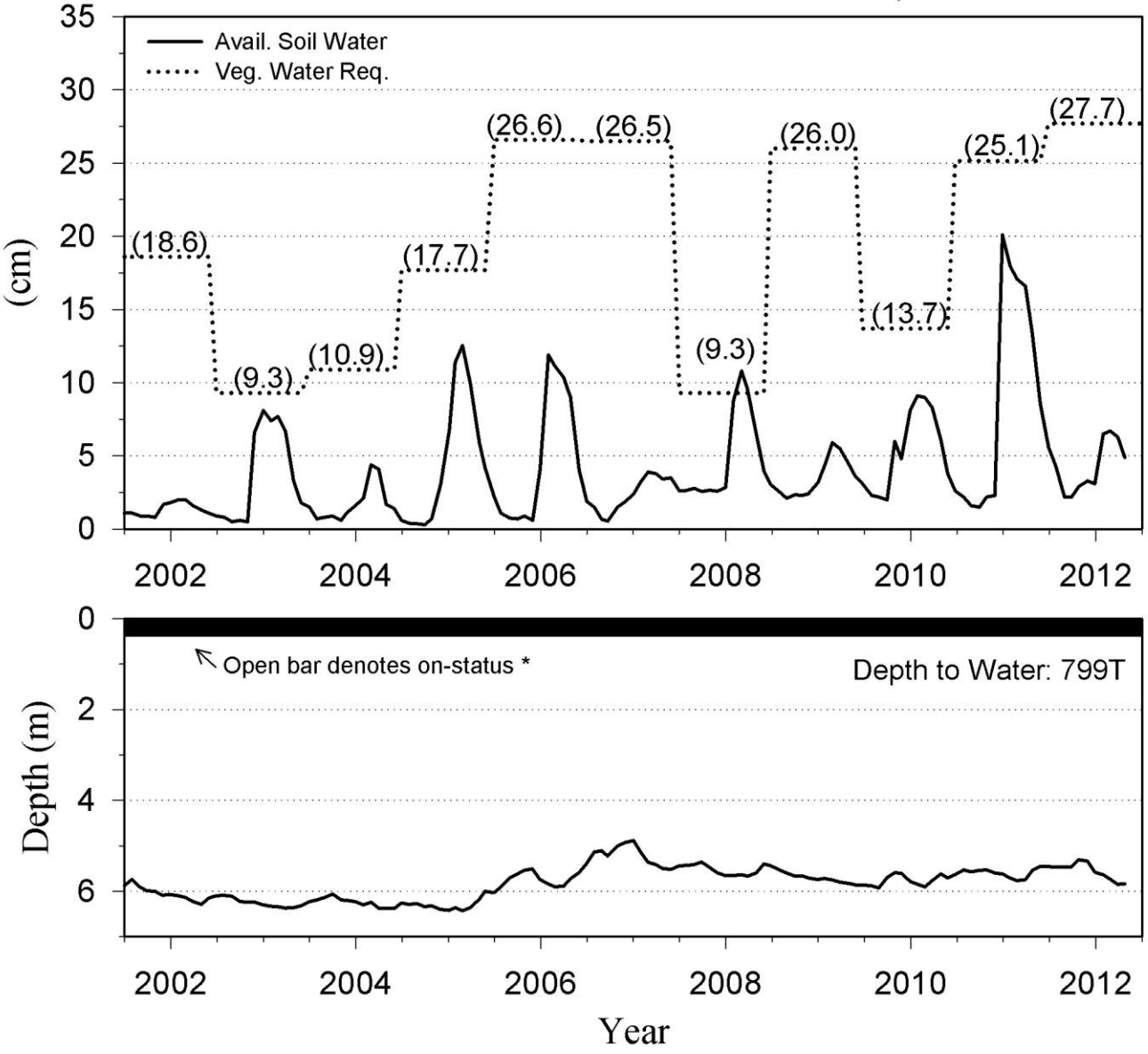
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping wells - 210, 378, 379, 389

Soil water required for turn on (22.9 cm)

BIG PINE MONITORING SITE #2

Soil-Plant Water Balance and Groundwater Data, 5/1/12



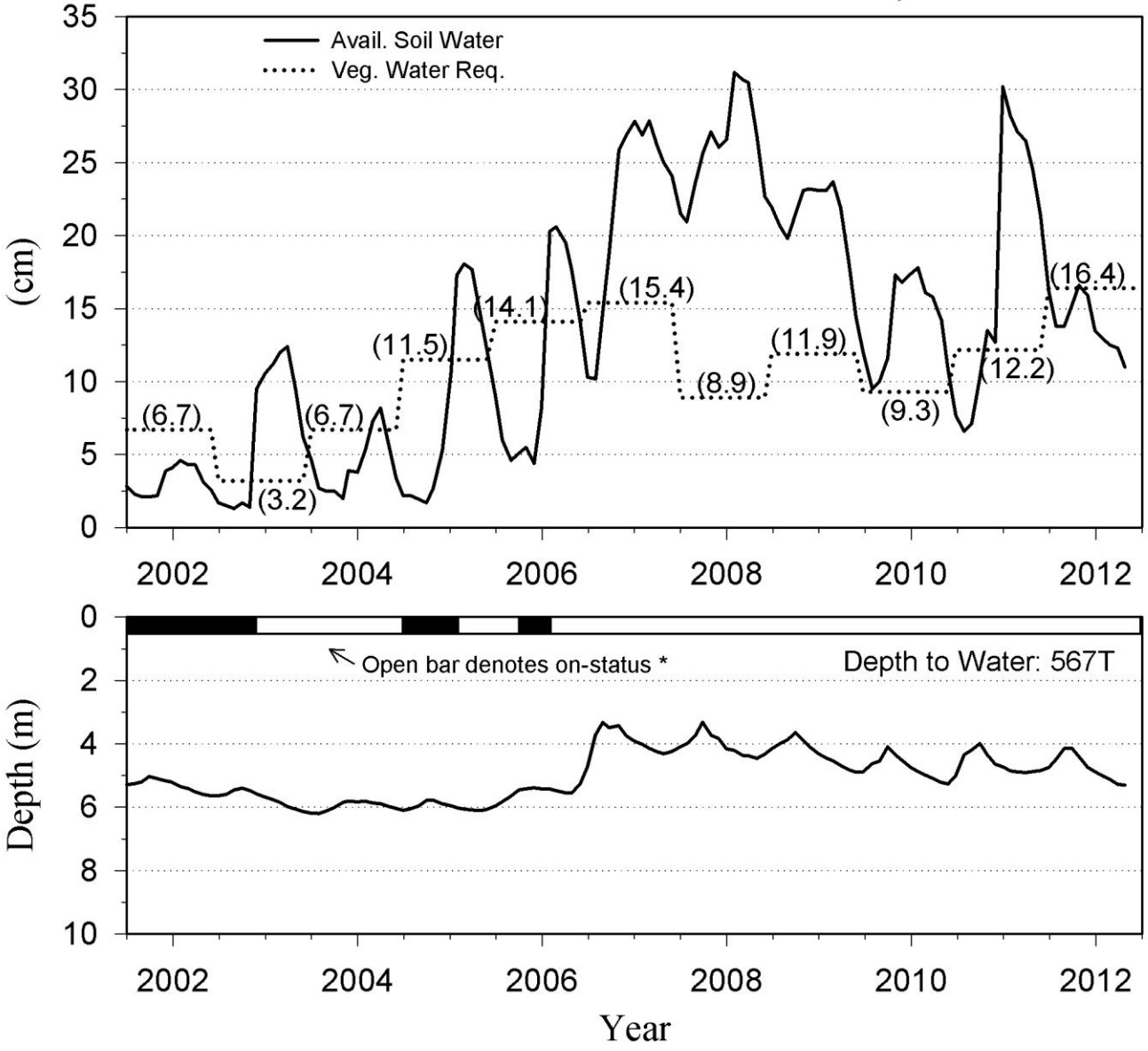
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping wells - 220, 229, 374, 375

Soil water required for turn on (28.4 cm)

BIG PINE MONITORING SITE #3

Soil-Plant Water Balance and Groundwater Data, 5/1/12



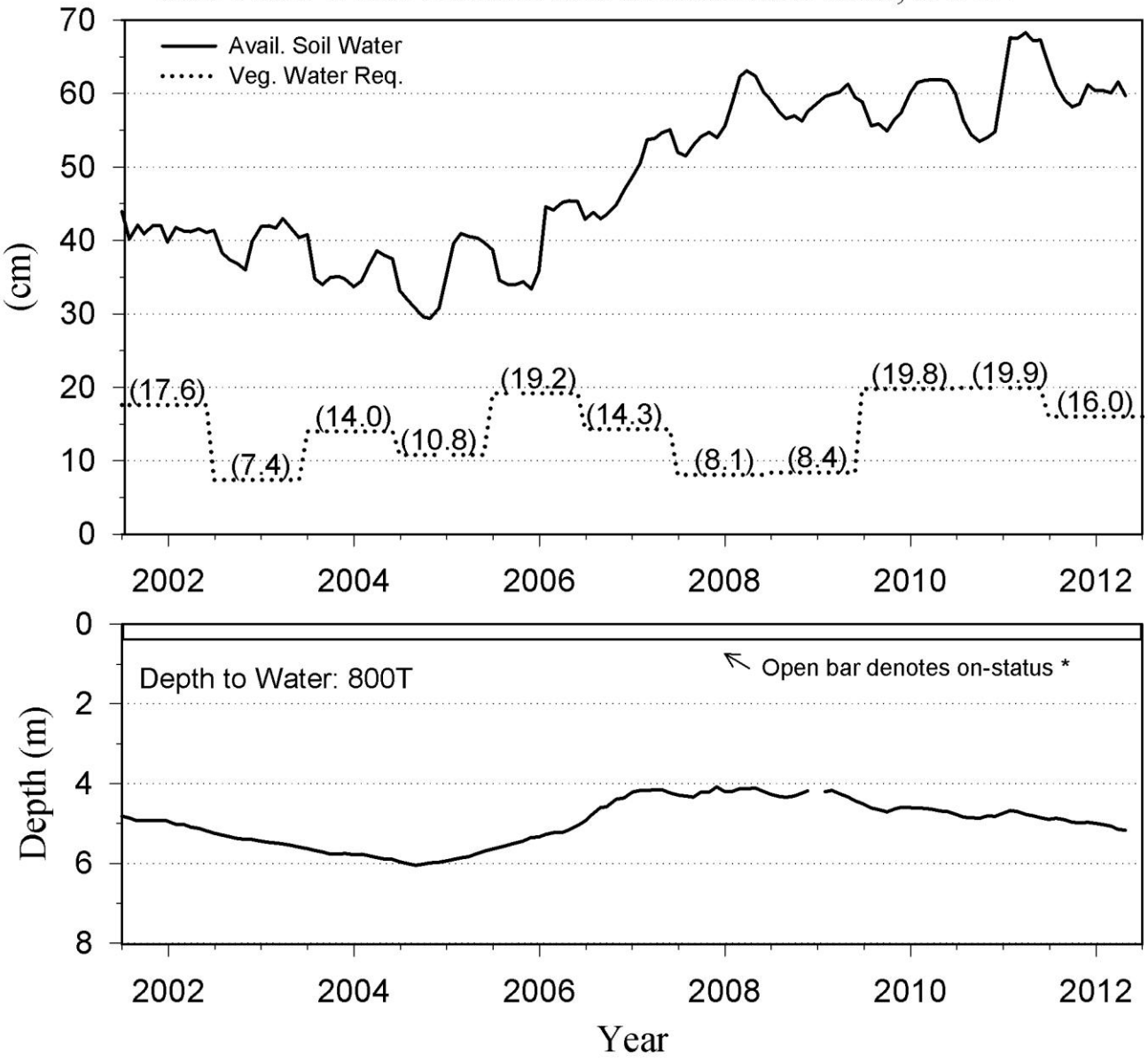
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping wells - 222, 223, 231, 232

