ANNUAL REPORT FOR 2004

Haws Run Mitigation Site
Pender and Onslow Counties
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 the Haws Run Mitigation Site. This site was constructed in 1998 and planted in early 1999. 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 twenty-five groundwater-monitoring gauges, two surface gauges, and one rain gauge.

The daily rainfall data depicted on the monitoring gauge graphs is recorded from an onsite rain gauge, which was installed in July 2001. Historical rainfall data used for the 30^{th} – 70^{th} percentile analysis was recorded at the Wilmington Rain Gauge, maintained by the NC State Climate Office.

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

In the swamp forest area, all gauges exceeded the 12.5% jurisdictional wetland criteria. In the pine savanna area, all gauges recorded hydroperiods of 8% of the growing season, or greater. Two of the five gauges along the haul road (southern swamp) met the jurisdictional criteria of 12.5%. Gauge HR-22 located in the haul road (southern swamp) area malfunctioned throughout the growing season, thus preventing an accurate success calculation. Gauges HR-23 and HR-24 exhibited comparable depths to groundwater, however the duration of the hydroperiods was shorter than the HR-25 reference for the 2004-growing season.

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

Vegetation monitoring consists of three 500 feet by 500 feet sample plots in the savanna areas and seven 50 feet by 50 feet sample plots within the bottomland hardwood area. Various types of grasses were planted in ten 100 feet by 100 feet test plots. Vegetation success criteria were met for 2004, with 30 trees per acre in the savanna area and 397 trees per acre in the swamp forest area. The planted grass areas were establishing well.

NCDOT proposes to discontinue hydrology and vegetation monitoring at the Haws Run Mitigation Site.

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 (Figure 1). 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 the 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 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 species.

After the hurricane season in 1999, the northern slope between the swamp forest and savanna was eroded in several locations. The 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. In summer 2003, repairs were made to the two slopes that were initially seeded and matted. Stone lined swales were used to stabilize these areas, and superficial repairs were made to the remaining stone swales. No wetland mitigation credit is expected from this zone.

SUMMARY

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Figure 1: Vicinity Map

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 during the 2004-year on the Haws Run Mitigation Site.

1.3 Project History

Winter 1997	Pilot Study
Summer 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)
September 2003	Slope Repair
September 2003	Vegetation Monitoring (Year 4)
March – November 2003	Hydrologic Monitoring (Year 5)
August 2004	Vegetation Monitoring (Year 5)
March – November 2004	Hydrologic Monitoring (Year 6)

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 on the site. The success criteria for the swamp restoration area are based on the hydrologic regime of the 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 the USACE, Lanier Quarry savanna was deemed unsuitable as a reference site. Therefore, the success criteria for the 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 groundwater 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 (southern swamp) were based on re-establishing the hydrologic connection of that area to the southern swamp. Reference gauges were installed in the southern swamp area to compare with those in the restoration southern swamp area. The flooding regime and groundwater depths should be similar in each area or show recovery of these processes after removal of the haul road (southern swamp).

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

The growing season for the 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 238 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 threshold 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 being located in the delineated wetland in the pine savanna reference area. A GPS survey placed the actual location in the pine savanna restoration area. This revised location is reported below along with all of 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).
- 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).
- Three in the southern swamp restoration (haul road) area (HR-19, HR-22, HR-23).
- Two in the southern swamp reference (haul road) area (HR-24, HR-25).

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. The ground surface elevation was surveyed at each well and was 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-1 and SG-2, located along the forestry haul road (southern swamp), which were installed during the pre-construction monitoring phase. All of the monitoring gauges automatically record 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.

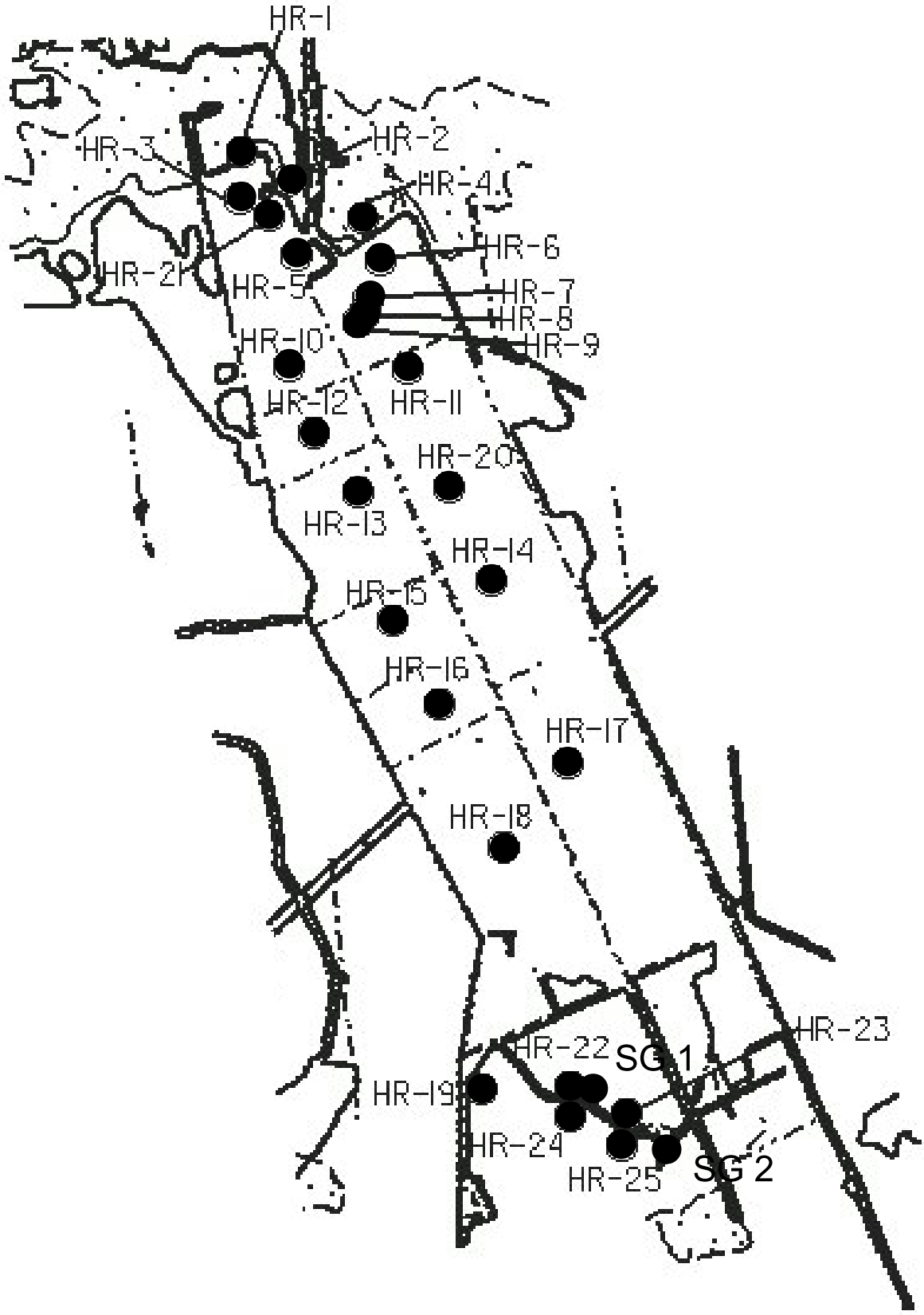


Figure 2. Gauge Location Map

N

Not to Scale

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 238-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 2004 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 also provided in Table 1.

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 21.4% of days in the Average Swamp Reference Area:

- HR-3: 61.3% of days at HR-1.
- HR-5: 29.8% of days at HR-2.
- HR-6: 82.4% of days at HR-4.

The Average Pine Savanna Restoration Area was comparable for 53.8% of days in the Average Pine Savanna Reference Area.

The Average Haul Road (southern swamp) Restoration Area was comparable for 85.7% of days in the Average Haul Road (southern swamp) Reference Area.

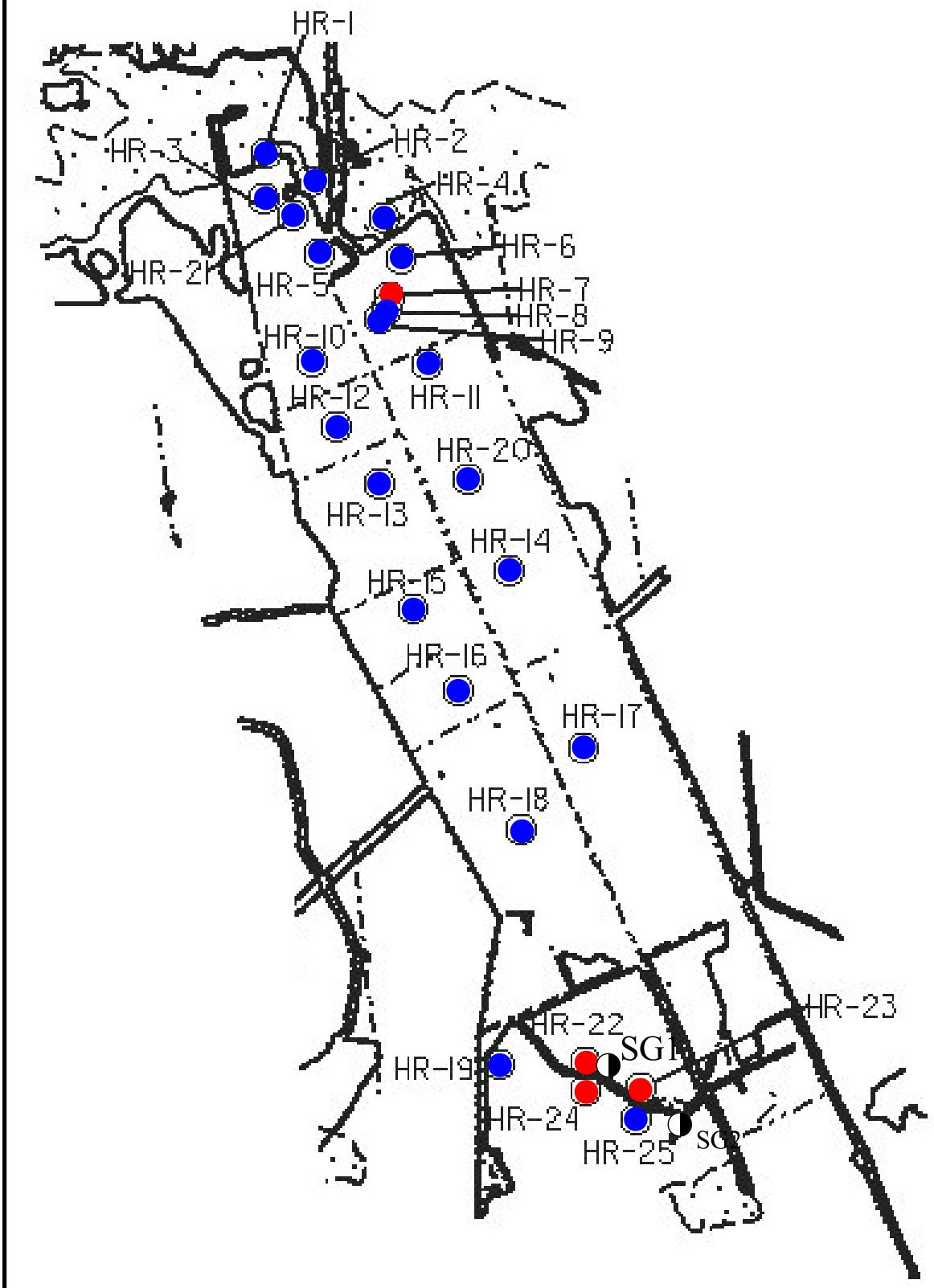


Figure 3. 2004 Hydrologic Monitoring Gauge Results

Hydrology Results

- < 5%
- 5 - 8%
- 8 - 12.5%
- > 12.5%

Rain Gauge

Surface Gauge

N

Not to Scale

Table 1. 2004 HYDROLOGIC MONITORING RESULTS

	Monitoring Gauge	< 5%	5 - 8%	8 – 12.5%	> 12.5%	Actual %	Dates Meeting Success
Swamp Forest (12.5% Expected)	HR-1Ref+				×	67.6	March 23-May 27 June 8-Nov 15
	HR-2 Ref+				×	100	March 23-Nov 15
	HR-3+				×	64.7	March 23-May 21 June 8-Nov 8
	HR-4 Ref+				×	71.0	March 23-May 29 May 31-Nov 15
	HR-5+				×	46.2	June 23-Oct 10
	HR-6+				×	55.5	March 23-June 5 July 7-Nov 15
	HR-21+				×	39.1	July 9-Oct 9
Trans. Slope (8-12.5% Expected)	HR-7+			×		11.3	Aug 27-Sept 27
	HR-8+				×	20.2	July 9-Aug 25 Aug 27-Sept 27
Pine Savanna (8-12.5% Expected)	HR-9+				×	39.9	April 15-May 15 July 9-Oct 11
	HR-10+				×	38.7	July 9-Oct 8
	HR-11+				×	46.6	March 23-April 27 July 9-Oct 27
	HR-12+				×	54.6	March 23-May 27 July 9-Nov 15
	HR-13 Ref+				×	51.7	March 23-May 17 July 9-Nov 8
	HR-14 Ref+				×	17.2	March 23-May 2 July 8-Aug 10
	HR-15+				×	100	March 23-Nov 15
	HR-16 Ref+				×	17.2	July 18-Aug 25 Aug 27-Oct 6
	HR-17 Ref+				×	51.3	March 23-April 22 July 9-Nov 7
	HR-18 Ref+				×	26.1	March 23-May 5 July 7-Aug 28 Sept 15-Nov 15
	HR-20+				×	22.7	March 23-May 6 Sept 15-Nov 7
Haul Road (southern swamp forest) (12.5% Expected)	HR-19+				×	43.7	March 23-May 19 July 10-Oct 21
	HR-22+			×		9.7	
	HR-23			×		11.8	
	HR-24 Ref			×		8.4	
	HR-25 Ref+				×	23.1	July 22-Sept 14

+ Gauge met the success criterion during an average rainfall month (January, April, May, June, July, September, and November).

Specific Gauge Problems:

- Gauge HR-22 malfunctioned during the growing season (April 15-August 10).

Comparison of Duration of Saturation

For each well, the longest hydroperiod (i.e., the number of consecutive days of soil saturation 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 64.6% of Average Swamp Reference Area hydroperiod:

- HR-3: 95.7% of HR-1.
- HR-5: 46.2% of HR-2.
- HR-6: 78.1% of HR-4.

Average Pine Savanna Restoration Area hydroperiod was 154.2% of Average Pine Savanna Reference Area hydroperiod.

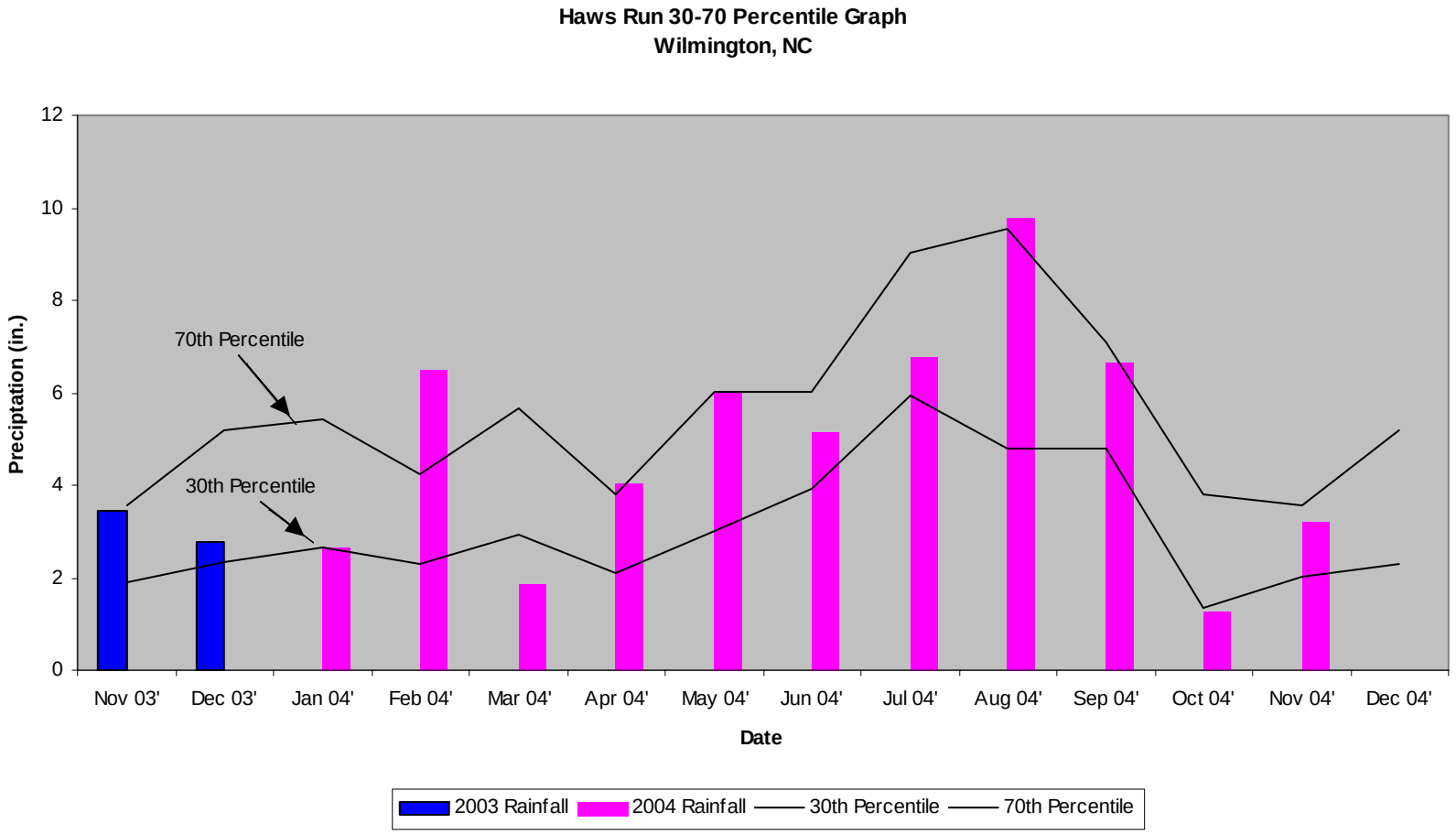
Average Haul Road (southern swamp) Restoration Area hydroperiod was 68.0% of Average Haul Road (southern swamp) Reference Area hydroperiod.

2.3.2 Climatic Data

Figure 4 is a comparison of monthly rainfall for the period of November 2003 through October 2004 to historical precipitation (collected between 1973 and 2004) for Wilmington, North Carolina. This comparison gives an indication of how 2004 relates to historical data in terms of climate conditions. The NC State Climate Office provided all offsite data.

For the 2004-year, February and August experienced above average rainfall. The months of March and October recorded below average rainfall for the site and November (03'), December (03'), January, April, May, June, July, September, and November experienced average rainfall. Overall, 2004 experienced an average rainfall year.

Figure 4. 30-70 Percentile Graph



2.4 Conclusions

In the swamp forest area, all gauges exceeded the 12.5% jurisdictional wetland criteria. In the pine savanna area, all gauges recorded hydroperiods of 8% of the growing season, or greater. Two of the five gauges along the haul road (southern swamp) met the jurisdictional criteria of 12.5%. Gauge HR-22 located in the haul road (southern swamp) area malfunctioned throughout the growing season, thus preventing an accurate success calculation. Gauges HR-23 and HR-24 exhibited comparable depths to groundwater, however the duration of the hydroperiods was shorter than the HR-25 reference for the 2004-growing season.

