



December 22, 2014

Ms. Wendy Wyels
California Regional Water Quality Control Board
Central Valley Region
11020 Sun Center Drive, #200
Rancho Cordova, CA 95670-6114

RE: Soil Moisture Monitoring Probe Installation Work Plan, Feather River Organics, Yuba County, California

Dear Ms. Wyels:

Recology Yuba Sutter is submitting the attached Soil Moisture Monitoring Probe Installation Work Plan which was prepared by Golder Associates Inc., as required by Facility Monitoring 4.c. of the Monitoring and Reporting Program Order R5-2014-0830 for LF-1 Compost Area, Recology Yuba Sutter and Feather River Organics.

The following statement is provided, as required, "I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

Sincerely,

A handwritten signature in blue ink, appearing to read 'Drew Lehman', is written over the word 'Sincerely,'.

Drew Lehman
Director, Environment & Planning

Attachment

cc: M. Okamoto, State Water Resources Control Board
P. Donoho, Yuba County Environmental Health Department
B. Clarkson, P. Graham, S. Kendall, D. Vaughn, P. Yamamoto, Recology
B. Schussman, Perkins Coie



December 22, 2014

Project No. 1419069

Mr. Jordan Norris
Recology Ostrom Road
5900 Ostrom Road
Wheatland, CA 95692

RE: SOIL MOISTURE MONITORING PROBE INSTALLATION WORK PLAN, RECOLOGY YUBA SUTTER AND FEATHER RIVER ORGANICS, MARYSVILLE, CALIFORNIA

Dear Jordan:

Golder Associates Inc. has prepared this work plan to install soil moisture monitoring probes at Recology Yuba Sutter/Feather River Organics (Figure 1). The work plan has been prepared for submittal to the Central Valley Regional Water Quality Control Board (RWQCB). The RWQCB transmitted the *Monitoring and Reporting Program (MRP) Order R5-2014-0830 for LF-1 Compost Area, Recology Yuba Sutter and Feather River Organics* by letter dated December 5, 2014. The transmittal letter included a requirement to submit a work plan proposing to install soil moisture instrumentation described in *Facility Monitoring 4.c.* of the MRP by December 22, 2014.

The MRP requires “a minimum four sets (clusters) of soil moisture probes for the 15 acre compost operations area. Each cluster shall contain a minimum of three sensors that can measure volumetric soil moisture. One sensor or probe should be buried at the interface of the low permeability pad and the final soil cover. The next two probes should be buried at depths of one foot and two feet below the top probe.”

Compost Area Pad Construction

The compost area overlies Landfill 1 (LF-1), which was previously closed in the 1980's in accordance with the regulations at the time. Based on test pitting and hand auger holes, LF-1 has a soil cover that has been shown to be approximately 2- to 3-feet thick.¹ The entire compost pad aggregate base surfacing was rebuilt in 2014 in accordance with a RWQCB approved work plan. The pad was constructed with a minimum 3% slope, with at least 6 inches of low permeability material, under third party CQA and thickness monuments installed.

Proposed Soil Moisture Probe Locations

Four locations within the compost area have been selected for the soil moisture probe clusters (see Figure 2 for probe locations). The locations were selected to provide representative data in spatially separated areas of the compost pad and allow for long-term protection from damage due to site operations.

Proposed Soil Moisture Probe Selection

Campbell Scientific CS650 soil moisture sensors (or equivalent) are recommended for installation (see attached Brochure). These sensors have 30 cm long probe rods and will be connected to a battery-powered data logger to record the soil moisture measurements.

¹ Golder Associates Inc., Subsurface Characterization of the Compost Pad at the Recology Yuba-Sutter Facility, Marysville, California, February 15, 2013.

g:\projects\yuba sutter\1419069 (rys soil moisture install workplan)\soil moisture probe install work plan 12-22-14.docx

Golder Associates Inc.

425 Lakeside Drive
Sunnyvale, CA 94085 USA

Tel: (408) 220-9223 Fax: (408) 220-9224 www.golder.com



Golder Associates: Operations in Africa, Asia, Australasia, Europe, North America and South America

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The soil moisture sensors determine volumetric water content of the soil surrounding the probe rods. The CS650 is configured as a water content reflectometer, with the two parallel rods forming an open-ended transmission line. The two-way travel time of the electromagnetic waves that are induced on the rod varies with soil water content. The travel time of the reflected wave increases with increasing water content and decreases with decreasing water content, hence the name water content reflectometer. The CS650 automatically compensates for changes in electrical conductivity that can affect the water content measurements.

