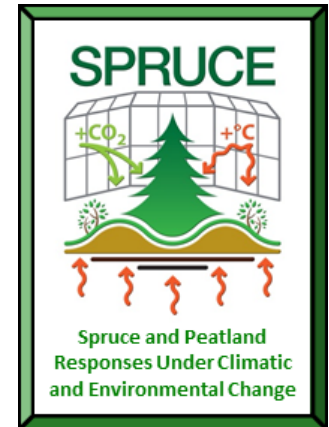


SPRUCE S1 Bog and SPRUCE Experiment Location Survey Results, 2015

Summary:

This data set provides a record of the horizontal and vertical survey results of SPRUCE experimental infrastructure and measurement locations on the S1-Bog on the Marcell Experimental Forest and the SPRUCE experimental site within the S1-Bog.



Oak Ridge National Laboratory contracted with NORTHERN LIGHTS LAND SURVEYING P.S.C. (Grand Rapids, MN. Jeffrey P. Major, PLS 44902) to perform a site survey and provide horizontal and vertical coordinates for selected locations with sub-centimeter horizontal accuracy and ± 2 cm vertical accuracy. It is important to note that the contractually required vertical accuracy of ± 2 cm refers to the absolute elevations set at the control points. The measurements at the selected points were made relative to control points and are much more accurate relative to each other.

Measurements, both horizontal and vertical, are generally to the nearest ~ 3 millimeters (0.01 foot), such that the precision of the measurements are ± 3 mm. Results of repeated vertical measurements are shown in Section 4.

Surveying was performed in July, August, and September 2015.

- Benchmarks were set at the entrance to each of the three transect boardwalks and then level loops were run inside and around the experimental plots to get the individual point horizontal and vertical coordinates. Figure 1.
- Selected points were surveyed in and around the 17 Plots including: Central Wells, Elevation Standards, Central Towers, 0 m Piezometers, Wood planks attached to the belowground corral, and 8 points around the octagonal Boardwalks. Note that not all plots have all of these features.
- Additional locations were surveyed across the S1 Bog including: EM1, EM2, and EM3 Wells, the Forest Service Bog Well, and the Test 6 Piezometer.

Sketches of each plot showing the surveyed locations (with location IDs) were provided and are included with this data set. Figure 2 shows the diagram for Plot 8.

In Section 5, a reference table is provided of the DESCRIPTION OF EXACT SURVEYED POINT OR MARK with an accompanying typical PHOTO OF SURVEYED MARK for use in the field by the SPRUCE Team.

