ANNUAL REPORT FOR 2002

DOWD DAIRY FARM MITIGATION SITE
BLADEN COUNTY
PROJECT NO. 8.1241802
TIP NO. R-2204WM

Prepared By:
Office of Natural Environment & Roadside Environmental Unit
North Carolina Department of Transportation
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2002 REPORT – EXECUTIVE SUMMARY

The following report summarizes the monitoring activities that have occurred in the past year at the Dowd Dairy Farm Mitigation Site. Phase 1 of this site was constructed in 1998, and Phase 2 was completed in 2000. Although monitoring for the site began in 1999, the Monitoring activities in 2002 represent the second year of official monitoring period following completion of the entire site. The site must demonstrate hydrologic and vegetation success for a minimum of 5 years or until the project is deemed successful.

The site contains 36 groundwater monitoring gauges, 2 rain gauges, and 38 vegetation plots.

Rainfall data has been acquired from an onsite rain gauge. Also, monthly rainfall data recorded from a rain gauge maintained by the NC State Climate Office in Elizabethtown was used for the historical data.

Hydrologic monitoring indicated 29 gauges met jurisdictional hydrologic success of at least 12.5% during the growing season; conversely, only 6 gauges met hydrology less than 5% of the growing season.

All vegetation monitoring plots indicated an average tree density of 505 trees per acres, well above the 320 trees per acre requirement.

Based on the monitoring results from the 2002 growing season, NCDOT recommends that monitoring continue.

1.0 INTRODUCTION

1.1 Project Description

The Dowd Dairy Farm Wetland Mitigation Site is located 7 miles north of Elizabethtown and 2 miles east of White Oak in Bladen County (Figure 1). It is bounded by SR 1324 (Dowd Dairy Farm Road) to the north, SR 1332 (Oak Grove Church Road) to the west, and dense forest to the south and east. The site represents a Coastal Plain interstream divide converted for agricultural use. The site receives drainage from elevated sandy terraces and discharges into Ellis Creek and Panther Branch, tributaries of the Cape Fear River.

The site encompasses approximately 658 acres and is designed as a mitigation site for the Cape Fear River Basin.

1.2 Purpose

In order to demonstrate successful mitigation, hydrologic and vegetative monitoring must be conducted for a minimum of five years or until success criteria are fulfilled. Success criteria are based on federal guidelines for wetland mitigation. These guidelines stipulate criteria for both hydrologic conditions and vegetation survival. The following report details the results of hydrologic and vegetative monitoring during 2002 at the Dowd Dairy Farm Mitigation Site.

Activities in 2002 reflect the second year of monitoring following the construction of Phase 2 at the site. Included in this report are analyses of both hydrologic and vegetative monitoring results as well as local climate conditions throughout the growing season.

1.3 Project History

Summer 1998	Construction – Phase 1
Spring 1999	Tree Planting – Phase 1
February – April 1999	Installation of Monitoring Gauges
March – November 1999	Hydrologic monitoring (Year 1)
Sept 1999	Construction Begins – Phase 2
November 1999	Vegetation Monitoring (Year 1)
March – November 2000	Hydrologic Monitoring (Year 2)
June 2000	Construction Completed – Phase 2
November 2000	Vegetation Monitoring (Year 2)
February 2001	Tree Planting – Phase 2
March – November 2001	Hydrologic Monitoring (Restart Year 1)
October 2001	Vegetation Monitoring (Restart Year 1)
August 2002	Vegetation Monitoring (2 yr.)
March – November 2002	Hydrologic Monitoring (2 yr.)

Phase 1 construction consisted of clearing, grubbing, ripping, filling lateral ditches, and adding ditch plugs. Phase 2 construction consisted of filling in the central canal. Completion of the site was delayed to June 2000 due to the saturated conditions from the hurricane activity in the fall of 1999.

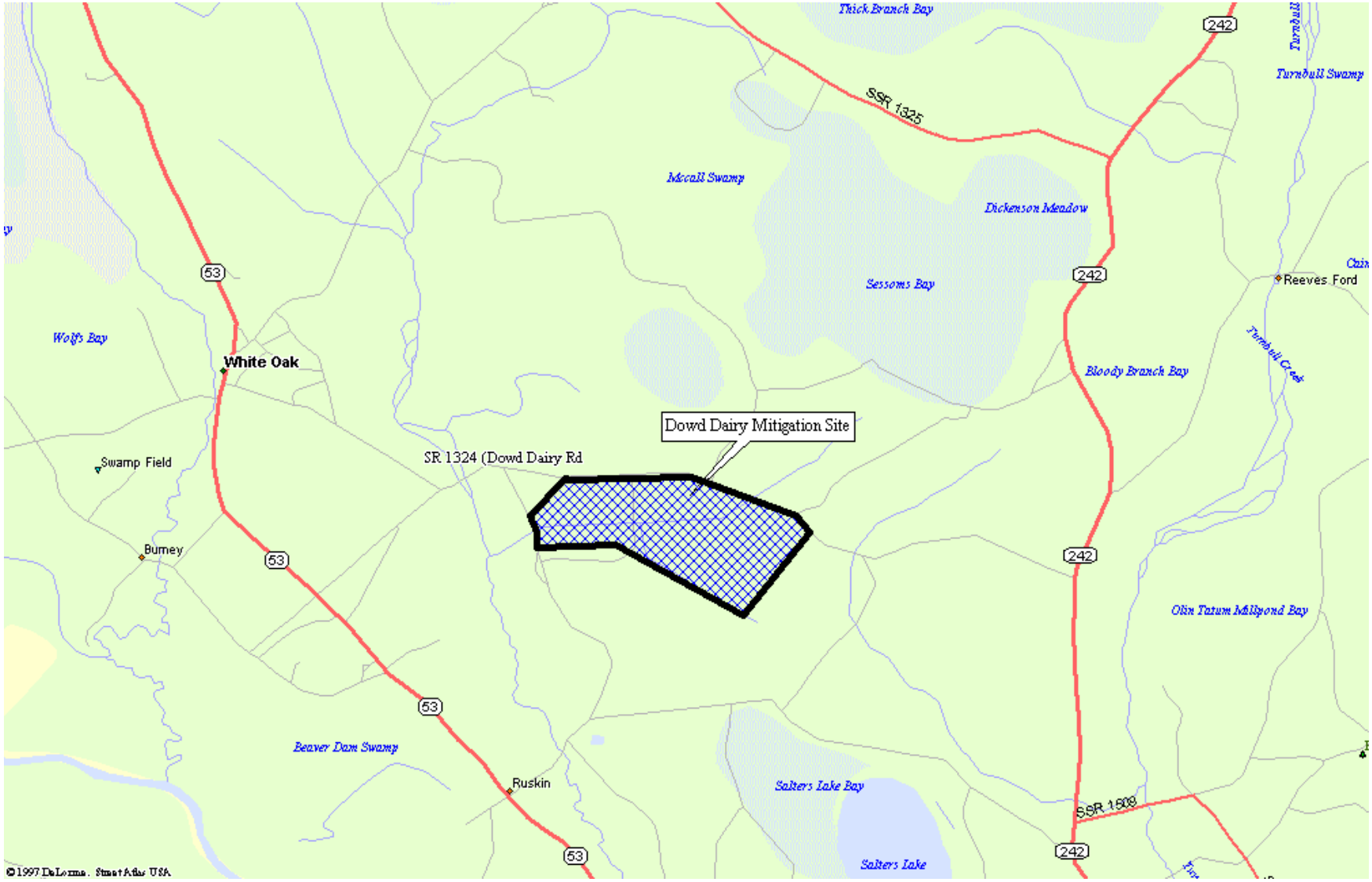


FIGURE 1: SITE LOCATION MAP

1.4 Debit Ledger

Because of its size, Dowd Dairy Farm will provide mitigation for several highway projects. Table 1 shows the projects that this site is providing mitigation for through November 2002.

Table 1
Dowd Dairy Debit Ledger

	Headwater Swamp (Riverine)	Nonriverine Swamp Forest	Nonriverine Wet Hardwood Forest	Wetland/ Upland Restoration	Nonriverine Atlantic White Cedar	Total
Acres at Start	13	198	357	20	70	658
TIP Project Debits						
R-2204A	0	17	0	0	0	17
R-2238AA	0.6	5.8	2.5	0	0	8.9
R-2562AA/AB	5.8	0	16.4	0	0	22.2
B-3412	0	1.18	0	0	0	1.18
B-3413	0	1.17	0	0	0	1.17
B-3409	0.8	0	0	0	0	0.8
Remaining Acres	5.8	172.85	338.1	20	70	606.75

1.5 Permit Requirements

As shown on the ledger, the Dowd Dairy Mitigation Site has been debited to compensate for impacts to TIP Project numbers R-2204A (USACE Action ID number 199602560), R-2562 AA/BB (USACE Action ID number 199304806), R-2238 AA (USACE Action ID Number 199302820), B-3412 (USACE Action ID Number 200200729), B-3413 (USACE Action ID Number 200200716) and B-3409 (USACE Action ID Number 200201004).

The permits for project R-2562AA/AB and R-2238AA stated that grading on the restoration site should be completed no later than August 1, 2000, and all planting should be completed by March 1, 2001. All grading and planting have been completed.

The permit for projects R-2204A stated that the annual monitoring reports should describe the overall success of the entire mitigation site and any recommended remedial actions that may become necessary. This report summarizes the findings for 2002.

The permits for projects B-3409, B-3412 and B-3413 contained no special conditions pertaining to the success criteria of the site that must be met in order for the site to be deemed successful.

2.0 HYDROLOGY

2.1 Success Criteria

In accordance with federal guidelines for wetland mitigation, the success criteria for hydrology states that the area must be inundated or saturated (within 12" of the surface) by surface or ground water for at least 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 other factors, such as the presence of hydrophytic vegetation and hydric soils.

The growing season in Bladen County begins March 16 and ends November 14. The dates correspond to a 50% probability that temperatures will drop to 28^{o} F or lower after March 16 and before November 14.[1] The growing season is 243 days; therefore the optimum duration for wetland hydrology is 31 days. Also, local climate must represent average conditions for the area.

2.2 Hydrologic Description

Historically, wetlands on the tract were created by a combination of radial groundwater and surface water flow from adjacent terraces as well as precipitation and vertical groundwater fluctuations maintained within the site. After an extensive study of the site's hydrology, it was concluded that blocking and filling the drainage ditches within the site would elevate the groundwater to a level that would saturate the soil stratum within the required twelve inches. It was predicted that this, in addition to surface water and runoff would be sufficient to restore wetland hydrology.

Thirty-one groundwater monitoring gauges, and two rain gauges were installed in 1999 (Figure 3). Five additional gauges were installed in transects along the main channel in 2001 to examine potential drainage effects of the large remaining canal. The rain gauges and groundwater monitoring gauges recorded daily readings of rainfall and depth to groundwater, respectively.

Appendix A contains a plot of the groundwater depth for each monitoring gauge. Data determined to be erroneous was omitted; therefore, some gaps appear in the plots. Daily rainfall is included on each graph as bars recorded by rain

[1] Natural Resources Conversation Service, Soil Survey of Bladen County, North Carolina, p. 123.

gauges located on the site. It must be noted that several gauges continued to be problematic throughout the growing season and were eventually replaced.

DOWD DAIRY FARM MITIGATION SITE

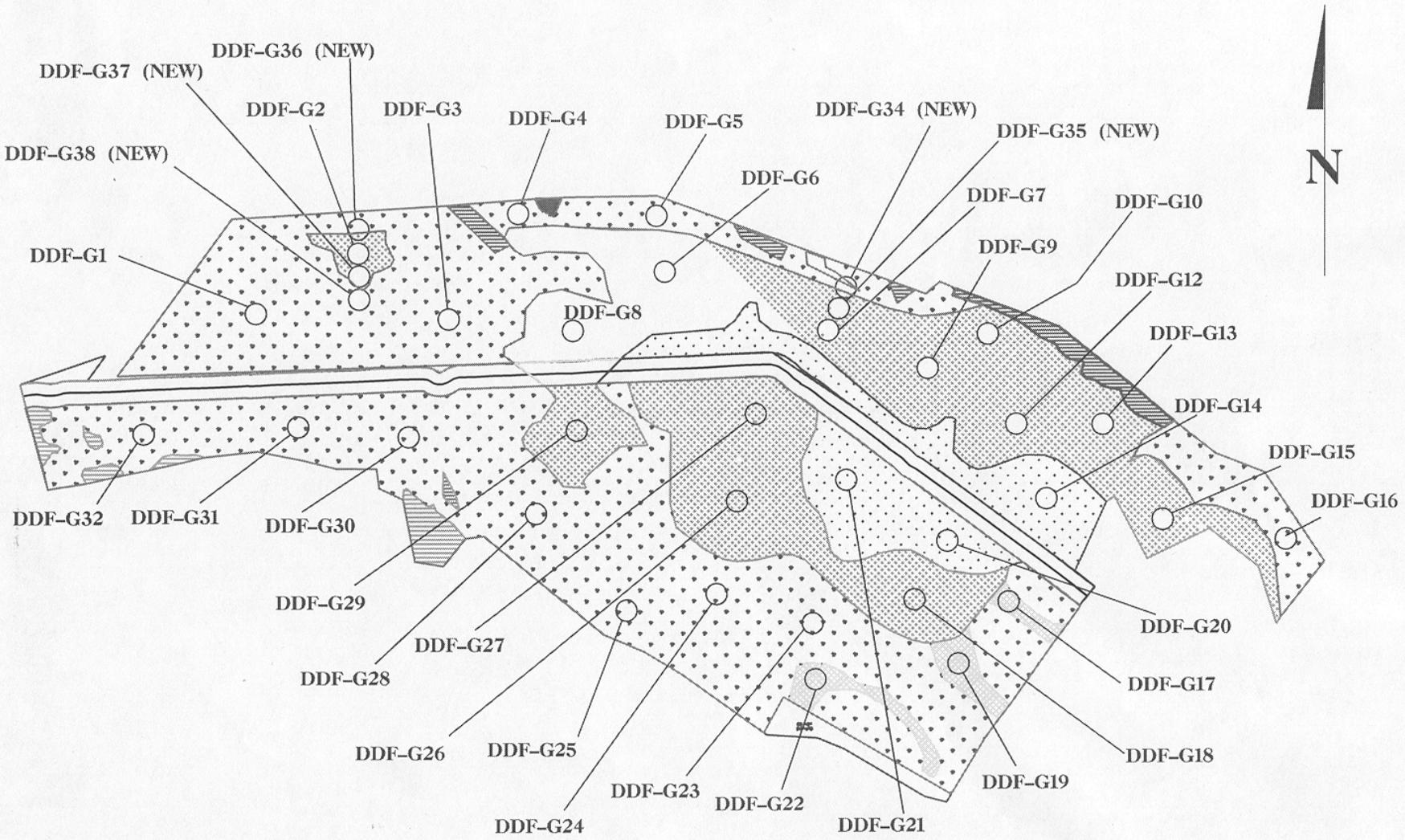


FIGURE 2: MONITORING GAUGE LOCATIONS

Rev. 12/11/01

2.3 Results of Hydrologic Monitoring

2.3.1 Site Data

The maximum number of consecutive days that the groundwater was within twelve inches of the surface was determined for each groundwater gauge. This number was converted into a percentage of the 243-day growing season. Table 2 presents the hydrologic monitoring results for 2002.

Figure 3 represents a graphical representation of the hydrologic results. Gauges highlighted in blue indicate wetland hydrology for more than 12.5% of the growing season. Gauges highlighted in red show hydrology between 8% and 12.5% of the season, while those in green indicate hydrology between 5% and 8% of the season. Gauges highlighted in black indicate no wetland hydrology (less than 5% of the growing season).

Appendix A contains a plot of the groundwater depth for each monitoring gauge. The maximum number of consecutive days that the groundwater is within 12 inches of the surface is noted on each graph.

Table 2
2002 HYDROLOGIC MONITORING RESULTS –
(MARCH 16 – NOVEMBER 14)

Monitoring Gauge	< 5% (<12 dy)	5 - 8% (12-19 dy)	8 – 12.5% (20-30 dy)	> 12.5% (>31 dy)	Actual %	Dates Meeting Success
DDF-G1				✓	16	3/16-4/23
DDF-G2	✓				2.5	
DDF-G3	✓				2.1	
DDF-G4	✓				1.6	
DDF-G5				✓	15.2	3/16-4/21
DDF-G6*				✓	25.0	3/16-5/15
DDF-G7*				✓	15.6	3/16-4/22
DDF-G8*				✓	16.1	3/16-4/23
DDF-G9*				✓	15.6	3/16-4/22
DDF-G10				✓	18.5	3/16-4/29
DDF-G12				✓	15.2	3/16-4/21
DDF-G13	✓				.4	
DDF-G14				✓	14.8	3/16-4/20
DDF-G15				✓	18.5	3/16-4/29 8/26-10/7 10/11-11/14
DDF-G16				✓	18.5	3/16-4/29
DDF-G17*				✓	26.8	3/16-5/19
DDF-G18*				✓	19.8	3/16-5/2
DDF-G19				✓	15.6	3/16-4/22
DDF-G20*				✓	25.5	3/16-5/16
DDF-G21*				✓	19.8	3/16-5/2
DDF-G22				✓	13.6	3/16-4/17
DDF-G23*				✓	17.7	3/16-4/27
DDF-G24*				✓	16.1	3/16-4/23
DDF-G25*				✓	15.6	3/16-4/22
DDF-G26*				✓	25.5	3/16-5/16
DDF-G27*				✓	19.8	3/16-5/2
DDF-G28				✓	16.9	3/16-4/25
DDF-G29				✓	28.4	3/16-5/23
DDF-G30				✓	25.5	3/16-5/16
DDF-G31				✓	16.1	3/16-4/23
DDF-G32				✓	16.5	3/16-4/24
DDF-G34	✓				3.3	
DDF-G35*				✓	14.4	3/16-4/19
DDF-G36	✓				0	
DDF-G37			✓		11.9	3/16-4/13
DDF-G38*				✓	18.5	3/16-4/29

*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:

- DDF-G3 had gauge malfunctions throughout the growing season beginning March 21.
- DDF-G7 stopped recording data (April 6-April 18)
- DDF-G6 stopped recording data (May 16-July 11)
- DDF-G8 stopped recording data (March 25-April 18) (July 27-September 12)
- DDF-G9 had no data available (January-April 19) The gauge stopped recording data (May 26-June 11) and (August 8-August 26)
- DDF-G17 stopped recording data (March 28-June 12) and (September 18-October 30)
- DDF-G18 stopped reading data 3 times between (April-June)
- DDF-G20 stopped recording data (March 19-May 15) and (October 17-October 30)
- DDF-G21 stopped recording data (March 29-April 19)
- DDF-G23 stopped reading data 3 times between (January-July 13)
- DDF-G25 stopped reading data at the beginning of the growing season (March 27-April 19)
- DDF-G26 experienced gauge malfunction at the beginning of the growing season and did not record data (January-April 9) (April 26-May 15)
- DDF-G27 stopped recording data (March 27-April 19) (August 24-September 13)
- Gauges DDF-G34,G35, and G38 stopped recording data at the beginning of the growing season (March 24-April 19)
- DDF-G36 experienced gauge malfunction and stopped recording data (June 24-September 12)

During the growing season from March through November 2002, twenty-nine of the thirty-six gauges met jurisdictional hydrologic success of at least 12.5% during the growing season. One gauge showed saturation between 8 and 12.5% of the growing season, while only six gauges showed saturation less than 5% of the growing season. Of the gauges that did not meet the minimum of 5% hydrology, two of them (G2 and G4) are located in an area that was estimated to be dry in the mitigation plan report.

