ANNUAL REPORT FOR 2002

Haws Run Mitigation Site

Pender and Onslow County

Project No. 6.259002T

TIP No. R-2405WM

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North Carolina Department of Transportation
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SUMMARY

The following report summarizes the monitoring activities that have occurred in the past year at Haws Run Mitigation Site. This site was constructed in 1998 and planted in early 1999. This is the fourth year of monitoring after site construction. The site must demonstrate both hydrologic and vegetation success for a minimum of five consecutive years.

Restoration activities at Haws Run included swamp forest and pine savanna restoration, enhancement, and preservation components. The site is equipped with 25 groundwater-monitoring gauges, 2 surface gauges, and one rain gauge.

The daily rainfall data depicted on the monitoring gauge graphs is recorded from an on-site rain gauge, which was installed in July 2001. Historical rainfall data used for the 30-70 percentile was recorded at the Wilmington rain gauge, maintained by the NC State Climate Office. The on-site rain gauge experienced gauge malfunctions twice during the growing season, during these periods the Wilmington rain gauge data was used for Appendix A graphs.

Hydrologic monitoring results are presented by three methods: jurisdictional wetland criteria, average depth to groundwater, and duration of soil saturation.

Based on jurisdictional wetland criteria, the Haws Run mitigation site met hydrologic success for the 2002-year. In the swamp forest area, all gauges met or exceeded the 12.5% jurisdictional wetland criteria. In the pine savanna area, all gauges recorded hydroperiods 8% or greater of the growing season. All gauges along the haul road, with the exception of HR-24, dramatically improved from last year, and met the jurisdictional criteria of 12.5%.

Hydrologic patterns of flooding in the restoration areas across Haws Run Mitigation site followed patterns in the reference areas. The duration of saturation between the restoration gauges and the reference gauges were also very comparable for the swamp, savanna, and haul road areas.

Vegetation monitoring consists of three 500 feet X 500 feet sample plots in the savanna areas, and seven 50 feet X 50 feet sample plots within the bottomland hardwood area. Various types of grasses were planted in ten 100’ x 100’ test plots. Vegetation success criteria were met for 2002, with 31 trees per acre in the savanna area and 517 trees per acre in the swamp forest area. The planted grass areas revealed that they were establishing well.

NCDOT will continue to monitor the hydrology and vegetation on the Haws Run Mitigation site to demonstrate successful achievement of the mitigation plan.

1.0 INTRODUCTION

1.1 Project Description

The Haws Run Mitigation Site was purchased in 1995 by the North Carolina Department of Transportation (NCDOT) to provide compensatory mitigation for unavoidable impacts to wetlands resulting from highway construction in the region. The site is located approximately 28 miles northeast of Wilmington, North Carolina, straddling the Pender-Onslow County line. The site consists of riverine swamp forests at the northern and southern ends and a cutover interior of former wet flats and savannas with an extensive ditch and canal system. The central canal and lateral ditches north of the electrical transmission line were plugged in December 1997 for a short –term study to determine effects of ditch-plugging and filling.

Full site construction began in Summer 1998 with excavation of the northern end of the site to the reference swamp elevation and plugging/filling of the central canal and lateral field ditches to the north of the powerline crossing. Construction was completed in February 1999 and the site was planted in the early spring 1999.

Final planting of pond cypress in the savanna area occurred in the Spring of 2000. This planting was delayed due to difficulty in obtaining needed quantities of this particular specie.

After the hurricane season in 1999, the northern slope between the swamp forest and savanna was eroded in several locations. Roadside Environmental Unit in cooperation with the Natural Systems Unit, Division Construction personnel, and the United States Army Corps of Engineers developed a slope remediation plan, dated June 8 2000. Eleven eroded areas were backfilled and stabilized with stone lined swales. Two areas were stabilized with seeding and matting. A low berm was constructed to direct overland flow into the stabilized swales. This slope constitutes the transition zone between the swamp restoration area and the savanna restoration area. No wetland mitigation credit is expected from this zone. A revised debit ledger is included with this report.

The adjacent land owned by The Nature Conservancy is being evaluated for potential wetland mitigation. The site consists of approximately 720 acres, including clear cuts, natural forests, and pine plantations. Several ditches, including the canal along the eastern boundary of Haws Run drain the site. Currently the site is being monitored with RDS gauges to determine existing hydrologic and ditch effects.

1.2 Purpose

In order to demonstrate successful mitigation, hydrologic and vegetative monitoring must be conducted for a minimum of five consecutive years. Development of the success criteria is discussed in the Haws Run Mitigation Plan. The following report documents the results of the hydrologic and vegetative monitoring activities in the year 2002 at the Haws Run mitigation site.

1.3 Project History

Winter 1997	Pilot Study
Sum 1998 – Winter 1999	Site Construction
Spring 1999	Site Planted (entire site, except pond cypress)
October 1999	Vegetation Monitoring (Year 1)
March – November 1999	Hydrologic Monitoring (Year 1
March 2000	Pond Cypress Planting Completed
August - October 2000	Slope Repair
October 2000	Vegetation Monitoring (Restart Year 1)
March – November 2000	Hydrologic Monitoring (Year 2)
October 2001	Vegetation Monitoring (Year 2)
March – November 2001	Hydrologic Monitoring (Year 3)
July 2002	Vegetation Monitoring (Year 3)
March – November 2002	Hydrologic Monitoring (Year 4)

1.4 Debit Ledger

Haws Run	Mit. Plan			TIP DEBIT	TIP DEBIT	TIP DEBIT
Pender/Onslow Co. Habitat	Acres at Start:	Acres Remaining		U-2107	R-2405C	U-3616
Swamp Forest Restoration	26	11.8	12.00	14.2		
Swamp Forest Enhancement	25	25	100.00			
Swamp Forest Preservation	171	171	100.00			
Wet Savanna Restoration	81	49.36	60.94		14.64	17
Wet Savanna Enhancement	99	99	100.00			
Wet Savanna Preservation	11	11	100.00			
Dry Savanna Enhancement	113	113	100.00			
TOTAL	526	480.16	91.29			

* The debit ledger has been revised to reflect comments made at the 2002 Annual Monitoring Report Meeting, March 12, 2003.

Figure 1: Vicinity Map

2.0 HYDROLOGY

2.1 Success Criteria

The Haws Run Mitigation Plan, and the Final Responses to Agency Comments, describe the success criteria for hydrology for the site. The success criteria for the swamp restoration area are based on the hydrologic regime of Sandy Run Swamp reference area. Specifically, the mean depth to groundwater for wells in the swamp restoration area should be at, above, or no more than 25% deeper than the mean depth to groundwater for wells in the reference area.

The success criteria for the pine savanna restoration area were initially tied to the Lanier Quarry Savanna reference site. Subsequent to review by NCDOT and USACE, Lanier Quarry savanna was deemed unsuitable as a reference site. Therefore, the success criteria for Haws Run savanna restoration area reverted to federal guidelines for wetlands as described in the 1987 USACE Wetlands Delineation Manual. These guidelines state that the area must be inundated or saturated (within 12" of the surface) by surface or ground water for a consecutive 12.5% of the growing season. Areas inundated less than 5% of the growing season are always classified as non-wetlands. Areas inundated between 5% - 12.5% of the growing season can be classified as wetlands depending upon factors such as the presence of hydrophytic vegetation and hydric soils.

Success criteria for the area isolated by the forestry haul road was based on reestablishing the hydrologic connection of the area to the southern swamp. The flooding regime and groundwater depths should be similar in each area or show recover of these processes after removal of the haul road.

This document uses three methods to report the hydrologic monitoring results for Haws Run mitigation site: jurisdictional wetland criteria, average depth to groundwater, and duration of soil saturation.

The growing season for Haws Run site was calculated as an average of data from Pender County, Onslow County, and the U.S. Weather Bureau publication, *Low Temperature Probabilities in North Carolina.* Using all three data sets, the average growing season for the Haws Run site was estimated to be 237 days in length, lasting from March 23 to November 15. Therefore, for Haws Run to meet the 12.5% jurisdictional wetland hydrology, the water table must not fall below the 12-inch line for at least 30 consecutive days during the growing season under normal precipitation. This hydroperiod is expected in the swamp forest restoration area. The pine savanna restoration area is expected to support jurisdictional wetland hydrology for 8% to 12.5% of the growing season. This translates into a hydroperiod of 19 to 30 consecutive days during the growing season along with the presence of hydrophytic vegetation and hydric soils.

2.2 Hydrologic Description

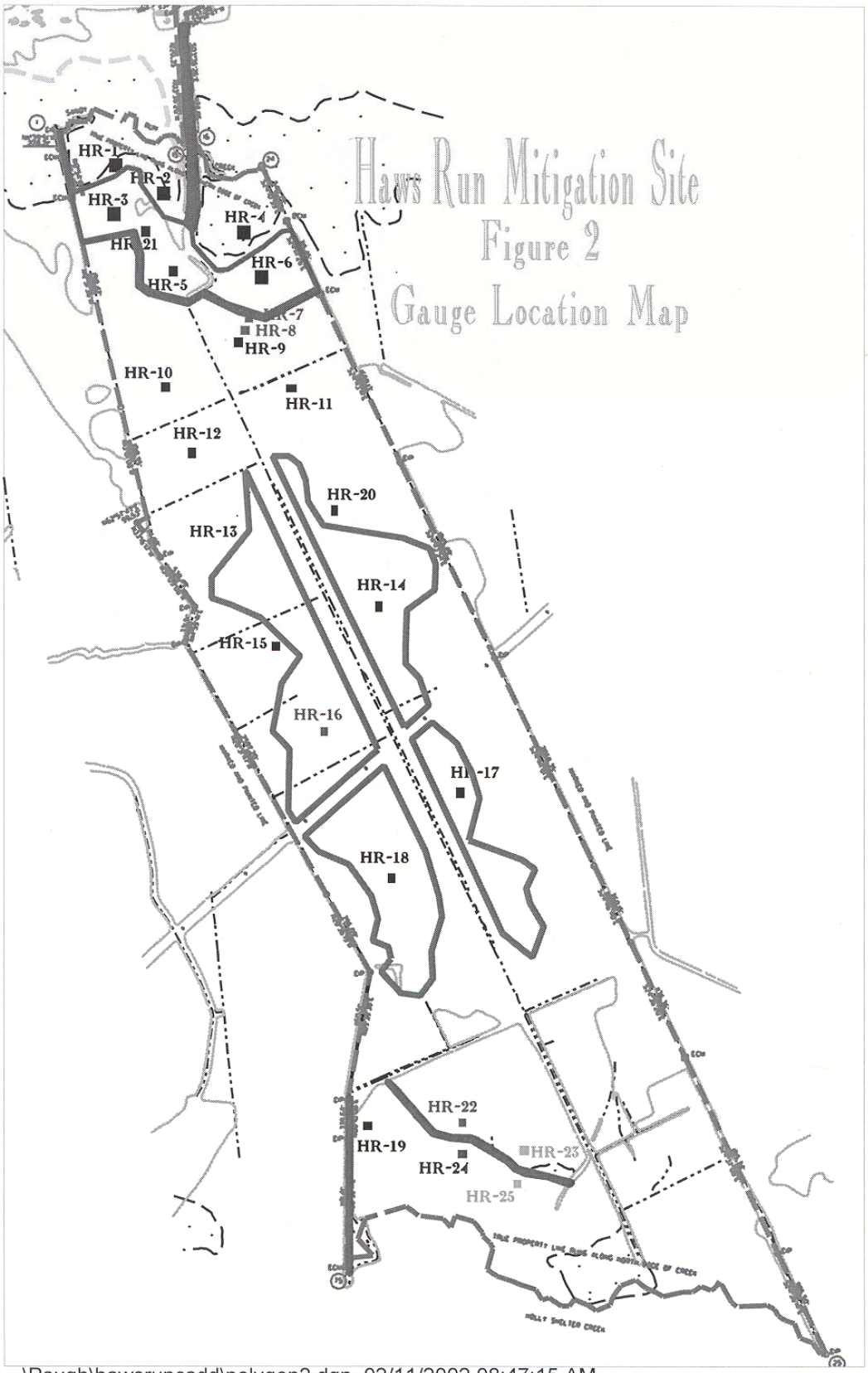
After site construction, nineteen groundwater monitoring gauges (RDS WL-40) were installed on the site (Figure 2). Two additional gauges, HR-20 and HR-21, were installed in early Spring 2000. HR-15 was reported in the 1999 Monitoring report as located in the delineated wetland in the pine savanna reference area. Using GPS, the location of HR-15 fell in the pine savanna restoration area. This revised location is reported below along with all the gauges located at Haws Run.

- three in the swamp reference area (HR –1, HR-2, HR-4)
- five in the swamp restoration area (HR-3, HR-5, HR-6, HR-21) (HR-19 in the southern swamp restoration area)
- two on the slope transition area (HR-7, HR-8)
- six in the pine savanna restoration area (HR-9 through 12, HR-15, HR-20)
- five in the pine savanna jurisdictional wetlands (HR-13, HR-14, HR-16, HR-17, HR-18)

After field inspection in April 1999, monitoring gauges HR-1 through HR-6 were relocated (as shown on Figure 2) to better represent site conditions. Ground surface elevation was surveyed at each well and used to correlate well data for restoration area and reference area comparisons. Based on similar elevations, the following wells were paired for hydrologic monitoring:

- HR-1 and HR-3 at a relative elevation of 6.2 ft
- HR-2 and HR-5 at a relative elevation of 5.8 ft
- HR-4 and HR-6 at a relative elevation of 4.9 ft

There are also four groundwater gauges, HR-22 through 25, and two surface gauges, SG-1and SG-2, located along the forestry haul road which were installed during the pre-construction monitoring phase. All of the monitoring gauges automatically recorded daily depth to groundwater or surface water on the site. Appendix A contains the graphs for each gauge along with daily rainfall data. Appendix B contains comparison graphs of the restoration and reference areas.



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2.3 Results of Hydrologic Monitoring

2.3.1 Site Data

The hydrologic monitoring results from the restoration areas are presented in this report by three methods:

1) Comparison to jurisdictional wetland criteria,
2) Comparison to reference area mean depth to groundwater,
3) Comparison to reference area duration of saturation.

Comparison to Jurisdictional Wetland Criteria

The maximum number of consecutive days that the groundwater was within twelve inches of the surface was determined at each gauge. This number was converted into a percentage of the 237-day growing season. Because of the variability between wetland systems and within wetland types, the monitoring gauge results are segmented into percentage ranges (Figure 3). Table 1 presents the monitoring results for the 2002 growing season as a range of percentages, actual percentages, and success dates of the longest hydroperiod for each gauge on the site. The Reference gauges are indicated in Table 1.

All gauges in swamp forest restoration area achieved the optimum hydrology for jurisdictional wetland criteria of 12.5% of the growing season. Gauges HR-2 and HR-4 exhibited the highest hydrology percentage at 100% for HR-2 and 61.6% for HR-4.

In the pine savanna restoration area, all gauges met the 8%-12.5% jurisdictional hydrology criteria. Gauges HR-15, HR-17, and HR-18 exhibited the highest hydrology percentage at 37.1%

The gauges along the haul road improved from last year. All gauges met the optimum hydrology for jurisdictional wetland criteria of 12.5% of the growing season, with the exception of HR-24, which exhibited soil saturation occurring for 2.1% of the growing season.

Results from gauges located in the reference areas at Haws Run also supported jurisdictional hydrology for the swamp forest and pine savanna. Gauges in the haul road reference area had mixed results; HR-25 met with 14.8% while HR-24 met for only 2.1%. NCDOT will investigate gauge HR-24 to determine any associated problems for this gauge not meeting success in the haul road area.

Haws Run Mitigation Site

Figure 3

Hydrologic Success Map

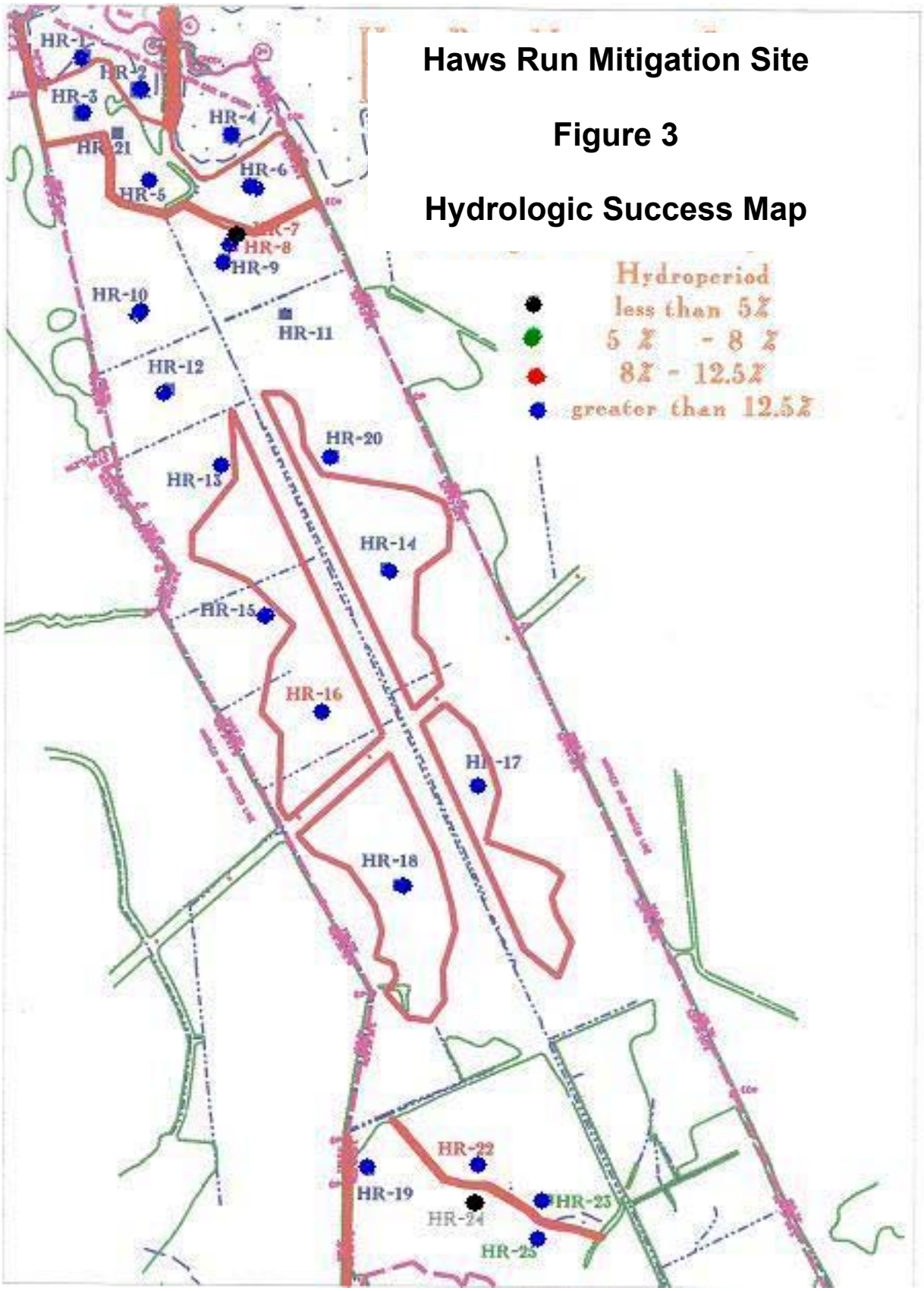


Table 1. 2002 HYDROLOGIC MONITORING RESULTS

	Monitoring Gauge	< 5% (<12 dy)	5 - 8% (12-19 dy)	8 – 12.5% (20-30 dy)	> 12.5% (>31 dy)	Actual %	Dates Meeting Success
Swamp Forest	HR-1* Ref				✔	37.1	3/23-6/13 6/15-7/8 8/20-11/15
	HR-2 Ref				✔	59.9	3/23-8/11 8/20-11/15
	HR-3				✔	37.1	3/23-5/26 8/20-11/15
	HR-4 Ref				✔	61.6	3/23-8/15 8/20-11/15
	HR-5				✔	35.0	3/23-5/2 8/24-11/15
	HR-6				✔	100.0	3/23-11/15
	HR-19				✔	23.2	3/2-5/16 8/28-10/5
	HR-21				✔	34.6	3/23-5/16 8/26-11/15
Transition Slope	HR-7	✔				4.2	
	HR-8				✔	17.3	3/23-5/2
Pine Savanna	HR-9				✔	24.9	3/23-5/20 8/29-10/1
	HR-10				✔	17.3	3/23-5/2
	HR-11				✔	24.9	3/23-5/20
	HR-12				✔	33.8	3/23-6/1 8/28-11/15
	HR-13 Ref				✔	25.7	3/23-5/22 8/28-10/8 10/11-11/15
	HR-14 Ref				✔	25.3	3/23-5/21 8/20-10/5
	HR-15				✔	37.1	3/23-6/13 8/20-11/15
	HR-16 Ref				✔	16.0	3/23-4/29
	HR-17 Ref				✔	37.1	3/23-5/26 8/20-11/15
	HR-18 Ref				✔	37.1	3/23-5/27 8/20-11/15
	HR-20*				✔	35.0	3/23-5/24 8/25-11/15
Haul Road	HR-22				✔	16.0	3/23-4/29
	HR-23				✔	14.8	3/23-4/26
	HR-24 Ref	✔				2.1	
	HR-25 Ref				✔	14.8	3/23-4/26

*Gauge malfunctions at the beginning of the growing season. These gauges experienced data loss, but appeared to be inundated or saturated for more than 12 inches.

Specific Gauge Problems:

- HR-1 experienced gauge malfunctions and stopped recording data (3/11-4/16) (4/25-6/3) (7/29-8/14)
- HR-20 experienced gauge malfunctions and stopped recording data (3/22-4/15) (5/25-7/19)
- Reference Gauge HR-24 showed minimal saturation in existing wetland and will not be included in the reference averages. NCDOT will investigate this gauge.
- HR-19 is located in the southern swamp restoration area therefore it was not included in the restoration average since it's performing in a different system.