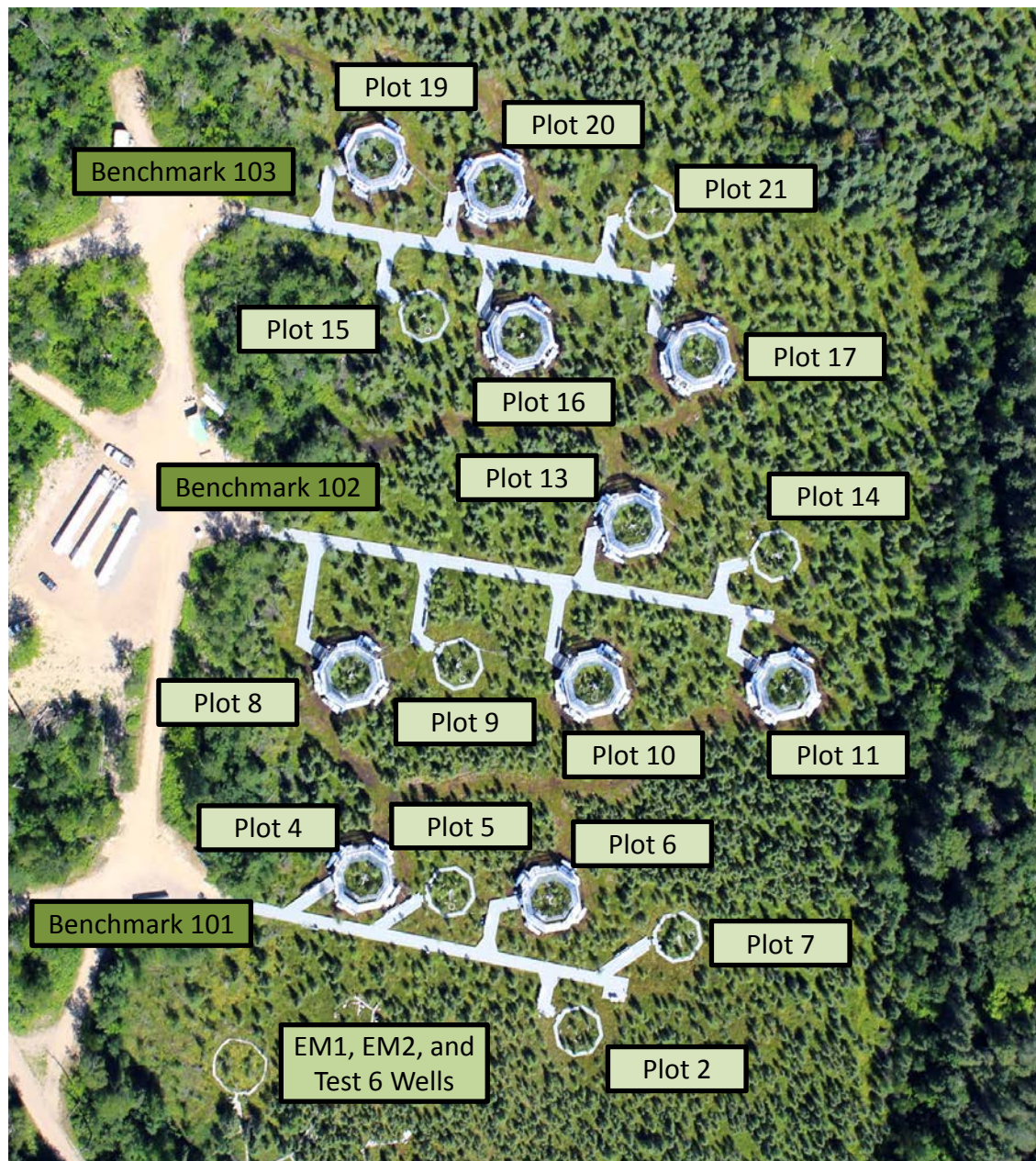


Figure 1. Benchmark locations, experimental plots, and wells included in the survey. EM3 well and the Bog Well are located north of the 3rd boardwalk, off the top of the photo.

Data Products

All point coordinates are contained in one comma delimited (*.csv) file including: UTM eastings and northings in meters, latitude and longitude coordinates in decimal degrees, and elevations in meters above mean sea level.

The same data are also provided as an *.xlsx format file.

Plot sketches are provided in the original *.pdf format and in *.png format for user convenience.