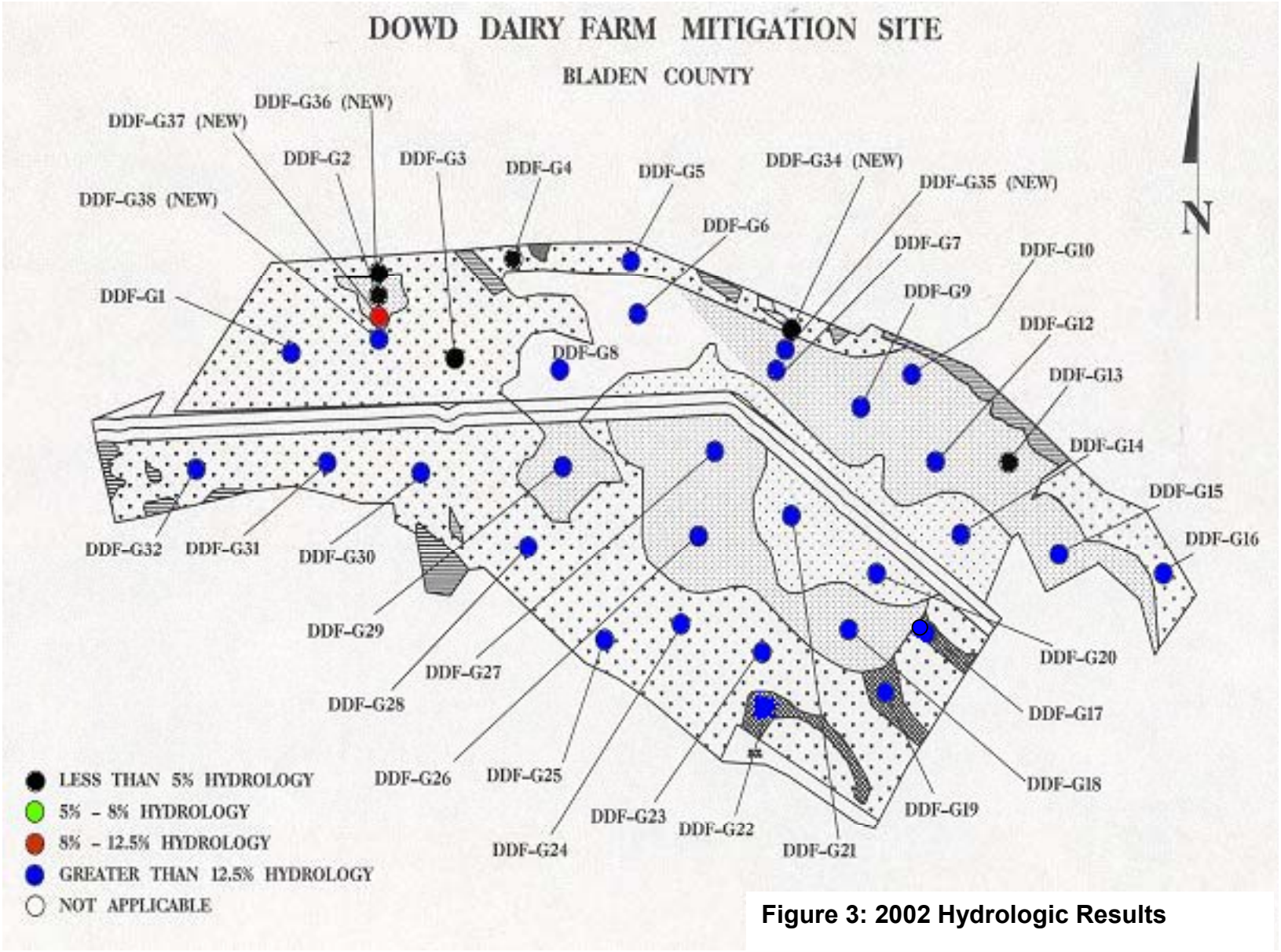


Figure 3: 2002 Hydrologic Results

2.3.2 Climatic Data

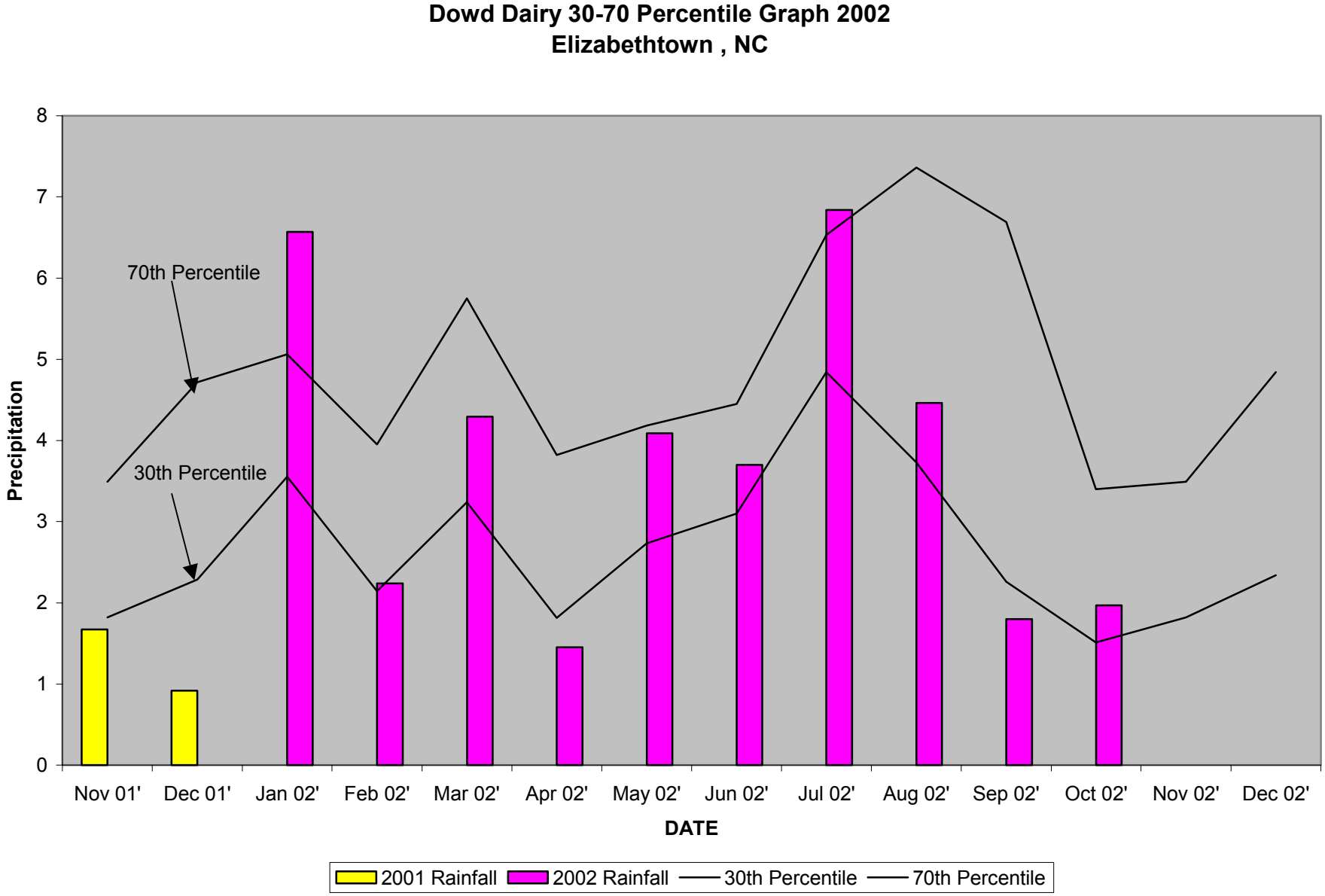
Figure 4 represents an examination of the local climate in comparison with historical data in order to determine whether 2002 was “average” in terms of climate conditions. The two lines represent the 30th and 70th percentiles of monthly precipitation for Elizabethtown, NC. The bars are monthly rainfall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

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

2.4 Conclusions

For the Year 2002, twenty-nine (29) of thirty-six (36) monitoring gauges indicated optimum hydrologic success of at least 12.5% from March through November, while only six (6) gauges met hydrology less than 5% of the growing season.

FIGURE 4


Dowd Dairy 30-70 Percentile Graph 2002
Elizabethtown , NC
Precipitation
8
7
6
5
4
3
2
1
0
70th Percentile
30th Percentile
Nov 01'
Dec 01'
Jan 02'
Feb 02'
Mar 02'
Apr 02'
May 02'
Jun 02'
Jul 02'
Aug 02'
Sep 02'
Oct 02'
Nov 02'
Dec 02'
DATE
2001 Rainfall
2002 Rainfall
30th Percentile
70th Percentile

3.0 VEGETATION

3.1 Success Criteria

Success Criteria states that there must be a minimum of 320 trees per acre living for at least five consecutive years. A minimum of 5 character tree species must be present, with no more than 20% of any one species is also required with the exception of Atlantic White Cedar which may comprise up to 75% in swamp forest restoration. Loblolly Pine cannot comprise of more than 10% of the 320 trees per acre requirement

3.2 Description of Species

The following tree species were planted in the Wetland Planting Areas:

Zone 1: Non-Riverine Wet Hardwood Forest (320.25 acres)

Quercus falcata var. pagodaefolia, Cherrybark Oak
Fraxinus pennsylvanica, Green Ash
Quercus laurifolia, Laurel Oak
Quercus lyrata, Overcup Oak
Quercus michauxii, Swamp Chestnut Oak
Nyssa aquatica, Water Tupelo
Quercus nigra, Water Oak
Quercus phellos, Willow Oak

Zone 2: Pine/Oak Hickory (17.68 acres)

Juglans nigra, Black Walnut
Nyssa sylvatica, Blackgum
Pinus palustris, Longleaf Pine
Quercus falcata, Southern Red Oak
Quercus nigra, Water Oak
Quercus alba, White Oak
Quercus phellos, Willow Oak
Liriodendron tulipfera, Tulip Poplar
Quercus lyrata, Overcup Oak
Quercus falcata var. pagodaefolia, Cherrybark Oak

Zone 3: Non-Riverine Swamp Forest (201.2 acres)

Chamaecyparis thyoides, Atlantic White Cedar
Taxodium distichum, Bald Cypress
Quercus falcata var. pagodaefolia, Cherrybark Oak
Fraxinus pennsylvanica, Green Ash
Quercus laurifolia, Laurel Oak
Quercus lyrata, Overcup Oak
Quercus nigra, Water Oak

Quercus phellos, Willow Oak
Nyssa aquatica, Water Tupelo

Zone 4: Headwater (Slope) Swamp (12.05 acres)

Taxodium distichum, Bald Cypress
Quercus falcata var. pagodaefolia, Cherrybark Oak
Quercus laurifolia, Laurel Oak
Quercus lyrata, Overcup Oak
Quercus michauxii, Swamp Chestnut Oak
Quercus nigra, Water Oak
Quercus phellos, Willow Oak
Liriodendron tulipfera, Tulip Poplar

Zone 5: Atlantic White Cedar Slope (67.76 acres)

Chamaecyparis thyoides, Atlantic White Cedar
Taxodium distichum, Bald Cypress
Pinus serotina, Pond Pine
Quercus michauxii, Swamp Chestnut Oak
Nyssa aquatica, Water Tupelo
Quercus phellos, Willow Oak
Liriodendron tulipfera, Tulip Poplar
Quercus falcata var. pagodaefolia, Cherrybark Oak
Fraxinus pennsylvanica, Green Ash
Quercus laurifolia, Laurel Oak
Quercus lyrata, Overcup Oak

3.3 Results of Vegetation Monitoring (2 yr.)

Table 3 shows the results for the vegetation for the Year 2002.

Table 3: 2002 Vegetation Monitoring Results

ZONE	Plot #	Swamp Chestnut Oak	Laurel Oak	Willow Oak	Cherrybark Oak	Water Tupelo	Water Oak	Green Ash	Overcup Oak	White Oak	Southern Red Oak	Longleaf Pine	Pond Pine	Blackgum	Black Walnut	Tulip Poplar	Baldcypress	Atlantic White Cedar	Total (2 year)	Total (at planting)	Density (Trees/Acre)
1	1			8	1			6	10										25	37	459
	3	7	1	6		1			3										18	40	306
	4	2	2	2		1		1	18										26	28	631
	5		6	3		4	1	9	12										35	39	610
	8	4	1	3	1	5		8											22	38	394
	14	5	3	6	8														22	39	384
	15	3	4	10	4	1													22	32	468
	17	13	3	1	11														28	41	464
	19	4	2	2		1			3										12	35	233
	28	3		9		3		7	4										26	37	478
	29	5	1	1				6	19										32	41	531
	30		3	10				18	2										33	39	575
	31	15			1	2		6	5										29	37	533
	32	7		5		2		8	3										25	38	447
	33		5		1		25	13											44	44	680
	34	7	3	1		6		6	10										33	39	575
													ZONE 1 AVERAGE								**486**
2	2			1					21		1				1	1			25	25	680
	12			4			1				9								14	26	366
													ZONE 2 AVERAGE								**523**

ZONE	Plot #	Swamp Chestnut Oak	Laurel Oak	Willow Oak	Cherrybark Oak	Water Tupelo	Water Oak	Green Ash	Overcup Oak	White Oak	Southern Red Oak	Longleaf Pine	Pond Pine	Blackgum	Black Walnut	Tulip Poplar	Baldcypress	Atlantic White Cedar	Total (2 year)	Total (at planting)	Density (Trees/Acre)
3	6		5	1	4		1	1	2								8	7	29	30	657
	7				1			10	2								19		32	40	544
	9			3	1												10	7	21	34	420
	10		5		2		2		10								12	1	32	44	495
	11		2	13	1				4								7	1	28	28	680
	20		1	1				10											12	37	221
	24		1	5	4			3	1								4	5	23	34	460
	25		1	6	6			7	5								1	5	31	31	680
	26			2				19	1								6	5	33	35	641
	27		1	4	1			1	9								4		20	36	378
	35				1	3		6	4								1		15	37	276
	36		3	5				3									2		13	36	246
													ZONE 3 AVERAGE								475
4	16	3			3				6								12		24	31	526
	18	6	3	1					1							2	9		22	35	427
													ZONE 4 AVERAGE								477
5	13		3	1	6		1	4	3										18	24	510
	21			6									10				13		29	29	680
	22	8		3		3							1				8	2	25	27	630
	23	1		9		2							6				12		30	38	537
	37	12		9		4							6				15		46	47	666
	38	21		12					4				1	8		1	3		50	50	680
													ZONE 5 AVERAGE								617
													TOTAL AVERAGE								505

Site Notes:

Zone 1: Other species noted: goldenrod, briars, red maple, broomsedge, pine, sweetgum, stinkweed, sicklepod, trumpet creeper, *Juncus* sp., *Aster* sp., switch grass, giant foxtail, fennel, sassafras, ragweed, *Baccharis halimifolia, Panicum* sp., woolgrass, and *Bidens* sp.

Zone 2: Other species noted: ragweed, *Aster* sp., *Juncus* sp., broomsedge, pine, goldenrod, *Panicum* sp., and cacti.

Zone 3: Other species noted: fennel, broomsedge, goldenrod, winged sumac, *Baccharis halimifolia*, cattail, stinkweed, *Juncus* sp., black willow, foxtail, sweetgum, briars, sassafras, ragweed, smartgrass, sicklepod, bahia, winged sumac, and aster. Planted green ash (10 ft. tall) noted outside of plot 9.

Zone 4: Other species noted: sweetgum, briars, fennel, red maple, broomsedge, *Aster* sp., and *Juncus* sp.

Zone 5: Other species noted: fennel, briars, sweetgum, red maple, bermuda grass, *Juncus* sp., cattail, *Aster* sp., winged sumac, and broomsedge.

3.4 Conclusions

Of the 658 acres of this site, approximately 619 acres involved tree planting. There were 38 test plots established throughout the planting areas, covering all plant communities. The 2002 vegetation monitoring of the planted areas revealed an average density of 505 trees per acre, which is well above the minimum requirement of 320 trees per acre. It should be noted that since this was a phased project the majority of the plots contain 4-year old trees.

Phase II construction was completed in 2000 and the remainder of the site was planted in Spring 2001. The upland area along the road was planted in March 2002.

NCDOT will continue vegetation monitoring at the Dowd Dairy Mitigation Site.

4.0 OVERALL CONCLUSIONS/ RECOMMENDATIONS

For the Year 2002, twenty-nine (29) of thirty-six (36) monitoring gauges indicated optimum hydrologic success of at least 12.5% from March through November, while six gauges indicated below 5%.

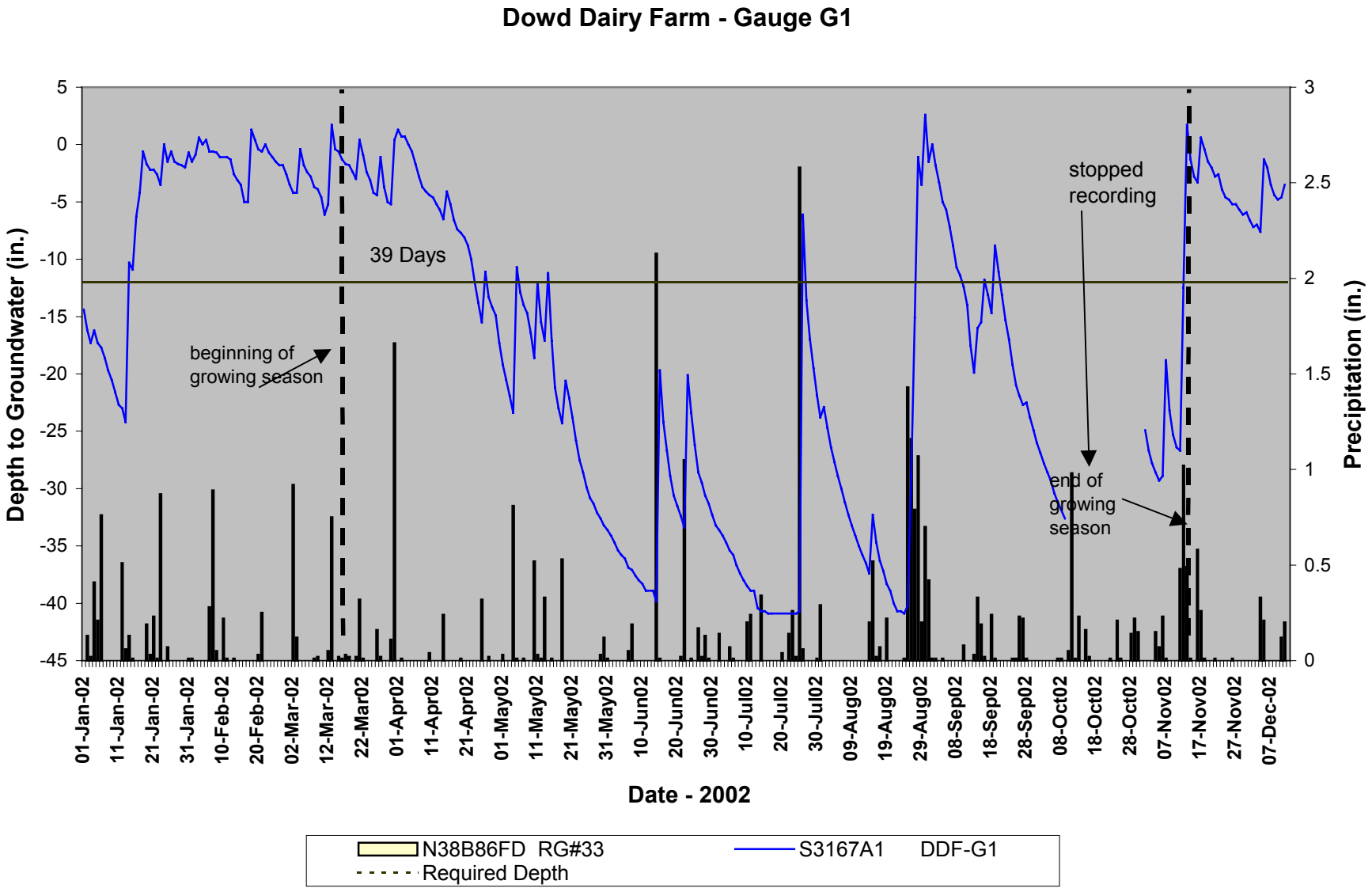
The second year of vegetation monitoring of the planted areas revealed an average density to be 505 trees per acre, which is well above the minimum requirement of 320 trees per acre, after 3 years.

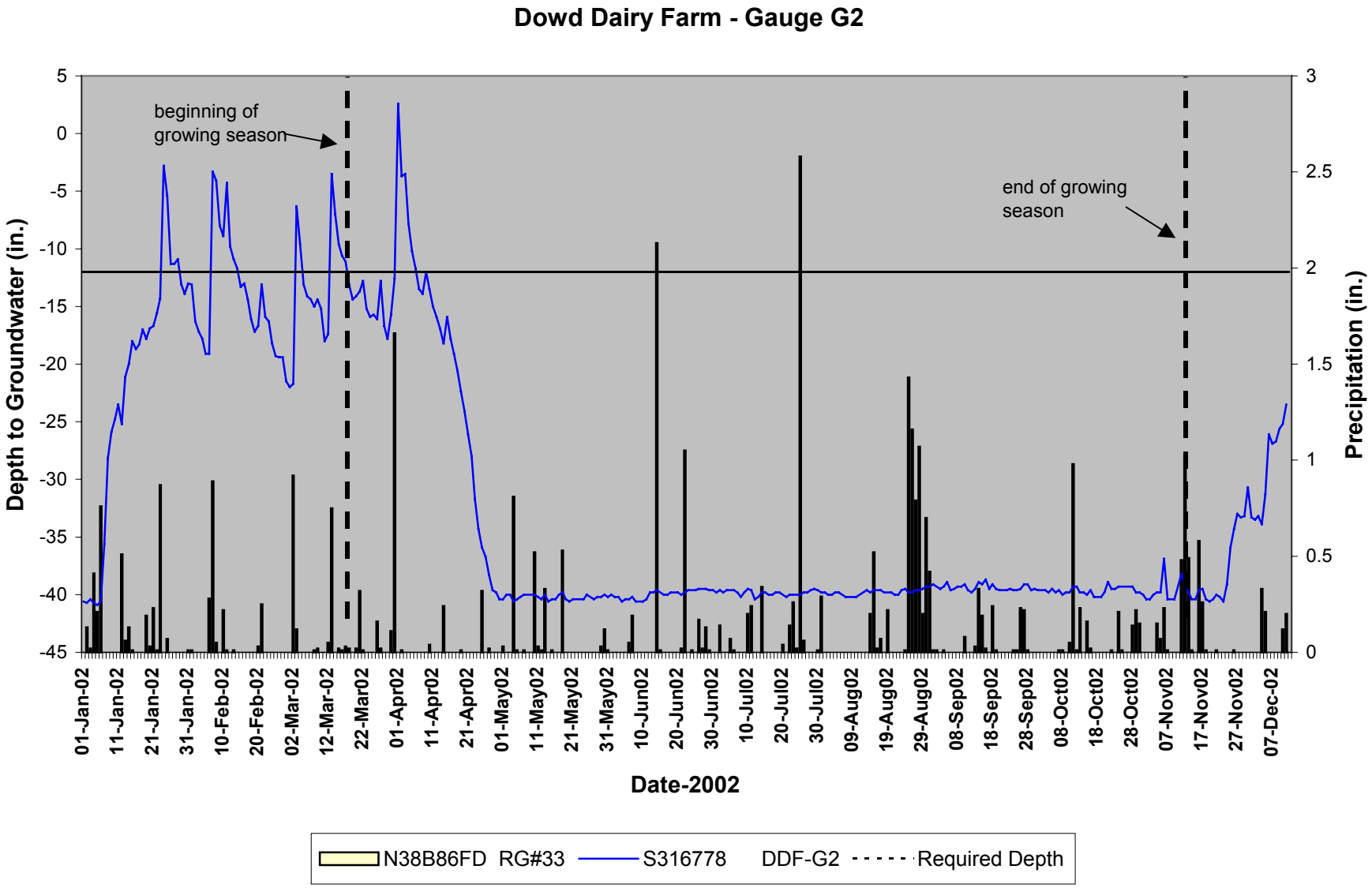
NCDOT will continue to monitor both hydrology and site vegetation.