Comparison of Average Depth to Groundwater

The average depth to groundwater for both the reference and restoration area gauges was calculated and plotted for the growing season (Appendix B). Appendix B also contains the comparisons of depth to groundwater for paired gauges. The results are presented as a percentage of the days when the depth to groundwater in the restoration area was at, above, or no deeper than 25% of the depth to groundwater in the reference area. The results are as follows.

- Average Swamp restoration area was comparable for 40.9% of days in the Average Swamp reference area.
- HR-3: 44.7% of days at MW-1.
- HR-5: 29.5% of days at MW-2.
- HR-6: 97% of days at HR-4.

- Average Pine Savanna restoration area was comparable for 59.1% of days in the Average Pine Savanna reference area.

- Average Haul road restoration area was comparable for 72.6% of days in the Average Haul road reference area.

Comparison of Duration of Saturation

For each well, the longest hydroperiod i.e., the number of consecutive days of soil saturation (free water table) within 12 inches of the surface, was calculated and averaged for the restoration areas and the reference areas. The average hydroperiod for the restoration area is reported as a percentage of the average hydroperiod for the reference area. The comparison is also made for the paired wells. The results are as follows.

- Average Swamp restoration area hydroperiod was 97.7% of Average Swamp reference area hydroperiod.
- HR-3: 100% of HR-1.
- HR-5: 58.5% of HR-2.
- HR-6: 162.3% of HR-4. (Gauge exceeded hydroperiod in reference).

- Average Pine Savanna restoration area hydroperiod was 102% of Average Pine Savanna reference area hydroperiod.

- Average Haul road restoration area hydroperiod was 104.3% of Average Haul road reference area hydroperiod.

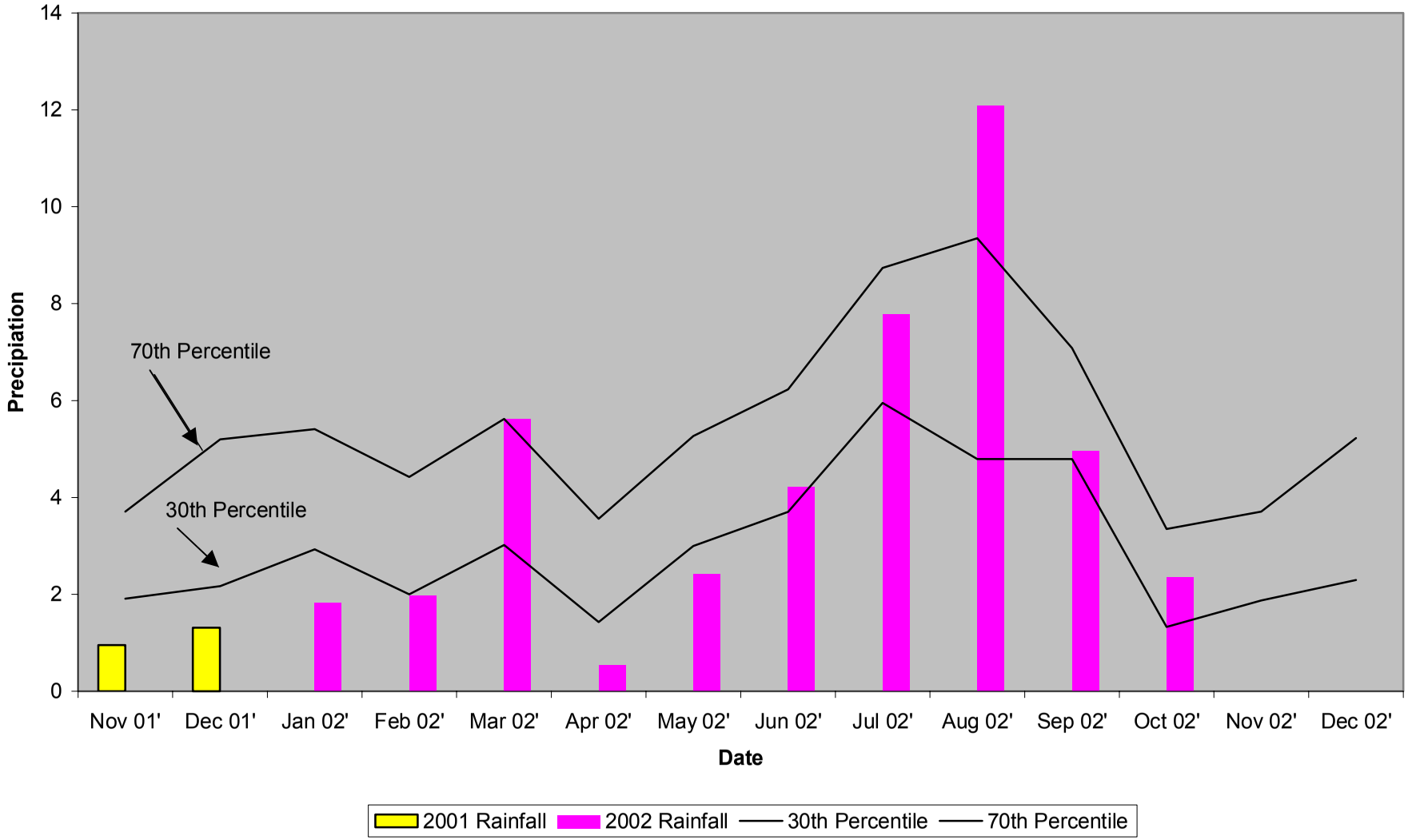
2.3.2 Climatic Data

Figure 4 represents an examination of the local climate in comparison with historical data in order to determine whether 2002 was “average” in terms of climate conditions. The two lines represent the 30th and 70th percentiles of monthly precipitation for Wilmington, NC. The bars are monthly rainfall totals for 2001 and 2002. The historical data was collected from the State Climate Office of North Carolina.

The months of July, September and October were considered “average”. November 01, December 01, January, February, April, May, and June was considered below “normal”. March and August were above “normal” months. Overall the site experienced below average rainfall in 2002

Figure 4

Haws Run 30-70 Percentile Graph 2002
Wilmington, NC



2.4 Conclusions

Based on jurisdictional wetland criteria, the Haws Run mitigation site met hydrologic success for the year 2002. In the swamp forest area, all gauges met or exceeded the 12.5% jurisdictional wetland criteria. HR-6 recorded a substantially longer hydroperiod than rest of the swamp area. It is located in a low area of the swamp restoration that receives and holds runoff from the adjacent land. The swamp reference area gauges showed similar results. In the pine savanna area, all gauges recorded hydroperiods 8% or greater than the growing season. The pine savanna reference area at Haws Run also showed results similar to the restoration area. Results at the haul road area substantially improved. All gauges met the optimum hydrology for jurisdictional wetland criteria of 12.5% of the growing season, with the exception of HR-24.

Hydrologic patterns in the restoration areas across Haws Run Mitigation site did follow patterns in the reference areas. Flooding frequency and depth in the swamp restoration area coincided with flooding in the swamp reference area. The comparison plots in Appendix B clearly illustrate the restoration hydrologic regime coinciding with the reference area hydrologic regime. The water table did decline quicker in the swamp restoration area than in the swamp reference area, resulting in less storage time. This can be partially attributed to differences in soil organic matter content and surface roughness between the two areas. Gauge HR-19 is located in the southern swamp restoration area therefore it was not included in the restoration average since it's performing in a different system.

The plots in Appendix B show the similarities in hydrologic regime between the savanna reference and restoration areas. Average restoration and reference area values were very similar in the pine savanna area.

The average hydrologic regime for the haul road restoration area was very similar to the reference area; the flooding patterns coincided very well. The data illustrated the effects of removal of the haul road, reestablishing the hydrologic connection of the isolated area to the southern swamp area. Data for reference gauge HR-24 in the haul road was not used in the reference averages due to its minimal saturation. NCDOT will further investigate this gauge.

The duration of saturation between the restoration gauges and the reference gauges were also very comparable for the swamp and savanna areas. The average length of the hydroperiod for Swamp Forest restoration area was approximately 122 days compared to 125 days of the reference area hydroperiod. For the Pine Savanna area, the average hydroperiod length for the restoration area was approximately 68 days compared to 67 days for the reference area. The restoration gauges in the haul road area indicated an average hydroperiod of 36 days compared to 35 days for the reference area. The hydroperiod results indicate that the saturation among the restoration and reference areas is very similar.

3.0 VEGETATION: HAWS RUN MITIGATION SITE (YEAR 3 MONITORING)

3.1 Success Criteria

A. Savanna Areas

Success Criteria states that there must be a minimum of 20 trees per acre living for at least five consecutive years.

B. Swamp Forest Area

NCDOT will monitor the site for five years. A 320 stems per acre survival criterion for planted seedlings will be used to determine success for the first three years. The required survival criterion will decrease by 10% per year after the third year of vegetation monitoring (i.e., for an expected 290 stems per acre for year 4, and 260 stems per acre for year 5). The number of plants of one species will not exceed 20% of the total number of plants of all species planted.

C. Grass Area

No success criterion was established for the planted grass areas.

3.2 Description of Species

A. Savanna Areas

The following tree species were planted in the Savanna Restoration and Enhancement Areas:

Zone 1: Wet Savanna Restoration and Enhancement Area (202 acres)

Pinus palustris, Longleaf Pine

Pinus serotina, Pond Pine

Taxodium ascendens, Pond Cypress

Zone 2: Dry Savanna Enhancement Area (113 acres)

Pinus palustris, Longleaf Pine

B. Swamp Forest Area

The following tree species were planted in the Swamp Forest Area:

Zone 3: Swamp Forest Restoration Area (33 acres)

Nyssa sylvatica var. *biflora*, Swamp Blackgum

Taxodium distichum, Baldcypress

Quercus laurifolia, Laurel Oak

Quercus lyrata, Overcup Oak

Quercus michauxii, Swamp Chestnut Oak

Liriodendron tulipifera, Tulip Poplar

Quercus falcata var. *pagodaefolia*, Cherrybark Oak

Fraxinus pennsylvanica, Green Ash

Platanus occidentalis, American Sycamore

C. Grass Area

The following grass species were planted in ten 100' x 100' grass plots:

Wiregrass

Carolina Dropseed

Toothache grass

Savanna muhly

3.3 Results of Vegetation Monitoring

A. Savanna Areas (Table 2)

ZONE	Plot #	Longleaf Pine	Pond Pine	Pond Cypress	Total (3 year)	Density (Trees/Acre)
1	S1	19	131	21	171	30
	S3	57	184	1	242	42
	ZONE 1 AVG.					**36**
2	S2	115			115	20
	ZONE 2 AVG.					**20**
	TOTAL AVG.					**31**

To determine tree density, 500' x 500' plots (5.7 acre) were installed immediately following planting. The actual numbers of planted trees, which occur within the plot, were counted. Since the actual plot size is 5.7 acres, actual trees per acre can be estimated.

Site Notes: Pines in savanna areas growing well. Broomsedge present throughout plots. Trees difficult to find in large plots, especially the small cypresses and longleaf pines.

B. Swamp Forest Area (Table 2)

Plot #	Swamp Blackgum	Baldcypress	Pond Cypress	Laurel Oak	Overcup Oak	Swamp Chestnut Oak	Tulip Poplar	Cherrybark Oak	Green Ash	American Sycamore	Total (3 year)	Total (at planting)	Density (Trees/Acre)
1	8	35			15				5		53	53	680
2	6	9			7	3		3	19		47	53	603
3	1	4			2	6			9		22	34	440
4	3	3			8	7			7		28	35	544
5					19	5		4			28	39	488
6	5			2	5			3	4		19	36	359
7	3	2		3	5			1	6	12	32	43	506
TOTAL AVG.													**517**

Site Notes: Other species noted: Fennel, *Juncus* sp., cattail, *Bidens* sp., *Baccharis halimifolia*, various grasses and sedges, broomsedge, woolgrass, giant cane, *Panicum* sp., fern, bay, *Carex* sp., elder, *Distichlis spicata*, *Eleocharis* sp., sweet bay, sweetgum, red maple, black willow, blackgum, and pine. Plot 1 had 1 to 3 inches of standing water. Plots 3 and 5 had heavy herbaceous vegetation

C. Grass Area

Only visual inspection was done within the grass plots. Grasses appear to be establishing well.

3.4 Conclusions

A. Savanna Areas

Of the 595 acres of this site, approximately 315 acres involved savanna tree planting. There were 3 test plots established throughout the planting. The 2002 vegetation monitoring of the planted areas revealed an average density of 31 trees per acre, which is well above the minimum requirement of 20 trees per acre.

B. Swamp Forest Area

Of the 595 acres of this site, approximately 33 acres involved tree planting. There were 7 test plots established throughout the planting. The 2002 vegetation monitoring of the planted areas revealed an average density of 517 trees per acre, which is well above the minimum requirement of 320 trees per acre.

The transect areas at the southern end of the site were supplementally planted Spring 2000.

The area around plot one has been inundated with water at every site visit (See photos 1 and 2). The planted tree seedlings have not been able to survive in this area. NCDOT supplementally planted this area in March 2002 with bald cypress, swamp blackgum, overcup oak, and green ash. These more wet tolerant trees have survived well in the wet area.

The washouts along the northern side of the site adjacent to the swamp forest area were repaired and are stabilizing. The washes stabilized with stone are doing well. One of the washes stabilized only with matting and vegetation has minor erosion problems (see photo 6 and 7). DOT will continue to monitor these washes throughout the year to determine if further repair is necessary.

C. Grass Area

Of the 595 acres of this site, approximately 2.3 acres involved grass planting. The grasses were planted in ten 100’ x 100’ test plots. The vegetation monitoring of the planted areas revealed that the planted grasses were establishing well.

NCDOT will continue vegetation monitoring at the Haws Run Mitigation Site.

4.0 OVERALL CONCLUSIONS / RECOMMENDATIONS

Overall, the Haws Run Mitigation site performed successfully in 2002. Hydrologic monitoring revealed trends in the restoration areas similar to those in the reference areas. With the exception of HR-24 reference gauge, all gauges on site met the jurisdictional wetland criteria. The gauges also exhibited comparable depths to groundwater and duration of the hydroperiods for the 2002-growing season.

Vegetation monitoring for 2002 revealed the Savanna and Swamp Forest areas are performing successfully, with average densities indicating well above the minimum requirement. The vegetation monitoring of the planted areas revealed that the planted grasses were establishing well.

The potential addition of the adjacent Nature Conservancy land to the Haws Run Mitigation site will provide both hydrologic and habitat benefits.

NCDOT will continue to monitor the site for both vegetation and hydrologic success.

Appendix A
Depth to Groundwater

&

Surface Water Graphs

Appendix B
Comparison of Reference & Restoration Gauges

Appendix C

Site Photos

&

Photo and Plot Locations

HAWS RUN

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

2002

HAWS RUN

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

Photo 12

2002

HAWS RUN

Photo 13

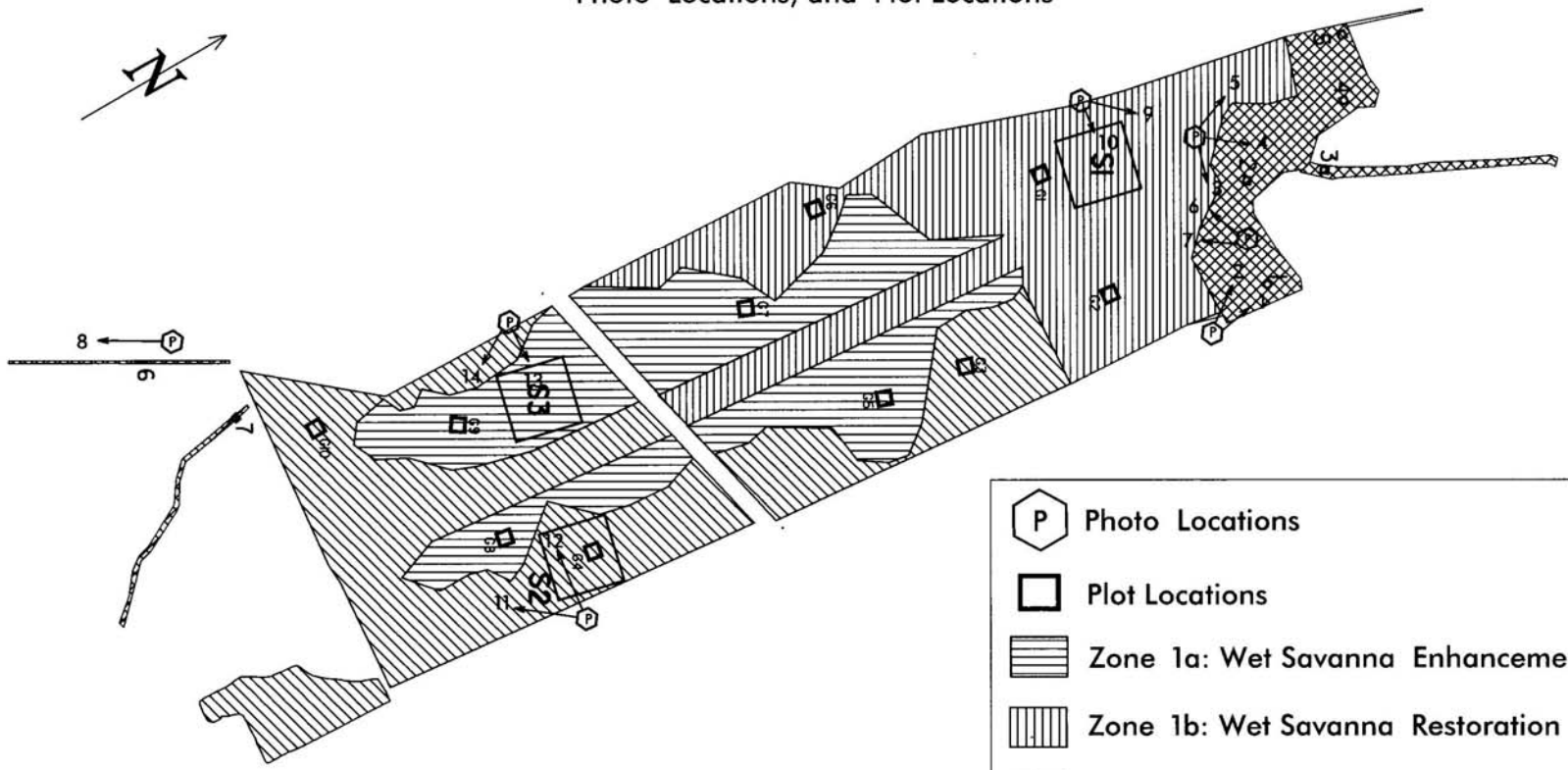
Photo 14

2002

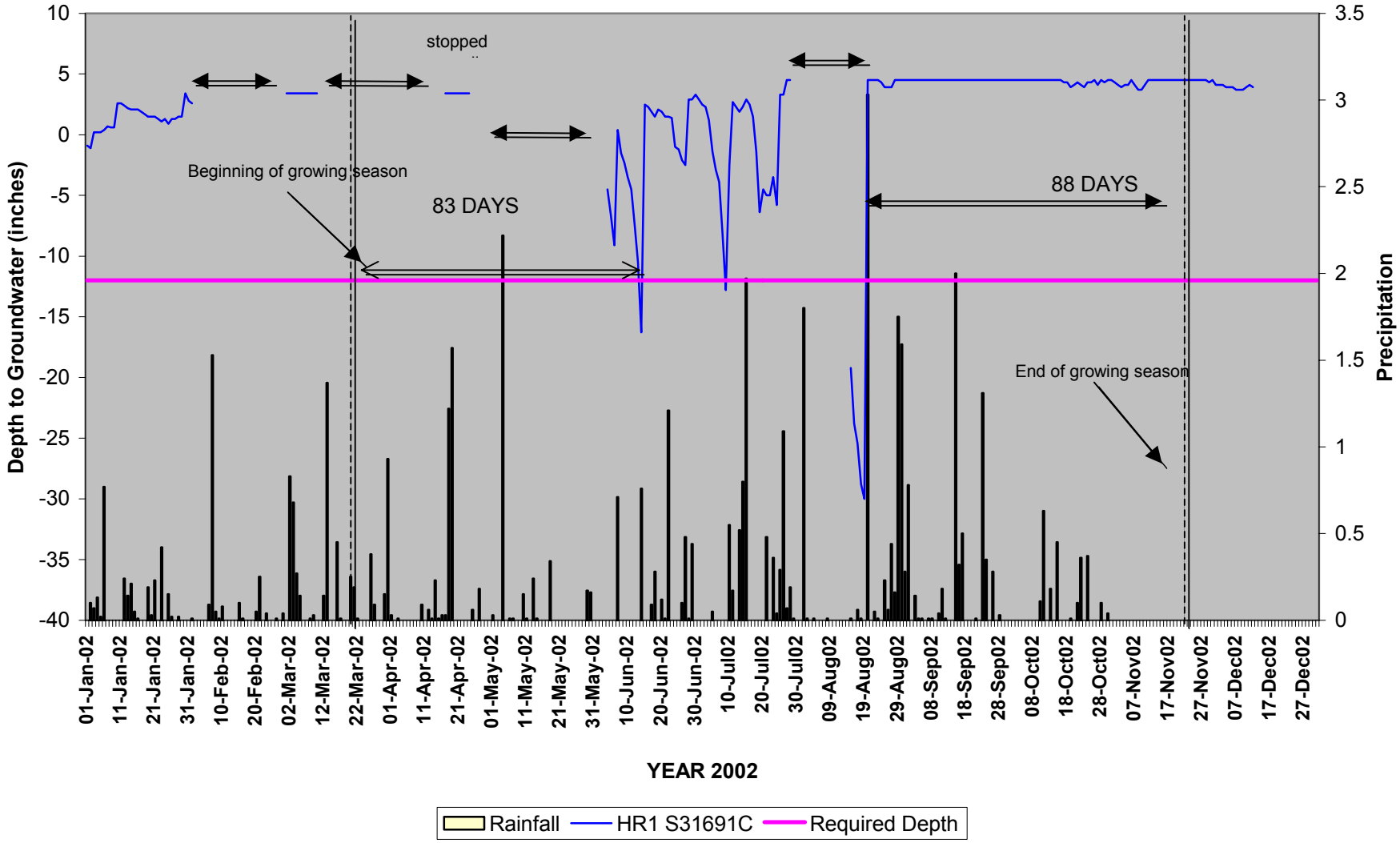
PROJ. REFERENCE NO. R-0525G	SHEET NO. MAP	TOTAL SHEETS
STATE PROJECT NO.	F.A. PROJ. NO.	DESCRIPTION