Hydrologic patterns in the restoration areas across the Haws Run Mitigation Site followed 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 (southern swamp) restoration area was similar to the reference area; the flooding patterns coincided well. The data illustrated the effects of removal of the haul road (southern swamp) (re-establishing the hydrologic connection of the isolated area to the southern swamp area).

The duration of saturation between the restoration gauges and the reference gauges were also comparable to the swamp and savanna areas. The average length of the hydroperiod for the Swamp Forest restoration area was approximately 122 days compared to the 189-day hydroperiod in the reference area. For the Pine Savanna area, the average hydroperiod length for the restoration area was approximately 120 days compared to 78 days for the reference area. The restoration gauges in the haul road (southern swamp) area indicated an average hydroperiod of 26 days compared to 38 days for the reference area. The hydroperiod results indicate that the saturation regime in the restoration and reference areas is very similar.

3.0 VEGETATION: HAWS RUN MITIGATION SITE (YEAR 5 MONITORING)

3.1 Success Criteria

A. Savanna Areas

The success criteria state 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 criteria were 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 2A.)

ZONE	Plot #	Longleaf Pine	Pond Pine	Pond Cypress	Total (5 year)	Density (Trees/Acre
1	S1	19	130	33	182	32
	S3	51	190		241	42
	ZONE 1 AVG.					37
2	S2	97			97	17
	ZONE 2 AVG.					17
	TOTAL AVG.					30

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 are growing well. Broomsedge was present throughout the plots. Pitcher plant noted in some areas.

B. Swamp Forest Area (Table 2B.)

Plot #	Swamp Blackgum	Baldcypress	Laurel Oak	Overcup Oak	Swamp Chestnut Oak	Tulip Poplar	Cherrybark Oak	Green Ash	American Sycamore	Total (5 year)	Total (at planting)	Density (Trees/Acre)
1	9	28		9				3		49	53	629
2	7	9		3	3			13		35	53	449
3	2	5		2	2			7		18	34	360
4	4	3		3	5		2	3		20	35	389
5	2			12	2					16	39	279
6	6		2	1			2	2		13	36	246
7	2	2	2	4		1		4	12	27	43	427
TOTAL AVG.												**397**

Site Notes: Other species noted: Fennel, *Juncus* sp., cattail, *Bidens* sp., *Baccharis halimifolia*, various grasses and sedges, broomsedge, woolgrass, giant cane, *Panicum* sp., fern, *Distichlis spicata*, *Eleocharis* sp., sweet bay, sweetgum, red maple, black willow, blackgum, goldenrod, and pine. Plot 1 had 8 inches to 1 foot 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 three test plots established throughout the planted area. The 2004 vegetation monitoring of the planted areas revealed an average density of 30 trees per acre, which is 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 seven test plots established throughout the planted area. The 2004 vegetation monitoring of the planted areas revealed an average density of 397 trees per acre, which is above the minimum requirement of 260 trees per acre.

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

The area around plot one has been inundated with water at every site visit (See photos 1 and 2). The planted tree seedlings did not survive in this area. NCDOT supplemental 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 that area.

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 are becoming well established.

NCDOT proposes to discontinue vegetation monitoring at the Haws Run Mitigation Site.

4.0 OVERALL CONCLUSIONS / RECOMMENDATIONS

Hydrologic monitoring revealed trends in the restoration areas similar to those in the reference areas. With the exception of HR-22, HR-23, and the HR-24 reference gauge, all of the other onsite gauges met the optimum jurisdictional wetland criteria. Gauge HR-22 located in the haul road (southern swamp) area malfunctioned throughout the growing season, thus preventing an accurate success calculation. Gauges HR-23 and HR-24 exhibited comparable depths to groundwater, however the duration of the hydroperiods was shorter than the HR-25 reference for the 2004-growing season.

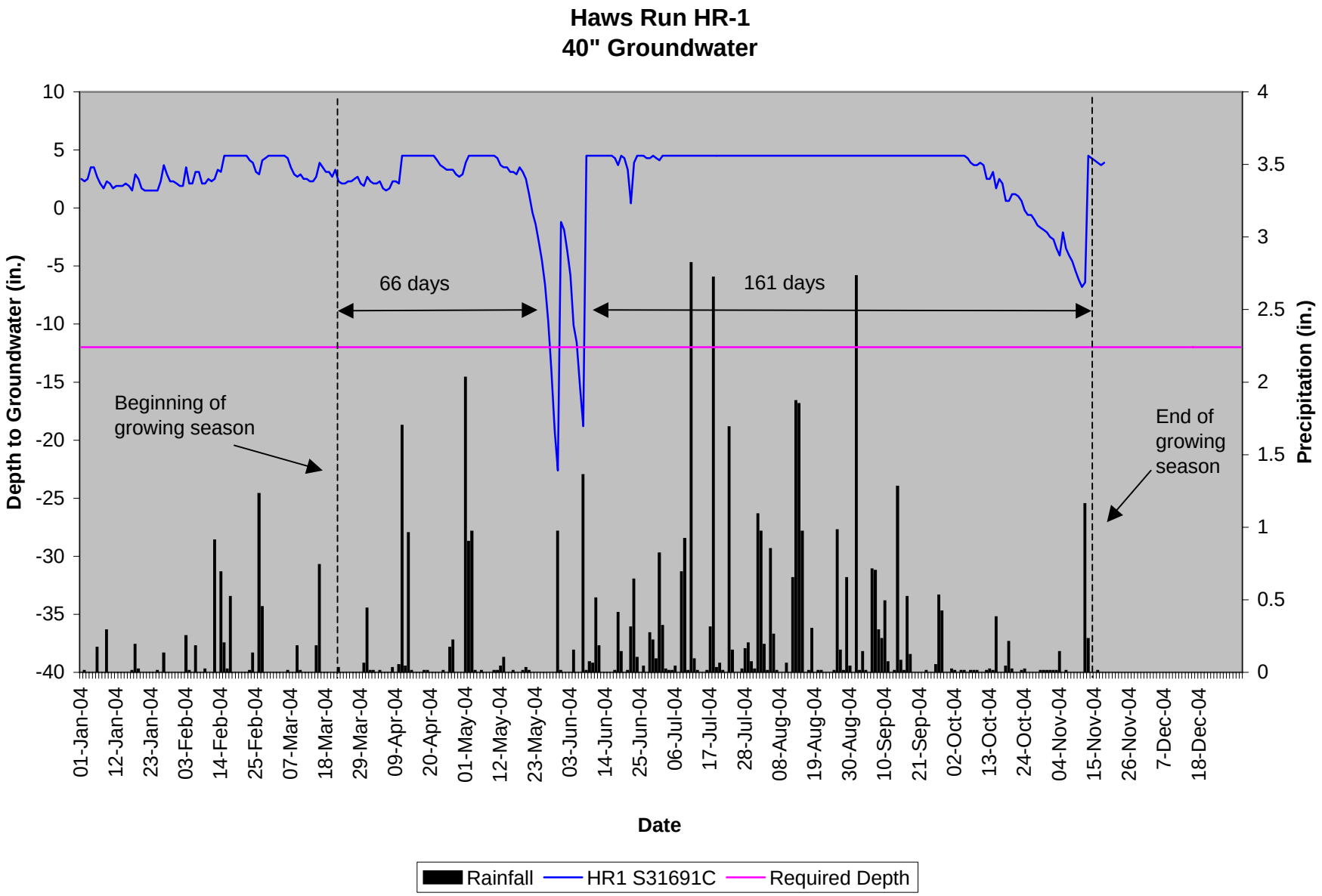
Vegetation monitoring for 2004 revealed that the Savanna and Swamp Forest areas are performing successfully, with average densities above the minimum requirements. The vegetation monitoring of the planted areas revealed that the planted grasses were establishing well.

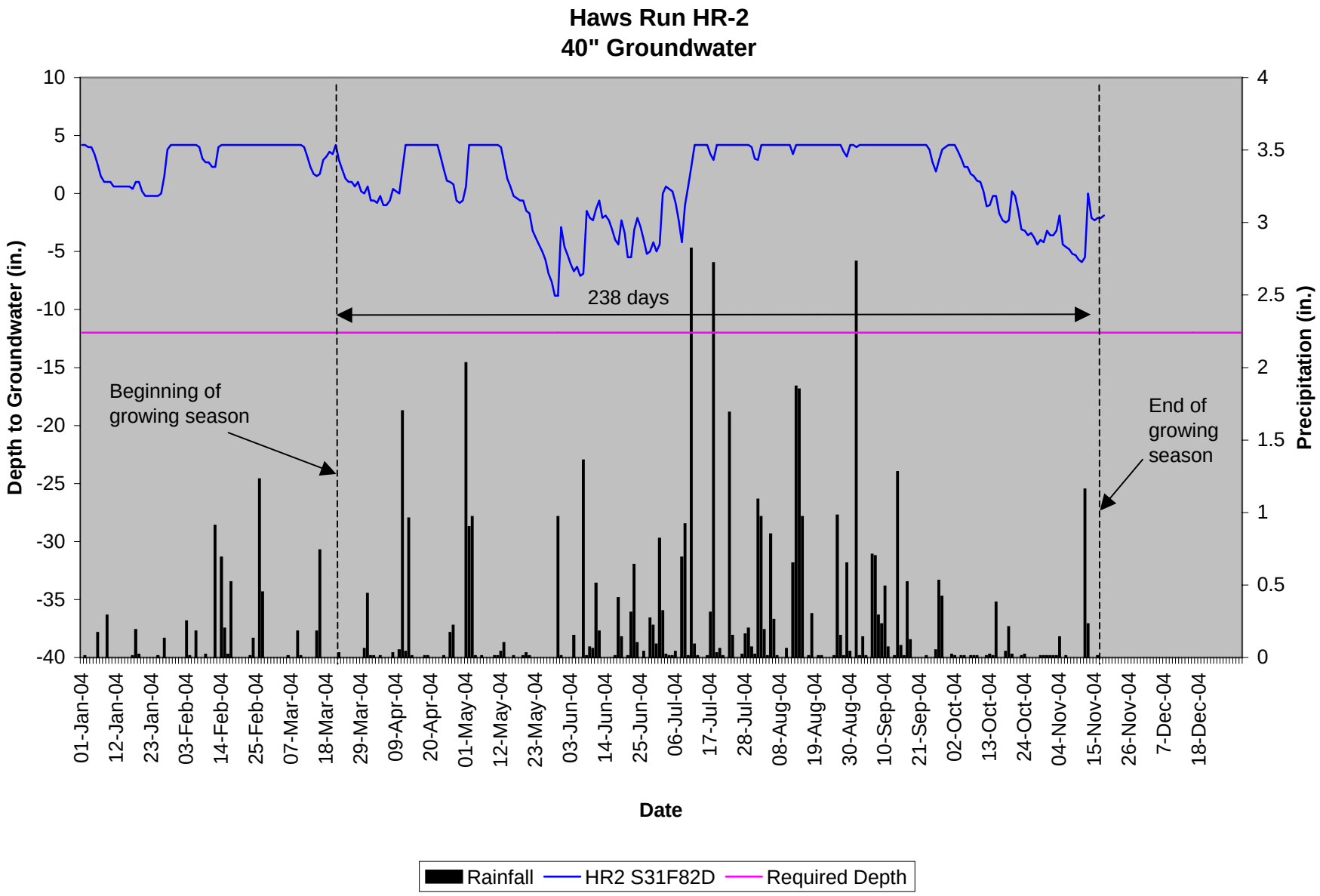
NCDOT proposes to discontinue vegetation and hydrology monitoring at the Haws Run Mitigation Site.

