# Powell Property Wetland and Stream Mitigation Project
**Bertie County, NC**

**2010 Annual Monitoring Report**
**Year 2**

**NCEEP Project Number D06065-B**
**Chowan River Basin**
**USGS Catalog Unit 03010203**

Submitted to
NCDENR/Ecosystem Enhancement Program
2728 Capital Blvd.
Raleigh, NC 27604

Date: August, 2010

Monitoring:
**Albemarle Restorations, LLC**
P. O. Box 176
Fairfield, NC 27826

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## Executive Summary

The Powell Property Wetland and Stream Mitigation Site is a headwater riverine wetland and stream mitigation project located southeast of Powellsville, in Bertie County, North Carolina. It was constructed by Albemarle Restorations, LLC, under contract with EEP to provide 48.4 acres of riverine wetland mitigation credits and 3,310 linear feet of stream mitigation credits in the Chowan River Basin. Construction activities, in accordance with the approved restoration plan, began in June of 2008, and were completed in January of 2009. Tree and shrub planting on the project site occurred immediately afterward in January of 2009. An emergent wetland seed mixture was sown shortly afterward.

Ten water level monitoring gauges are located at varying elevations throughout the riverine wetland and stream valley areas of the site to measure surface and subsurface water elevations. Two additional gauges are located in the headwater stream reference area to help monitor flow and water level within the reference stream system. Of the ten gauges deployed across the project site, eight indicated successful wetland hydrology by showing water levels within 12 inches of the ground surface for a minimum of 5% of the growing season. The two gauges that did not show successful hydrology were both located in the riverine wetland areas of the project. Through July 31 there was a cumulative rainfall deficit of .75 inches, though it was sporadic in nature with April being an unusually dry month. It is anticipated that wetland hydrology will continue to equilibrate as soil structure develops and precipitation patterns normalize. Two separate flow events are documented during the first half of the 2010 growing season.

A total of ten vegetation monitoring plots are located on the site, seven in the riverine wetland areas and three more situated to monitor the swamp run vegetation. One plot is entirely within the boundaries of the swamp run and two more are located so as to share both land forms, making a total of ten plots. Each plot is a 10m X 10m square, as recommended by the CVS-EEP protocol for recording vegetation sampling. All ten plots met the third year survival success criterion which is a minimum of 320 stems per acre.

Table ES-1 shows the levels of success attained by each of the water level monitoring gauges and the vegetation plots. The success criterion for hydrology is maintained groundwater levels within 12 inches of the soil surface for 5% to 8% of the growing season (12 to 19 consecutive days). Table C-1 in Appendix C has a detailed breakdown of hydrologic success. The success criterion for the vegetation plots at this point in monitoring is the third year level of survival (320 stems per acre).

**Table ES-1. Project Success Summary**

| Success | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Percent Success |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year 1 | Gauges | Y | Y | Y | N | Y | N | N | Y | Y | Y | 70% |
| | Veg. Plots | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | 100% |
| Year 2 | Gauges | Y | Y | Y | Y | Y | N | N | Y | Y | Y | 80% |
| | Veg. Plots | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | 100% |

# I. Project Background

## 1.0 Project Objectives

The goal of the Powell Property Mitigation Project was to create a riverine wetland system typically found in the middle to upper reaches of first or zero order tributary systems. The project is to serve as compensation for wetland loss in the Chowan River Basin. The restoration plan was developed and implemented to eliminate pattern drainage and restore topography and hydrology that more closely resembled that of similar undisturbed land. Construction resulted in the development of a broad, branched, frequently flooded swamp run following a historical path as evidenced by archived aerial photographs and signature topography. Subsequent planting was designed to restore a wetland forest ecosystem that is typically found in the immediate area characteristic of similar soils, topography and hydrology.

Ecological benefits of the restored riparian headwater system and its associated riverine wetlands are the following:

1. Water quality improvements, including nutrient, toxicant and sediment retention and reduction, increasing dissolved oxygen levels, as well as reducing excessive algae growth, and reducing surface water temperatures in receiving waters by providing permanent shading in the form of a shrub/scrub and forested headwater wetland system.
2. Wildlife habitat enhancement by adding to the existing adjacent forested areas creating a continuous travel corridor between habitat blocks and providing a wide range of habitat areas (open water, emergent, shrub/scrub and forested) for amphibians, reptiles, birds, insects and mammals.
3. Flood flow attenuation during storm events which reduces sedimentation and erosion downstream, and improves long term water quality within the Chowan River.
4. Passive outdoor recreation and educational opportunities for the landowner and the surrounding community.

## 2.0 Project Structure, Restoration Type, and Approach

Table I lists the estimated wetland acreage to be restored on the Powell Property. The mitigation plan provides for the restoration of 48.4 acres of riverine wetlands and 3,310 linear feet of stream (swamp run) restoration. Prior to construction, the easement area was used entirely for row crop agriculture, primarily soy beans, corn, cotton and tobacco. The agricultural fields were drained by several ditches that traversed the site and one main drainage ditch that emptied into Quioccosin Swamp. Construction was done in accordance with the approved restoration plan and completed in January of 2009. Native tree and shrub species were planted in January of 2009 and the resulting riverine system is designed to emulate natural swamp run systems found within the Chowan River Basin.

| Table I. Project Restoration Components<br>Powell Wetland and Stream Mitigation Site/EEP #D06065-B | | | | |
|---|---|---|---|---|
| **Restoration Type** | **Pre-Existing Acres/Linear Feet** | **Post Construction Acres/ Linear Feet** | **Credit Ratio (Restoration : WMU)** | **Total WMU's/SMU's** |
| Riverine Wetland | 0.0 acres | 48.4 acres | 1:1 | 48.4 WMUs |
| Stream (Swamp Run) | 0.0 linear feet | 3,310 linear feet | 1:1 | 3,310 SMUs |

## 3.0 Location and Setting

The Powell Property Mitigation Site is located in Bertie County, just north of Buzzard's Crossroads on Meadow Road (approximately 4.6 miles southeast of Powellsville). The easement area is situated on the eastern portion of the Powell farm and adds contiguous swamp run and forested wetlands to Quioccosin Swamp which flows to the Wiccacon River, a tributary of the Chowan River. The surrounding area is primarily forest and agricultural land with residential properties as a minor component.

Figure 1 is a location map for the project site. Directions to the site are as follows: from Powellsville (Hwy. 42), travel south on Sally Freeman Rd., turn left on Dilday Rd., right on Luther Brown Rd., then right on Meadow Rd. Access to the site is approximately 2 miles from this intersection, on the right.


VICINITY MAP

Scale: 1" = 4000' | 4/2008 | Drawn By: LMS

PREPARED FOR:

ALBEMARLE RESTORATIONS, LLC

WETLAND RESTORATION,
STREAM RESTORATION,
& WILDLIFE HABITAT CREATION

494 COURT STREET • GATESVILLE, NC 27938
(252) 333-9248 • FAX (252) 357-4892

SCALE

0 4,000' 8,000'

POWELL PROPERTY

RIVERINE WETLAND RESTORATION
48.4 ACRES (48.4 WMU'S)

STREAM RESTORATION
3,310 LINEAR FEET (3,310 SMU'S)

BERTIE COUNTY, NORTH CAROLINA
CONTRACT # 16-006065-B

## 4.0 Project History and Background

Table II provides the history of data collection and actual completion of various milestones of the Powell Property Wetland Mitigation Site.

| Table II. Project Activity and Reporting History<br>Powell Wetland and Stream Mitigation Project/EEP #D06065-B | | |
|---|---|---|
| **Activity or Report** | **Data Collection Complete** | **Actual Completion or Delivery** |
| Restoration Plan | January 2008 | May 2008 |
| Final Design -90% | January 2008 | May 2008 |
| Construction | N/A | January 2009 |
| Temporary S & E mix applied to entire project area | N/A | January 2009 |
| Permanent seed mix applied to entire project area | N/A | January 2009 |
| Containerized and Bare Root Planting | N/A | January 2009 |
| Mitigation Plan/As-built | April 2009 | June 2009 |
| Year 1 monitoring | September 2009 | March 2010 |
| Year 2 monitoring | August 2010 | August 2010 |
| Year 3 monitoring | | |
| Year 4 monitoring | | |
| Year 5 monitoring | | |

Points of contact for the various phases of the Powell Project are provided in Table III.

| Table III. Project Contacts<br>Powell Wetland and Stream Mitigation Site/EEP #D06065-B | |
|---|---|
| **Designer**<br>Primary Project design POC | Ecotone, Inc. (Scott McGill 410-692-7500)<br>1204 Baldwin Mill Road<br>Jarrettsville, MD 21804 |
| **Construction Contractor**<br>Construction contractor POC | Armstrong, Inc. (Tink Armstrong 252-943-2082)<br>P. O. Box 96<br>25852 US Hwy 64<br>Pantego, NC 27860 |
| **Planting Contractor**<br>Planting contractor POC | Carolina Silvics, Inc.<br>908 Indian Trail Road<br>Edenton, NC 27932<br>Mary-Margaret McKinney (252-482-8491) |
| **Seeding Contractor**<br>Seed planting contractor POC | Armstrong, Inc. (Tink Armstrong 252-943-2082)<br>P. O. Box 96<br>25852 US Hwy 64<br>Pantego, NC 27860 |
| Seed mix sources | Ernst Conservation Seeds, LLP, Meadville, PA |
| Nursery stock suppliers | Arborgen, Blenheim, SC, Native Roots, Clinton, NC |
| **Monitoring Performers**<br>Wetland and Vegetation POC | Woods, Water and Wildlife, Inc. (Ashby Brown 757-651-3162)<br>P. O. Box 176<br>Fairfield, NC 27826 |

Project background information for the Powell project is provided in Table IV.