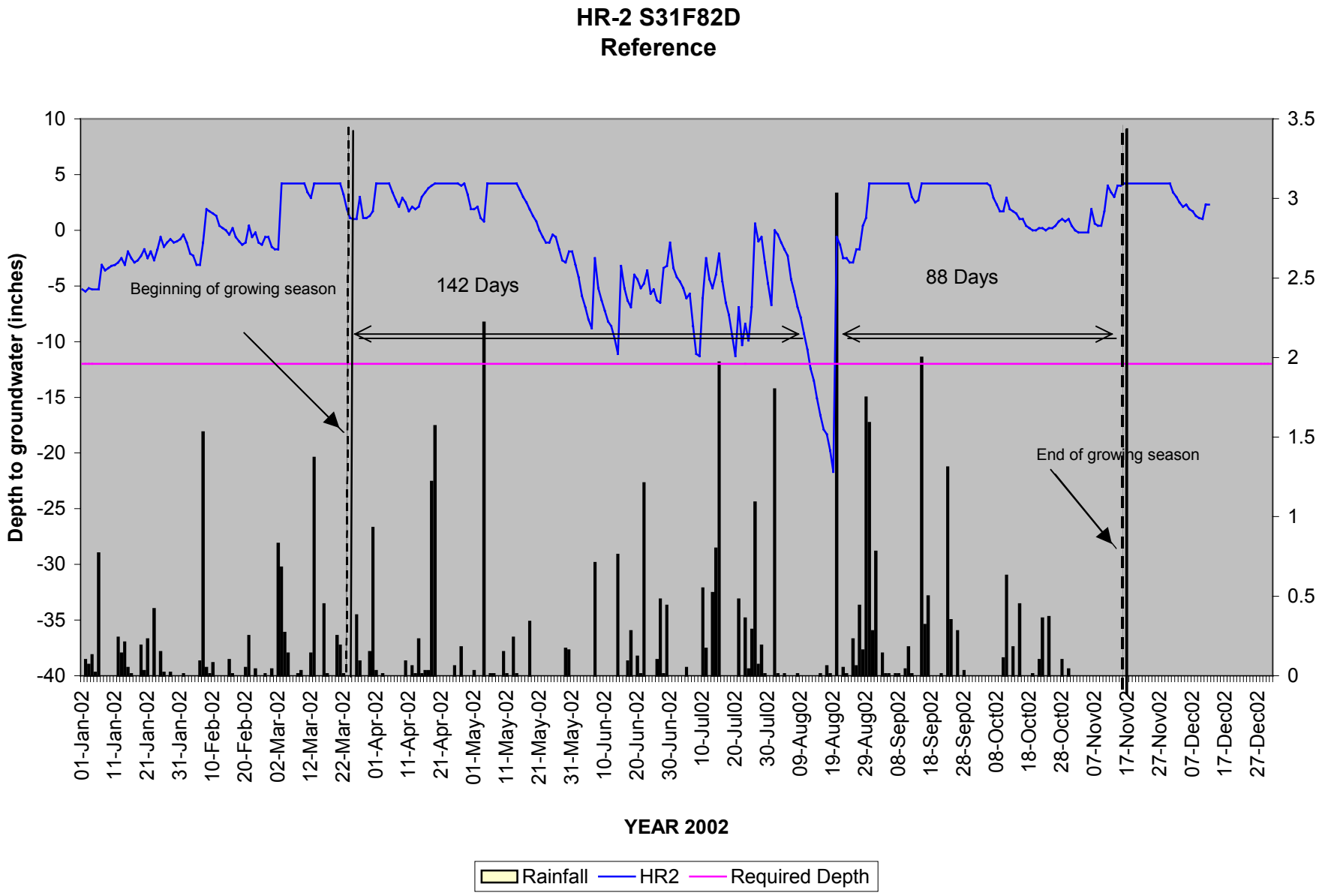
HAWS RUN MITIGATION SITE

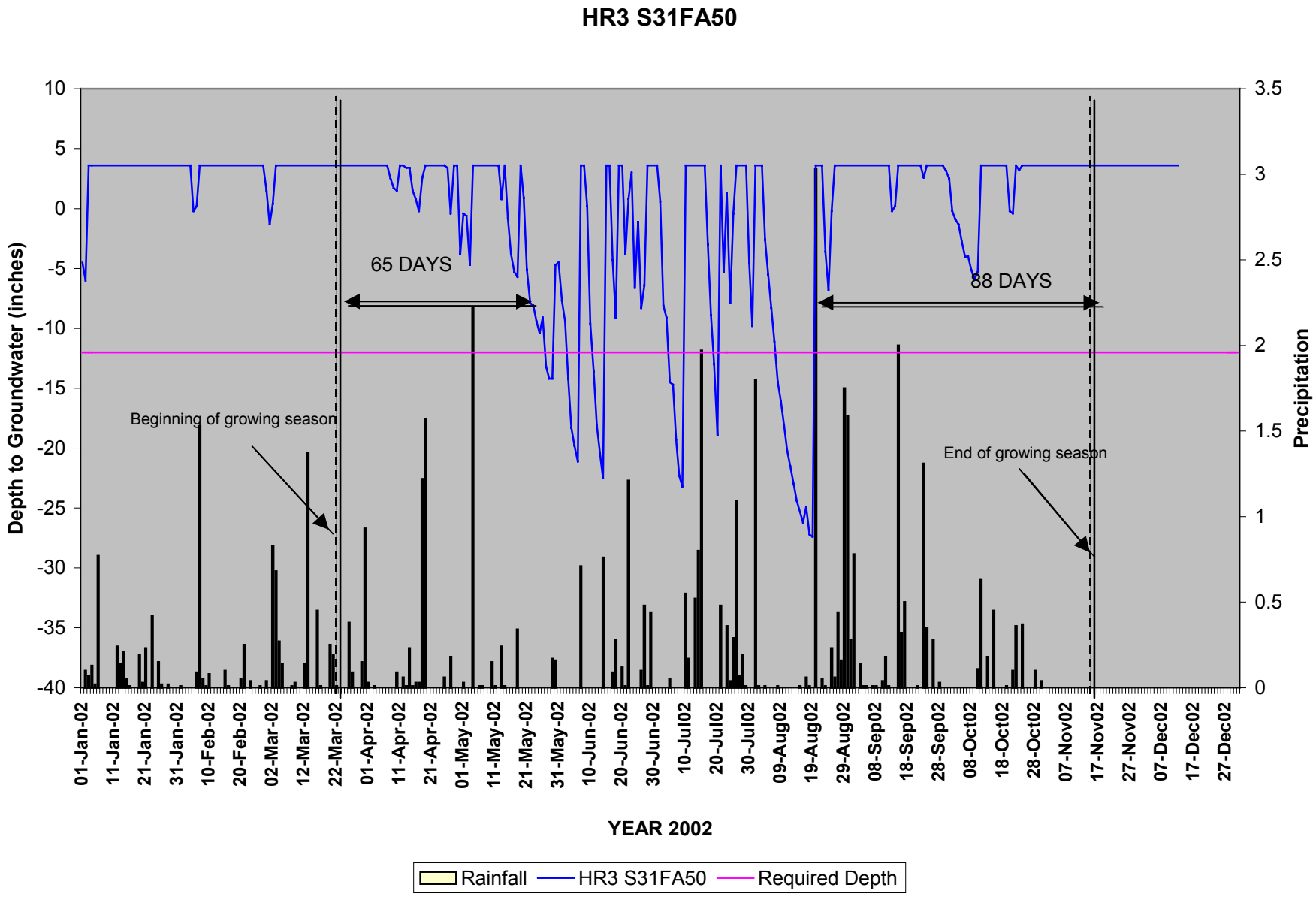
Planting Plan
Photo Locations, and Plot Locations

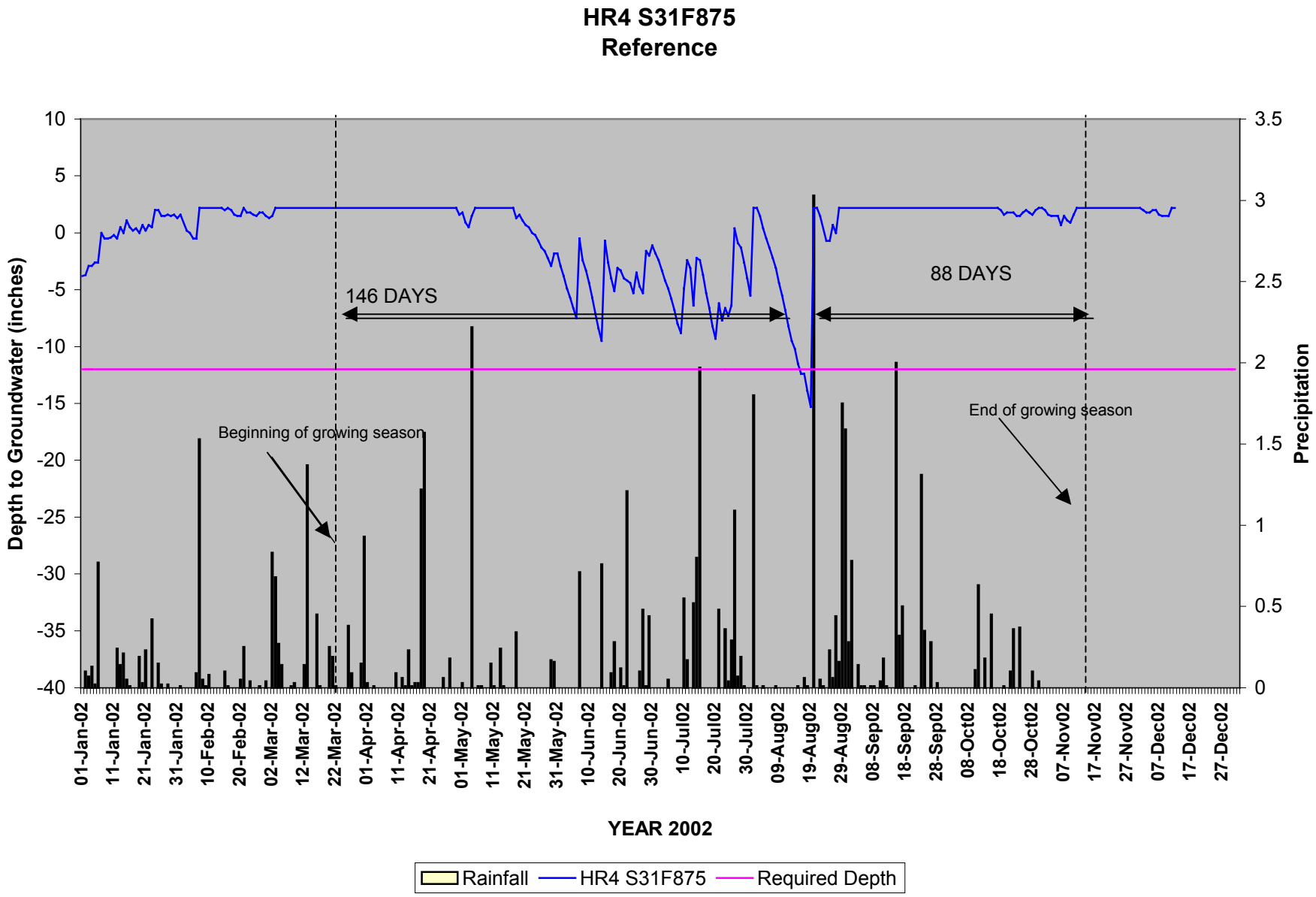


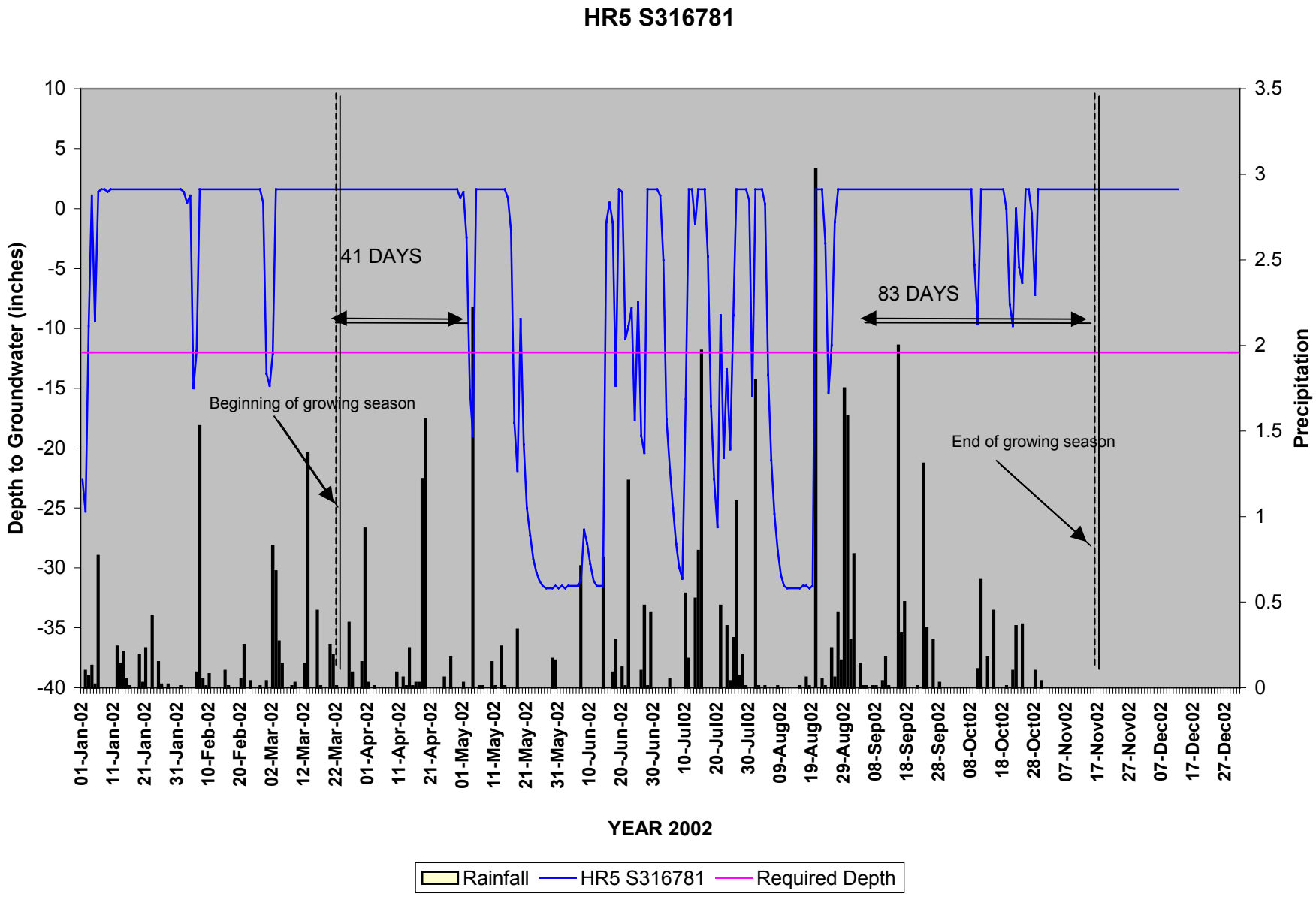
HR1 S31691C
Reference

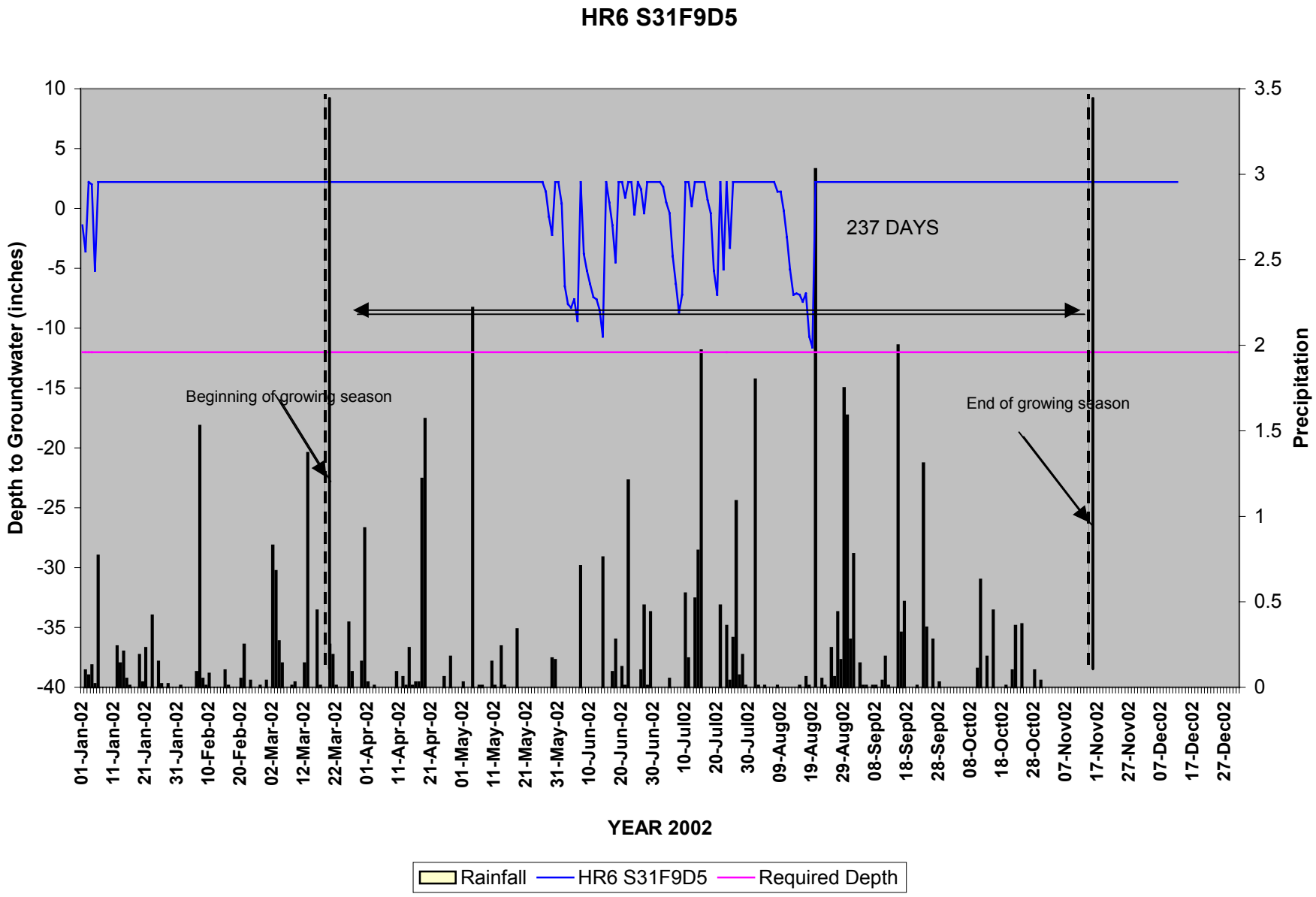


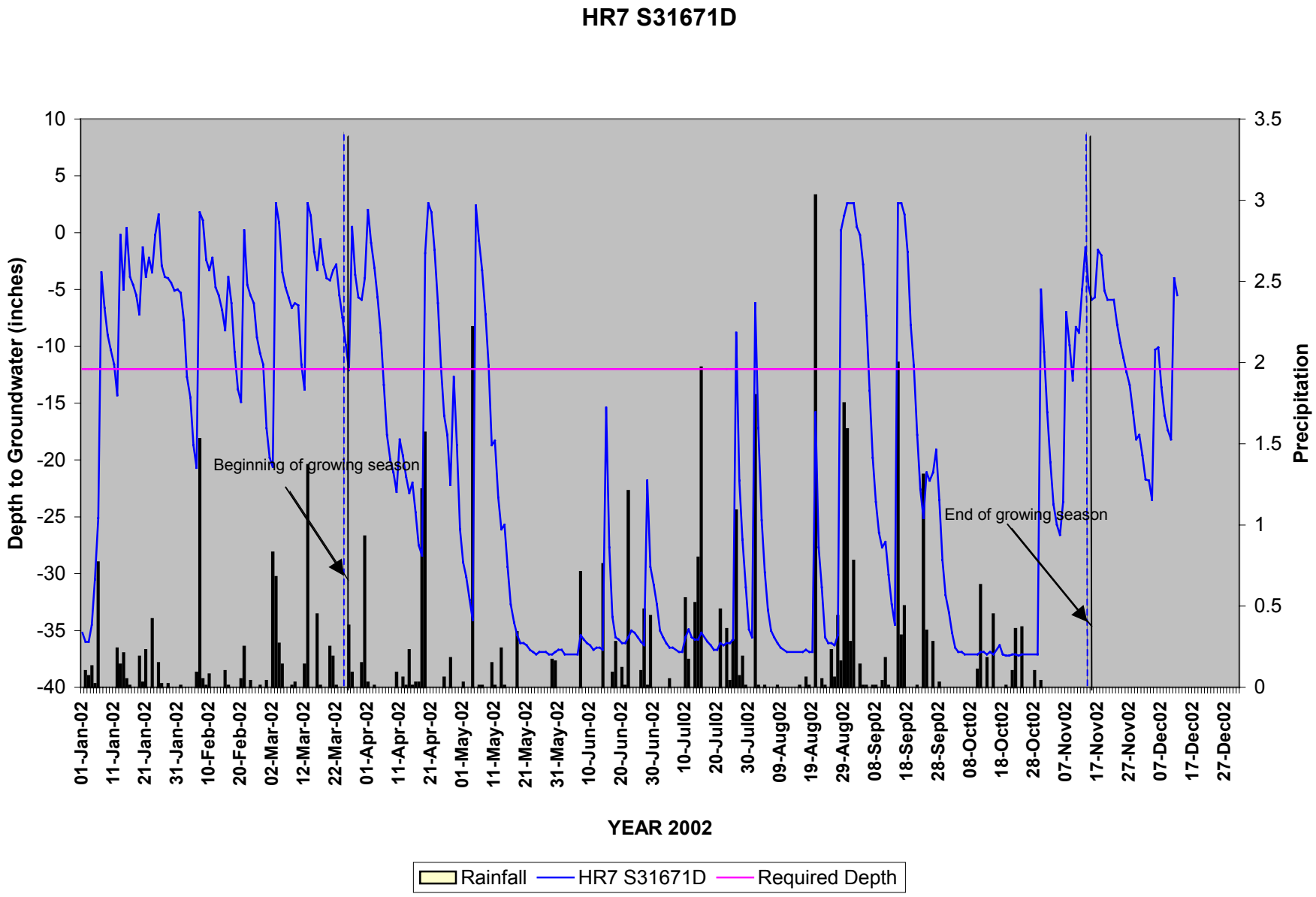

HR-2 S31F82D
Reference
Depth to groundwater (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3.5
3
2.5
2
1.5
1
0.5
0
Beginning of growing season
142 Days
88 Days
End of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar-02
01-Apr-02
11-Apr-02
21-Apr-02
01-May-02
11-May-02
21-May-02
31-May-02
10-Jun-02
20-Jun-02
30-Jun-02
10-Jul02
20-Jul02
30-Jul02
09-Aug02
19-Aug02
29-Aug02
08-Sep02
18-Sep02
28-Sep02
08-Oct02
18-Oct02
28-Oct02
07-Nov02
17-Nov02
27-Nov02
07-Dec02
17-Dec02
27-Dec02
YEAR 2002
Rainfall
HR2
Required Depth