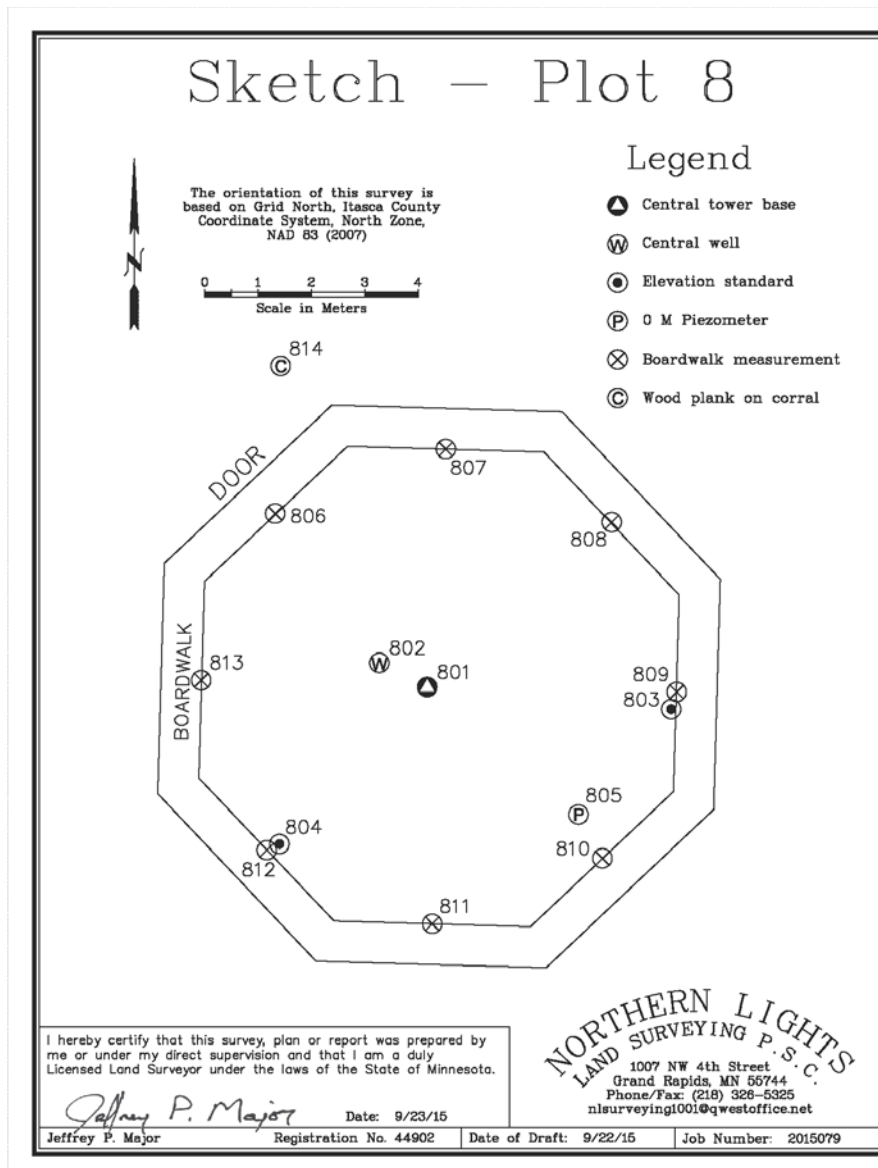


Figure 2. Provided sketch of Plot 8. Sketches available in both .pdf and .png formats for all 17 plots.

Data and Documentation Access:

Get Data

For public access to SPRUCE data please visit the SPRUCE Web

Site: <http://mnspruce.ornl.gov/>

Description and Links to Supplemental Information

Marcell Experimental Forest Website: <http://www.nrs.fs.fed.us/ef/locations/mn/marcell/>

SPRUCE Project Website with project plans and additional information: <http://mnspruce.ornl.gov/>

SPRUCE Data Policy - Sharing, Access, and Use

Recommendations: <http://mnspruce.ornl.gov/content/spruce-data-policies>

Related Data Sets:

- Hanson, P.J. 2015. SPRUCE S1 Bog and SPRUCE Experiment Aerial Photographs. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A. <http://dx.doi.org/10.3334/CDIAC/spruce.014>

Data Citation:

Cite this data set as follows:

Griffiths, N.A., L.A. Hook and P.J. Hanson. 2016. SPRUCE S1 Bog and SPRUCE Experiment Location Survey Results, 2015. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, U.S.A. <http://dx.doi.org/10.3334/CDIAC/spruce.015>

SPRUCE Project Description

SPRUCE (Spruce and Peatland Responses Under Climatic and Environmental Change) is an experiment to assess the response of northern peatland ecosystems to increases in temperature and exposures to elevated atmospheric CO₂ concentrations. It is a key component of the Terrestrial Ecosystem Science Scientific Focus Area of ORNL's Climate Change Program, focused on terrestrial ecosystems and the mechanisms that underlie their responses to climatic change. The experimental work is to be conducted in a *Picea mariana* [black spruce] – *Sphagnum* spp. bog forest in northern Minnesota, 40 km north of Grand

Rapids, in the USDA Forest Service Marcell Experimental Forest (MEF). The site is located at the southern margin of the boreal forest. It is an ecosystem considered especially vulnerable to climate change, and anticipated to be near its tipping point with respect to climate change. Responses to warming and interactions with increased atmospheric CO₂ concentration are anticipated to have important feedbacks on the atmosphere and climate, because of the high carbon stocks harbored by peatlands.

Experimental work in the 8.1-ha S1 bog will be a climate change manipulation focusing on the combined responses to multiple levels of warming at ambient or elevated CO₂ (eCO₂) levels. The experiment provides a platform for testing mechanisms controlling the vulnerability of organisms, biogeochemical processes and ecosystems to climatic change (e.g., thresholds for organism decline or mortality, limitations to regeneration, biogeochemical limitations to productivity, the cycling and release of CO₂ and CH₄ to the atmosphere).

The manipulation will evaluate the response of the existing biological communities to a range of warming levels from ambient to +9°C, provided via large, modified open-top enclosures. All temperatures, ambient through the +9°C warming treatment, will also be conducted at eCO₂ (in the range of 800 to 900 ppm). Both direct and indirect effects of these experimental perturbations will be analyzed to develop and refine models needed for full Earth system analyses.