Proposed Soil Moisture Probe Installation

A test pit will be excavated at each location to a depth of approximately 3 feet. Assuming the compost pad is 0.5 feet thick, the three probes in each cluster will be placed at depths of approximately 0.5 feet, 1.5 feet, and 2.5 feet. Figure 3 presents the proposed soil moisture probe construction details.

Following test pit excavation, one side wall will be cleaned to provide a relatively smooth surface to install the probes. Each probe will be inserted horizontally into the side wall soil by pushing by hand to avoid damage to the probe. An insertion tool supplied by the manufacturer may be required to aid in keeping the probe rods parallel during installation. The horizontal orientation allows the sensors to detect the passing of wetting fronts or other vertical water fluxes.

The cables from sensors will be buried below the ground surface and will be routed via plastic conduit to a battery powered data logger.

The test pits will be backfilled with the excavated material to restore the excavation back to the original conditions, with the compost pad aggregate base re-installed. The replacement of the soil cover and compost pad will be observed by Golder staff. The soil moisture probe installation and proper test pit backfilling will be documented in a letter report.

Proposed Soil Moisture Probe Monitoring

The soil moisture probe measurements will be collected monthly for presentation in the monthly and annual reports.

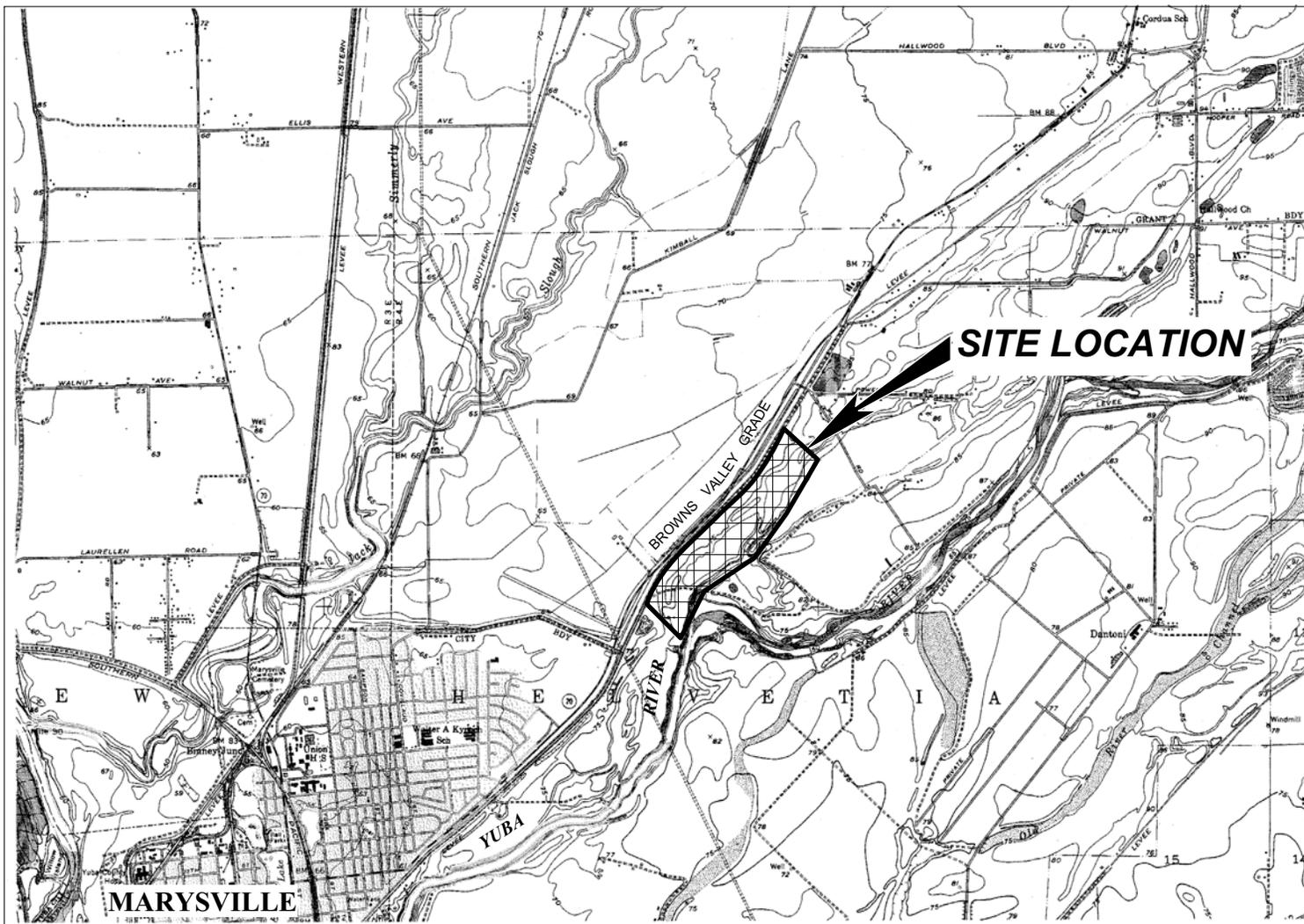
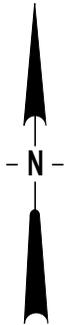
Please feel free to call if you have any questions regarding this work plan.

