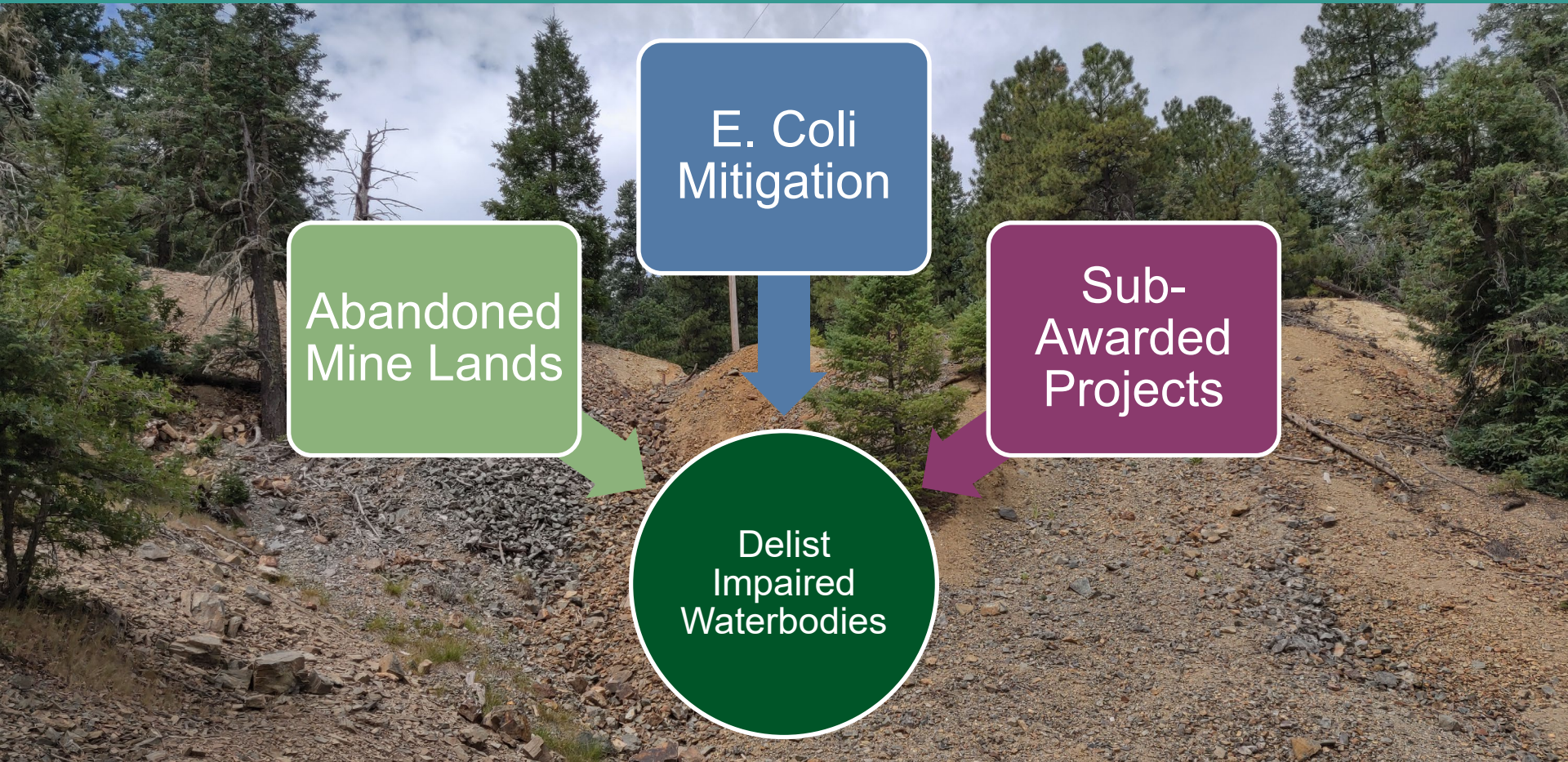
ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY

Leveraging Low -Cost Remote Environmental Monitors to Measure Stream Health in the Arid Southwest

Jason Elliott, R.G.
Senior Hydrogeologist
June 2025

Surface Water Quality Sampling

Watershed Improvement Unit



San Pedro

Storm Flows transport E. Coli

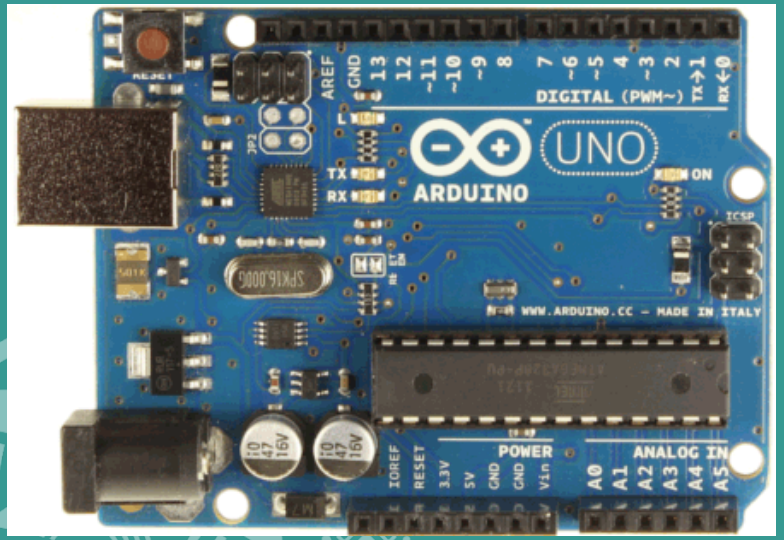
Sampling Methods – First Flush

Room for Improvement

Arduino

Hardware and Software

- creative commons
- open source hardware and software
- expanded without licensing fees.