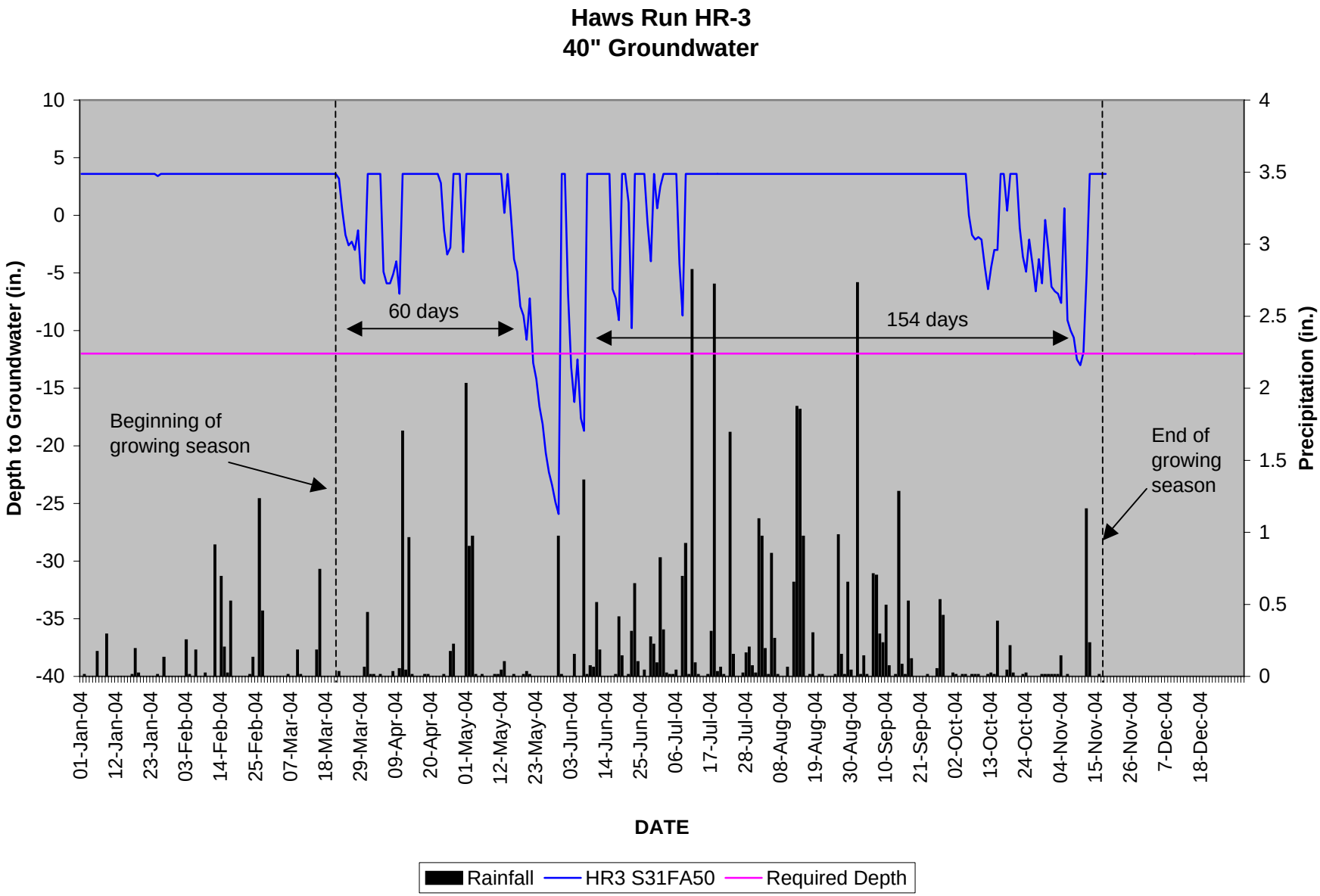
Appendix A

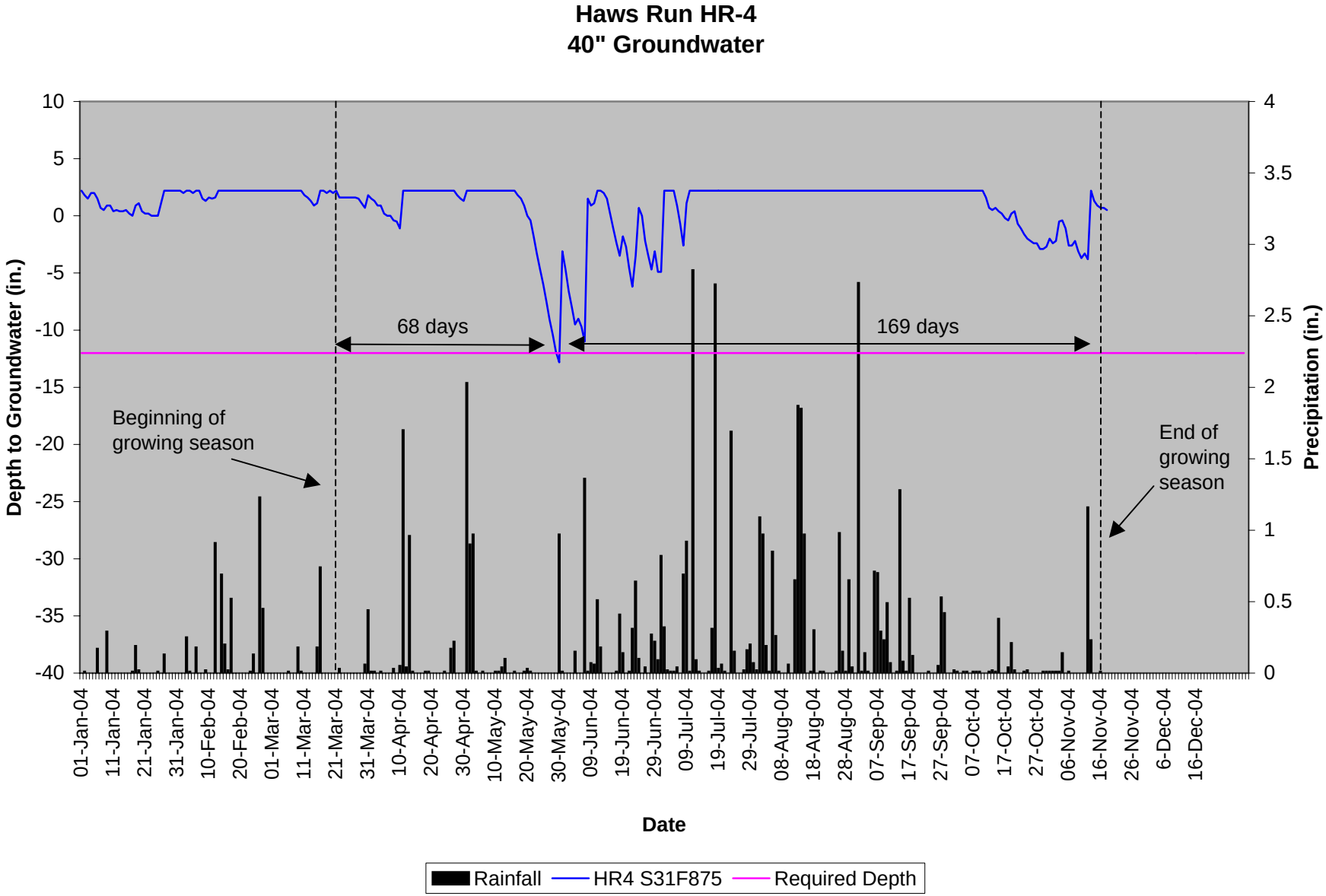
Gauge Data Graphs

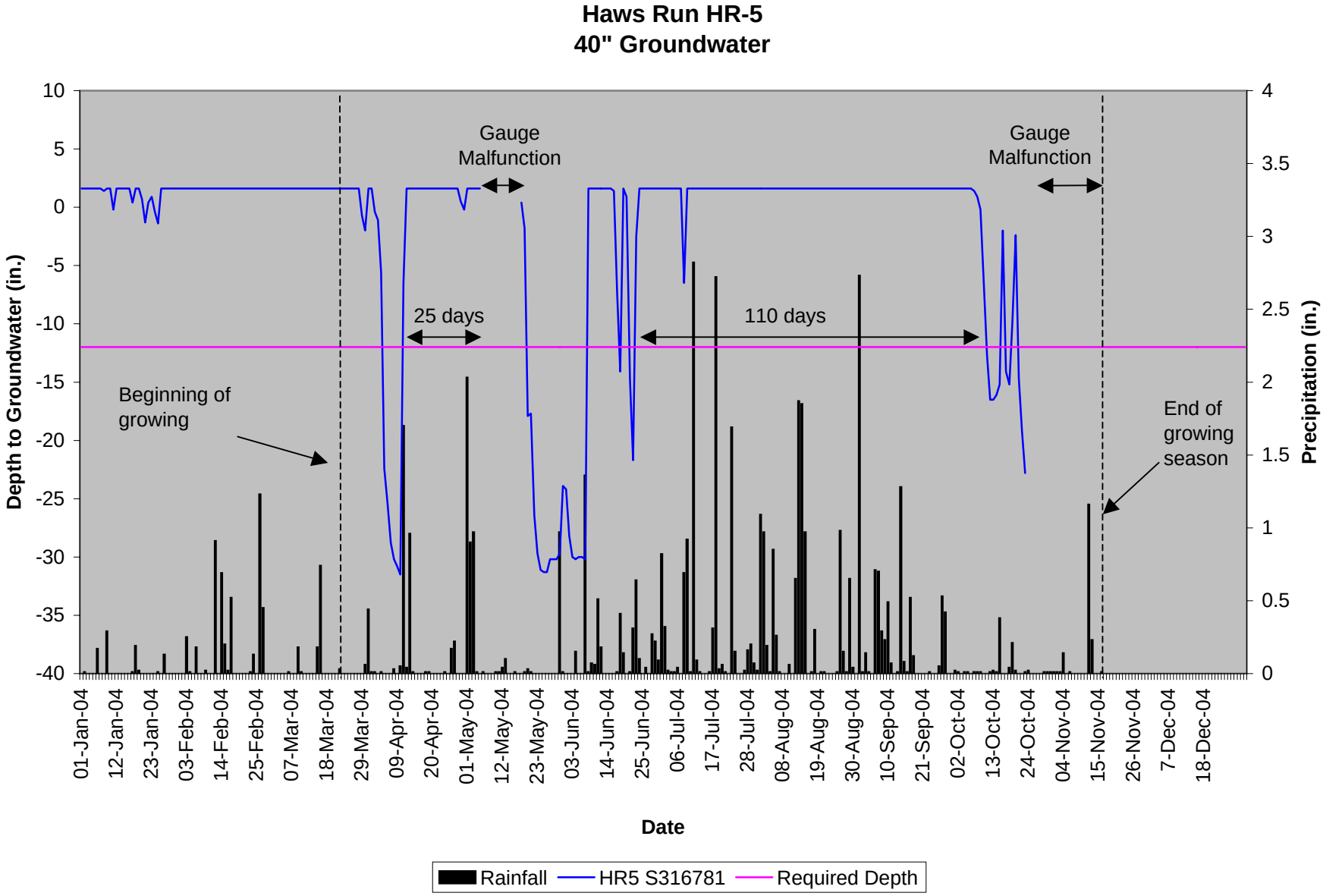
GROUNDWATER GAUGES

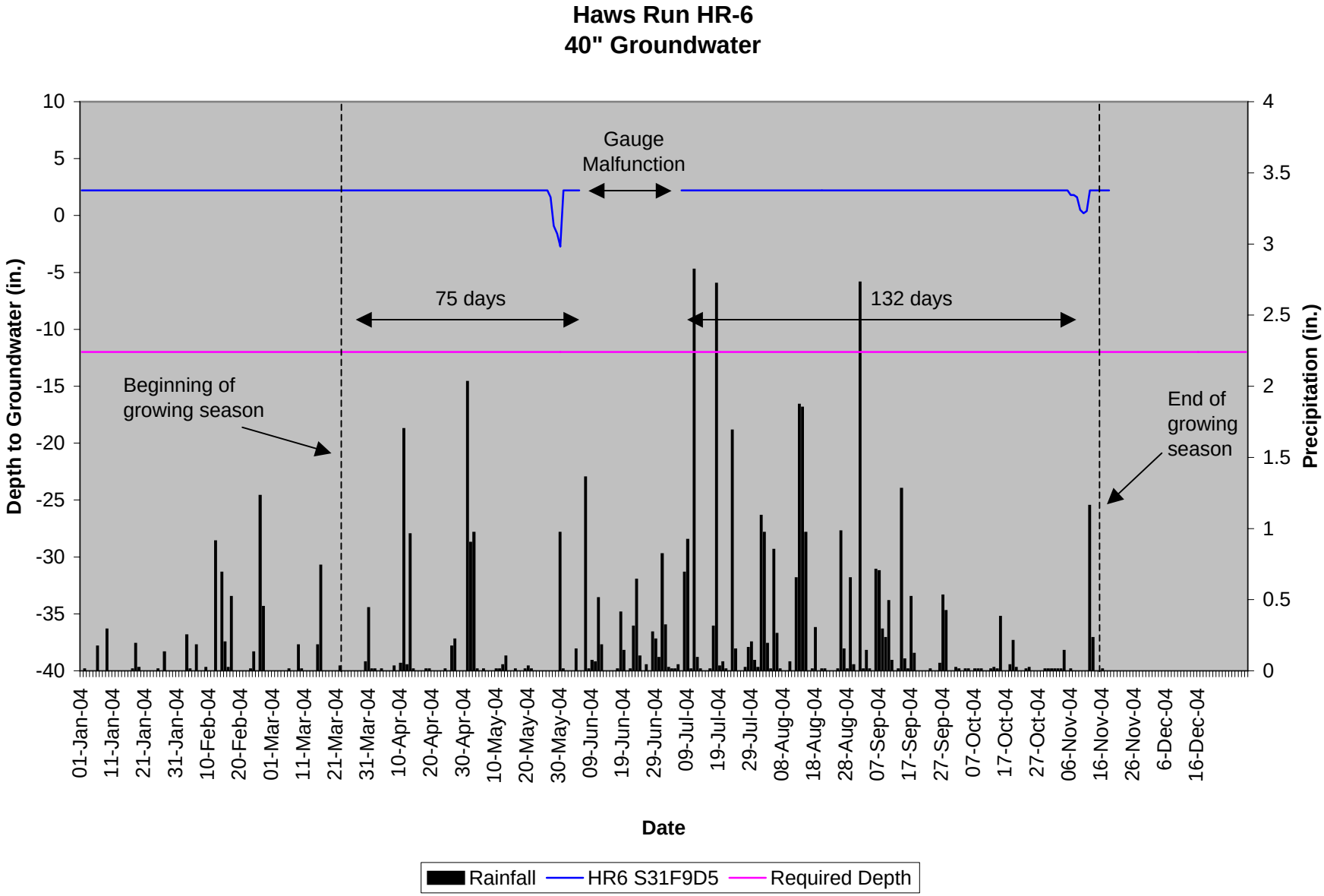

Haws Run HR-1
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
66 days
161 days
Beginning of growing season
End of growing season
Date
Rainfall
HR1 S31691C
Required Depth

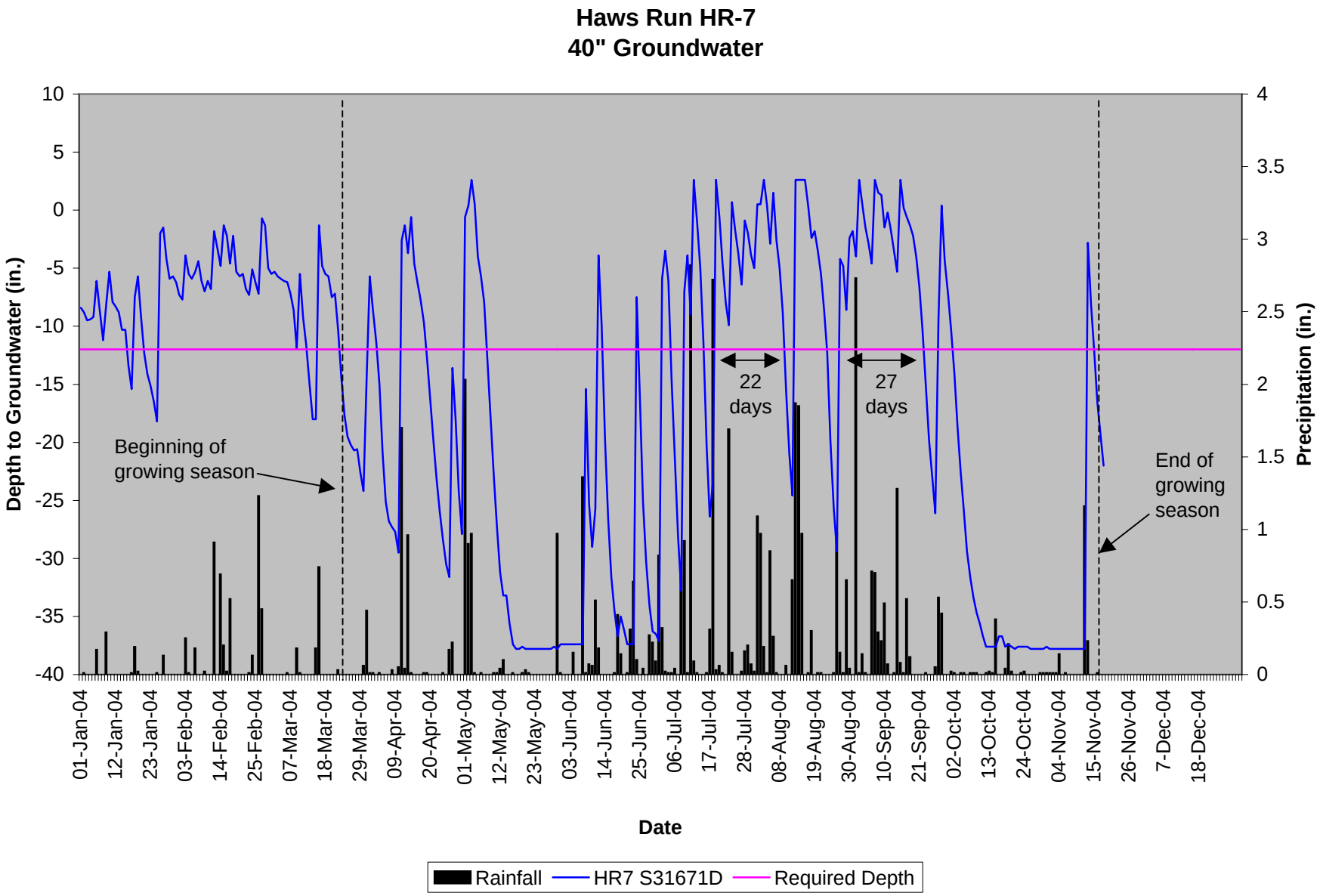

Haws Run HR-2
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
238 days
Beginning of growing season
End of growing season
Date
Rainfall
HR2 S31F82D
Required Depth

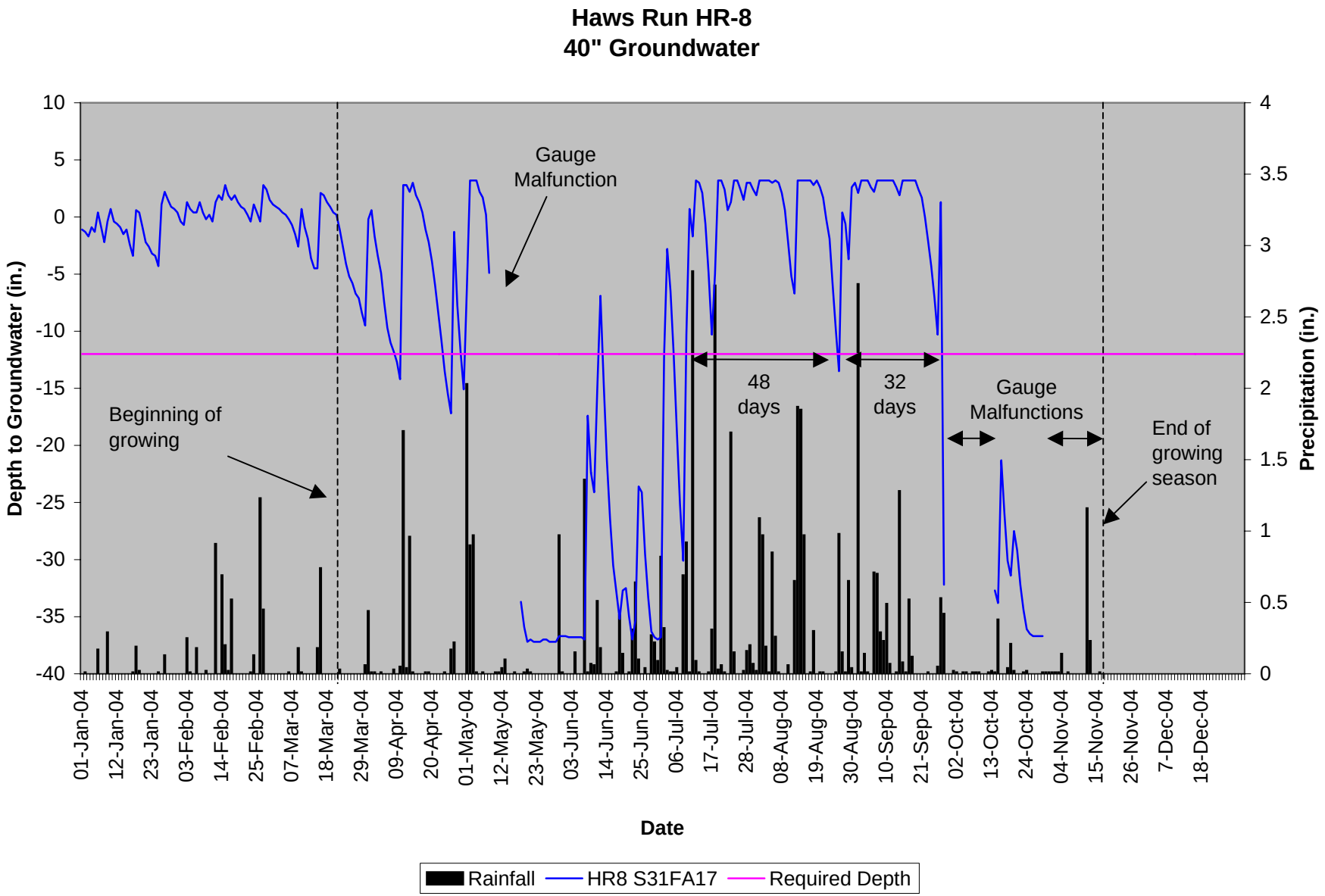

Haws Run HR-3
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
4
3.5
3
2.5
2
1.5
1
0.5
0
60 days
154 days
Beginning of growing season
End of growing season
01-Jan-04
12-Jan-04
23-Jan-04
03-Feb-04
14-Feb-04
25-Feb-04
07-Mar-04
18-Mar-04
29-Mar-04
09-Apr-04
20-Apr-04
01-May-04
12-May-04
23-May-04
03-Jun-04
14-Jun-04
25-Jun-04
06-Jul-04
17-Jul-04
28-Jul-04
08-Aug-04
19-Aug-04
30-Aug-04
10-Sep-04
21-Sep-04
02-Oct-04
13-Oct-04
24-Oct-04
04-Nov-04
15-Nov-04
26-Nov-04
7-Dec-04
18-Dec-04
DATE
Rainfall
HR3 S31FA50
Required Depth

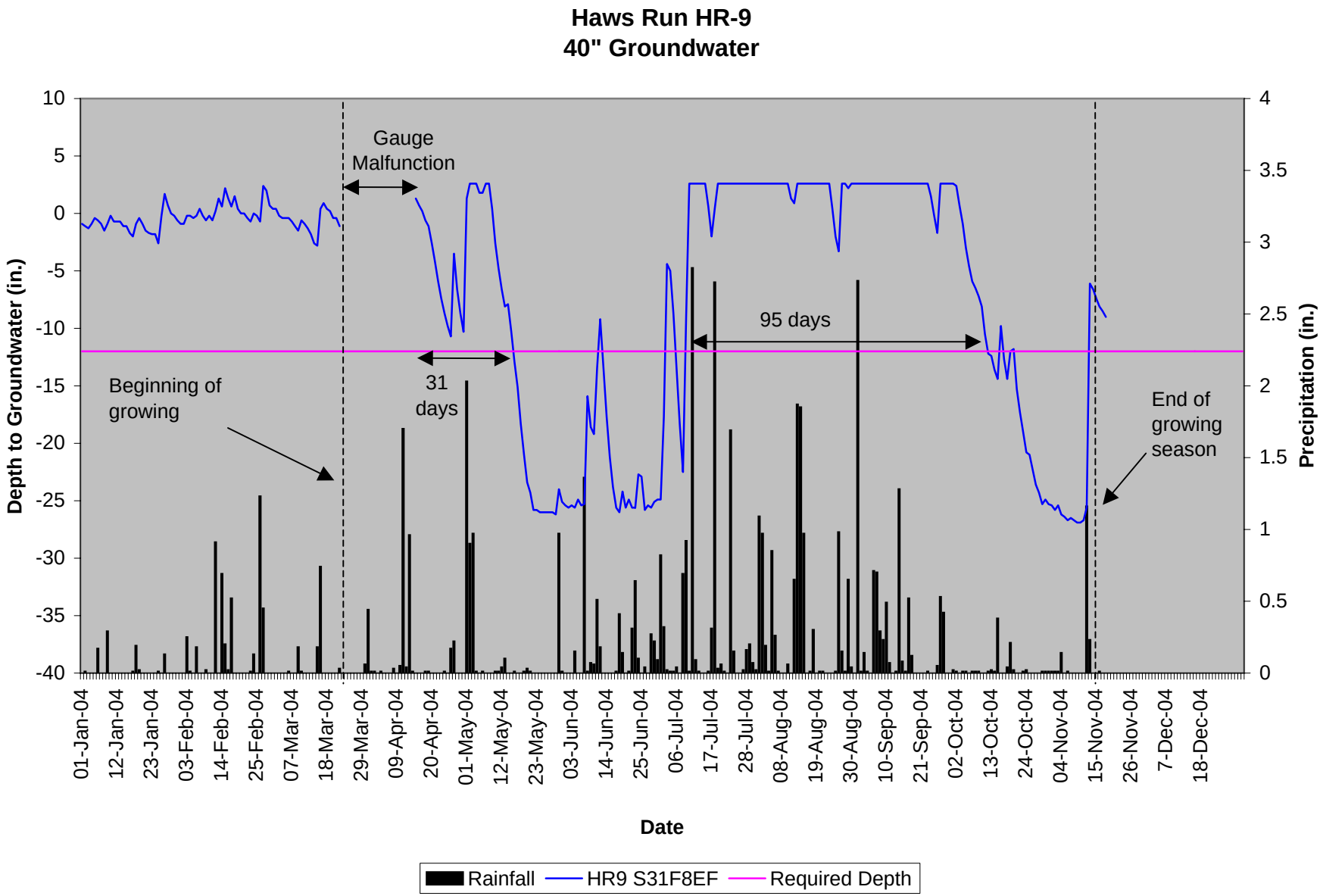

Haws Run HR-4
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
4
3.5
3
2.5
2
1.5
1
0.5
0
68 days
169 days
Beginning of growing season
End of growing season
01-Jan-04
11-Jan-04
21-Jan-04
31-Jan-04
10-Feb-04
20-Feb-04
01-Mar-04
11-Mar-04
21-Mar-04
31-Mar-04
10-Apr-04
20-Apr-04
30-Apr-04
10-May-04
20-May-04
30-May-04
09-Jun-04
19-Jun-04
29-Jun-04
09-Jul-04
19-Jul-04
29-Jul-04
08-Aug-04
18-Aug-04
28-Aug-04
07-Sep-04
17-Sep-04
27-Sep-04
07-Oct-04
17-Oct-04
27-Oct-04
06-Nov-04
16-Nov-04
26-Nov-04
6-Dec-04
16-Dec-04
Date
Rainfall
HR4 S31F875
Required Depth