APPENDIX A

DEPTH TO GROUNDWATER GRAPHS

Dowd Dairy First 20 Groundwater Graphs




Dowd Dairy Farm - Gauge G2
beginning of growing season
end of growing season
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
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-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
10-Jul02
20-Jul02
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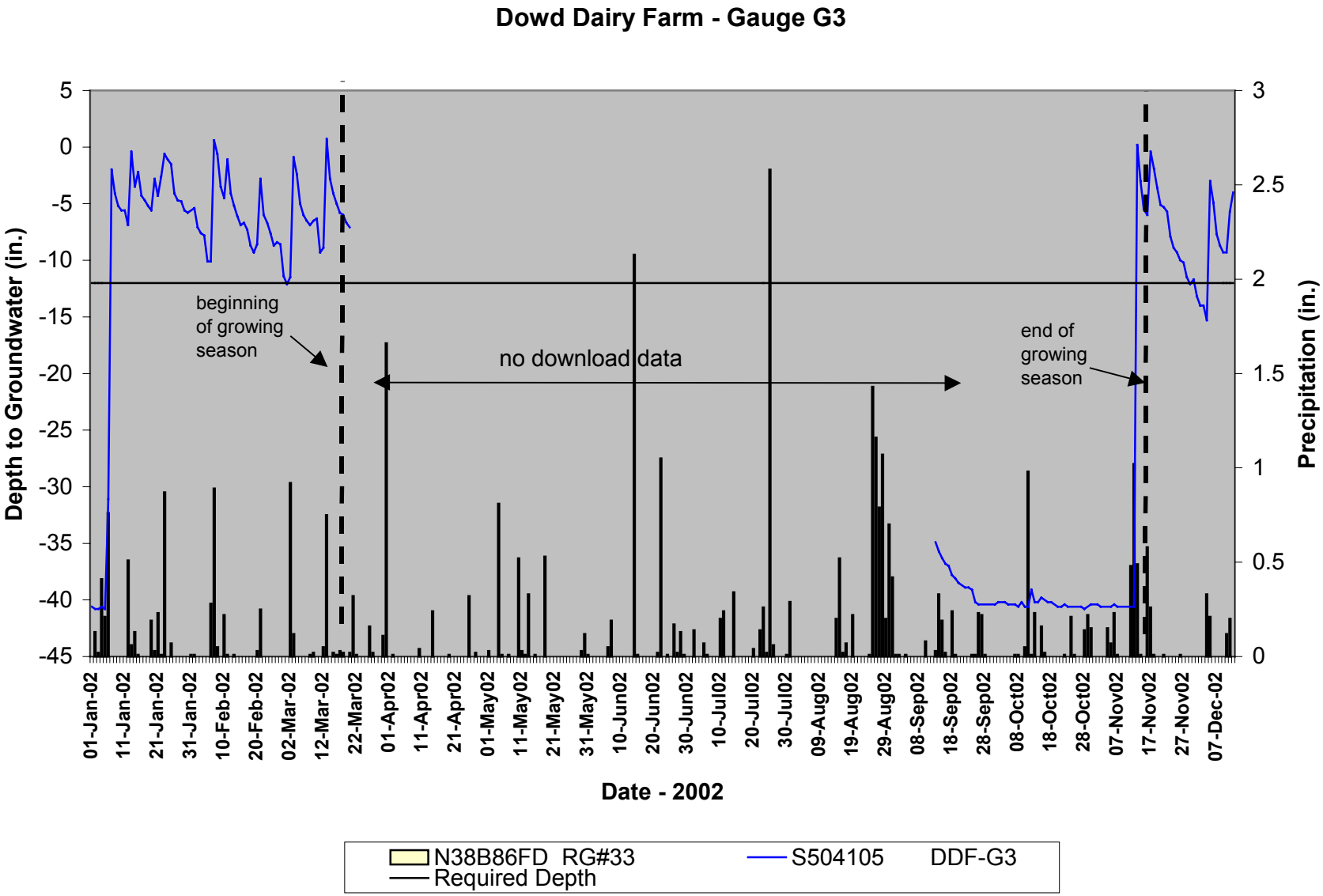
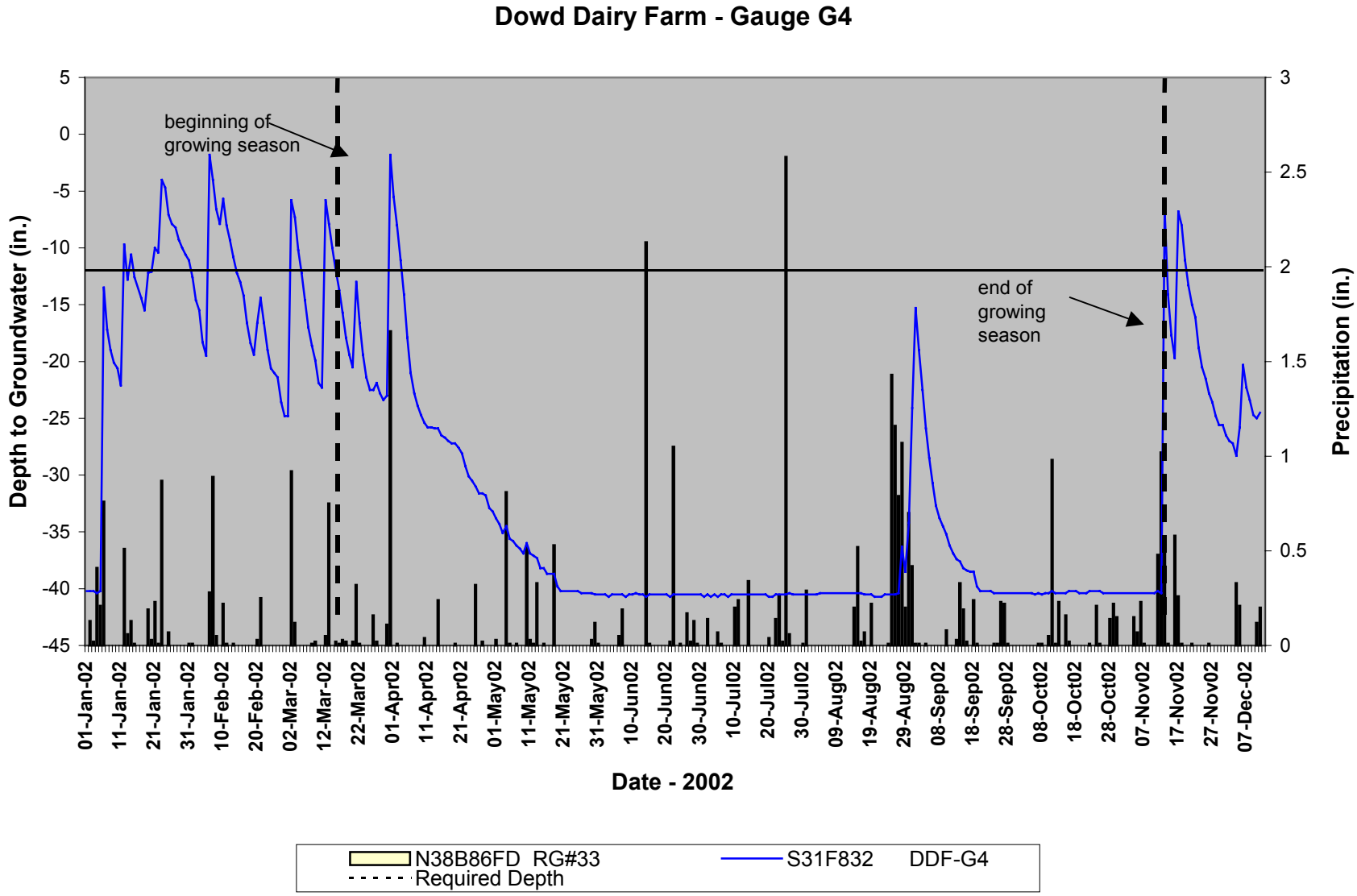
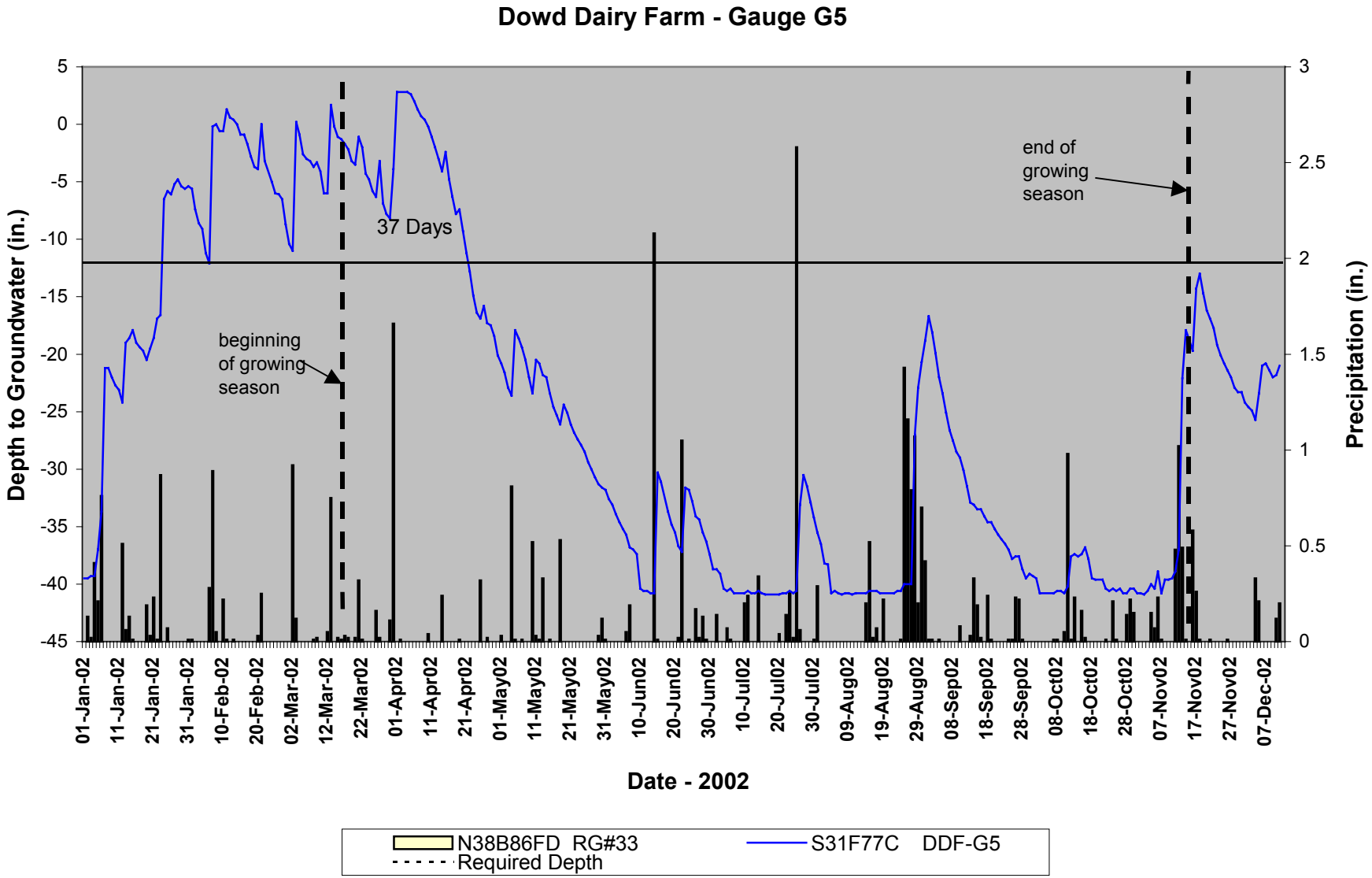
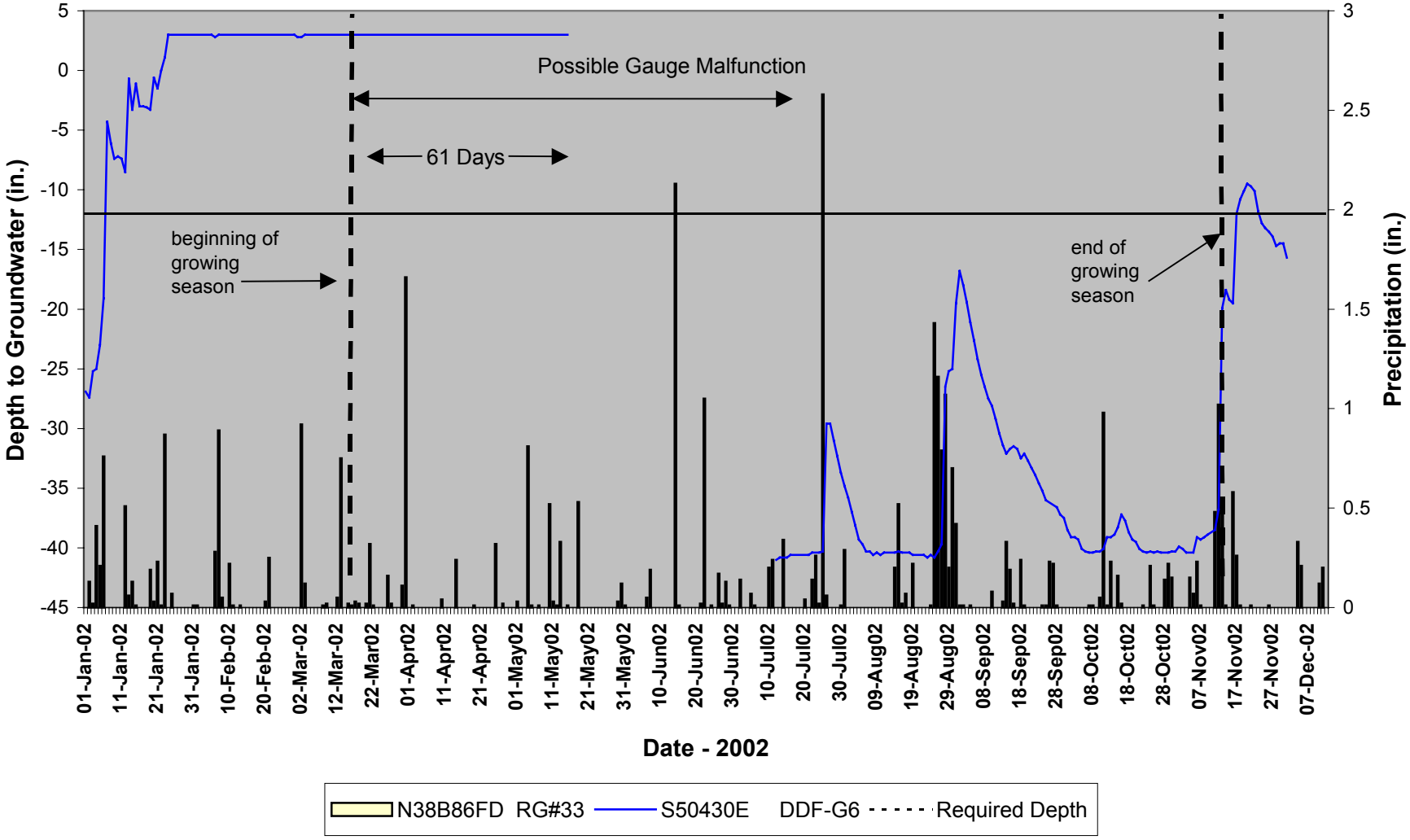
09-Aug02
19-Aug02
29-Aug02
08-Sep02
18-Sep02
28-Sep02
08-Oct02
18-Oct02
28-Oct02
07-Nov02
17-Nov02
27-Nov02
07-Dec-02
Date-2002
N38B86FD RG#33
S316778 DDF-G2
Required Depth

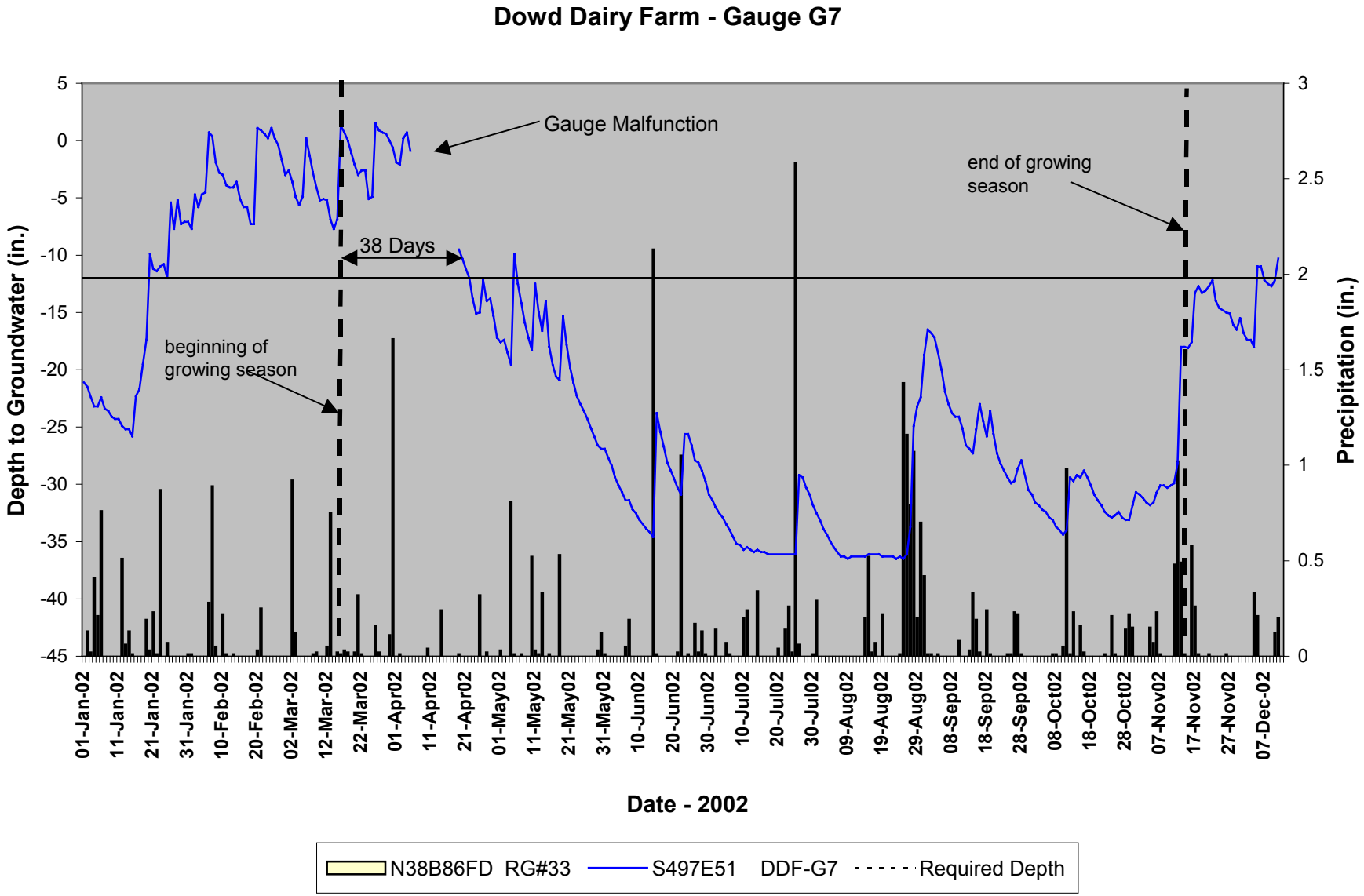

Dowd Dairy Farm - Gauge G3
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
beginning of growing season
no download data
end of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
N38B86FD RG#33
S504105 DDF-G3
Required Depth

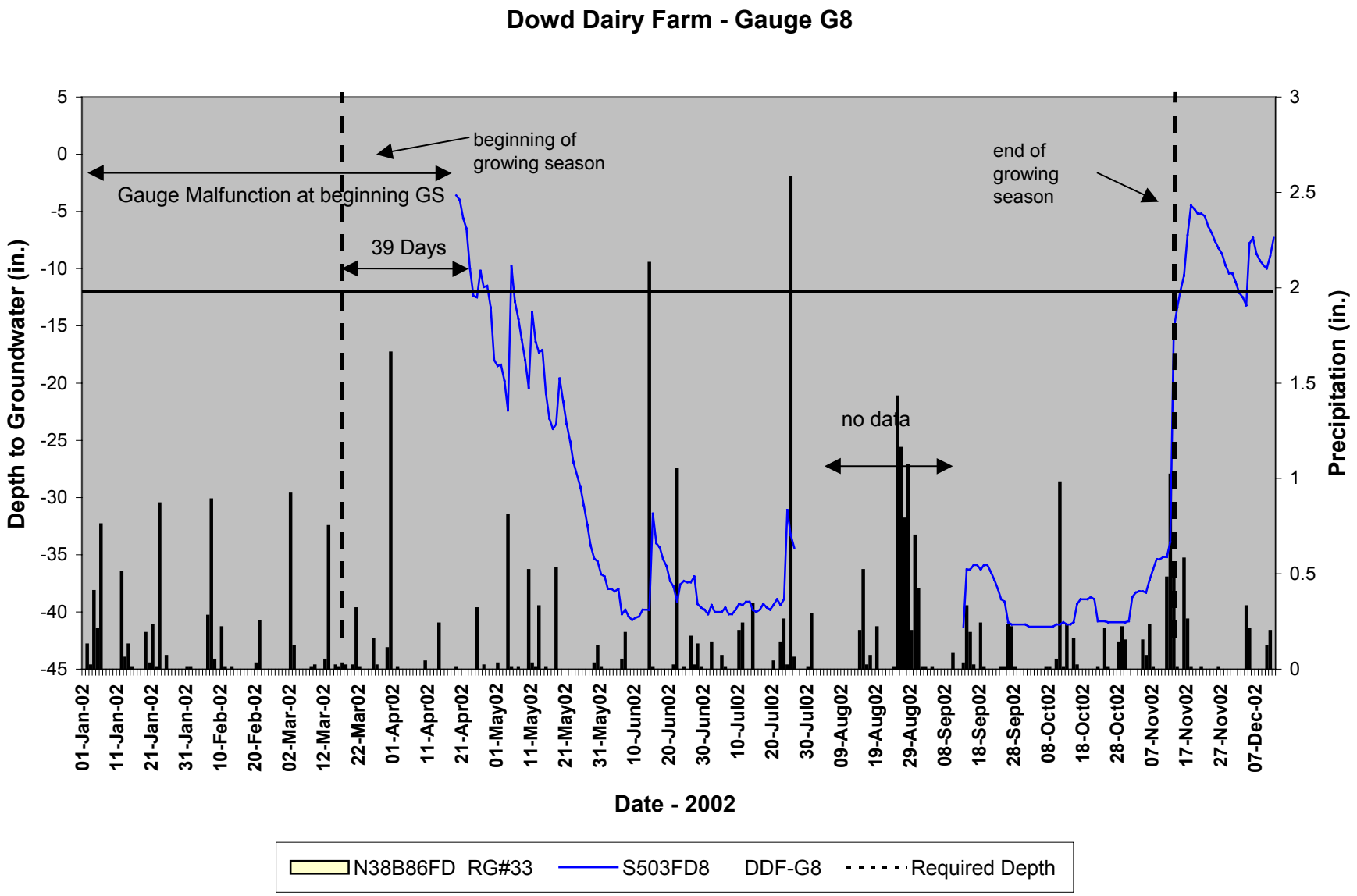

Dowd Dairy Farm - Gauge G4
beginning of growing season
end of growing season
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
N38B86FD RG#33
S31F832 DDF-G4
Required Depth