Open Source

Open source is a development model that promotes universal access and redistribution to a product's design or blueprint, including subsequent improvements by others.

It gives people the freedom to share knowledge while encouraging commerce through open exchange of designs and ideas.

Surrogate for customer support.

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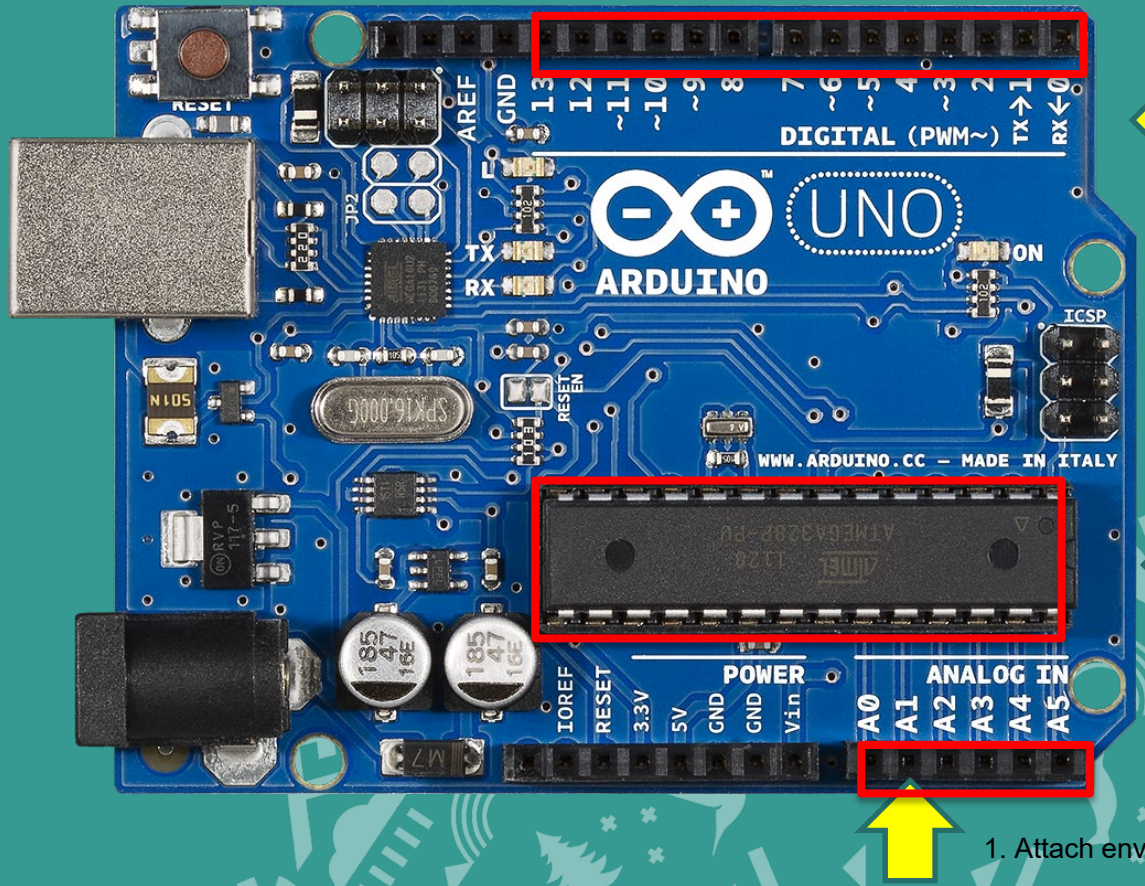
Arduino Function