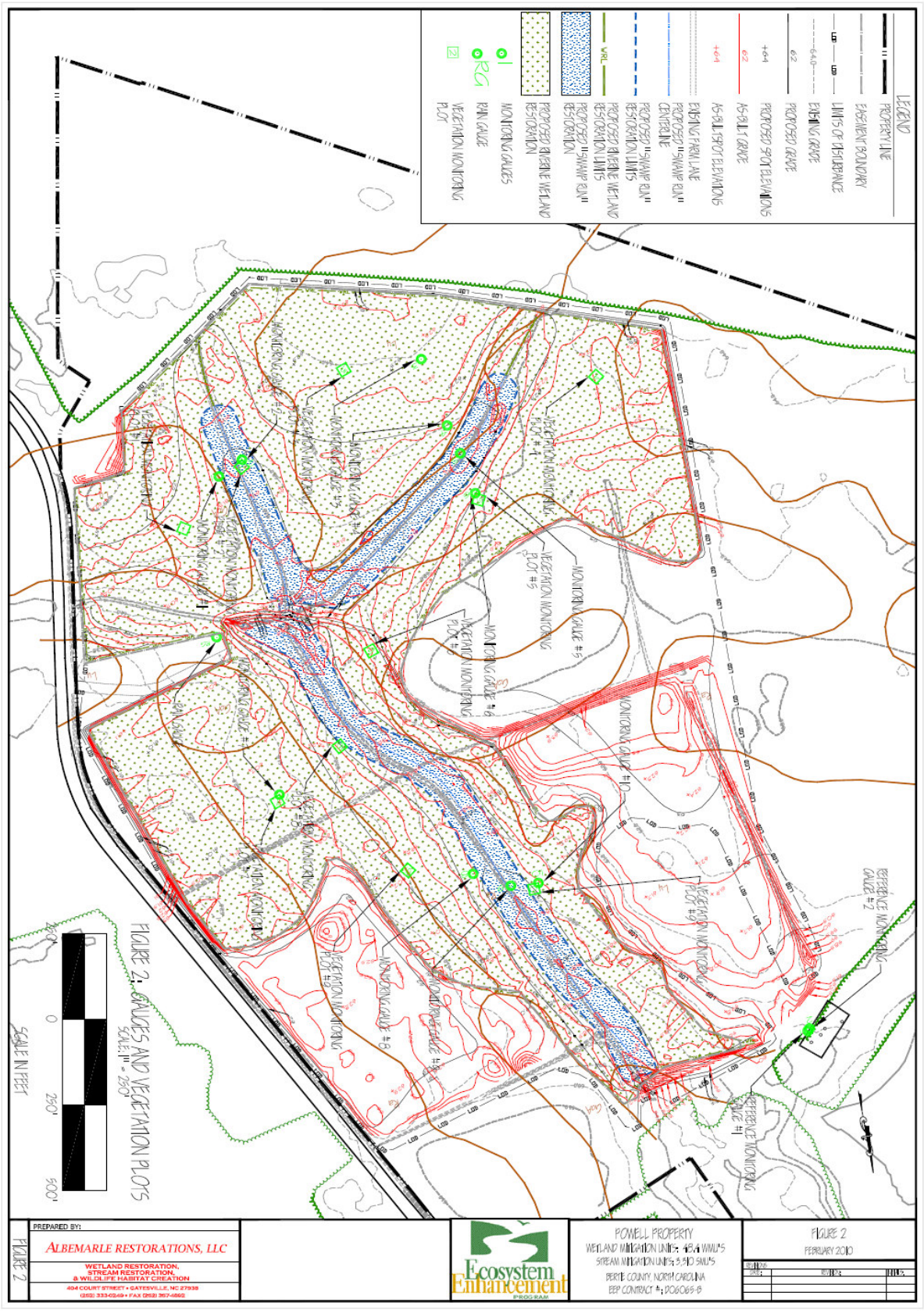
| Table IV. Project Background<br>Powell Wetland and Stream Mitigation Site/EEP #D06065-B | |
|---|---|
| Project County | Bertie County |
| Drainage Area | Approximately 871 Acres |
| Drainage impervious cover estimate (%) | 0 |
| Physiographic Region | Coastal Plain |
| Ecoregion | 8.3.5 Southeastern Plains |
| Rosgen Classification of As-built | N/A |
| Cowardin Classification | PSS, PFO |
| Dominant Soil Types | Goldsboro, Lynchburg |
| Reference site ID | Quioccosin Swamp |
| USGS HUC for Project and Reference | 03010203 |
| NCDWQ Sub-basin for Project and Reference | 03-01-01 |
| NCDWQ classification for Project and Reference | C |
| Any portion of any project segment 303d listed? | No |
| Any portion of any project segment upstream of a 303d listed segment? | Yes, Wiccacon River |
| Reasons for 303d listing or stressor? | Non-Point Source |
| % of project easement fenced | None |

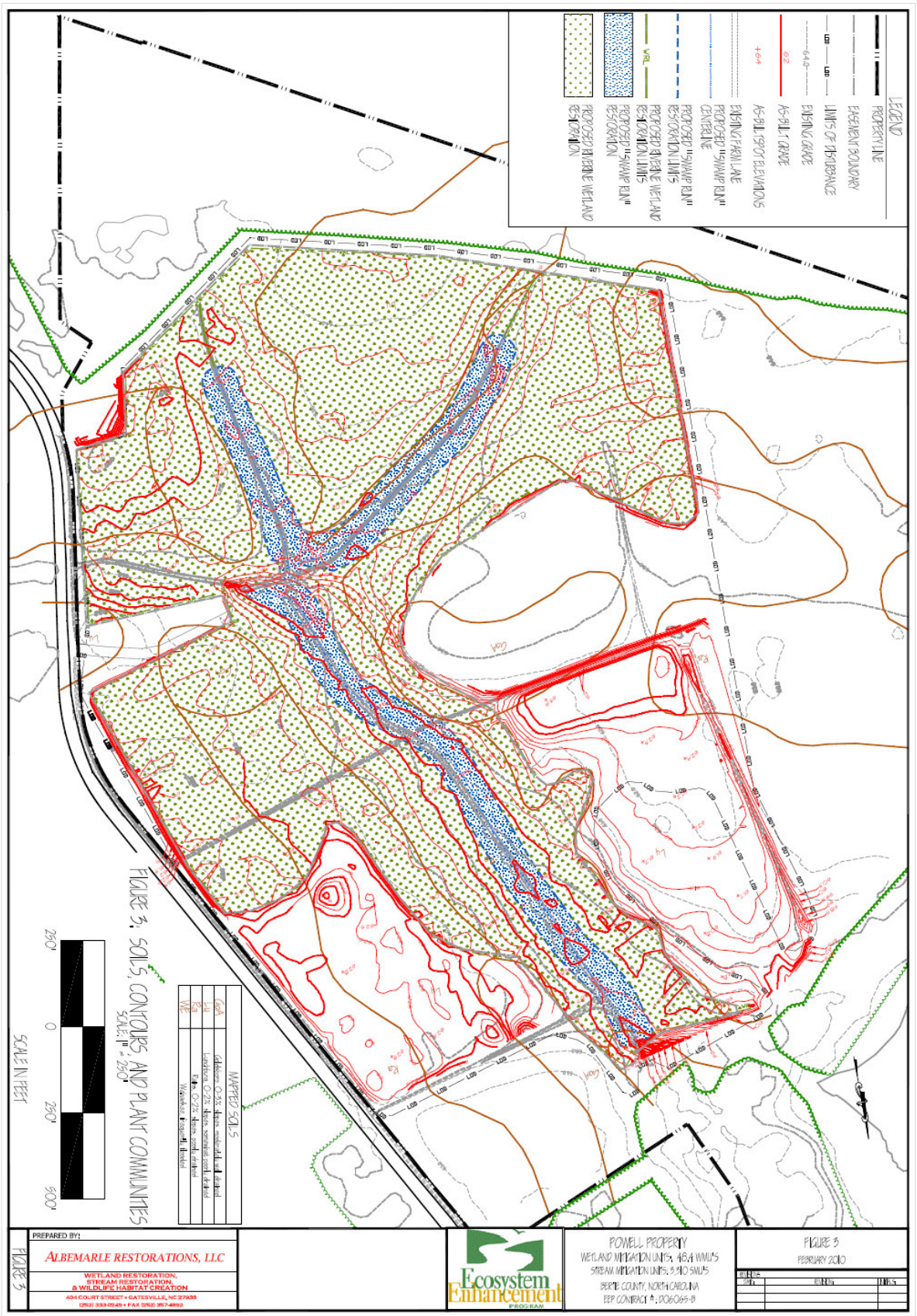
## 5.0 Monitoring Plan View

A total of ten water level monitoring gauges are installed across the site. These gauges are suspended in two-inch pvc pipe that is set from two to four feet vertically in the ground. The gauges have been located to assess the groundwater levels throughout the year at various elevations and topographies within the site. Two more gauges are installed in an offsite riverine wetland area to serve as references for a naturally functioning riverine wetland and headwater swamp run. In addition, there is a rain gauge onsite to capture and record precipitation.

Vegetation monitoring is accomplished by surveying the ten permanent sampling plots. The plots are ten meters square and are situated to give an accurate sample of the planted and natural woody vegetation in both the riverine and swamp run communities. For each site, the data recorded matches that required of the *CVS-EEP Protocol for Recording Vegetation, v 4.0, 2006,* level 1-2.

Figures 2 and 3 provide plan views of the site showing the location of all monitoring features including gauges, sampling plots and the rain gauge as well as the vegetative communities.


LEGEND
PROPERTY LINE
EASEMENT BOUNDARY
LIMITS OF DISTURBANCE
EXISTING GRADE
PROPOSED GRADE
PROPOSED SPOT ELEVATIONS
AS-BUILT GRADE
AS-BUILT SPOT ELEVATIONS
EXISTING FARM LANE
PROPOSED "SWAMP RUN" CENTERLINE
PROPOSED "SWAMP RUN" RESTORATION LIMITS
PROPOSED RIPARIAN WETLAND RESTORATION LIMITS
PROPOSED "SWAMP RUN" RESTORATION
PROPOSED RIPARIAN WETLAND RESTORATION
MONITORING GAUGES
RAIN GAUGE
VEGETATION MONITORING PLOT
MONITORING GAUGE #1
MONITORING GAUGE #2
MONITORING GAUGE #3
MONITORING GAUGE #4
MONITORING GAUGE #5
MONITORING GAUGE #6
MONITORING GAUGE #7
MONITORING GAUGE #8
VEGETATION MONITORING PLOT #1
VEGETATION MONITORING PLOT #2
VEGETATION MONITORING PLOT #3
VEGETATION MONITORING PLOT #4
VEGETATION MONITORING PLOT #5
REFERENCE MONITORING GAUGE #1
REFERENCE MONITORING GAUGE #2
FIGURE 2: GAUGES AND VEGETATION PLOTS
SCALE 1" = 250'
SCALE IN FEET
0
250'
500'
PREPARED BY:
ALBEMARLE RESTORATIONS, LLC
WETLAND RESTORATION, STREAM RESTORATION, & WILDLIFE HABITAT CREATION
404 COURT STREET • GATESVILLE, NC 27938
(252) 333-0249 • FAX (252) 357-1662
Ecosystem Enhancement PROGRAM
POWELL PROPERTY
WETLAND MITIGATION UNITS: 18.6 WMU'S
STREAM MITIGATION UNITS: 3,310 SMU'S
BERTIE COUNTY, NORTH CAROLINA
EEP CONTRACT #: 003069-8
FIGURE 2
FEBRUARY 2010
FIGURE 2


LEGEND
PROPERTY LINE
EASEMENT BOUNDARY
LIMITS OF DISTURBANCE
EXISTING GRADE
AS-BUILT GRADE
AS-BUILT SPOT ELEVATIONS
EXISTING FARM LANE
PROPOSED "HSWAMP RUN" CENTERLINE
PROPOSED "HSWAMP RUN" RESTORATION LIMITS
PROPOSED RIVERINE WETLAND RESTORATION LIMITS
PROPOSED "HSWAMP RUN" RESTORATION
PROPOSED RIVERINE WETLAND RESTORATION
MAPPED SOILS
FIGURE 3. SOILS, CONTOURS AND PLANT COMMUNITIES
SCALE: 1" = 250'
SCALE IN FEET
250' 0 250' 500'
PREPARED BY:
ALBEMARLE RESTORATIONS, LLC
WETLAND RESTORATION, STREAM RESTORATION, & WILDLIFE HABITAT CREATION
404 COURT STREET • GATESVILLE, NC 27938
(252) 339-0249 • FAX (252) 357-4892
Ecosystem Enhancement PROGRAM
POWELL PROPERTY
WETLAND MITIGATION UNITS: 46.4 WMU'S
STREAM MITIGATION UNITS: 3,910 SMUS
BERTIE COUNTY, NORTH CAROLINA
EEP CONTRACT #: D06065-B
FIGURE 3
FEBRUARY 2010

## II. Project Condition and Monitoring Results

### 1.0 Vegetation Assessment

The vegetation success criterion was developed in accordance with the CVS-EEP protocol. The Powell project was designed to include both riverine and bottomland hardwood plant communities. The project was planted with a mixture of tree and shrub species that would resemble that of naturally occurring swamp runs and adjacent riverine wetlands in the local area. The run and area immediately adjacent were planted heavily with cypress, willow and tupelo. The riverine wetland zone beyond the swamp run is populated by a broader mix of native hydrophytic tree and shrub species. The species mix was based on the vegetation noted at the reference site and all species are classified from FAC to OBL (Table V). The site was planted at a rate of 600 stems per acre in January of 2009.