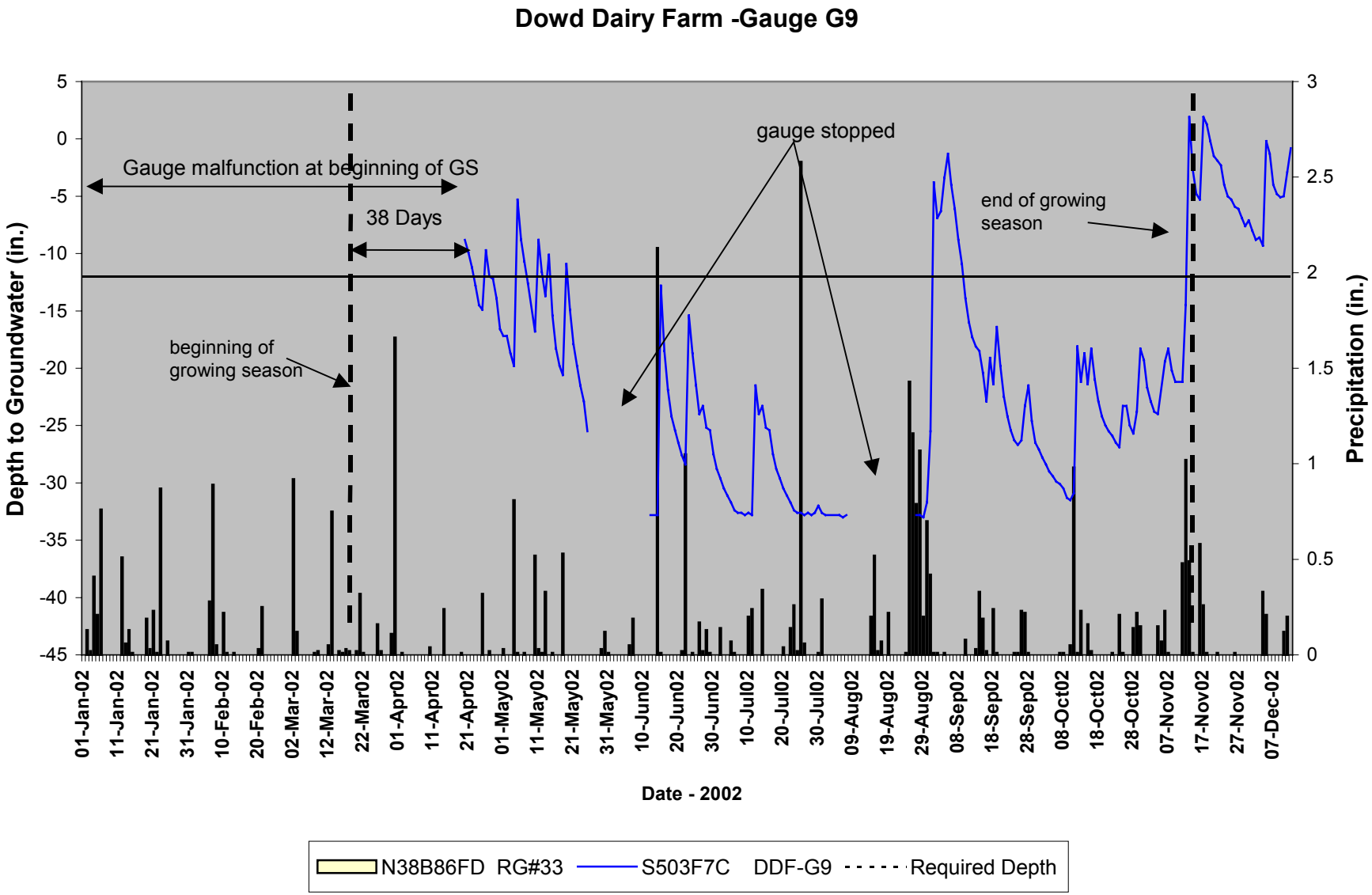

Dowd Dairy Farm - Gauge G5
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
37 Days
beginning of growing season
end of growing season
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
N38B86FD RG#33
S31F77C DDF-G5
Required Depth

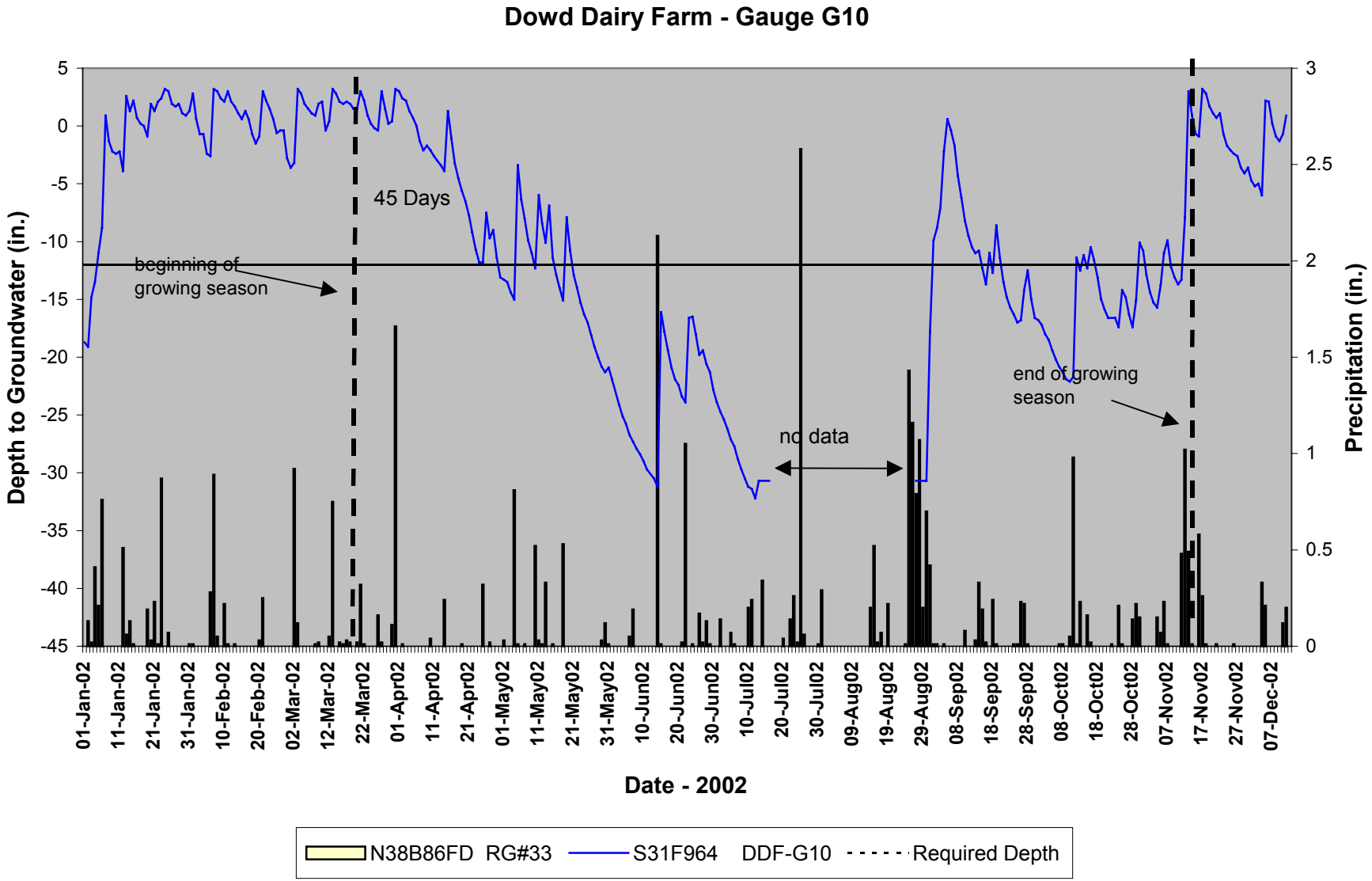
Dowd Dairy Farm - Gauge G6

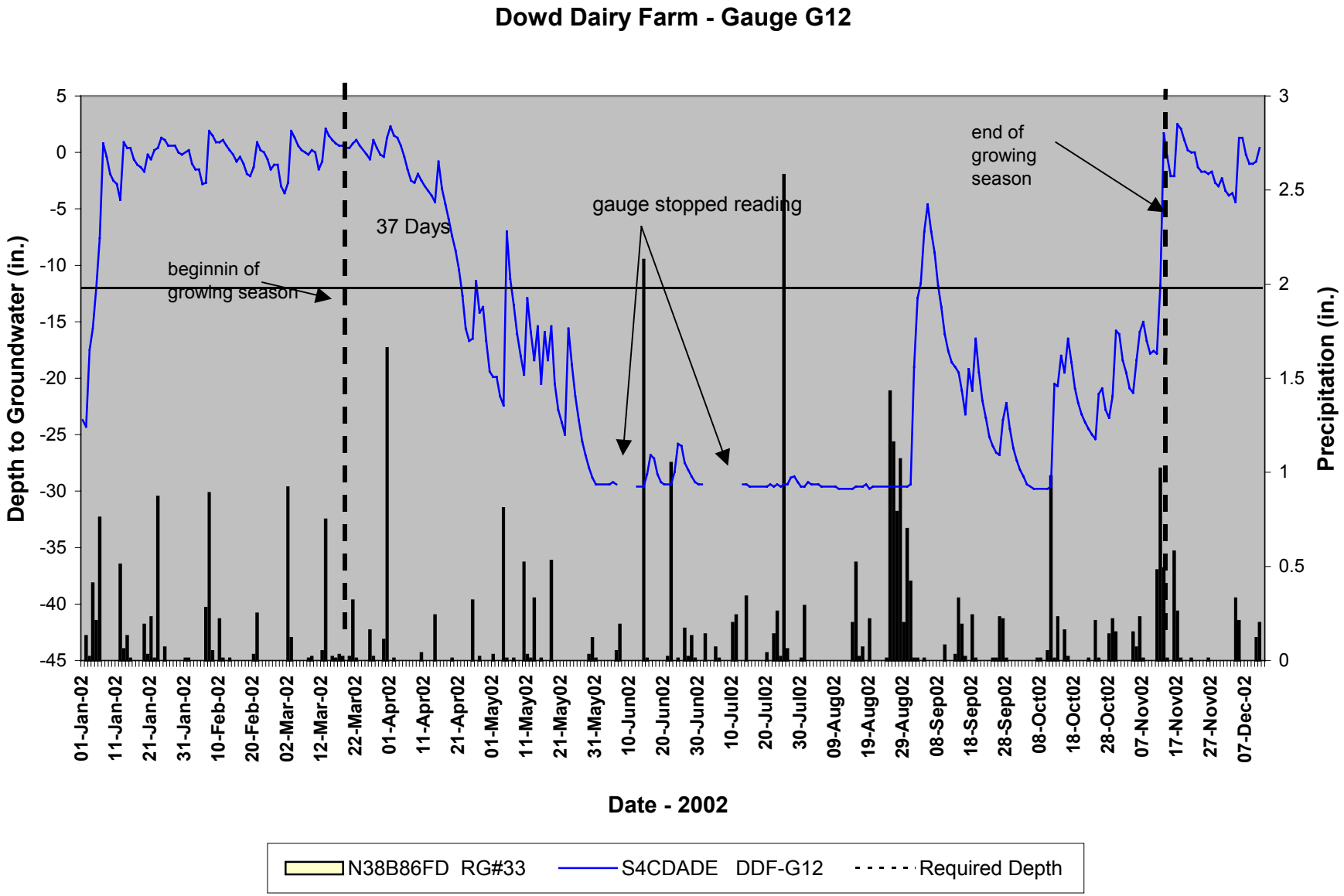


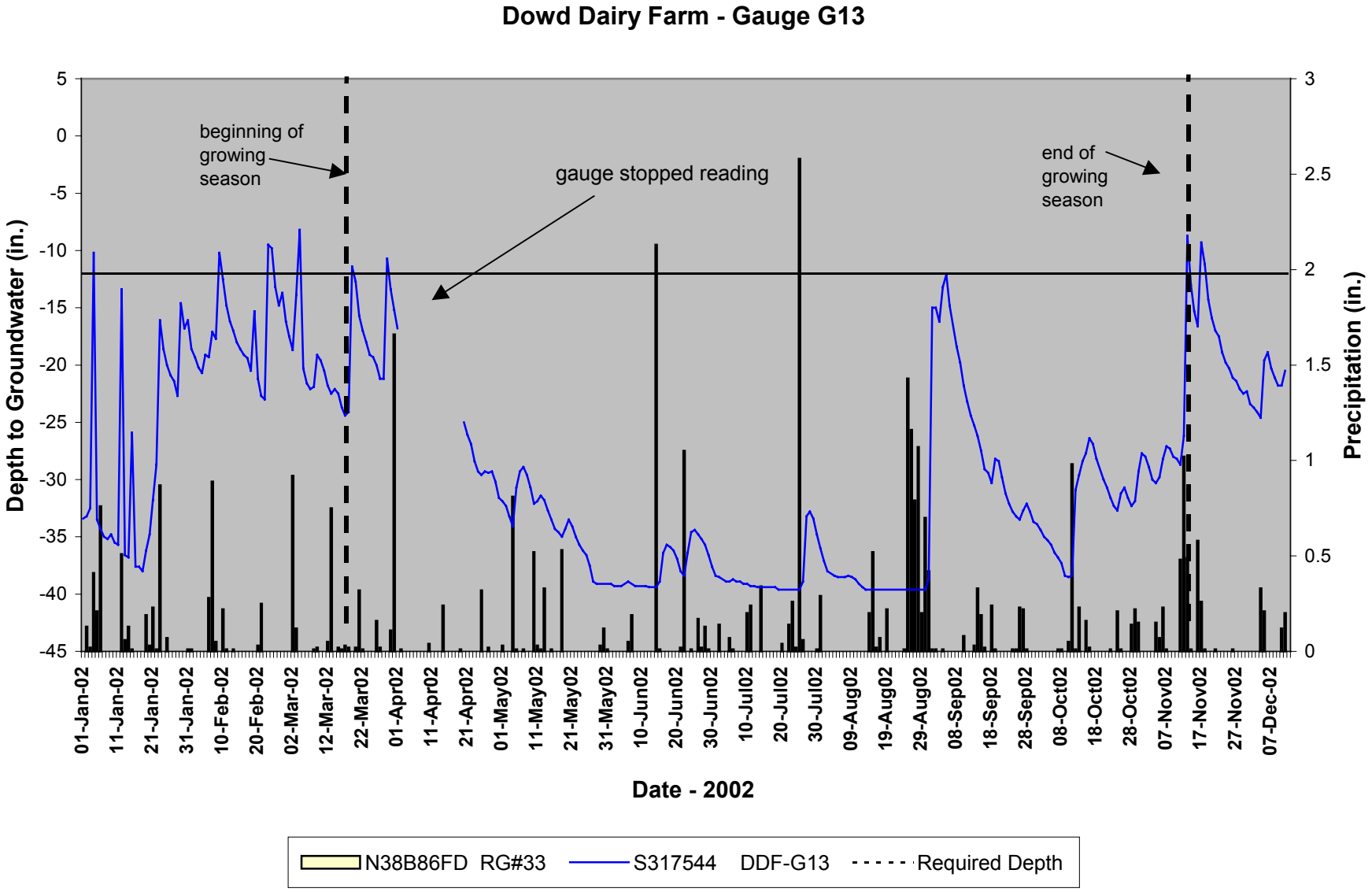

Dowd Dairy Farm - Gauge G7
Depth to Groundwater (in.)
Precipitation (in.)
Gauge Malfunction
38 Days
beginning of growing season
end of growing season
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
N38B86FD RG#33
S497E51 DDF-G7
Required Depth

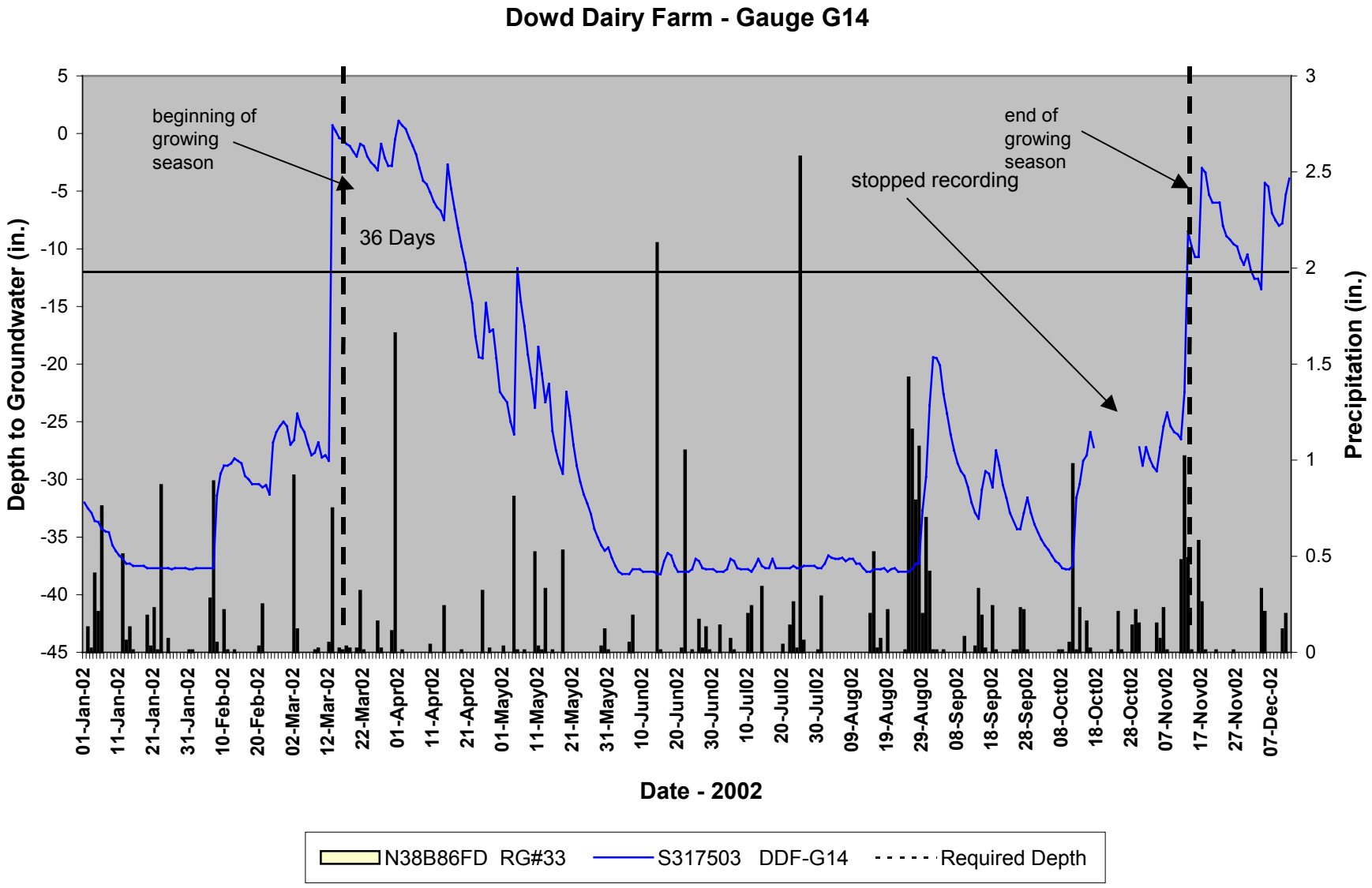

Dowd Dairy Farm - Gauge G8
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
beginning of growing season
end of growing season
Gauge Malfunction at beginning GS
39 Days
no data
N38B86FD RG#33
S503FD8 DDF-G8
Required Depth

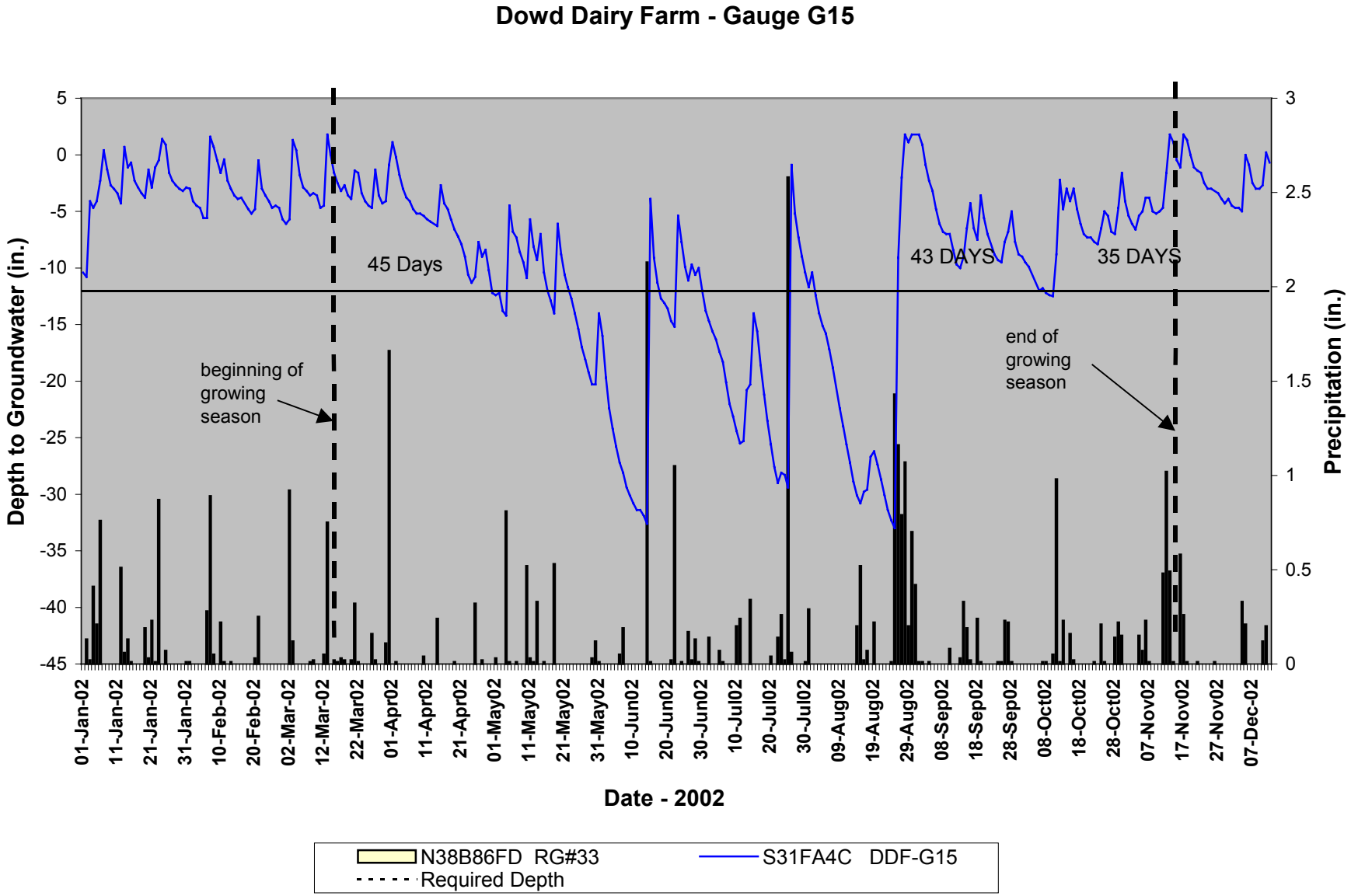

Dowd Dairy Farm -Gauge G9
Depth to Groundwater (in.)
Precipitation (in.)
Gauge malfunction at beginning of GS
38 Days
gauge stopped
end of growing season
beginning of growing season
Date - 2002
N38B86FD RG#33
S503F7C DDF-G9
Required Depth