Soil water required for turn on (--)

BIG PINE MONITORING SITE #4

Soil-Plant Water Balance and Groundwater Data, 5/1/12



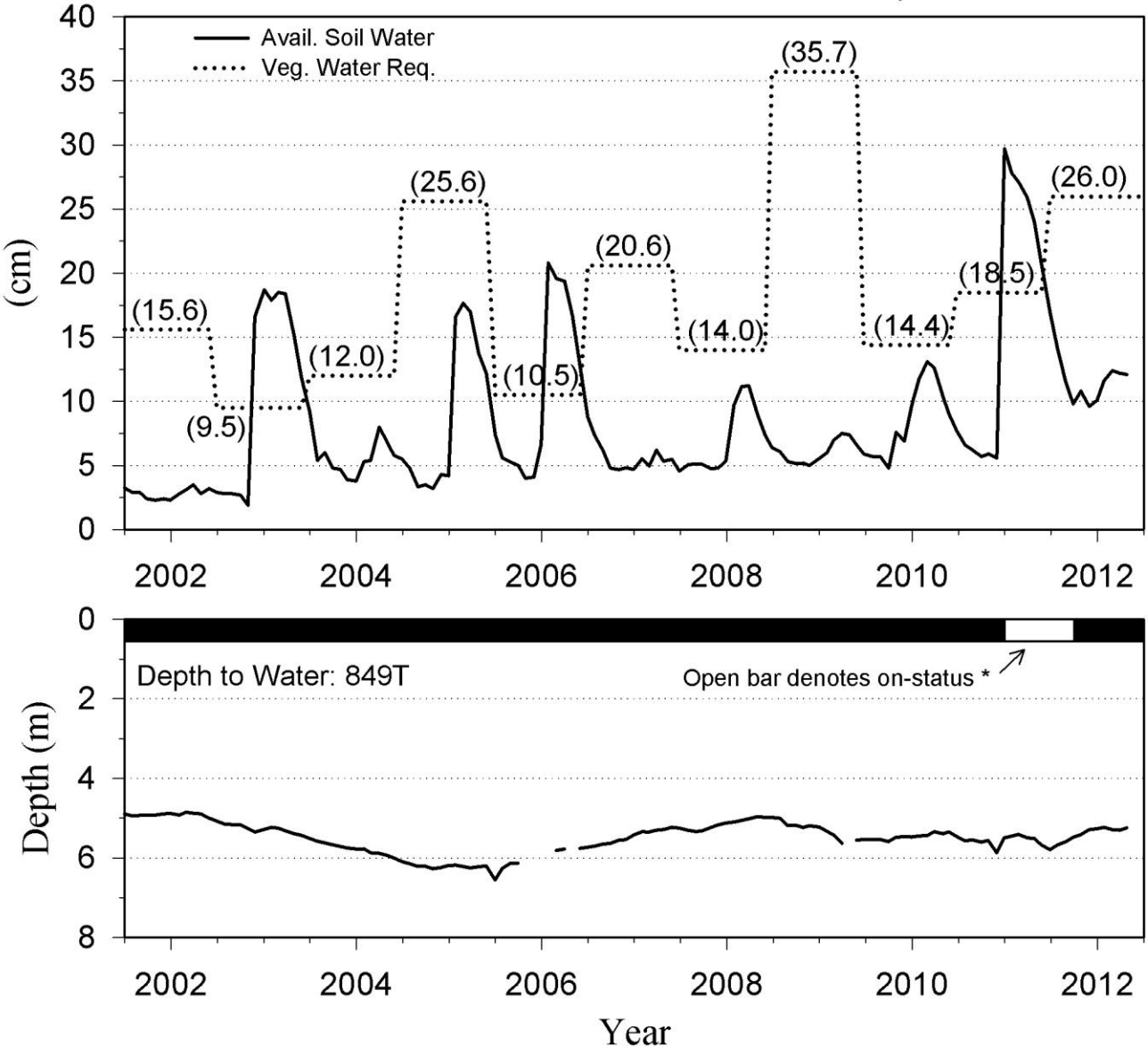
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping well - 331

Soil water required for turn on (--)

TABOOSE/ABERDEEN MONITORING SITE #3

Soil-Plant Water Balance and Groundwater Data, 5/1/12



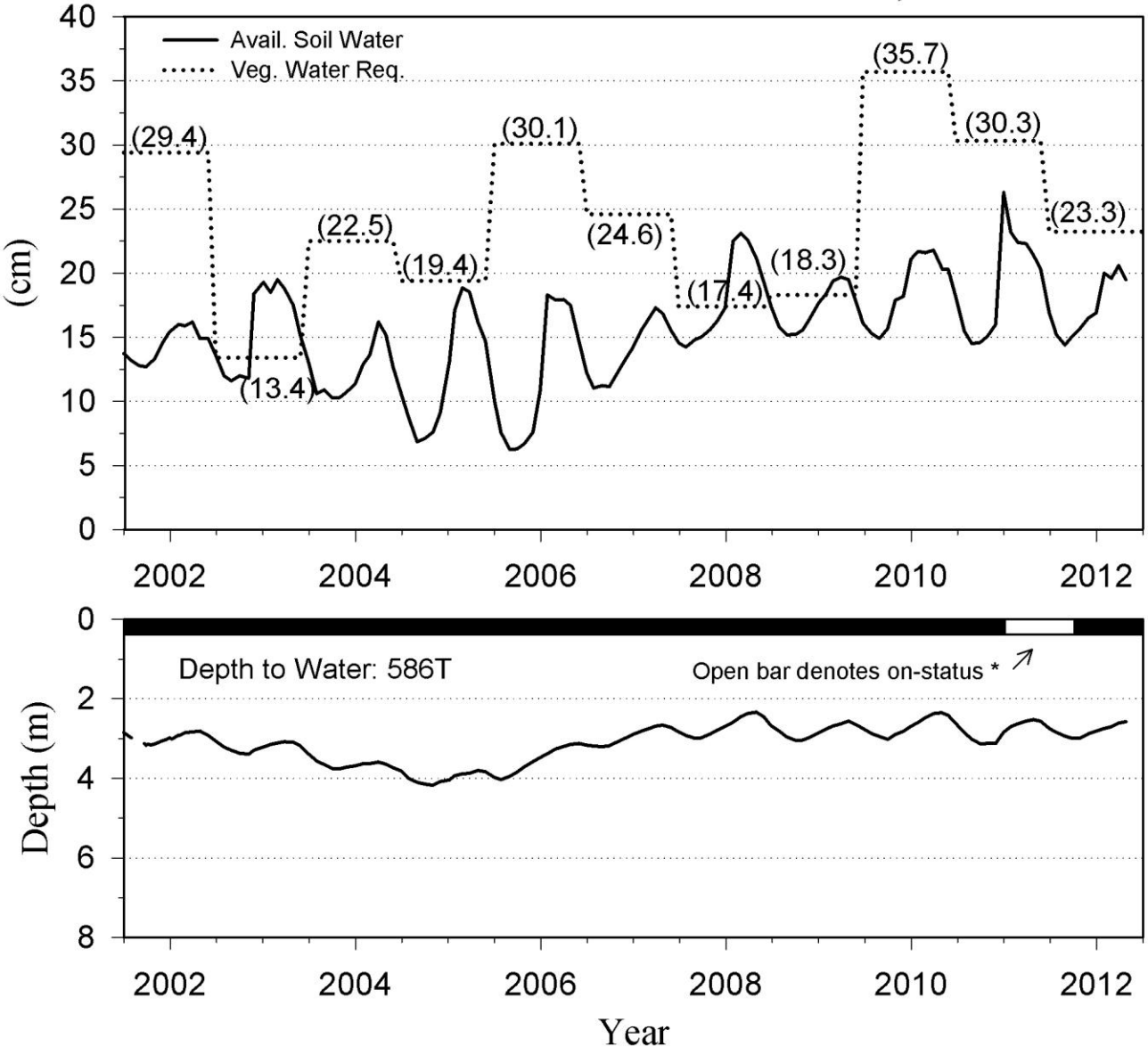
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping wells - 106, 110, 111, 114

Soil water required for turn on (26.0 cm)

TABOOSE/ABERDEEN MONITORING SITE #4

Soil-Plant Water Balance and Groundwater Data, 5/1/12



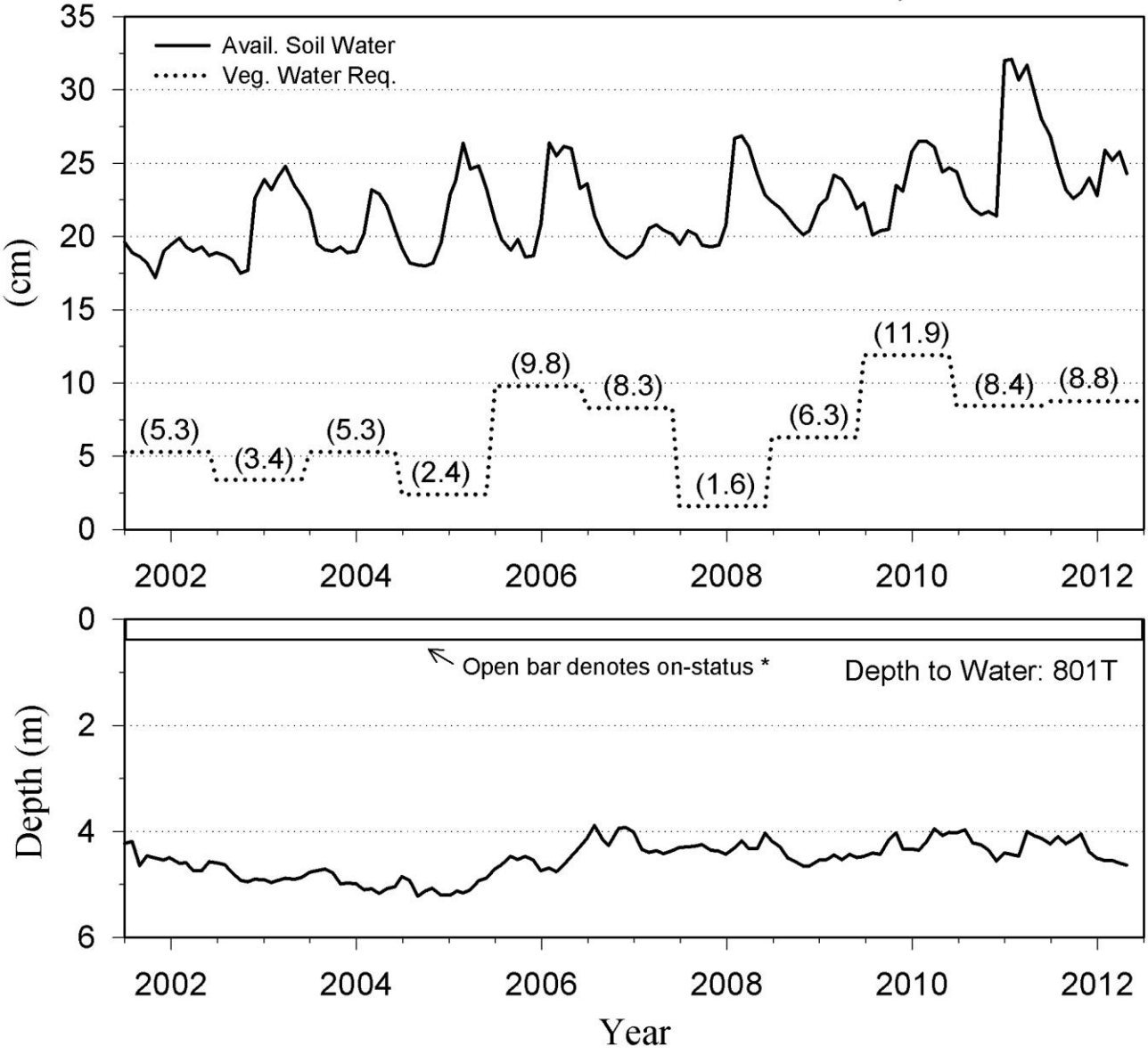
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping wells - 342, 347

