



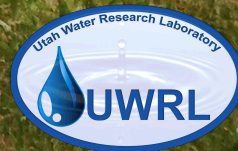
Support:
EPS 1208732

Cyberinfrastructure for Data Management and Sharing within a Large-scale, Heterogeneous Sensor Network

Amber Spackman Jones
Jeffery S. Horsburgh
Stephanie Reeder

Mountain Observatories-Reno Nevada- July 17, 2014

UtahState
University



Challenges to Managing Sensor Data

- Volume of data
- Data heterogeneity
- Multiple watersheds
- Multiple institutions
- Multiple personnel
- Scale
- Data quality assurance and quality control
- Standardize data editing
- Synchronize timing, data access, equipment tracking

Rain, Snow, and Climate



Sapflux



Soil water and chemistry



Water quality



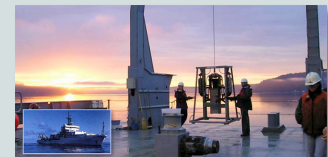
Water quantity



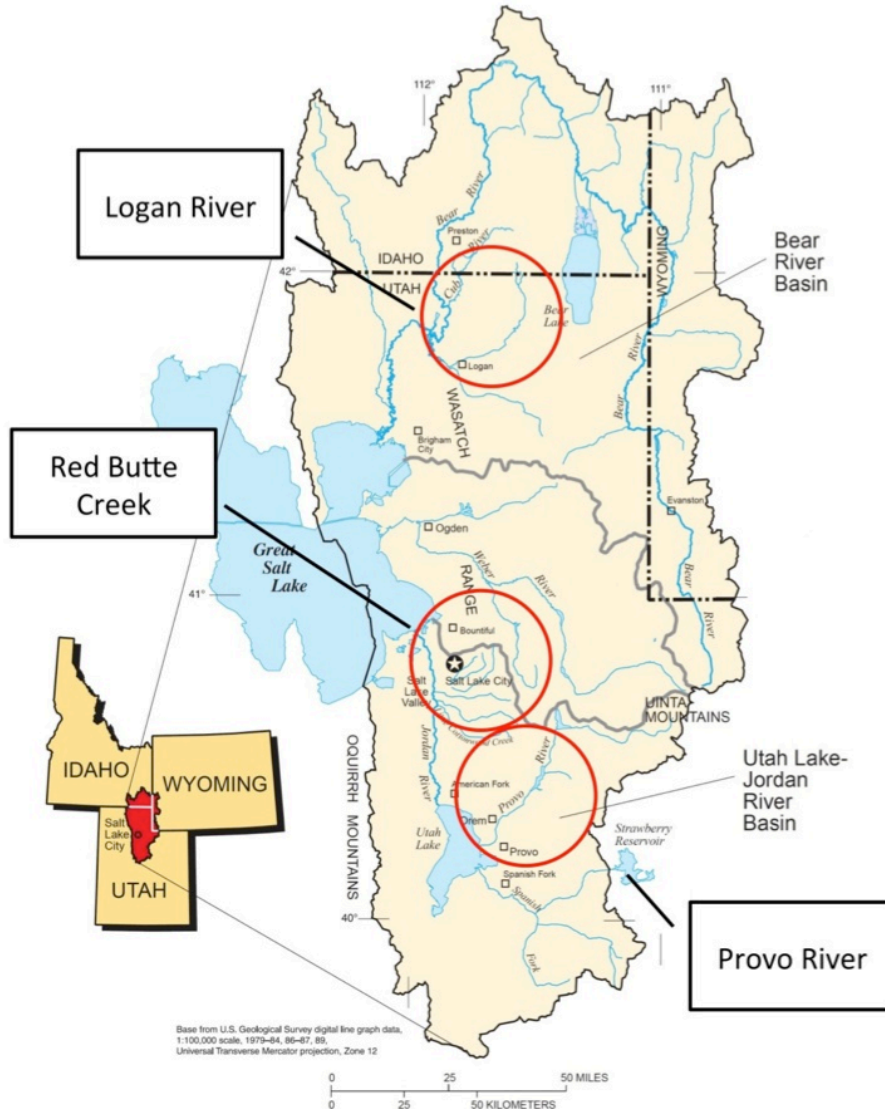
Groundwater



Mobile Platforms



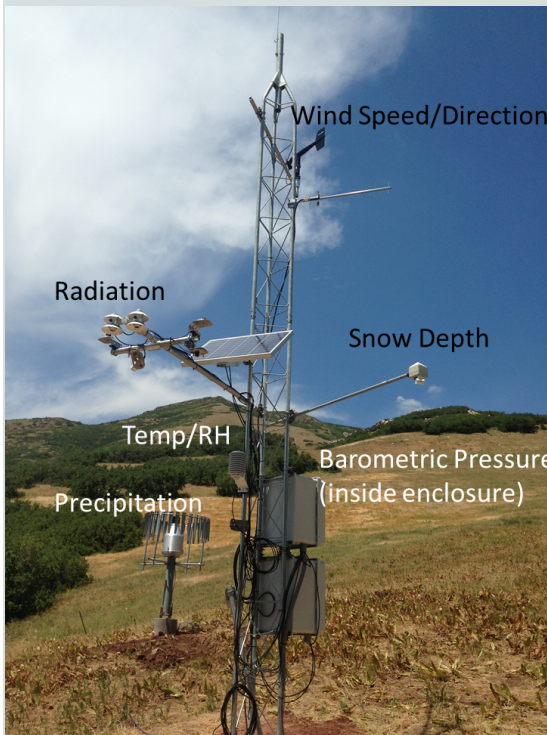
Gradients Along Mountain To Urban Transitions (GAMUT) Network



- Ecohydrologic observatory deployed in 3 watersheds in northern Utah, USA: Logan River, Red Butte Creek, Provo River
- Watersheds with similar water source (high elevation snow) but different land use transitions
- Measures aspects of water inputs and outputs and water quality over mountain-to-urban gradient
- Mix of aquatic and terrestrial *in situ* and re-locatable sensors

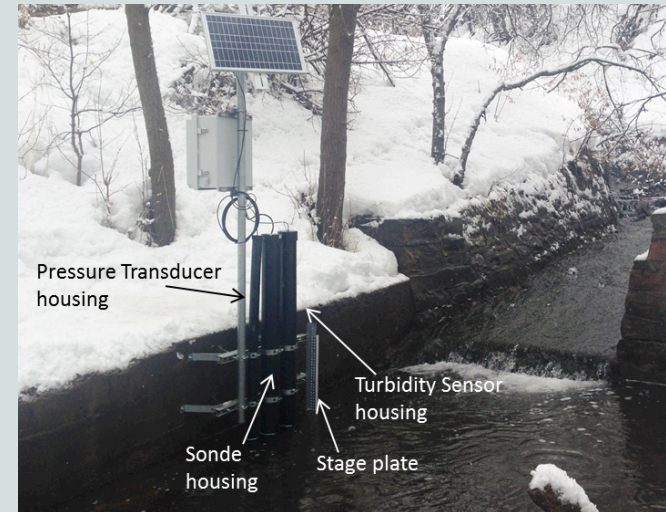
Gradients Along Mountain to Urban Transitions (GAMUT) Network

Climate/Terrestrial Sites



Manufacturer	Instrument	Variables Measured
Campbell	HC2S3	Air Temperature and Relative Humidity
Apogee	ST110	Air Temperature
Campbell	CS106	Barometric Pressure
RM Young	5303	Wind Speed/Direction
Geonor	TB-200	Precipitation
Judd	Depth Sensor	Snow Depth
Hukseflux	NR01	Incoming and Outgoing Shortwave and Longwave Radiation
Apogee	SP-230	Incoming Shortwave Radiation
Apogee	SQ-110	Incoming and Outgoing Photosynthetically Active Radiation
Apogee	SI-111	Surface Temperature
Acclima	ACC-SEN-SDI	Soil Moisture, Temperature, and Conductivity at 5 cm, 10 cm, 20 cm, 50 cm, 100 cm below ground
Campbell	CS210	Enclosure Humidity
Campbell	18166	Enclosure open door sensor

Aquatic Sites



Manufacturer	Instrument	Variables Measured
YSI	599100-01	Dissolved Oxygen
YSI	599870-01	Specific Conductivity and Water Temperature
YSI	599795-02	pH
YSI	599101-01	Fluorescent Dissolved Organic Matter (fDOM)
YSI	599102-01	Blue Green Algae and Chlorophyll <i>a</i>
Campbell	CS451	Water Depth and Water Temperature
FTS	DTS-12	Turbidity and Water Temperature