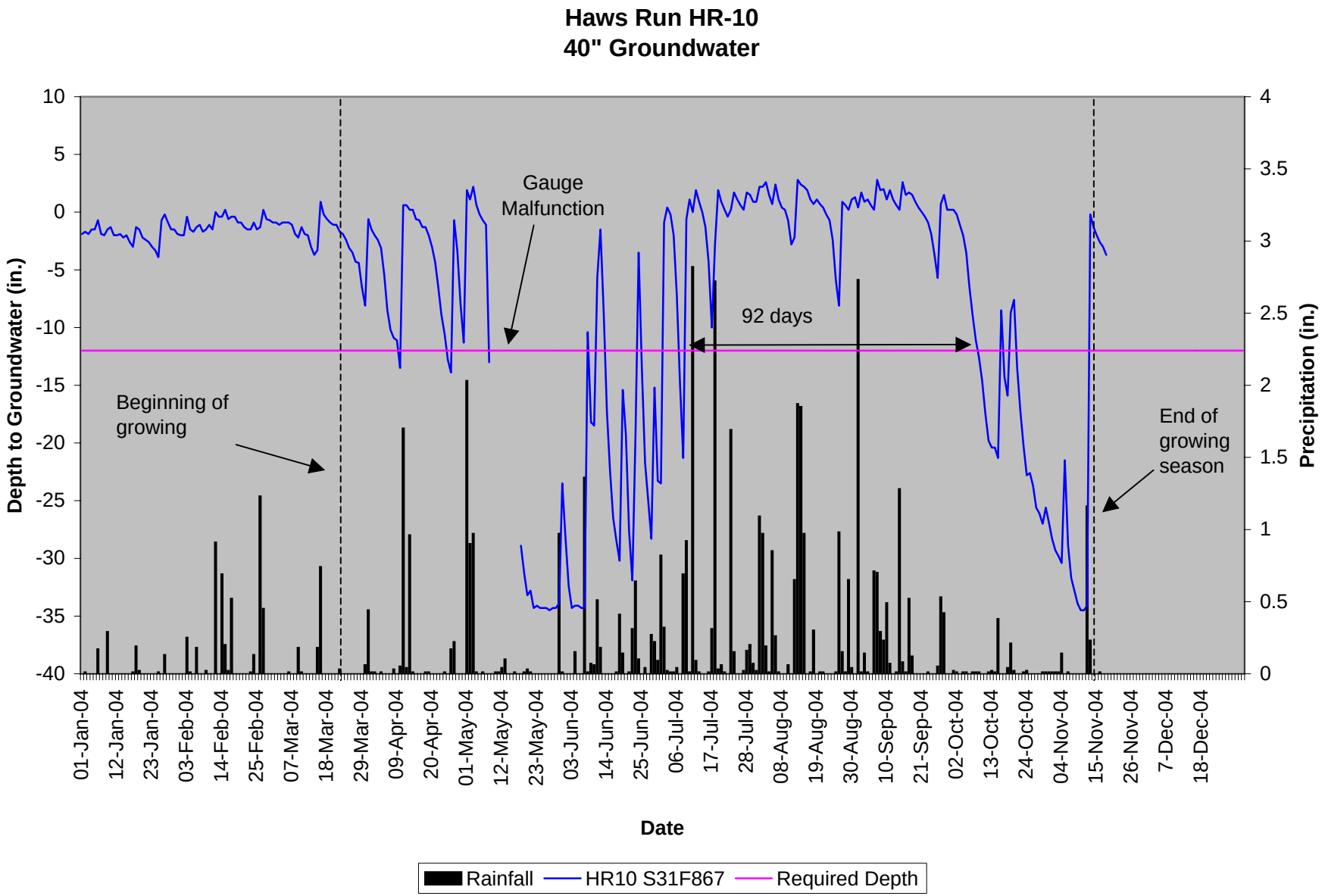

Haws Run HR-5
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Gauge Malfunction
Gauge Malfunction
25 days
110 days
Beginning of growing
End of growing season
Rainfall
HR5 S316781
Required Depth

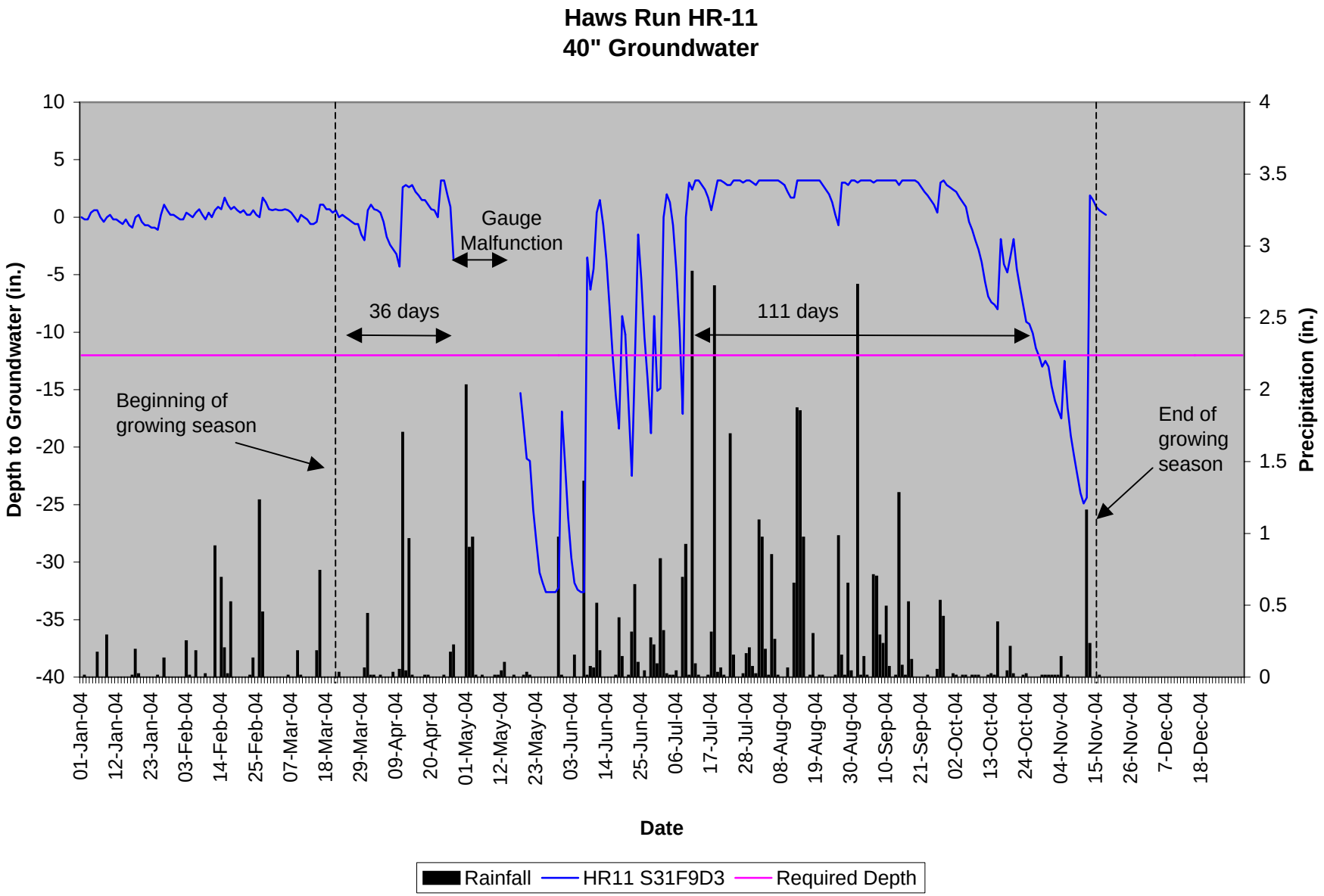

Haws Run HR-6
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Gauge Malfunction
75 days
132 days
Beginning of growing season
End of growing season
Date
Rainfall
HR6 S31F9D5
Required Depth

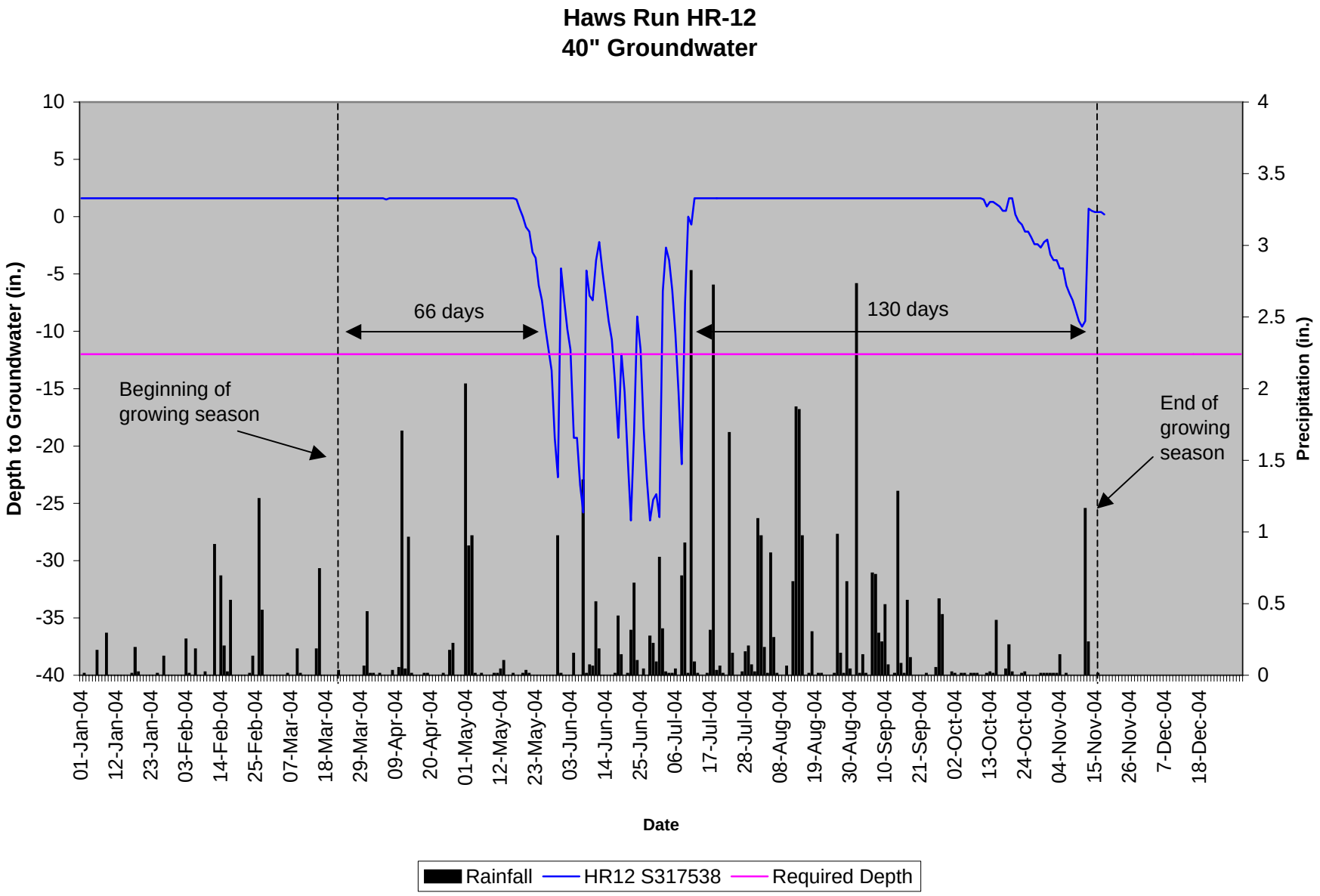

Haws Run HR-7
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Beginning of growing season
End of growing season
22 days
27 days
Rainfall
HR7 S31671D
Required Depth
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
4
3.5
3
2.5
2
1.5
1
0.5
0
01-Jan-04
12-Jan-04
23-Jan-04
03-Feb-04
14-Feb-04
25-Feb-04
07-Mar-04
18-Mar-04
29-Mar-04
09-Apr-04
20-Apr-04
01-May-04
12-May-04
23-May-04
03-Jun-04
14-Jun-04
25-Jun-04
06-Jul-04
17-Jul-04
28-Jul-04
08-Aug-04
19-Aug-04
30-Aug-04
10-Sep-04
21-Sep-04
02-Oct-04
13-Oct-04
24-Oct-04
04-Nov-04
15-Nov-04
26-Nov-04
7-Dec-04
18-Dec-04

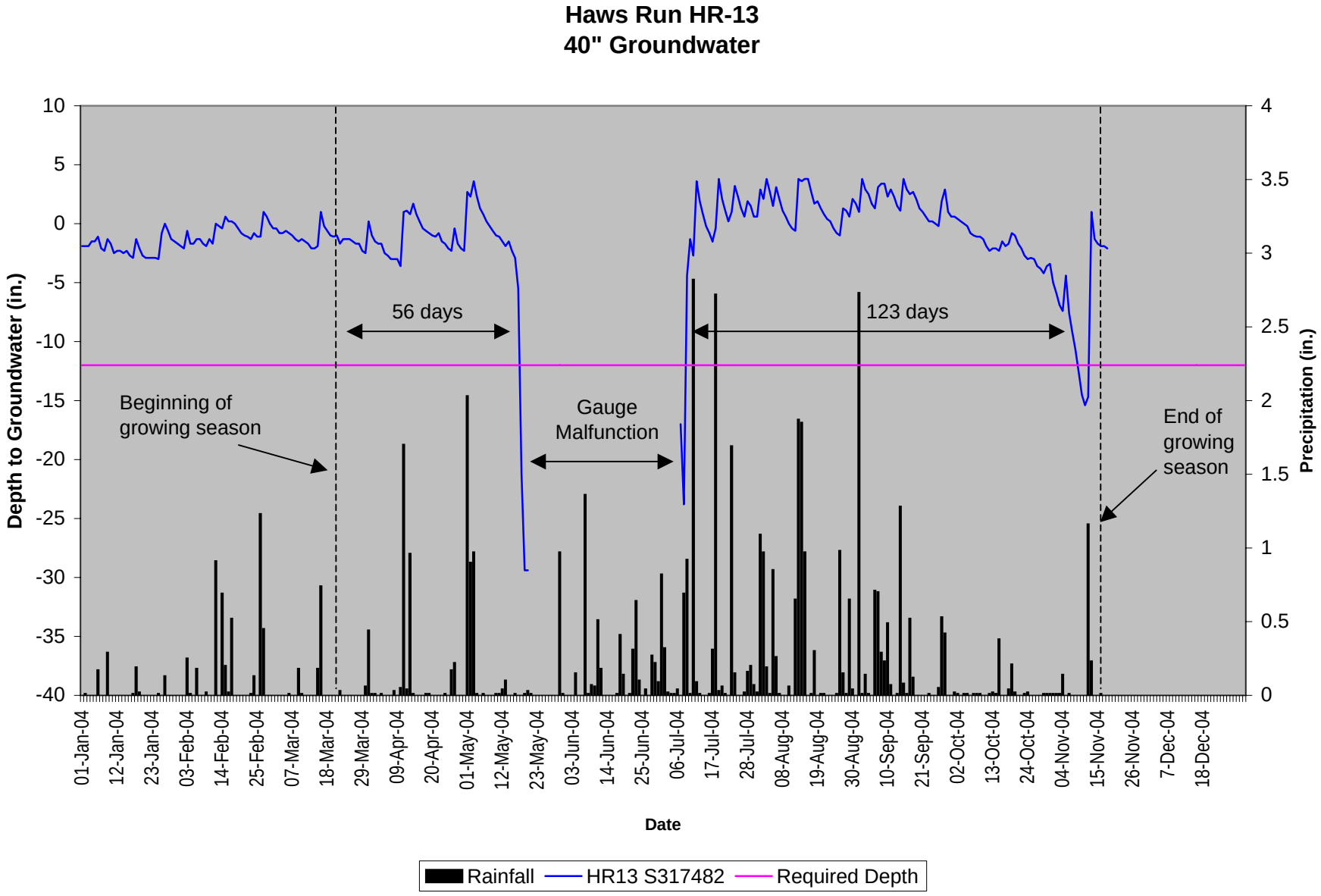

Haws Run HR-8
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Gauge Malfunction
Beginning of growing
48 days
32 days
Gauge Malfunctions
End of growing season
Rainfall
HR8 S31FA17
Required Depth

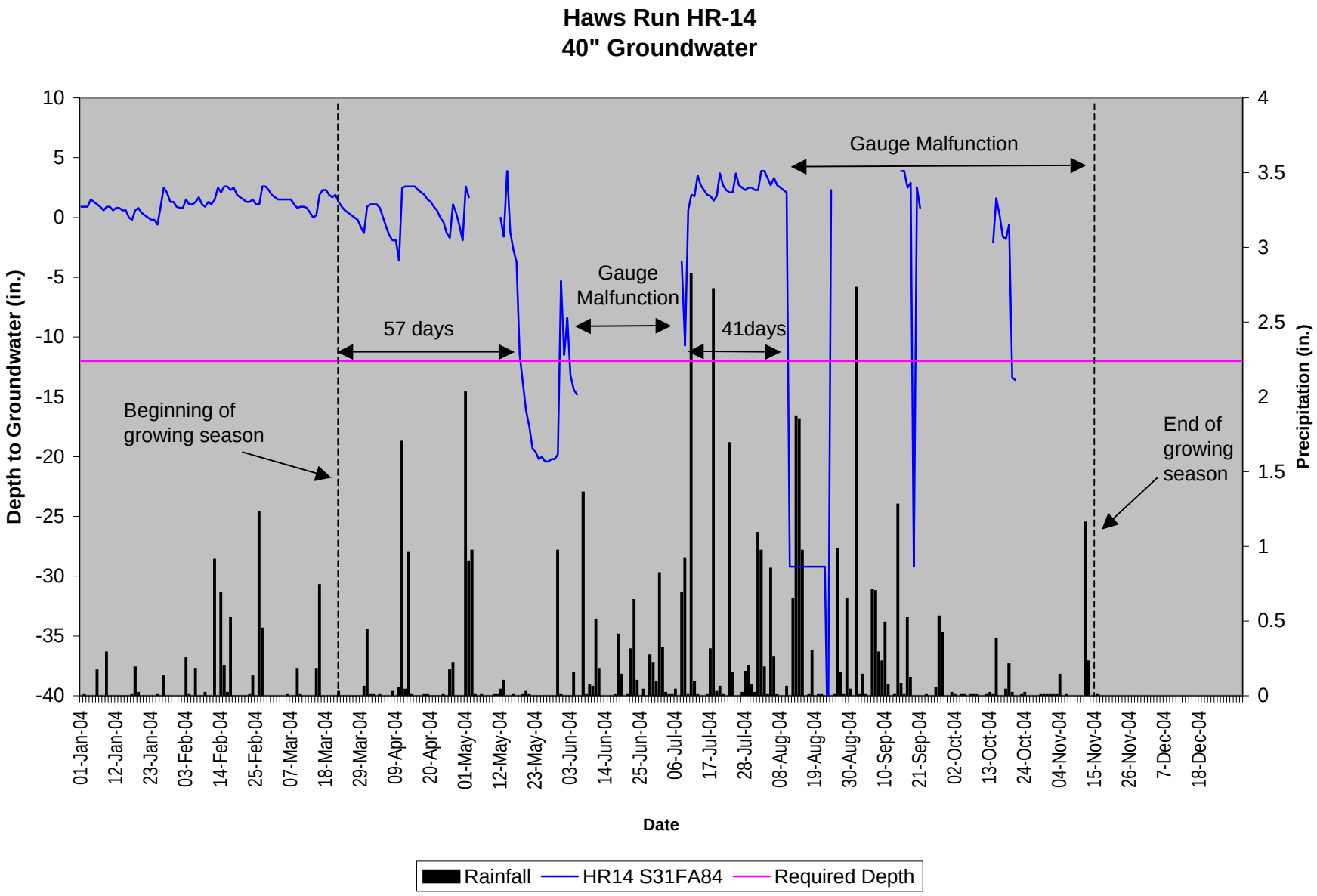

Haws Run HR-9
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Gauge Malfunction
Beginning of growing
31 days
95 days
End of growing season
Rainfall
HR9 S31F8EF
Required Depth