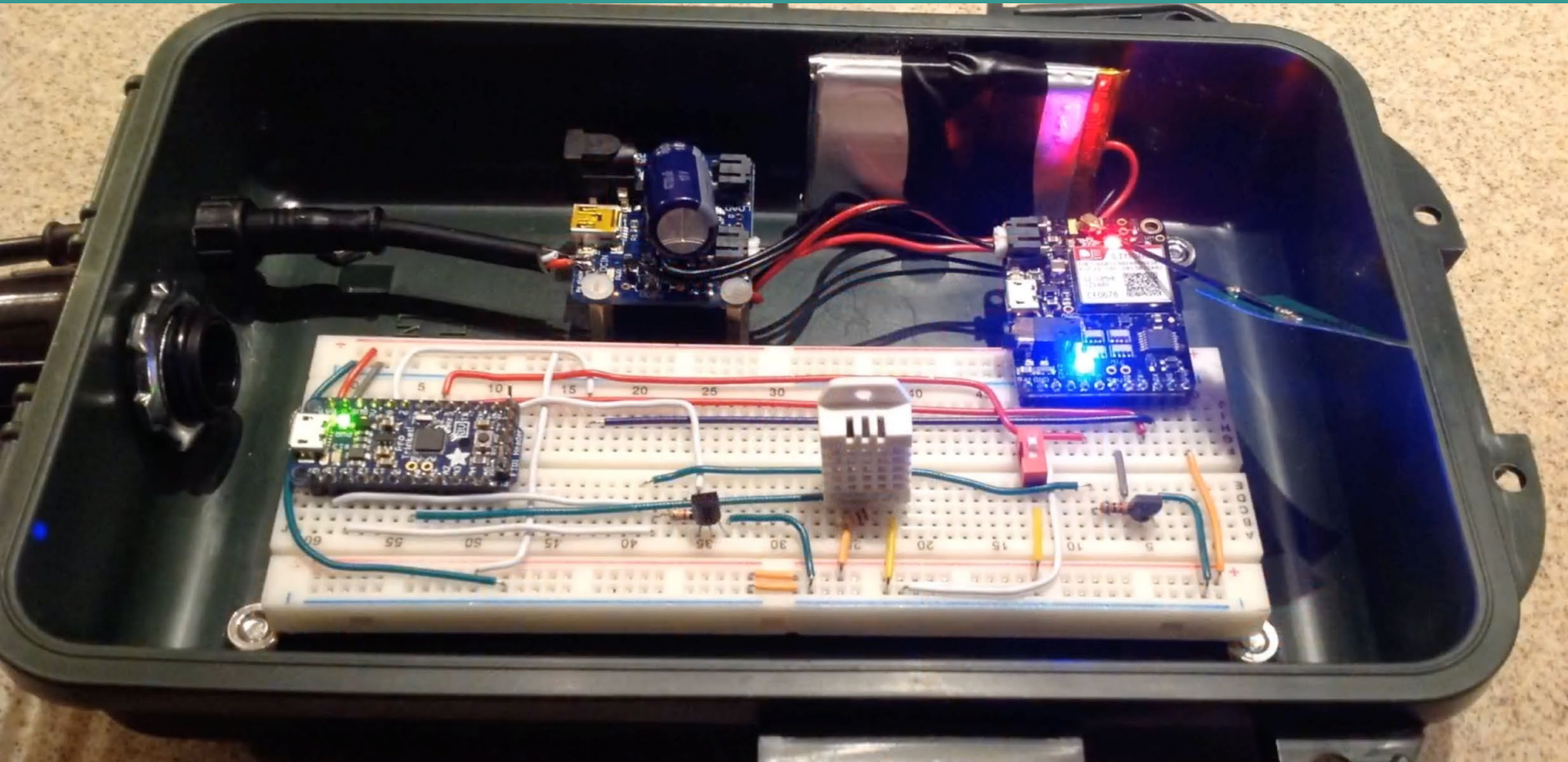


3. … to engage motors, servos, LCD displays, cell phones, servers, etc.

2. Program the microcontroller to record and respond to sensors

1. Attach environmental sensors to socket headers

Prototype Cellular REM



REM Development

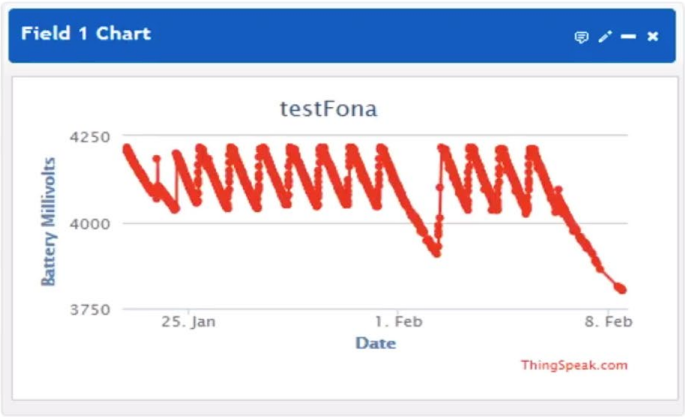
testFona

Channel ID:	62784
Author:	Biod101
Access:	Public

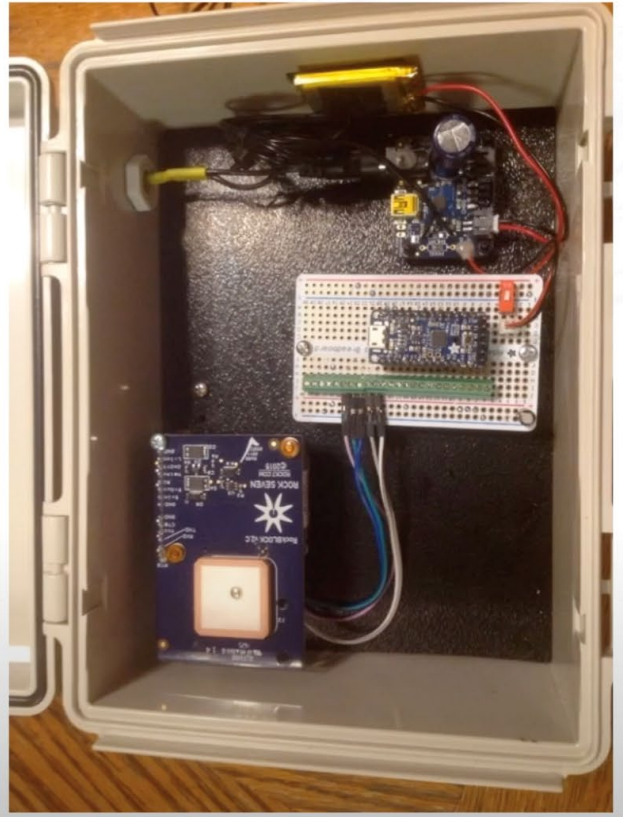
Registering battery voltage to the web using a solar powered ProTrinket and FONA breakout. Cycling shows battery charging in the morning, and then discharging over the course of the day.