Sincerely,
GOLDER ASSOCIATES INC.



Kris H. Johnson, P.G. 4496, C.E.G. 1763
Associate and Senior Consultant

Attachments: Figure 1 – Site Location
Figure 2 – Proposed Soil Moisture Probe Locations
Figure 3 – Proposed Soil Moisture Probe Construction Diagram
Brochure for Campbell Scientific CS650 and CS655 Soil Water Content Reflectometers



SCALE: 0 4000 8000 FEET



Base map from USGS 7.5' Quad. Map:
Yuba City, CA (PR 1973).



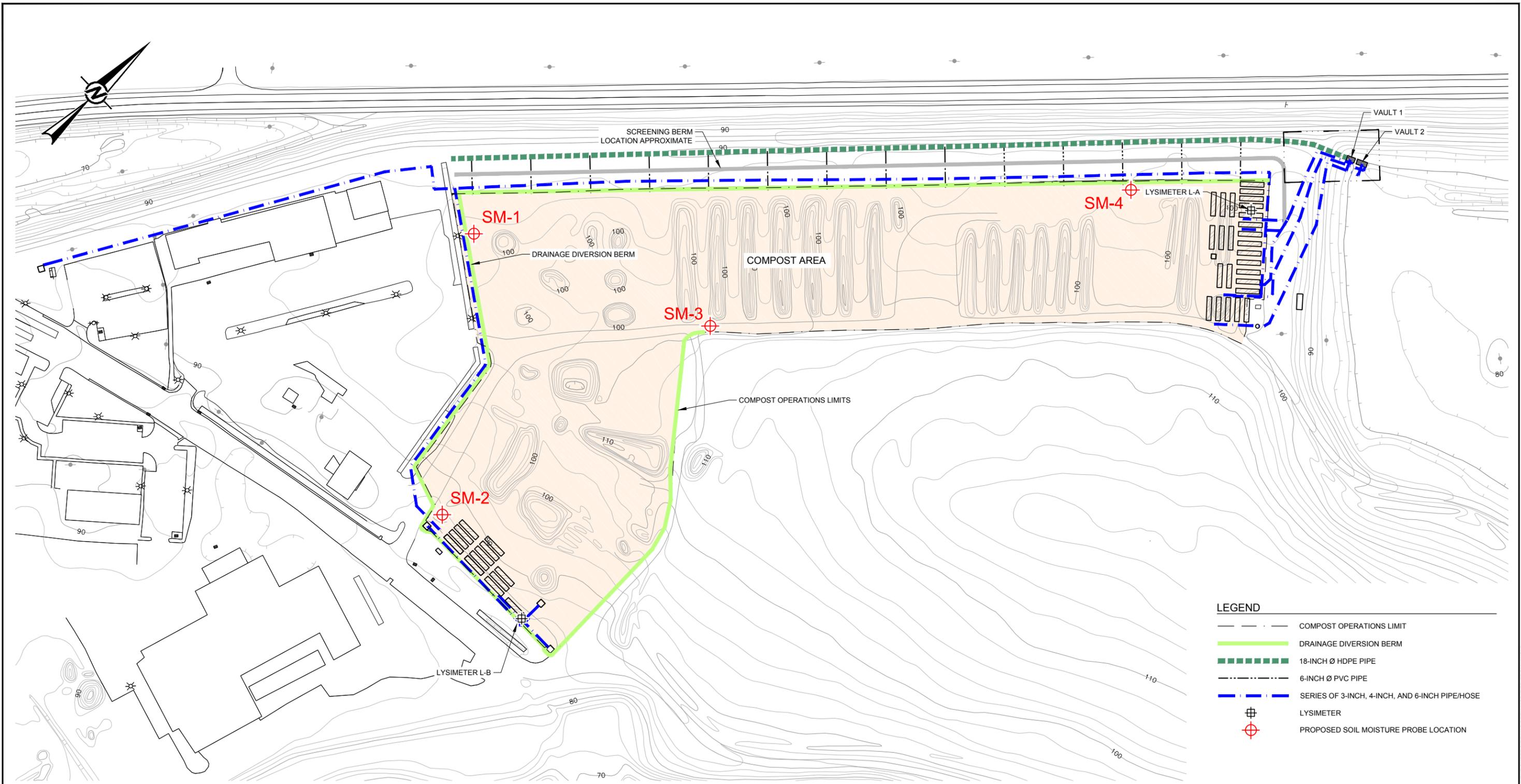
RECOLOGY YUBA SUTTER LANDFILL
RECOLOGY YUBA SUTTER
YUBA COUNTY, CALIFORNIA

SITE LOCATION

FIGURE

1

PROJECT NO.
053-7442-13



LEGEND

	COMPOST OPERATIONS LIMIT
	DRAINAGE DIVERSION BERM
	18-INCH Ø HDPE PIPE
	6-INCH Ø PVC PIPE
	SERIES OF 3-INCH, 4-INCH, AND 6-INCH PIPE/HOSE
	LYSIMETER
	PROPOSED SOIL MOISTURE PROBE LOCATION

GENERAL NOTES

1. TOPOGRAPHY PROVIDED BY AERIAL DATA INC. DATE OF TOPOGRAPHY: APRIL 30, 2012.



Path: \\nasarament\shared\Sheel\YSD\LP\CIVIL\2012\11-14-Compost_SM_Probe_Locations.dwg

1 in = 100 feet IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI D

2014-12-18	PROPOSED SOIL MOISTURE PROBE LOCATIONS	KMM	KJ	KJ	KJ
Rev.	YYYY-MM-DD DESCRIPTION	PREPARED	DESIGN	REVIEW	APPROVED