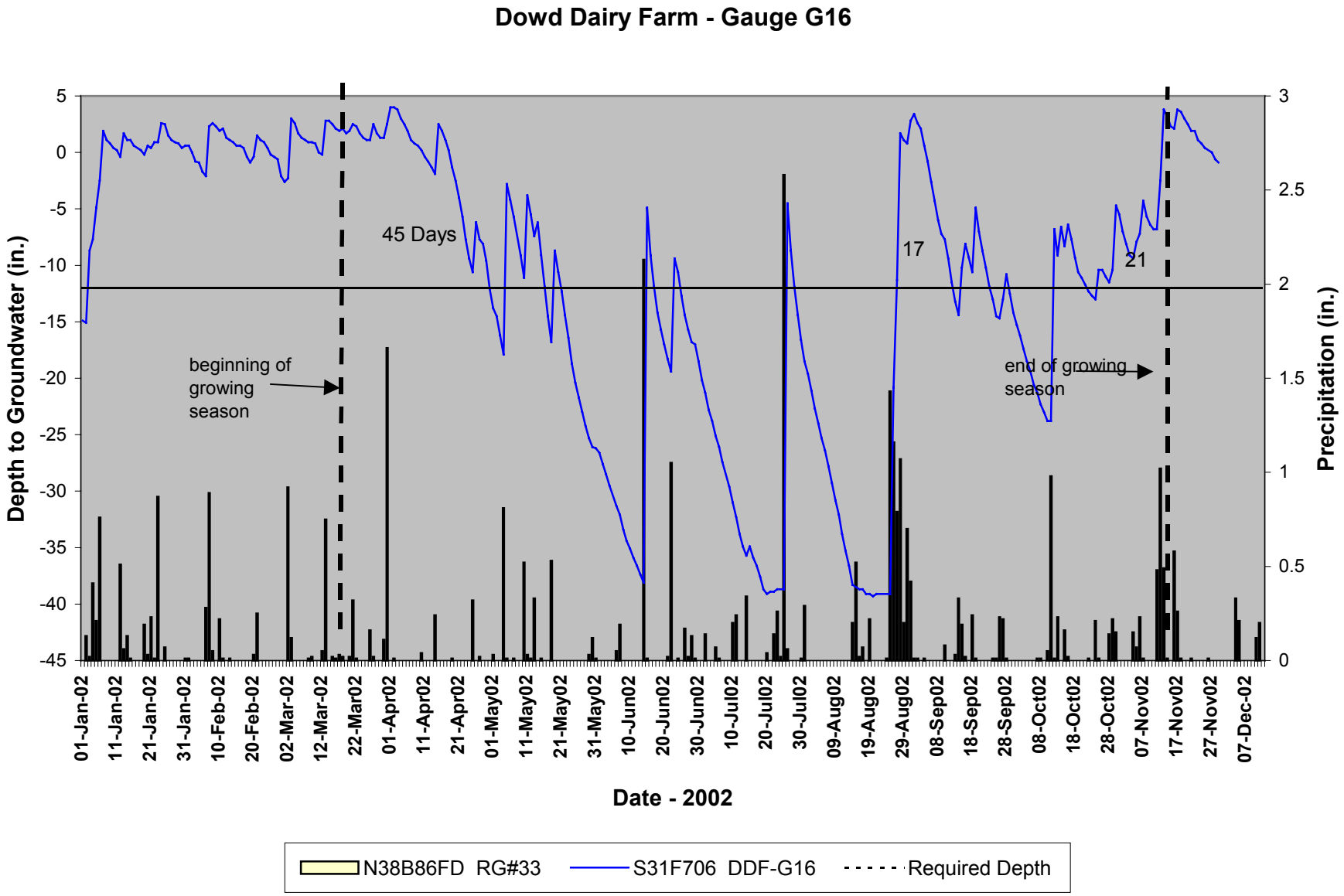

Dowd Dairy Farm - Gauge G10
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
45 Days
beginning of growing season
end of growing season
no data
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
N38B86FD RG#33
S31F964 DDF-G10
Required Depth

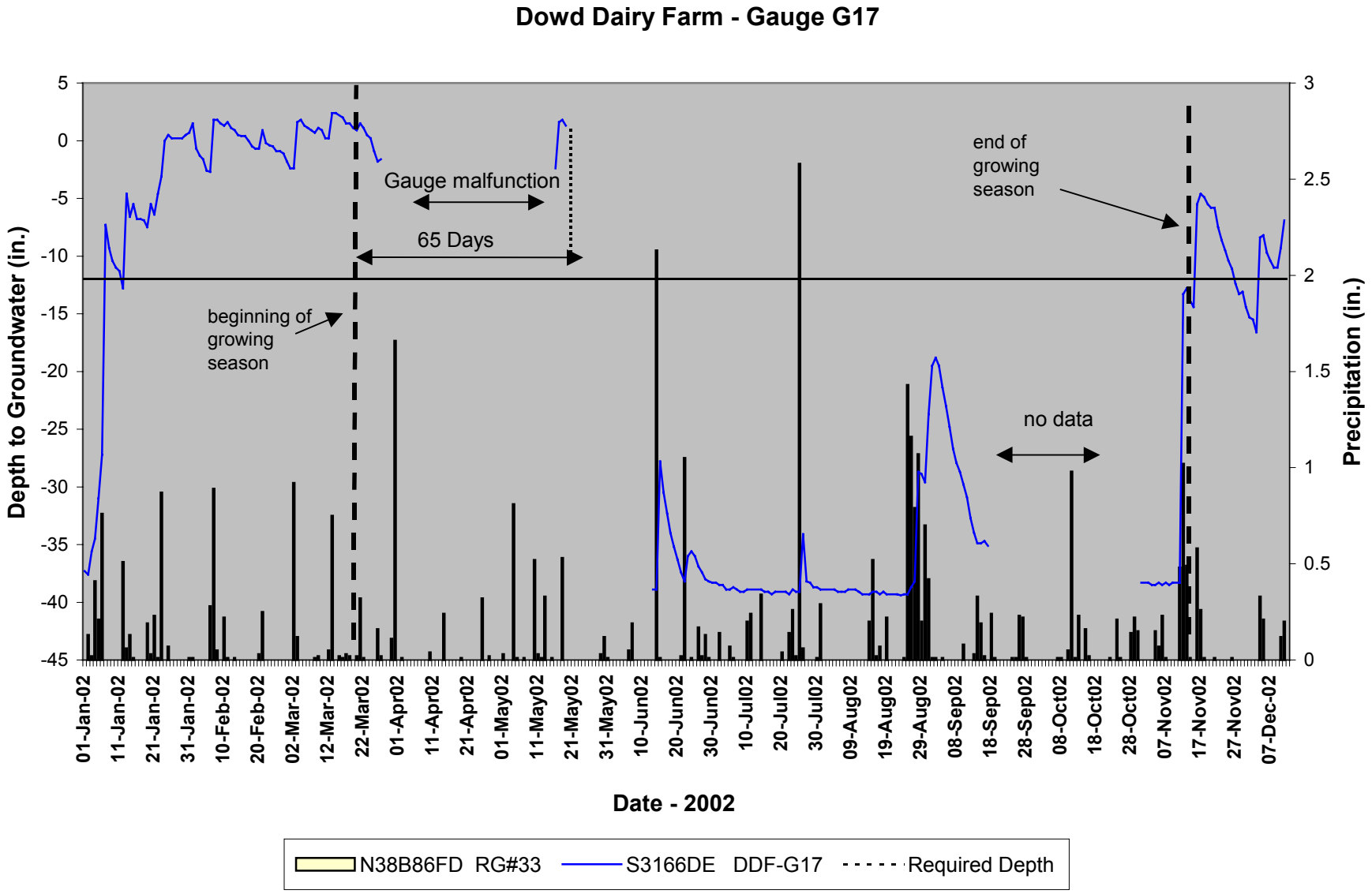

Dowd Dairy Farm - Gauge G12
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
37 Days
beginnin of growing season
gauge stopped reading
end of growing season
N38B86FD RG#33
S4CDADE DDF-G12
Required Depth

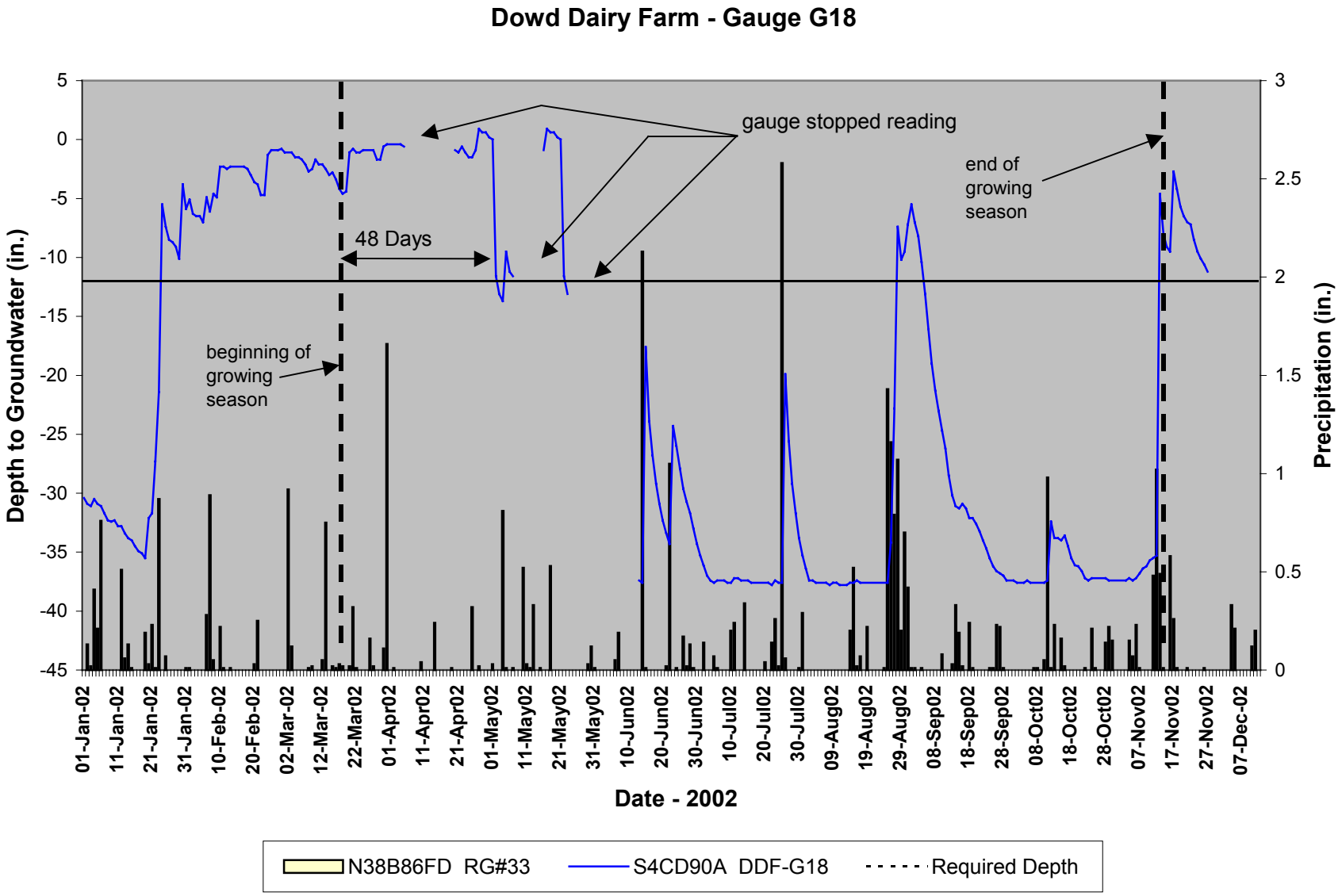

Dowd Dairy Farm - Gauge G13
beginning of growing season
gauge stopped reading
end of growing season
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
N38B86FD RG#33
S317544 DDF-G13
Required Depth

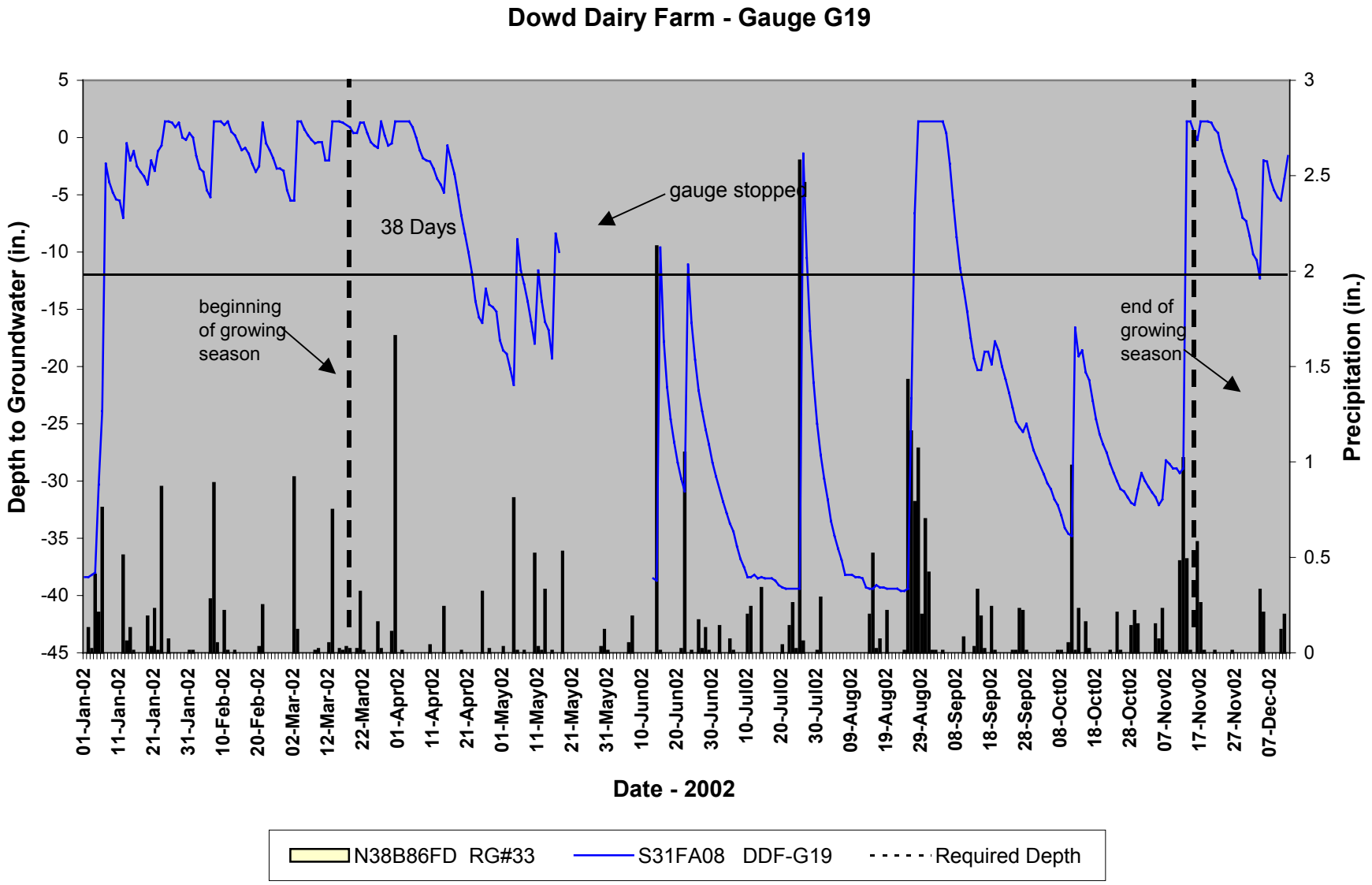

Dowd Dairy Farm - Gauge G14
beginning of growing season
36 Days
stopped recording
end of growing season
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
N38B86FD RG#33
S317503 DDF-G14
Required Depth

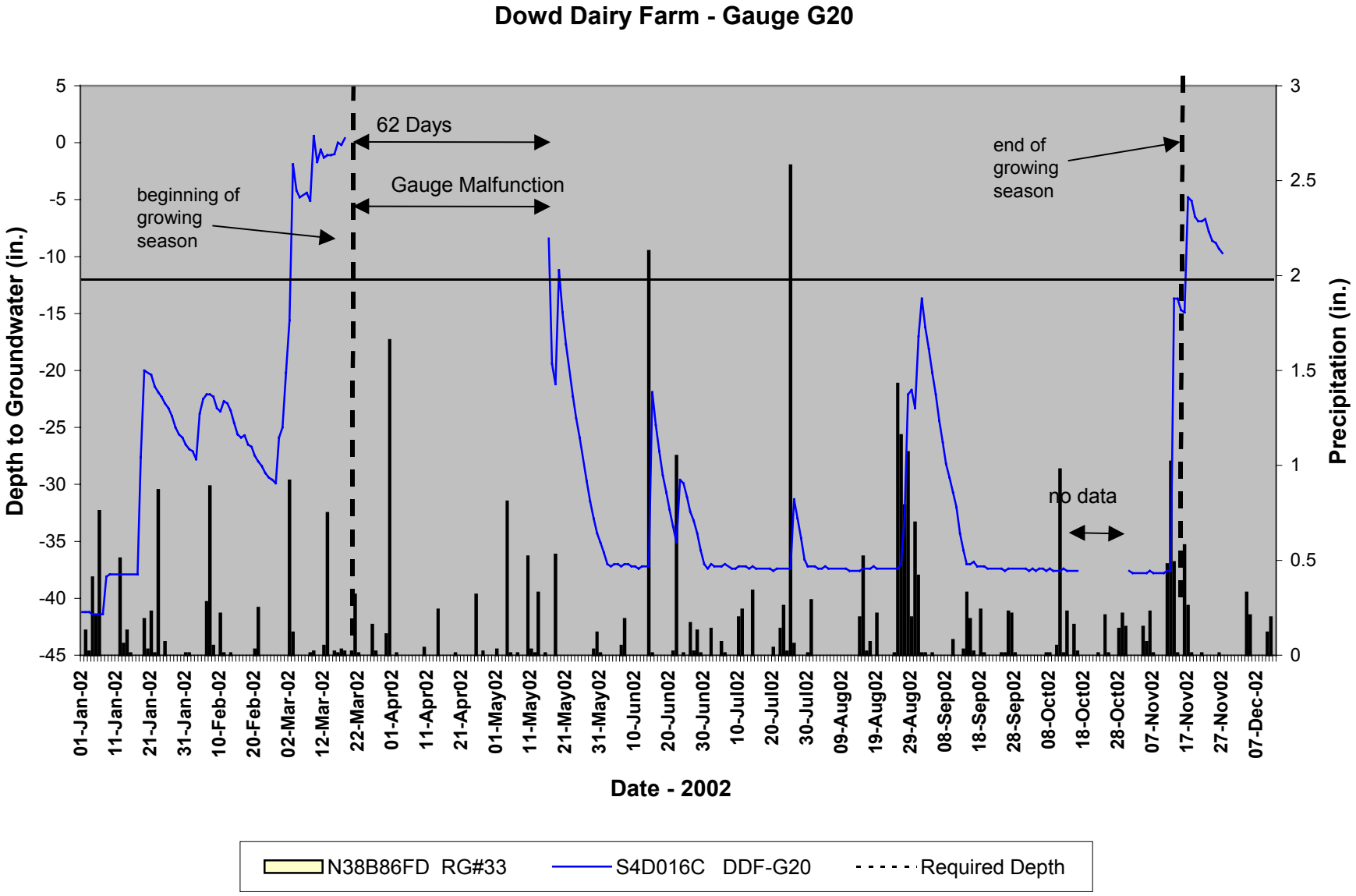

Dowd Dairy Farm - Gauge G15
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
45 Days
43 DAYS
35 DAYS
beginning of growing season
end of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
N38B86FD RG#33
S31FA4C DDF-G15
Required Depth


Dowd Dairy Farm - Gauge G16
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
45 Days
17
21
beginning of growing season
end of growing season
N38B86FD RG#33
S31F706 DDF-G16
Required Depth

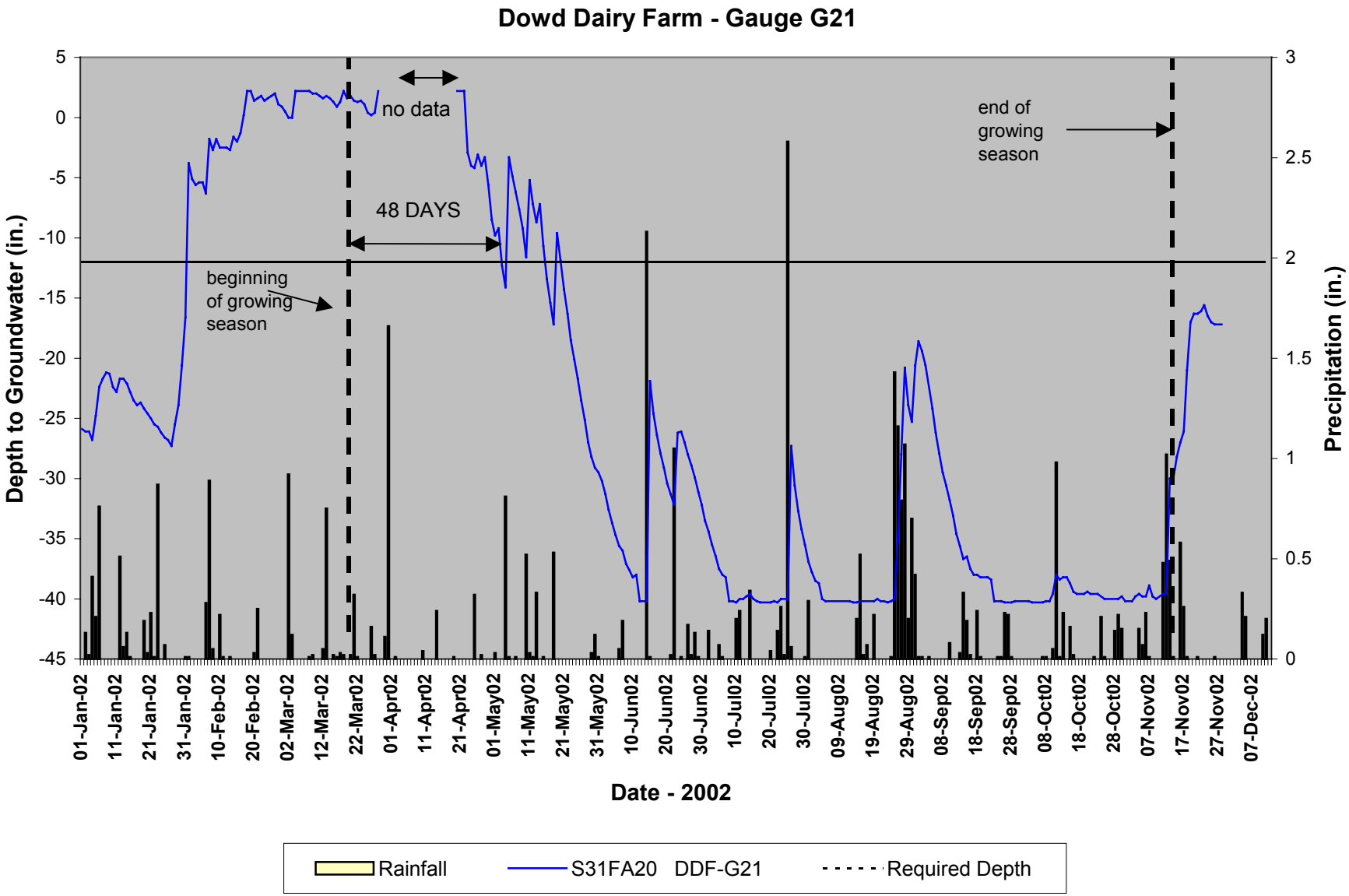

Dowd Dairy Farm - Gauge G17
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
Gauge malfunction
65 Days
beginning of growing season
end of growing season
no data
N38B86FD RG#33
S3166DE DDF-G17
Required Depth