Private View | Public View | Channel Settings | API Keys | Data Import / Export

Add Visualizations | Data Export | MATLAB Analysis



Prototype Satellite REM



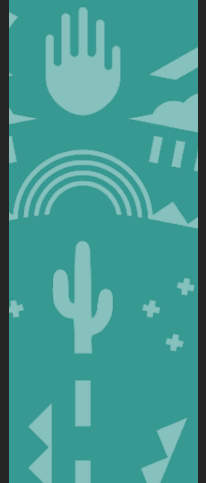
REM Documentation

Arizona Department of Environmental Quality

Remote Environmental Monitoring

Background on New Operational Standards

Hans Huth
11-19-2021



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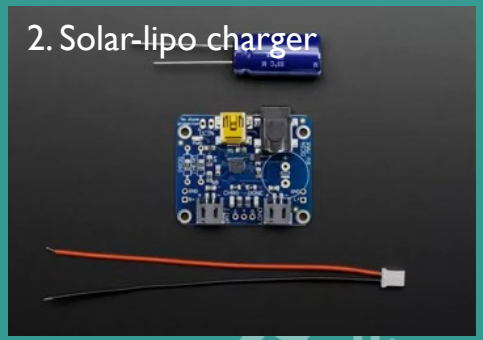
Components

1. Lithium ion battery

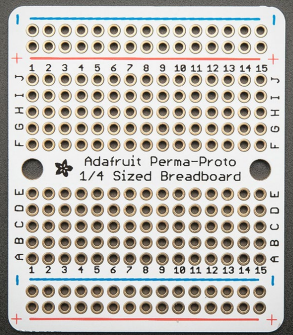
2. Solar-lipo charger



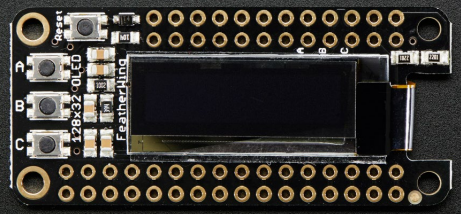
3. RockBLOCK 9603 satellite modem

4. Solar panel (outside of box)

5. Quarter-sized breadboard

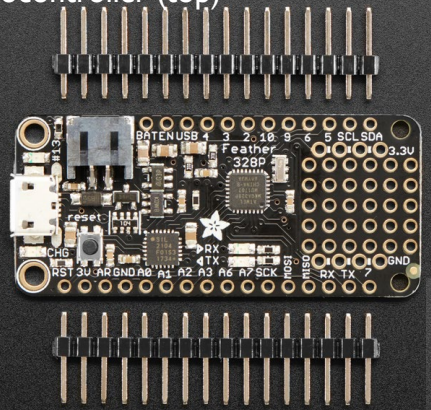


6. Adafruit FeatherWing OLED



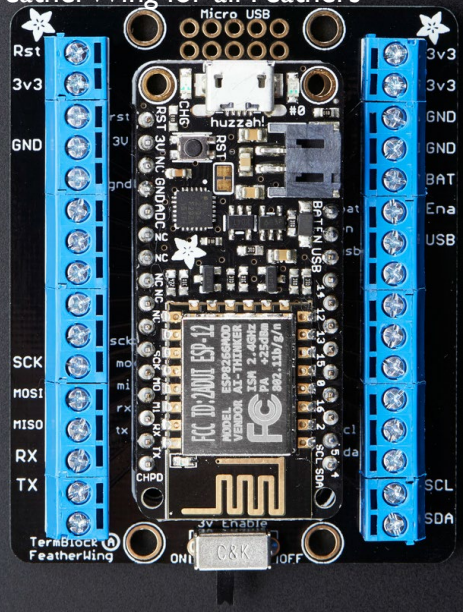
Components, continued

7. Microcontroller (top)



Microcontroller (bottom)
Adafruit Feather 328P

8. Terminal Block Breakout FeatherWing for all Feathers

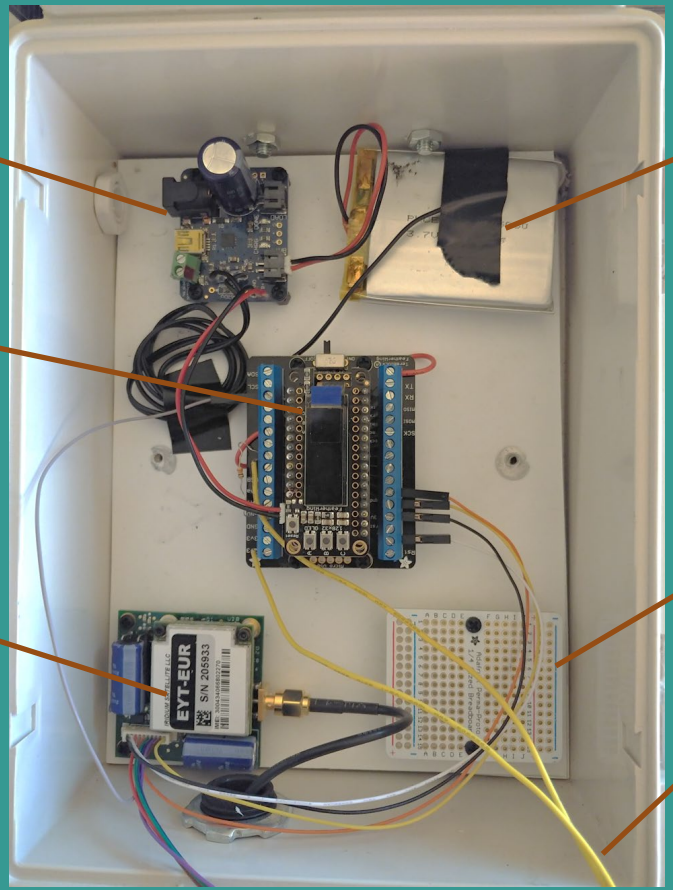


Finished product (inside)