Soil water required for turn on (23.3 cm)

TABOOSE/ABERDEEN MONITORING SITE #5

Soil-Plant Water Balance and Groundwater Data, 5/1/12



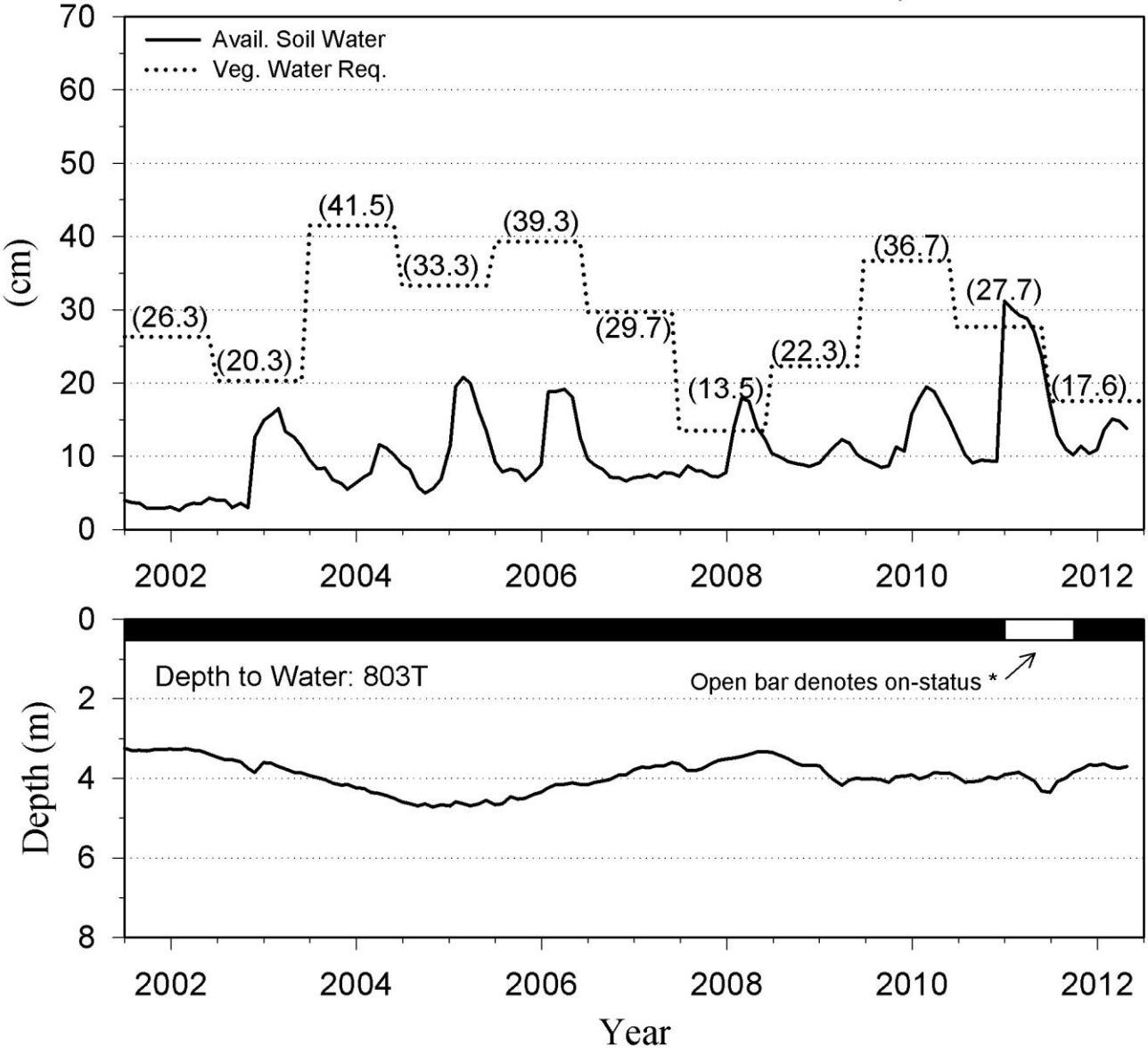
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III value for Veg. Water Req.

Linked pumping well - 349

Soil water required for turn on (--)

TABOOSE/ABERDEEN MONITORING SITE #6

Soil-Plant Water Balance and Groundwater Data, 5/1/12



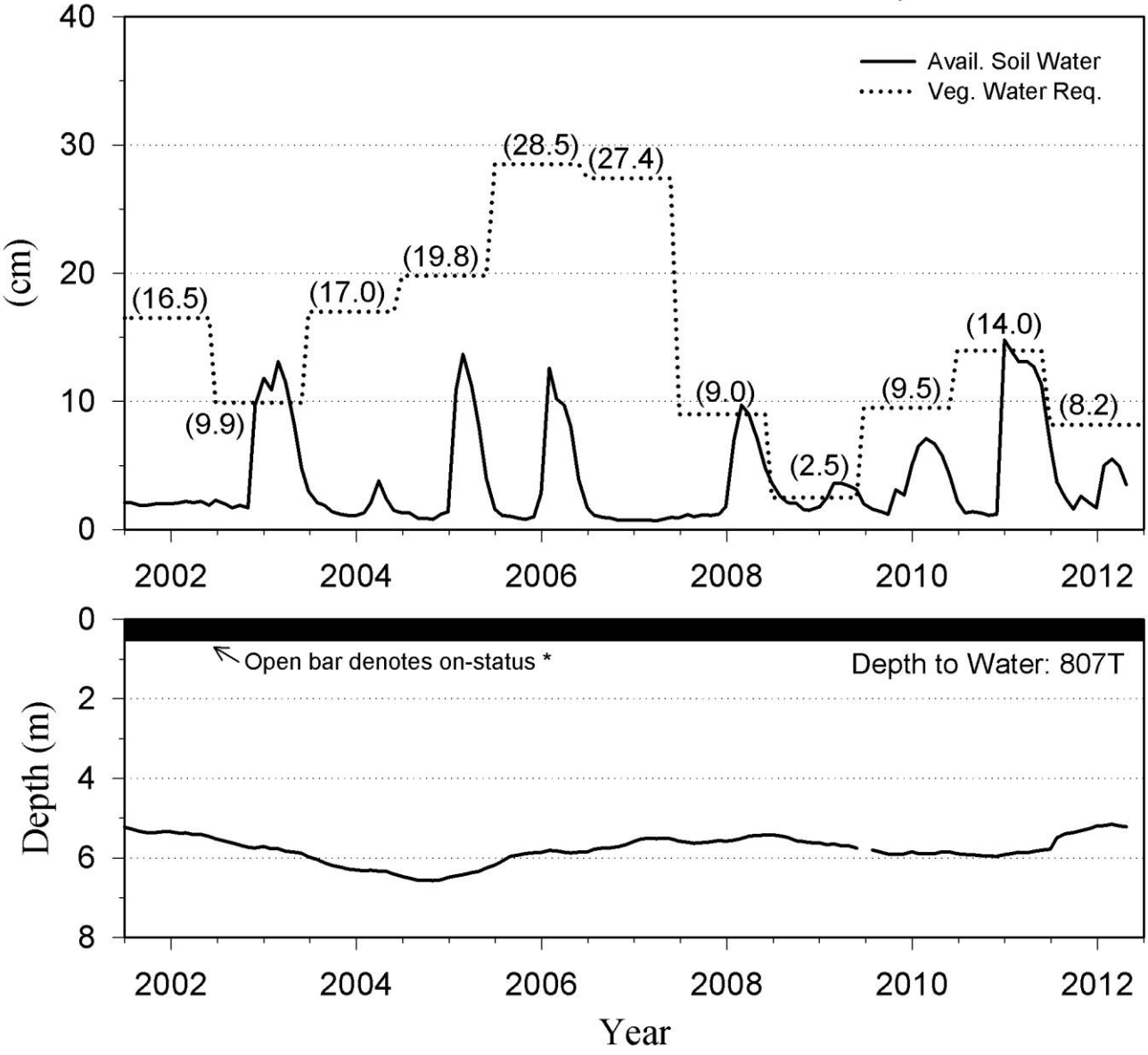
* Wells not necessarily operated when in on-status. On\off according to Green Book Section III values for Veg. Water Req.