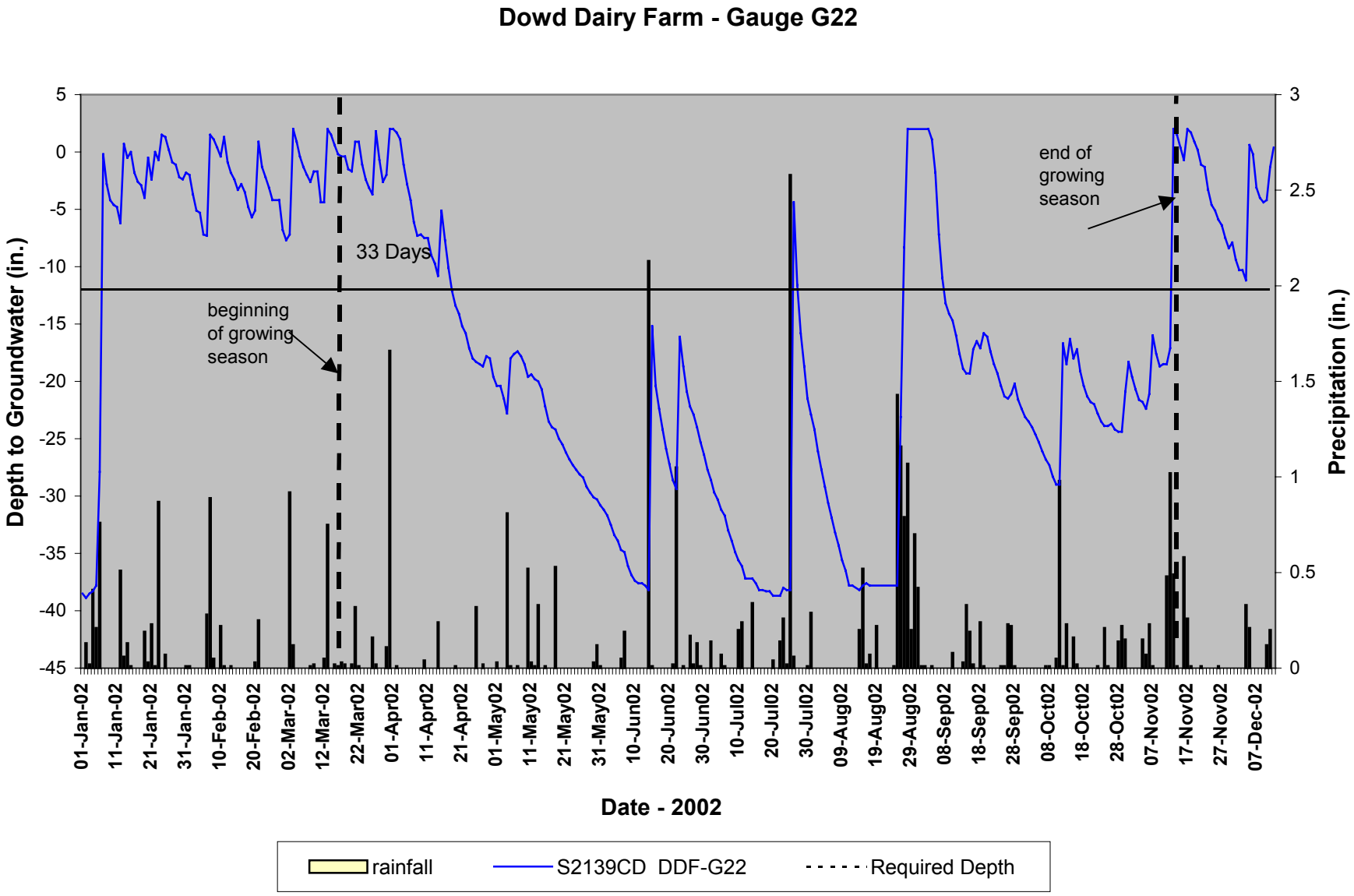

Dowd Dairy Farm - Gauge G18
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
gauge stopped reading
end of growing season
48 Days
beginning of growing season
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
N38B86FD RG#33
S4CD90A DDF-G18
Required Depth

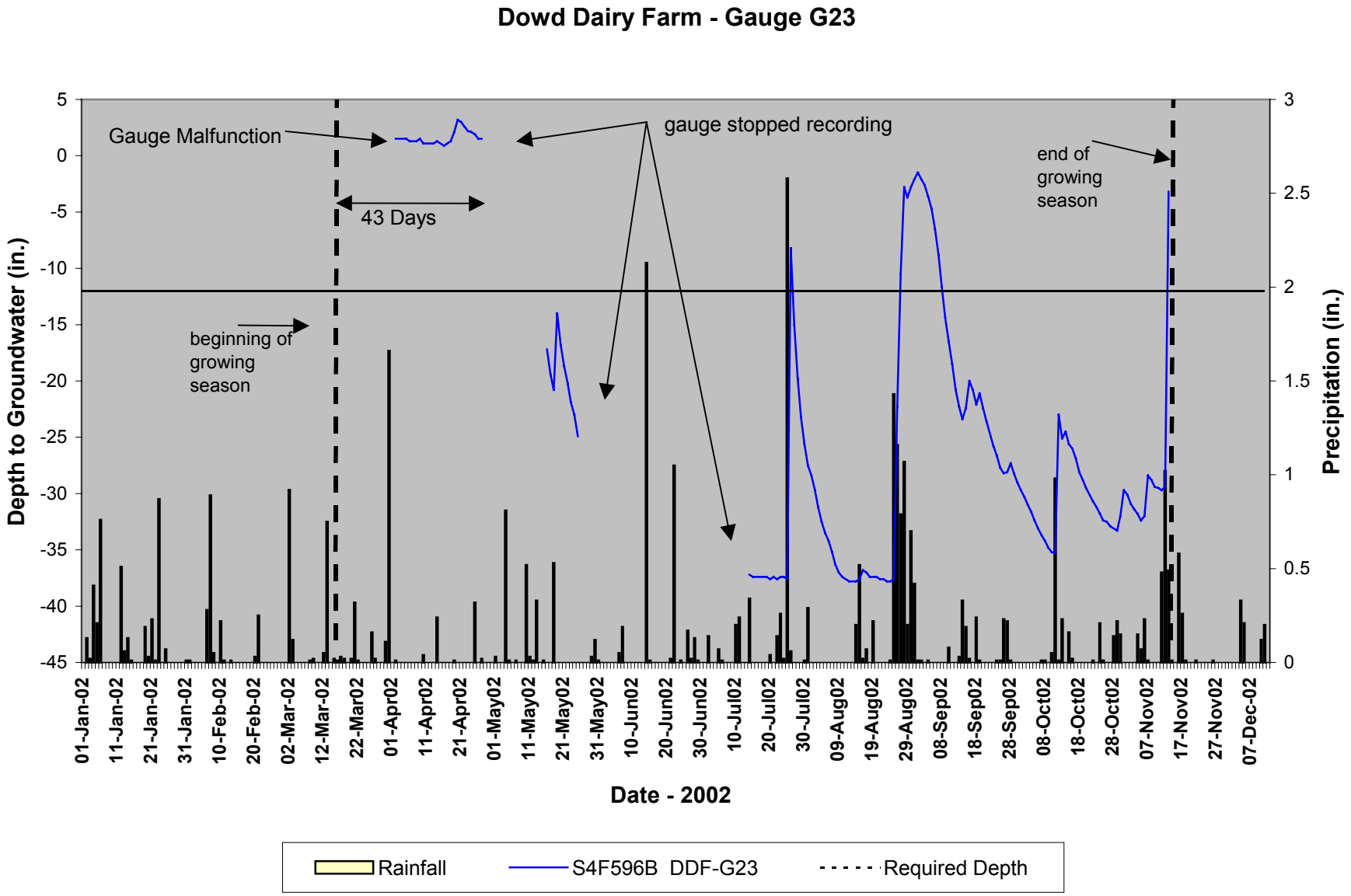

Dowd Dairy Farm - Gauge G19
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
38 Days
gauge stopped
beginning of growing season
end of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
N38B86FD RG#33
S31FA08 DDF-G19
Required Depth

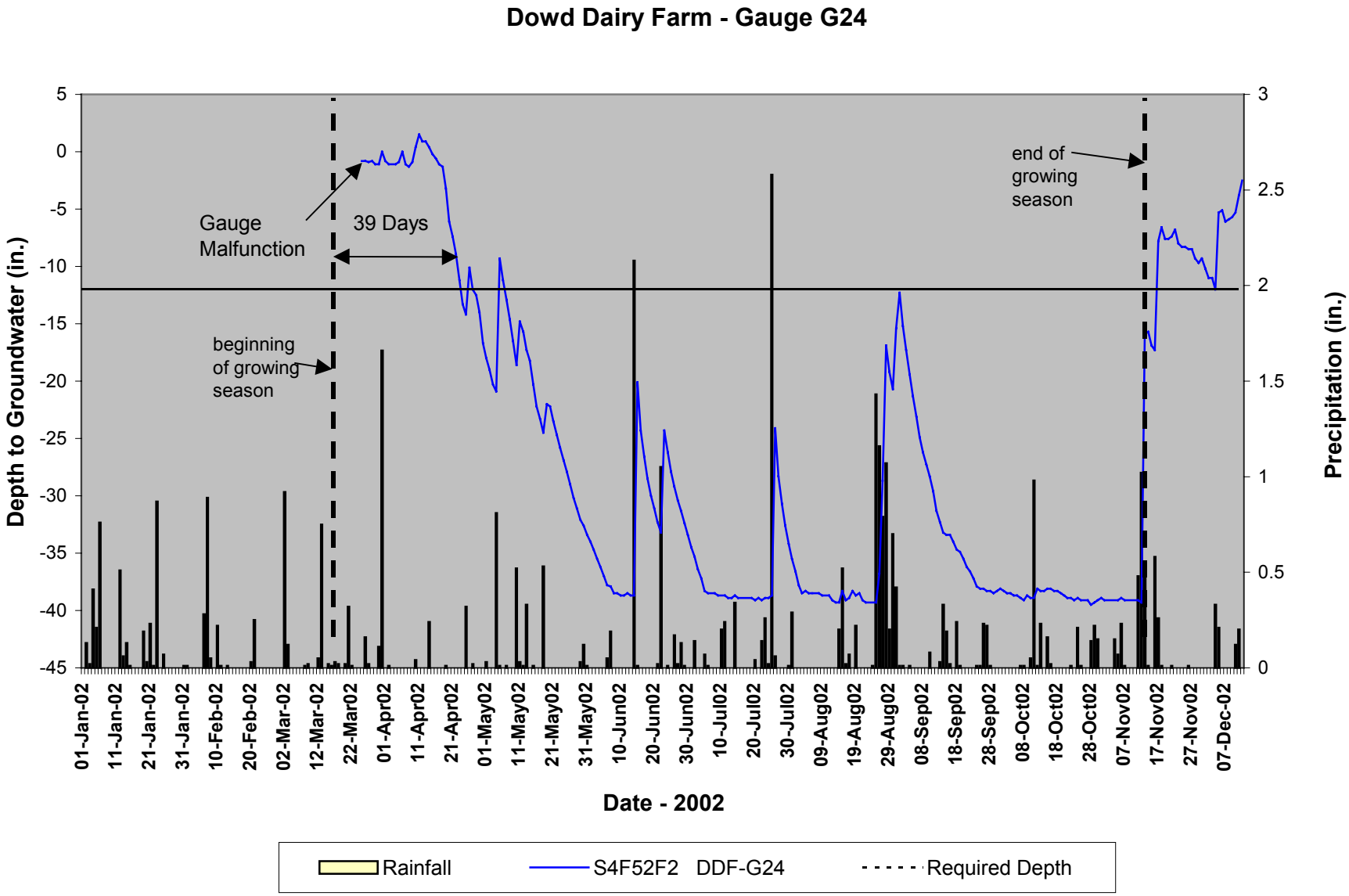

Dowd Dairy Farm - Gauge G20
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
62 Days
Gauge Malfunction
beginning of growing season
end of growing season
no data
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
N38B86FD RG#33
S4D016C DDF-G20
Required Depth

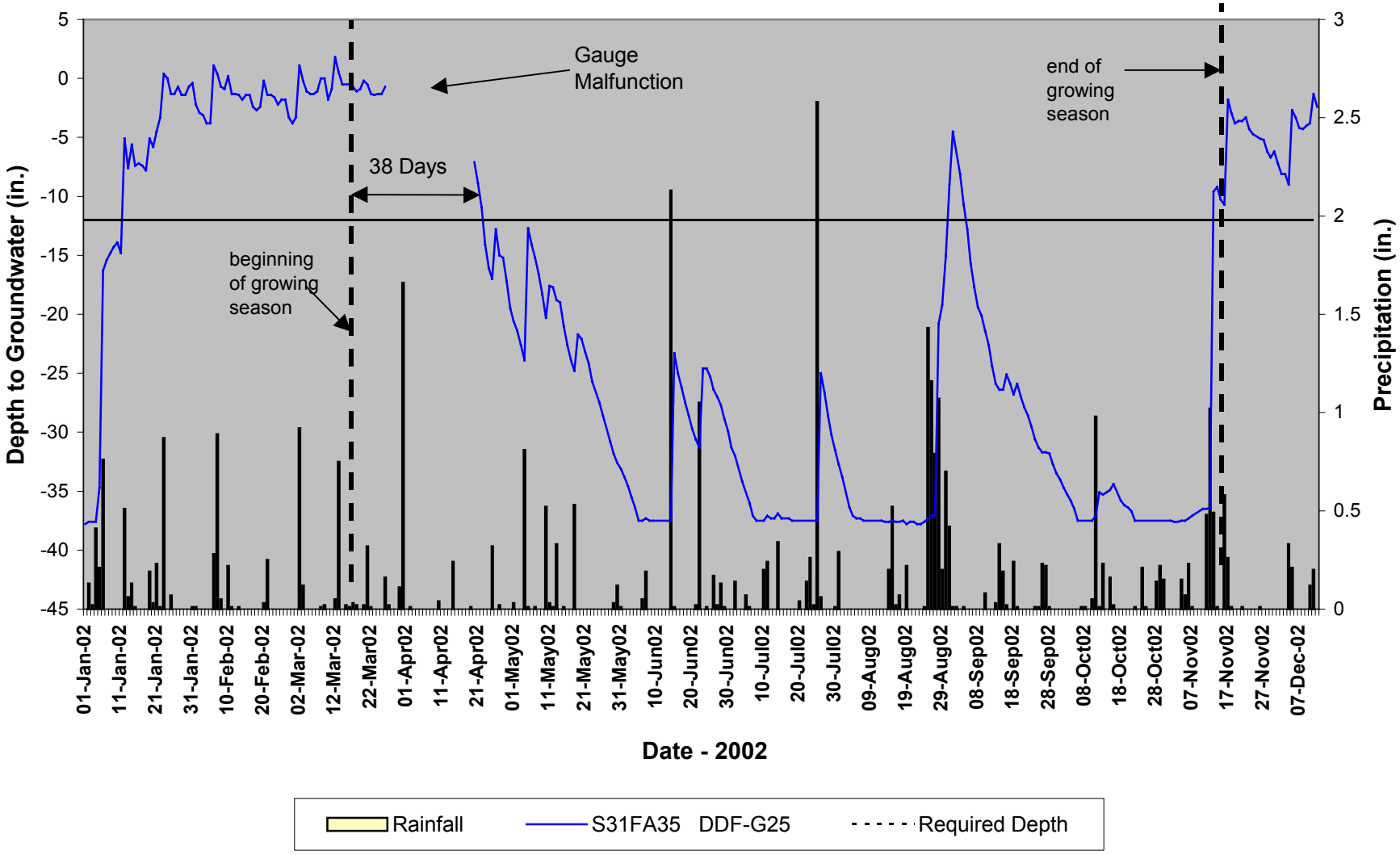
Dowd Dairy Groundwater Graphs Gauges 21-38

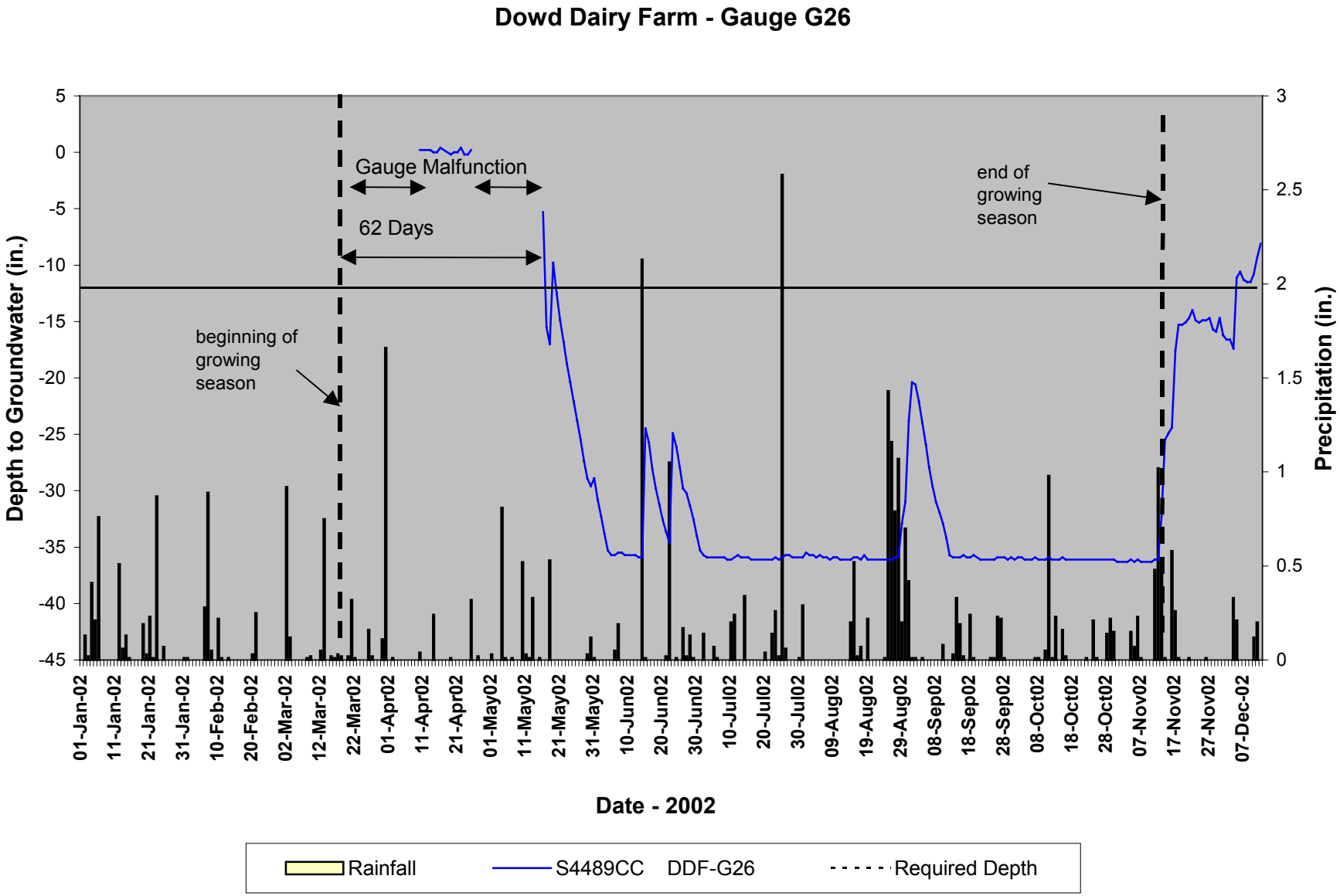


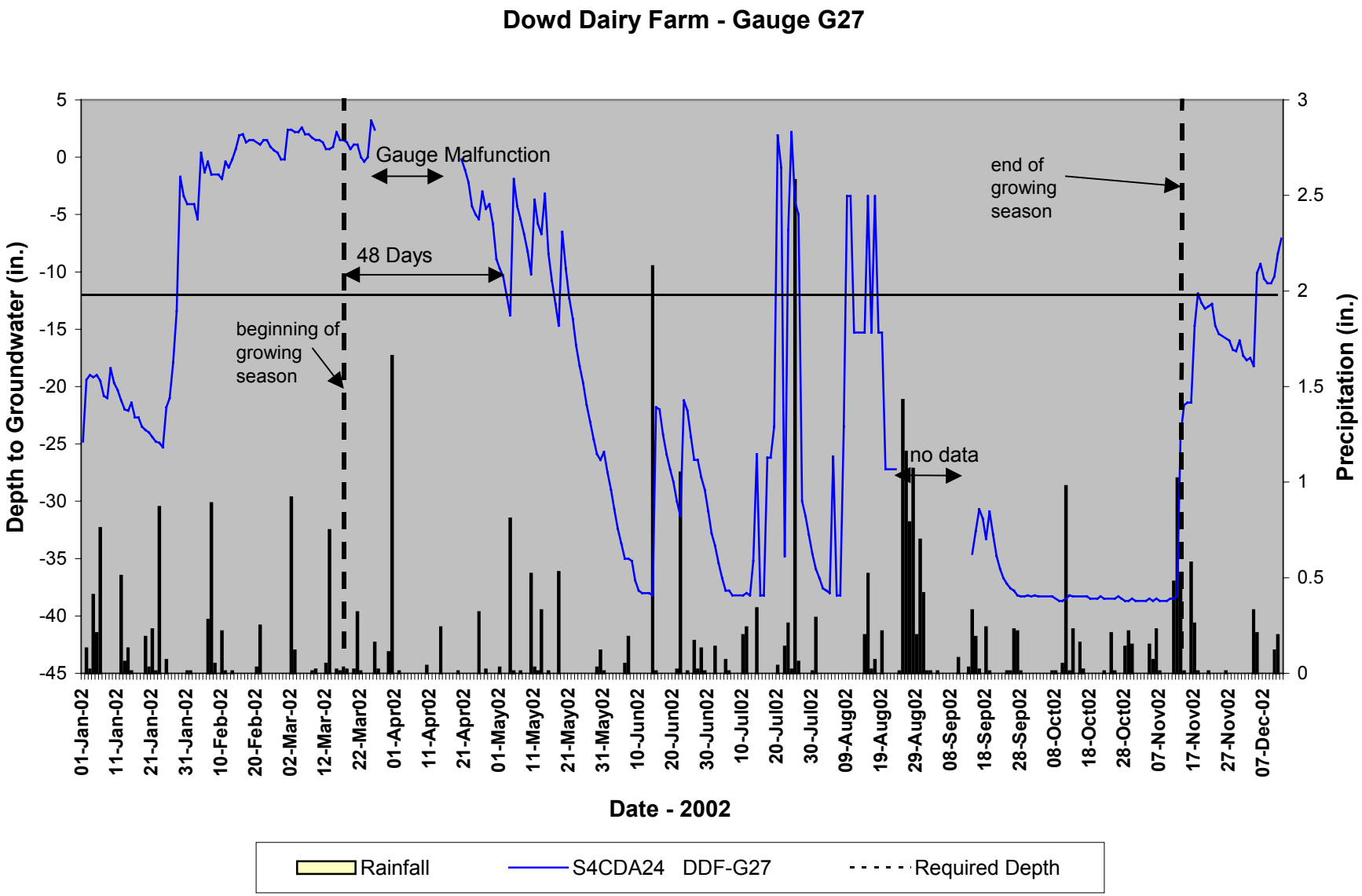

Dowd Dairy Farm - Gauge G22
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
33 Days
beginning of growing season
end of growing season
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
rainfall
S2139CD DDF-G22
Required Depth