2. Solar lipo charger

Stacked:
6. OLED (top)
7. Microcontroller (middle)
8. Terminal block (bottom)

3. RockBLOCK satellite modem



1. Lithium ion battery

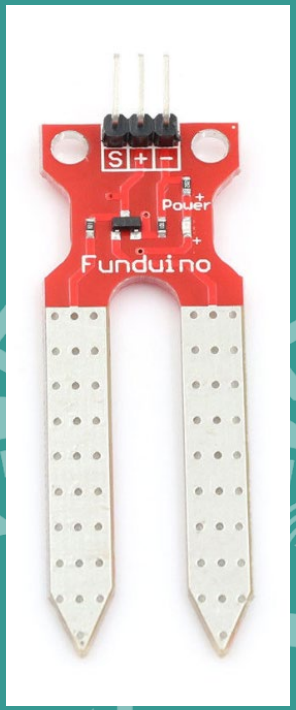
5. Quarter-sized breadboard

Wires to float sensor (not listed in components)

Sensors

Ultrasonic

Moisture



Float

Finished product (outside)

4. Solar Panel

Communication

2.

RockBlock Server
ROCK SEVEN
LOCATION COMMUNICATION

3.Delivery Groups

ThingSpeak™

4. React /ThingHTTP (if condition is met)

5.

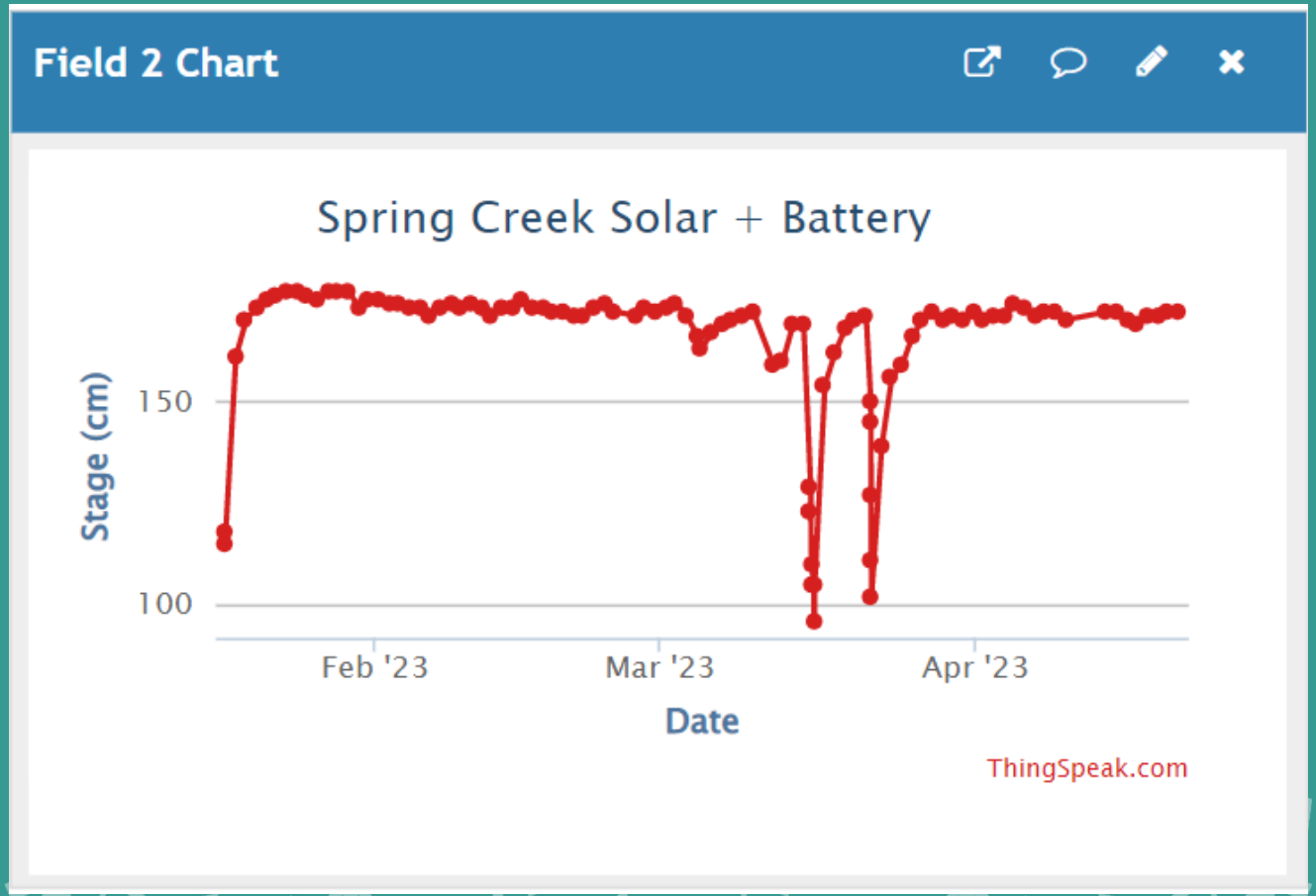
twilio
SMS

Twilio accepts message data and sends the message to the number set in ThingHTTP.