**Table V. Species by Community Type**
**Powell Wetland and Stream Mitigation Project/EEP #D06065-B**
**Total Forested Wetland 55.9 Acres**

| Common Name | Scientific Name | Wetland Indicator Status |
|---|---|---|
| **Trees** | | |
| Bald Cypress | Taxodium distichum | OBL |
| Water tupelo | Nyssa aquatica | OBL |
| Swamp Black Gum | Nyssa biflora | FAC |
| Willow Oak | Quercus phellos | FACW- |
| Swamp White Oak | Quercus bicolor | FACW+ |
| Pin Oak | Quercus palustris | FACW |
| Water Oak | Quercus nigra | FAC |
| Swamp Chestnut Oak | Quercus michauxii | FACW- |
| **Shrubs** | | |
| Staggerbush | Lyonia mariana | FAC |
| Tag Alder | Alnus serrulata | FACW+ |
| Highbush Blueberry | Vaccinium corymbosum | FACW |
| Sweet Pepperbush | Clethra alnifolia | FACW |
| Virginia Sweetspire | Itea virginica | FACW+ |
| Button Bush | Cephalanthus occidentalis | OBL |
| Swamp Bay | Persea palustris | FACW |
| Inkberry | Ilex glabra | FACW |
| Wax Myrtle | Myrica cerifera | FAC+ |
| Black Willow | Salix nigra | OBL |
| Sweetbay Magnolia | Magnolia virginiana | FACW+ |

### 1.1 Vegetation Discussion and Problem Areas

All ten plots met the Year 3 success criterion of a minimum of 320 stems per acre. Over the entire project, the survival rate averaged 429 live stems per acre. Mortality between 2009 and 2010 was light; most of the lost stems appeared to be those that were so weak in 2009 as to be unidentifiable. Survival continues to be more than adequate to ensure a well stocked, diverse community and the overall growth rate and health of the stand is good.

## 2.0 Wetland Assessment

The hydrologic success criterion for any gauge is to achieve a minimum of 12 to 19 consecutive days where the groundwater level is within 12 inches of the soil surface during the growing season. This represents 5% to 8% of the growing season which for this site runs from March 22 to November 8, a period of 231 days (WETS Table for Lewiston, NC).

Three of the ten monitoring gauges deployed across the site are located at or near the center of the swamp runs in order to assist with documenting flow (gauges 2, 5 and 9). The other seven gauges are installed in the riverine portion of the project, some in a perpendicular pattern to the swamp runs to assist in documenting flow and to assess hydrology in the riverine wetlands. A rain gauge is also kept onsite and its data are compared to that collected at the NOAA cooperator sites in Murfreesboro and Lewiston, NC. To further monitor the affect of seasonal and annual variations in precipitation in restored wetlands, hydrologic success of the site was assessed in relation to the reference wetland site where two more monitoring gauges are installed (gauge 11 as a riverine wetland reference and & gauge 12 as a swamp run reference).

### 2.1 Wetland Discussion and Problem Areas

Rainfall from late March through July was close to normal in 2010, but episodic in nature with extended periods of rainfall drought in the interim. Rainfall during the month of April, which is a critical month for hydrology success, totaled only .97 inches, well below the long-term average of 3 inches. Despite that deficit, and as a result of ample rainfall in March, five of the riverine wetland gauges met hydrologic success as did the three located in the swamp runs. Two of the gauges in the riverine wetlands failed to meet hydrologic success at 5% of the growing season (12 days). While rainfall in May was 1.59 inches above normal, a cumulative deficit for the months of June and July of 5.4 inches will make recharge of groundwater levels slow unless autumn precipitation is above normal.

Wetland hydrology should continue to develop across the site as the soils are able to equilibrate and build structure but the areas surrounding Gauges 6 and 7 in the riverine wetlands continue to be a source of concern. Soil compaction is believed to be the cause of poor hydrology in these spots so subsoiling is scheduled to be done in late summer of 2010. The areas will be replanted in early 2011 and additional monitoring gauges will be installed to help pinpoint any remaining problem areas.

The three gauges located within the swamp runs showed successful hydrology in 2010 as would be expected considering early season rainfall amounts. Gauges 2, 5 and 9 are set in the swamp runs as is Reference Gauge 11. All show similar patterns of prolonged above-ground water levels after a period of heavy rainfall in March, followed by gradual runoff.

## 2.15 Flow

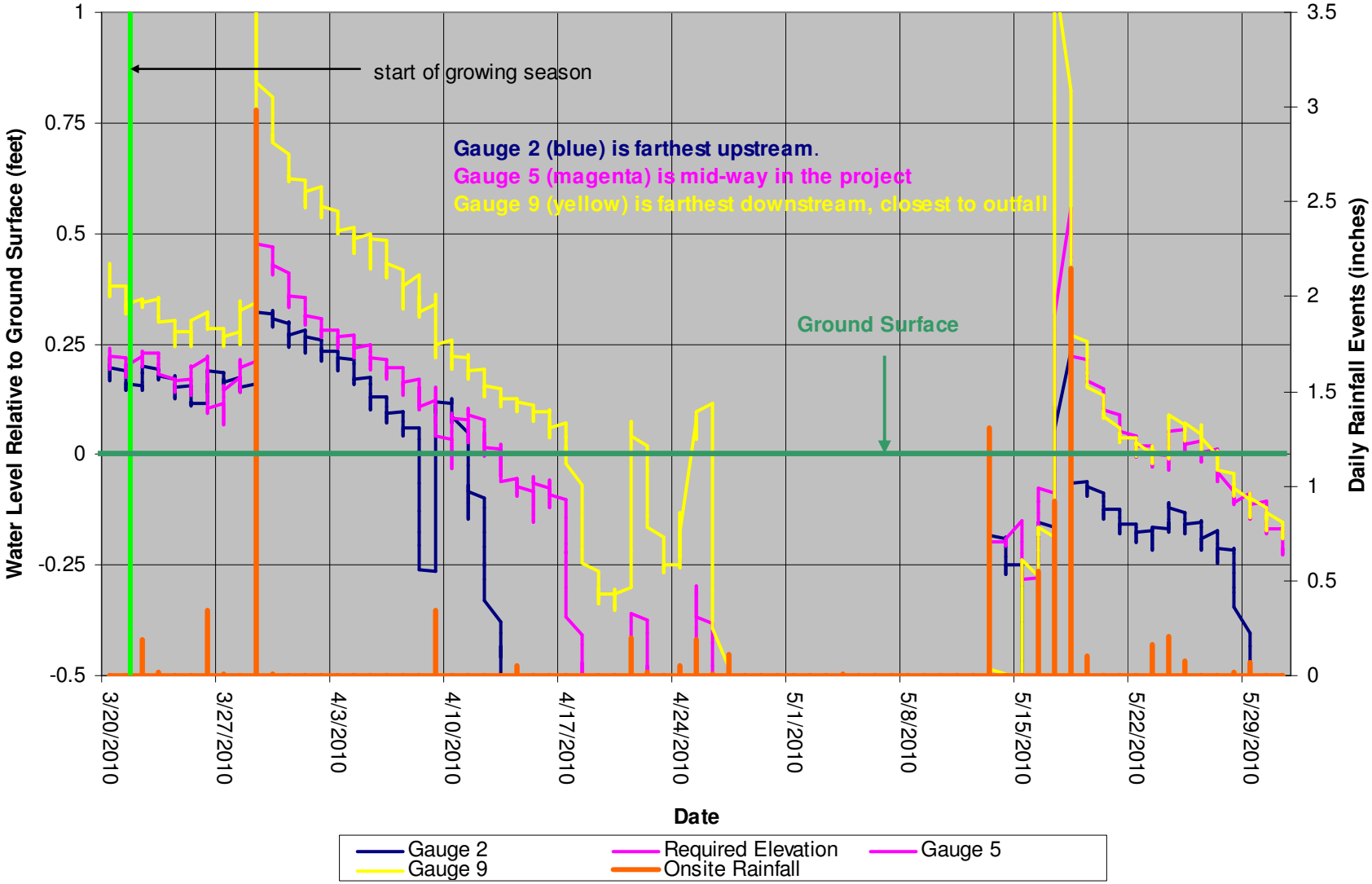
Refer to Figure F1 which is a composite chart for gauges 2, 5 & 9, for the following discussion of evidence of flow within the swamp runs. Figure F1 is a composite chart showing a brief period of flow as a result of a single rainfall event in late March that produced nearly three inches of rain. As a result of this single heavy rain event, the water levels at Gauges 2, 5 and 9 immediately rose to .46 ft, .62 ft. and 1.2 ft. (respectively) above the ground surface. Given their positions in the landscape, Gauge 2 being farthest upstream will naturally show the fastest drainage. The water level surrounding this gauge drops from its high point of .46 feet back to ground surface in a matter of eleven days. Conversely, Gauge 9, being in the position farthest downstream and closest to the outfall end, will naturally collect the greatest amount of water in a any rainfall event and will be the slowest to drain, having to endure the total of the upstream flow. At its peak height on March 29, the water level at Gauge 9 was 1.2 feet above the ground surface and required twenty days to return to ground level. Gauge 5 measured a peak water level of .62 feet which required thirteen days to return to ground level. The data from these three gauges, taken in their entirety, show perfect evidence of water flowing through the project site.

By comparison, Reference Gauge 11, which is in the center of the reference swamp run, showed water levels above ground for a total of 31 days after the rainfall on March 29. Since this gauge is situated in a channelized run (and consequently set below the surrounding ground level), it will require a longer period to indicate complete drainage, yet offers a sound comparison to the behavior of Gauge 9.

Another, less impressive flow event occurred in mid-May after a series of smaller rainfall events. During the period from May 13 to May 19, a total of 5.03 inches of rain fell onsite, but coming on the heels of a particularly droughty period in April and early May, this precipitation produced only minor flow through the site. Total rainfall for the month of April was a mere .97 inches. Consequently, the groundwater levels had to be recharged before any flow could occur thus limiting the duration of flow.

It must also be noted that flow begins at the very upper reaches of the project site particularly when rainfall is heavy or frequent enough to cause drainage from the upstream watershed onto the project. Video and visual documentation during the winter of 2009-2010 show excellent diffuse flow at the upper boundary of the site where drainage water enters the site. The water quickly disperses and floods the upper reaches of the project as evidenced by the data shown in the charts for Gauges 1 through 4 which are located across the upstream portion of the project. As a result, the Powell project serves as a fully functioning connector in the Quioccosin Swamp watershed.

**Figure F1.**
**Monitoring Gauges 2, 5 & 9**
**Indicating Flow in April and May**



## 2.2 Wetland Monitoring Plan View (Integrated)

Figure 4 in Appendix D provides an overview of the areas where hydrology is still developing around Gauges 6 and 7. These will be the areas targeted for subsoiling and replanting in an attempt to accelerate hydrologic development.

**Table VI. Hydrology and Vegetation Criteria Success by Plot**
**Powell Wetland and Stream Mitigation Project/EEP #D06065-B**

| Gauge | Hydrology Success Met | Hydrology Mean | Vegetation Plot | Vegetation Success Met | Vegetation Mean |
|---|---|---|---|---|---|
| 1 | Y | 80% | 1 | Y | 100% |
| 2 | Y | | 2 | Y | |
| 3 | Y | | 3 | Y | |
| 4 | Y | | 4 | Y | |
| 5 | Y | | 5 | Y | |
| 6 | N | | 6 | Y | |
| 7 | N | | 7 | Y | |
| 8 | Y | | 8 | Y | |
| 9 | Y | | 9 | Y | |
| 10 | Y | | 10 | Y | |
| 11 (Ref)* | Y | | | | |
| 12 (Ref)* | Y | | | | |

* Gauges 11 & 12 are reference gauges and not included in the hydrology mean

## 3.0 Project Success Discussion

After the second year of monitoring and a season of erratic rainfall, the wetland hydrology on the majority of the Powell project shows indications of successful restoration. Specifically, the hydrology within the swamp run has been restored and the project is functioning like a natural riparian headwater system. Flow of water across the site was successfully measured and documented on at least two separate occasions in 2010.

The reference gauges are measuring very similar above- and below-ground water patterns at the reference site as those measured on the project, confirming that the site is beginning to function like a natural system. Overall tree survival is good; growth in the first year was good due to site maintenance and adequate rainfall.

Listed below are the field indicators from the approved mitigation plan that are to be used to help substantiate flow. Those shown in ***blue*** were observed and/or video or photo documented in 2010.