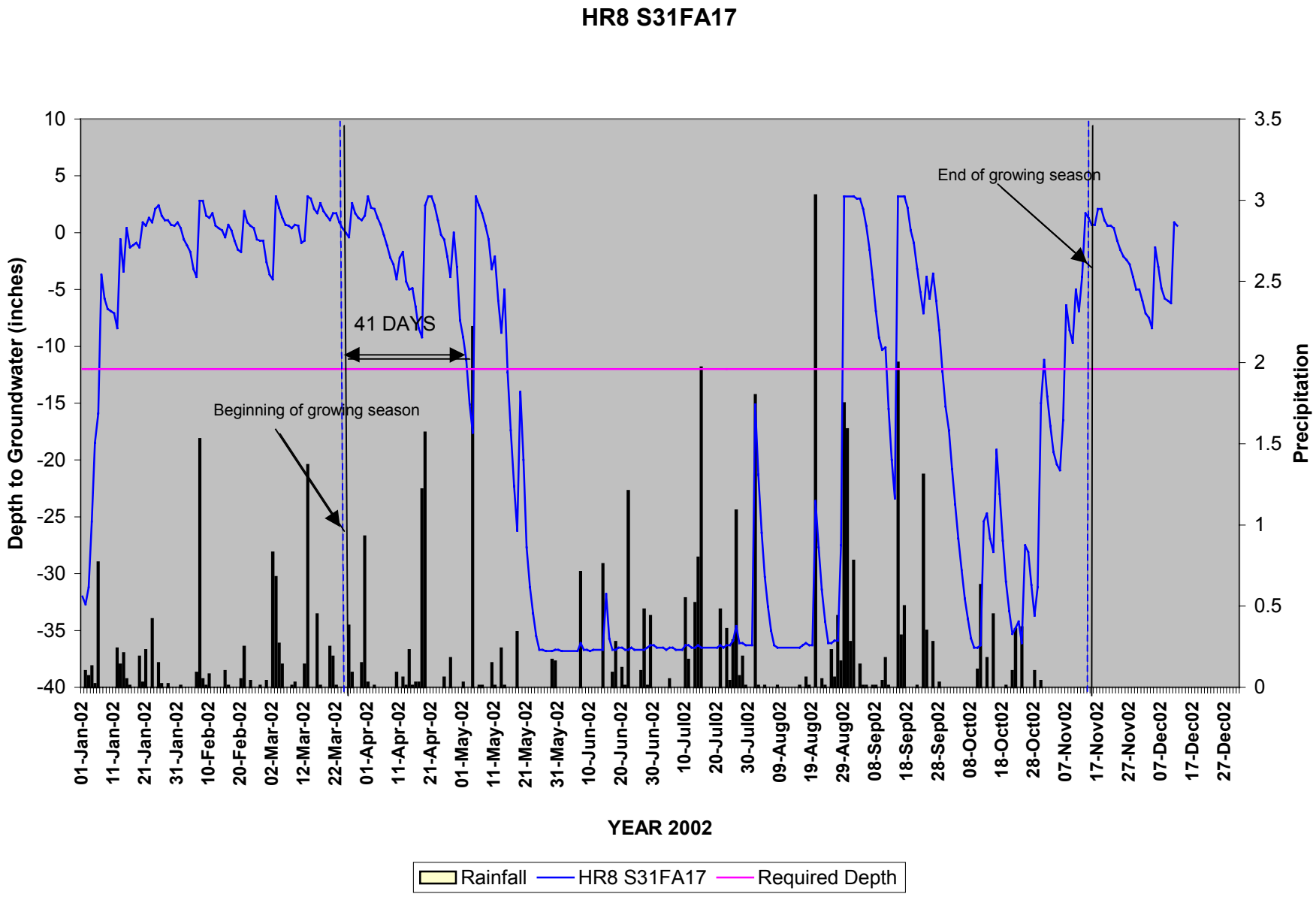

HR3 S31FA50
Depth to Groundwater (inches)
Precipitation
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3.5
3
2.5
2
1.5
1
0.5
0
65 DAYS
88 DAYS
Beginning of growing season
End of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar-02
01-Apr-02
11-Apr-02
21-Apr-02
01-May-02
11-May-02
21-May-02
31-May-02
10-Jun-02
20-Jun-02
30-Jun-02
10-Jul02
20-Jul02
30-Jul02
09-Aug02
19-Aug02
29-Aug02
08-Sep02
18-Sep02
28-Sep02
08-Oct02
18-Oct02
28-Oct02
07-Nov02
17-Nov02
27-Nov02
07-Dec02
17-Dec02
27-Dec02
YEAR 2002
Rainfall
HR3 S31FA50
Required Depth

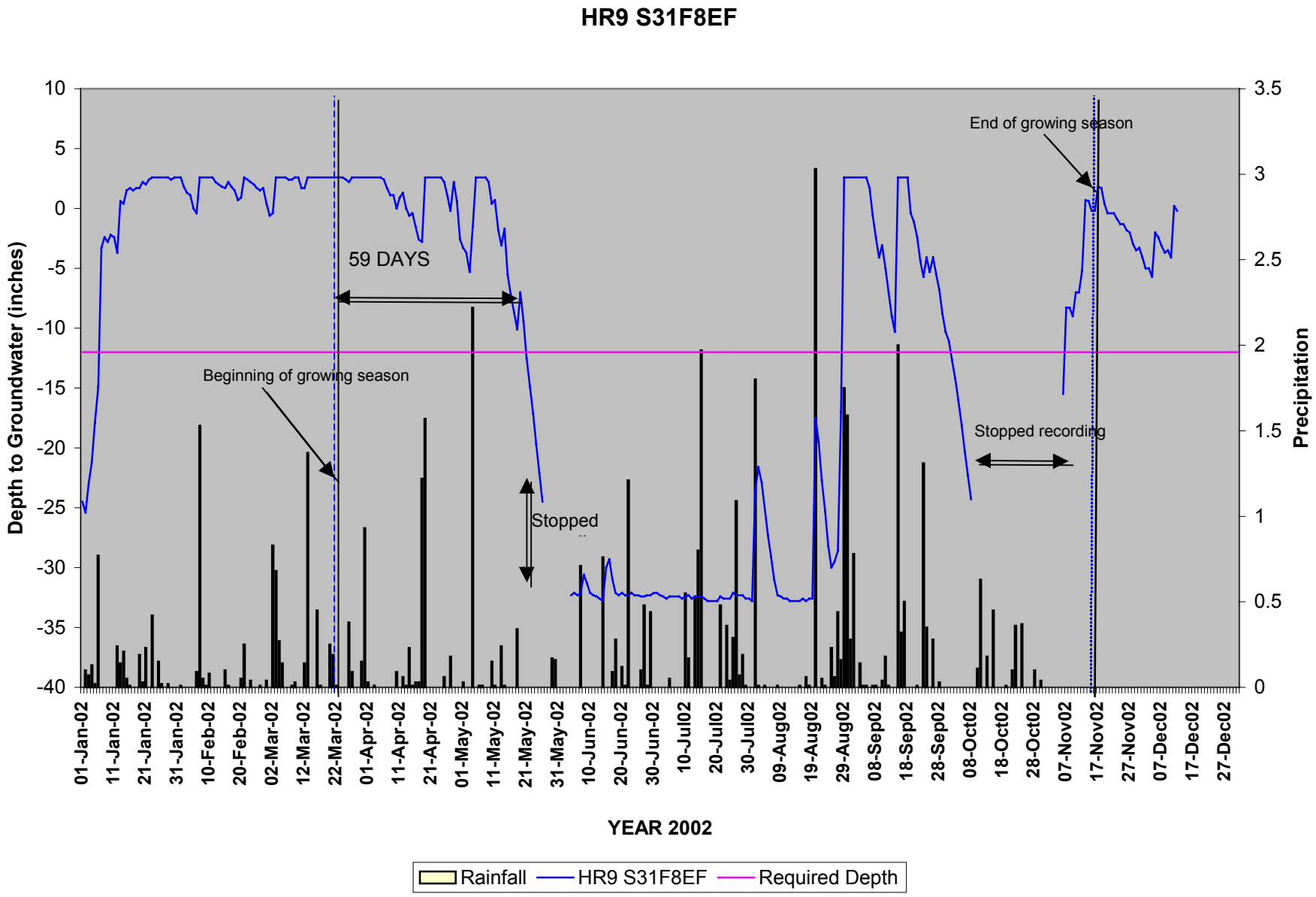

HR4 S31F875
Reference
Depth to Groundwater (inches)
Precipitation
146 DAYS
88 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR4 S31F875
Required Depth

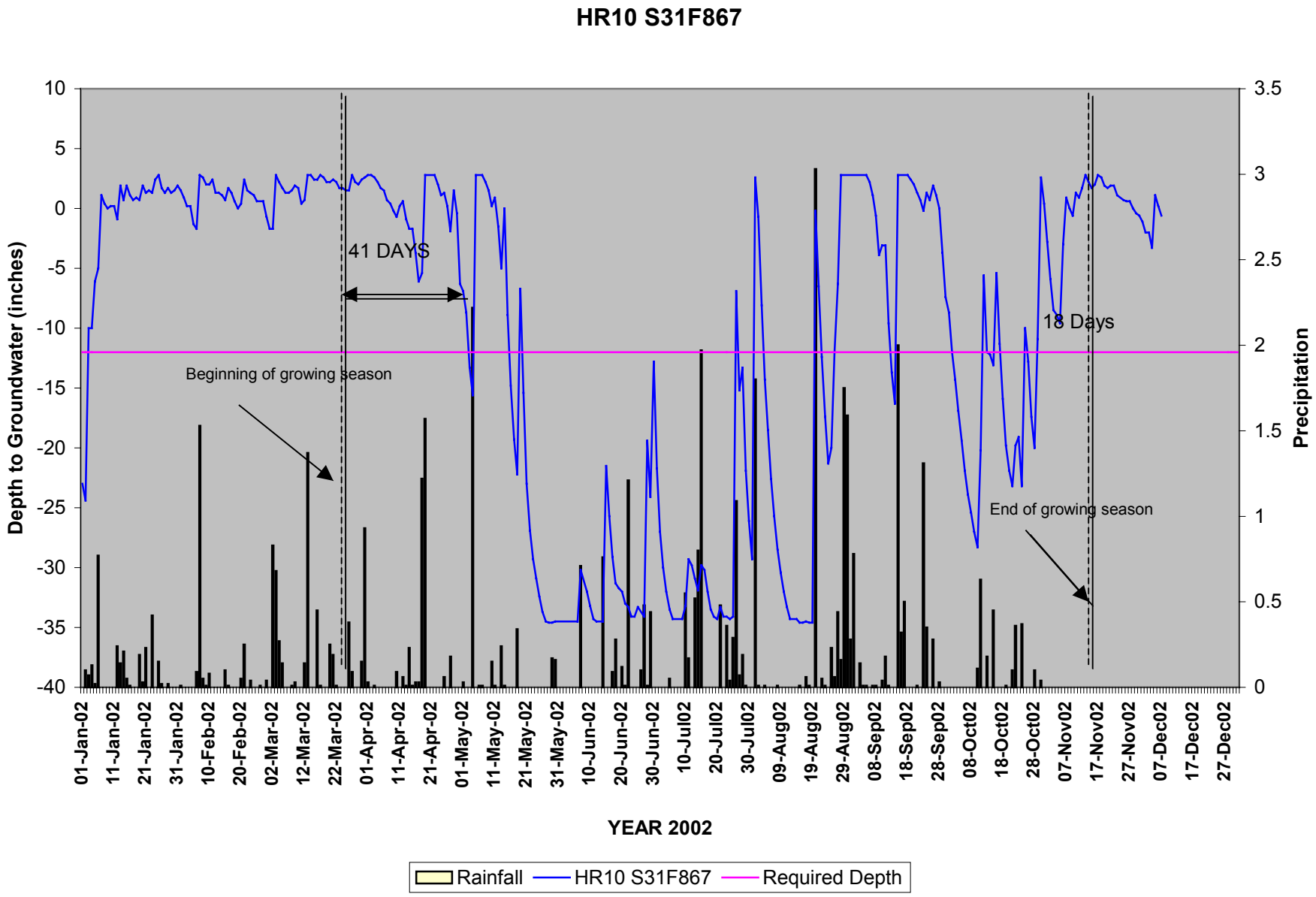

HR5 S316781
Depth to Groundwater (inches)
Precipitation
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3.5
3
2.5
2
1.5
1
0.5
0
41 DAYS
83 DAYS
Beginning of growing season
End of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar-02
01-Apr-02
11-Apr-02
21-Apr-02
01-May-02
11-May-02
21-May-02
31-May-02
10-Jun-02
20-Jun-02
30-Jun-02
10-Jul02
20-Jul02
30-Jul02
09-Aug02
19-Aug02
29-Aug02
08-Sep02
18-Sep02
28-Sep02
08-Oct02
18-Oct02
28-Oct02
07-Nov02
17-Nov02
27-Nov02
07-Dec02
17-Dec02
27-Dec02
YEAR 2002
Rainfall
HR5 S316781
Required Depth

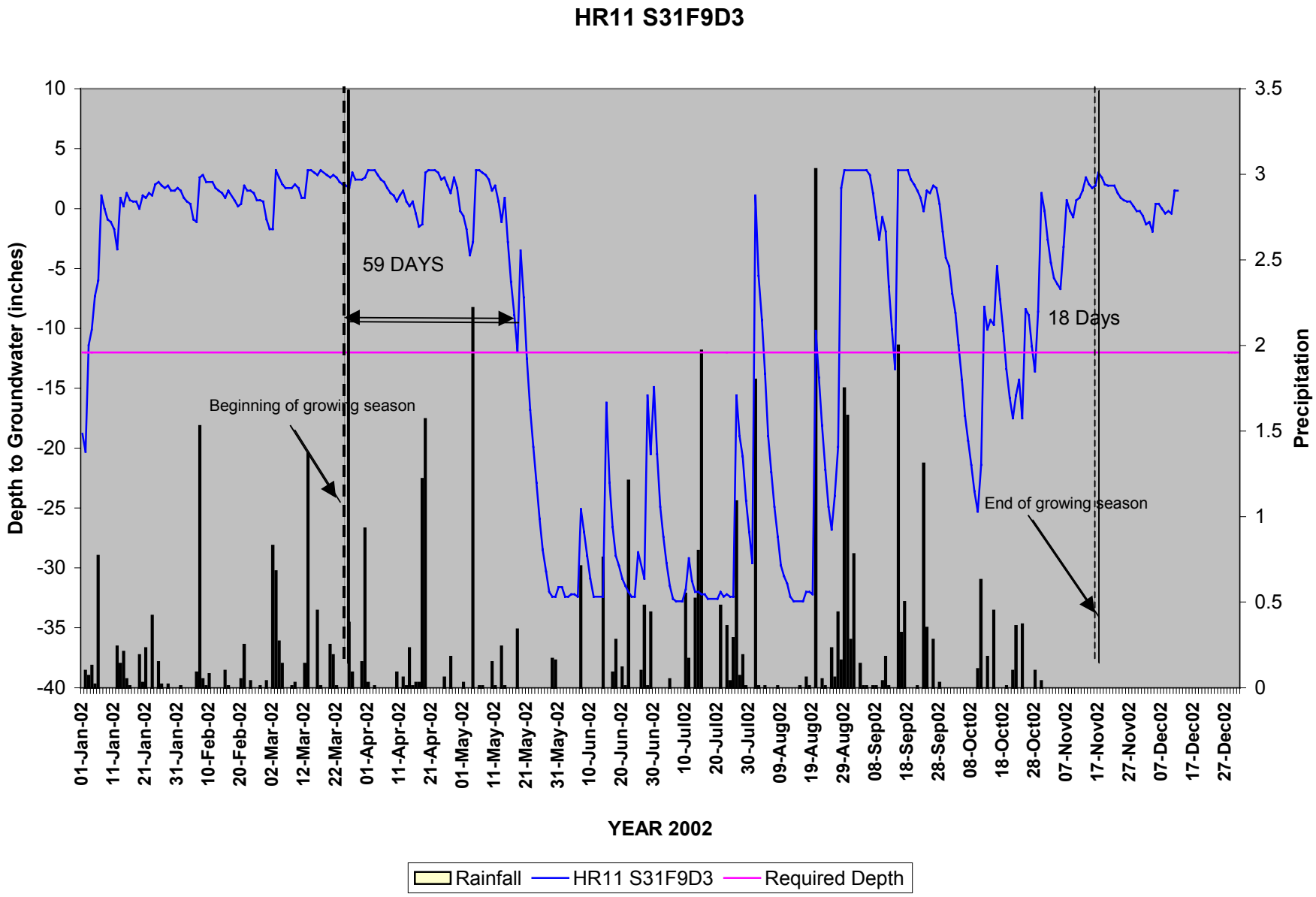

HR6 S31F9D5
Depth to Groundwater (inches)
Precipitation
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3.5
3
2.5
2
1.5
1
0.5
0
237 DAYS
Beginning of growing season
End of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar-02
01-Apr-02
11-Apr-02
21-Apr-02
01-May-02
11-May-02
21-May-02
31-May-02
10-Jun-02
20-Jun-02
30-Jun-02
10-Jul02
20-Jul02
30-Jul02
09-Aug02
19-Aug02
29-Aug02
08-Sep02
18-Sep02
28-Sep02
08-Oct02
18-Oct02
28-Oct02
07-Nov02
17-Nov02
27-Nov02
07-Dec02
17-Dec02
27-Dec02
YEAR 2002
Rainfall
HR6 S31F9D5
Required Depth

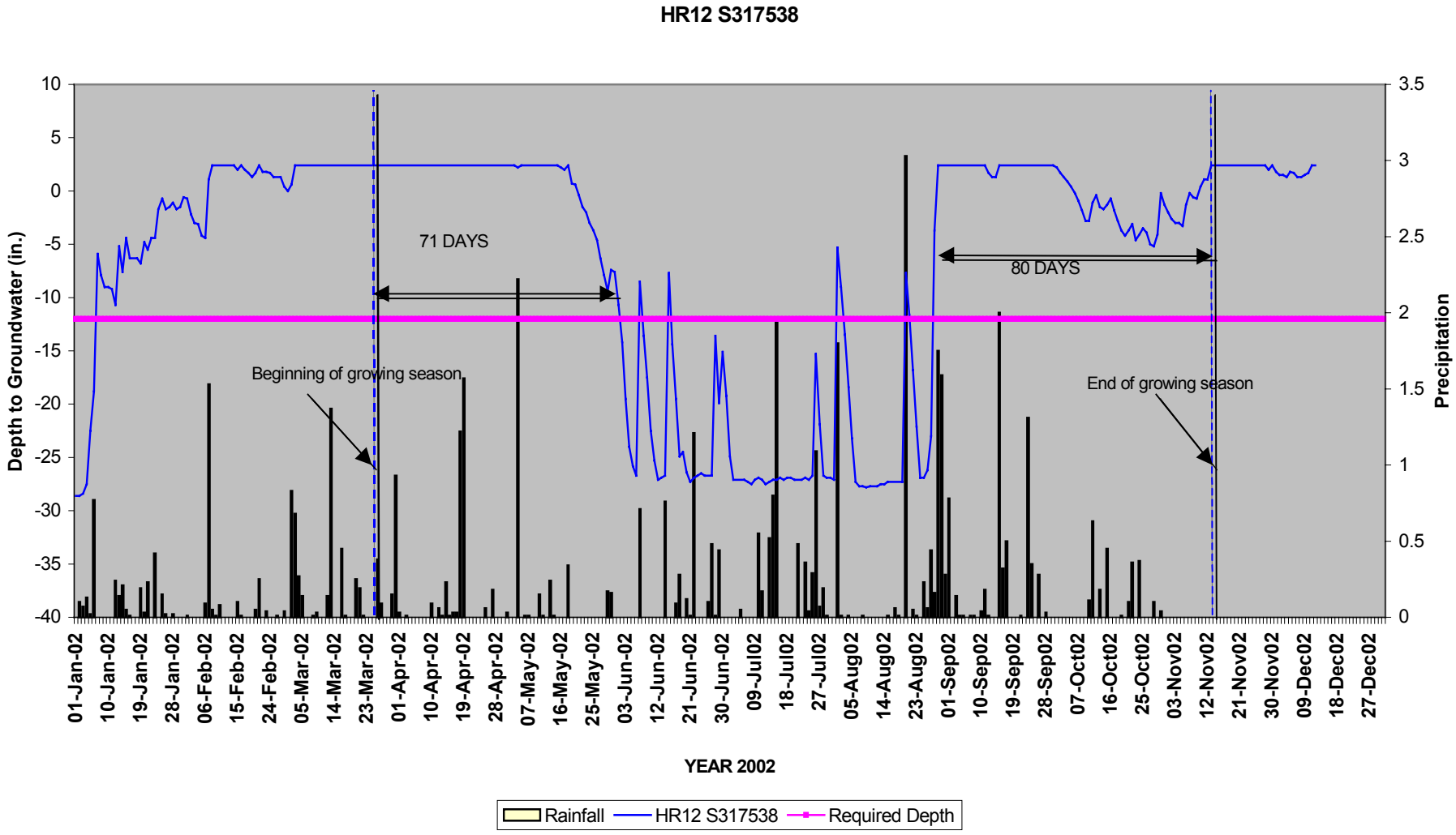

HR7 S31671D
Depth to Groundwater (inches)
Precipitation
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3.5
3
2.5
2
1.5
1
0.5
0
Beginning of growing season
End of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar-02
01-Apr-02
11-Apr-02
21-Apr-02
01-May-02
11-May-02
21-May-02
31-May-02
10-Jun-02
20-Jun-02
30-Jun-02
10-Jul02
20-Jul02
30-Jul02
09-Aug02
19-Aug02
29-Aug02
08-Sep02
18-Sep02
28-Sep02
08-Oct02
18-Oct02
28-Oct02
07-Nov02
17-Nov02
27-Nov02
07-Dec02
17-Dec02
27-Dec02
YEAR 2002
Rainfall
HR7 S31671D
Required Depth