Gradients Along Mountain to Urban Transitions (GAMUT) Network





BYU
BRIGHAM YOUNG
UNIVERSITY




UtahStateUniversity

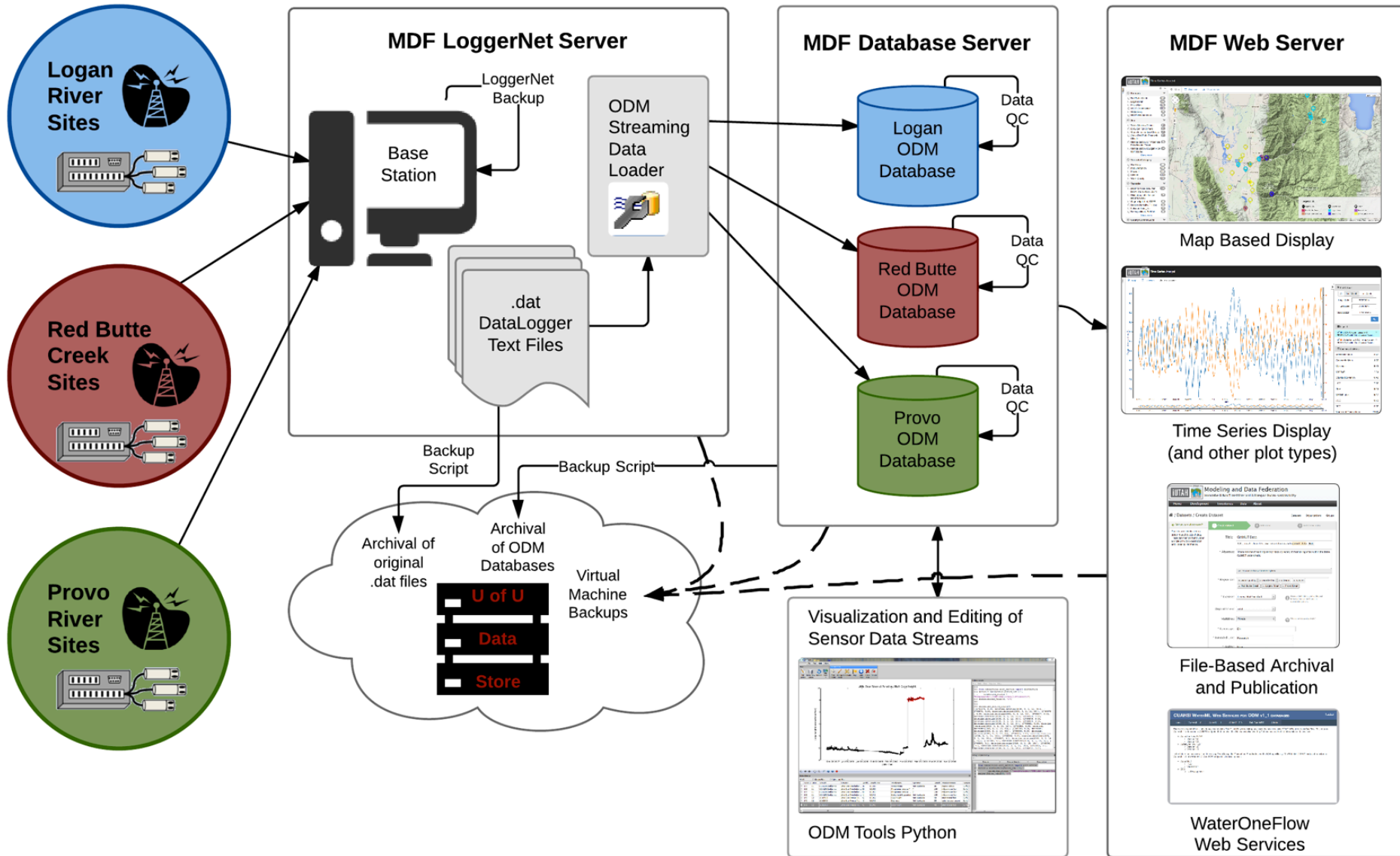



THE
UNIVERSITY
OF UTAH

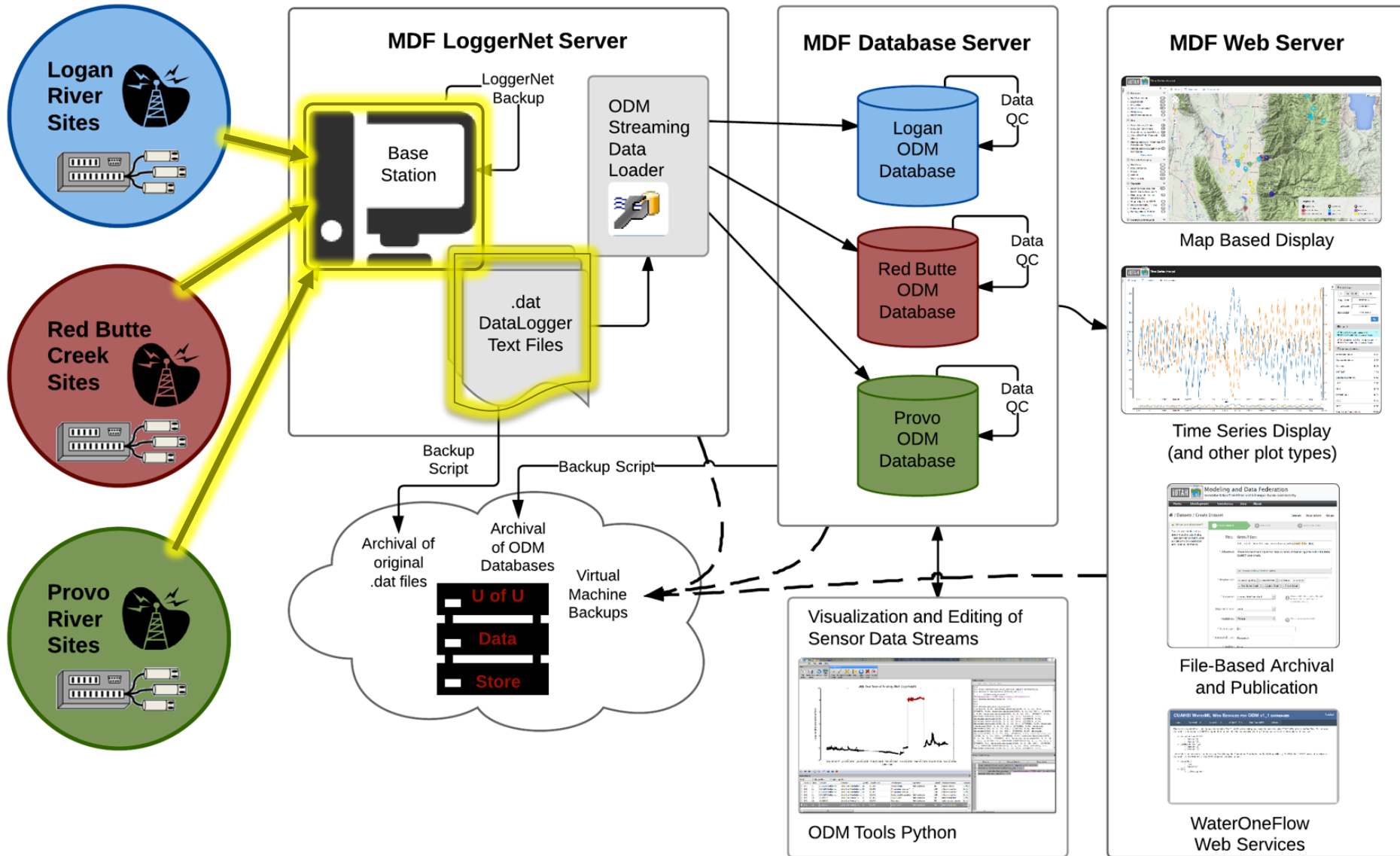
  **Modeling and Data Federation**
innovative Urban Transitions and Aridregion Hydro-sustainability



GAMUT Data Workflow



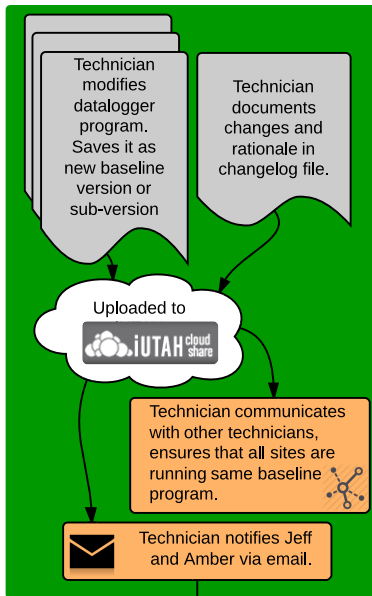
Sensor Data Acquisition



Datalogger Program Updates

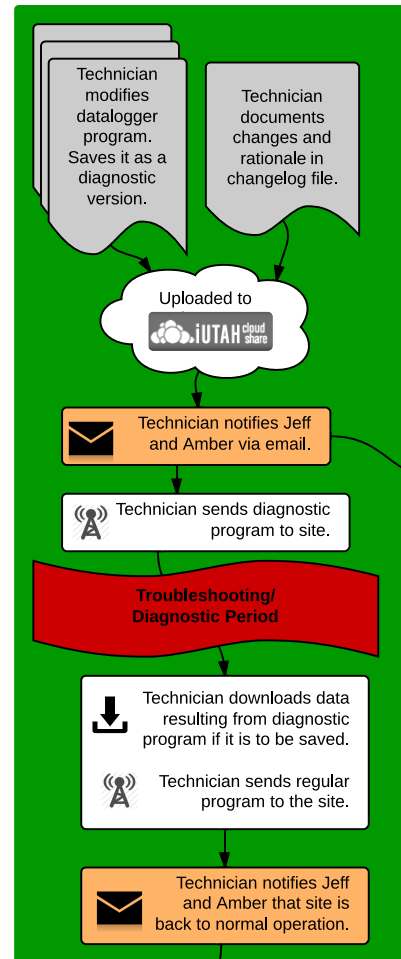
Planned Update
for addition/deletion of long term variable, adding tables for adaptive sampling, etc.