Linked pumping wells - 109, 370

Soil water required for turn on (17.6 cm)

THIBAUT/SAWMILL MONITORING SITE #1

Soil-Plant Water Balance and Groundwater Data, 5/1/12



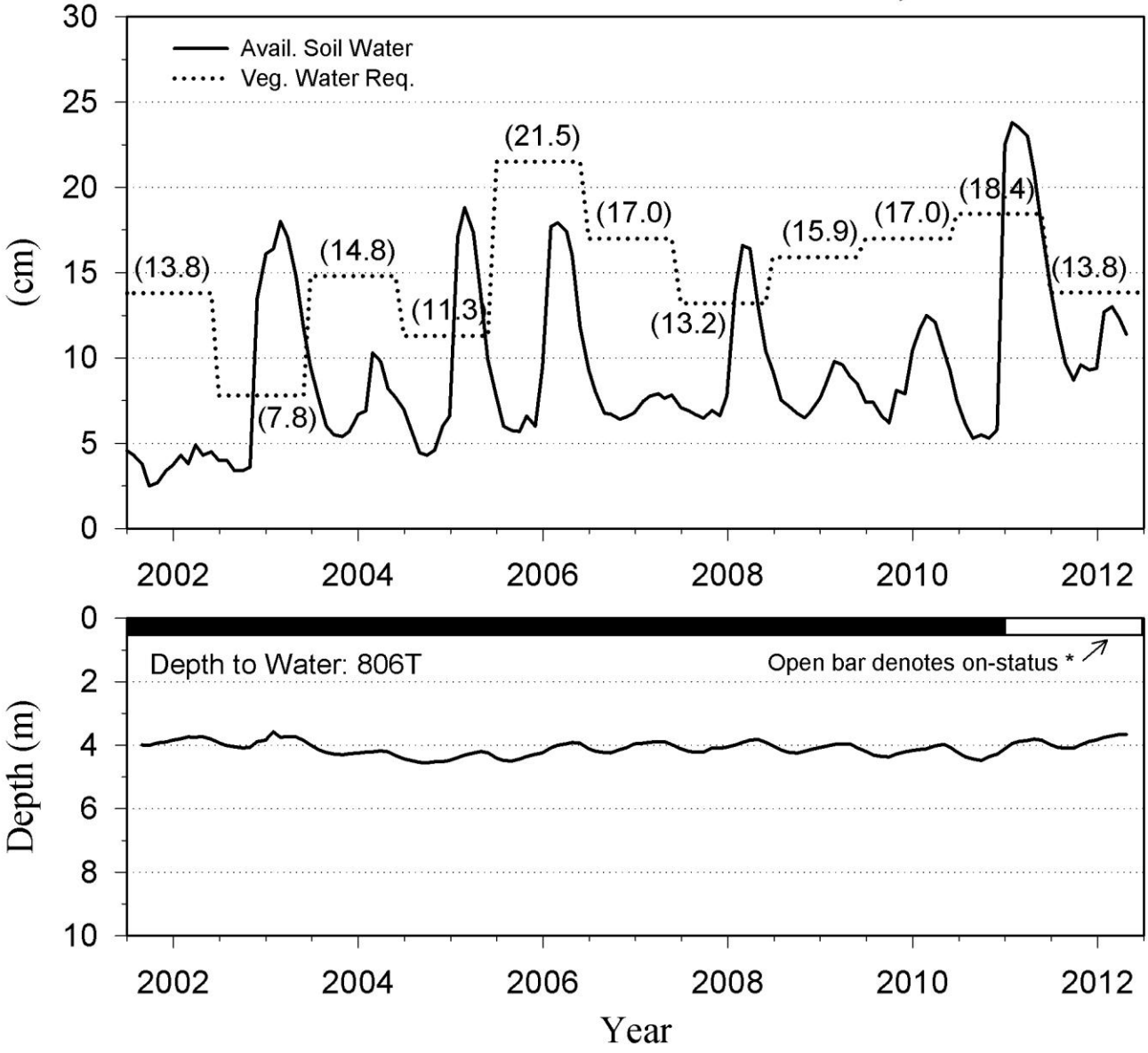
* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Linked pumping well - 159

Soil water required for turn on (20.4 cm)

THIBAUT/SAWMILL MONITORING SITE #2

Soil-Plant Water Balance and Groundwater Data, 5/1/12



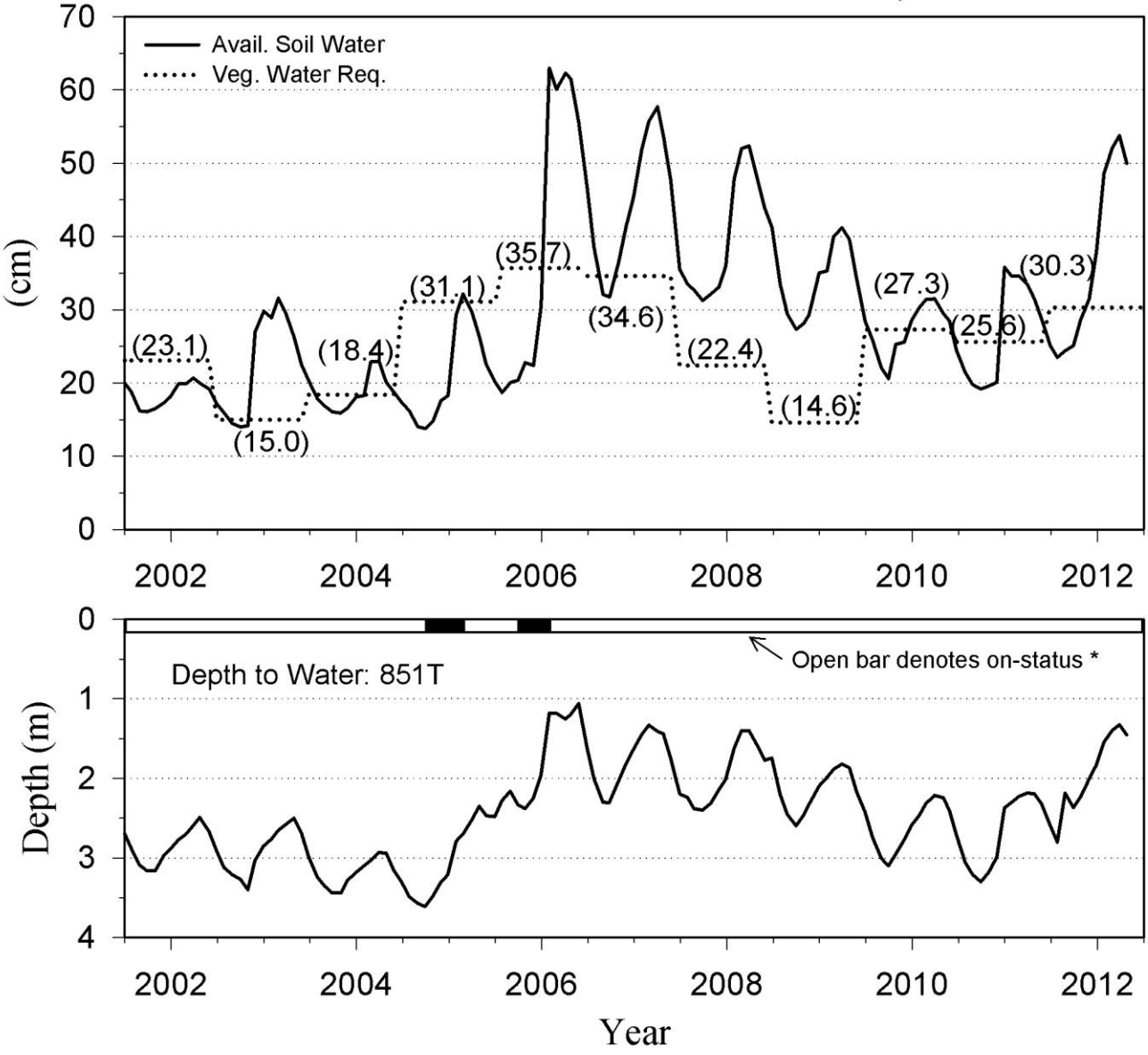
* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Linked pumping well - 155

Soil water required for turn on (--)

THIBAUT/SAWMILL MONITORING SITE #3

Soil-Plant Water Balance and Groundwater Data, 5/1/12



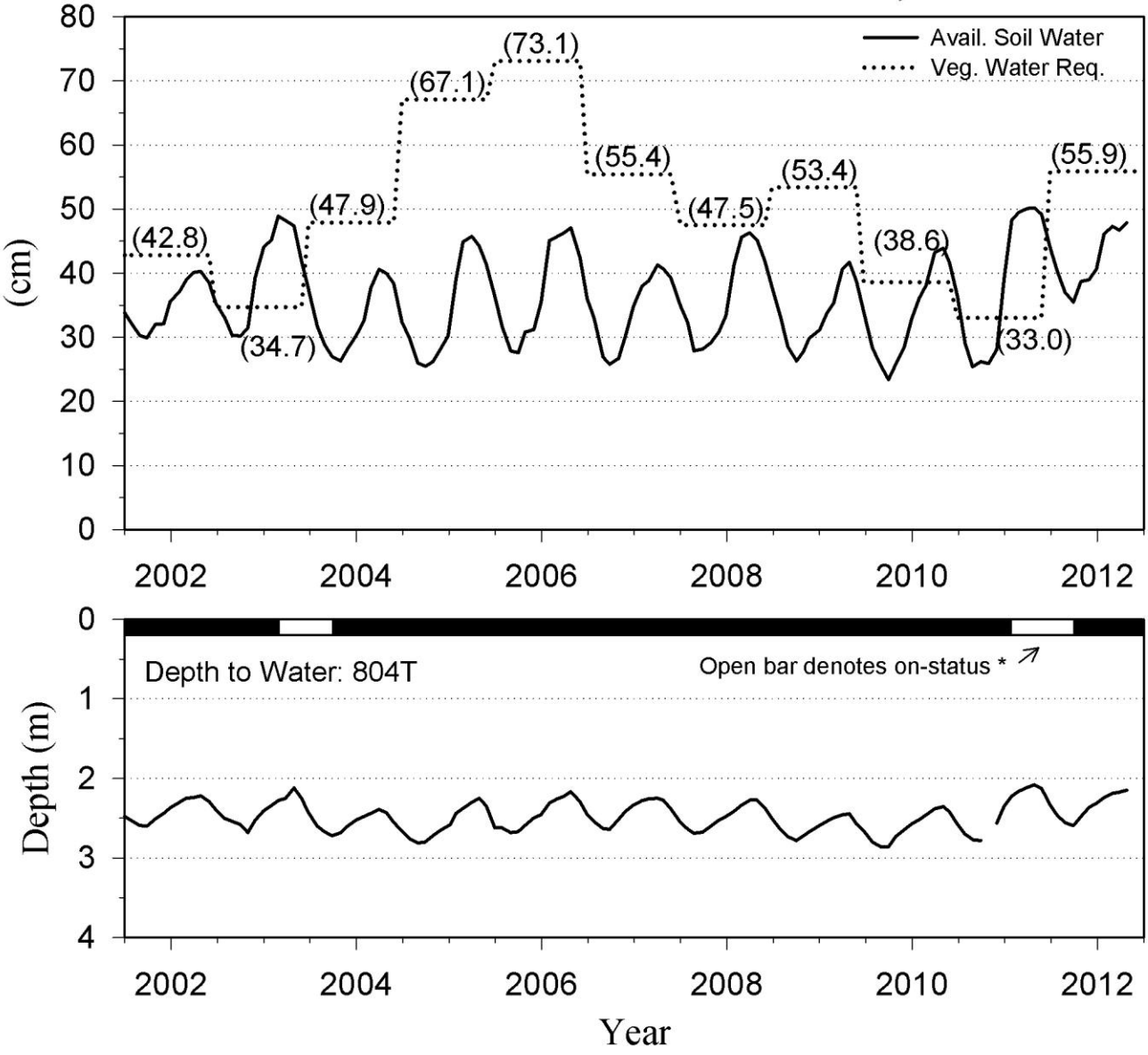
* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Linked pumping wells - 103, 104, 382

Soil water required for turn on (--)