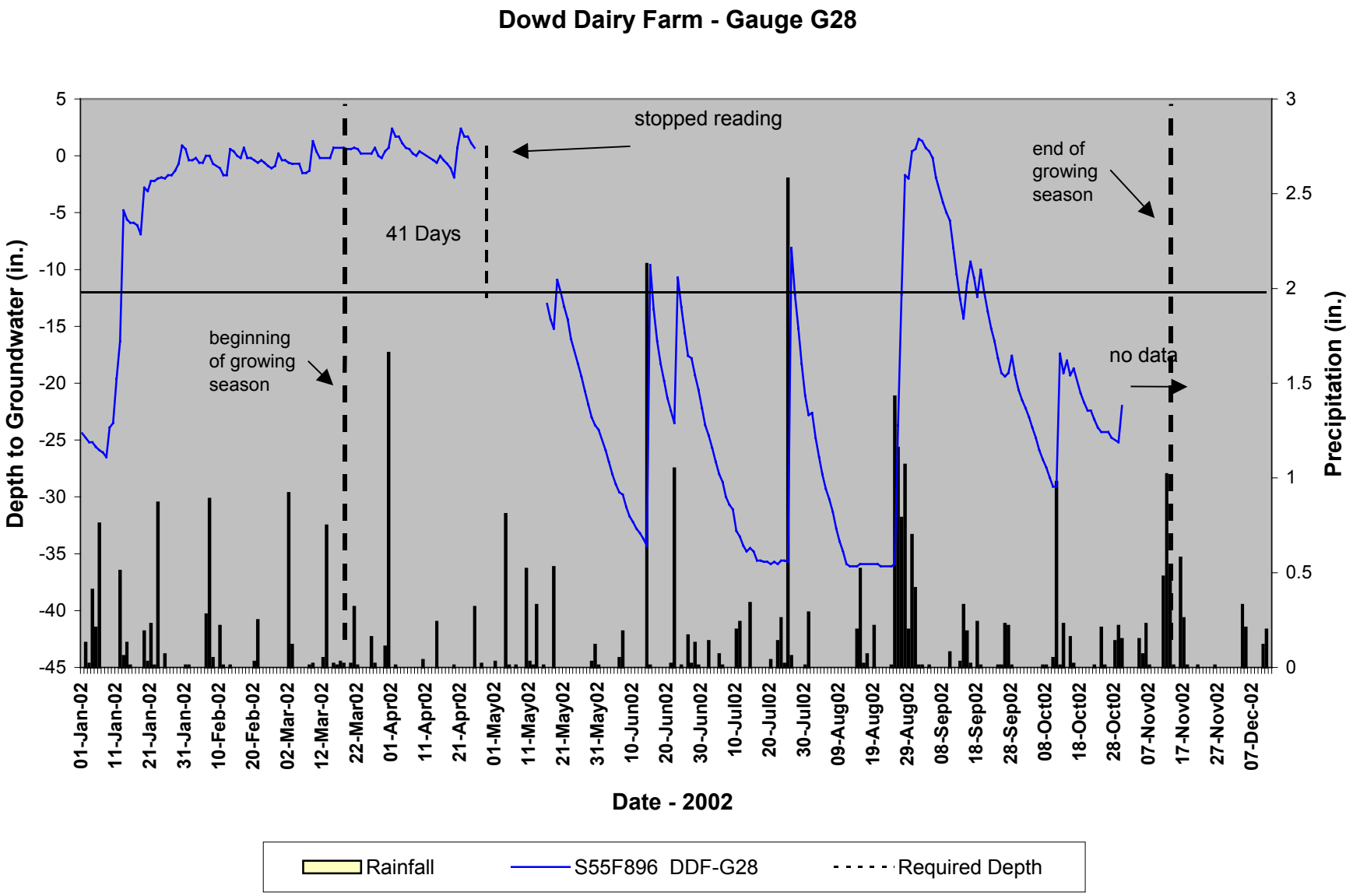

Dowd Dairy Farm - Gauge G23
Depth to Groundwater (in.)
Precipitation (in.)
Gauge Malfunction
43 Days
gauge stopped recording
end of growing season
beginning of growing season
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
Rainfall
S4F596B DDF-G23
Required Depth

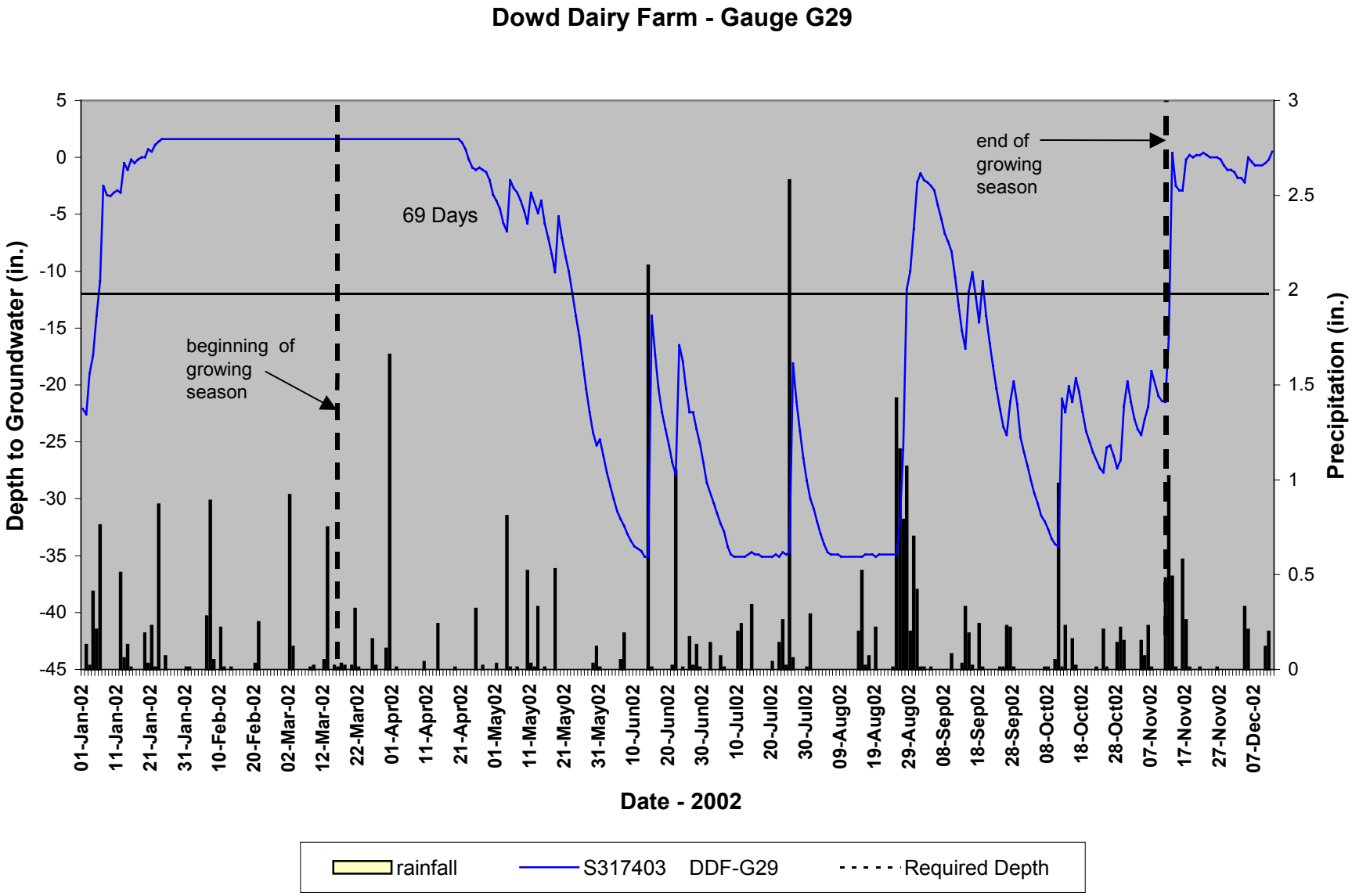

Dowd Dairy Farm - Gauge G24
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
Gauge Malfunction
39 Days
beginning of growing season
end of growing season
Rainfall
S4F52F2 DDF-G24
Required Depth

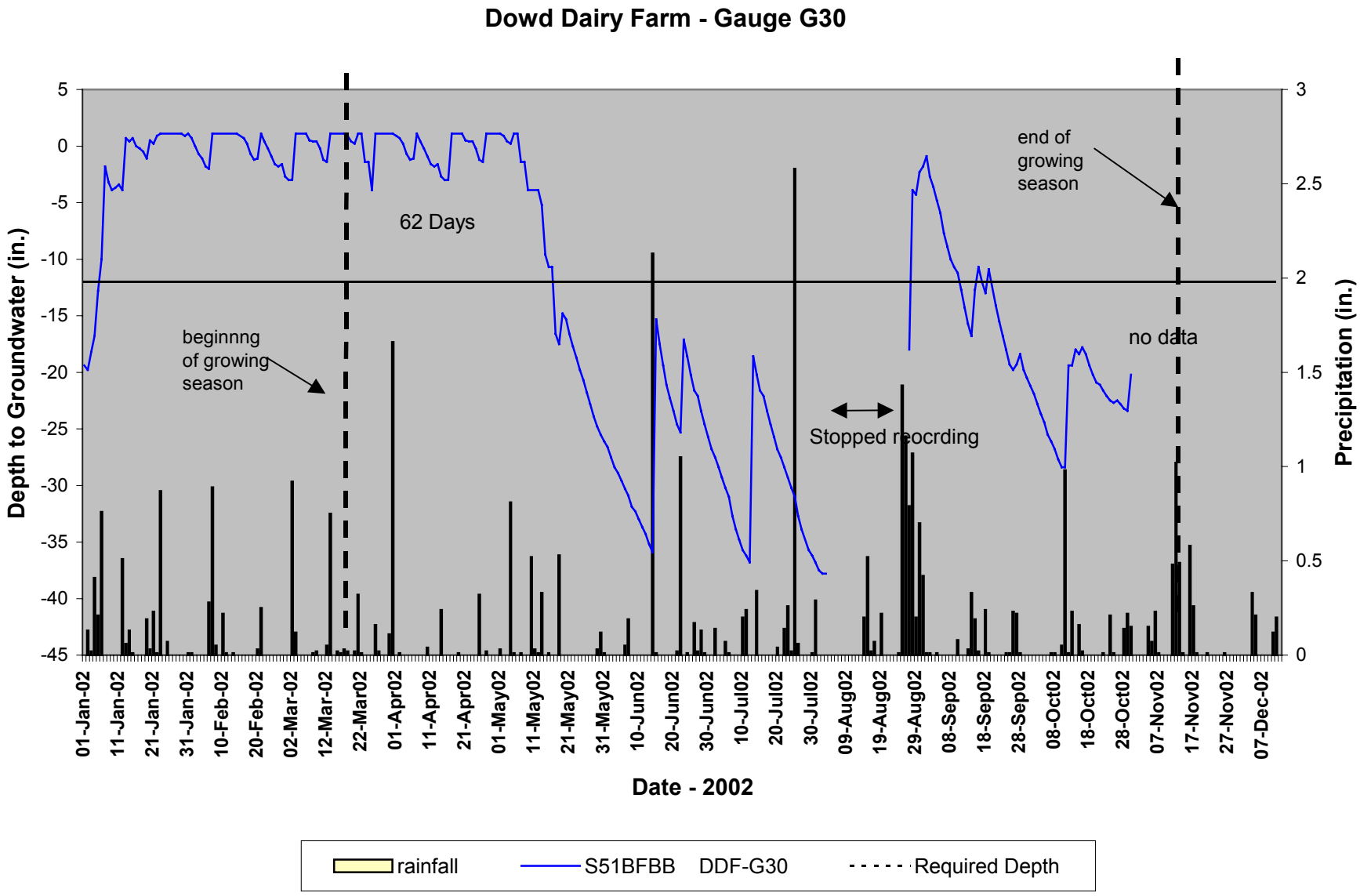

Dowd Dairy Farm - Gauge G25
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
Gauge Malfunction
38 Days
beginning of growing season
end of growing season
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Rainfall
S31FA35 DDF-G25
Required Depth

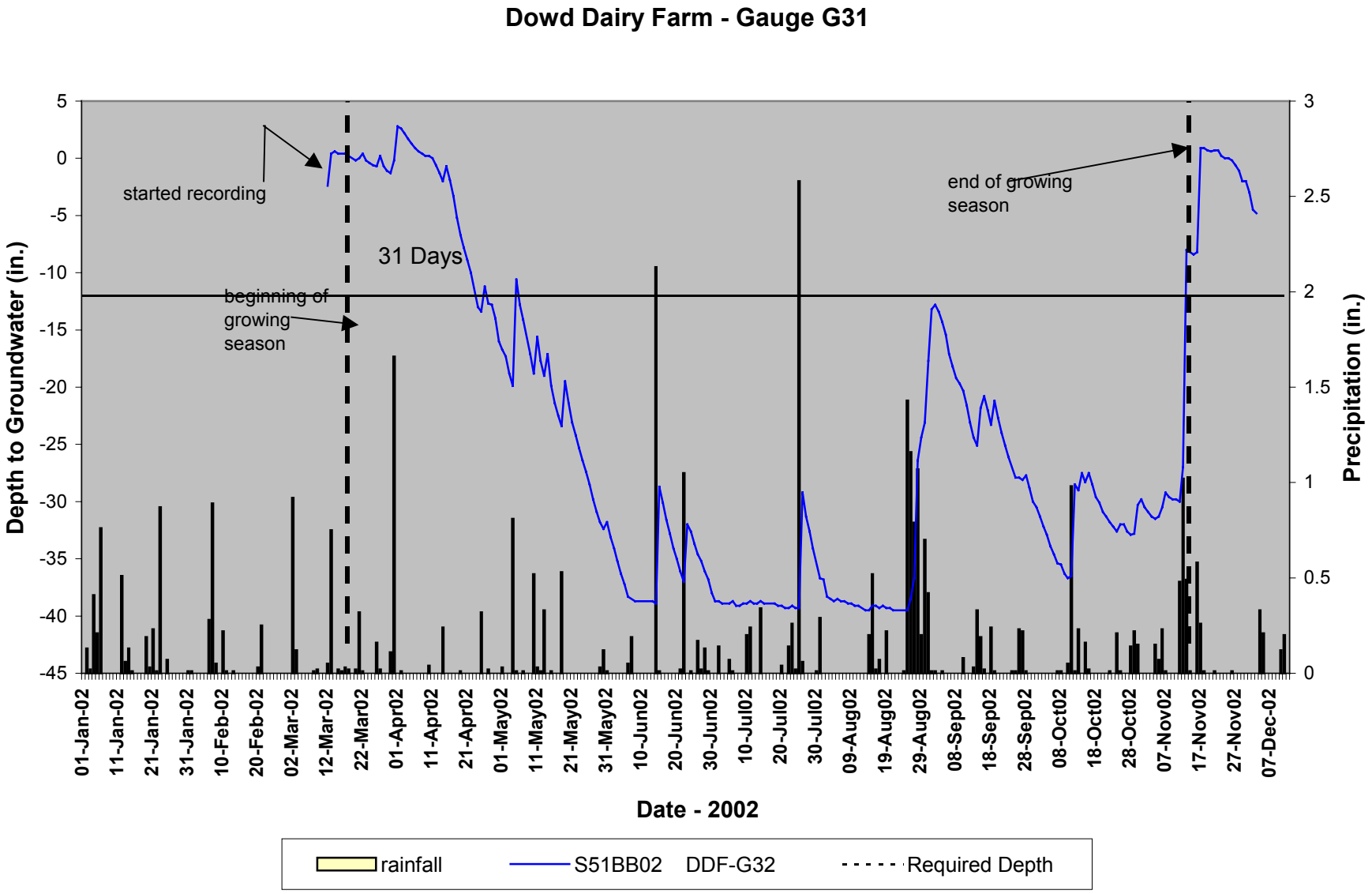

Dowd Dairy Farm - Gauge G26
Depth to Groundwater (in.)
Precipitation (in.)
Gauge Malfunction
62 Days
beginning of growing season
end of growing season
Date - 2002
Rainfall
S4489CC DDF-G26
Required Depth

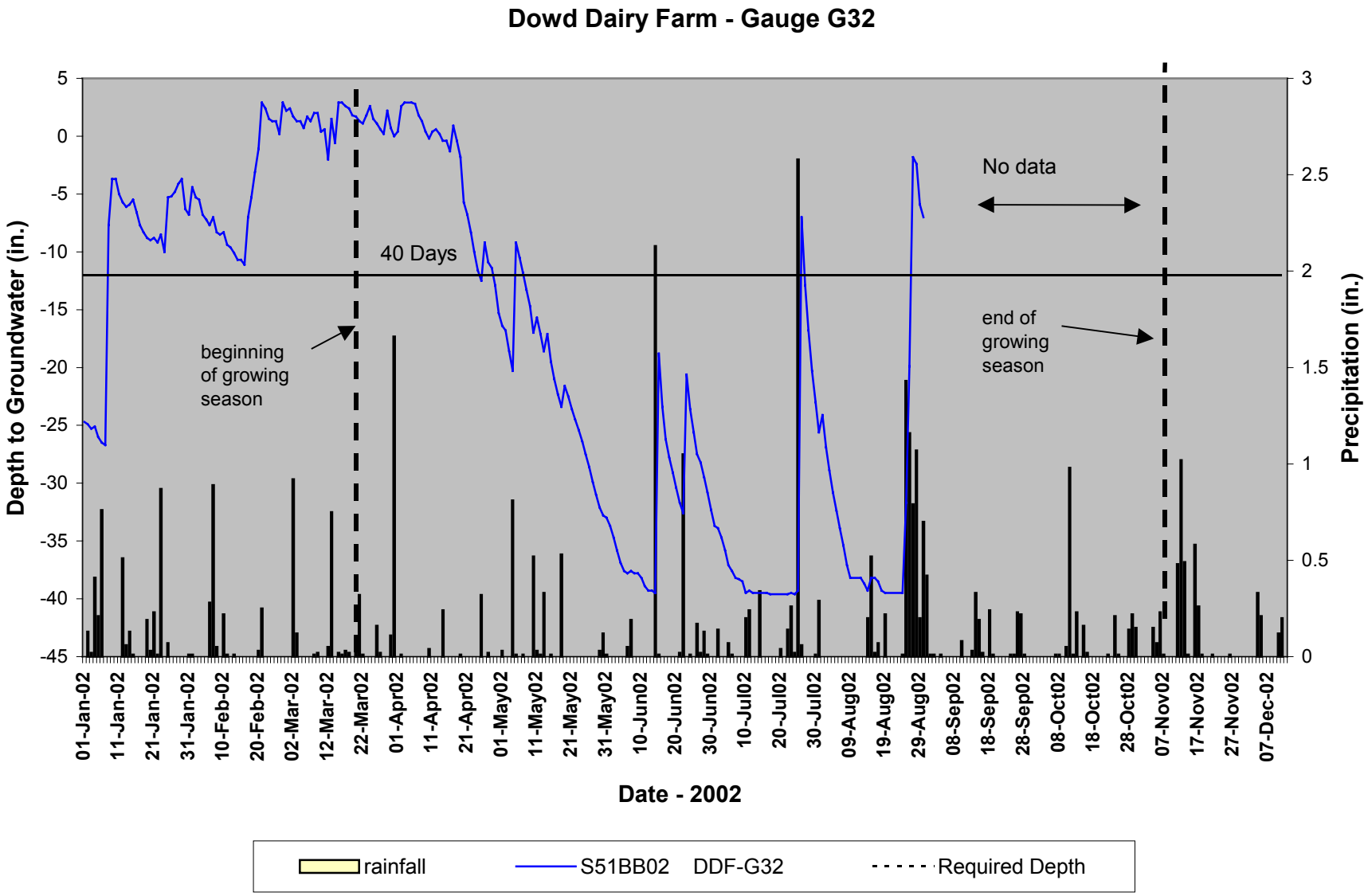

Dowd Dairy Farm - Gauge G27
Depth to Groundwater (in.)
Precipitation (in.)
Gauge Malfunction
48 Days
beginning of growing season
end of growing season
no data
Date - 2002
Rainfall
S4CDA24 DDF-G27
Required Depth