CLIENT
RECOLOGY YUBA SUTTER
 3001 NORTH LEVEE ROAD
 MARYSVILLE, CA 95901

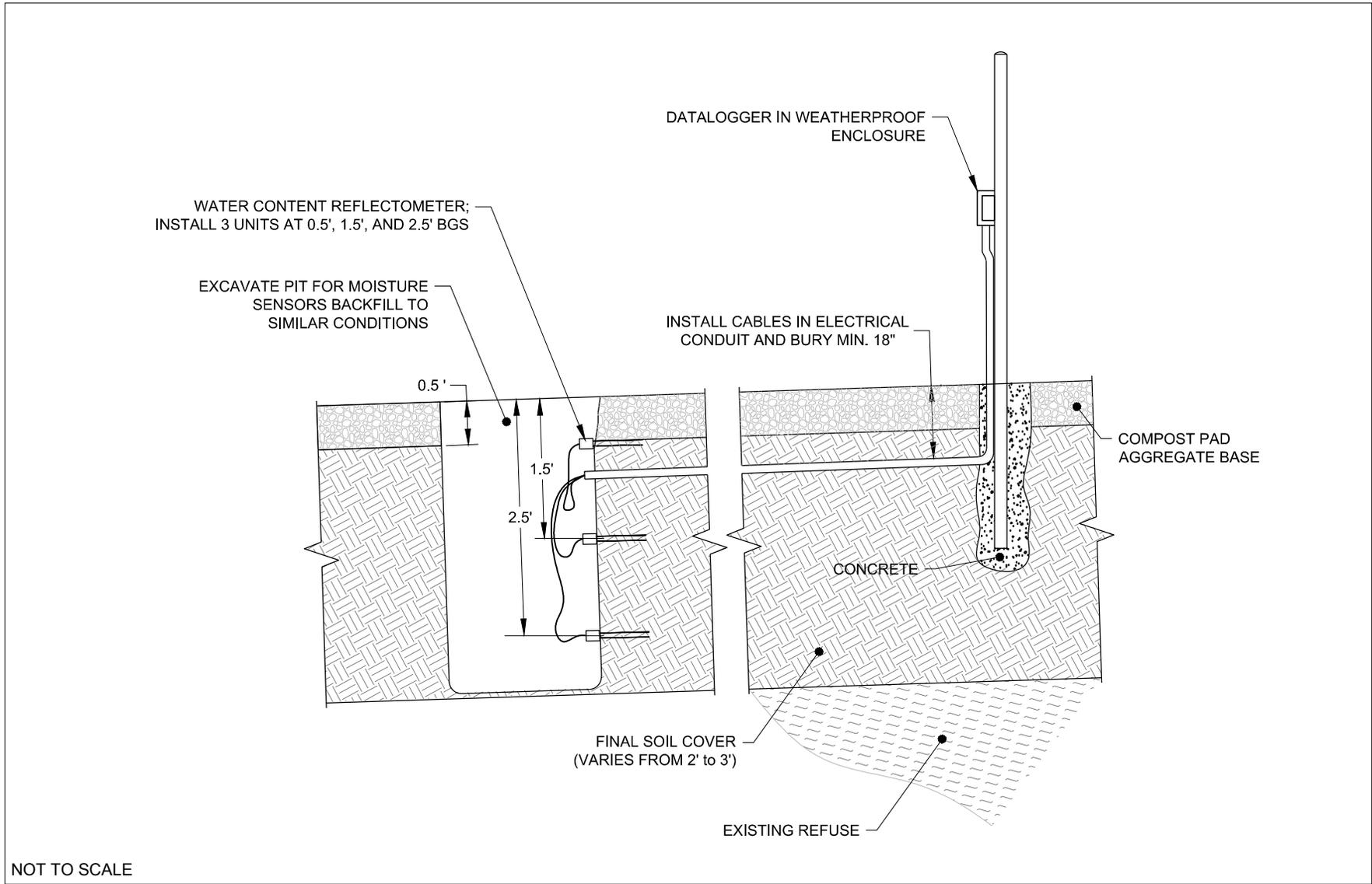
CONSULTANT

 Sunnyvale
 425 Lakeside Drive
 Sunnyvale, CA 94085
 Phone: (408) 220-9223
 www.golder.com