THIBAUT/SAWMILL MONITORING SITE #4

Soil-Plant Water Balance and Groundwater Data, 5/1/12



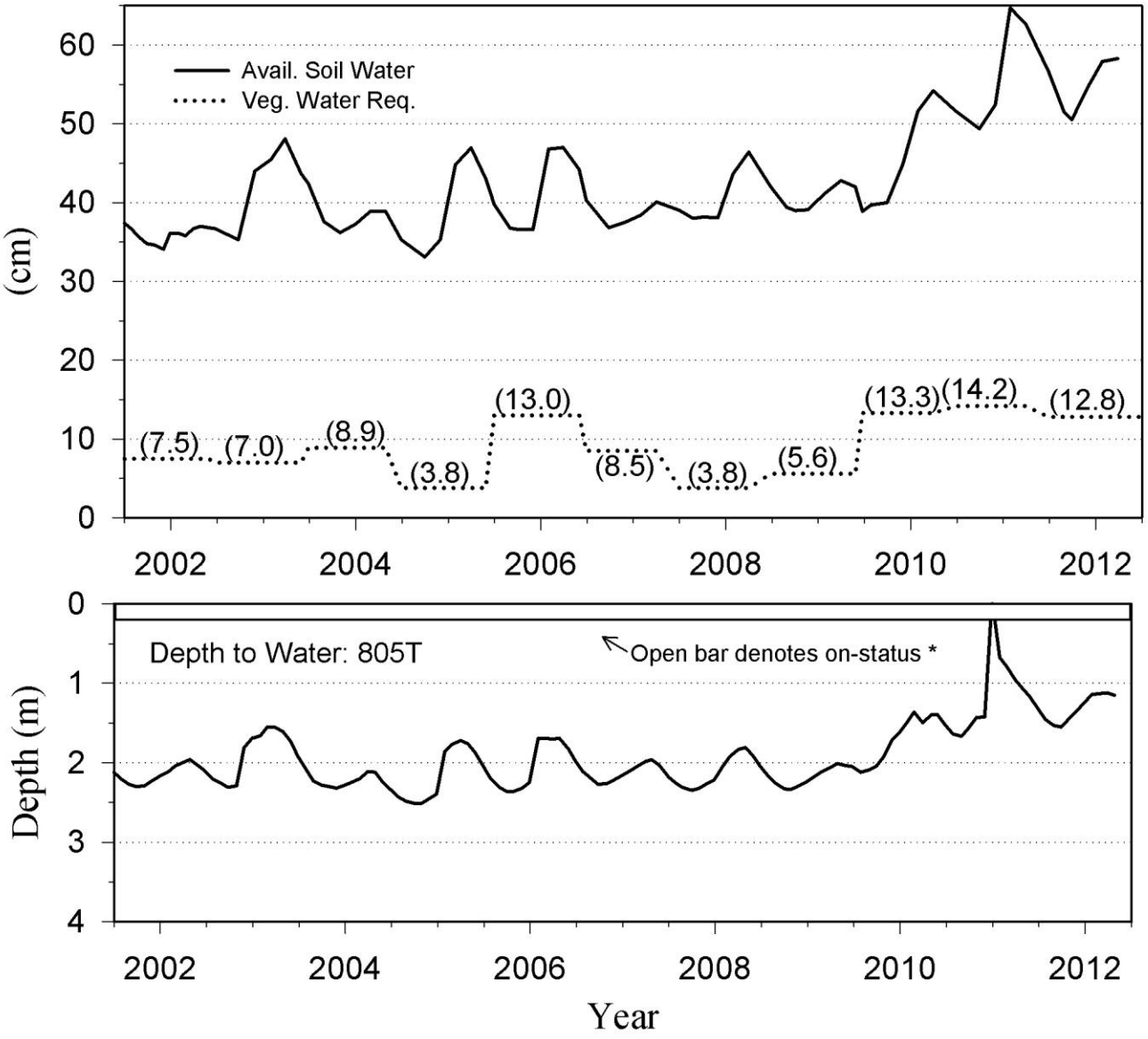
* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Linked pumping wells - 380, 381

Soil water required for turn on (55.9 cm)

THIBAUT/SAWMILL CONTROL SITE

Soil-Plant Water Balance and Groundwater Data, 5/1/12

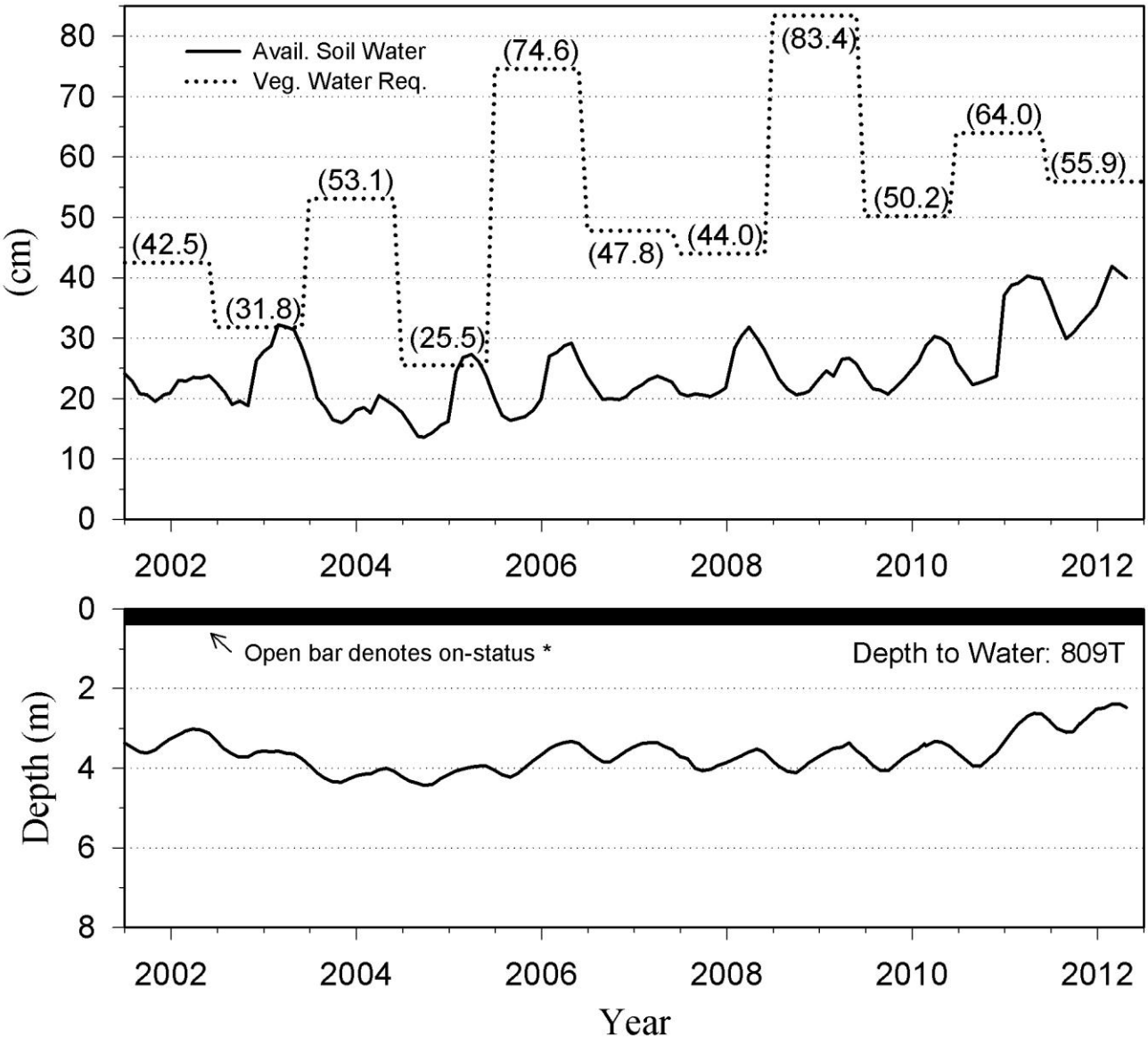


* On\off according to the Green Book Section III values for Veg. Water Req.

Soil water required for turn on (--)

INDEPENDENCE/OAK MONITORING SITE #1

Soil-Plant Water Balance and Groundwater Data, 5/1/12



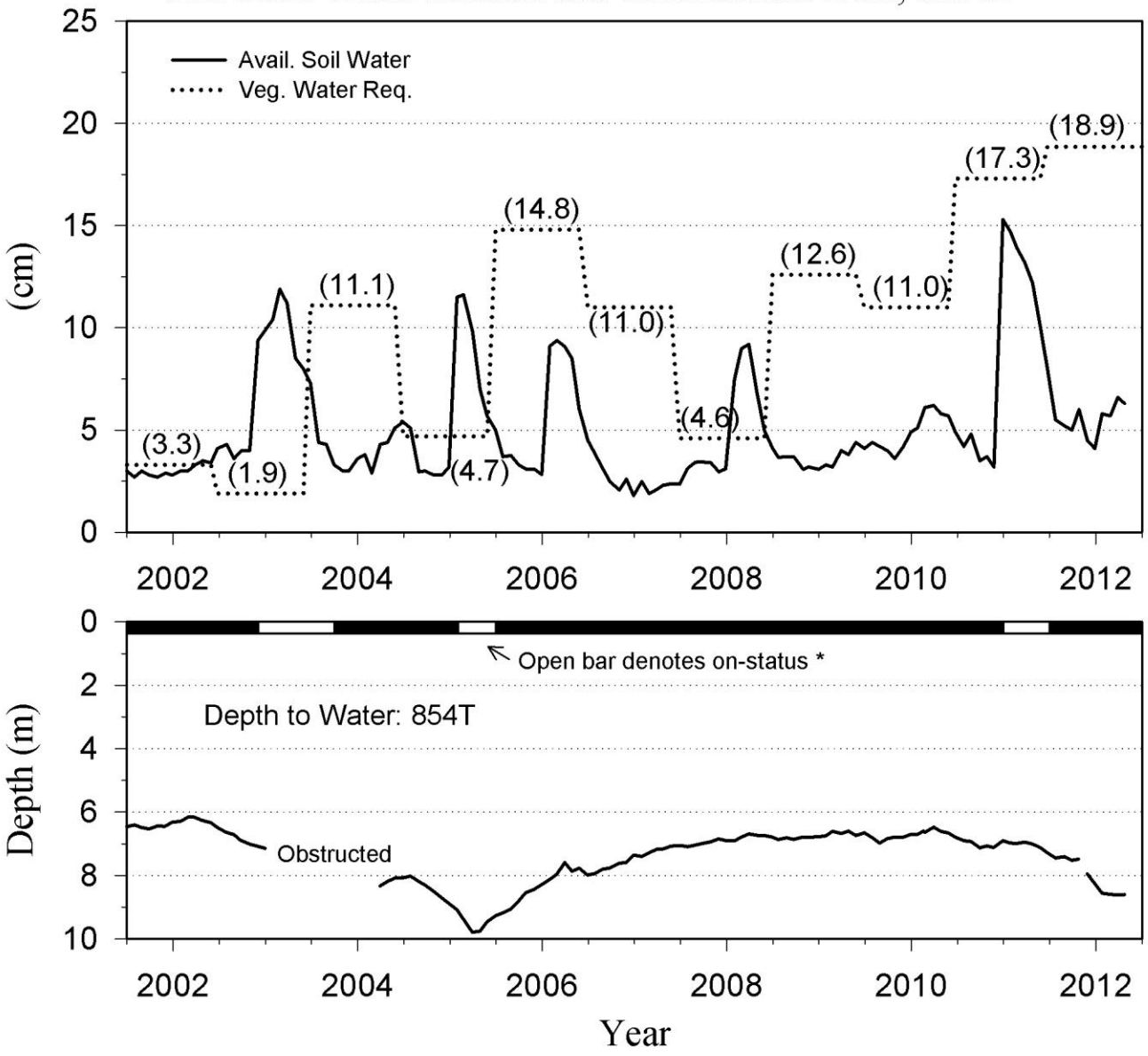
* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Linked pumping wells - 61, 391, 400