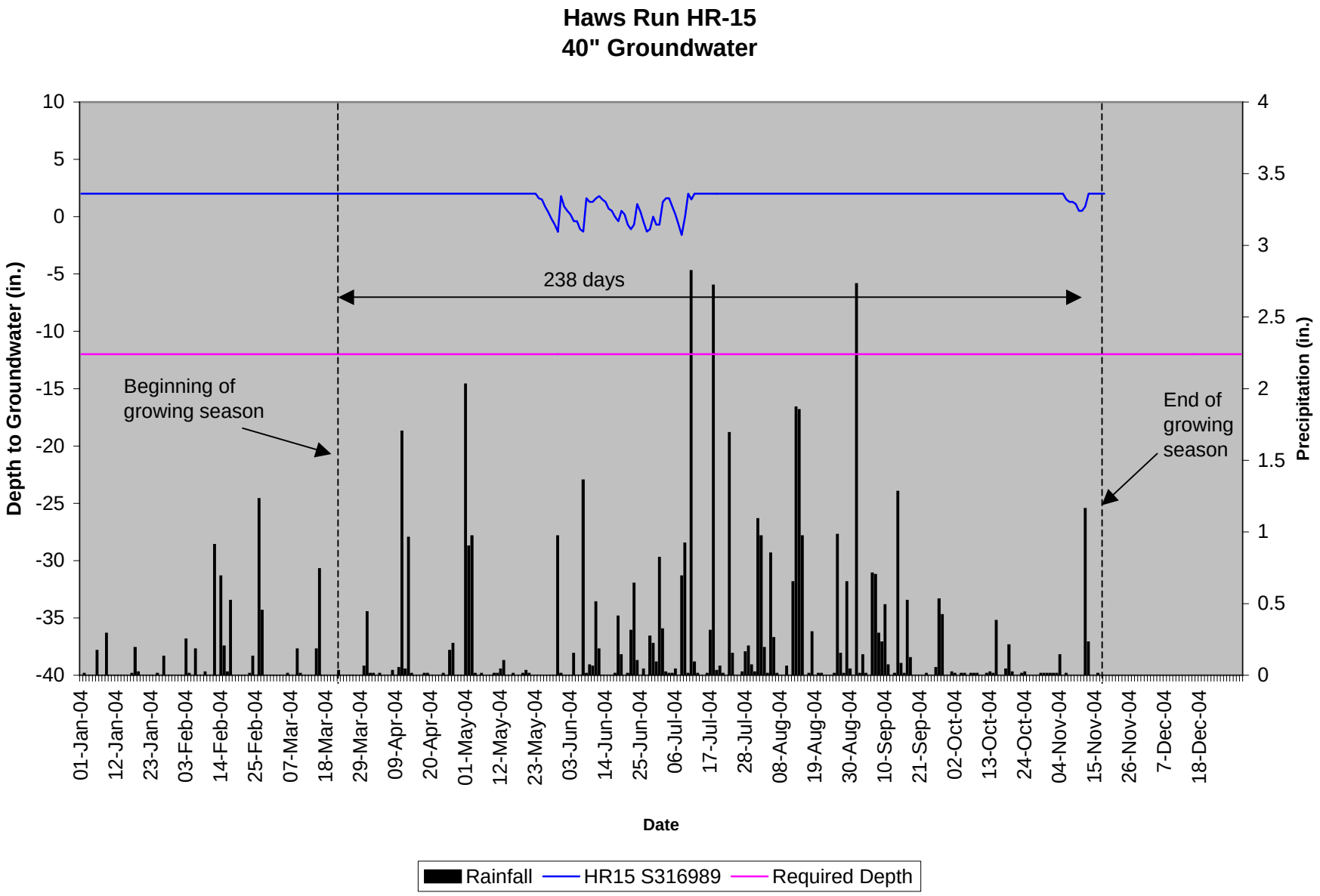

Haws Run HR-10
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Gauge Malfunction
92 days
Beginning of growing
End of growing season
Date
Rainfall
HR10 S31F867
Required Depth

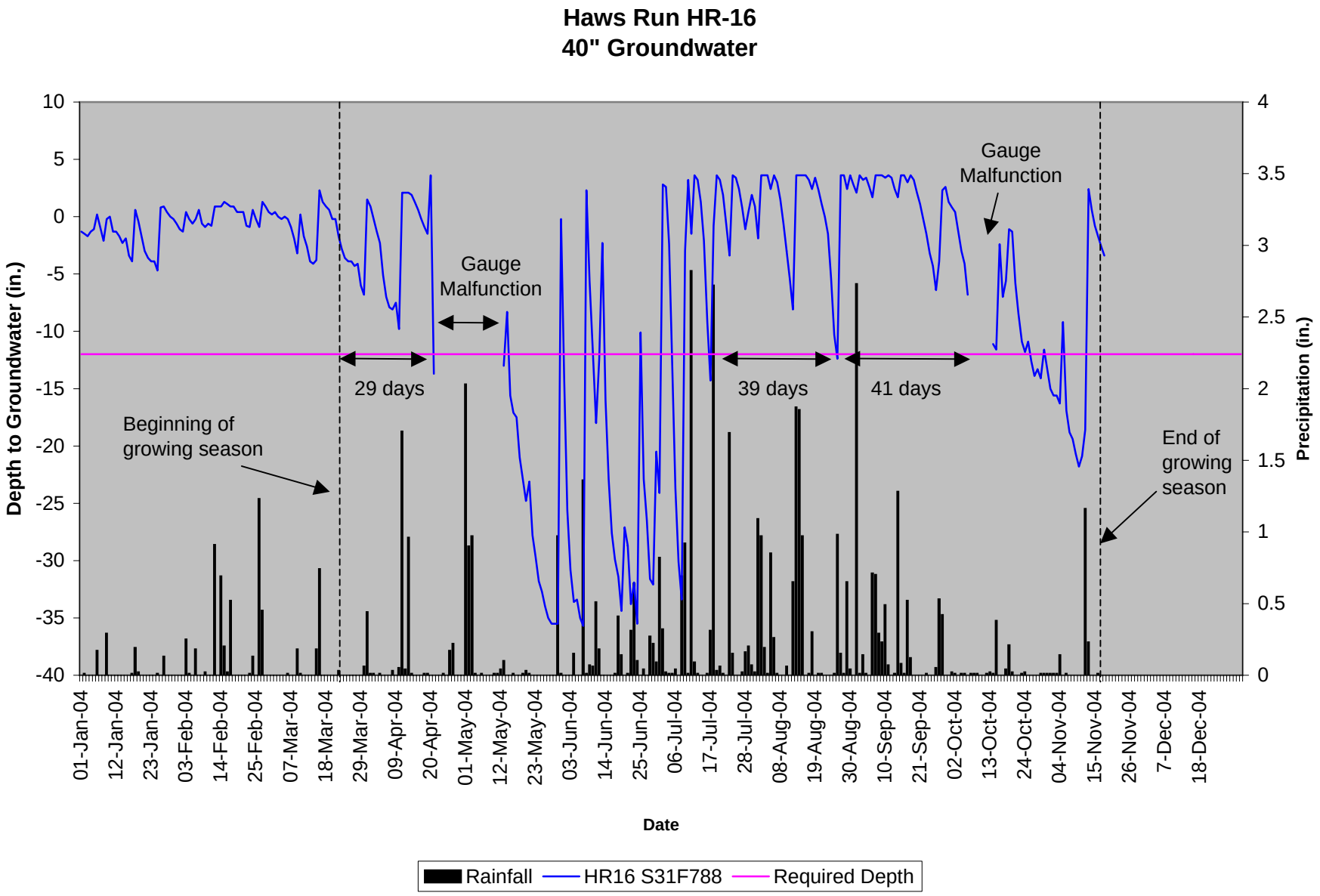

Haws Run HR-11
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Gauge Malfunction
36 days
111 days
Beginning of growing season
End of growing season
Rainfall
HR11 S31F9D3
Required Depth

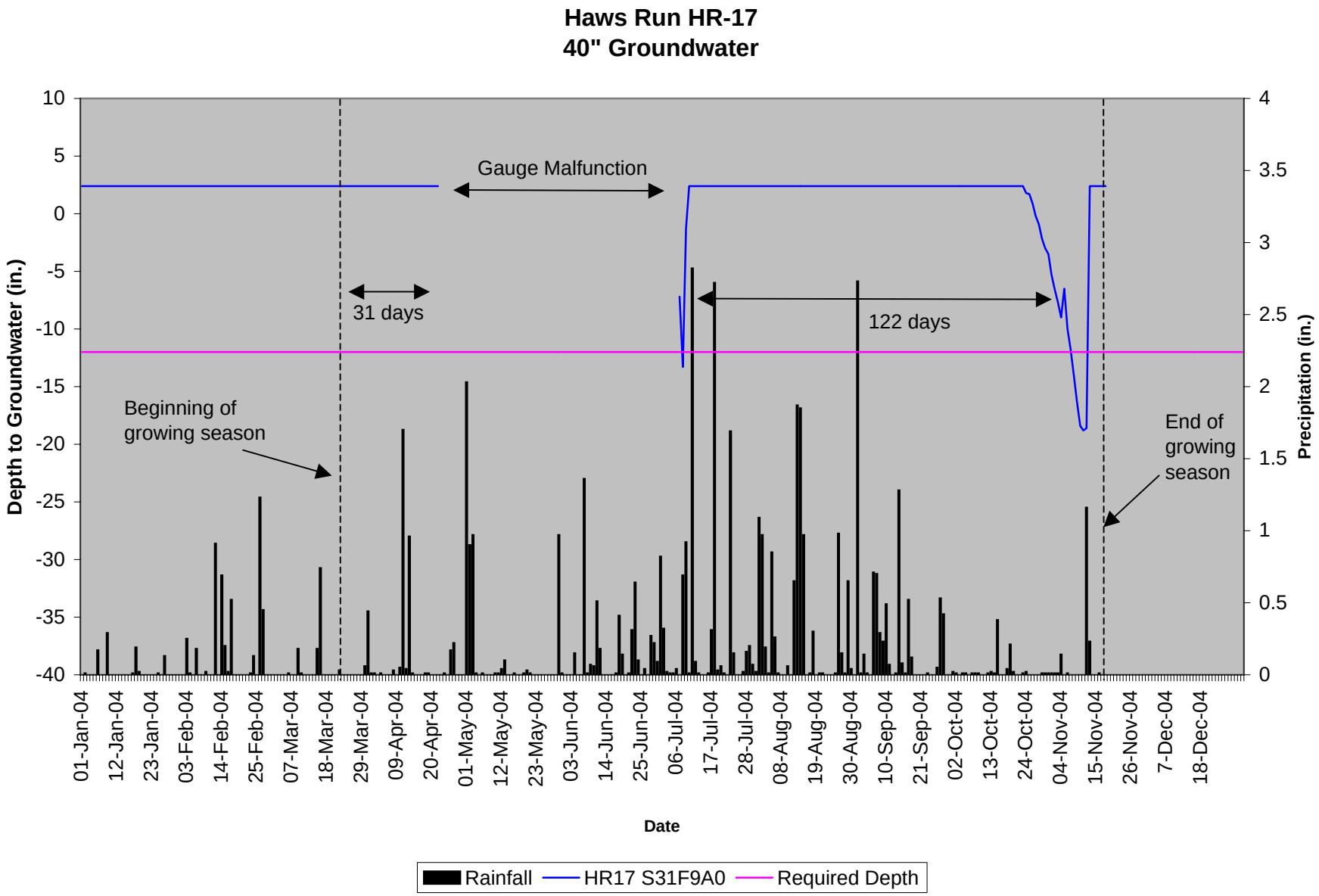

Haws Run HR-12
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
66 days
130 days
Beginning of growing season
End of growing season
Date
Rainfall
HR12 S317538
Required Depth

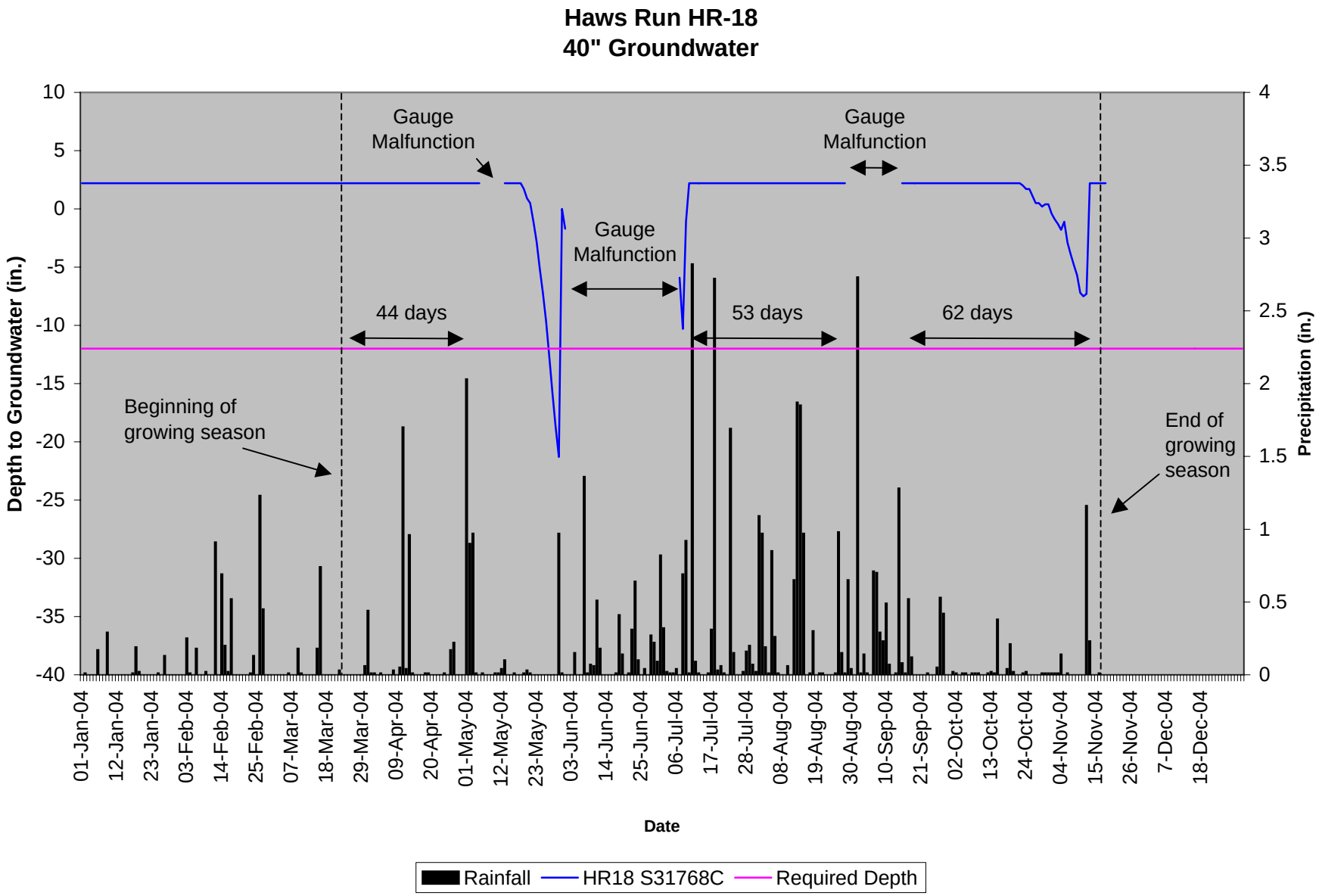

Haws Run HR-13
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
56 days
123 days
Beginning of growing season
Gauge Malfunction
End of growing season
Rainfall
HR13 S317482
Required Depth

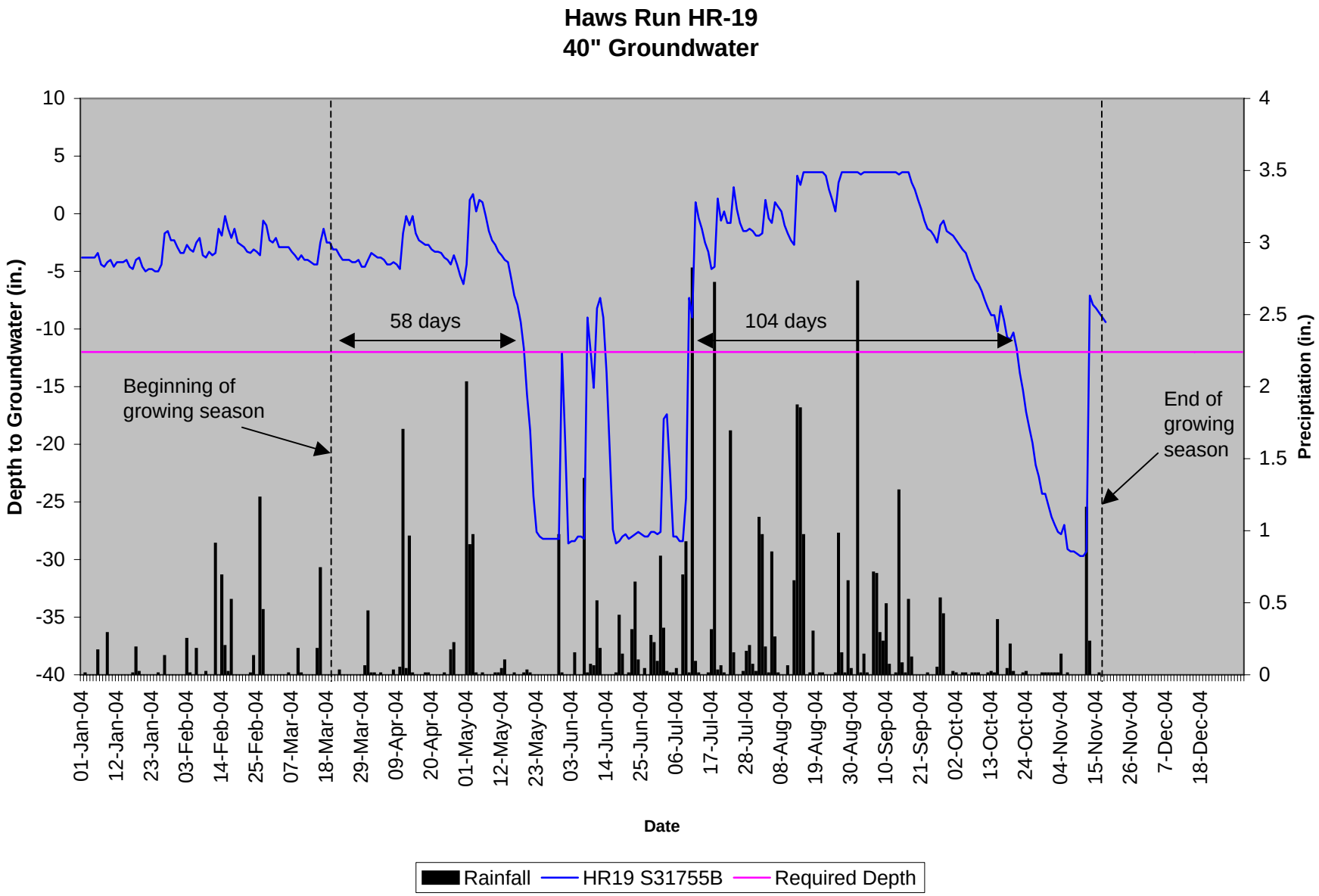

Haws Run HR-14
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Gauge Malfunction
Gauge Malfunction
57 days
41days
Beginning of growing season
End of growing season
Rainfall
HR14 S31FA84
Required Depth