Data for 1-2 time steps may be lost in this process



Urgent Update
for diagnostic or troubleshooting purposes

Some data may be lost under this scenario!



iUTAH GAMUT Technicians

iUTAH CI Team

- Jeff or Amber performs the following on the LoggerNet Server:
- Downloads latest data from the site.
 - Runs the Streaming Data Loader.
 - Pauses the Streaming Data Loader.
 - Moves the old datalogger file into a backups folder.
 - Sends the new datalogger program to the site
 - Modifies the Streaming Data Loader to account for any changes to the datalogger file.
 - Restarts the Streaming Data Loader.

Jeff or Amber notifies technician that process is complete.

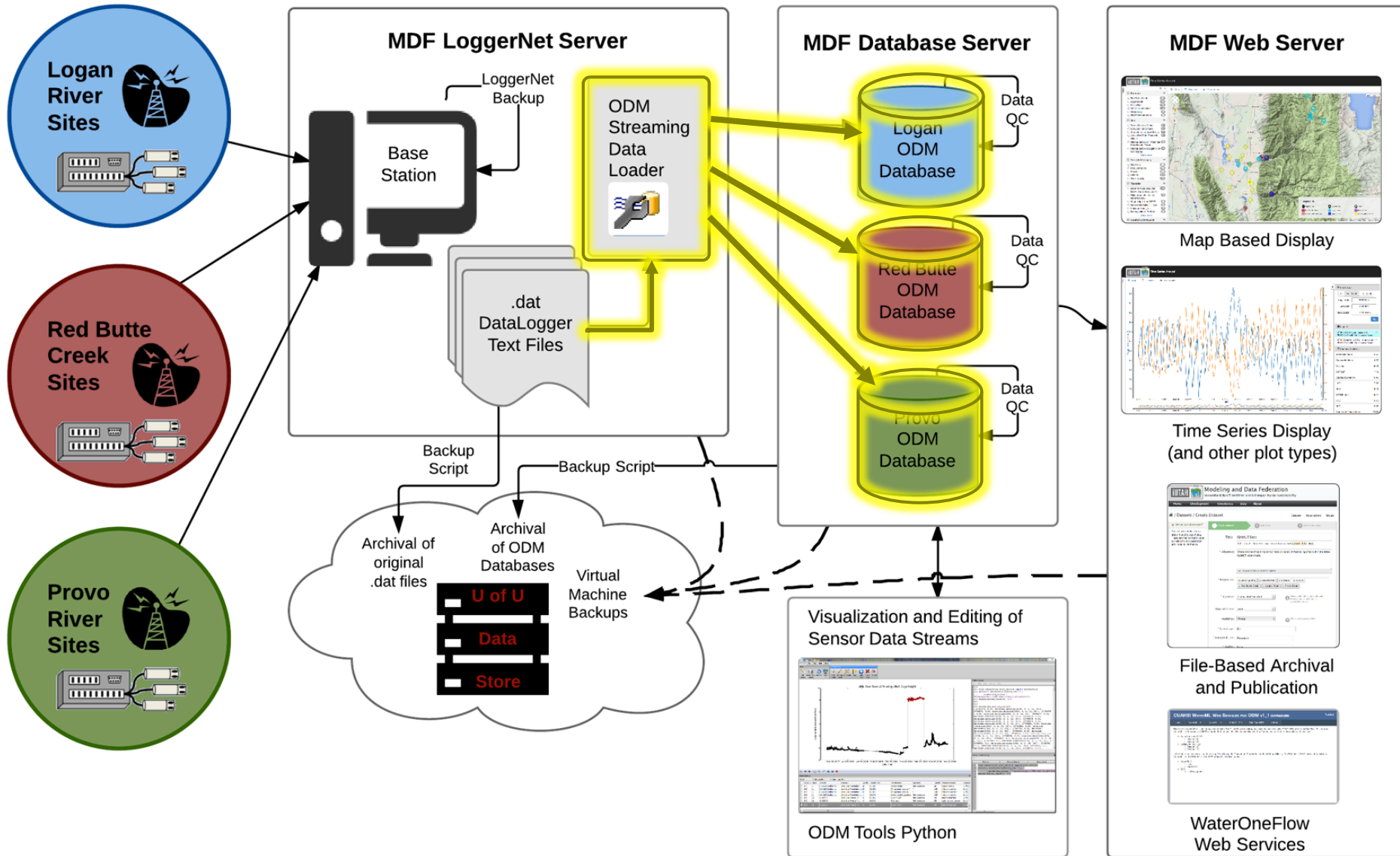
If available, Jeff or Amber will:
-Download data to LoggerNet Server just prior to diagnostic program being sent.
-Pause Streaming Data Loader.

If there is no central data download prior to sending new program, all data not yet loaded to database will be lost.

Site is taken offline. It is assumed that any data collected during this period will not be stored in the database.

Jeff or Amber restart the Streaming Data Loader for the site.