Message is received on phone. Within a minute of step 1

1. Rock Block Modem sends sensor data

ThingSpeak Output



REM Support Program

Commercial Comparison

- Box, battery, electronics, program, antennae
- Transmits text message alarms to a text enable phone or "pager"
- Communicates with a "modem-equipped" PC for remote data retrieval/ control
- Remote control of sampler functions using a terminal program
- Powered by and communicates with the autosampler
- Customer support

Item	Qty	Description (Part Number)	Unit Price	Ext. Price
1)	1	SPA 1563. GSM Cell Phone Modem Package. This cell phone modem accepts SIM cards purchased by the customer from their preferred provider. Connects to 4100/4200 flow meters & 6712 samplers. Text message output capable for 6712 samplers. Primarily for use in overseas and select U.S. markets. (P/N 605314563)	$2,266.00	$2,266.00
		Freight		$28.00
		Total		$2,294.00

Delivery: 3-4 weeks receipt of purchase order. Please note that the above total does not include any applicable taxes.

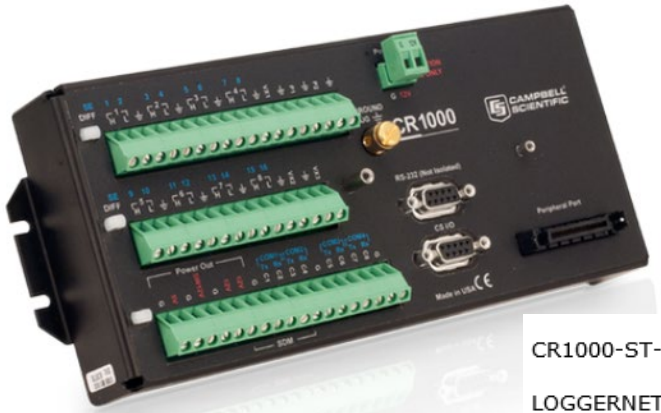
Commercial Options

CAMPBELL SCIENTIFIC
WHEN MEASUREMENTS MATTER

CR1000

Measurement and Control Datalogger

CR1000 Measurement and Control System / CR1000



- Robust Construction
- Data acquisition and peripheral control
- Multiple communication peripherals (separate)
- Customer support
- Proprietary Sensors with code examples

CR1000-ST-SW-NC - Measurement and Control Datalogger (1) $1495.00

LOGGERNET-SDK-D - LoggerNet Software Development Kit (1) $555.00

17324 - CR1000WP Insulated Terminal Cover (1) $25.00

CR1000KD - Keyboard/Display for the CR1000, CR800, or CR6 (1) $280.00

Commercial Options

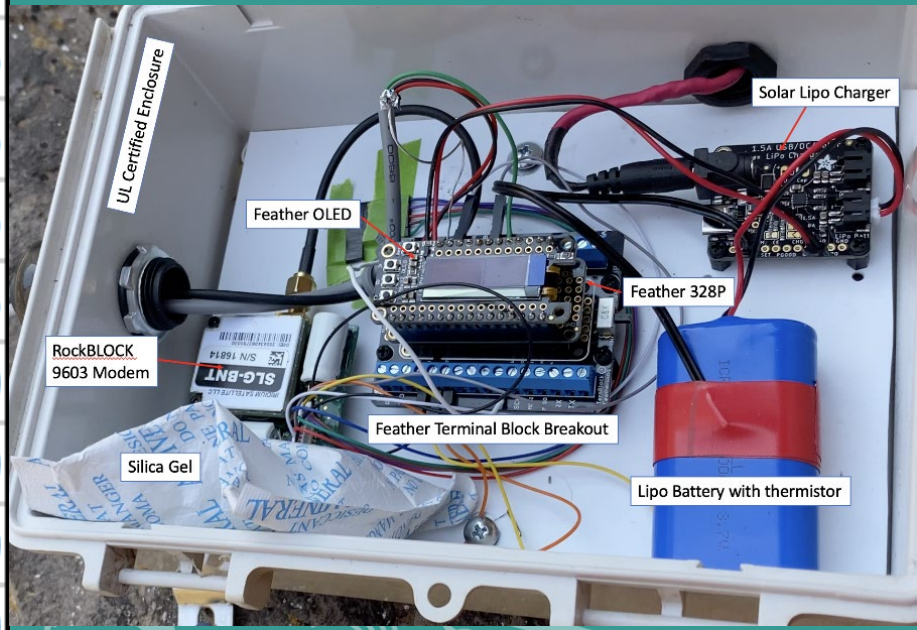
Equipment

Line	Product Description	Part Number	Unit of Sale	Qty.	Unit List Price	Total List Price	Disc.	Customer Total Price
1.	Aqua TROLL 600, Vented 0-9m	0074080	Each	1	$4,695.00	$4,695.00	18.00%	$3,849.90
2.	Aqua TROLL 500/600 Wiper	0063500	Each	1	$1,195.00	$1,195.00	18.00%	$979.90
3.	Aqua TROLL Temperature/Conductivity Sensor	0063460	Each	1	$895.00	$895.00	18.00%	$733.90
4.	Aqua TROLL pH/ORP Sensor	0063470	Each	1	$795.00	$795.00	18.00%	$651.90
5.	Aqua TROLL Turbidity Sensor	0063480	Each	1	$1,095.00	$1,095.00	18.00%	$897.90
6.	Aqua TROLL RDO Sensor (includes RDO-X Cap)	0063450	Each	1	$1,095.00	$1,095.00	18.00%	$897.90
7.	Rugged Twist-Lock Cable, Vented, TPU, No Reel, Twist-Lock,	0052000-POLY-NONE-TWISTLOCK-	10m	1	$272.50	$272.50	18.00%	$223.45
8.	TROLL Com Bundle USB Direct Connect (Programming Cable)	0052510	Each	1	$795.00	$795.00	18.00%	$651.90
9.	TROLL Link 201 Telemetry System - Iridium Satellite (Isi Data Center Link)	0058140	Each	1	$2,295.00	$2,295.00	18.00%	$1,881.90
10.	External Battery Kit for Use w/ Optional Solar Panels. Includes 14 Ah Battery. Combine w/ Existing System for 21 Ah Capacity.	0058950	Each	1	$595.00	$595.00	18.00%	$487.90
11.	Optional 20-W Solar Panel (Requires Solar Panel Mounting Bracket)	1016480	Each	1	$365.00	$365.00	18.00%	$299.30
12.	Solar Panel Mounting Bracket for 10W/20W Panel	0058290	Each	1	$70.00	$70.00	18.00%	$57.40
13.	Data Service Activation Fee Per Unit	0098350	Each	1	$35.00	$35.00	18.00%	$28.70
14.	Data Service 201 Monthly Fee Per Unit	0098340	Each	12	$53.00	$636.00	18.00%	$521.52
15.	HydroVu Professional Prepaid Code (Months)	0102510	Each	12	$20.00	$240.00	18.00%	$196.80
							Subtotal:	**$12,360.27**