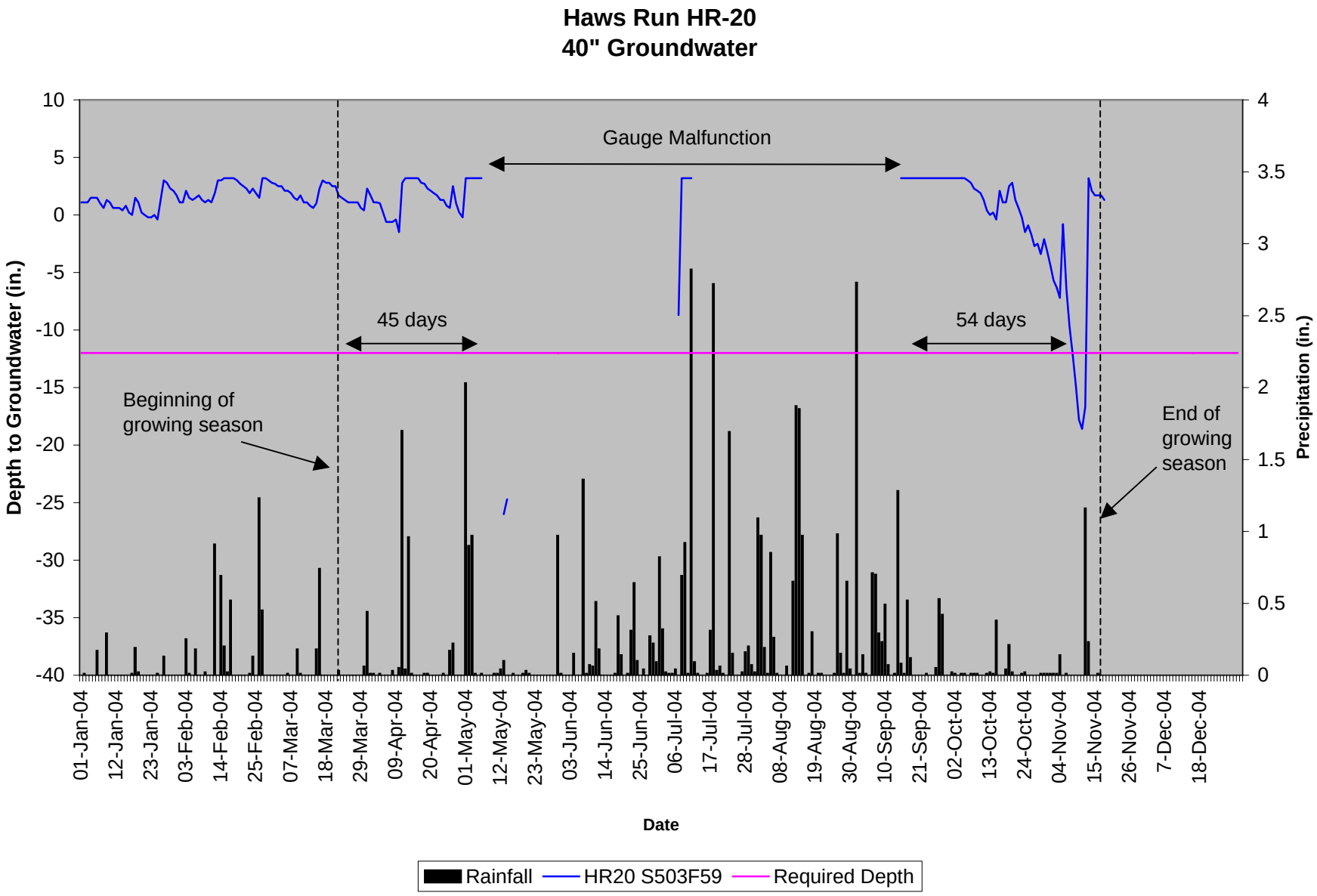

Haws Run HR-15
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
238 days
Beginning of growing season
End of growing season
Date
Rainfall
HR15 S316989
Required Depth

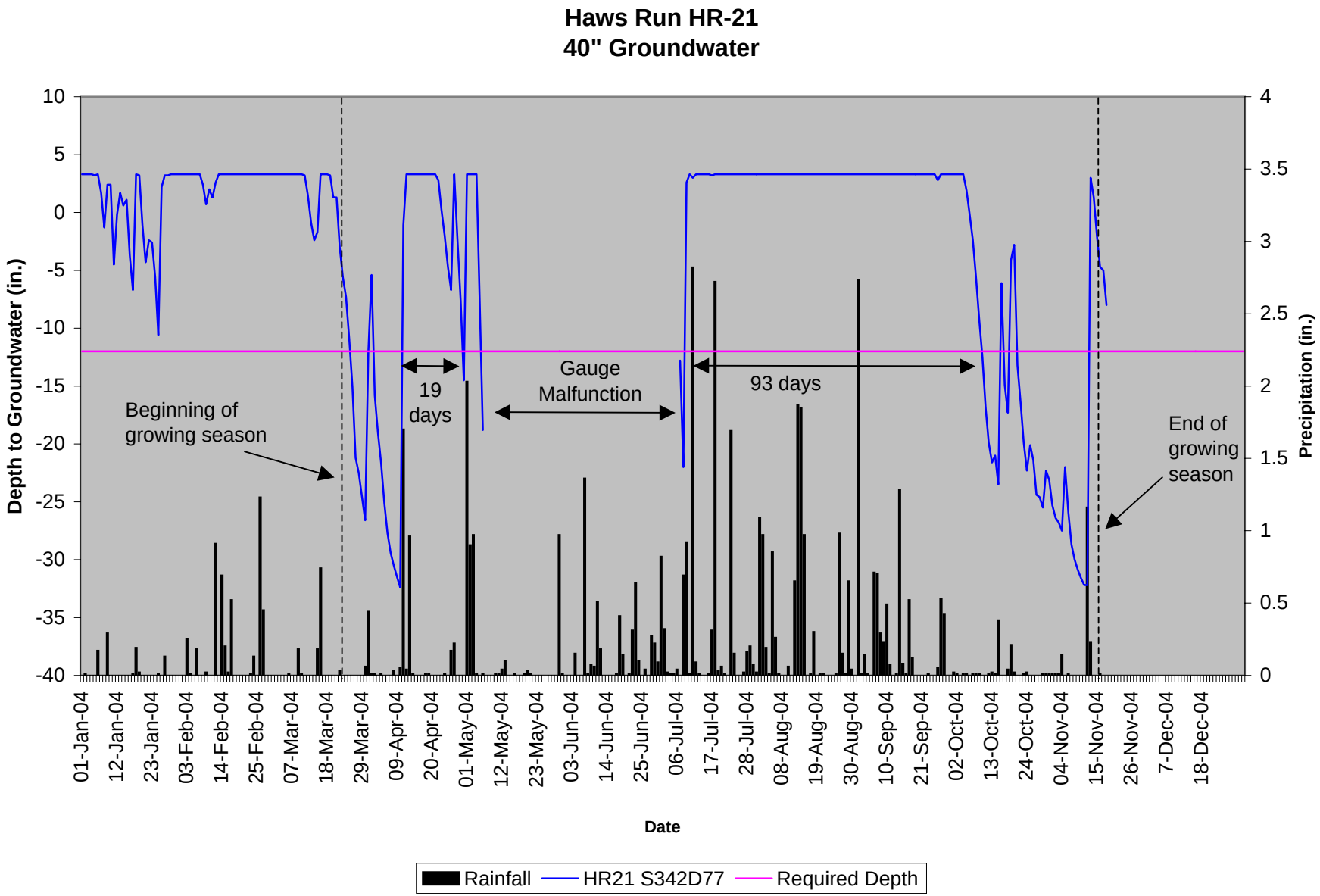

Haws Run HR-16
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Gauge Malfunction
Gauge Malfunction
29 days
39 days
41 days
Beginning of growing season
End of growing season
Rainfall
HR16 S31F788
Required Depth

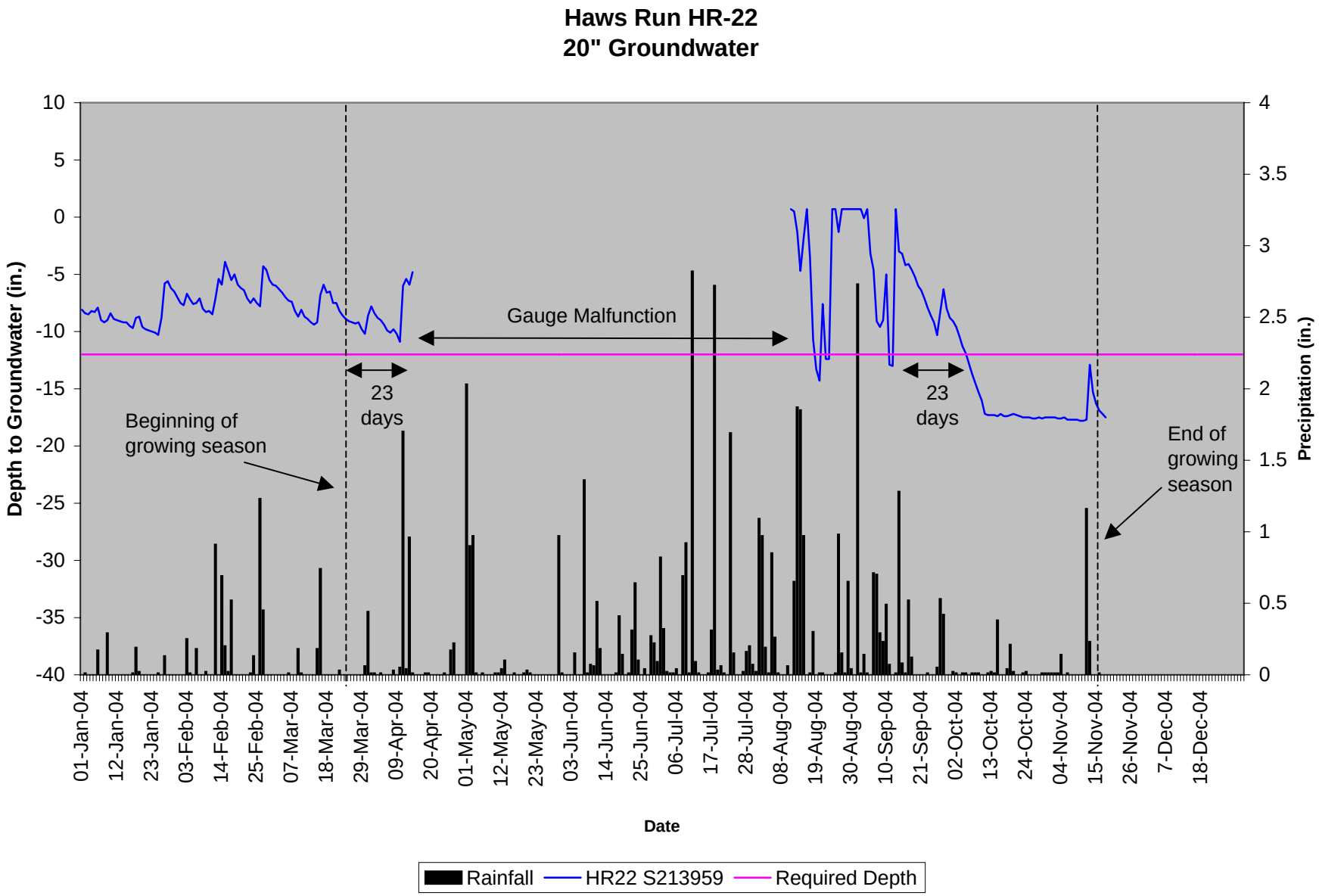

Haws Run HR-17
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Gauge Malfunction
31 days
122 days
Beginning of growing season
End of growing season
Date
Rainfall
HR17 S31F9A0
Required Depth

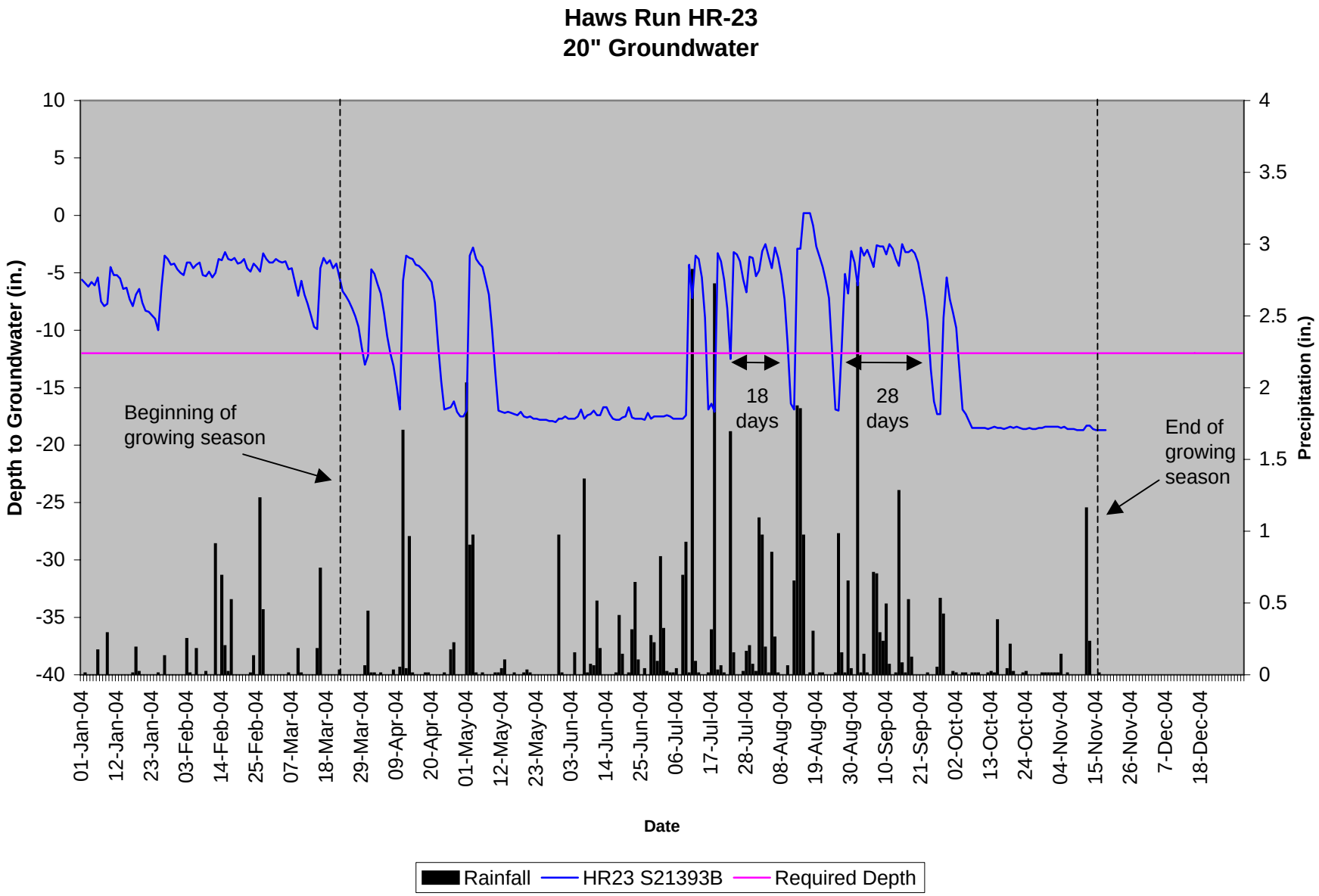

Haws Run HR-18
40" Groundwater
Gauge Malfunction
Gauge Malfunction
Gauge Malfunction
44 days
53 days
62 days
Beginning of growing season
End of growing season
Depth to Groundwater (in.)
Precipitation (in.)
Date
Rainfall
HR18 S31768C
Required Depth

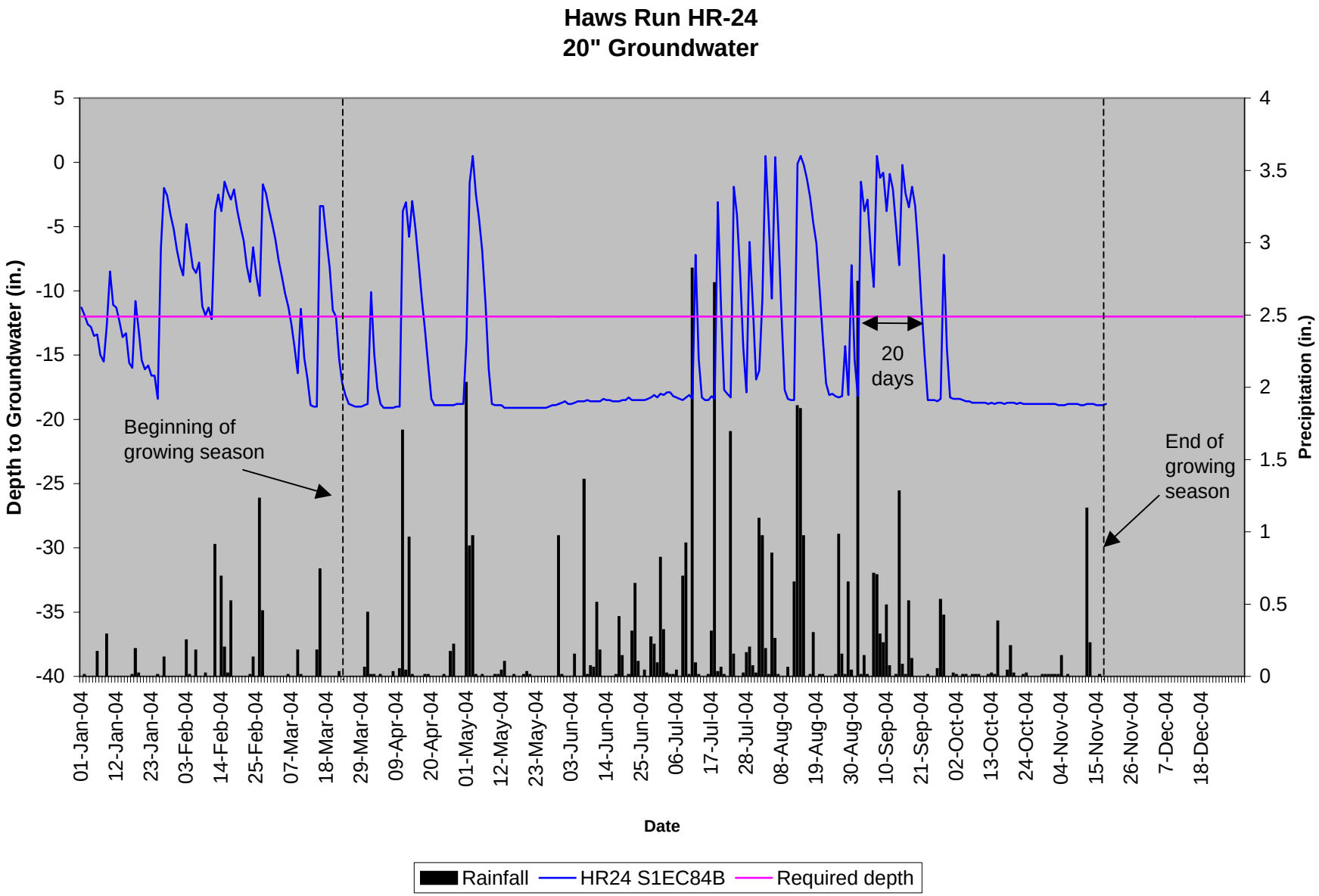

Haws Run HR-19
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
58 days
104 days
Beginning of growing season
End of growing season
Rainfall
HR19 S31755B
Required Depth