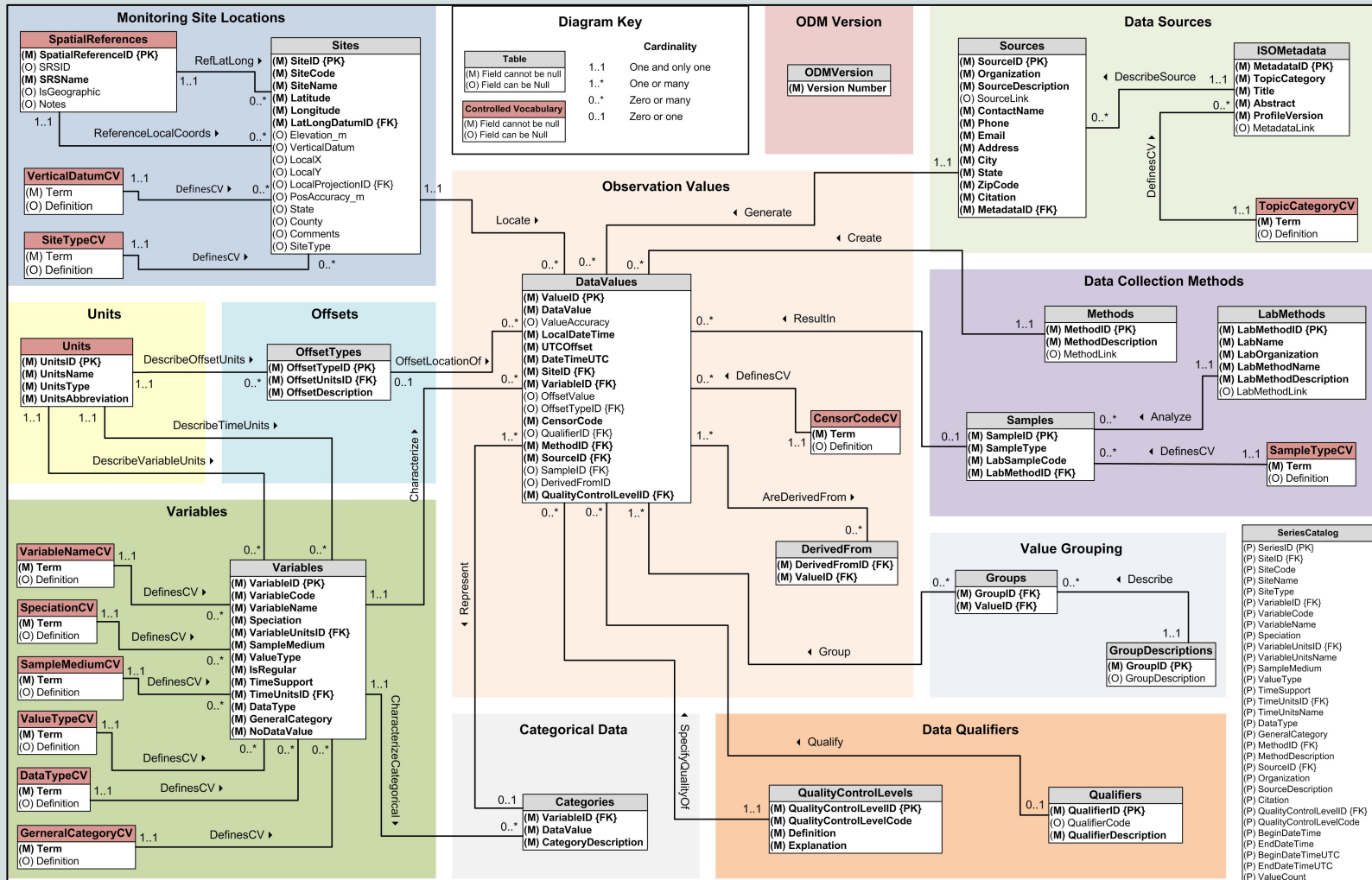
Data Loading and Storage



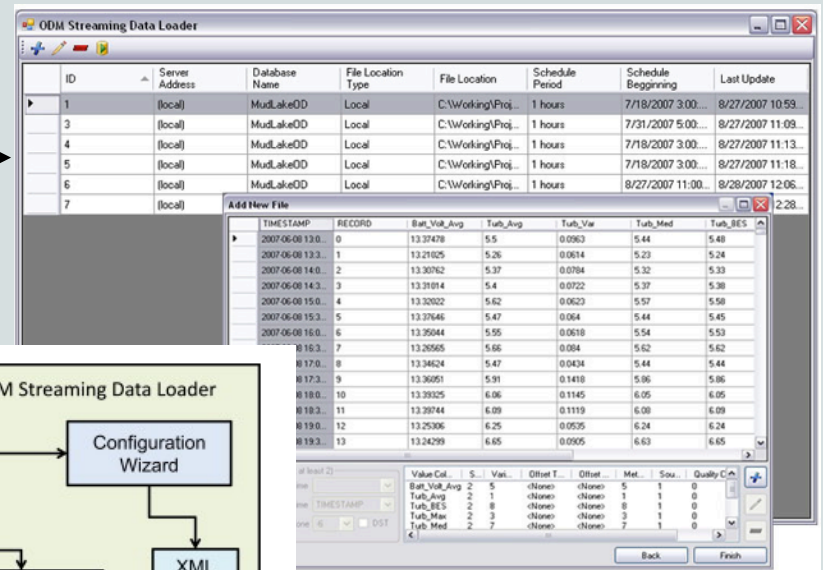
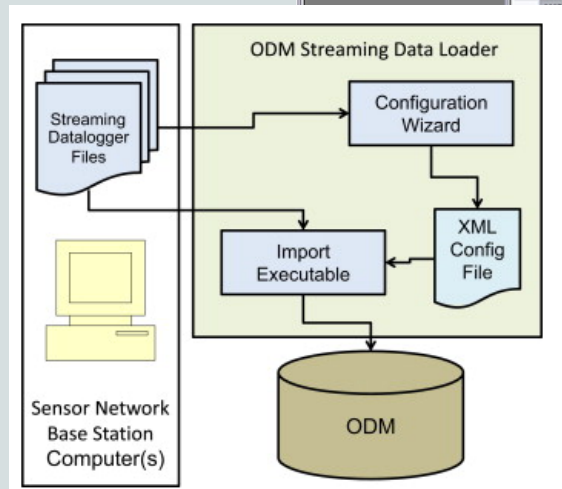
Data Loading and Storage



CUAHSI
HIS
Sharing hydrologic data



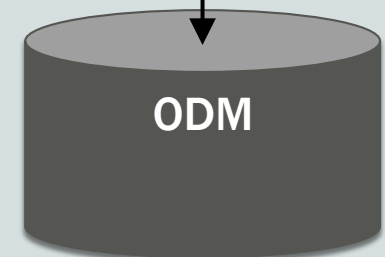
Data Loading and Storage



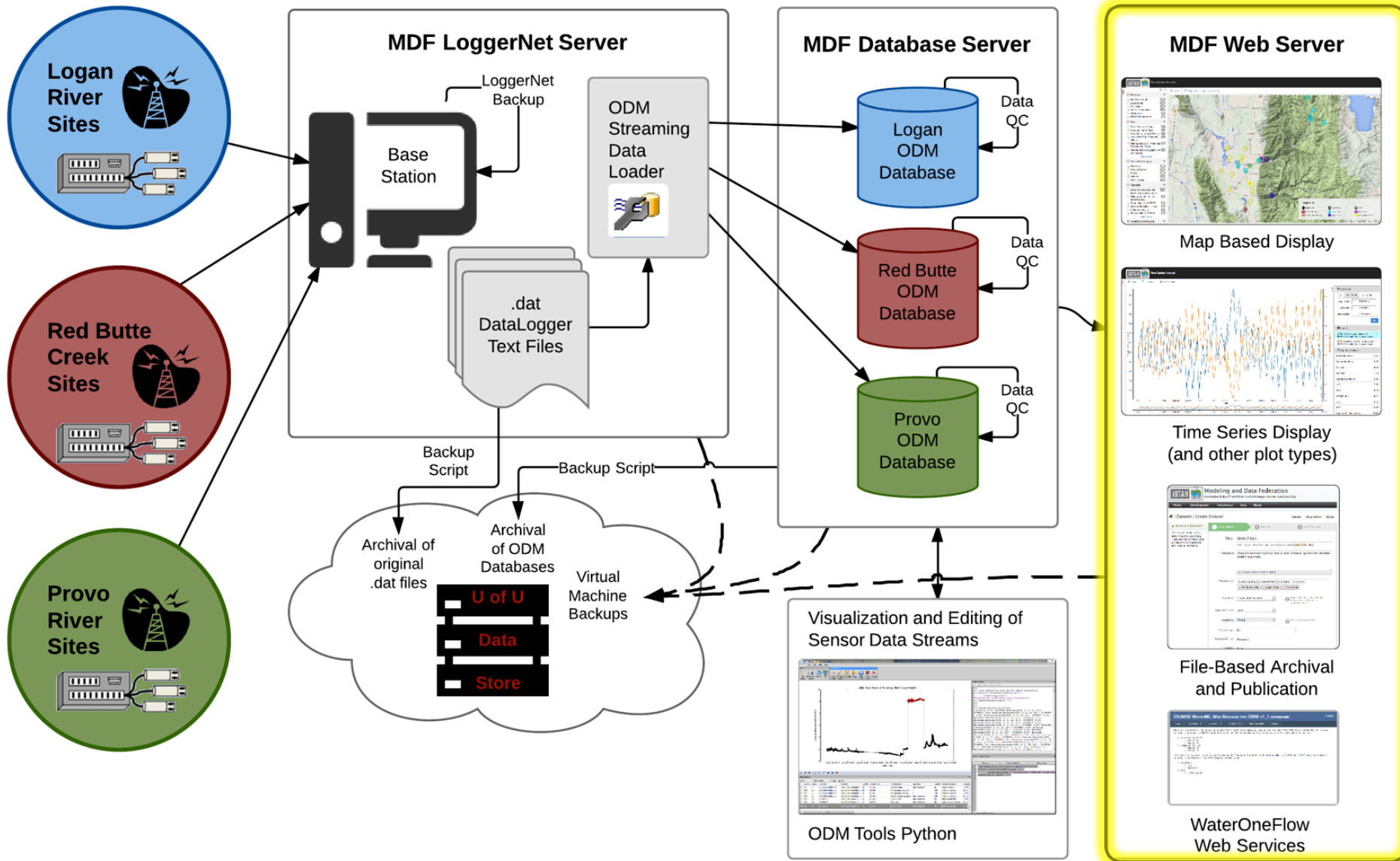
The screenshot shows the 'ODM Streaming Data Loader' application window. It features a table with columns for ID, Server Address, Database Name, File Location Type, File Location, Schedule Period, Schedule Beginning, and Last Update. Below the table is an 'Add New File' dialog box with a table of columns: TIMESTAMP, RECORD, Bat_Volt_Avg, Tub_Avg, Tub_Vis, Tub_Med, and Tub_BES. The 'Add New File' table contains 13 rows of data.

ID	Server Address	Database Name	File Location Type	File Location	Schedule Period	Schedule Beginning	Last Update
1	(local)	MudLakeOD	Local	C:\Working\Proj...	1 hours	7/18/2007 3:00...	8/27/2007 10:59...
3	(local)	MudLakeOD	Local	C:\Working\Proj...	1 hours	7/31/2007 5:00...	8/27/2007 11:09...
4	(local)	MudLakeOD	Local	C:\Working\Proj...	1 hours	7/18/2007 3:00...	8/27/2007 11:13...
5	(local)	MudLakeOD	Local	C:\Working\Proj...	1 hours	7/18/2007 3:00...	8/27/2007 11:18...
6	(local)	MudLakeOD	Local	C:\Working\Proj...	1 hours	8/27/2007 11:00...	8/28/2007 12:06...
7	(local)						

