

Materials List for

In situ Soil Moisture Sensors in Undisturbed Soils

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Materials

Name	Company	Catalog Number	Comments
System components, essential			This system is the typical micro-station used in the TxSON soil moisture network. The TxSON meteorological station is listed under optional components. https://access.onlinelibrary.wiley.com/doi/full/10.2136/vzj2019.04.0034
Battery, sealed rechargeable 12 V 12 AH	Campbell Scientific	BP12	7 amp-hour (AH) minimum
Charging regulator	Campbell Scientific	CH200	Charge regulator, needed for any unregulated solar panel
Conduit, schedule 40 PVC, 1 to 2" diameter	Any home supply store		Diameter sized appropriate to number of sensors and cable thickness. Length dependent on height of enclosure
Data acquisition software	Campbell Scientific	PC400	Free versions with limited programability, for more basic applications, manual downloads and simple sensor configurations
Data control platform	Campbell Scientific	CR300	Any SDI-12 compatible DCP is sufficient. Many also have integrated cellular modems available
Enclosure (NEMA), 10 x 12 inch, -DC 2 conduits for cables, -MM tripod mast mount	Campbell Scientific	ENC10/12-DC-MM	Two bottom conduits are required for above and below ground instruments
Mounting pole (47 inch) with pedestal legs	Campbell Scientific	CM305-PL	Smaller footprint, not tall enough for weather sensors
Rain Gage with 8 in. Orifice, 20 ft of cable	Campbell Scientific	TE525WS-L20-PT	Recommend installing rain gage on a separate vertical pole some distance from the instrument stand
Sensors, 12 cm water content reflectometer, 17ft cable, -VS SDI-12 address varies	Campbell Scientific	CS655-17-PT-VS	See Supplement Table 1 for more options

Solar panel, 20 W	Campbell Scientific	SP20	Use higher wattage panels for northern sites and lower for southern sites with higher exposure
System components, optional			
Cellular Antenna, 2 dB multiband omnidirectional	Campbell Scientific	32262	Directional antennas can improve signal, if the tower location is known.
Cellular modem for Verizon/ATT	Campbell Scientific	CELL210/205	Provider is site-dependent
Crossarm mount, 4 feet	Campbell Scientific	CM204	Ideal for mounting 2 m sensors
Data acquisition software, advanced	Campbell Scientific	Loggernet	More advanced commercial software that includes remote communications options and advanced programming
DIN Rail Perforated Steel	Phoenix Contact	1207639	Used to mount terminal blocks inside enclosure
Galvanized steel water pipe, 1.5 or 2 inch diameter, 10 ft in length	Any home supply store		The most economical option for an instrument mast. Can be cut to length. Replaces the 47 inch mounting pole with legs
Instrument tripod, 10 foot stainless-Steel with grounding kit	Campbell Scientific	CM110	Taller instrument stand for 2 m meteorologic sensors
Lever nut connectors, five ports (Figure 5)	Digi-Key	222-415/VE00/1000	Connect one SDI-12 wire to 4 sensor wires. Alternative to DIN rail.
Null modem cable	Campbell Scientific	18663	Interface cable between DCP with modem. Not required for integrated cellular modems
Plug-in bridge - FBS 3-5	Phoenix Contact	3030174	Used to connect the circuit of multiple terminal blocks. Available at mouser.com
Secure Set Foam, 10 Post Kit (2 gallon)	Any home supply store		Alternative to concrete when using a steel pipe mast or for precipitation gage pole. Two part foam mixture
Sensor, air temperature and relative humidity, 10 ft cable	Campbell Scientific	HygroVUE10-10-PT	Lower accuracy and precision option. Replacable chips are the fastest means to meet annual calibration cycles.
Sensor, solar radiation pyranometer, digital thermopile	Campbell Scientific	CS320	Most inexpensive, ISO class C (second class). Better options are available but much more expensive
Sensor, wind speed anemometer, 10 ft cable	Met One	014A-10	More expensive options include wind direction, or sonic sensors with no moving parts
Solar shield for air temperature and relative humidity sensor	Campbell Scientific	RAD10E	All air temperature sensors require shielded from the sun
Terminal blocks (Figure 5), feed-through	Phoenix Contact	3064085	The most secure method to connect multiple SDI-12 sensor wires. Available at mouser.com
Field tools, essential			
Freezer bags: quart and gallon sized	Any grocery store		Storage for soil samples collected for characterization
Miscellaneous digging tools including hand trowl, flat spade, and pointed spade	Any home supply store		Backup tools to aid excavation
Shovel (Sharpshooter) 16 in. D-handle drain spade	Razorback		Manual tool for excavating soil pit. Any narrow pointed spade will work.
Shovel, trenching, 4 in wide steel blade	Any home supply store		Ideal trenching tool for burying cable or conduit
Soil auger (<4 in diameter) with T-handle or and extension bar as needed for r test holes	AMS Samplers	400.06	Recommended for test holes. The auger type should match soil, but 'regular' performs well in most soils