- A natural line impressed on the bank
- Shelving
- Changes in soil characteristics

- **Destruction of terrestrial vegetation**
- **Presence of litter and debris**
- Wracking
- **Vegetation matted down or absent**
- Sediment sorting
- Leaf litter disturbed or washed away
- **Scour**
- Deposition
- **Bed and bank formation**
- **Water staining**
- **Change in plant community**

High water marks on bank vegetation were noted and photographed during December of 2009 after heavy rainfall. Matted vegetation was noted and photographed in April of 2010, the remnants of winter flooding. Further evidence of flow is deposition of small detritus after flow events as well as some scouring in the mid portion of the project.

## III. Methodology Section

Year 2 monitoring for the Powell project occurred in August of 2010. Monitoring and vegetation sampling procedures were established in the mitigation plan for this project and no deviations were made.

# Appendix A

Vegetation Data Tables

Site Photos

## 1. Vegetation Data Tables

Table 1. Project Metadata

| | |
|---|---|
| **Report Prepared By** | Ashby Brown |
| **Date Prepared** | 8/18/2010 18:27 |
| | |
| **DESCRIPTION OF WORKSHEETS IN THIS DOCUMENT--** | |
| **Vigor by Spp** | Frequency distribution of vigor classes listed by species. |
| **Damage by Spp** | Damage values tallied by type for each species. |
| **Damage by Plot** | Damage values tallied by type for each plot. |
| **ALL Stems by Plot and spp** | A matrix of the count of total living stems of each species (planted and natural volunteers combined) for each plot; dead and missing stems are excluded. |
| | |
| **PROJECT SUMMARY---------** | |
| **Project Code** | D06065B |
| **Project Name** | Powell |
| **Description** | Powell wetland and stream mitigation |
| **River Basin** | Chowan |
| **Sampled Plots** | 10 |

Table 2. Vegetation Vigor by Species

| | Species | 4 | 3 | 2 | 1 | 0 | Missing | Unknown |
|---|---|---|---|---|---|---|---|---|
| | Alnus serrulata | 1 | | | | | | |
| | Cephalanthus occidentalis | 3 | 3 | | | | | |
| | Itea virginica | 3 | 10 | 7 | | | 2 | |
| | Nyssa biflora | | 2 | 3 | | | 1 | |
| | Persea palustris | | | | | | 1 | |
| | Quercus bicolor | 3 | 3 | | | | | |
| | Quercus michauxii | 3 | 2 | 2 | | | 1 | |
| | Quercus phellos | 14 | 5 | 2 | | | 1 | |
| | Salix nigra | 2 | 3 | | | | | |
| | Taxodium distichum | 15 | 13 | 3 | | | 1 | |
| | Vaccinium corymbosum | | | | | | 1 | |
| | Unknown | 2 | 1 | 1 | | | 5 | |
| **TOT:** | **12** | **46** | **42** | **18** | | | **13** | |

Table 3. Vegetation Damage by Species

| | Species | All Damage Categories | (no damage) | Site Too Dry |
|---|---|---|---|---|
| | Alnus serrulata | 1 | 1 | |
| | Cephalanthus occidentalis | 6 | 6 | |
| | Itea virginica | 22 | 19 | 3 |
| | Nyssa biflora | 6 | 5 | 1 |
| | Persea palustris | 1 | 1 | |
| | Quercus bicolor | 6 | 6 | |
| | Quercus michauxii | 8 | 8 | |
| | Quercus phellos | 22 | 22 | |
| | Salix nigra | 5 | 5 | |
| | Taxodium distichum | 32 | 27 | 5 |
| | Unknown | 9 | 9 | |
| | Vaccinium corymbosum | 1 | 1 | |
| **TOT:** | **12** | **119** | **110** | **9** |

Table 4. Vegetation Damage by Plot

| | Plot | All Damage Categories | (no damage) | Site Too Dry |
|---|---|---|---|---|
| | D06065B-AB-0001-year:2 | 14 | 13 | 1 |
| | D06065B-AB-0002-year:2 | 10 | 10 | |
| | D06065B-AB-0003-year:2 | 12 | 12 | |
| | D06065B-AB-0004-year:2 | 11 | 6 | 5 |
| | D06065B-AB-0005-year:2 | 10 | 9 | 1 |
| | D06065B-AB-0006-year:2 | 12 | 12 | |
| | D06065B-AB-0007-year:2 | 9 | 9 | |
| | D06065B-AB-0008-year:2 | 17 | 17 | |
| | D06065B-AB-0009-year:2 | 11 | 10 | 1 |
| | D06065B-AB-0010-year:2 | 13 | 12 | 1 |
| **TOT:** | **10** | **119** | **110** | **9** |

Table 5. Stem Count by Plot and Species

| | | | | Plot | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Total Planted Stems** | **# plots** | **avg# stems** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Alnus serrulata | 1 | 1 | 1 | | | 1 | | | | | | | |
| Cephalanthus occidentalis | 6 | 2 | 3 | 3 | | | | | | | 3 | | |
| Itea virginica | 20 | 6 | 3.33 | 3 | | 2 | 2 | 5 | | 1 | 7 | | |
| Nyssa biflora | 5 | 3 | 1.67 | | | | 2 | | 2 | | 1 | | |
| Quercus bicolor | 6 | 3 | 2 | | 1 | | | | 3 | 2 | | | |
| Quercus michauxii | 7 | 3 | 2.33 | | 1 | | | | | 2 | | | 4 |
| Quercus phellos | 21 | 5 | 4.2 | 7 | 4 | 5 | | | 4 | 1 | | | |
| Salix nigra | 5 | 1 | 5 | | | | | | | | 5 | | |
| Taxodium distichum | 31 | 6 | 5.17 | | | 2 | 7 | 5 | | 2 | | 9 | 6 |
| Unknown | 4 | 2 | 2 | | 3 | | | | 1 | | | | |
| **Totals:** | **106** | **10** | | **13** | **9** | **10** | **11** | **10** | **10** | **8** | **16** | **9** | **10** |
| **Average Stems/Acre** | | | | **526** | **364** | **405** | **445** | **405** | **405** | **324** | **647** | **364** | **405** |

**Project Total Average Stems/Acre: 429**

Table 6. Problem Areas

| Feature/Issue | Gauge | Probable Cause |
|---|---|---|
| Inadequate Hydrology | 6 and 7 | Soil Compaction |

**Inflow from upstream watershed in February. Vegetation too thick to show flow.**

**Remaining evidence of substantial flow event in late March-early April.**

**Very dry late spring-early summer conditions.**


**Further evidence of flow in March/April. This photo is from center of main run and shows matted vegetation and some litter deposition**

**Droughty conditions in August have caused early leaf fall in some Cypress.**

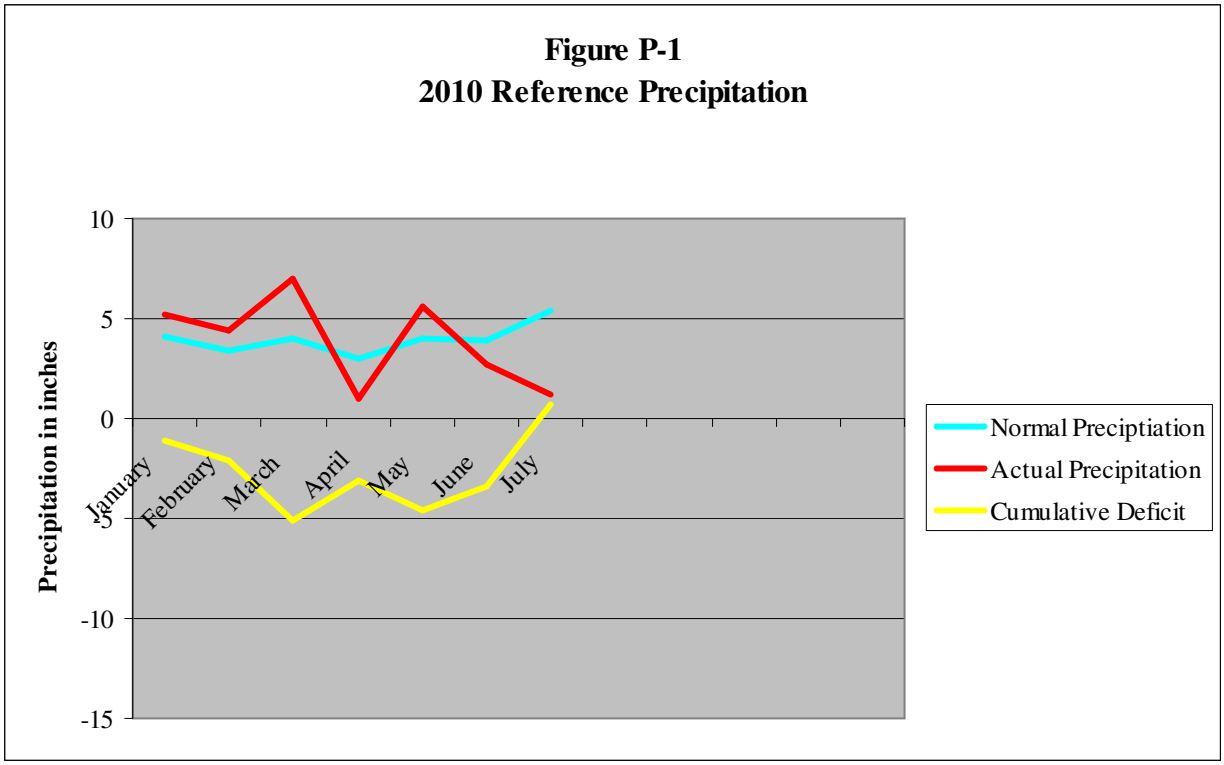
**Trees show good height growth, but droughty summer conditions have ceased growth.**

**Reference area in August is completely dry.**

| Table C-1<br>Longest Consecutive Successful Hydrologic Period<br>in Days and Success at 5% and 8% of Growing Season | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Year 1 | | | Year 2 | | | Year 3 | | | Year 4 | | | Year 5 | | |
| Gauge | Days | 5% | 8% | Days | 5% | 8% | Days | 5% | 8% | Days | 5% | 8% | Days | 5% | 8% |
| 1 | 14 | Y | N | 18 | Y | N | | | | | | | | | |
| 2 | 34 | Y | Y | 25 | Y | Y | | | | | | | | | |
| 3 | 15 | Y | N | 17 | Y | N | | | | | | | | | |
| 4 | 4 | N | N | 15 | Y | N | | | | | | | | | |
| 5 | 35 | Y | Y | 34 | Y | Y | | | | | | | | | |
| 6 | 4 | N | N | 7 | N | N | | | | | | | | | |
| 7 | 7 | N | N | 4 | N | N | | | | | | | | | |
| 8 | 39 | Y | Y | 38 | Y | Y | | | | | | | | | |
| 9 | 24 | Y | Y | 39 | Y | Y | | | | | | | | | |
| 10 | 14 | Y | N | 28 | Y | Y | | | | | | | | | |
| 11 (Ref) | 53 | Y | Y | 38 | Y | Y | | | | | | | | | |
| 12 (Ref) | 39 | Y | Y | 36 | Y | Y | | | | | | | | | |

5% of growing season is 12 days, 8% is 19 days
Hydrology is deemed successful if longest consecutive hydrologic period meets minimum of 5% of the growing season

**Figure P-1**
**2010 Reference Precipitation**




Total precipitation from January 1, 2010 through July 31, 2010 was near normal (.75" deficit) though April was a particularly dry month (only .97"). Precipitation in July was also well below normal (only 1.18").