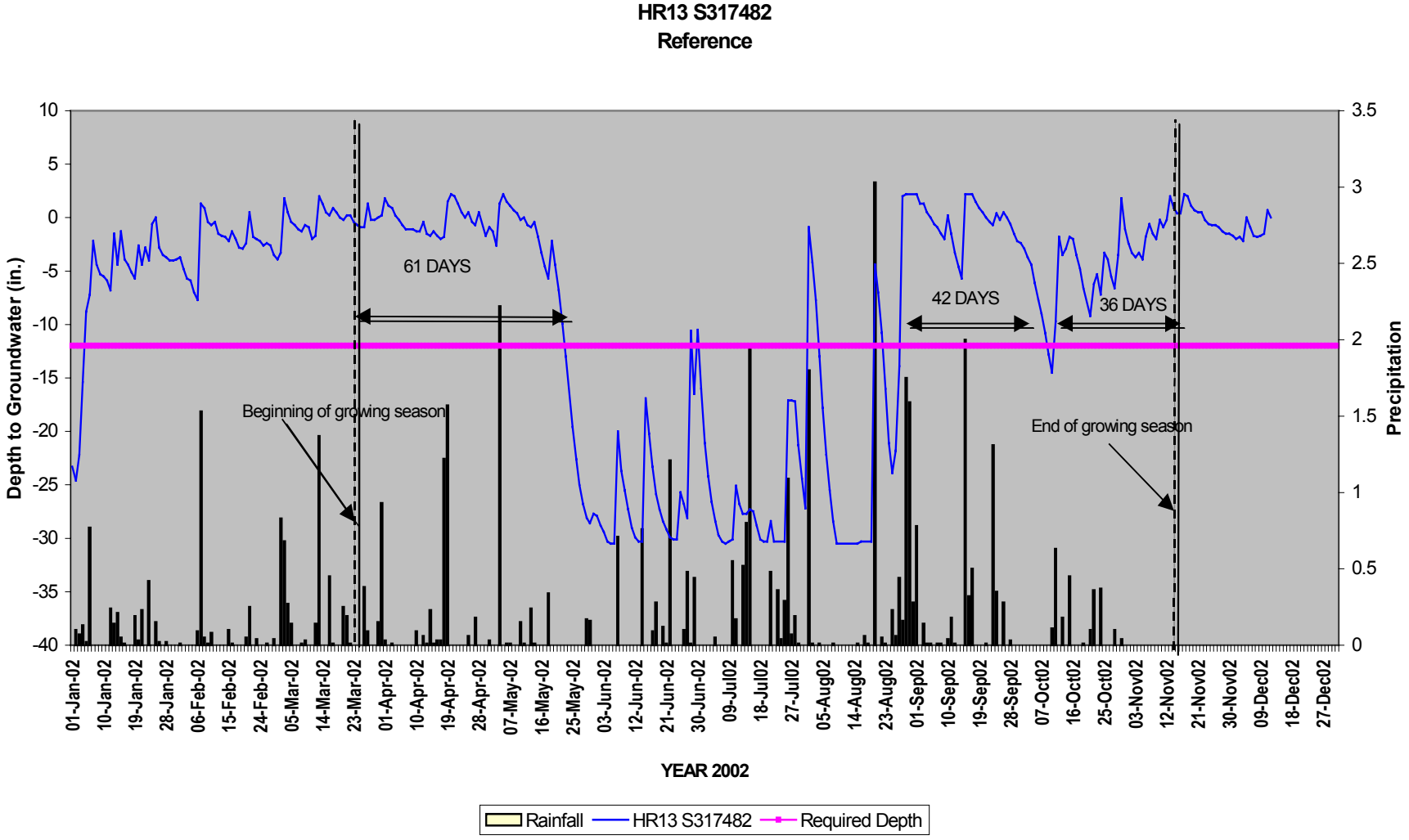

HR8 S31FA17
Depth to Groundwater (inches)
Precipitation
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3.5
3
2.5
2
1.5
1
0.5
0
End of growing season
41 DAYS
Beginning of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar-02
01-Apr-02
11-Apr-02
21-Apr-02
01-May-02
11-May-02
21-May-02
31-May-02
10-Jun-02
20-Jun-02
30-Jun-02
10-Jul02
20-Jul02
30-Jul02
09-Aug02
19-Aug02
29-Aug02
08-Sep02
18-Sep02
28-Sep02
08-Oct02
18-Oct02
28-Oct02
07-Nov02
17-Nov02
27-Nov02
07-Dec02
17-Dec02
27-Dec02
YEAR 2002
Rainfall
HR8 S31FA17
Required Depth

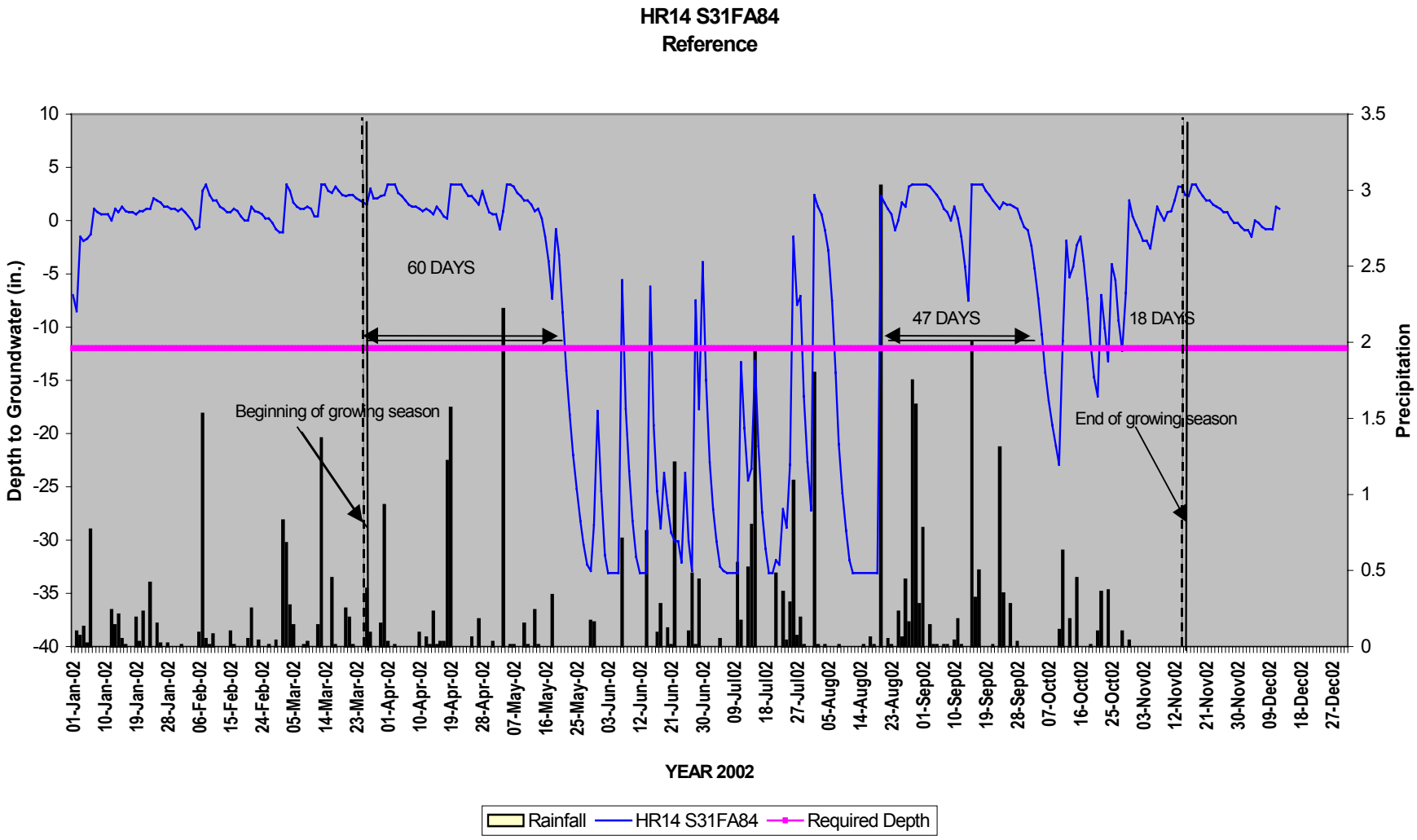

HR9 S31F8EF
Depth to Groundwater (inches)
Precipitation
YEAR 2002
59 DAYS
Beginning of growing season
End of growing season
Stopped
Stopped recording
Rainfall
HR9 S31F8EF
Required Depth

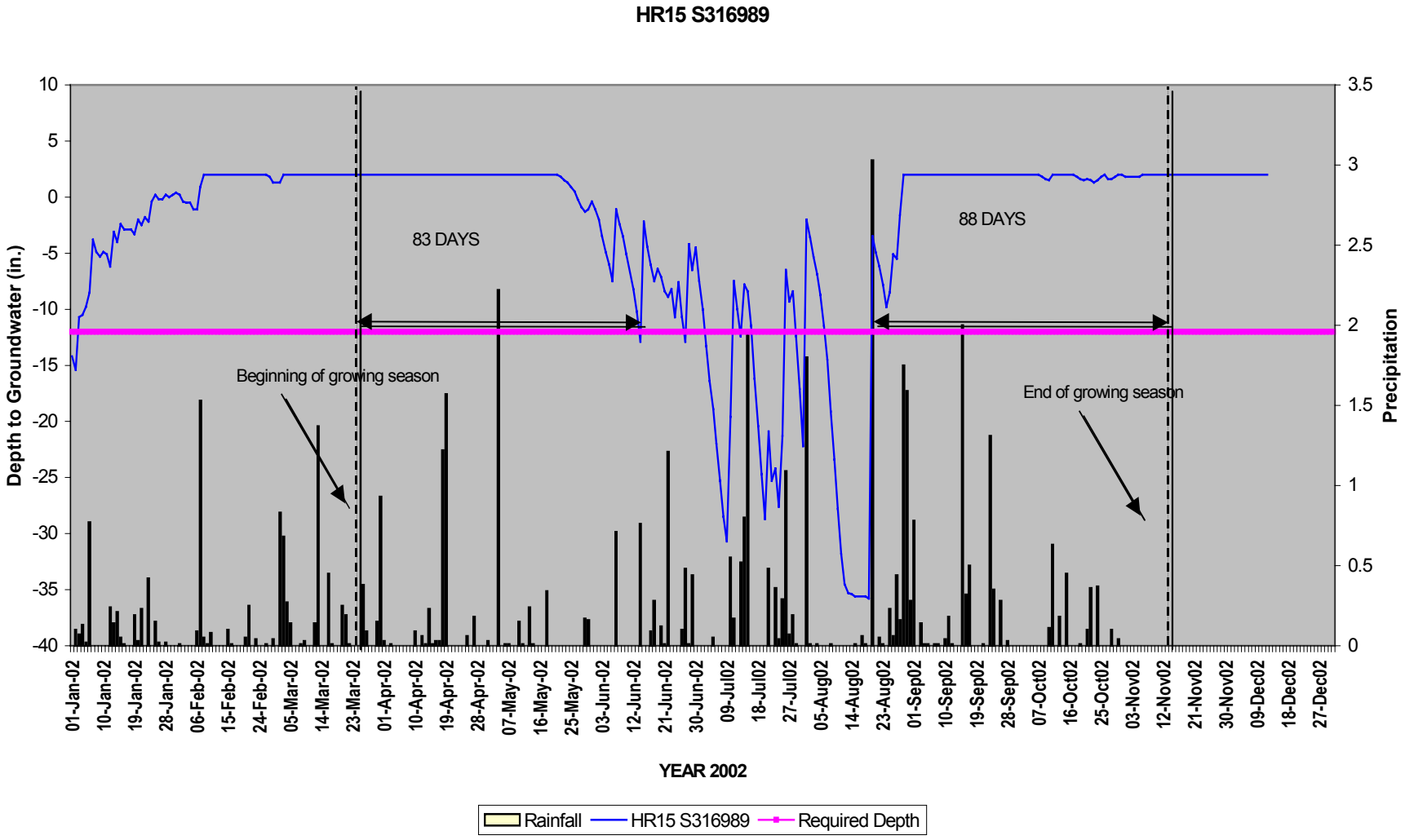

HR10 S31F867
Depth to Groundwater (inches)
Precipitation
YEAR 2002
41 DAYS
18 Days
Beginning of growing season
End of growing season
Rainfall
HR10 S31F867
Required Depth

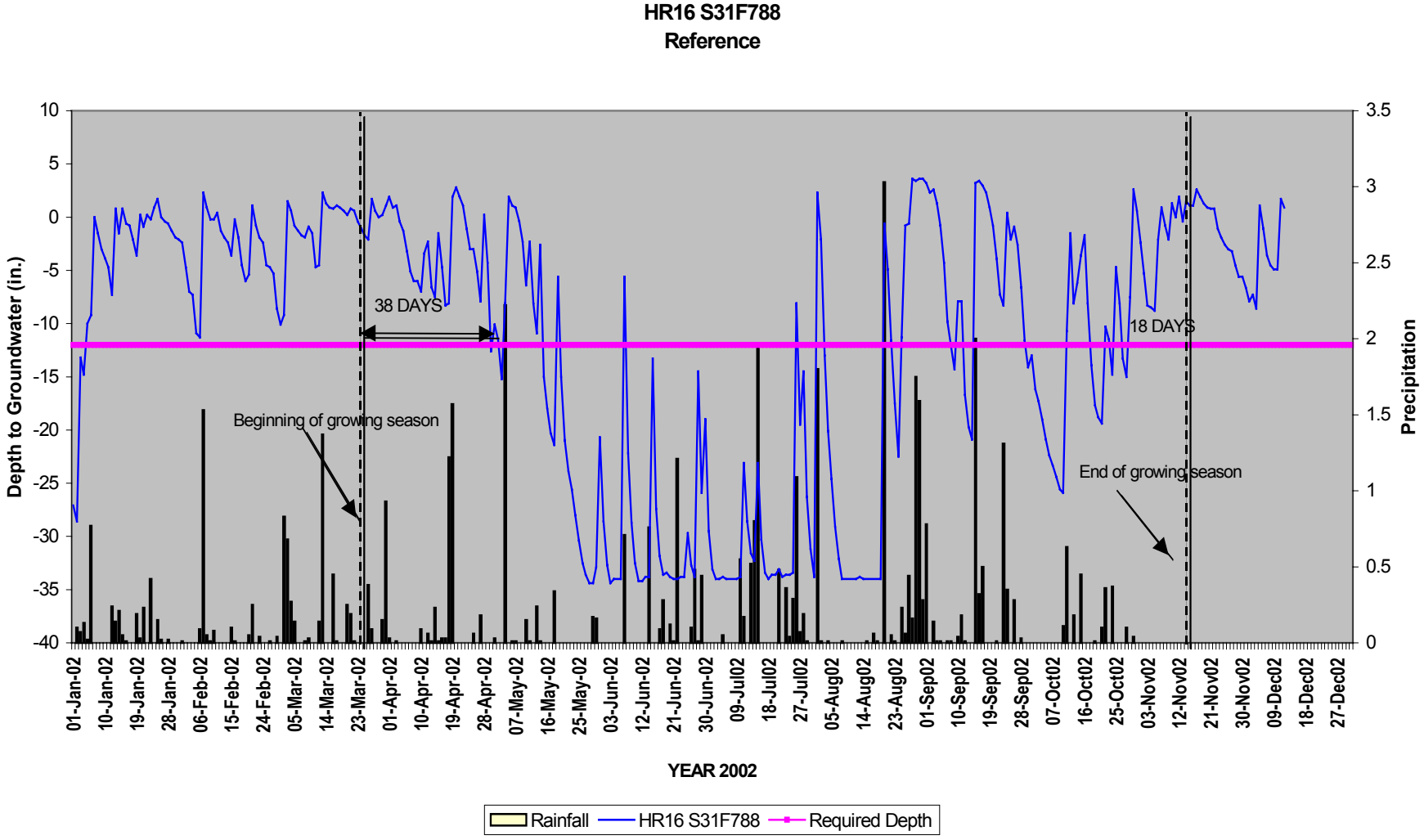

HR11 S31F9D3
Depth to Groundwater (inches)
Precipitation
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3.5
3
2.5
2
1.5
1
0.5
0
59 DAYS
18 Days
Beginning of growing season
End of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar-02
01-Apr-02
11-Apr-02
21-Apr-02
01-May-02
11-May-02
21-May-02
31-May-02
10-Jun-02
20-Jun-02
30-Jun-02
10-Jul02
20-Jul02
30-Jul02
09-Aug02
19-Aug02
29-Aug02
08-Sep02
18-Sep02
28-Sep02
08-Oct02
18-Oct02
28-Oct02
07-Nov02
17-Nov02
27-Nov02
07-Dec02
17-Dec02
27-Dec02
YEAR 2002
Rainfall
HR11 S31F9D3
Required Depth

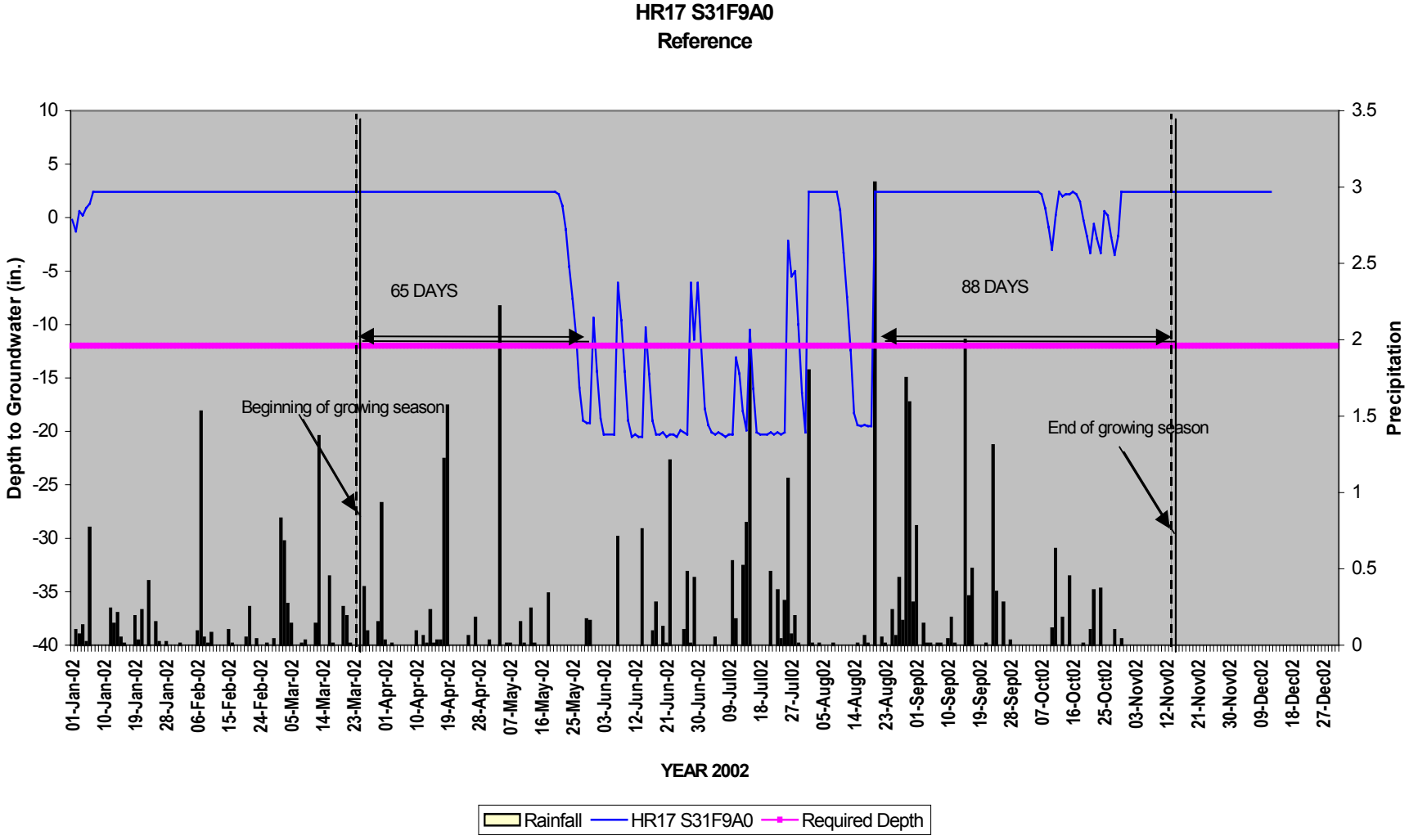

HR12 S317538
Depth to Groundwater (in.)
Precipitation
71 DAYS
80 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR12 S317538
Required Depth