PROJECT
FEATHER RIVER ORGANICS
 RECOLOGY YUBA SUTTER FACILITY
 MARYSVILLE, CALIFORNIA

TITLE
PROPOSED SOIL MOISTURE PROBE LOCATIONS

PROJECT No. 141069
 Rev. 1 of 1
 FIGURE 2



CLIENT
RECOLOGY YUBA SUTTER
3001 NORTH LEVEE ROAD
MARYSVILLE, CA 95901

CONSULTANT



YYYY-MM-DD 2014-12-22

PREPARED KMM

DESIGN KHJ

REVIEW KHJ

APPROVED KHJ

PROJECT
FEATHER RIVER ORGANICS
RECOLOGY YUBA SUTTER FACILITY
MARYSVILLE, CA

TITLE

SOIL MOISTURE MONITORING PROBE INSTALLATION DIAGRAM

PROJECT No.
141069

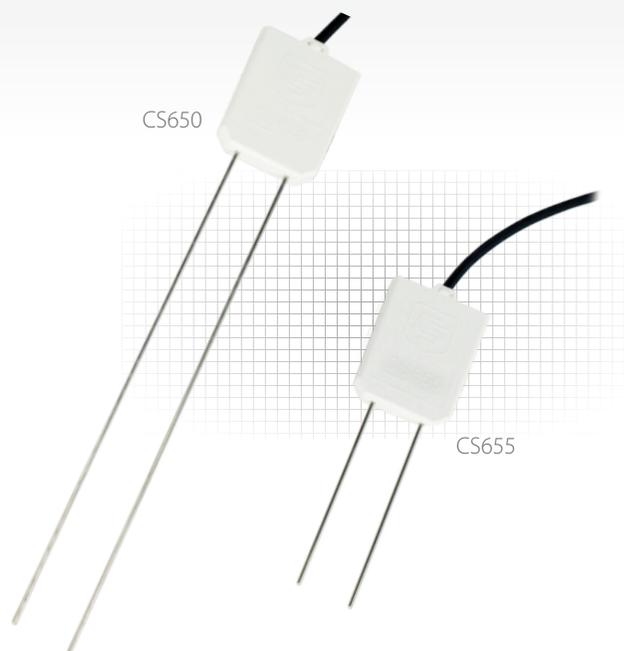
Rev.

FIGURE
3



CS650 and CS655

Soil Water Content Reflectometers



Innovative

More accurate in soils with high bulk EC

Benefits and Features

- › More accurate water content measurements in soils with solution EC ≤ 3 dS m⁻¹ (CS650) or ≤ 8 dS m⁻¹ (CS655) without performing a soil-specific calibration
- › Larger sample volume reduces error
- › Measurement corrected for effects of soil texture and electrical conductivity
- › Estimates soil-water content for a wide range of mineral soils
- › Versatile sensor—measures dielectric permittivity, bulk electrical conductivity (EC), and soil temperature

Overview

The CS650 and CS655 soil water content reflectometers use innovative techniques to monitor soil volumetric water content, bulk electrical conductivity, and temperature. They consist of two stainless-steel rods connected to a printed circuit board. The

CS650 has 30 cm rods, and the CS655 has 12 cm rods. The probe's circuit board is encapsulated in epoxy and a shielded cable is attached to the circuit board for datalogger connection.

Ordering Information

Water Content Reflectometers

For either reflectometer, must choose a cable termination option and SDI-12 Address option (see below).

CS650-L 30 cm Water Content Reflectometer with user-specified cable length. Enter cable length, in feet, after -L. Refer to specifications for maximum cable length.

CS655-L 12 cm Water Content Reflectometer with user-specified cable length. Enter cable length, in feet, after -L. Refer to specifications for maximum cable length.

Cable Termination Options (choose one)

- PT Cable terminates in pigtailed for direct connection to datalogger's terminals.
- PW Cable terminates in a connector for attachment to a prewired enclosure.

SDI-12 Address Options (choose one)

- DS SDI-12 Address is set to 0
- VS SDI-12 Address is set to the last digit of the probe's serial number (0 to 9).

Installation Tools and PC Interface

CS650G Rod Insertion Guide Tool with Pilot Rod that helps maintain the proper spacing and parallel orientation of the rods during probe insertion. It also helps the insertion of the probe in high density or rocky soils.

A200 Sensor to PC Interface (for configuring sensor)

DIN-Rail Accessories

The following accessories can facilitate wiring when several reflectometers need to be connected to one terminal.

25458 5 in. Din Rail Mounting Kit. A complete configuration requires terminal strips, end plates, and jumpers (see below).

15920 3-pin 4 mm Spring Loaded Din Rail Connectors that provide connection points for individual wires. Up to 20 of these terminal strips may be fastened to the 25458.

15909 Horizontal Jumper for Din Rail Connector that electrically connects terminals on the 15920 connectors.

15907 The 15907 End Plates separate the terminal strips.

questions & quotes: 435.227.9000

www.campbellsci.com/cs650



Measurement Method

The CS650 and CS655 measure propagation time, signal attenuation, and temperature. Dielectric permittivity, volumetric water content, and bulk electrical conductivity are then derived from these raw values.

Measured signal attenuation is used to correct for the loss effect on reflection detection and thus propagation time measurement. This loss-effect correction allows accurate water content measurements in soils with solution EC ≤ 3 dS m⁻¹ (CS650) or ≤ 8 dS m⁻¹ (CS655)

without performing a soil specific calibration. Soil bulk electrical conductivity is also calculated from the attenuation measurement.