Marcell Experimental Forest

Stream flow, weather, and well data collection began on the Marcell Experimental Forest in 1960. This 1100-ha site has six calibrated watersheds, each consisting of a mineral soil upland and organic soil peatland; an intermittent or perennial stream drains each peatland and its larger watershed. Formally established in 1962, the Marcell contains two units on land owned by the USDA Forest Service, Chippewa National Forest, State of Minnesota, Itasca County, and a private individual. Previous and ongoing research addresses the ecology and hydrology of peatland. Research concerns typical upland/wetland watersheds in the Lake States, atmospheric chemistry, nutrient cycling, soil quality, tree-stand dynamics, and a variety of watershed treatments applied to upland or bogs to investigate impacts on water yield, peak stream flow, water quality and nutrient processing.

SPRUCE Sponsor

Research sponsored by the [Office of Biological and Environmental Research](#) within the [U.S. Department of Energy's Office of Science](#).

The SPRUCE experiment is a multi-year cooperative interaction among scientists of the [Oak Ridge National Laboratory](#) operated by UT-Battelle, LLC and the U.S. Forest Service, [Northern Research Station](#), [Marcell Experimental Forest](#).

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1. Data Set Overview:

This data set provides a record of the horizontal and vertical survey results of SPRUCE experimental infrastructure and measurement locations on the S1-Bog on the Marcell Experimental Forest and the SPRUCE experimental site within the S1-Bog.

2. Data Characteristics:

Coordinate Reference System

Survey coordinates are based on Grid North, Itasca County Coordinate System, South Zone (NAD 83) and provided as eastings and northings in meters.

- Surveyor Note: The coordinates are in Itasca County South Zone, not Itasca County North Zone. The division line between North and South is Latitude 47°30', so the SPRUCE site is actually in the North Zone but the base from which the coordinates originated is in the South Zone.

The elevation datum is the North American Vertical Datum of 1988 (NAVD88). Elevations are shown in meters above mean sea level.

Surveying was performed in July, August, and September 2015.

Data Products

All location coordinates are contained in one comma delimited (*.csv) file including: UTM eastings and northings in meters, latitude and longitude coordinates in decimal degrees, and elevations in meters above mean sea level.

The same data are also provided as an *.xlsx format file.

Plot sketches are provided in the original *.pdf format and in *.png format for user convenience. Both set of files have been zipped for distribution.

Data Dictionary

File: PLOT_survey_data_20151203.csv (and *.xlsx)

Column Heading	Units / format	Description
PLOT_LOCATION	text	Plot location as provided.
PLOT_NUMBER	integer	SPRUCE plot number
POINT_ID	integer	Identifier of surveyed point. Note that POINT_ID begins with the respective PLOT_NUMBER.
POINT_DESCRIPTION	text	Description of the surveyed points. See Table 1 below for details. Plots: PIEZOMETER, BOARDWALK, CENTRAL TOWER, CENTRAL WELL, ELEVATION STANDARD, WOOD PLANK S1 Bog: BENCHMARK, EM1, EM2, EM3, BOG WELL, TEST6
NORTHING	meters	North horizontal coordinate
EASTING	meters	East horizontal coordinate
ELEVATION	meters (amsl)	Elevation of point
LONGITUDE	decimal degrees	Longitude
LATITUDE	decimal degrees	Latitude

Example data records:

```
PLOT_LOCATION,PLOT_NUMBER,POINT_ID,DESCRIPTION,NORTHING,EASTING,ELEVATION,LATITUDE, LONGITUDE
,,,meters,meters,meters (amsl),decimal degrees,decimal degrees
GENERAL S1 Bog,,101,BENCHMARK,83762.782,173397.714,413.92,47.50528,93.45464
GENERAL S1 Bog,,102,BENCHMARK,83834.061,173428.972,413.995,47.50592,93.45422
GENERAL S1 Bog,,103,BENCHMARK,83898.037,173439.819,413.327,47.50650,93.45407
GENERAL S1 Bog,,110,EM1,83724.421,173438.87,412.433,47.50494,93.45409
...
PLOT 2,2,205,PIEZOMETER,83710.66,173481.077,413.287,47.50481,93.45353
```