Tarp (plastic) or plywood sheet	Any home supply store		Soil management during excavation and trenching
Field tools, optional			
2,000 lb Mini Excavator	Sunbelt Rentals	350110	Rental equipment for mechanical excavation
Breaker or digging bar	Any home supply store		Useful to break rocks and cut roots during excavation
Galvanized Cattle Fence Panel, 16 ft x 50 in	Tractor Supply Co.	350207799	Recommend cutting fencing panels into 8' sections
Pick mattock or pulaski	Any home supply store		Great for loosening in hard or rocky soils
Post Hole Auger Hydraulic Tow Behind with 18" diameter auger	Sunbelt Rentals	700033	Rental equipment for mechanical excavation
Post hole digger, 48 in handle	Any home supply store		Useful to clear soil in bottom of pit, or for test holes
Steel fence T-posts, 6 feet tall and fence post driver, ~14 lb.	Any home supply store		Fencing support and installation
Steel rake	Any home supply store		Ideal for smoothing disturbed soil at field area
Every Day Carry (EDC), recommendations for any field technician's toolbag			
Adjustable wrench with insulated handle	Any home supply store		
Assorted UV-resistant zip ties	Any home supply store		Critical for neat wiring
Diagonal cutting pliers	Any home supply store		Efficient way to cut light and heavy wires and snip zip ties
Digital camera, GPS, and compass	Misc.		Ideally, these are all on your smartphone
Digital multimeter	Any home supply store		Key tool for troubleshooting power and connectivity issues in electrical systems
Electrical tape	Any home supply store		Non-black tape can be used for labeling
Electrician's Puddy for filling entrance holes of enclosures	Any home supply store		Needed to close and seal all conduit ports in the enclosure
Hex key sets in both standard and metric sizes	Any home supply store		Required for many sensor mounts
Magnetic torpedo level (8 to 12")	Any home supply store		Needed to get instrument stand vertical and leveling any meteorological sensors
Metric tape measure	Any home supply store		Critical for inserting probes and sampling soils - both use metric depths.
Pliers: needle nose, lineman's, and channel-lock	Any home supply store		Lineman's pliers are essential for bailing wire fences.
Portable drill, bits, nut drivers	Any home supply store		
Ratchet wrench and appropriate socket sizes	Any home supply store		Ratch wrenches can get into tight spaces around sensor mounts where standard box wrenches do not work
Safety: first aid kit, water (5 gallons), trash bags, gloves, sunscreen, insect repellent	Any home supply store		
Screw drivers: small and large size with insulated handles	Any home supply store		Screws on DCP and terminal blocks are very small. Small flat and phillips heads are required. Larger tools will also come in handy

Sharpies, pencils, and notebook	Forestry Supplier		Basic record keeping is essential for metadata
Step ladder, 6 ft	Any home supply store		Hard to install 2m sensors without a ladder
Utility knife and box cutter	Any home supply store		
Vegetation control: hand loppers, weed whacker, saw	Any home supply store		Depending on the environment, vegetation can quickly overwhelm a fenced off areas.
Wire strippers (8-20 gage)	Any home supply store		Essential tool for preparing wires for insertion into DCP or terminal blocks. Self-adjusting strippers are the latest rage
Annual Maintenance Supplies			
Battery cleaner (baking soda) and brush	Any grocery store		
Cleaning: compressed air, isopropyl alcohol, tooth brush, pipe cleaners, paper towels	Any grocery store		
Desiccant, silica gel bags	Clariant	Desi Pak	Reusable after oven drying at 105 °C for over 24 h. Swap out annually.
Field calibration device for rain gage	R.M. Young	52260	Device that drips water into a rain gage at varying intensity
Handheld Weather Meter	Kestrel Instruments	0830	Direct measurement of air temperature, relative humidity, and wind speed for field verification
One quart and one gallon freezer bags	Any grocery store		Storage for any gravimetric soil samples
Portable soil moisture sensor	Delta-T Devics	SM150T	A variety of sensors exist. See evaluation at https://access.onlinelibrary.wiley.com/doi/pdf/10.1002/vzj2.20033
Soil core sampler, 2-1/4 in. Diameter	Soilmoisture Equipment Corp.	0200	Gravimetric soil moisture and bulk density sampler