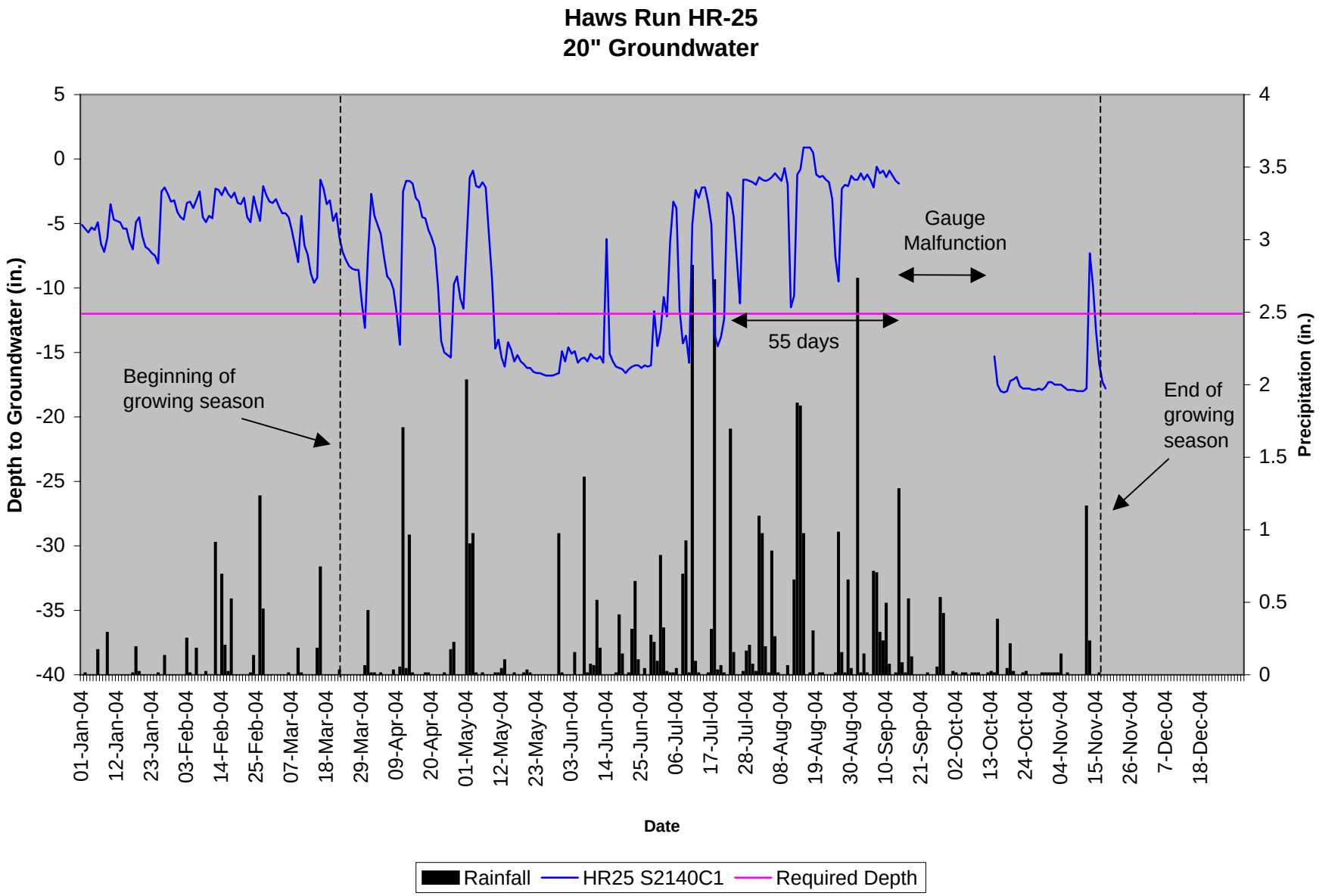

Haws Run HR-20
40" Groundwater
Gauge Malfunction
45 days
54 days
Beginning of growing season
End of growing season
Depth to Groundwater (in.)
Precipitation (in.)
Date
Rainfall
HR20 S503F59
Required Depth


Haws Run HR-21
40" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Beginning of growing season
19 days
Gauge Malfunction
93 days
End of growing season
Rainfall
HR21 S342D77
Required Depth

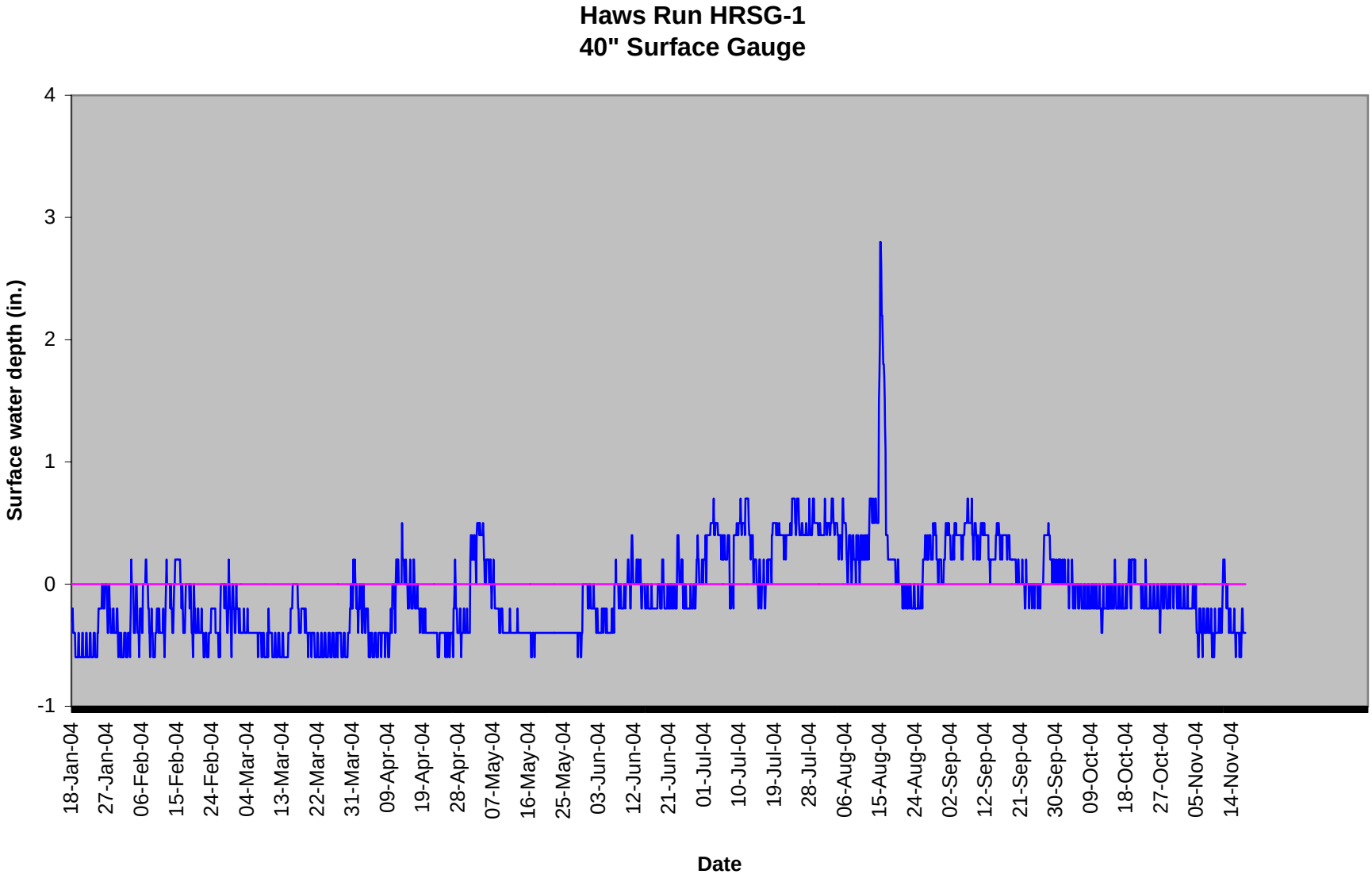

Haws Run HR-22
20" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Gauge Malfunction
23 days
23 days
Beginning of growing season
End of growing season
Date
Rainfall
HR22 S213959
Required Depth

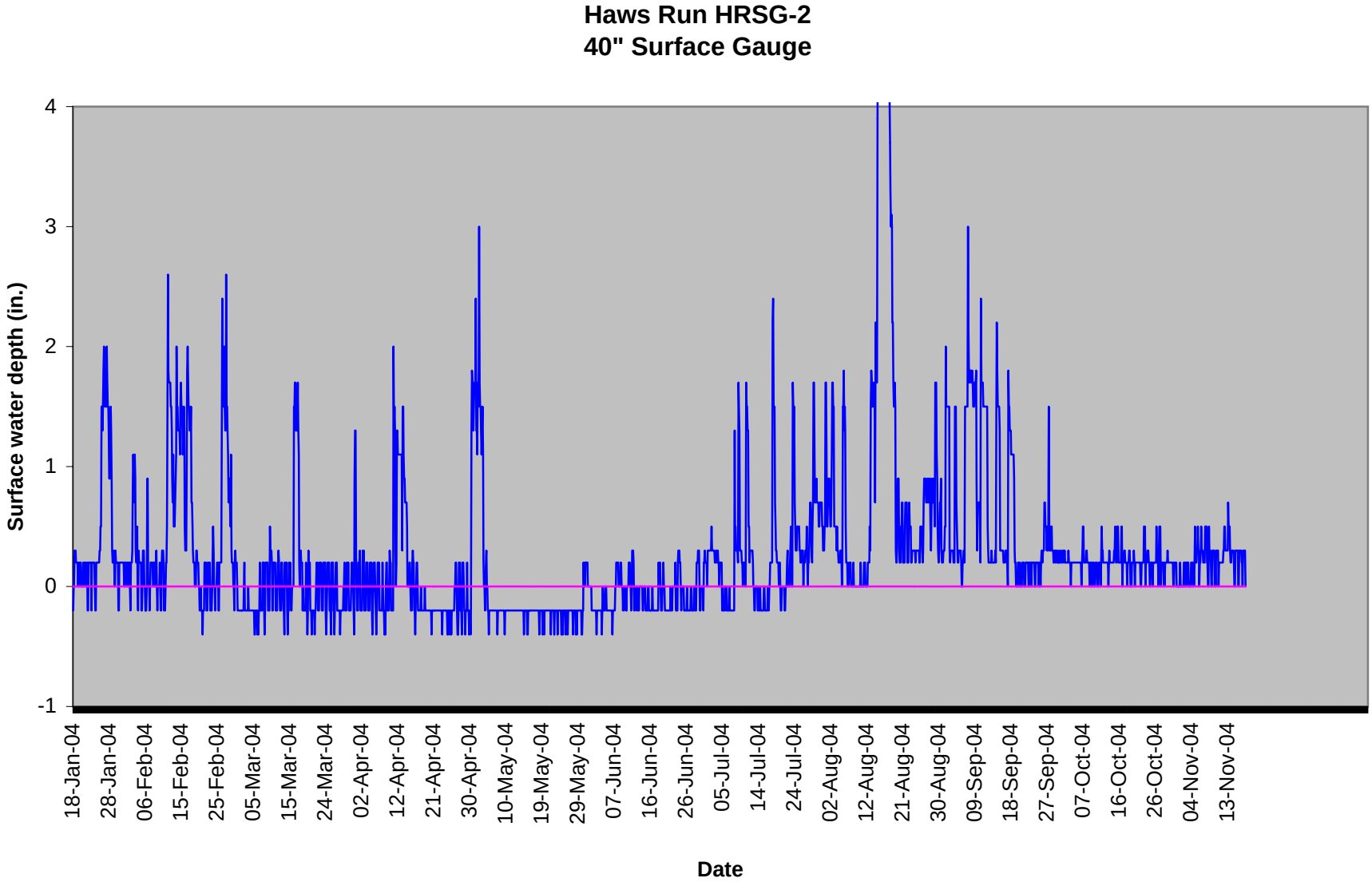

Haws Run HR-23
20" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Beginning of growing season
18 days
28 days
End of growing season
Rainfall
HR23 S21393B
Required Depth


Haws Run HR-24
20" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
4
3.5
3
2.5
2
1.5
1
0.5
0
Beginning of growing season
20 days
End of growing season
01-Jan-04
12-Jan-04
23-Jan-04
03-Feb-04
14-Feb-04
25-Feb-04
07-Mar-04
18-Mar-04
29-Mar-04
09-Apr-04
20-Apr-04
01-May-04
12-May-04
23-May-04
03-Jun-04
14-Jun-04
25-Jun-04
06-Jul-04
17-Jul-04
28-Jul-04
08-Aug-04
19-Aug-04
30-Aug-04
10-Sep-04
21-Sep-04
02-Oct-04
13-Oct-04
24-Oct-04
04-Nov-04
15-Nov-04
26-Nov-04
7-Dec-04
18-Dec-04
Date
Rainfall
HR24 S1EC84B
Required depth


Haws Run HR-25
20" Groundwater
Depth to Groundwater (in.)
Precipitation (in.)
Date
Gauge Malfunction
55 days
Beginning of growing season
End of growing season
Rainfall
HR25 S2140C1
Required Depth

SURFACE WATER GAUGES

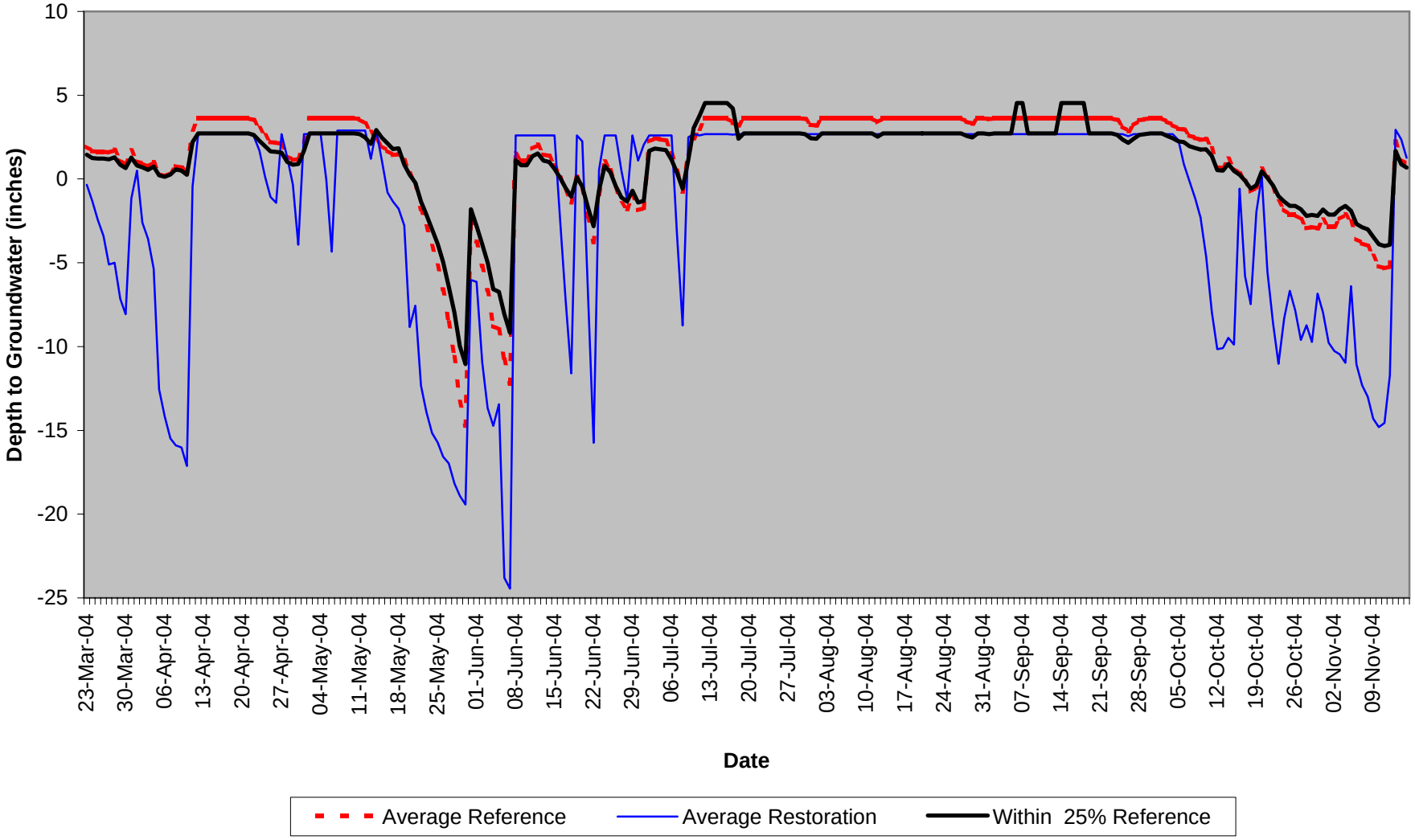

Haws Run HRSG-1
40" Surface Gauge
Surface water depth (in.)
4
3
2
1
0
-1
18-Jan-04
27-Jan-04
06-Feb-04
15-Feb-04
24-Feb-04
04-Mar-04
13-Mar-04
22-Mar-04
31-Mar-04
09-Apr-04
19-Apr-04
28-Apr-04
07-May-04
16-May-04
25-May-04
03-Jun-04
12-Jun-04
21-Jun-04
01-Jul-04
10-Jul-04
19-Jul-04
28-Jul-04
06-Aug-04
15-Aug-04
24-Aug-04
02-Sep-04
12-Sep-04
21-Sep-04
30-Sep-04
09-Oct-04
18-Oct-04
27-Oct-04
05-Nov-04
14-Nov-04
Date


Haws Run HRSG-2
40" Surface Gauge
Surface water depth (in.)
4
3
2
1
0
-1
18-Jan-04
28-Jan-04
06-Feb-04
15-Feb-04
25-Feb-04
05-Mar-04
15-Mar-04
24-Mar-04
02-Apr-04
12-Apr-04
21-Apr-04
30-Apr-04
10-May-04
19-May-04
29-May-04
07-Jun-04
16-Jun-04
26-Jun-04
05-Jul-04
14-Jul-04
24-Jul-04
02-Aug-04
12-Aug-04
21-Aug-04
30-Aug-04
09-Sep-04
18-Sep-04
27-Sep-04
07-Oct-04
16-Oct-04
26-Oct-04
04-Nov-04
13-Nov-04
Date