Soil water required for turn on (42.2 cm)

INDEPENDENCE/OAK MONITORING SITE #2

Soil-Plant Water Balance and Groundwater Data, 5/1/12



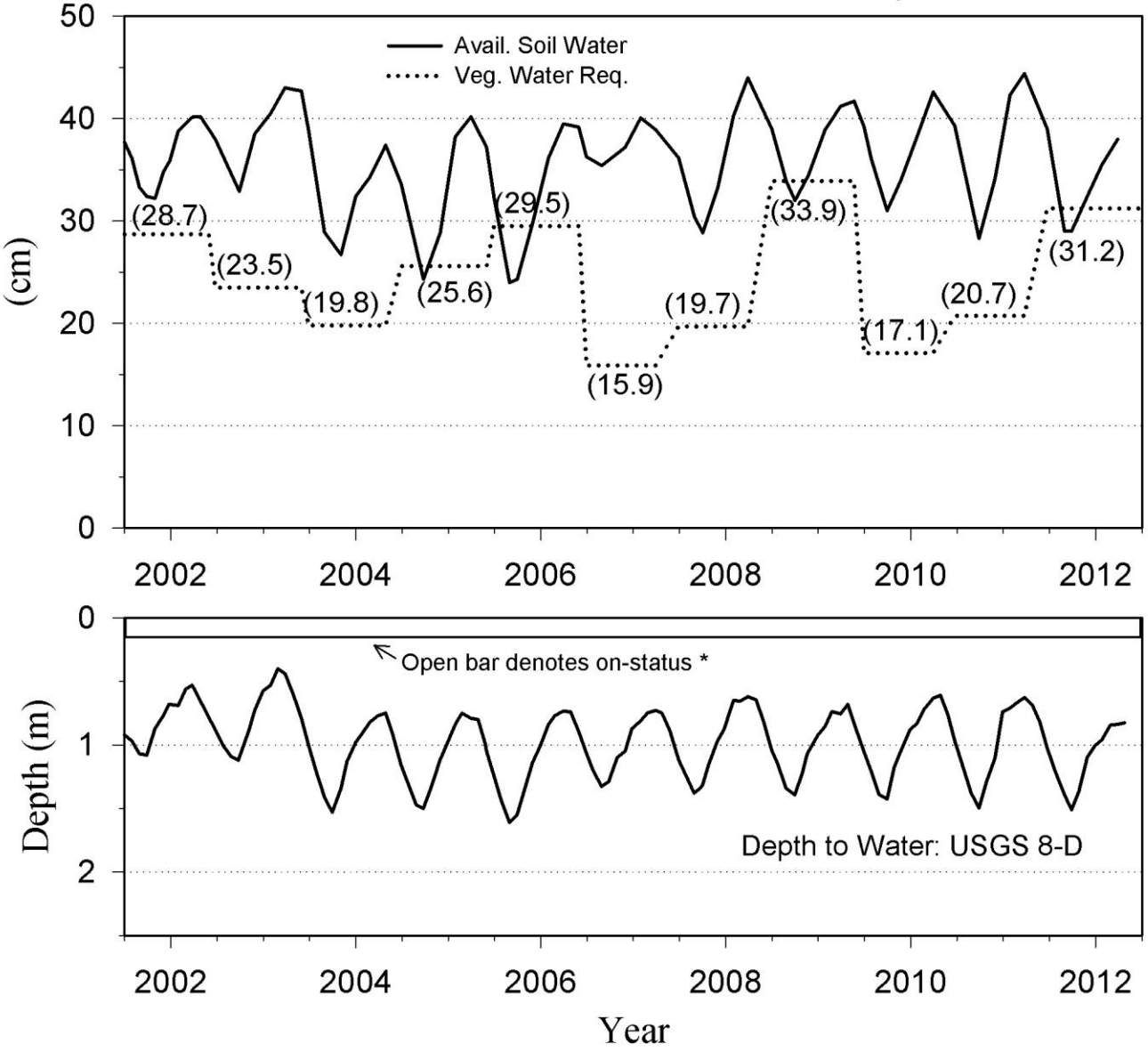
* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Linked pumping well - 63

Soil water required for turn on (18.9 cm)

INDEPENDENCE/OAK CONTROL SITE #1

Soil-Plant Water Balance and Groundwater Data, 5/1/12

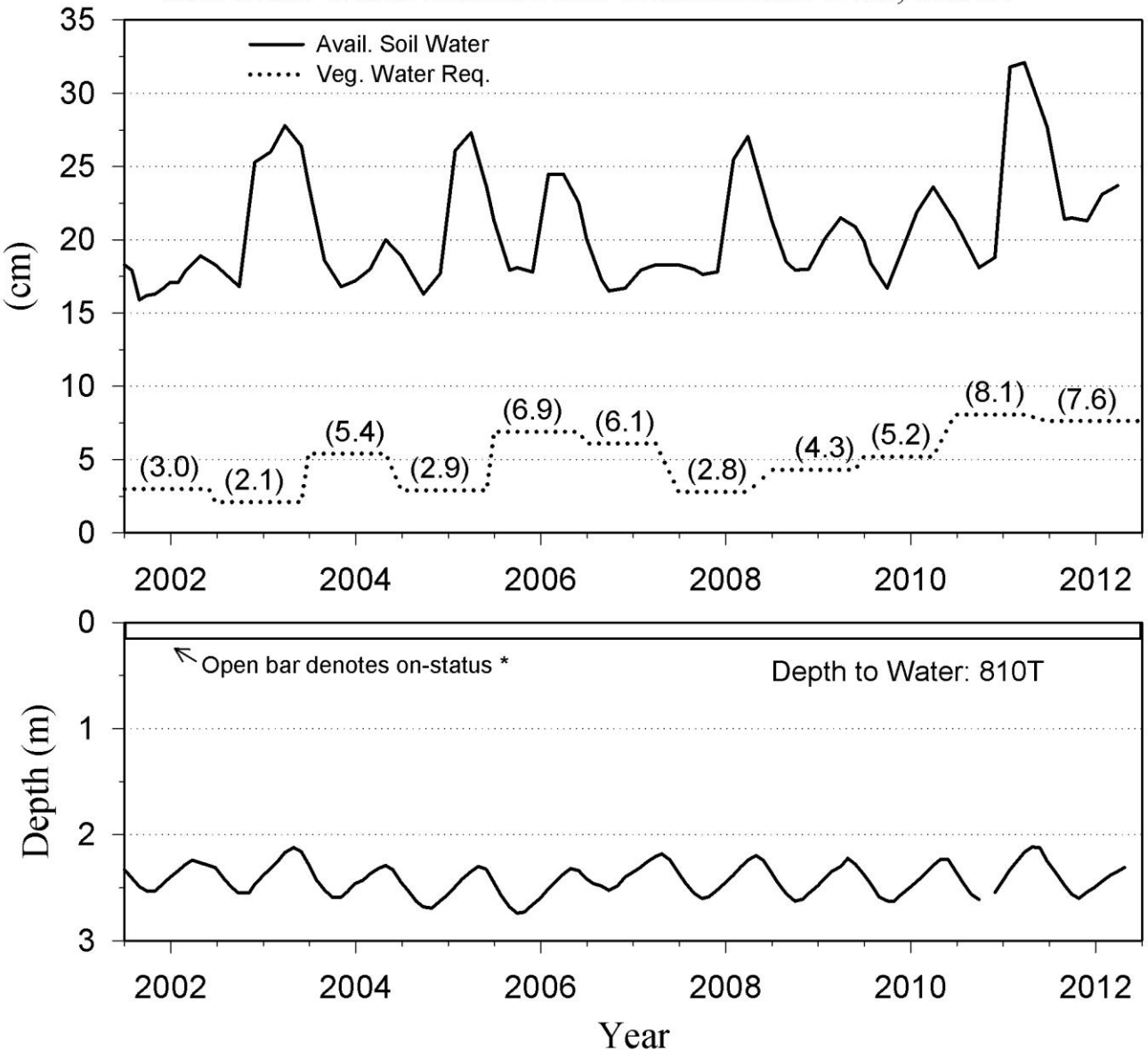


* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Soil water required for turn on (--)