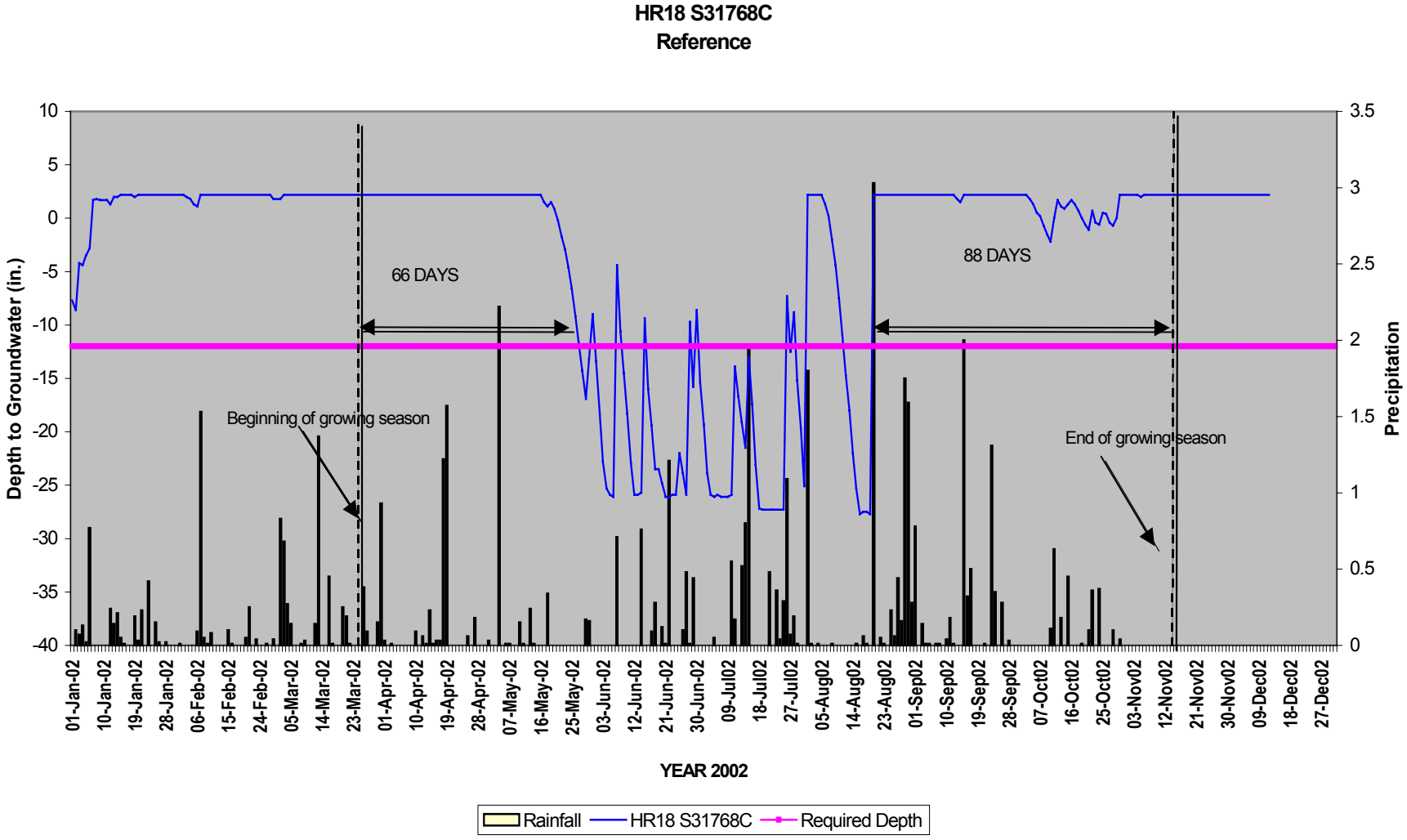

HR13 S317482
Reference
Depth to Groundwater (in.)
Precipitation
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3.5
3
2.5
2
1.5
1
0.5
0
61 DAYS
42 DAYS
36 DAYS
Beginning of growing season
End of growing season
01-Jan-02
10-Jan-02
19-Jan-02
28-Jan-02
06-Feb-02
15-Feb-02
24-Feb-02
05-Mar-02
14-Mar-02
23-Mar-02
01-Apr-02
10-Apr-02
19-Apr-02
28-Apr-02
07-May-02
16-May-02
25-May-02
03-Jun-02
12-Jun-02
21-Jun-02
30-Jun-02
09-Jul02
18-Jul02
27-Jul02
05-Aug02
14-Aug02
23-Aug02
01-Sep02
10-Sep02
19-Sep02
28-Sep02
07-Oct02
16-Oct02
25-Oct02
03-Nov02
12-Nov02
21-Nov02
30-Nov02
09-Dec02
18-Dec02
27-Dec02
YEAR 2002
Rainfall
HR13 S317482
Required Depth

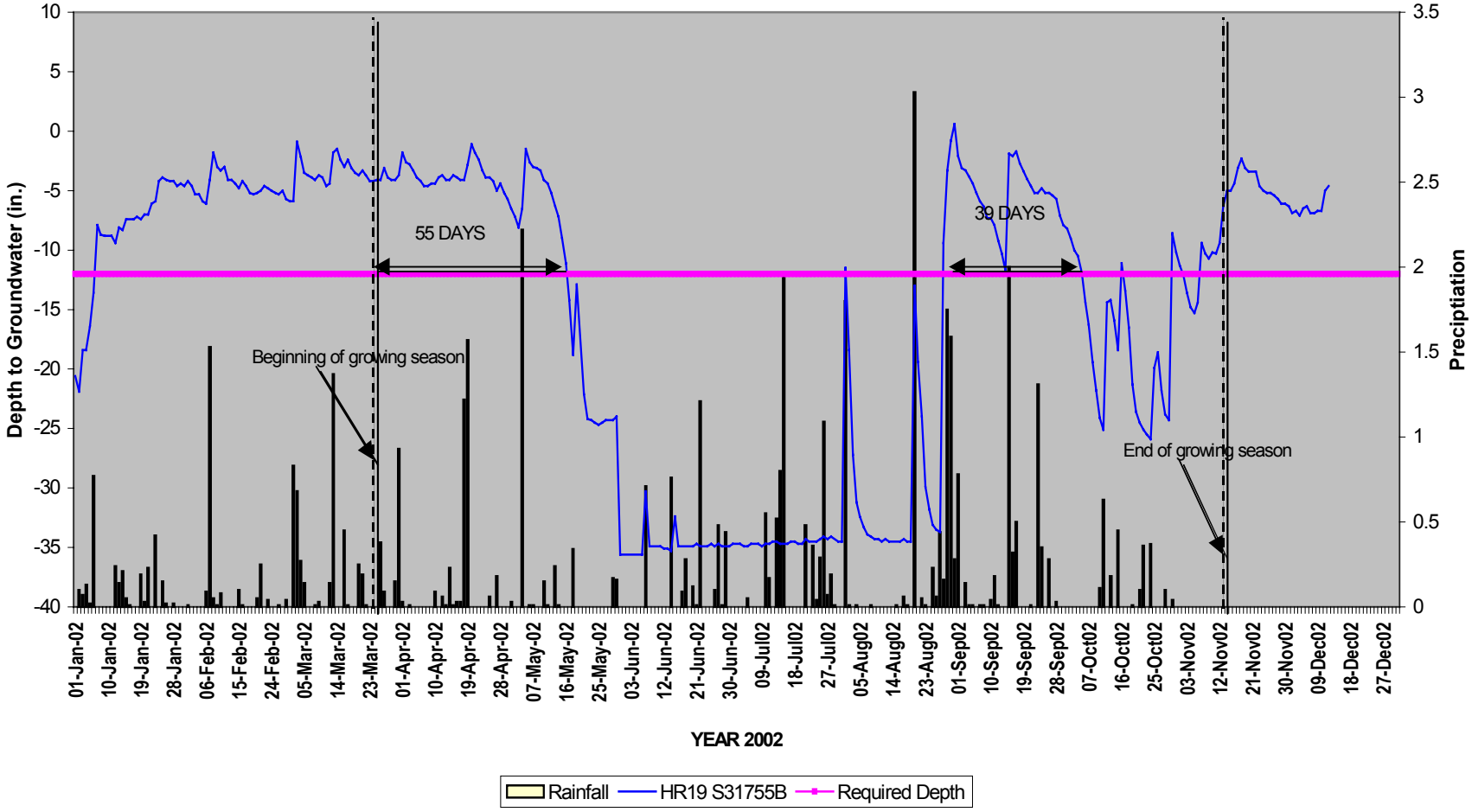

HR14 S31FA84
Reference
Depth to Groundwater (in.)
Precipitation
60 DAYS
47 DAYS
18 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR14 S31FA84
Required Depth

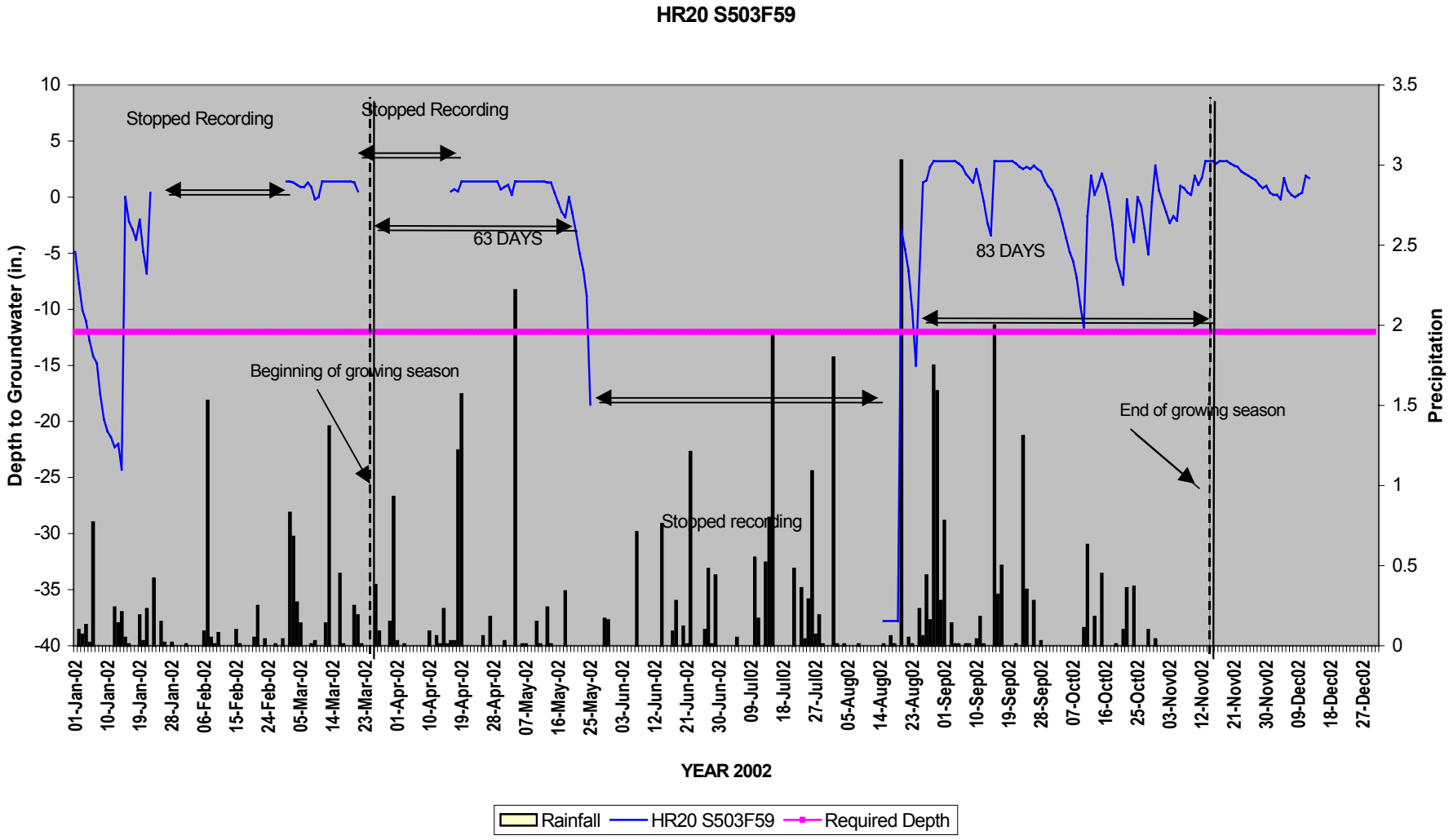

HR15 S316989
Depth to Groundwater (in.)
Precipitation
83 DAYS
88 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR15 S316989
Required Depth

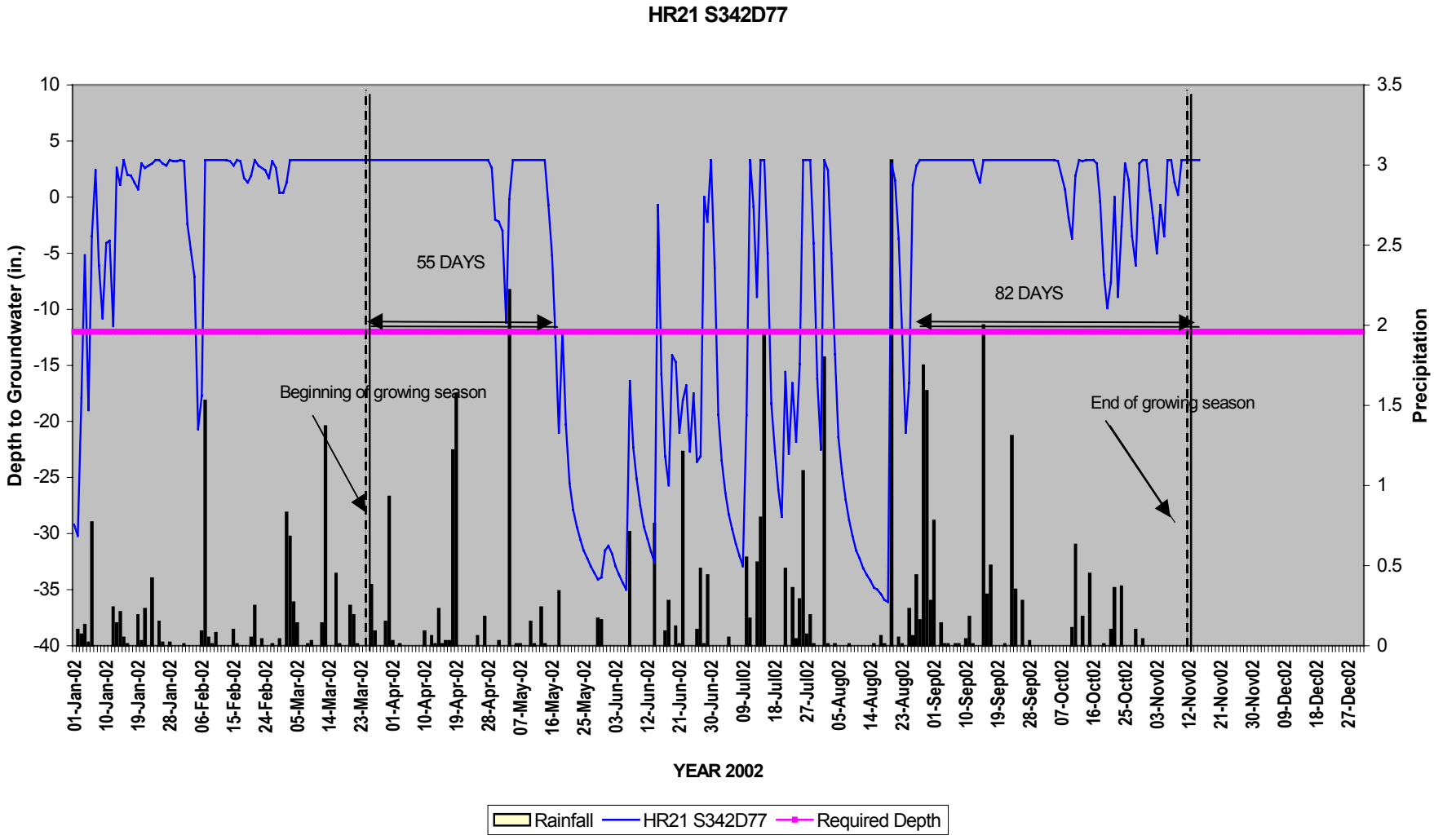

HR16 S31F788
Reference
Depth to Groundwater (in.)
Precipitation
38 DAYS
18 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR16 S31F788
Required Depth

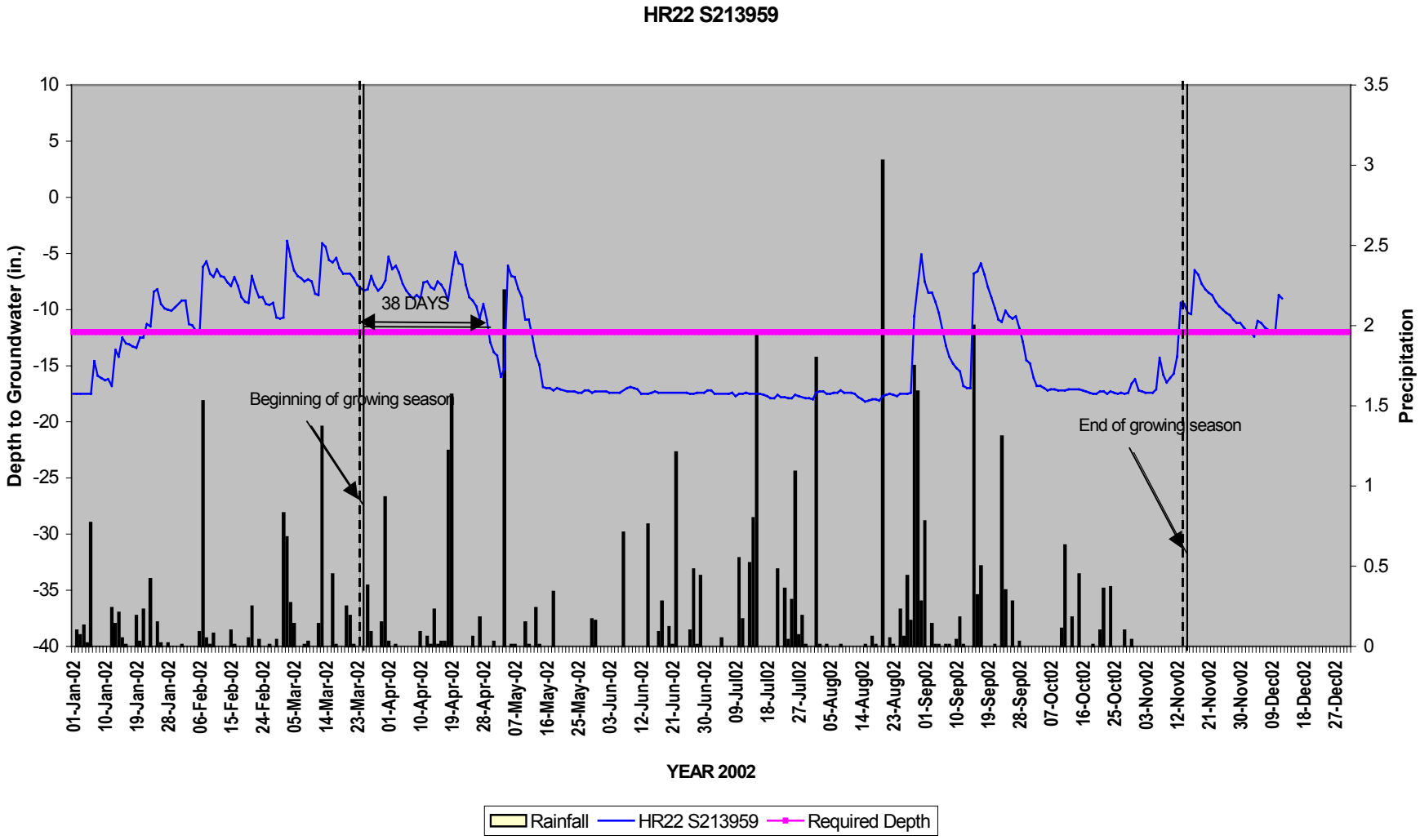

HR17 S31F9A0
Reference
Depth to Groundwater (in.)
Precipitation
65 DAYS
88 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR17 S31F9A0
Required Depth

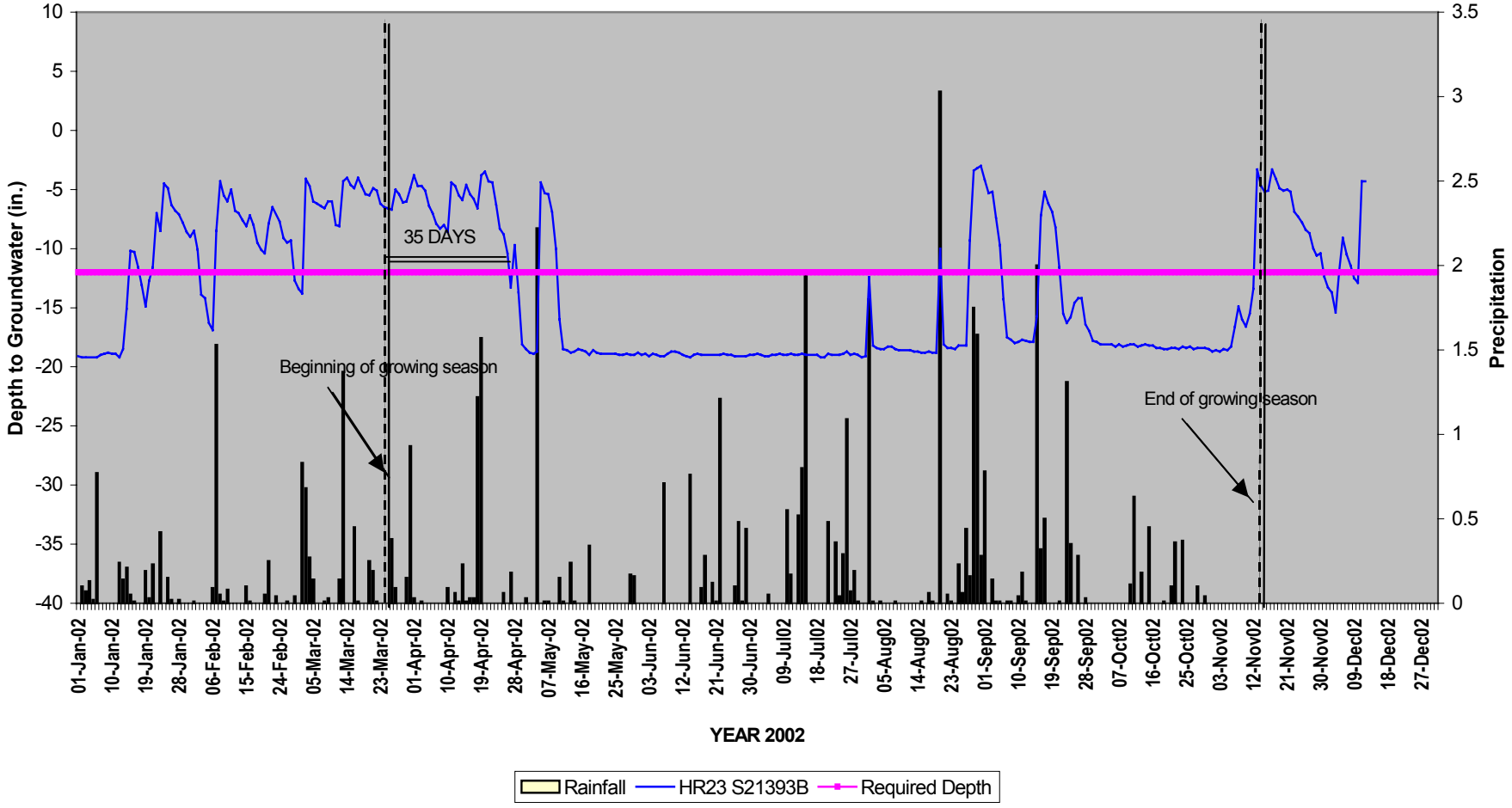

HR18 S31768C
Reference
Depth to Groundwater (in.)
Precipitation
66 DAYS
88 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR18 S31768C
Required Depth