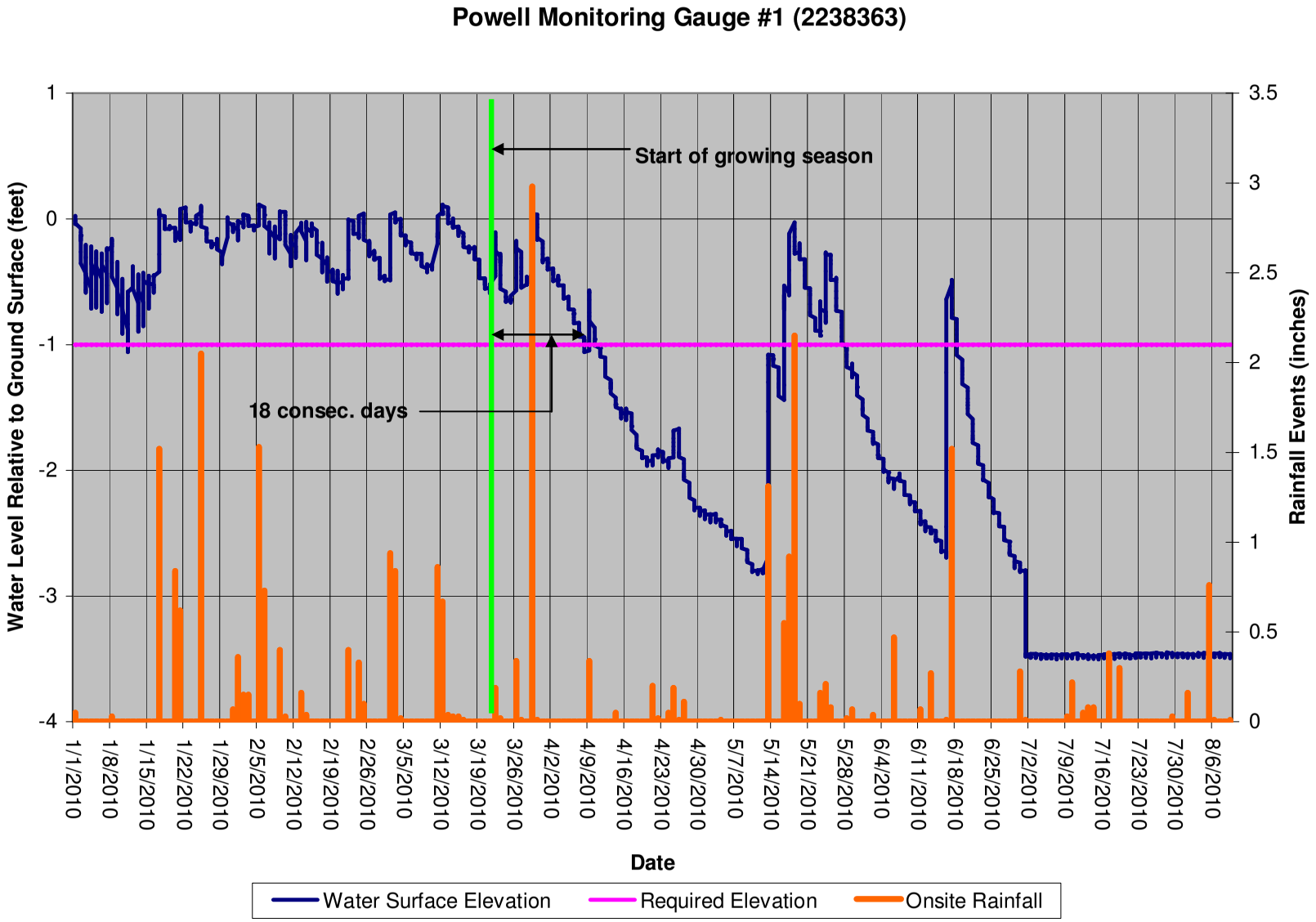
# Appendix B

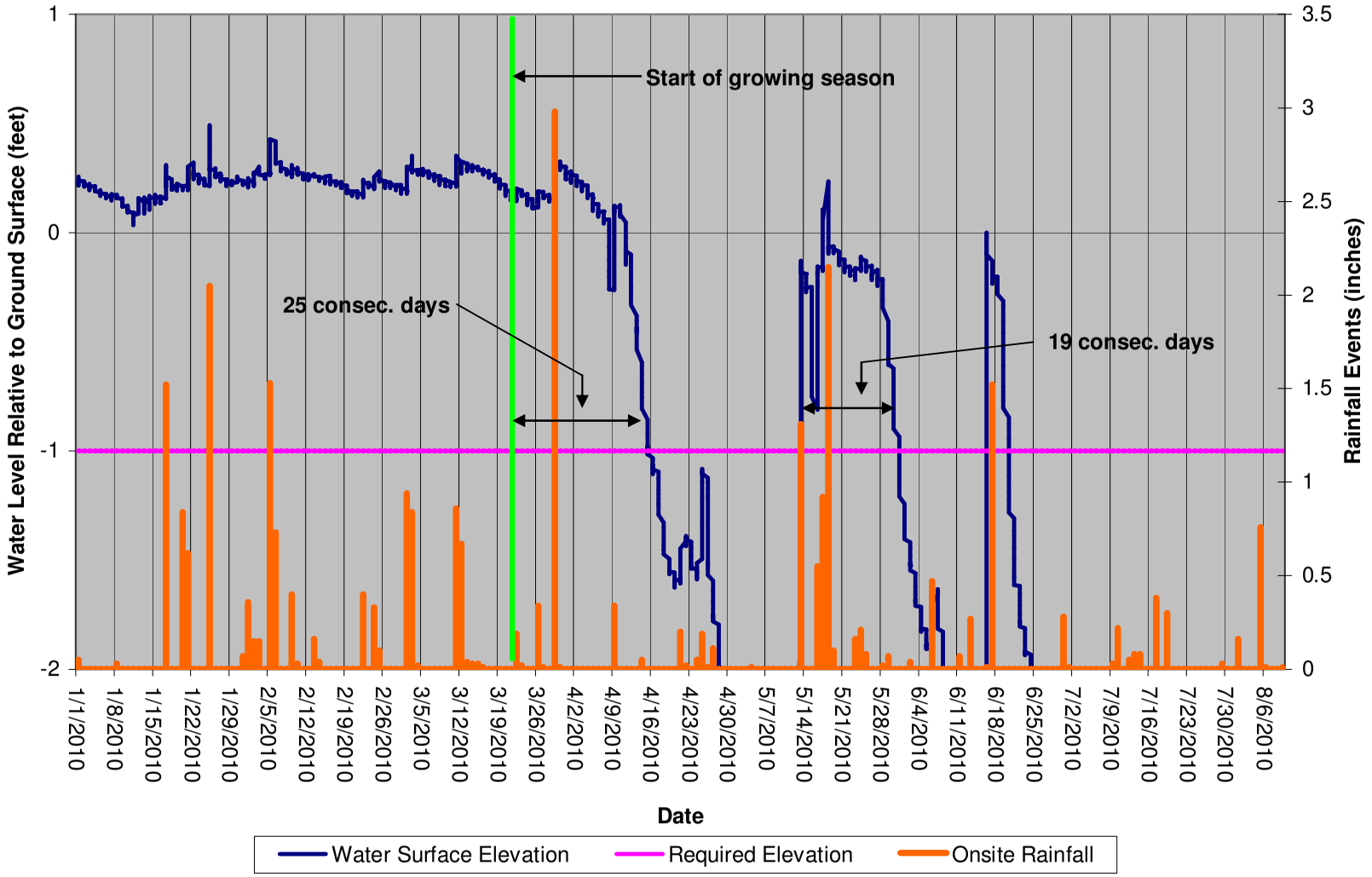
Geomorphologic Raw Data

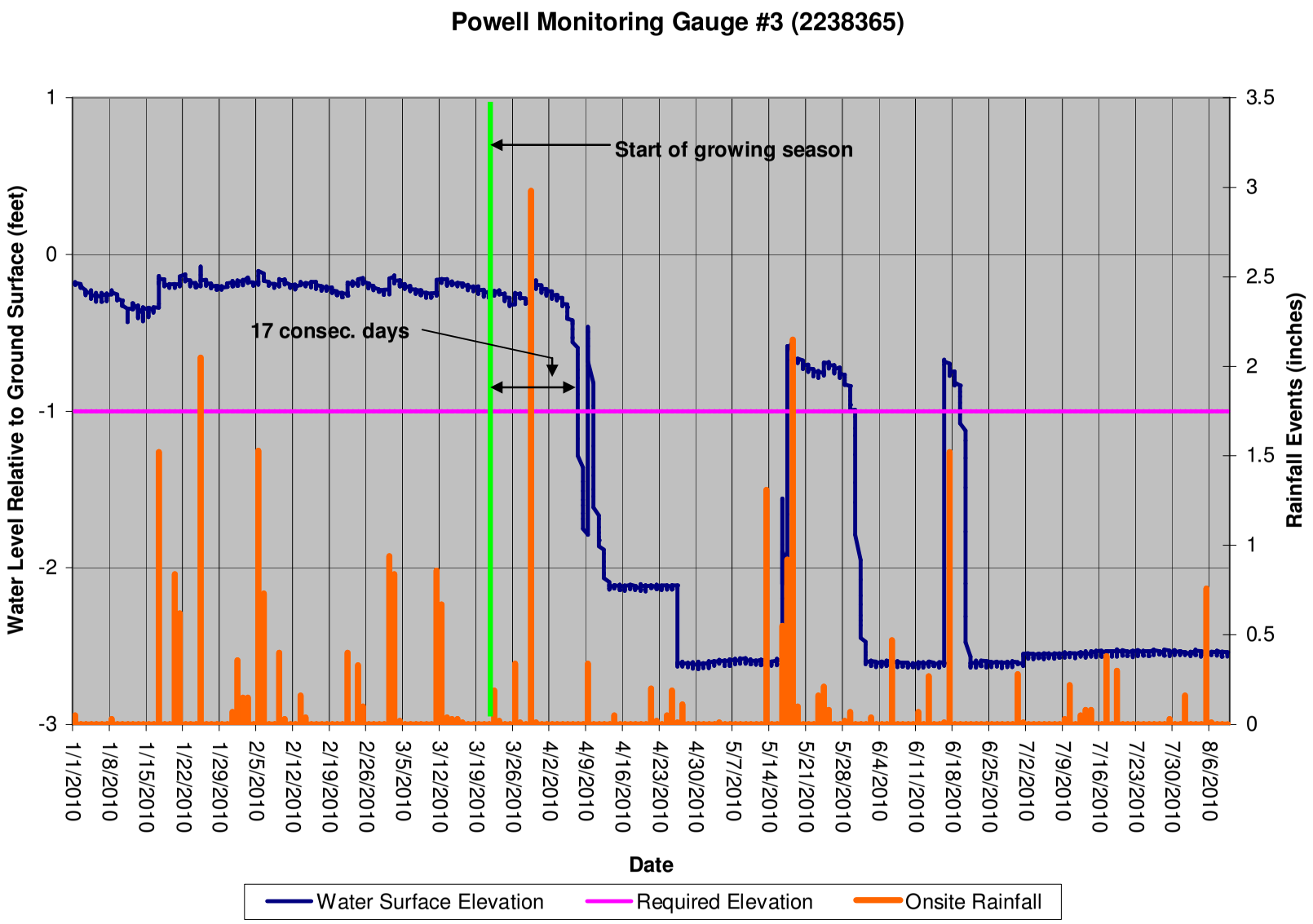
Not used in this report

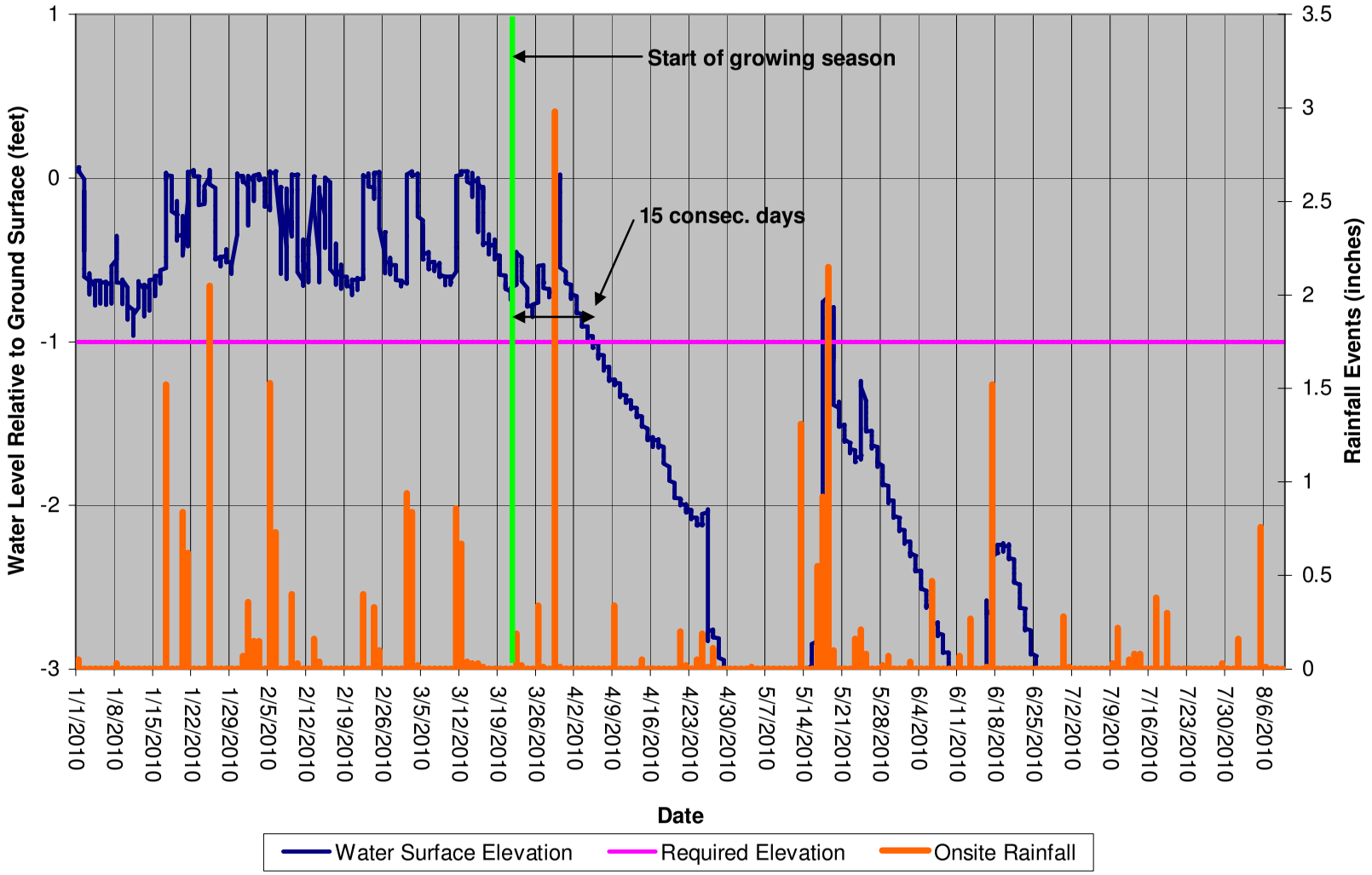
# Appendix C

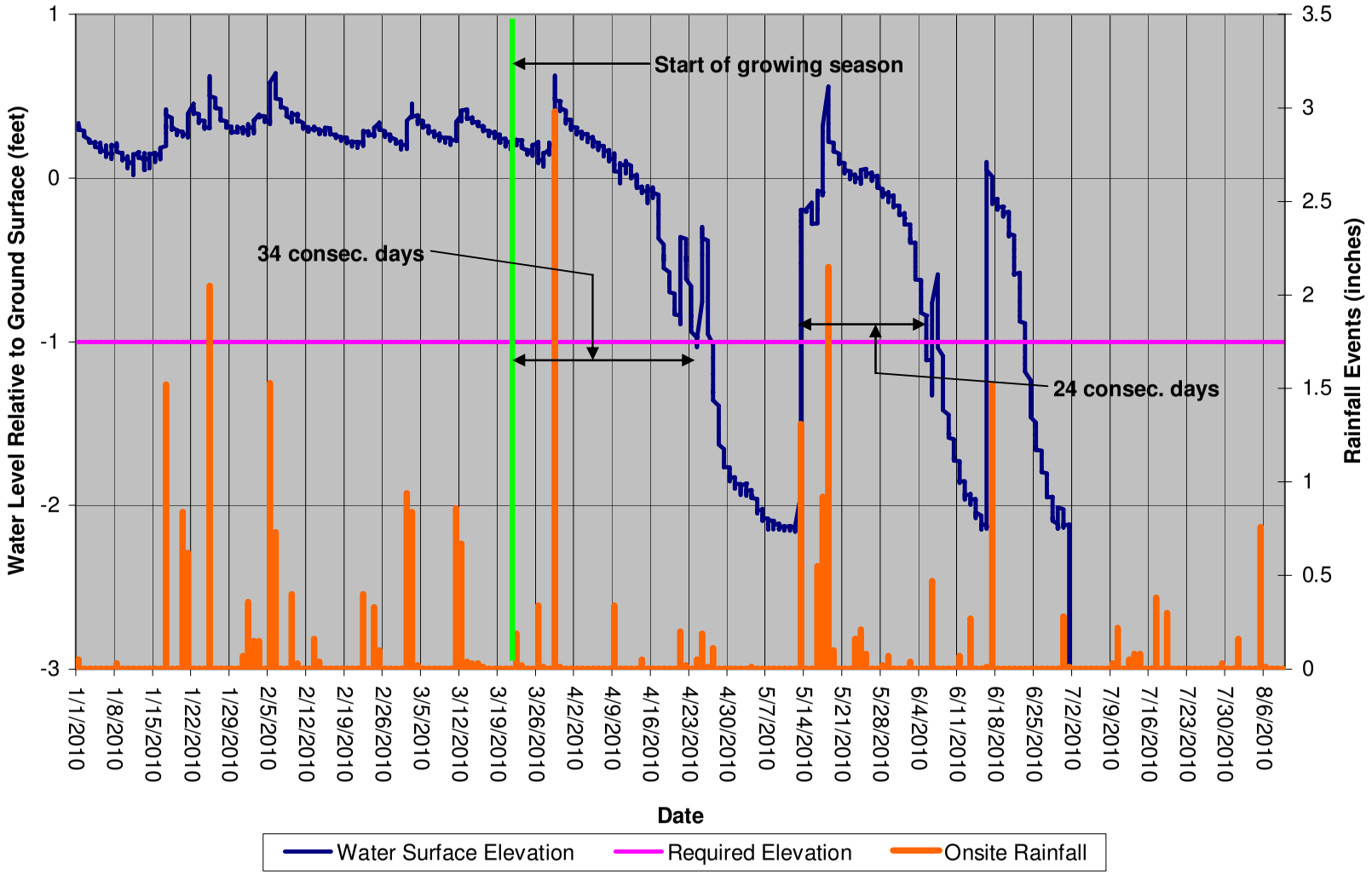
Hydrologic Data Tables