$4,125.42

Satellite REM Comparison

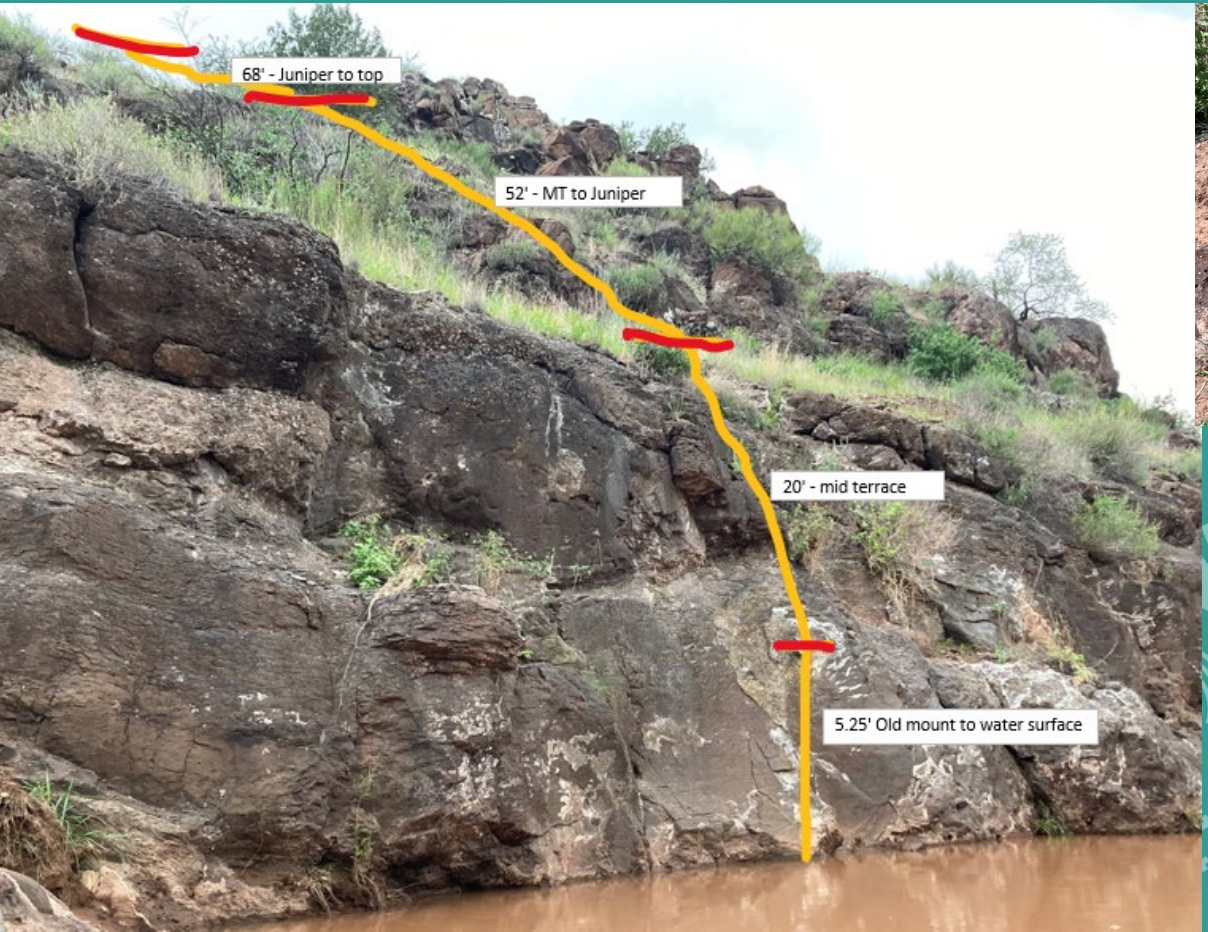
Item	Cost/ea
Feather 238P	$12.50
Terminal Block	$14.95
OLED screen	$14.95
Rock Block 9603 Modem	$299.95
Rock Block Connector	$4.95
Enclosures	$20.00
Solar Panels	$30.00
LiPo Solar Charge Controllers	$15.00
ultra sonic sensor	$110.00
Total	$522.30