HR19 S31755B
Depth to Groundwater (in.)
Preciptiation
55 DAYS
39 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR19 S31755B
Required Depth

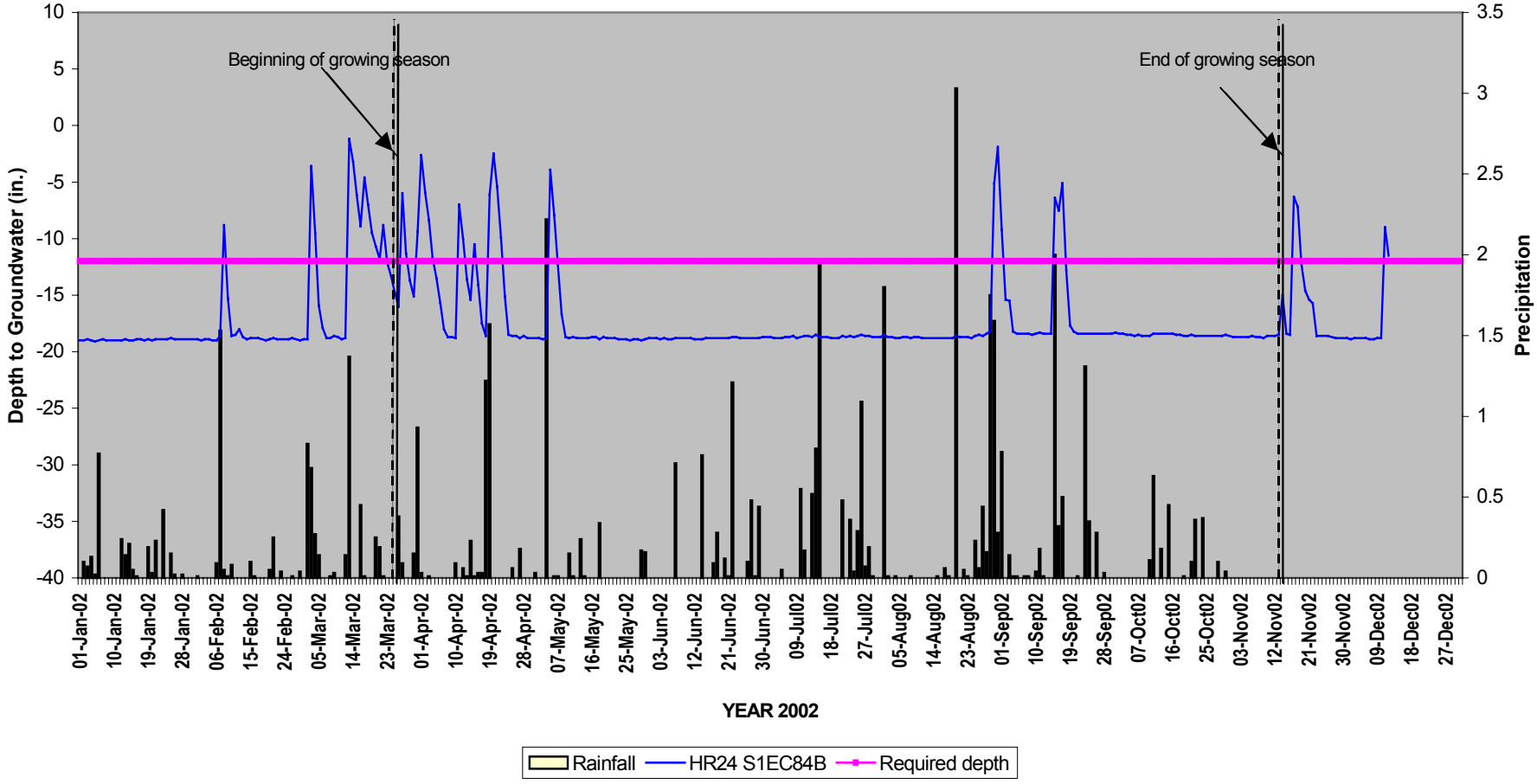

HR20 S503F59
Stopped Recording
Stopped Recording
63 DAYS
83 DAYS
Beginning of growing season
End of growing season
Stopped recording
Depth to Groundwater (in.)
Precipitation
YEAR 2002
Rainfall
HR20 S503F59
Required Depth

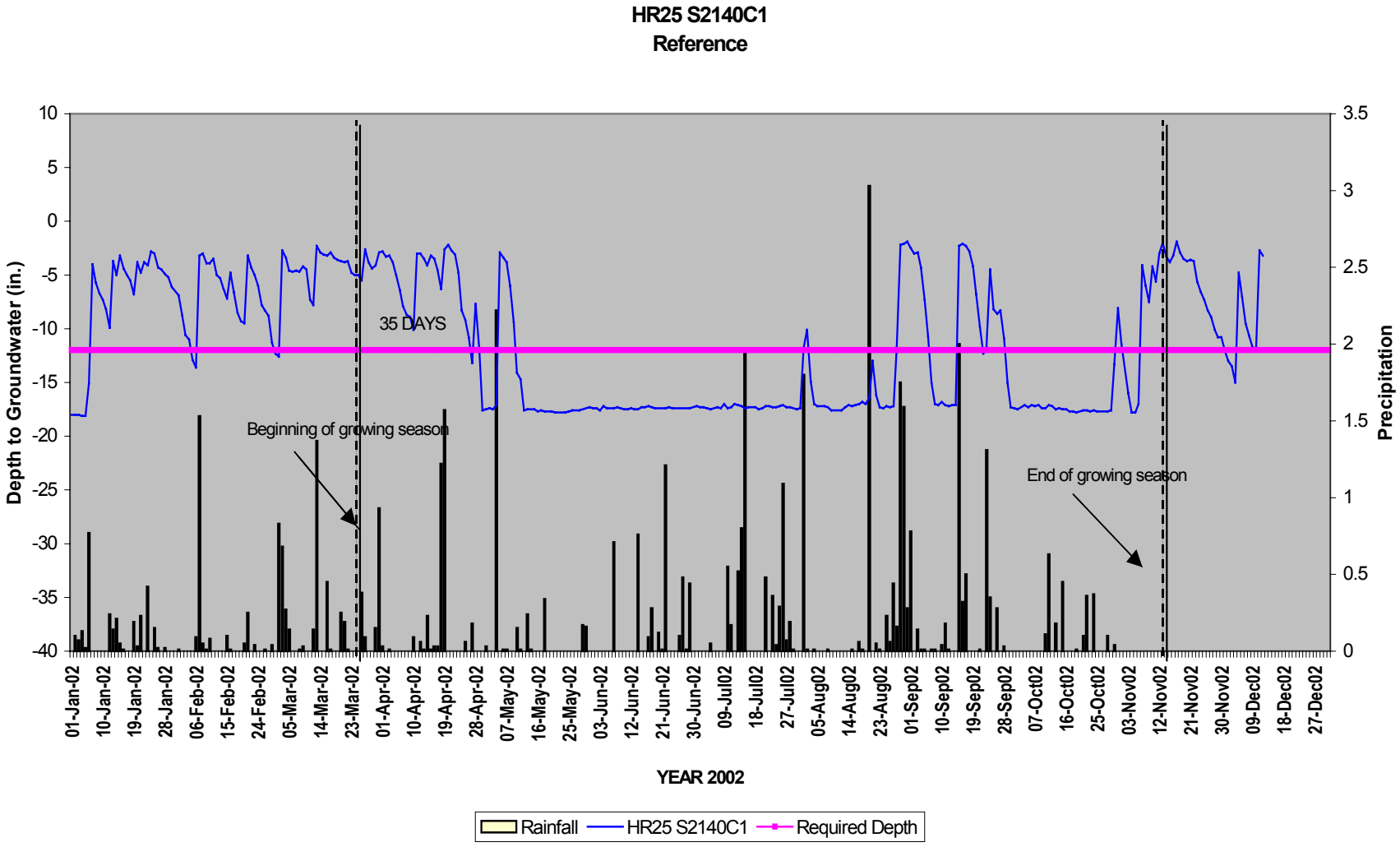

HR21 S342D77
Depth to Groundwater (in.)
Precipitation
55 DAYS
82 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR21 S342D77
Required Depth


HR22 S213959
Depth to Groundwater (in.)
Precipitation
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
3.5
3
2.5
2
1.5
1
0.5
0
38 DAYS
Beginning of growing season
End of growing season
01-Jan-02
10-Jan-02
19-Jan-02
28-Jan-02
06-Feb-02
15-Feb-02
24-Feb-02
05-Mar-02
14-Mar-02
23-Mar-02
01-Apr-02
10-Apr-02
19-Apr-02
28-Apr-02
07-May-02
16-May-02
25-May-02
03-Jun-02
12-Jun-02
21-Jun-02
30-Jun-02
09-Jul02
18-Jul02
27-Jul02
05-Aug02
14-Aug02
23-Aug02
01-Sep02
10-Sep02
19-Sep02
28-Sep02
07-Oct02
16-Oct02
25-Oct02
03-Nov02
12-Nov02
21-Nov02
30-Nov02
09-Dec02
18-Dec02
27-Dec02
YEAR 2002
Rainfall
HR22 S213959
Required Depth

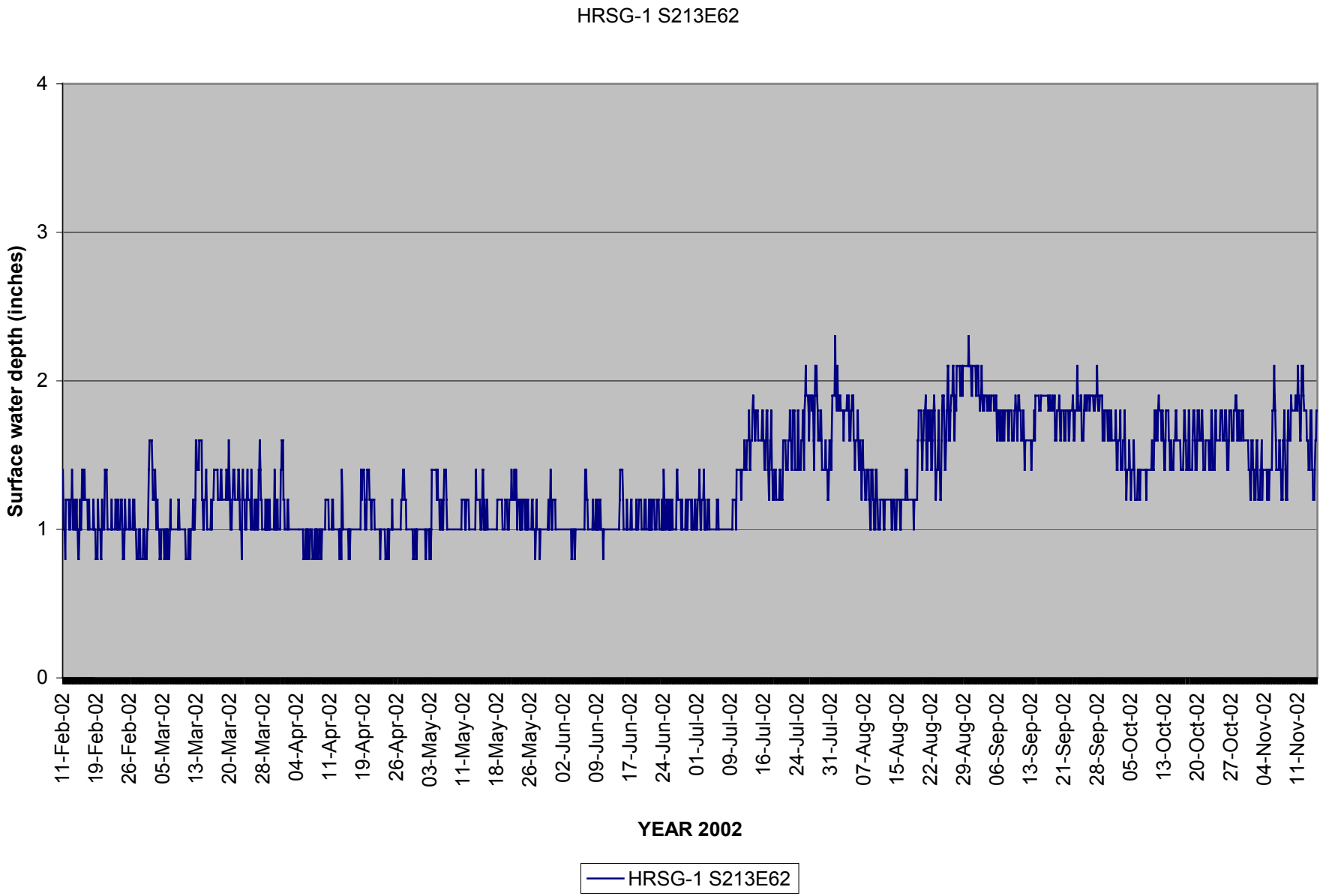

HR23 S21393B
Depth to Groundwater (in.)
Precipitation
35 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR23 S21393B
Required Depth

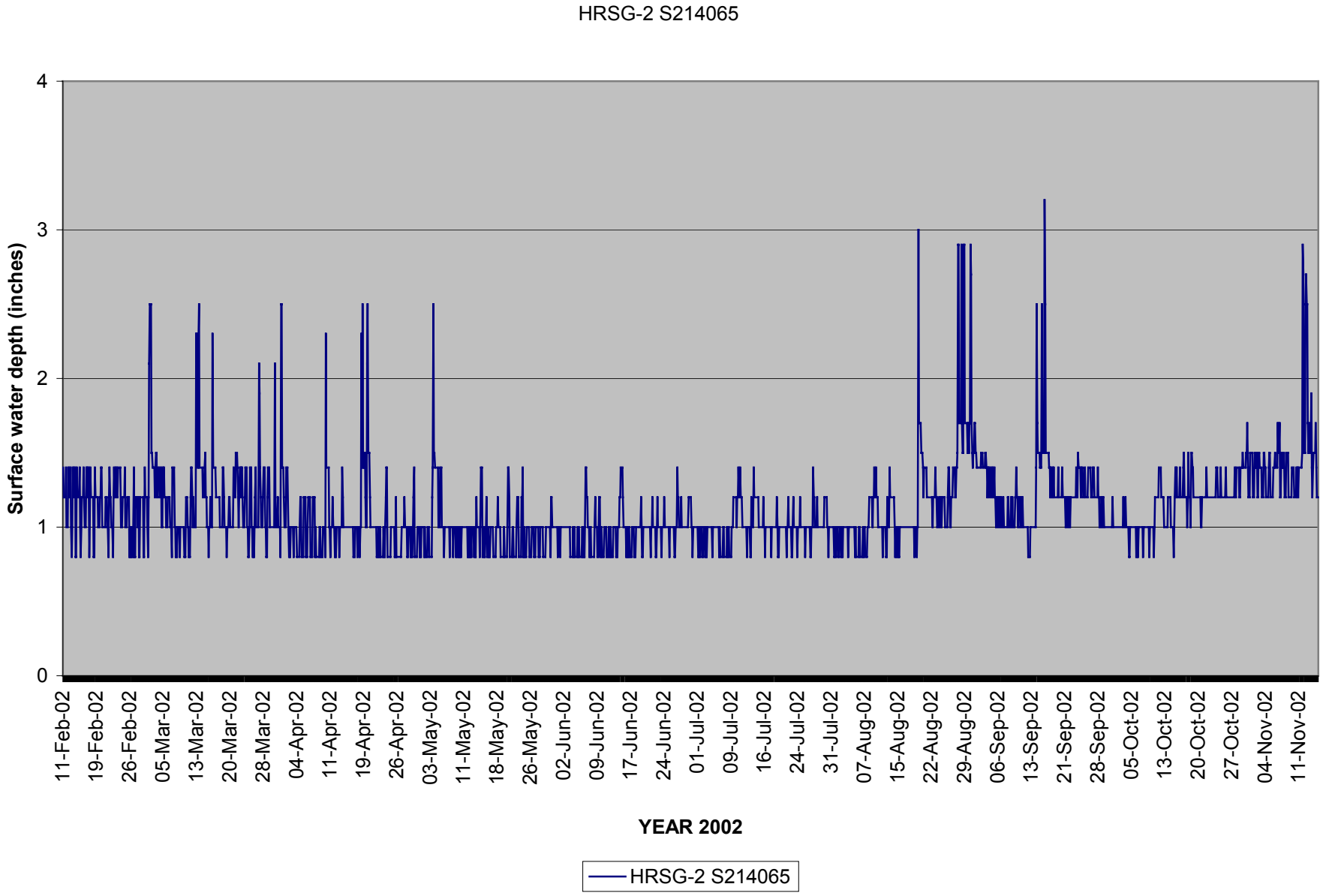
HR24 S1EC84B
Reference



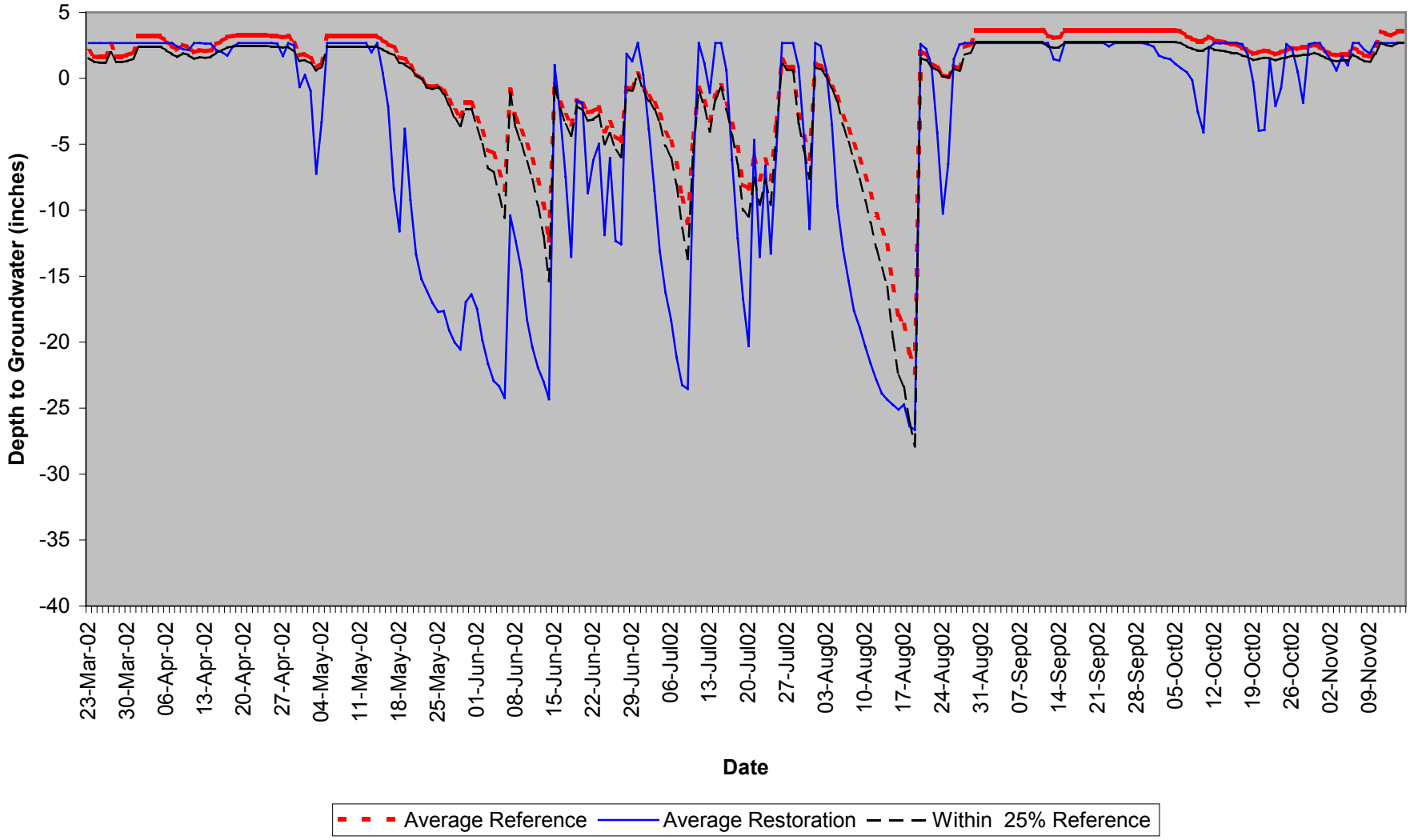

HR25 S2140C1
Reference
Depth to Groundwater (in.)
Precipitation
35 DAYS
Beginning of growing season
End of growing season
YEAR 2002
Rainfall
HR25 S2140C1
Required Depth