A thermistor in thermal contact with a probe rod near the epoxy surface measures temperature. Horizontal installation of the sensor provides accurate soil temperature measurement at the same depth as the water content. Temperature measurement in other orientations will be that of the region near the rod entrance into the epoxy body.

Specifications

- › Sensing Volume¹: 7800 cm³ (CS650), 3600 cm³ (CS655)
- › Maximum Cable Length: 610 m (2000 ft) combined length for up to 10 sensors connected to the same datalogger control port.
- › Probe Head Dimensions: 85 x 63 x 18 mm (3.3 x 2.5 x 0.7 in)
- › Rod Diameter: 3.2 mm (0.13 in)
- › Rod Spacing: 32 mm (1.3 in)

Rod Length

- › CS650: 300 mm (11.8 in)
- › CS655: 120 mm (4.72 in)

Weight

- › CS650 without cable: 280 g (9.9 oz)
- › CS655 without cable: 240 g (8.5 oz)
- › Cable: 35 g per m (0.38 oz. per ft)

Soil Temperature

- › Measurement Range: -10° to + 70°C
- › Accuracy²: $\pm 0.5^\circ\text{C}$ for probe body buried in soil
- › Precision³: $\pm 0.02^\circ\text{C}$

Relative Dielectric Permittivity Measurements

- › Range: 1 to 81
- › Accuracy²

Range	CS650	CS655
1 to 40	$\pm(2\% \text{ of reading} + 0.6)$ for solution EC ≤ 3 dS m ⁻¹	$\pm(3\% \text{ of reading} + 0.8)$ for solution EC ≤ 8 dS m ⁻¹
40 to 81	± 1.4 for solution EC ≤ 1 dS m ⁻¹	± 2 for solution EC ≤ 2.8 dS m ⁻¹

- › Precision³: < 0.02

Volumetric Water Content Measurements

- › Range: 5% to 50%
- › Precision³: $< 0.05\%$

Accuracy²

- › CS650: $\pm 3\%$ typical in mineral soils, where solution EC ≤ 3 dS m⁻¹
- › CS655: $\pm 3\%$ typical in mineral soils, where solution EC ≤ 10 dS m⁻¹

Electrical Conductivity Measurements

- › Range

	CS650	CS655
Solution EC	0 to 3 dS m ⁻¹	0 to 8 dS m ⁻¹
Bulk EC	0 to 3 dS m ⁻¹	0 to 8 dS m ⁻¹

- › Accuracy²: $\pm(5\% \text{ of reading} + 0.05)$
- › Precision³: 0.5% of BEC

Electrical

- › Sensor Output: SDI-12; serial RS-232.
- › Warmup Time: 3 s
- › Measurement Time: 3 ms to measure; 600 ms to complete SDI-12 command
- › Power Supply Requirements: 6 Vdc to 18 Vdc; must be able to supply 45 mA @ 12 Vdc
- › Electromagnetic: CE compliant (EMC compliant performance criteria available upon request). Meets EN61326 requirements for protection against electrostatic discharge and surge. External RF sources can affect the probe's operation. Therefore, the probe should be located away from significant sources of RF such as ac power lines and motors.
- › Interprobe Interference: Multiple reflectometers can be installed within 4 inches of each other when using the standard datalogger SDI-12 "M" command. The SDI-12 "M" command allows only one reflectometer to be enabled at a time.

Current Drain (see graph in manual)

- › Active (3 ms): 45 mA typical @ 12 Vdc (80 mA @ 6 Vdc, 35 mA @ 18 Vdc)
- › Quiescent: 135 μA typical @ 12 Vdc
- › Average: $I = 0.09n + [3.5 + 0.024(n-1)]n/s$
Where,
I = average current in milliamps
n = number of probes
s = number of seconds between measurement

¹ Approximately 7.5 cm radius around each probe rod and 4.5 cm beyond the end of the rods.

² Accuracy specifications are based on laboratory measurements in a series of solutions with dielectric permittivities ranging from 1 to 81 and solution electrical conductivities ranging from 0 to 3 dS m⁻¹.

³ Precision describes the repeatability of a measurement. It is determined for the reflectometer by taking repeated measurements in the same material.