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PLOT 2,2,206,BOARDWALK,83712.631,173481.931,412.739,47.50483,93.45352
PLOT 2,2,207,BOARDWALK,83713.85,173485.125,412.727,47.50484,93.45348
...
PLOT 4,4,401,CENTRAL TOWER,83752.478,173447.097,412.762,47.50519,93.45398
PLOT 4,4,402,CENTRAL WELL,83752.404,173446.68,412.817,47.50519,93.45399
PLOT 4,4,403,ELEVATION STANDARD,83754.11,173442.785,412.734,47.50520,93.45404
PLOT 4,4,404,ELEVATION STANDARD,83751.431,173451.116,412.812,47.50518,93.45393
...
PLOT 6,6,612,BOARDWALK,83734.469,173485.5,412.748,47.50503,93.45347
PLOT 6,6,613,BOARDWALK,83735.96,173482.421,412.734,47.50504,93.45351
PLOT 6,6,614,WOOD PLANK,83741.31,173479.518,412.796,47.50509,93.45355
...
PLOT 21,21,2111,BOARDWALK,83868.325,173542.857,412.801,47.50623,93.45271
PLOT 21,21,2112,BOARDWALK,83866.989,173539.727,412.778,47.50622,93.45275
PLOT 21,21,2113,BOARDWALK,83868.262,173536.561,412.778,47.50623,93.45279

```

3. Data Application and Derivation:

The elevations of the central wells will be used to express the water table level in meters above sea level.

The surveyed locations can be used as reference points to determine the vertical and horizontal coordinates of additional pieces of equipment and sampling sites in the SPRUCE experimental plots and across the S1-Bog in general.

4. Quality Assessment:

These data are considered at Quality Level 2 as provided by NORTHERN LIGHTS LAND SURVEYING P.S.C. and are publically available.

Evaluation of agreement between repeated elevation measurements at same point.

Ten (10) repeated observations were made on Plot boardwalks during the survey task. Five were on different days separated by two months and five were made on the same day.

Different days:

- Plot 2: Elevation differences between measurements of same two points on two different dates (2015-07-28 and 2015-09-15). Differences were 0.003 and 0.002 meters. Measured elevation on 2015-09-15 was lower.

- Plot 7: Elevation differences between measurements of same one point on two different dates (2015-07-28 and 2015-09-15). Difference was 0.001 meters. Measured elevation on 2015-09-15 was higher.
- Plot 9: Elevation differences between measurements of same two points on two different dates (2015-07-28 and 2015-09-18). Differences were 0.008 and 0.010 meters. Measured elevation on 2015-09-18 was lower.

Surveyor suggests that differences in the elevations in Plots 2 and especially 9 may be due to the boardwalks settling during the nearly 2 months between observations.

Same Day:

- There were five same-day redundant location measurements at various Plots with differences being 0.001, 0.002, 0.000, 0.002, and 0.000 meters.

Elevation Evaluation:

- The measurements at the selected points were made relative to benchmark control points and are much more accurate relative to each other compared to the ± 2 cm absolute vertical accuracy of the benchmarks. Settling and rising of boardwalks over short and long time intervals is not unexpected.