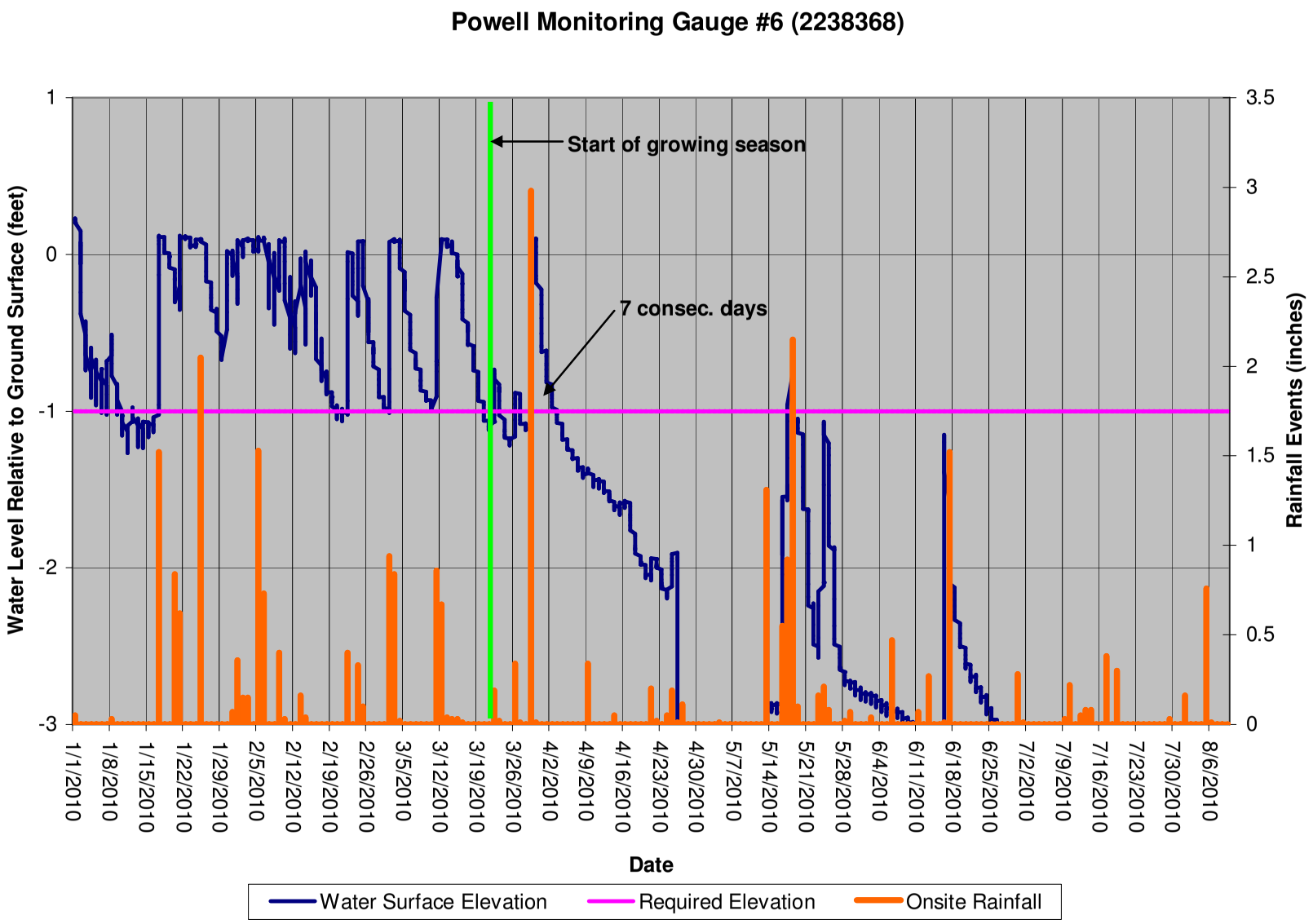

Powell Monitoring Gauge #1 (2238363)
Start of growing season
18 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
Date
1
0
-1
-2
-3
-4
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Water Surface Elevation
Required Elevation
Onsite Rainfall