INDEPENDENCE/OAK CONTROL SITE #2

Soil-Plant Water Balance and Groundwater Data, 5/1/12

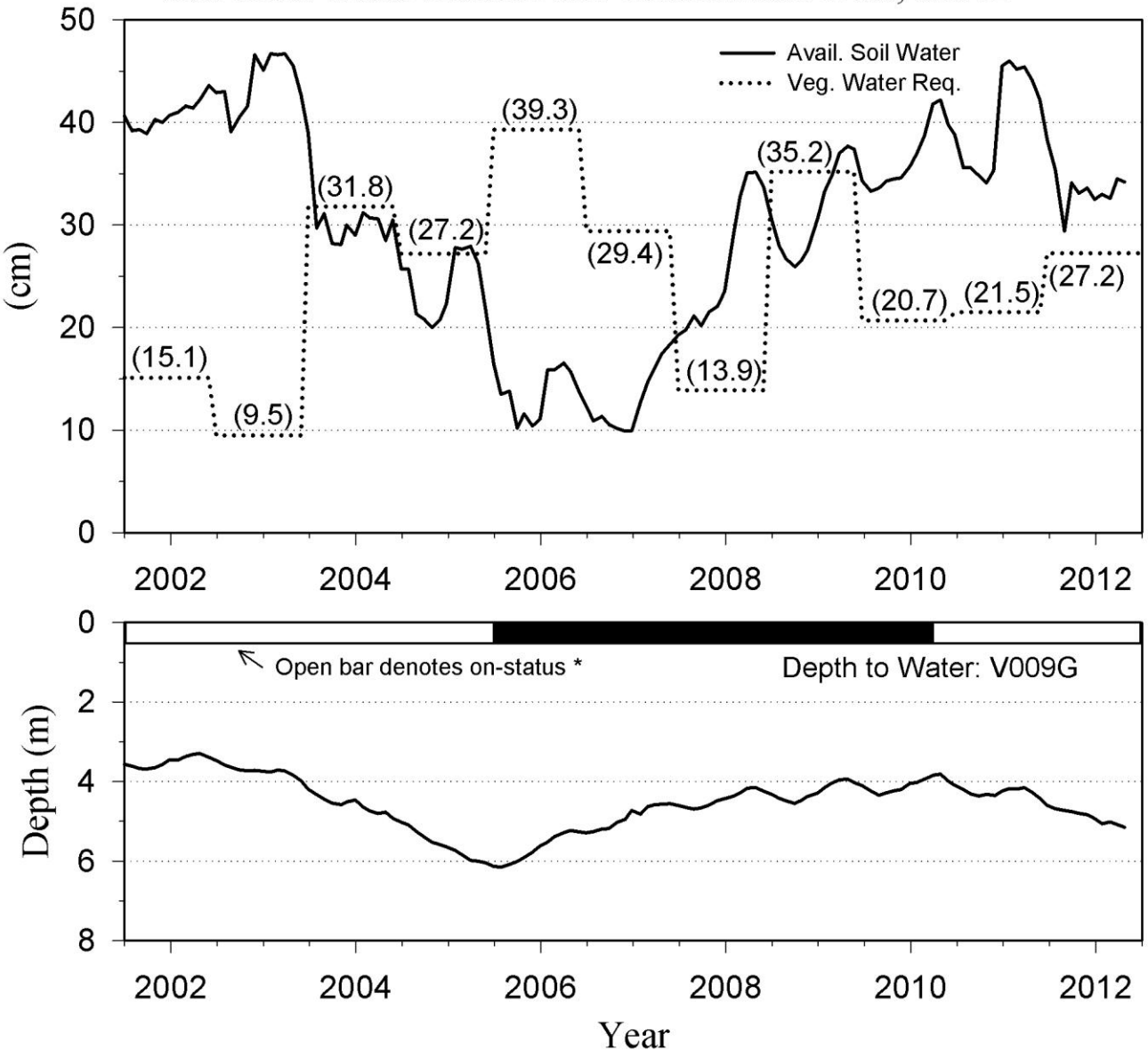


* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Soil water required for turn on (--)

SYMMES/SHEPHERD MONITORING SITE #1

Soil-Plant Water Balance and Groundwater Data, 5/1/12



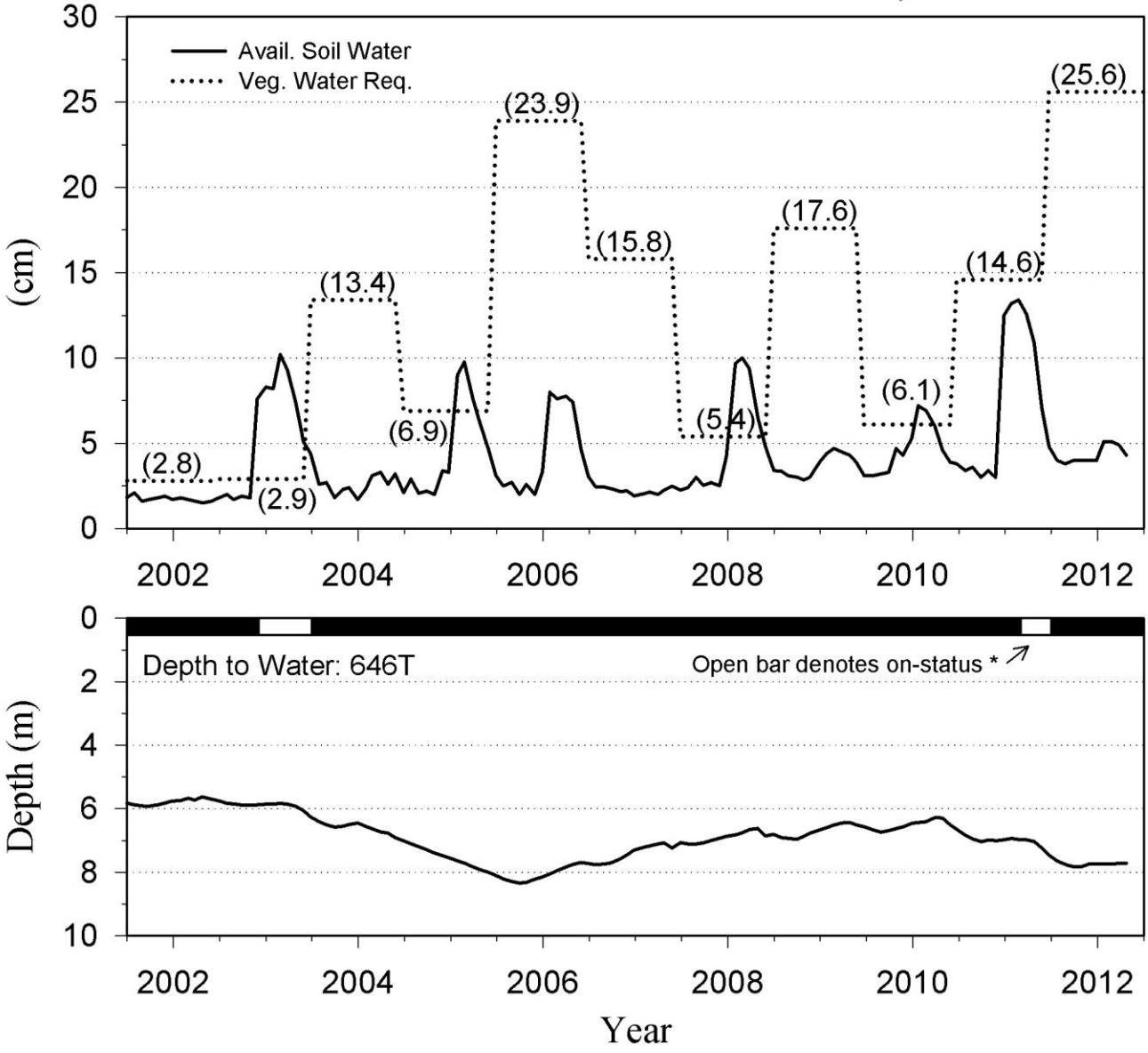
* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Linked pumping wells - 69, 392, 393

Soil water required for turn on (--)

SYMMES/SHEPHERD MONITORING SITE #2

Soil-Plant Water Balance and Groundwater Data, 5/1/12



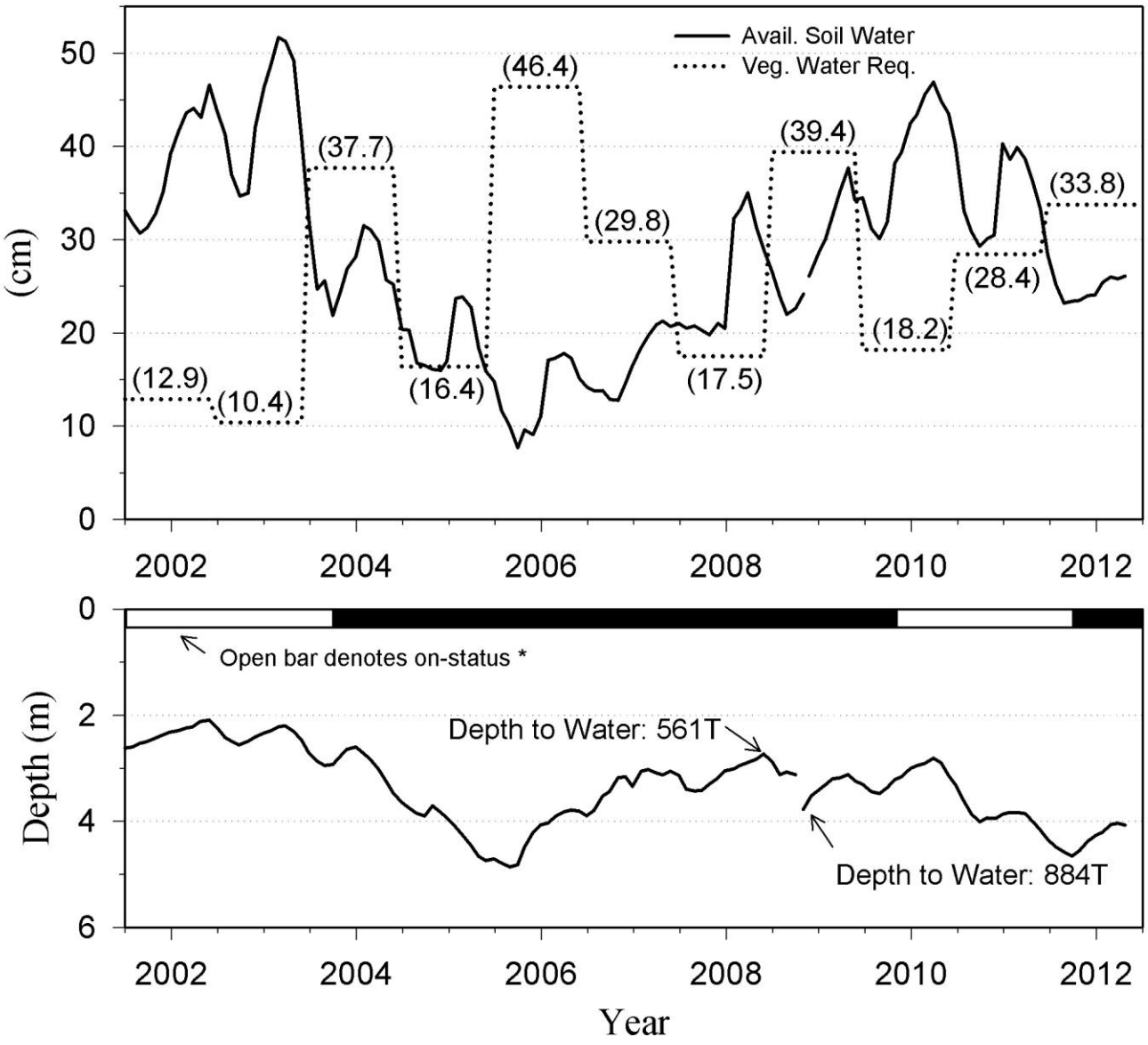
* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Linked pumping wells - 74, 394, 395

Soil water required for turn on (25.6 cm)