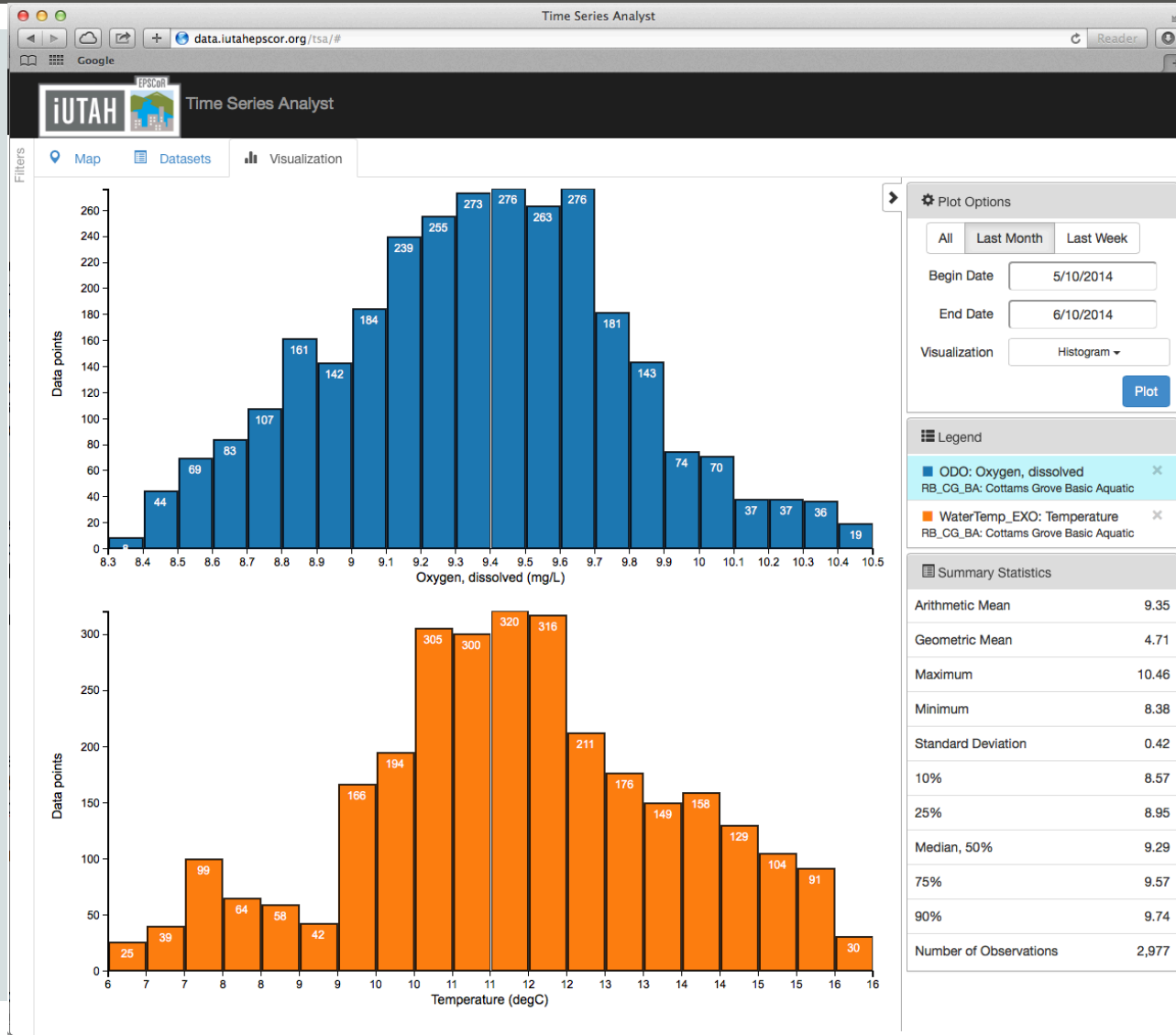
TIMESTAMP	RECORD	Bat_Volt_Avg	Tub_Avg	Tub_Vis	Tub_Med	Tub_BES
2007-06-08 13.0	0	13.27478	5.5	0.0963	5.44	5.48
2007-06-08 13.1	1	13.27625	5.26	0.0614	5.23	5.24
2007-06-08 14.0	2	13.30762	5.37	0.0784	5.32	5.33
2007-06-08 14.3	3	13.31614	5.4	0.0722	5.37	5.38
2007-06-08 15.0	4	13.32022	5.62	0.0623	5.57	5.58
2007-06-08 15.3	5	13.37646	5.47	0.064	5.44	5.45
2007-06-08 16.0	6	13.35044	5.56	0.0618	5.54	5.53
2007-06-08 16.3	7	13.25565	5.66	0.084	5.62	5.62
2007-06-08 17.0	8	13.34624	5.47	0.0434	5.44	5.44
2007-06-08 17.3	9	13.36051	5.91	0.1418	5.86	5.86
2007-06-08 18.0	10	13.39325	6.06	0.1145	6.05	6.05
2007-06-08 18.3	11	13.39744	6.09	0.1119	6.08	6.09
2007-06-08 19.0	12	13.25306	6.25	0.0535	6.24	6.24
2007-06-08 19.3	13	13.24299	6.65	0.0505	6.63	6.65



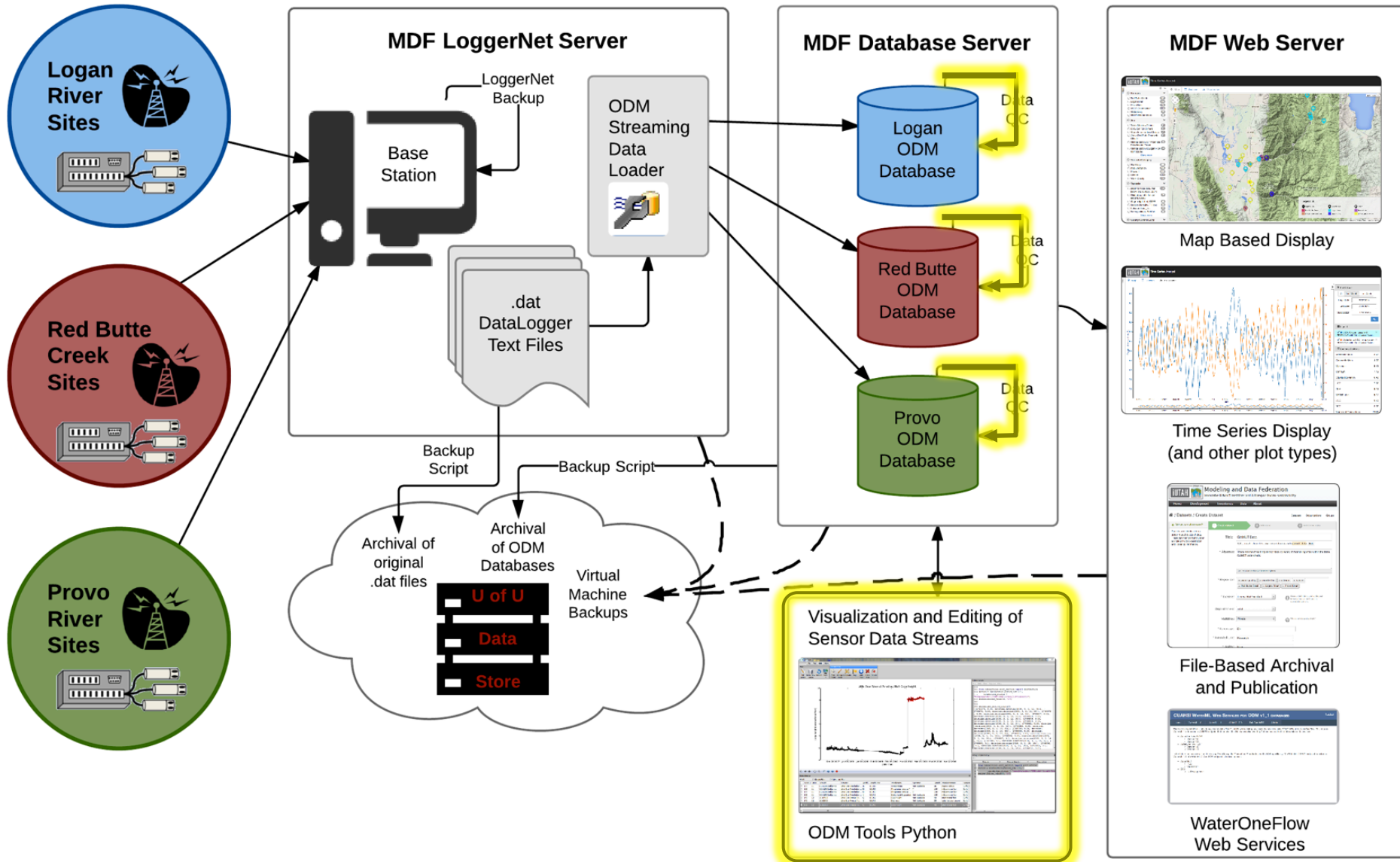
Web-Based Data Access



Enhanced Web-Based Time Series Data Access and Visualization



Sensor Data QAQC



Development of a QAQC Plan

Quality Assurance:

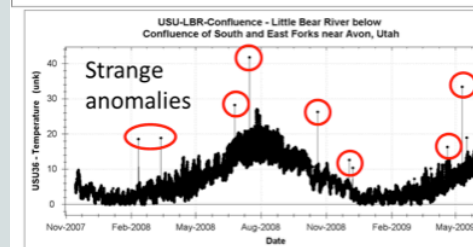
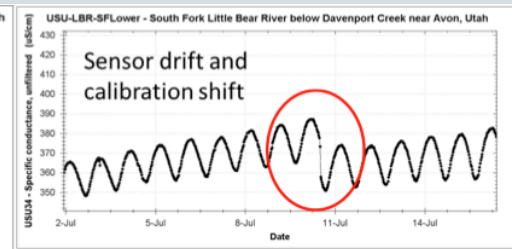
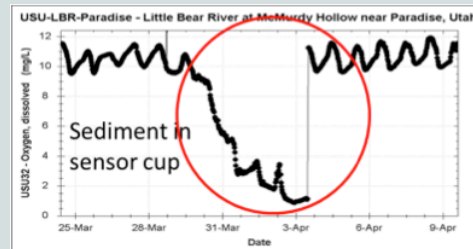
“...protocols developed and adhered to in a way that minimizes inaccuracies in the data produced ... produces high-quality data while minimizing the need for corrective measures to improve data quality.”

- Site Standardization
- Data Curation (Datalogger Programs and Files, Data Averaging, Database Structure, Equipment Management)
- Replicate Sensors
- Factory Maintenance
- Field Maintenance Schedule and Procedures
- Field Calibration Schedule and Procedures
- Manual Data Monitoring
- Automated Data Monitoring and Alerts
- Recording Events

Quality Control:

“occurs after the data are generated and tests whether they meet the necessary requirements for quality outlined by the end users.”