Surface Gauge Graphs

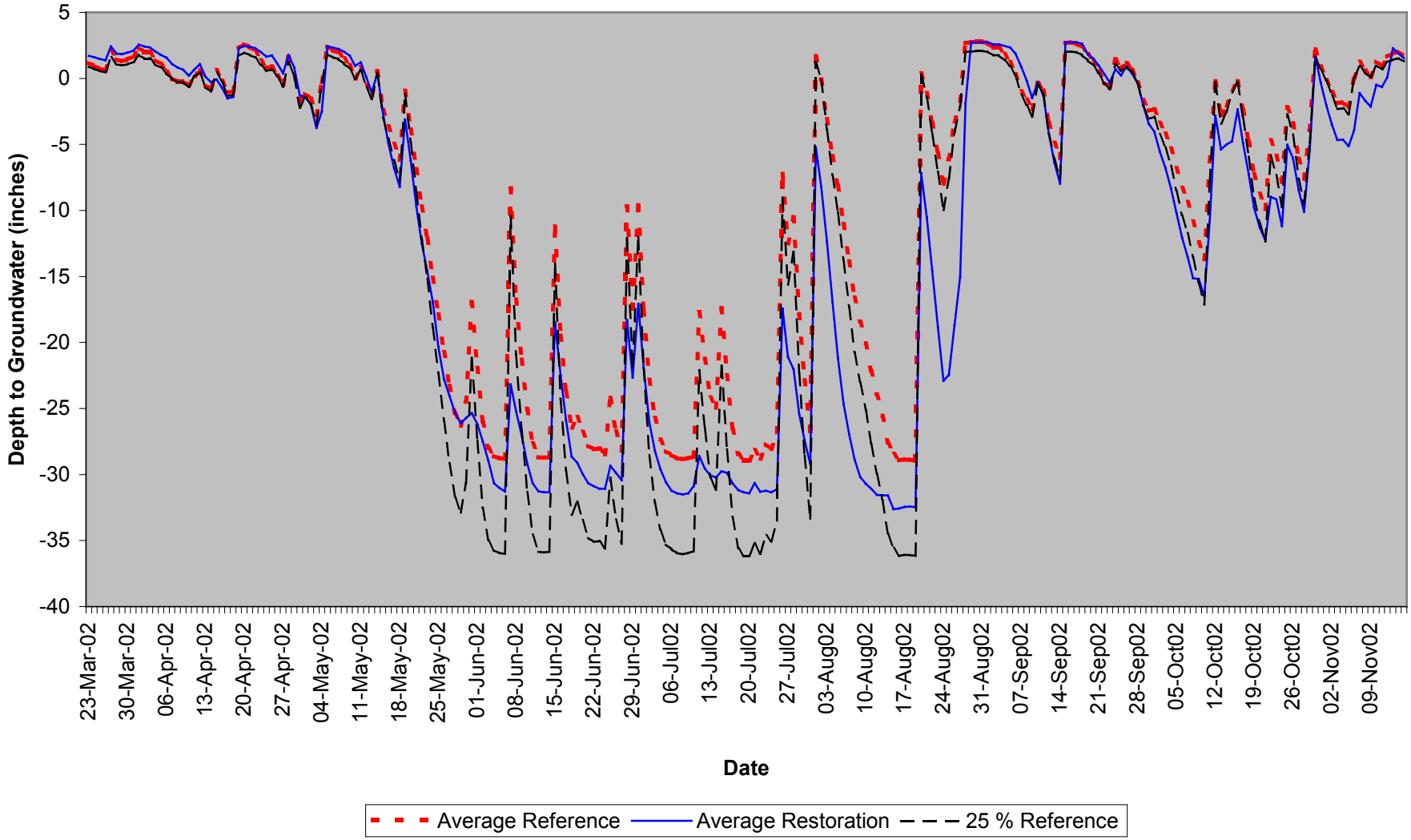



HRSG-2 S214065
Surface water depth (inches)
0
1
2
3
4
11-Feb-02
19-Feb-02
26-Feb-02
05-Mar-02
13-Mar-02
20-Mar-02
28-Mar-02
04-Apr-02
11-Apr-02
19-Apr-02
26-Apr-02
03-May-02
11-May-02
18-May-02
26-May-02
02-Jun-02
09-Jun-02
17-Jun-02
24-Jun-02
01-Jul-02
09-Jul-02
16-Jul-02
24-Jul-02
31-Jul-02
07-Aug-02
15-Aug-02
22-Aug-02
29-Aug-02
06-Sep-02
13-Sep-02
21-Sep-02
28-Sep-02
05-Oct-02
13-Oct-02
20-Oct-02
27-Oct-02
04-Nov-02
11-Nov-02
YEAR 2002
HRSG-2 S214065

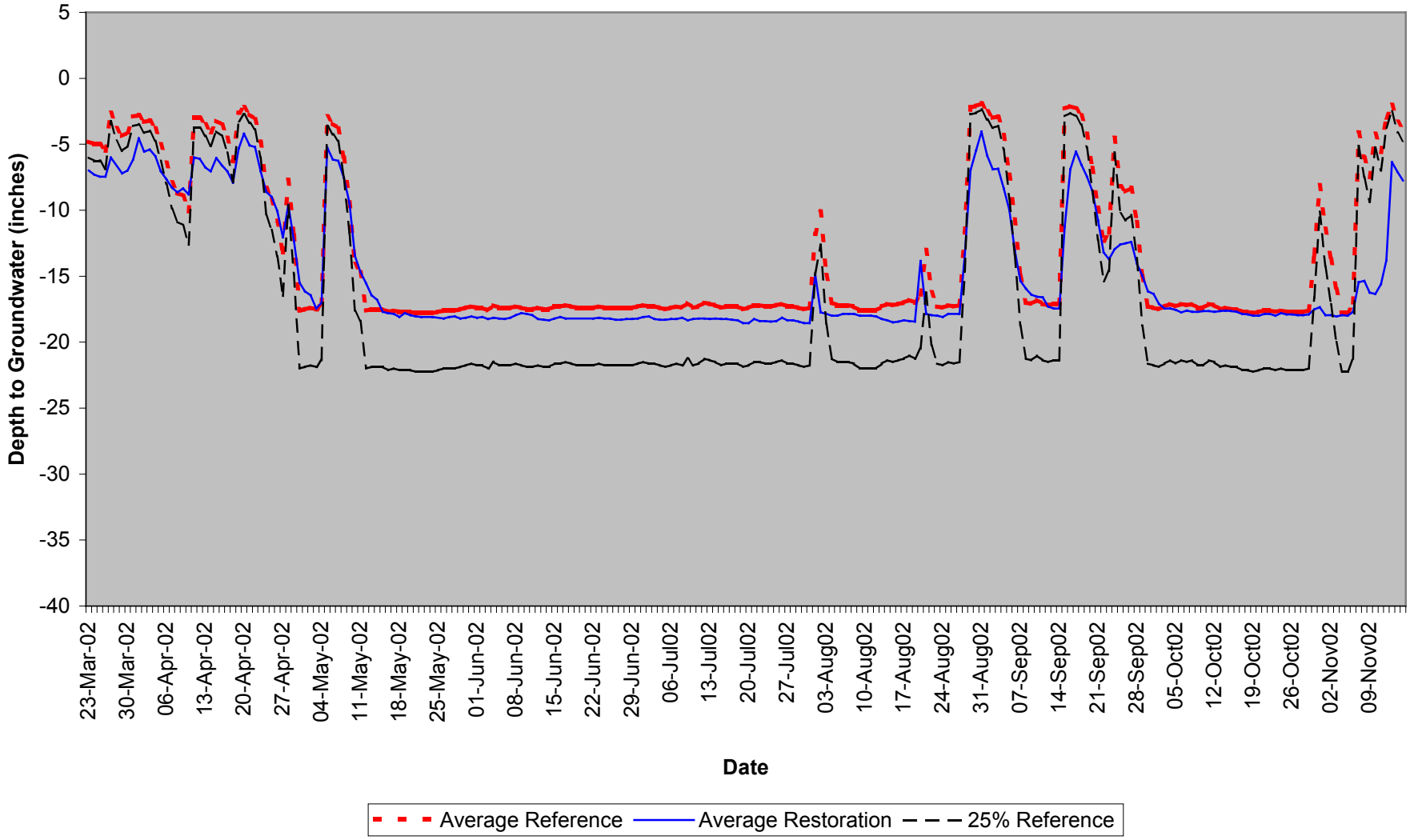
Haws Run Swamp Forest 2002
Average Reference vs. Average Restoration

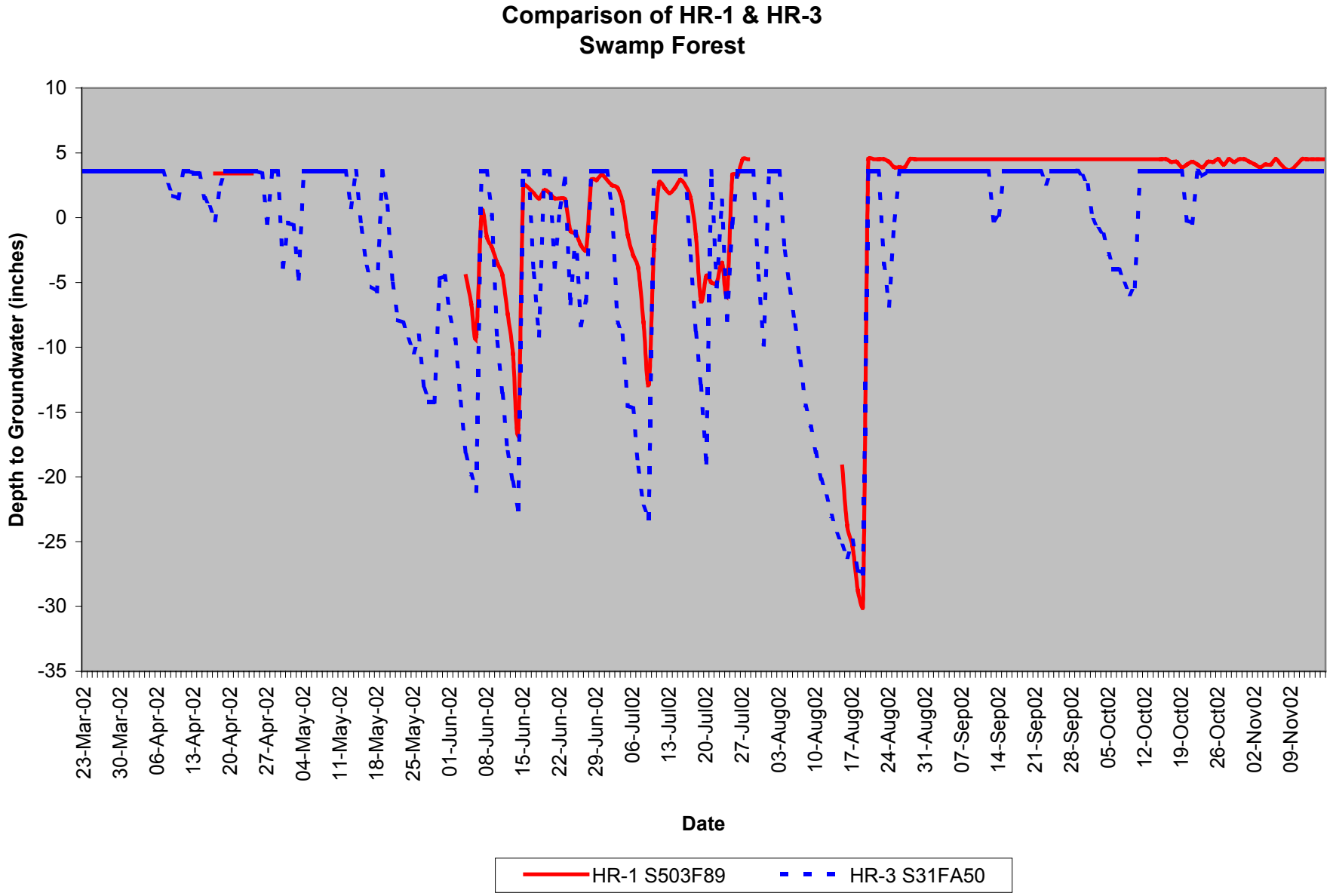


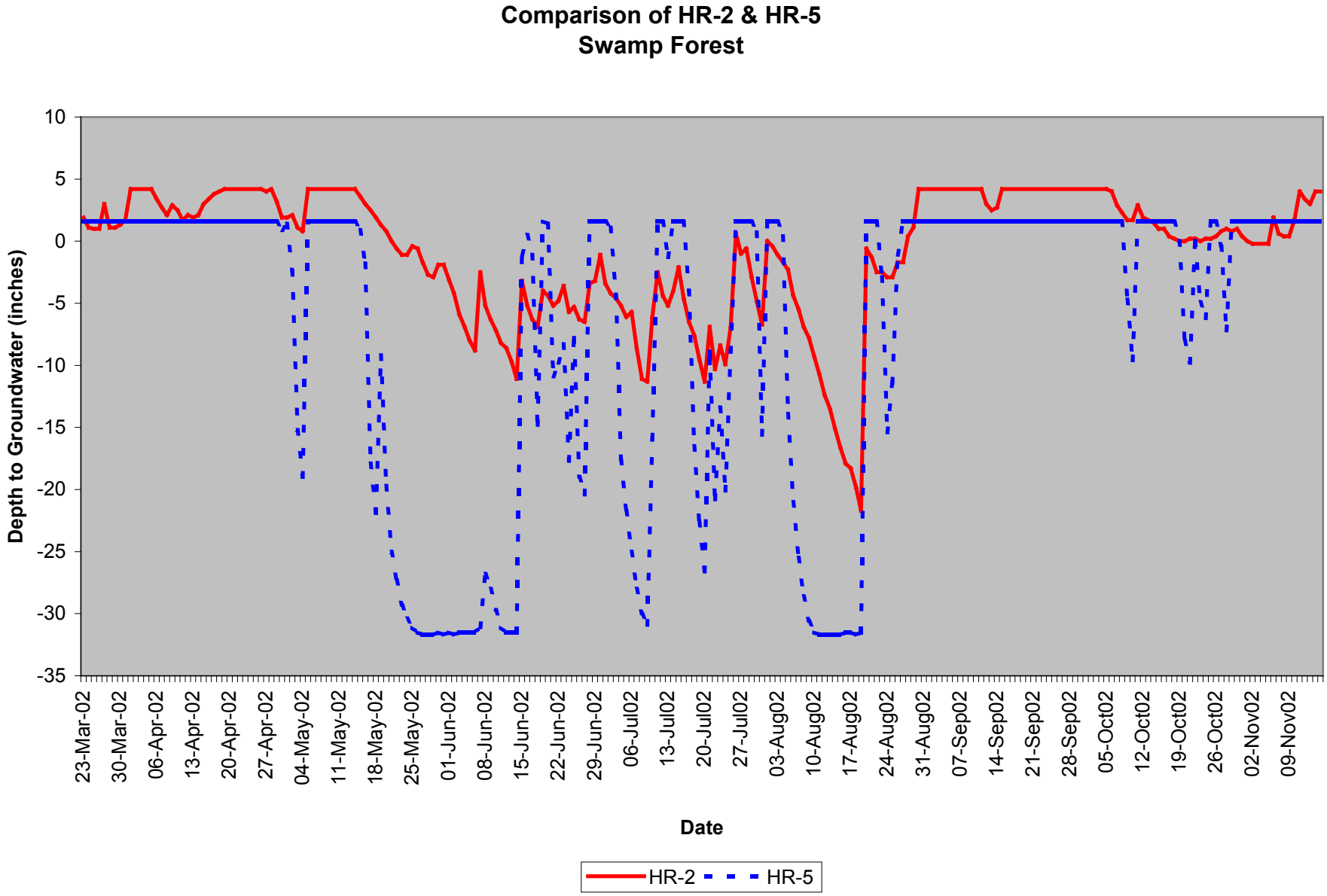
Haws Run Savanna 2002
Average Reference vs. Average Restoration

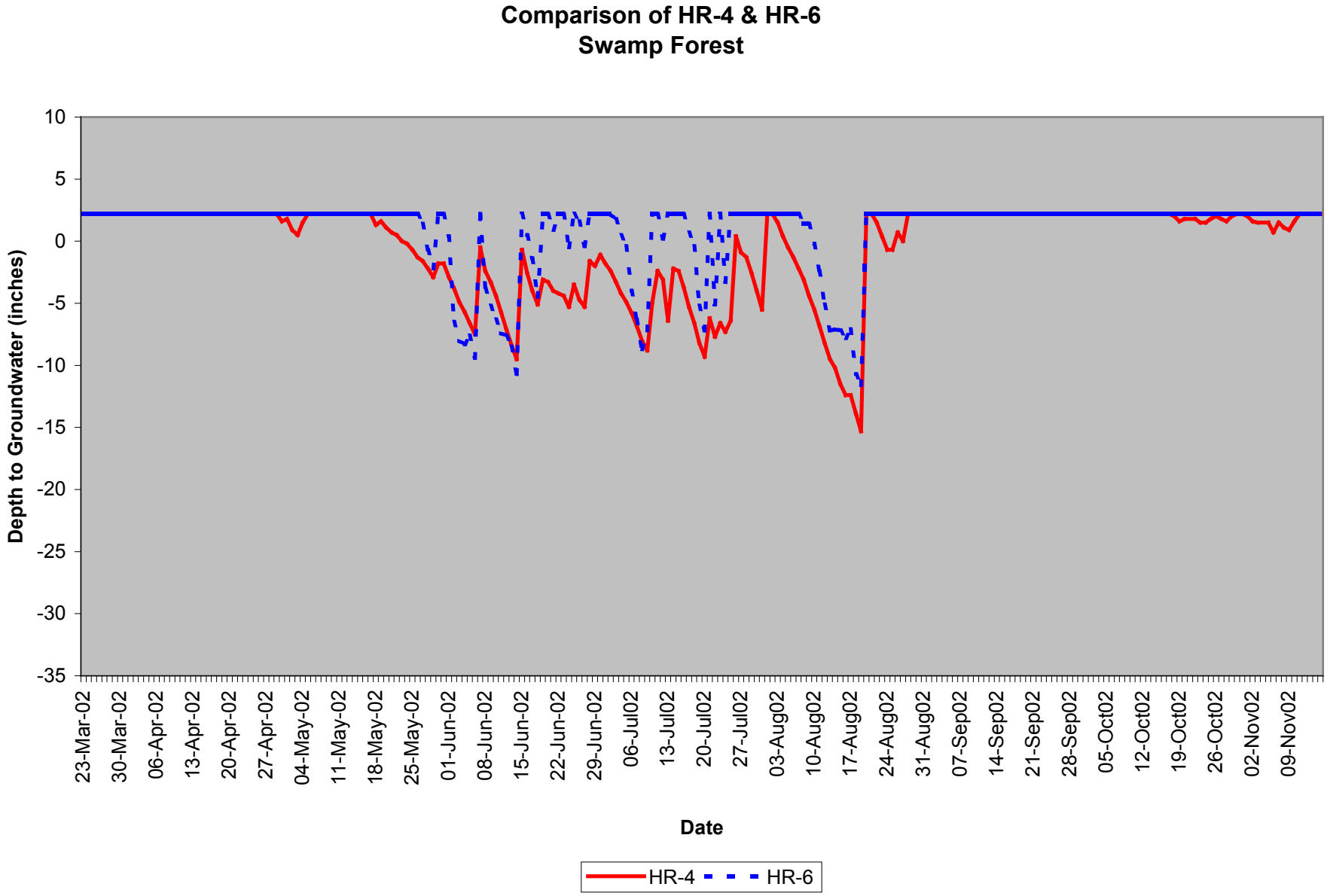


Haws Run Hauls Road 2002
Average Reference vs. Average Restoration




Comparison of HR-1 & HR-3
Swamp Forest
Depth to Groundwater (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
23-Mar-02
30-Mar-02
06-Apr-02
13-Apr-02
20-Apr-02
27-Apr-02
04-May-02
11-May-02
18-May-02
25-May-02
01-Jun-02
08-Jun-02
15-Jun-02
22-Jun-02
29-Jun-02
06-Jul02
13-Jul02
20-Jul02
27-Jul02
03-Aug02
10-Aug02
17-Aug02
24-Aug02
31-Aug02
07-Sep02
14-Sep02
21-Sep02
28-Sep02
05-Oct02
12-Oct02
19-Oct02
26-Oct02
02-Nov02
09-Nov02
Date
HR-1 S503F89
HR-3 S31FA50


Comparison of HR-2 & HR-5
Swamp Forest
Depth to Groundwater (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
23-Mar-02
30-Mar-02
06-Apr-02
13-Apr-02
20-Apr-02
27-Apr-02
04-May-02
11-May-02
18-May-02
25-May-02
01-Jun-02
08-Jun-02
15-Jun-02
22-Jun-02
29-Jun-02
06-Jul02
13-Jul02
20-Jul02
27-Jul02
03-Aug02
10-Aug02
17-Aug02
24-Aug02
31-Aug02
07-Sep02
14-Sep02
21-Sep02
28-Sep02
05-Oct02
12-Oct02
19-Oct02
26-Oct02
02-Nov02
09-Nov02
Date
HR-2
HR-5


Comparison of HR-4 & HR-6
Swamp Forest
Depth to Groundwater (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
23-Mar-02
30-Mar-02
06-Apr-02
13-Apr-02
20-Apr-02
27-Apr-02
04-May-02
11-May-02
18-May-02
25-May-02
01-Jun-02
08-Jun-02
15-Jun-02
22-Jun-02
29-Jun-02
06-Jul02
13-Jul02
20-Jul02
27-Jul02
03-Aug02
10-Aug02
17-Aug02
24-Aug02
31-Aug02
07-Sep02
14-Sep02
21-Sep02
28-Sep02
05-Oct02
12-Oct02
19-Oct02
26-Oct02
02-Nov02
09-Nov02
Date
HR-4
HR-6