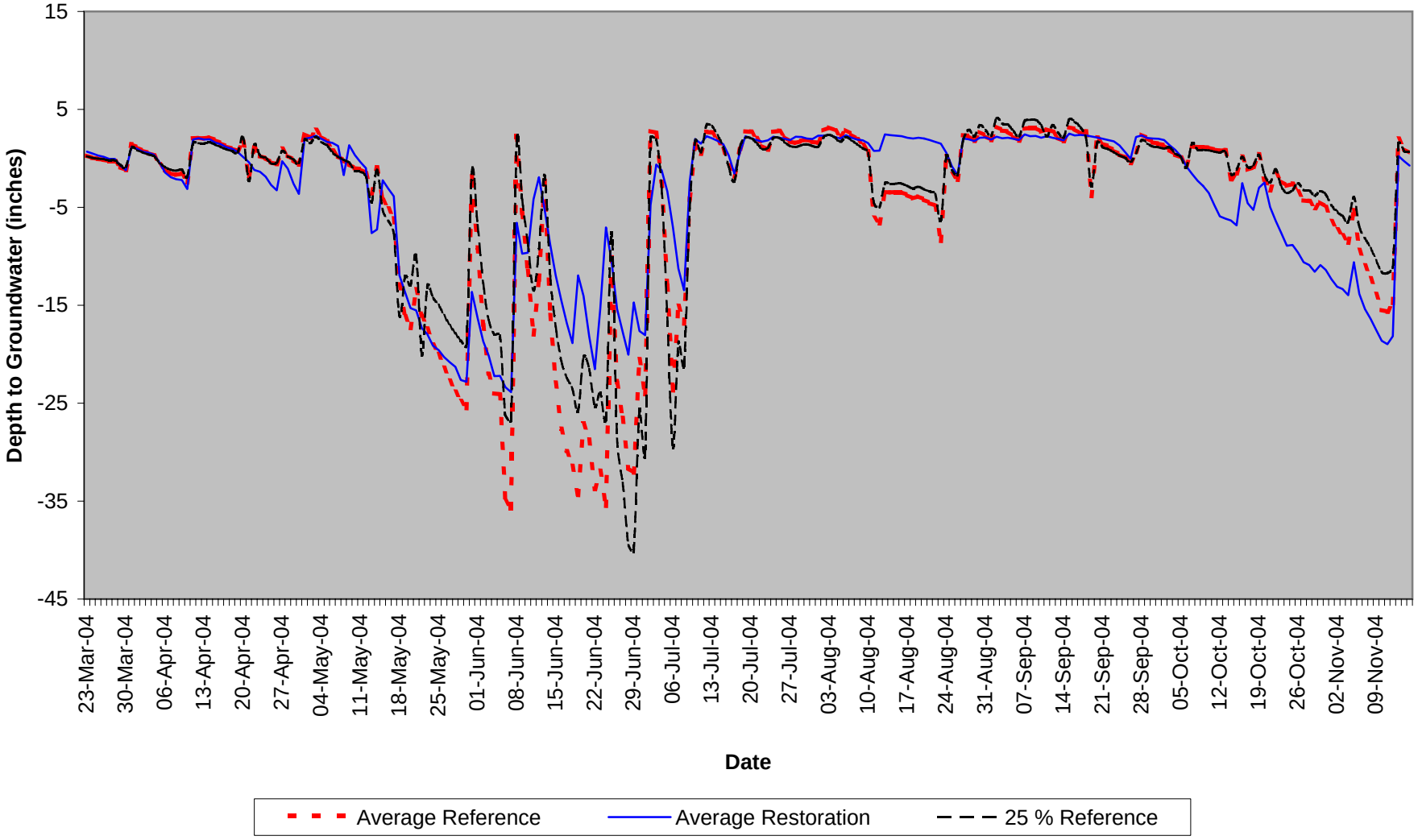
Appendix B

Comparison of Reference & Restoration Gauges

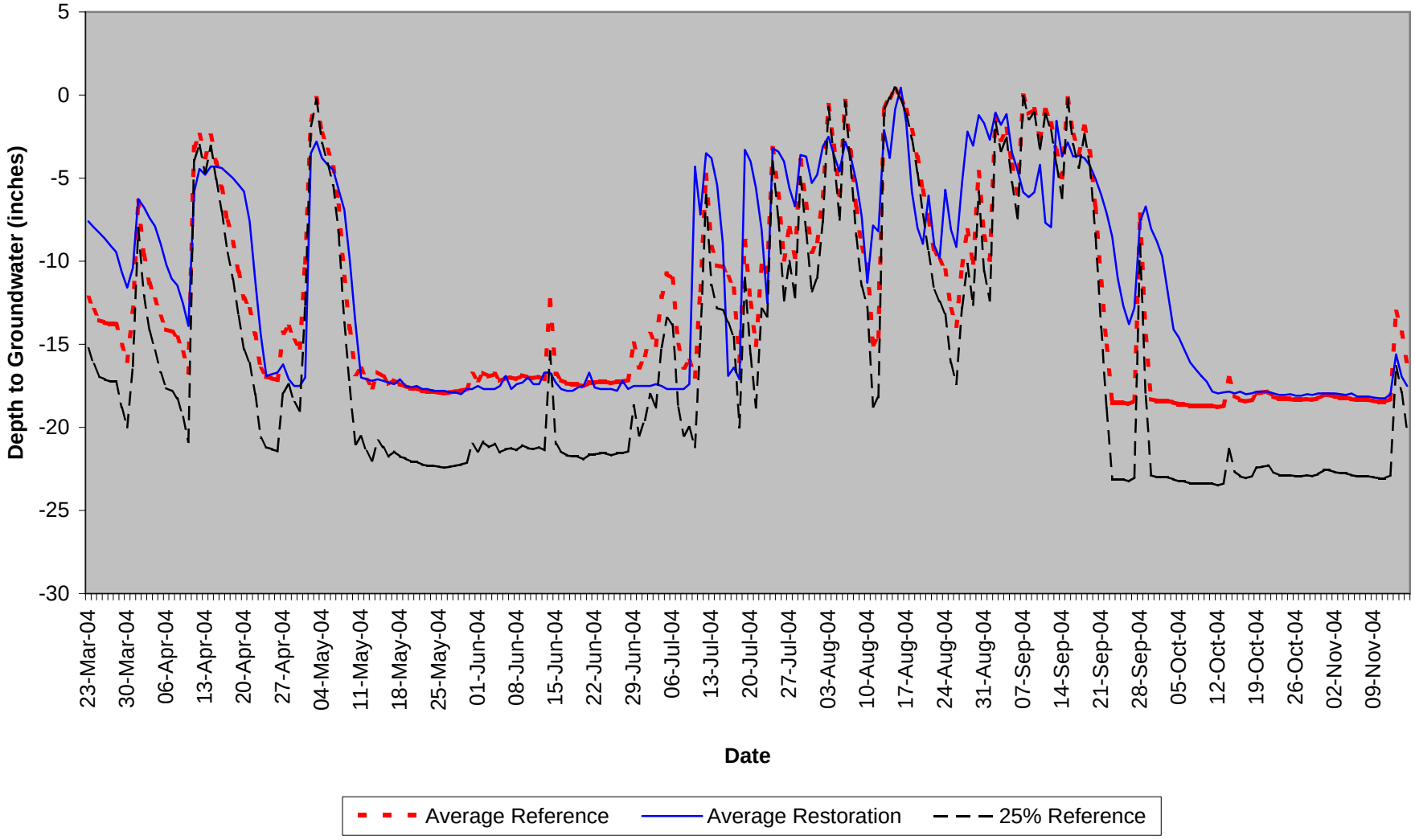
Haws Run Swamp Forest 2004
Average Reference vs. Average Restoration



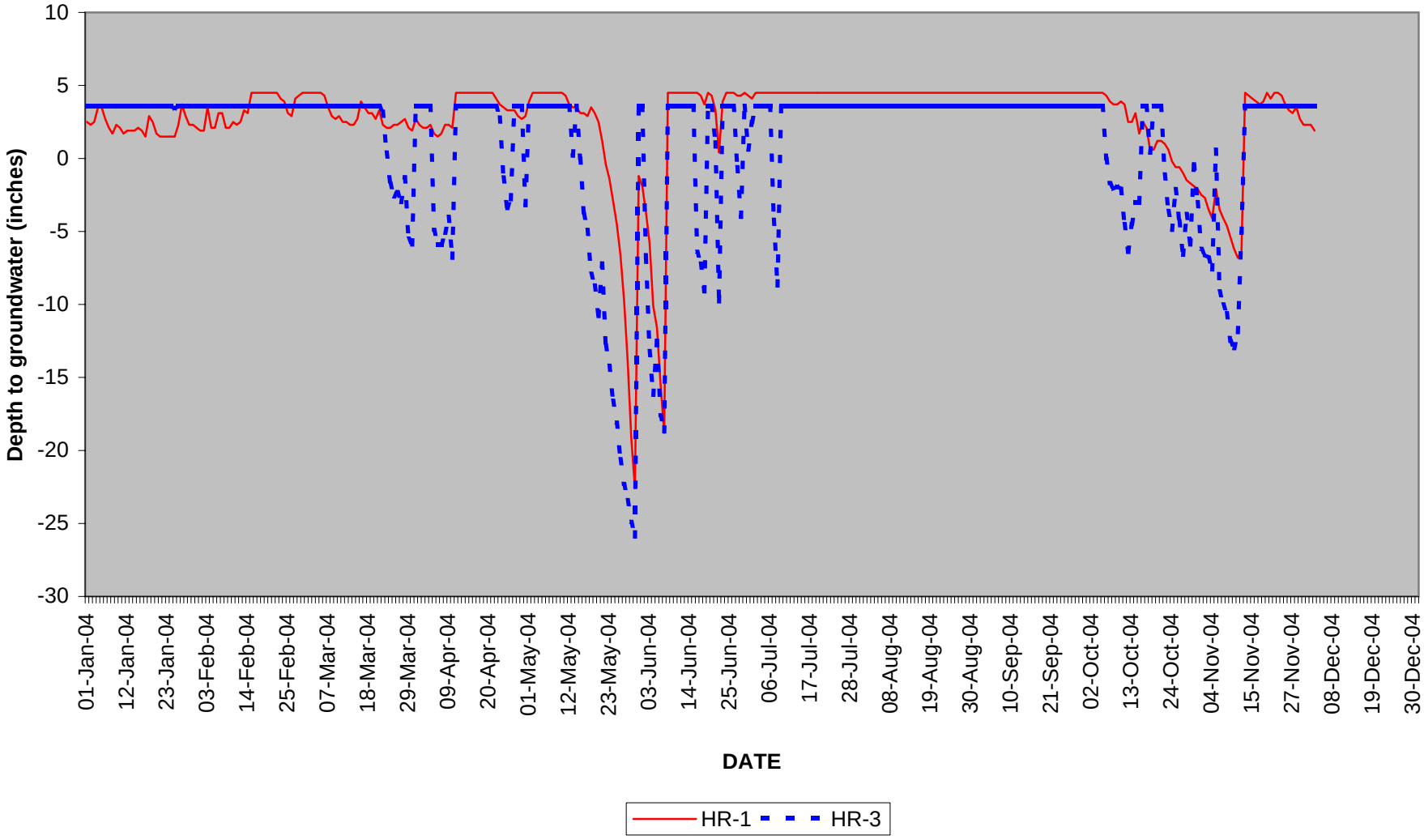
Haws Run Savanna 2004
Average Reference vs. Average Restoration

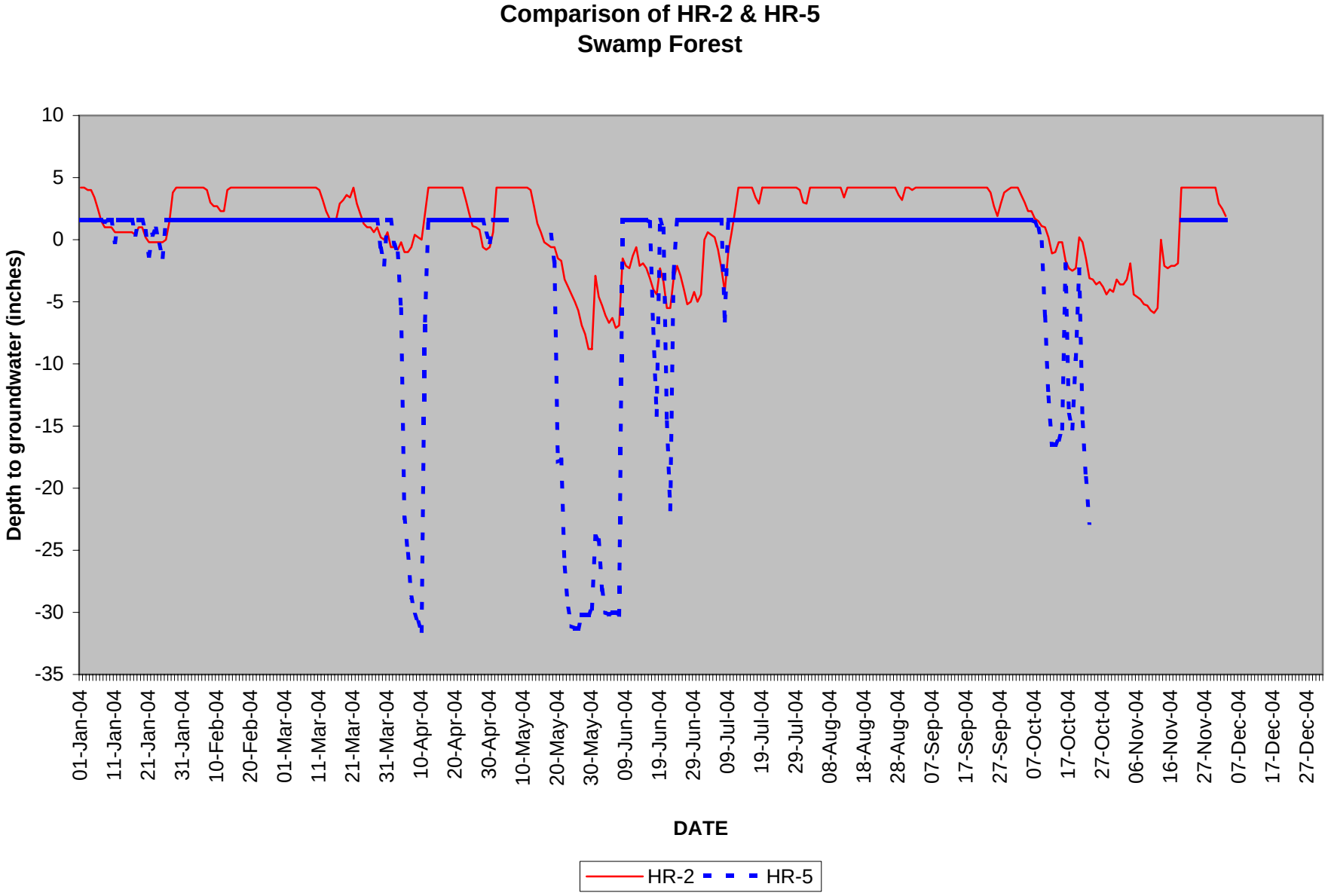


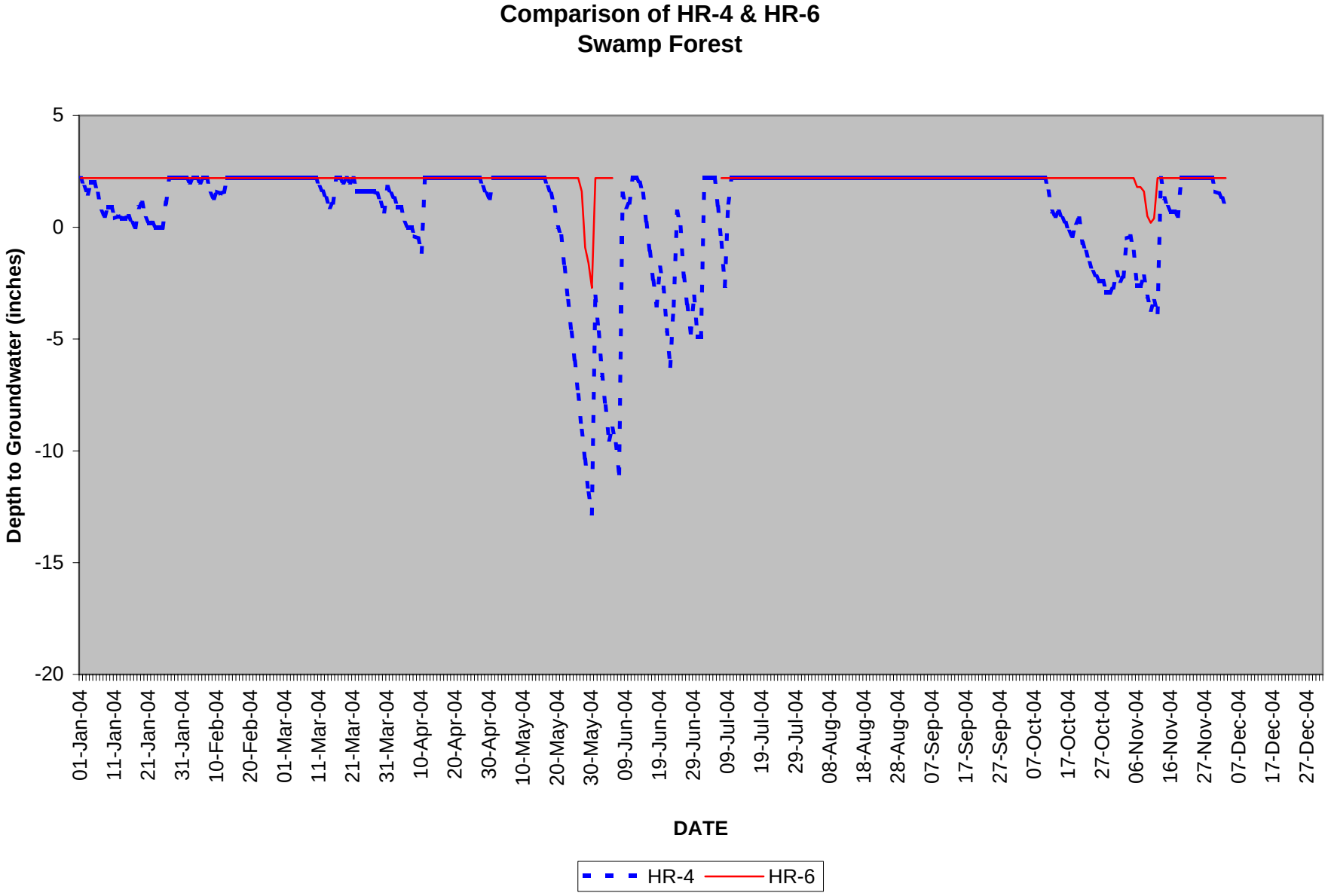
Haws Run Hauls Road (Southern Swamp) 2004
Average Reference vs. Average Restoration



Comparison of HR-1 & HR-3
Swamp Forest




Comparison of HR-2 & HR-5
Swamp Forest
Depth to groundwater (inches)
10
5
0
-5
-10
-15
-20
-25
-30
-35
01-Jan-04
11-Jan-04
21-Jan-04
31-Jan-04
10-Feb-04
20-Feb-04
01-Mar-04
11-Mar-04
21-Mar-04
31-Mar-04
10-Apr-04
20-Apr-04
30-Apr-04
10-May-04
20-May-04
30-May-04
09-Jun-04
19-Jun-04
29-Jun-04
09-Jul-04
19-Jul-04
29-Jul-04
08-Aug-04
18-Aug-04
28-Aug-04
07-Sep-04
17-Sep-04
27-Sep-04
07-Oct-04
17-Oct-04
27-Oct-04
06-Nov-04
16-Nov-04
27-Nov-04
07-Dec-04
17-Dec-04
27-Dec-04
DATE
HR-2
HR-5


Comparison of HR-4 & HR-6
Swamp Forest
Depth to Groundwater (inches)
5
0
-5
-10
-15
-20
01-Jan-04
11-Jan-04
21-Jan-04
31-Jan-04
10-Feb-04
20-Feb-04
01-Mar-04
11-Mar-04
21-Mar-04
31-Mar-04
10-Apr-04
20-Apr-04
30-Apr-04
10-May-04
20-May-04
30-May-04
09-Jun-04
19-Jun-04
29-Jun-04
09-Jul-04
19-Jul-04
29-Jul-04
08-Aug-04
18-Aug-04
28-Aug-04
07-Sep-04
17-Sep-04
27-Sep-04
07-Oct-04
17-Oct-04
27-Oct-04
06-Nov-04
16-Nov-04
27-Nov-04
07-Dec-04
17-Dec-04
27-Dec-04
DATE
HR-4
HR-6

Appendix C

Site Photos

&

Photo and Plot Locations

Haws Run

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

2004

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

Photo 12

2004

Photo 13

Photo 14

2004

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

HAWS RUN MITIGATION SITE

Planting Plan
Photo Locations, and Plot Locations