- Data Qualifiers and Flagging
- ODM Tools Python (data management software)
- Quality Control Levels
- Data Processing Steps

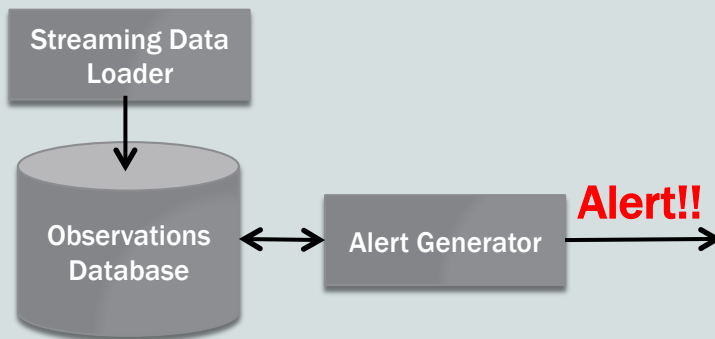


QAQC: Automated Alerts

Technicians receive email alerts daily

1. Power: batter voltage < 12 volts
2. Persistence: value of a variable is unchanging
3. Updates: data are not being reported
4. NaNs: sensor is reporting "NaN" values

Additional alerts will be implemented as needed (e.g., variable-specific range checks, internal consistency, spatial consistency).



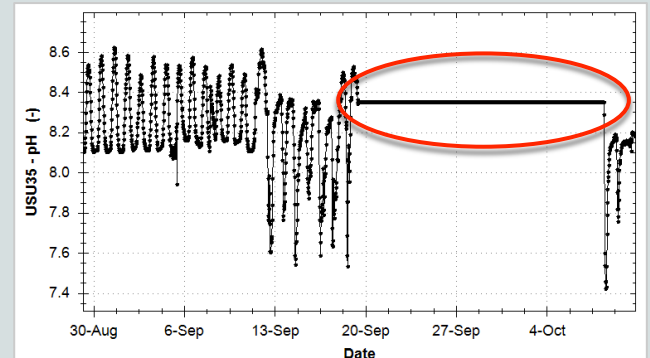
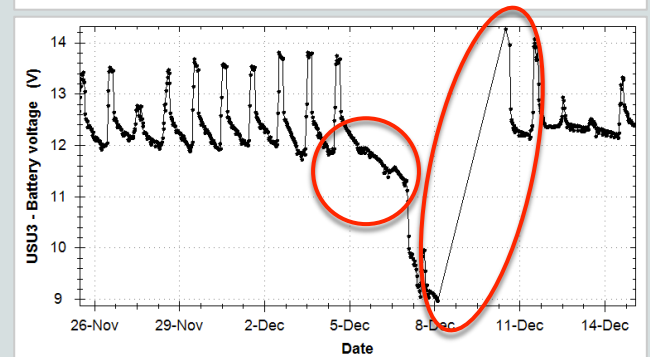
Must...
fix...
sensor...

IUTAH Data Alerts <data.alerts@usu.edu>
to chris.cox, amber.jones

The following results are have repeated values in the past day.

SiteID	SiteCode	VariableID	VariableCode	DataValue	Start	End	ValueCount
3	LR_MainStree	61	ODO_Sat	84.90	2014-02-17 21:15	2014-02-18 01:15	17
4	LR_TWDEF_C	9	Precip_Tot	9.74	2014-02-17 18:00	2014-02-18 00:45	28
4	LR_TWDEF_C	13	SWIn_NR01_Avg	-4.88	2014-02-17 20:30	2014-02-18 00:30	17
4	LR_TWDEF_C	14	SWOut_NR01_Avg	.00	2014-02-17 18:30	2014-02-18 04:00	39
4	LR_TWDEF_C	24	PARIn_Avg	.00	2014-02-17 18:45	2014-02-18 04:00	38
4	LR_TWDEF_C	25	PAROut_Avg	.00	2014-02-17 18:45	2014-02-18 04:00	38
4	LR_TWDEF_C	41	SoilCond_20cm_Avg	.00	2014-02-17 06:15	2014-02-18 04:00	88
4	LR_TWDEF_C	45	SoilCond_50cm_Avg	.00	2014-02-17 06:15	2014-02-18 04:00	88
4	LR_TWDEF_C	48	SoilTemp_100cm_Avg	-2.06	2014-02-17 09:15	2014-02-17 13:15	17
4	LR_TWDEF_C	49	SoilCond_100cm_Avg	.00	2014-02-17 06:15	2014-02-18 04:00	88
4	LR_TWDEF_C	91	Precip_HrDiff	.00	2014-02-17 19:00	2014-02-18 01:00	25
5	LR_GC_C	5	BP_Avg	86.00	2014-02-17 21:45	2014-02-18 01:45	17
5	LR_GC_C	9	Precip_Tot	-9999.00	2014-02-17 06:15	2014-02-18 04:45	91
5	LR_GC_C	45	SoilCond_50cm_Avg	.00	2014-02-17 06:15	2014-02-18 04:45	91
5	LR_GC_C	91	Precip_HrDiff	.00	2014-02-17 06:15	2014-02-18 04:45	91

(15 rows affected)



QAQC: Data Visualization and Management

Multiple Plot Types

Plot Display Options

Dynamic
Zooming and
Panning

Date Range
Restrictions

Filters on
Data Series

Build Query

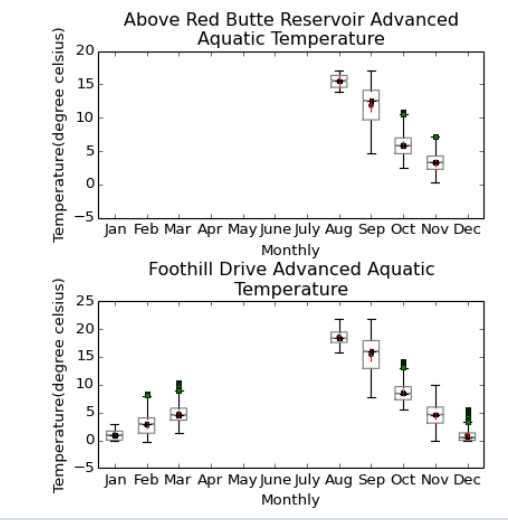
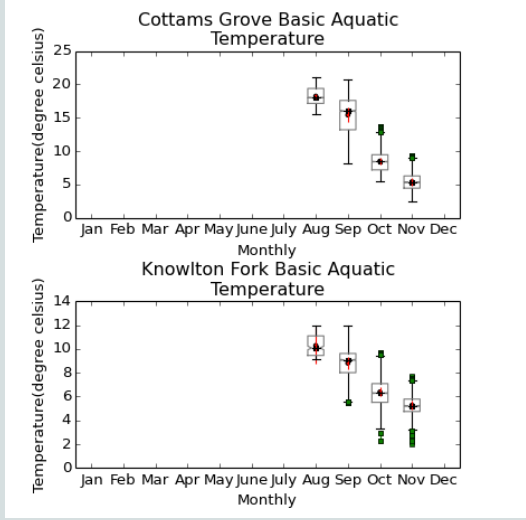
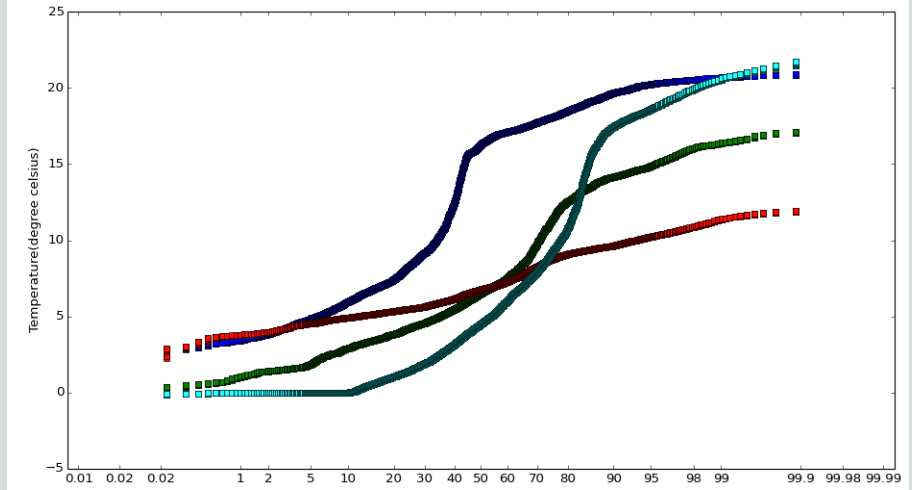
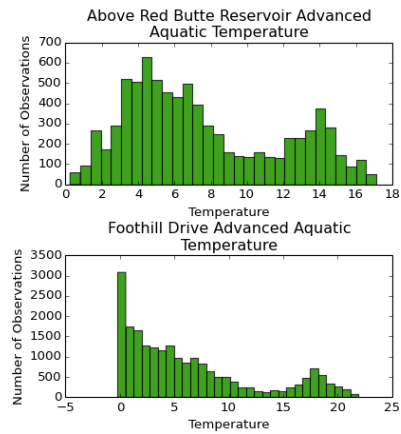
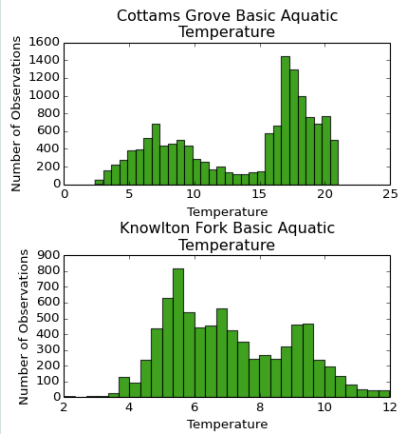
Time Series
Selection

Export Data Series

The screenshot displays the QAQC software interface. At the top, there are menu options: Plot, Edit, View. Below the menu is a toolbar with icons for Time Series, Probability Histogram, Box/Whisker, and Summary. The main plot area shows a time series plot with multiple data series. The x-axis represents dates from Dec 23 2013 to Mar 17 2014. The y-axis represents Turbidity/nephelometric Gage height (centimeters) and Temperature (degree celsius). A legend at the bottom of the plot identifies the series: Foothill Drive Advanced Aquatic Gage height (green circles), Foothill Drive Advanced Aquatic Temperature (red circles), and Foothill Drive Advanced Aquatic (blue circles). A 'Query Builder' window is open on the right, showing a list of field names (SiteName, SiteCode, Latitude, Longitude, VariableName, VariableCode, DataType, ValueType, Speciation) and unique values ('Little Bear 11', 'Little Bear River at M...'). The query builder also includes buttons for 'Is Null', 'Is Not Null', '>=', '<=', 'Like', 'Get Unique Values', 'And', 'Or', 'Not', and 'Commit'. A 'Series Selector' window is open at the bottom, showing a table of data series with columns: SeriesID, SiteID, SiteCode, SiteName, VariableCode, VariableName, Speciation, VariableUnitsName, and Sample. A context menu is open over the table, showing options: Plot, Edit, Export Data, and Export MetaData.