5. Data Acquisition Materials and Methods:

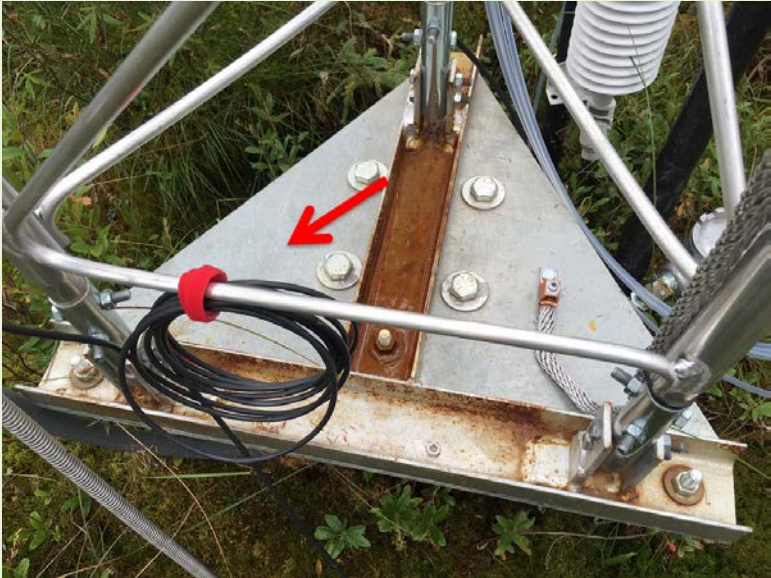
Site Description:

The site is the 8.1-ha S1-bog, a *Picea mariana* [black spruce] – *Sphagnum* spp. ombrotrophic bog forest in northern Minnesota, 40 km north of Grand Rapids, in the USDA Forest Service Marcell Experimental Forest (MEF). The S1 bog was harvested in successive strip cuts in 1969 and 1974 and the cut areas were allowed to naturally regenerate. The 1974 strips are characterized by medium density of 3-5 meter black spruce and larch trees with an open canopy. The 1969 harvest strips are characterized by a higher density of 3-5 meter black spruce and larch trees with a generally closed canopy.

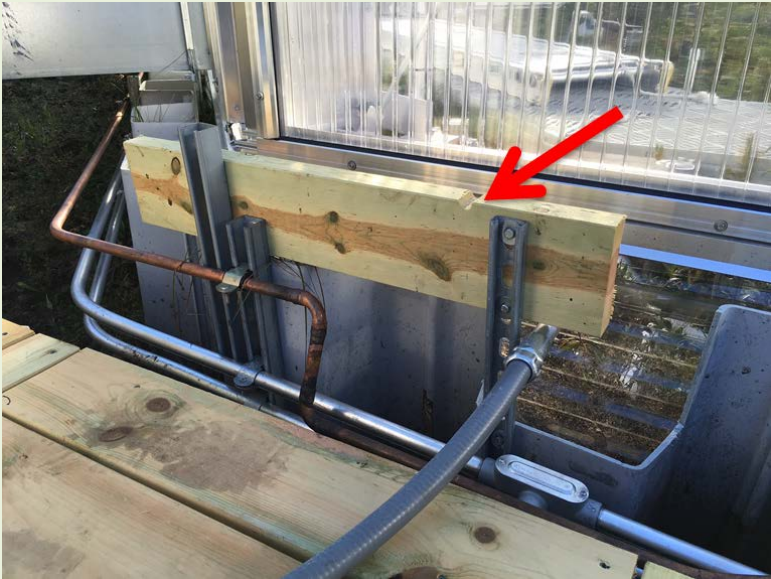
Survey Details:

Table 1. Descriptions of the surveyed points or marks by Point Description as given in the data file. Photos of the surveyed points by Natalie Griffiths. Bog well photo by Steve Sebestyen.

POINT DESCRIPTION: DESCRIPTION OF SURVEYED POINT	PHOTO OF SURVEYED POINT
CENTRAL WELL: (in Plots) At the highest point on the top of the cap beside the water level sensor. One per plot. Also applies to wells at EM1, EM2, and EM3.	
ELEVATION STANDARD: Top of base of the elevation standard. Two per plot.	

POINT DESCRIPTION: DESCRIPTION OF SURVEYED POINT	PHOTO OF SURVEYED POINT
CENTRAL TOWER: Flat portion of the base of the central tower on the side closest to the drop down bridge access point. One per plot.	
PIEZOMETER: (0-m Piezometers) Top of 0-m piezometer well (with cap off) beside v-notch. One per plot. See detail photo. Also applies to Test 6 piezometer (beside sharpie mark on Test 6 piezometer).	

POINT DESCRIPTION: DESCRIPTION OF SURVEYED POINT	PHOTO OF SURVEYED POINT
PIEZOMETER: (0-m Piezometers) Detail -- Top of 0-m piezometer well (with cap off) beside v-notch.	
WOOD PLANK: (Wooden board by sump/outflow system) Top of the wooden board (beside v-notch) by sump/outflow system near the entrance to each enclosure. One per enclosure. See detail photo.	

POINT DESCRIPTION: DESCRIPTION OF SURVEYED POINT	PHOTO OF SURVEYED POINT
WOOD PLANK: (Wooden board by sump/outflow system) Detail -- Top of the wooden board (beside v-notch) by sump/outflow system near the entrance to each enclosure.	
BOARDWALK: Top of the boardwalk panels in the middle of each side of octagonal boardwalk where the 2 panels meet. Eight (8) per plot.	

POINT DESCRIPTION: DESCRIPTION OF SURVEYED POINT	PHOTO OF SURVEYED POINT
Bog Well: Near access hole adjacent to the water level recorder in instrument housing above well. The location is coincident with the previous Forest Service survey point.	

6. References:

TBD

7. Data Access:

This data is available through the Oak Ridge National Laboratory (ORNL) Carbon Dioxide Information Analysis Center (CDIAC)

Data Archive Center:

Contact for Data Center Access Information:

E-mail: <http://cdiacservices.ornl.gov/feedback.cfm>