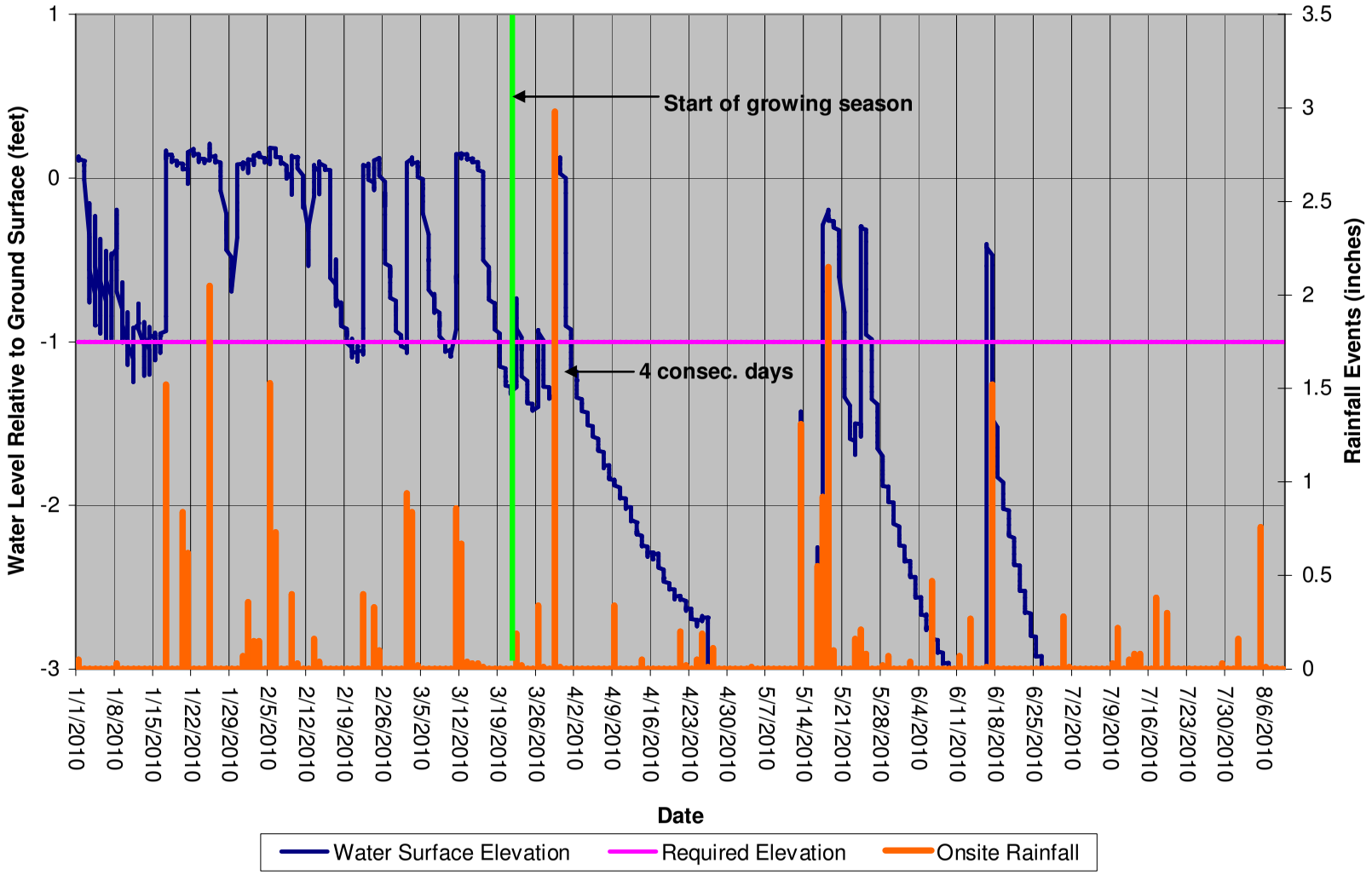

Powell Monitoring Gauge #2 (2238364)
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
Start of growing season
25 consec. days
19 consec. days
1
0
-1
-2
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall

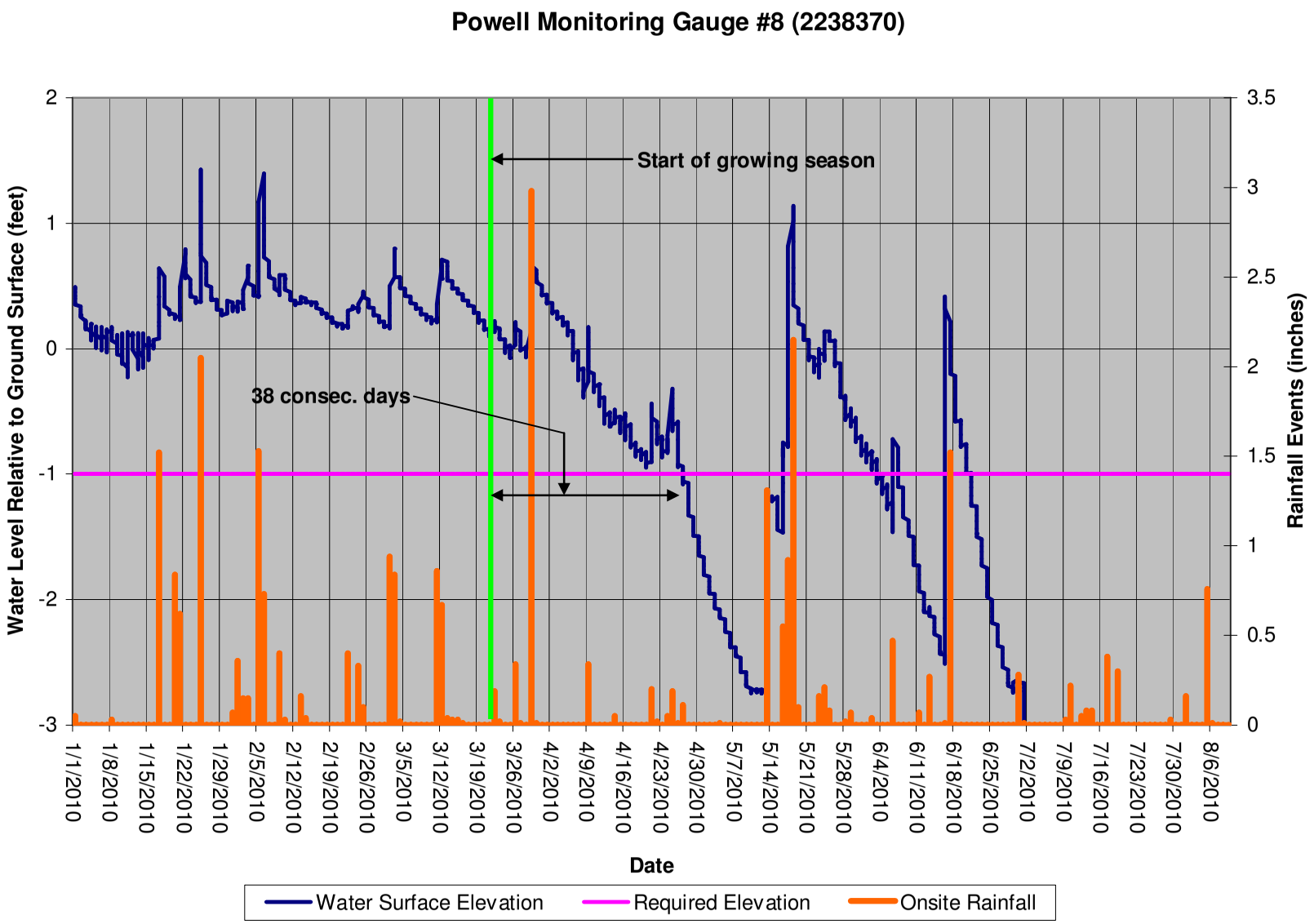

Powell Monitoring Gauge #3 (2238365)
Start of growing season
17 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
1
0
-1
-2
-3
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall

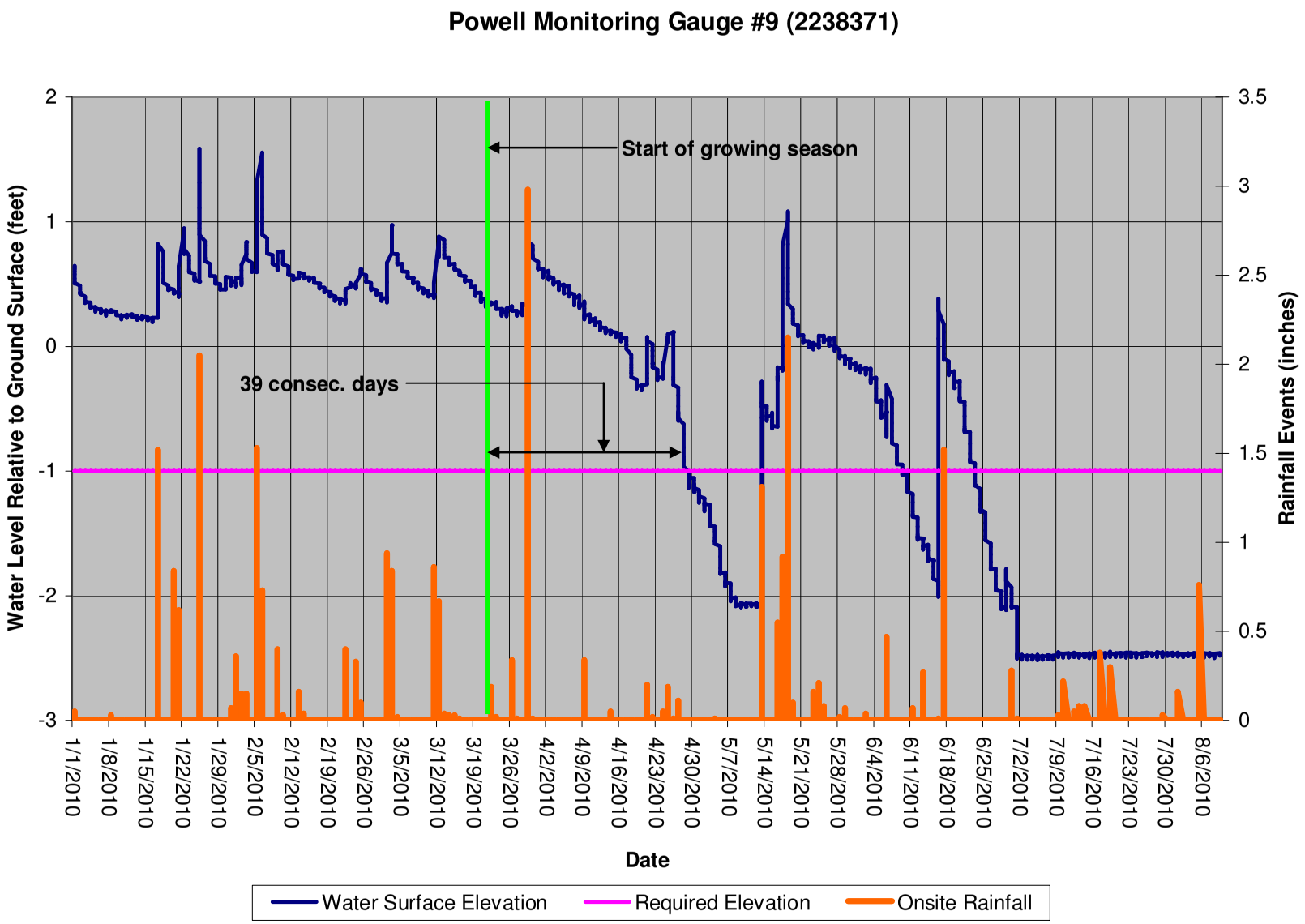

Powell Monitoring Gauge #4 (2238366)
Start of growing season
15 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
1
0
-1
-2
-3
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall

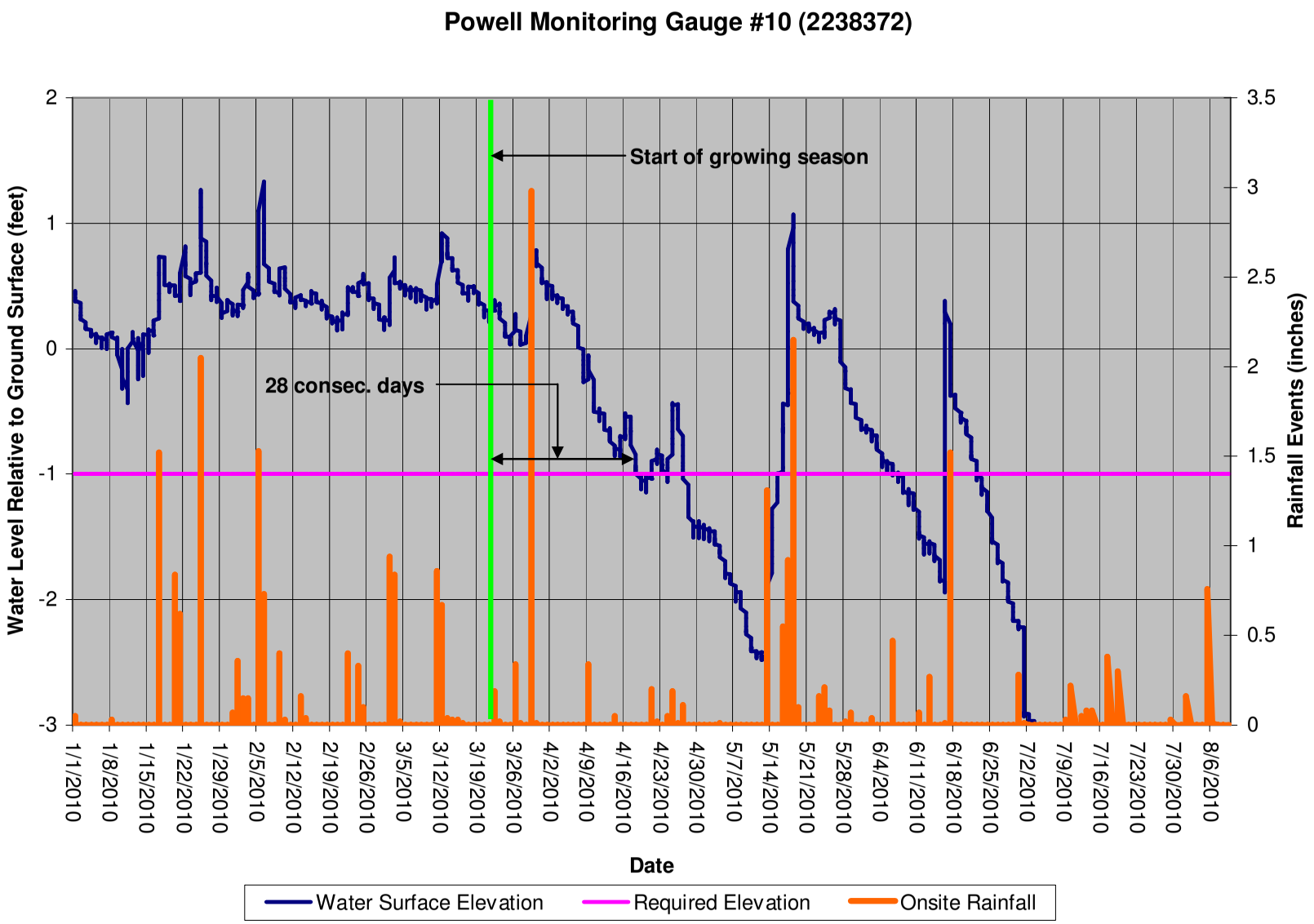

Powell Monitoring Gauge #5 (2238367)
Start of growing season
34 consec. days
24 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
1
0
-1
-2
-3
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall

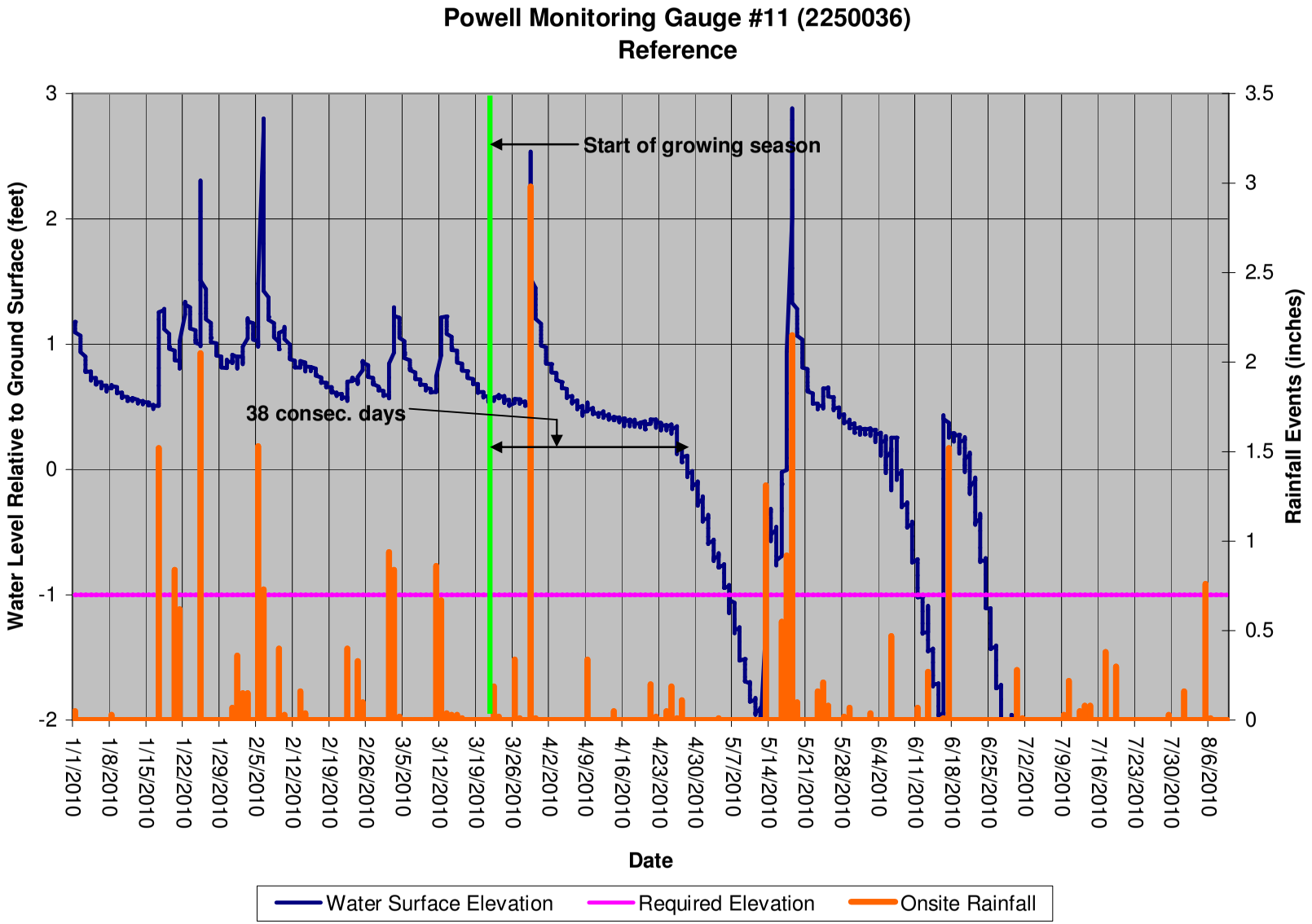

Powell Monitoring Gauge #6 (2238368)
Start of growing season
7 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
1
0
-1
-2
-3
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall

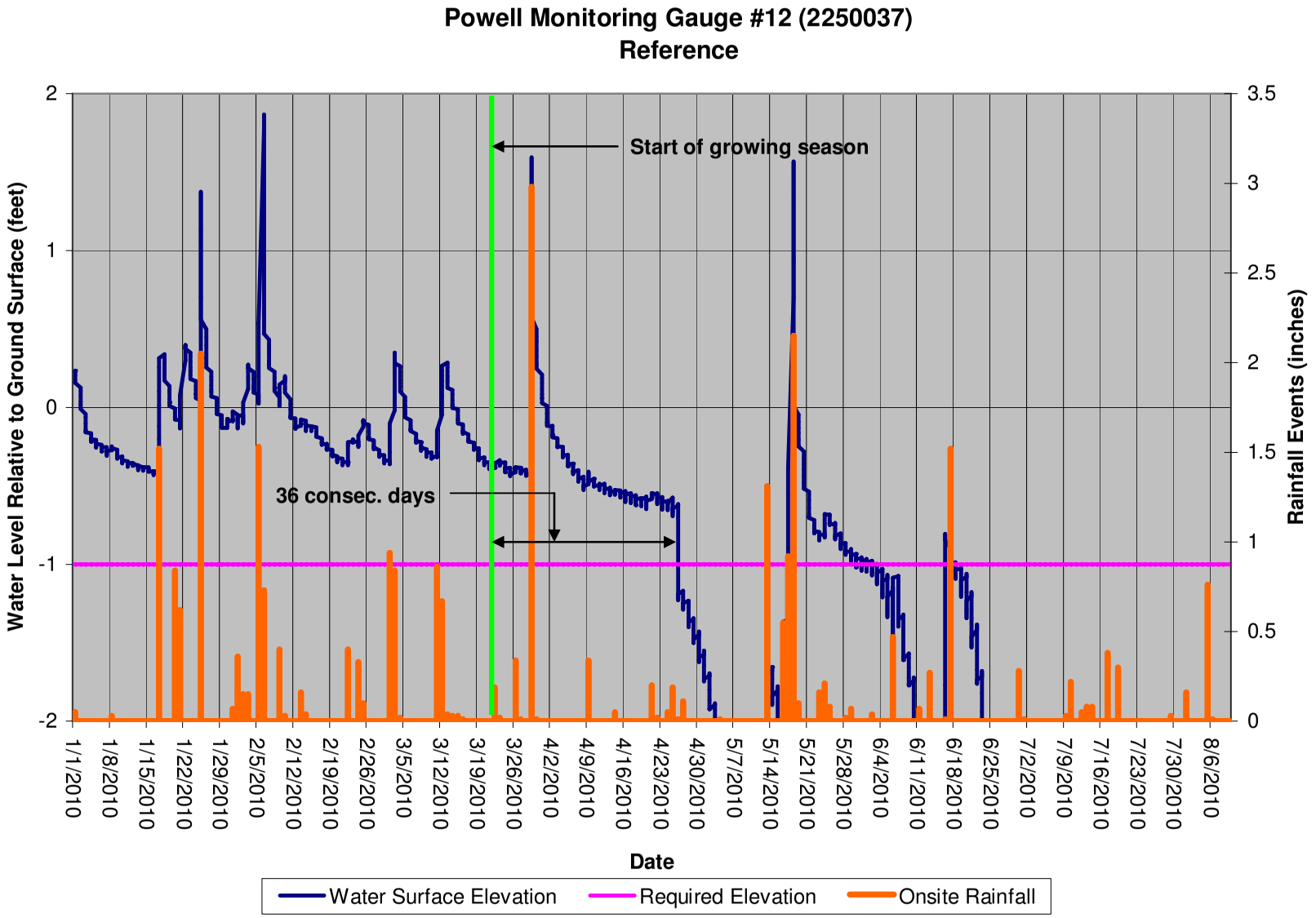

Powell Monitoring Gauge #7 (2238369)
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
Start of growing season
4 consec. days
1
0
-1
-2
-3
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall


Powell Monitoring Gauge #8 (2238370)
Start of growing season
38 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall
2
1
0
-1
-2
-3
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010


Powell Monitoring Gauge #9 (2238371)
Start of growing season
39 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
Date
2
1
0
-1
-2
-3
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Water Surface Elevation
Required Elevation
Onsite Rainfall


Powell Monitoring Gauge #10 (2238372)
Start of growing season
28 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
Date
Water Surface Elevation
Required Elevation
Onsite Rainfall
2
1
0
-1
-2
-3
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010


Powell Monitoring Gauge #11 (2250036)
Reference
Start of growing season
38 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
Date
3
2
1
0
-1
-2
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Water Surface Elevation
Required Elevation
Onsite Rainfall


Powell Monitoring Gauge #12 (2250037)
Reference
Start of growing season
36 consec. days
Water Level Relative to Ground Surface (feet)
Rainfall Events (inches)
Date
2
1
0
-1
-2
3.5
3
2.5
2
1.5
1
0.5
0
1/1/2010
1/8/2010
1/15/2010
1/22/2010
1/29/2010
2/5/2010
2/12/2010
2/19/2010
2/26/2010
3/5/2010
3/12/2010
3/19/2010
3/26/2010
4/2/2010
4/9/2010
4/16/2010
4/23/2010
4/30/2010
5/7/2010
5/14/2010
5/21/2010
5/28/2010
6/4/2010
6/11/2010
6/18/2010
6/25/2010
7/2/2010
7/9/2010
7/16/2010
7/23/2010
7/30/2010
8/6/2010
Water Surface Elevation
Required Elevation
Onsite Rainfall

# Appendix D

Problem Areas Plan View (Integrated)

Figure 4 goes here