SYMMES/SHEPHERD MONITORING SITE #3

Soil-Plant Water Balance and Groundwater Data, 5/1/12



* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

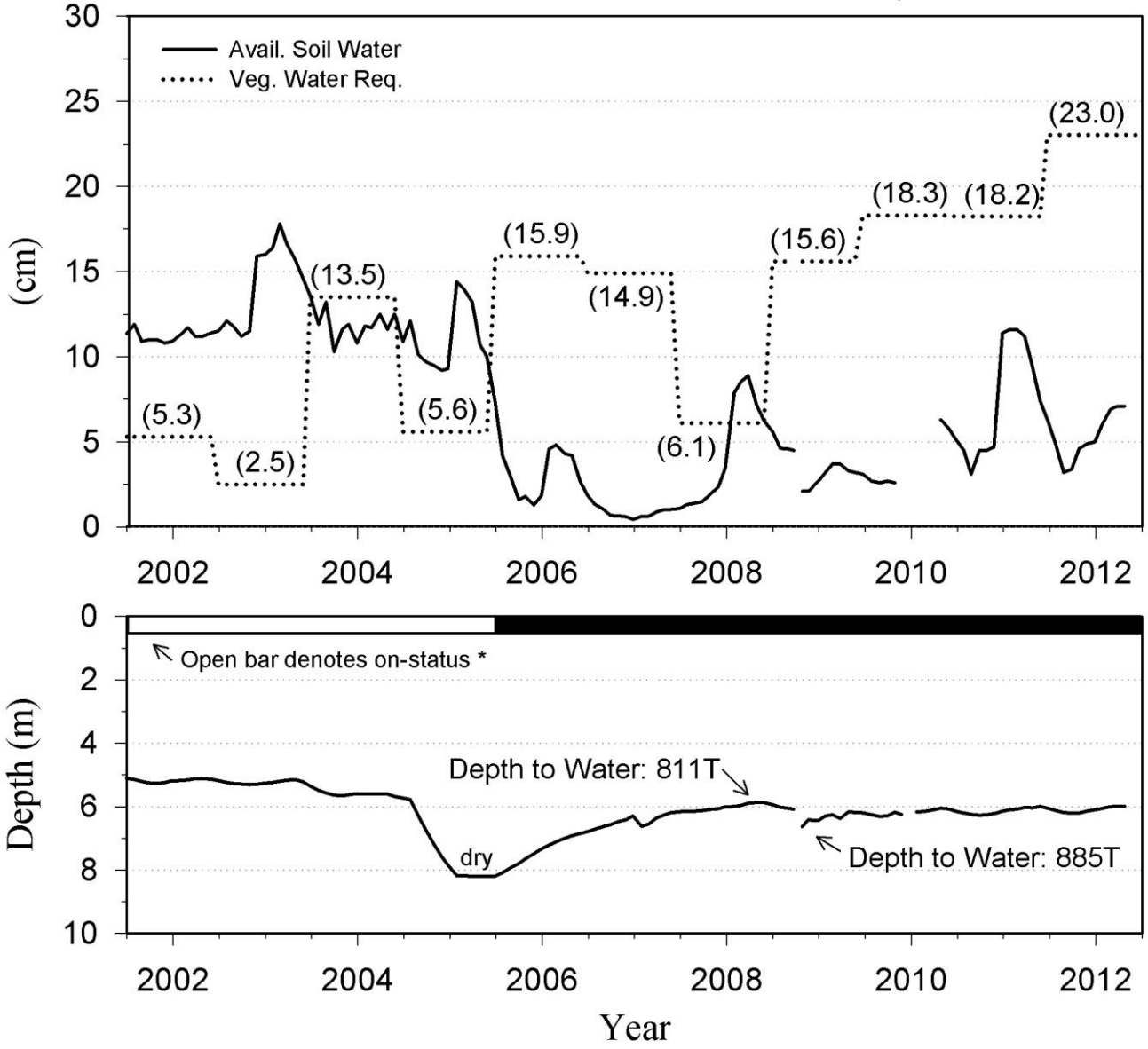
Linked pumping wells - 92, 396

Soil water required for turn on (33.8 cm)

New soil water monitoring locations established Dec 1, 2008

SYMMES/SHEPHERD MONITORING SITE #4

Soil-Plant Water Balance and Groundwater Data, 5/1/12



* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

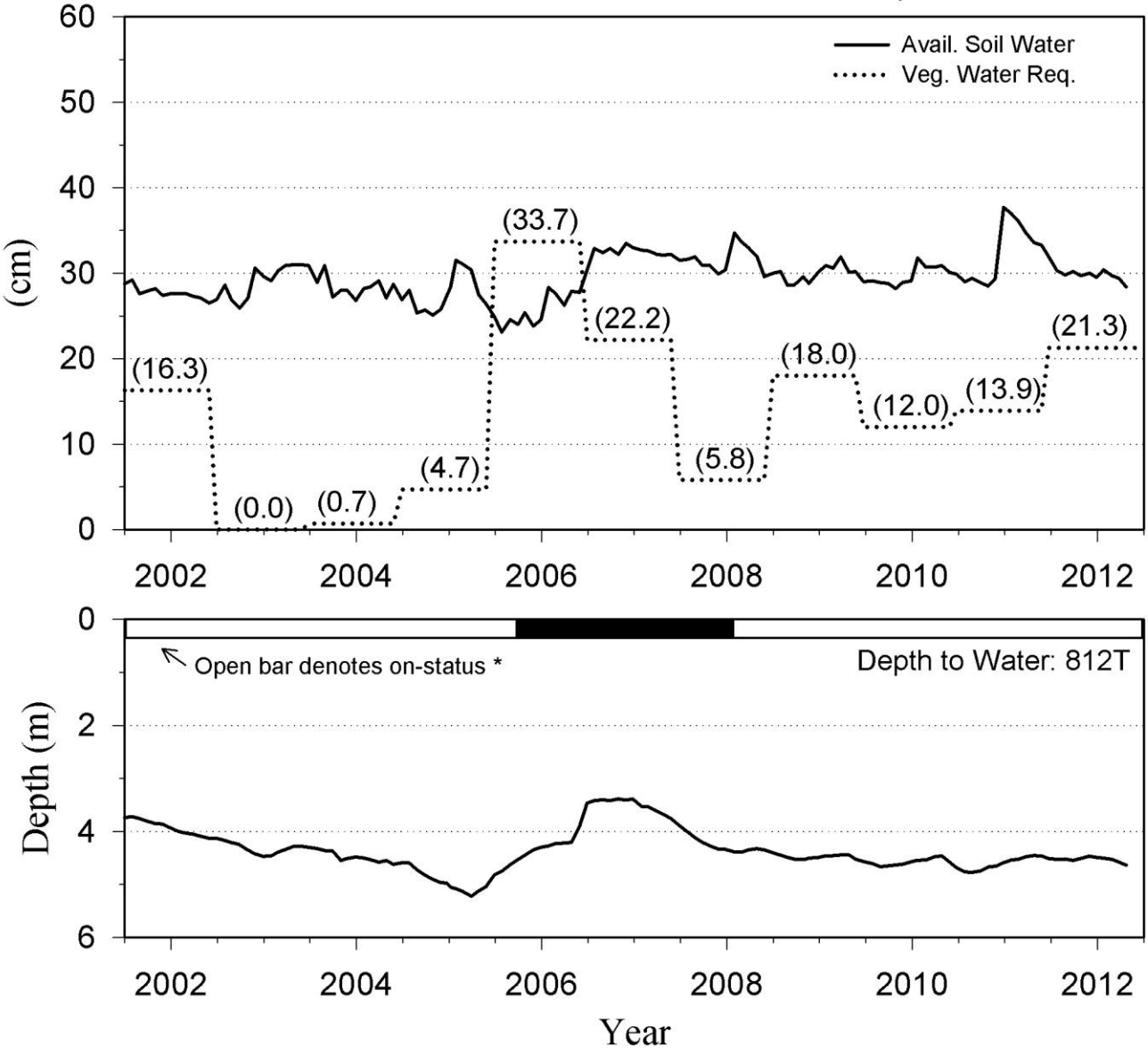
Linked pumping wells - 75, 345

Soil water required for turn on (15.9 cm)

New soil water monitoring locations established Nov 1, 2008 and May 1, 2010

BAIRS GEORGES MONITORING SITE #2

Soil-Plant Water Balance and Groundwater Data, 5/1/12



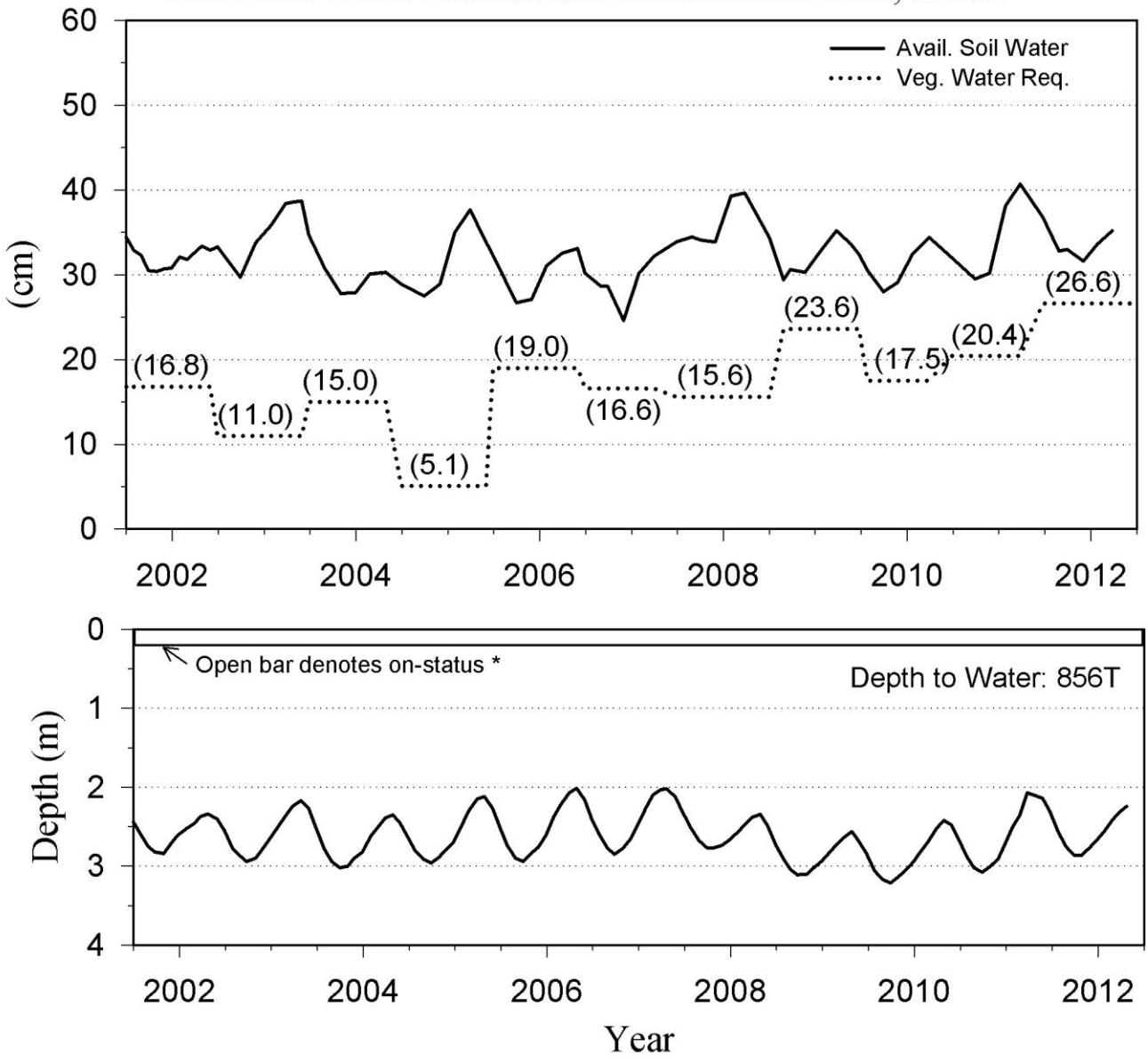
* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Linked pumping wells - 76, 403, 343, 348

Soil water required for turn on (--)

BAIRS/GEORGES CONTROL SITE

Soil-Plant Water Balance and Groundwater Data, 5/1/12



* Wells not necessarily operated when in on-status. On\off according to the Green Book Section III values for Veg. Water Req.

Soil water required for turn on (--)