SeriesID	SiteID	SiteCode	SiteName	VariableCode	VariableName	Speciation	VariableUnitsName	Sample
240	10	RB_FD_AA	Foothill Drive Advanc...	66	TurbMed	Turbidity	nephelometric turbidi...	Sur
241	10	RB_FD_AA	Foothill Drive Advanc...	67	TurbMin	Turbidity	nephelometric turbidi...	Sur
242	10	RB_FD_AA	Foothill Drive Advanc...	68	TurbMax	Turbidity	nephelometric turbidi...	Sur
243	10	RB_FD_AA	Foothill Drive Advanc...	69	TurbVar	Turbidity	nephelometric turbidi...	Sur
			Foothill Drive Advanc...	70	TurbBES	Turbidity	nephelometric turbidi...	Sur
			Foothill Drive Advanc...	71	WaterTemp_Turb	Temper		06
			Foothill Drive Advanc...	72	TurbWipe	Indicatio		
			Foothill Drive Advanc...	73	Stage	Gage height	Not Applicable	47

QAQC: Data Visualization and Management



QAQC: Post Processing

The screenshot displays the ODM Tools interface with several key components:

- Data editing tools:** A toolbar at the top left includes icons for Filter Points, Reset Selection, Change Interpolate Value, Linear Drift, Flag, Add Point, Delete Point, and Record.
- Data selection filters:** A 'Data Filter' dialog box is open, showing options for Value Threshold, Data Gaps, Date, and Value Change Threshold.
- Dynamic data editing display:** A plot titled 'Foothill Drive Advance' shows specific conductance (microsiemens per centimeter) on the y-axis (100 to 8000) against date on the x-axis (Jan 03 2014 to Feb 07 2014). The data points are highlighted in red.
- Tabular data view and selection:** A table on the right shows a list of data points with columns for ValueID, DataValue, ValueAccuracy, and LocalDate.
- Python script editor:** A window at the bottom shows a Python script for editing a new file.

ValueID	DataValue	ValueAccuracy	LocalDate
1413863			2013-08-:
1413864	606.7		2013-08-:
1413865	605.1		2013-08-:
1413866	603.7		2013-08-:
1413867	600.6		2013-08-:
1413868	600.2		2013-08-:
1413869	598.5		2013-08-:
1413870	597.3		2013-08-:
1413871	595.0		2013-08-:
1413872	595.4		2013-08-:
1413873	594.7		2013-08-:
1413874	594.7		2013-08-:
1413875	594.6		2013-08-:
1413876	595.5		2013-08-:
1413877	596.3		2013-08-:
1413878	596.2		2013-08-:
1413879	597.9		2013-08-:
1413880	598.3		2013-08-:
1413881	598.7		2013-08-:
1413882	598.3		2013-08-:
1413883	599.5		2013-08-:
1413884	599.2		2013-08-:
1413885	598.8		2013-08-:
1413886	599.2		2013-08-:
1413887	606.1		2013-08-:
1413888	609.0		2013-08-:
1413889	604.4		2013-08-:

```
3 edit_service = EditService(series_id=261, connection_string='mssql+pyodbc://Amber:xxxxxxxxxx@(local)/IUTAH_RedButte_OD')
4 series_service = SeriesService(connection_string='mssql+pyodbc://Amber:xxxxxxxxxx@(local)/IUTAH_RedButte_OD')
5 ## To run commands from the python console uncomment and run the following commands ##
6 #edit_service = Tools
7 #series_service = Tools.get_series_service()
8 edit_service.filter_date(datetime.datetime(2014, 1, 31, 0, 0), datetime.datetime(2014, 1, 15, 0, 0))
9 edit_service.filter_date(datetime.datetime(2014, 1, 15, 0, 0), datetime.datetime(2014, 1, 1, 0, 0))
10 edit_service.drift_correction(0.5)
11 edit_service.flag(5)
12
```

Monitoring Equipment Management



When was the last time we cleaned this sonde?

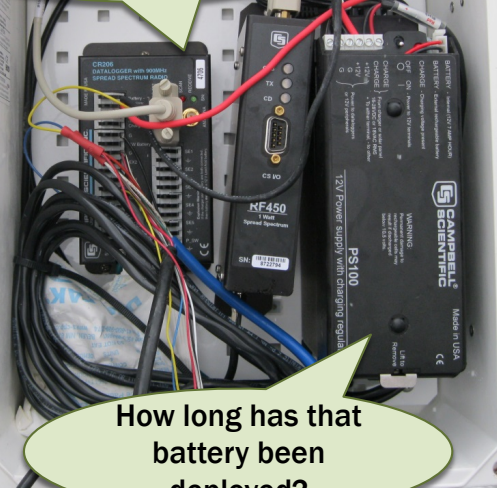


What were the field conditions of our discharge measurement?

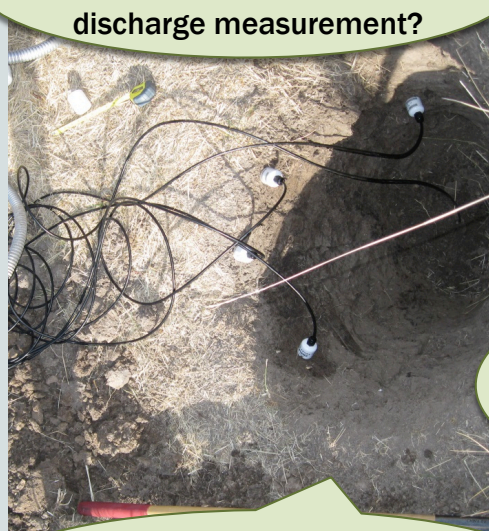


Which sensors were deployed at this site? Who installed them?

Who programmed this datalogger?



How long has that battery been deployed?



Which soil moisture sensor is buried at 40 cm?