Spring Creek

Spring Creek

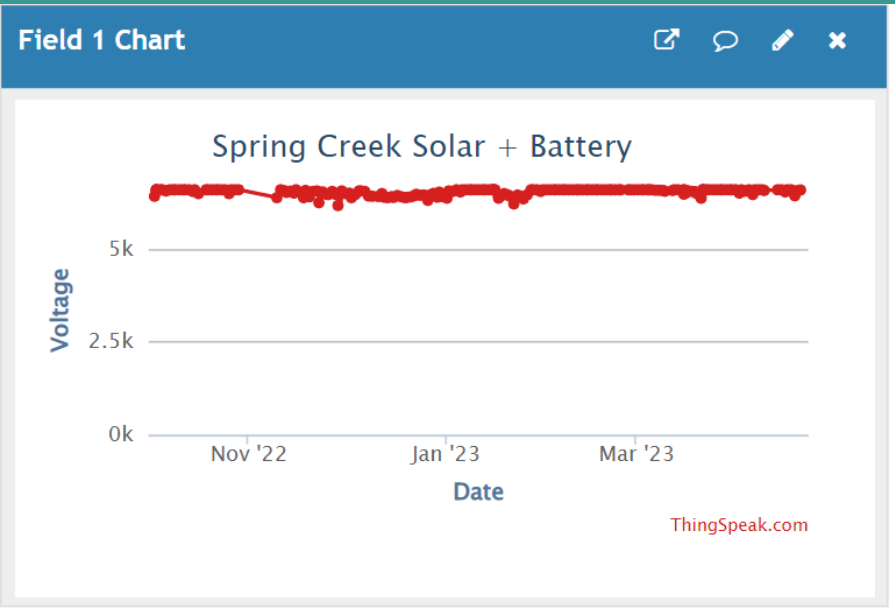
Spring Creek

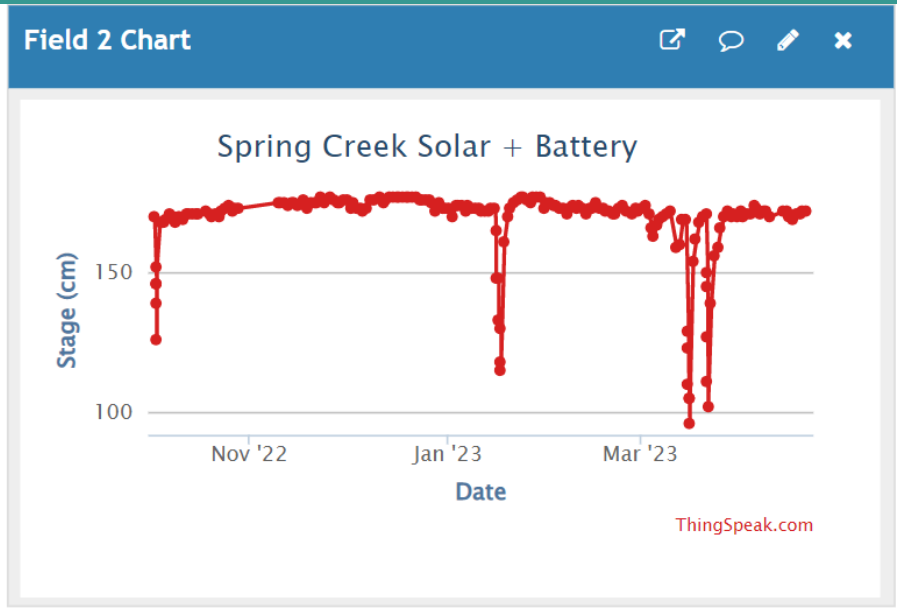


- Move Solar and Batteries to Rim
- 6 volt, lead acid batteries & charge controller
- 150 ft. power leads to REM box

Spring Creek

Results





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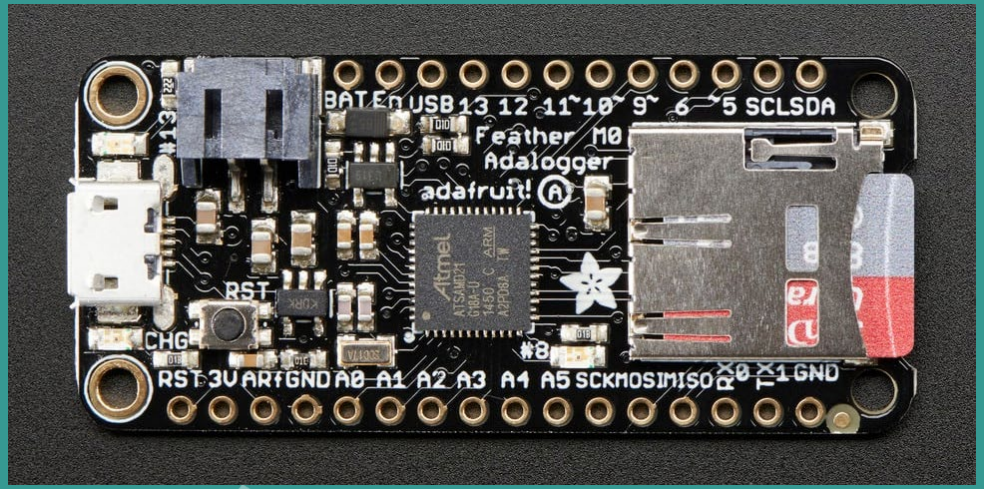
Future Development

Sensors
Power Supply
Telemetry
Datalogging



- Coordination with Universities and NGOs
- Explore commercial options
- Repurpose existing technology

Data logger credit, Hans Huth: https://www.youtube.com/watch?v=dC-deo3MdSE

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ARIZONA

Thank You!

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