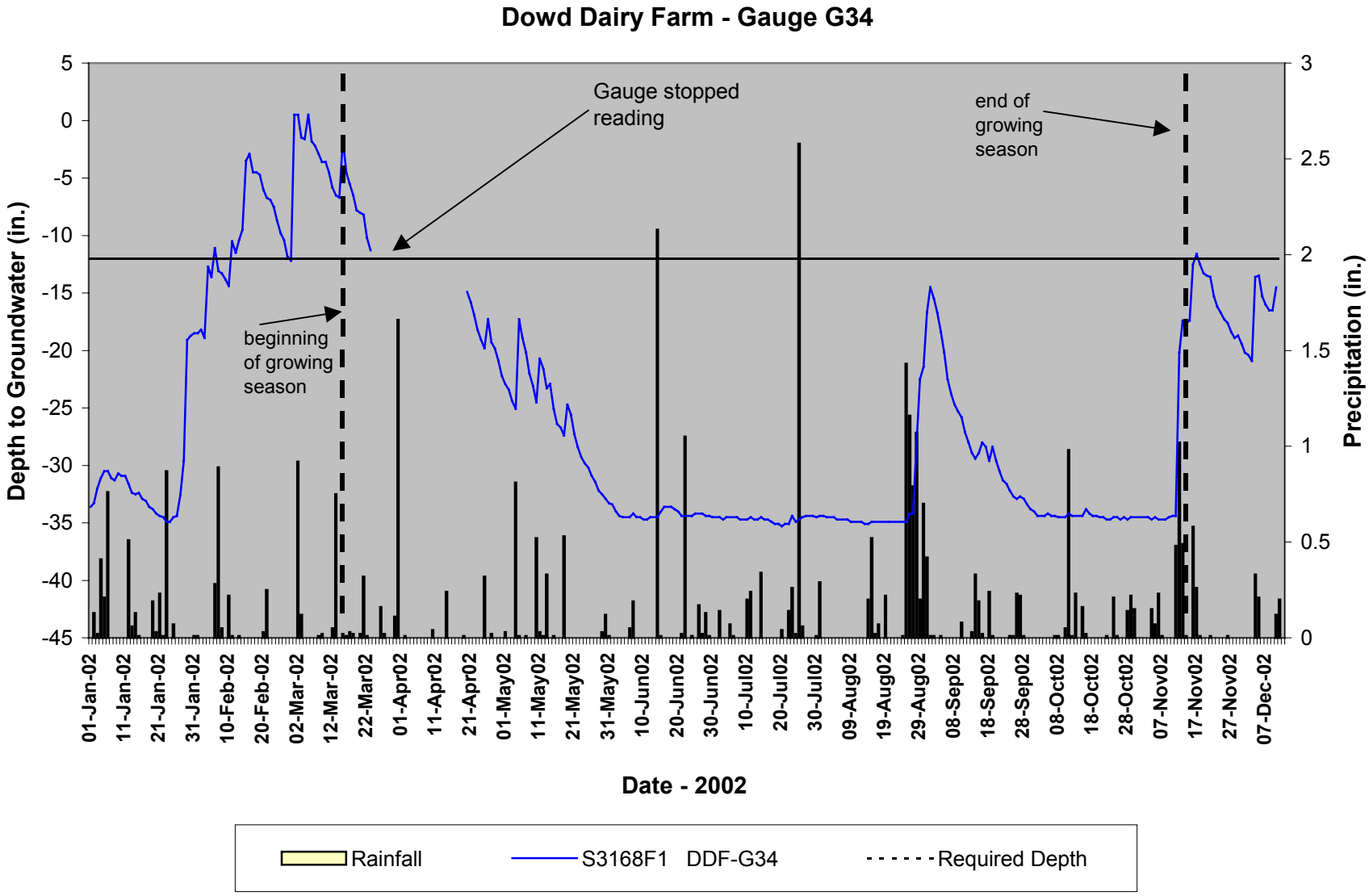

Dowd Dairy Farm - Gauge G28
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
stopped reading
41 Days
beginning of growing season
end of growing season
no data
Rainfall
S55F896 DDF-G28
Required Depth

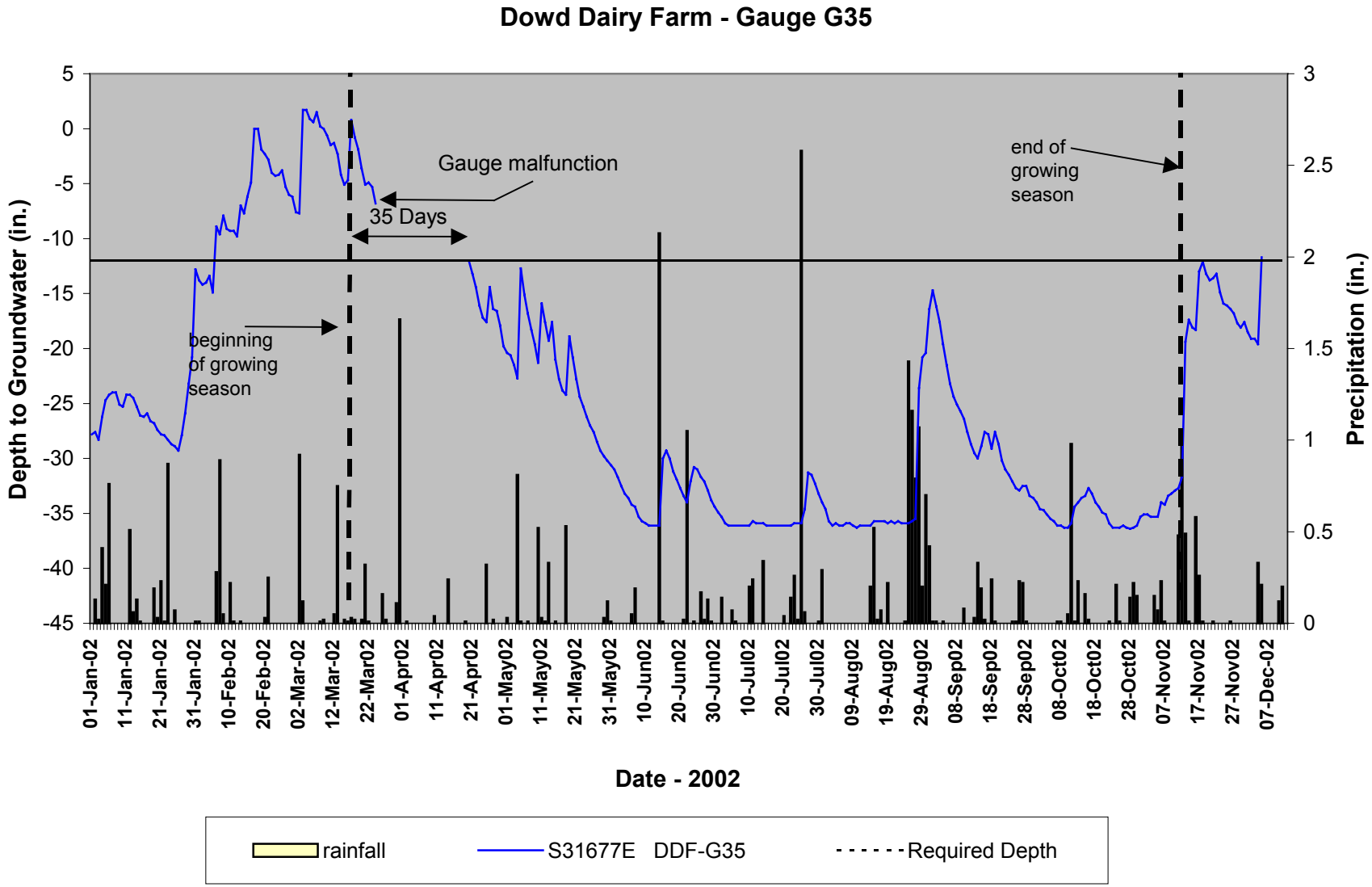

Dowd Dairy Farm - Gauge G29
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
69 Days
beginning of growing season
end of growing season
rainfall
S317403 DDF-G29
Required Depth

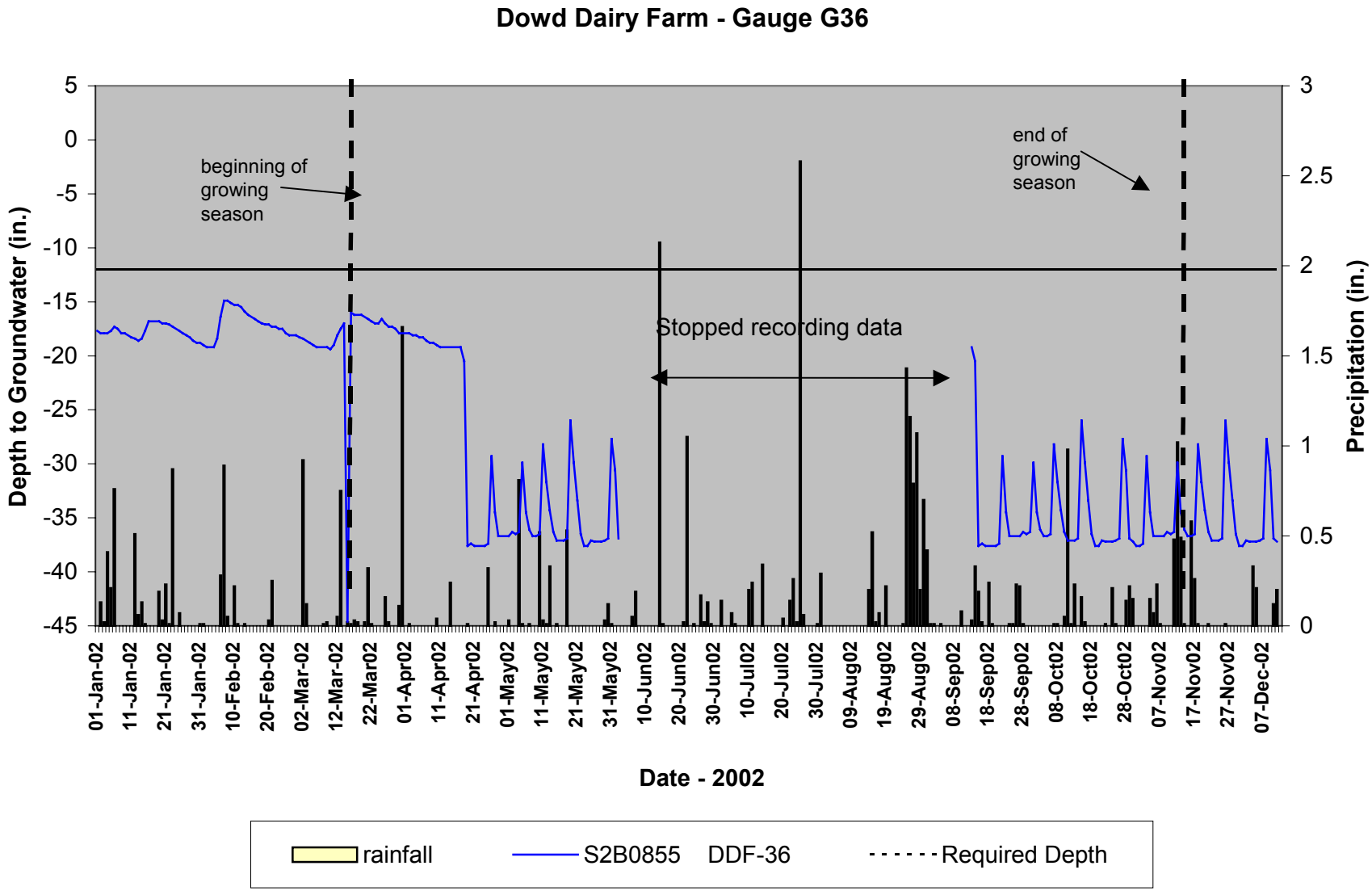

Dowd Dairy Farm - Gauge G30
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
62 Days
beginnng of growing season
end of growing season
no data
Stopped recocrding
rainfall
S51BFBB DDF-G30
Required Depth

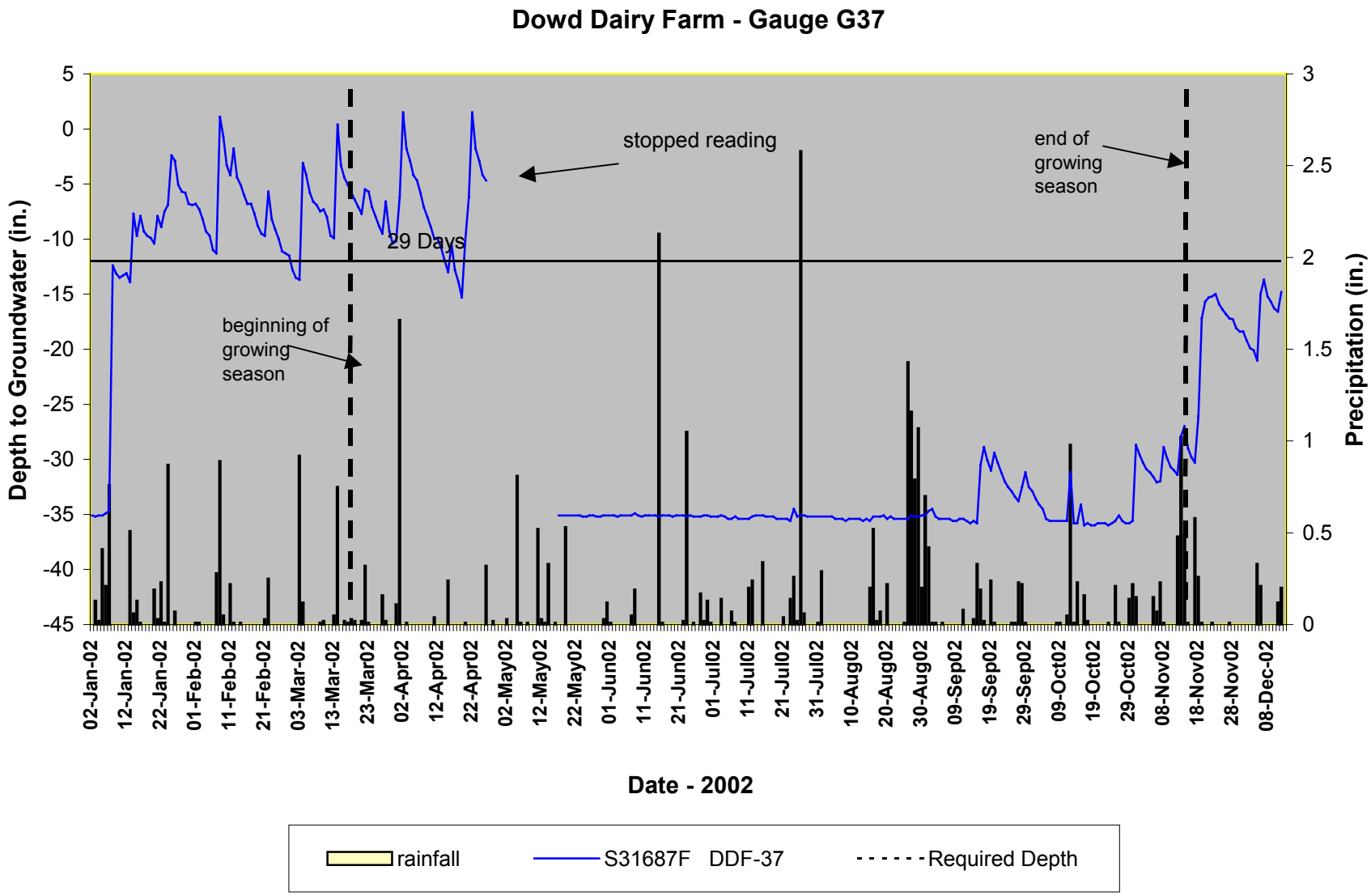

Dowd Dairy Farm - Gauge G31
started recording
31 Days
beginning of growing season
end of growing season
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
01-Jan-02
11-Jan-02
21-Jan-02
31-Jan-02
10-Feb-02
20-Feb-02
02-Mar-02
12-Mar-02
22-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
rainfall
S51BB02 DDF-G32
Required Depth

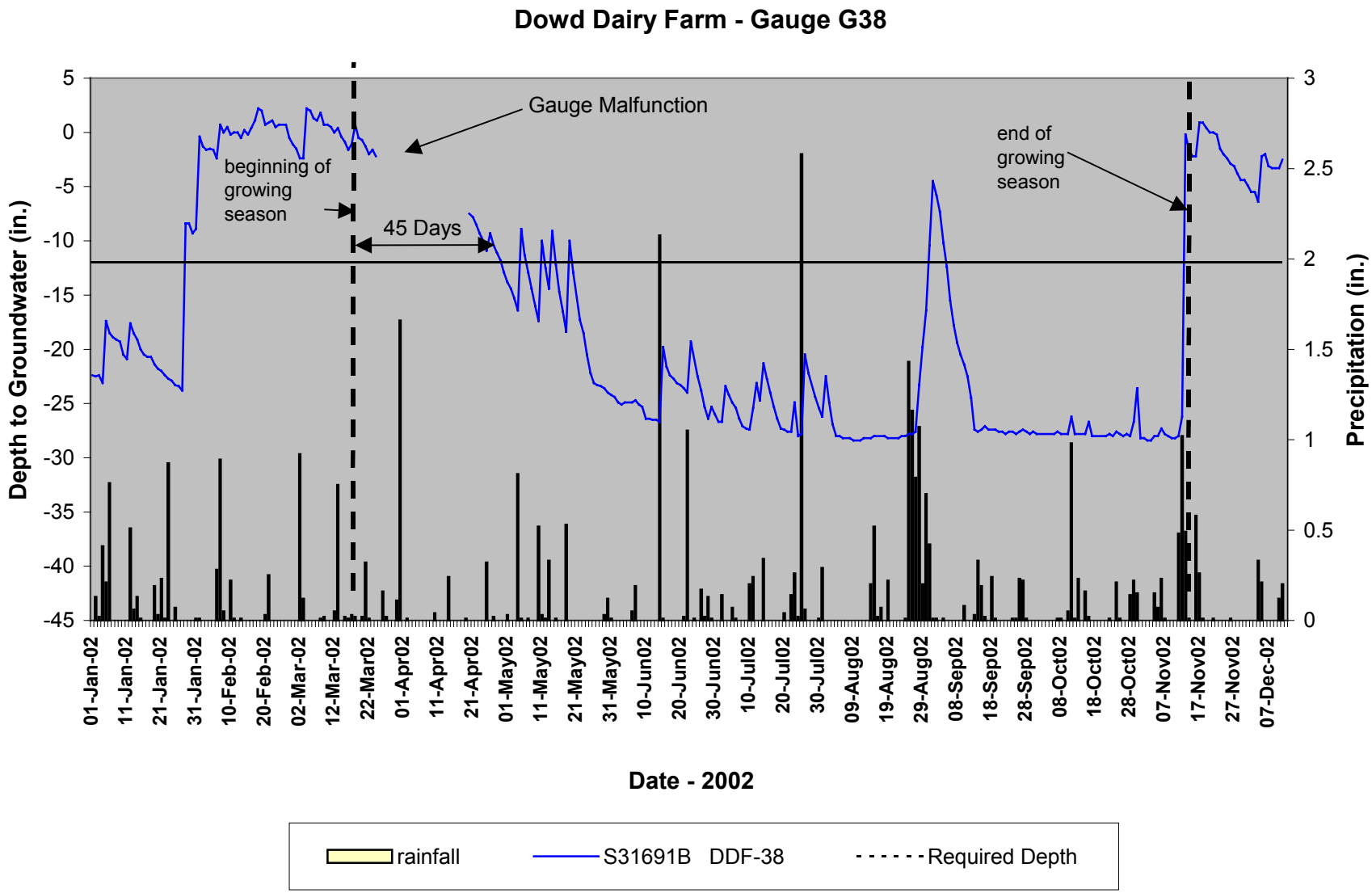

Dowd Dairy Farm - Gauge G32
Depth to Groundwater (in.)
Precipitation (in.)
Date - 2002
40 Days
No data
beginning of growing season
end of growing season
rainfall
S51BB02 DDF-G32
Required Depth


Dowd Dairy Farm - Gauge G34
Depth to Groundwater (in.)
Precipitation (in.)
Gauge stopped reading
end of growing season
beginning of growing season
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
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-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
Rainfall
S3168F1 DDF-G34
Required Depth


Dowd Dairy Farm - Gauge G35
Depth to Groundwater (in.)
Precipitation (in.)
Gauge malfunction
35 Days
beginning of growing season
end of growing season
Date - 2002
rainfall
S31677E DDF-G35
Required Depth


Dowd Dairy Farm - Gauge G36
Depth to Groundwater (in.)
Precipitation (in.)
beginning of growing season
end of growing season
Stopped recording data
Date - 2002
rainfall
S2B0855 DDF-36
Required Depth


Dowd Dairy Farm - Gauge G37
Depth to Groundwater (in.)
Precipitation (in.)
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
stopped reading
end of growing season
29 Days
beginning of growing season
02-Jan-02
12-Jan-02
22-Jan-02
01-Feb-02
11-Feb-02
21-Feb-02
03-Mar-02
13-Mar-02
23-Mar02
02-Apr02
12-Apr02
22-Apr02
02-May02
12-May02
22-May02
01-Jun02
11-Jun02
21-Jun02
01-Jul02
11-Jul02
21-Jul02
31-Jul02
10-Aug02
20-Aug02
30-Aug02
09-Sep02
19-Sep02
29-Sep02
09-Oct02
19-Oct02
29-Oct02
08-Nov02
18-Nov02
28-Nov02
08-Dec-02
Date - 2002
rainfall
S31687F DDF-37
Required Depth


Dowd Dairy Farm - Gauge G38
Depth to Groundwater (in.)
Precipitation (in.)
Gauge Malfunction
beginning of growing season
45 Days
end of growing season
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
3
2.5
2
1.5
1
0.5
0
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-Mar02
01-Apr02
11-Apr02
21-Apr02
01-May02
11-May02
21-May02
31-May02
10-Jun02
20-Jun02
30-Jun02
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-Dec-02
Date - 2002
rainfall
S31691B DDF-38
Required Depth

APPENDIX B

SITE PHOTOS
PHOTO AND VEGETATION PLOT LOCATIONS

DOWD DAIRY

Photo 1

Photo 2

Photo 3

Photo 4

2002

DOWD DAIRY

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

2002

DOWD DAIRY

Photo 11

Photo 12

Photo 13

Photo 14

2002

PROJECT REFERENCE NO.	SHEET NO.
R-2204W	MAP-1
R/W SHEET NO.	
ROADWAY DESIGN ENGINEER	HYDRAULICS ENGINEER

BLADEN COUNTY, NORTH CAROLINA
DOWD DAIRY FARM MONITORING

PLANTING ZONES, VEGETATION PLOT, AND PHOTO LOCATIONS