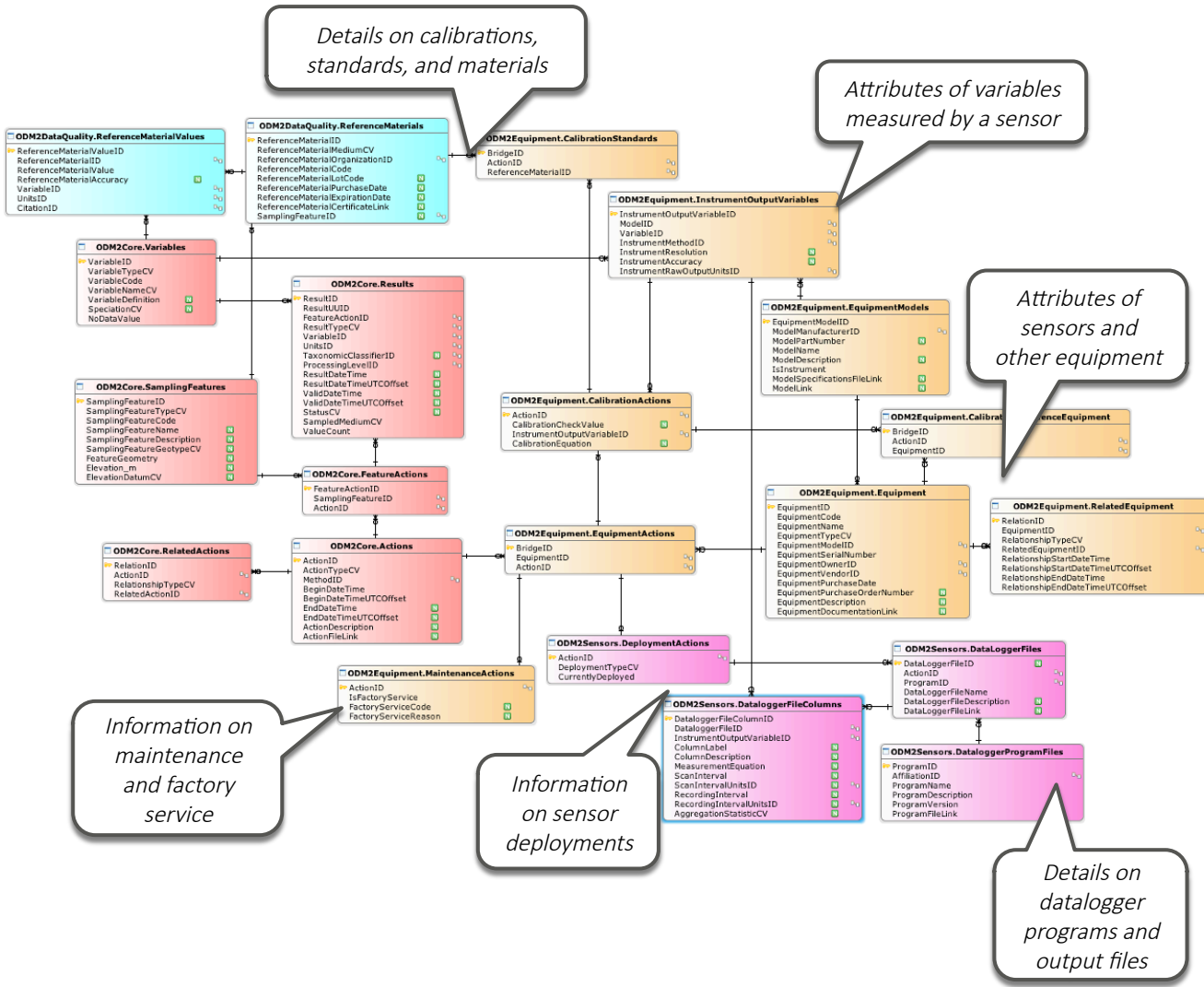


What is this dissolved oxygen sensor's calibration history?

Has this turbidity sensor been serviced at the factory?



Monitoring Equipment Management



Data Model developed to relate:

- Equipment
- Field Activities
- Deployments
- Calibrations
- Measured Variables
- Datalogger Programs

Database serves as underlying structure to web interface.



Monitoring Equipment Management

EPSCoR IUTAH **Sites** Manage Sites **Site Visits** Manage Site Visits **Equipment** Manage Equipment **Vocabularies** Manage Vocabularies Amber Logout

Sites

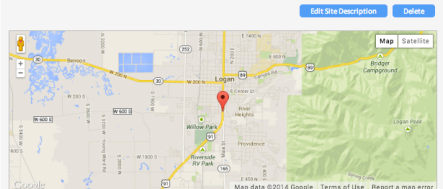
Keyword [New Site](#)

Site Code	Site Name	Site Group	Site Type
RB_KF_C	Knowlton Fork Climate	Red Butte Creek	Climate
RB_KF_R	Knowlton Fork Repeater	Red Butte Creek	Repeater
RB_KF_BA	Knowlton Fork Basic Aquatic	Red Butte Creek	Basic Aquatic
RB_KF_S	Knowlton Fork Sapflux	Red Butte Creek	Sapflux

EPSCoR IUTAH **Sites** Manage Sites **Site Visits** Manage Site Visits **Equipment** Manage Equipment **Vocabularies** Manage Vocabularies Amber Logout

Site Details

[Edit Site Description](#) [Delete](#)



Site Code: LR_MSB_BA Latitude: 41.721091 Longitude: 111.50749
 Site Name: Main Street Bridge Basic Aquatic Site Type: Basic Aquatic
 Elevation: 1377

Deployment Measured Variables

Variable Name	Recorded Status
Oxygen_dissolved	
pH	
Specific Conductance	
Temperature	
Oxygen_dissolved_TransducerSignal	

[View Deployed Equipment](#) [View Site Visits](#) [New](#)

EPSCoR IUTAH **Sites** Manage Sites **Site Visits** Manage Site Visits **Equipment** Manage Equipment **Vocabularies** Manage Vocabularies Amber Logout

Deployment History of Main Street Bridge Basic Aquatic

[New Deployment](#)

Date	Equipment Serial Number	Equipment Type	Manufacturer	Model	Site
2013/12/06 12:00 PM to Present	9532237	Radio	Campbell Scientific	RF450	Main Street Bridge Basic Aquatic
2013/12/06 12:00 PM to Present	25858	Data logger	Campbell Scientific	CR800	Main Street Bridge Basic Aquatic
2013/12/06 12:00 PM to Present	BL12	Battery	Power Sonic	35 Batt	Main Street Bridge

EPSCoR IUTAH **Sites** Manage Sites **Site Visits** Manage Site Visits **Equipment** Manage Equipment **Vocabularies** Manage Vocabularies Amber Logout

Site Visits

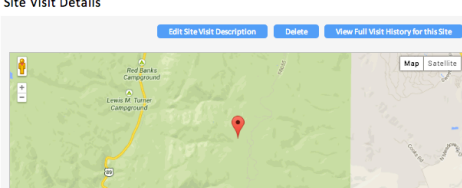
Keyword [New Site Visit](#)

Date	Site Name	Site Group	Crew
2014/02/11 10:30 AM	TWDEF Climate Station	Logan River	Chris Cox, Jobie Carlise, Joel Martin
2014/02/05 12:00 PM	TWDEF Climate Station	Logan River	Chris Cox, Allison Chan
2014/02/03 12:30 PM	Golf Course Climate	Logan River	Chris Cox
2014/02/03 12:00 PM			
2014/01/31 09:35 PM			
2014/01/24 03:00 PM			
2014/01/24 01:00 PM			

EPSCoR IUTAH **Sites** Manage Sites **Site Visits** Manage Site Visits **Equipment** Manage Equipment **Vocabularies** Manage Vocabularies Amber Logout

Site Visit Details

[Edit Site Visit Description](#) [Delete](#) [View Full Visit History for this Site](#)



Site Code: LR_TWDEF_C
 Site Name: TWDEF Climate Station
 Latitude: 41.864805 Longitude: -111.50749
 Elevation: 2628

Site Visit Description

Crew: Chris Cox, Jobie Carlise, Joel Martin
 Begin Date Time: 2014/02/11 10:30 AM
 End Date Time: 2014/02/11 12:00 PM
 UTC Offset: -07:00
 Environmental Observations: Light to moderate snowfall.
 Visit Notes: Noticed some riming on Rotronix and ST110 but did not think it was worth trying to clean.

Field Activities Performed

Activity Type	Begin Date/Time	End Date/Time	Description
Equipment Adjustment	2014/02/11 10:55 AM	2014/02/11 11:00 PM	Fixed inlet sensor. I had accidentally connected the jumper resistor to ground rather than VX2
Equipment Adjustment	2014/02/11 11:04 AM	2014/02/11 11:30 AM	Completely drained and refilled Geonor bucket. I added about 1.5L of new antifreeze and new oil (roughly .25L).
Sensor Cleaning	2014/02/11 11:35 AM	2014/02/11 12:00 PM	Tried to clean solar sensors. Some ice covered the Hukseflux and incoming PAR. I tried to remove without scratching sensor domes.

[Add New Calibration](#) [Add New Deployment](#) [Add Other Field Activity](#)

EPSCoR IUTAH **Sites** Manage Sites **Site Visits** Manage Site Visits **Equipment** Manage Equipment **Vocabularies** Manage Vocabularies Amber Logout

Equipment

Keyword [New Equipment](#)

Serial Number	Type	Model	Manufacturer	Owner
6500000	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500840	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500841	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500842	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500843	Sensor	SDI-12 Soil	Acclima, Inc.	Dave Eriksson
6500844	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500845	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500846	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500847	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500848	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500849	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox
6500850	Sensor	SDI-12 Soil	Acclima, Inc.	Chris Cox

EPSCoR IUTAH **Sites** Manage Sites **Site Visits** Manage Site Visits **Equipment** Manage Equipment **Vocabularies** Manage Vocabularies Amber Logout

Equipment Details

[Full History](#)

Equipment Description

Serial Number: 61022551
 Model Name: HC33
 Model Link: [HC33](#)
 Model Description: Humidity and temperature
 Inventory Number:
 Purchase Date: 2013/04/02
 Order Number: 192016
 Notes:

Owner Information

Contact: Joe Crawford
 Institution: Brigham Young University
 Address:
 Phone: 435-760-8334
 Email: joe_crawford@byu.edu

Manufacturer Information

Name: Rotronic
 Contact Name: unknown
 Address:
 Website: www.rotronic-usa.com
 Phone:

Vendor Information

Name: Campbell Scientific
 Contact Name: Kevin Rhodes
 Address: 855 West 1800 North, Logan, UT 84321
 Phone: 435-227-9000
 Email:
 Website: <http://www.campbellsci.com>

[Deployment History](#) [Factory Service History](#) [Calibration History](#)

EPSCoR IUTAH **Sites** Manage Sites **Site Visits** Manage Site Visits **Equipment** Manage Equipment **Vocabularies** Manage Vocabularies Amber Logout

Deployment Details

[Create New Deployment](#)

Equipment Description

Equipment Serial Number: 121100807
 Equipment Type: Sensor
 Model Name: EX02SDI
 Description: EX02 Sonde pH probe
 Purchase Date: 2012/11/12
 Equipment Notes:
 Links:
 Owner Institution: Utah State University
 Owner Contact: Chris Cox
 Owner Address:
 Owner Phone: 505-250-5885
 Email: chris.cox@usu.edu

Deployment Description

Site: [Borrow Jordanella Aquatic](#)
 Deployment: Begin Date: 2013/09/25 10:00 AM
 Deployment: End Date: 2013/11/26 01:00 PM
[See Historical Information](#)
 Deployment: UTC Offset: -07:00
 Currently Deployed: No
 Deployment Type: Fixed monitoring
 Deployment: Description: This is the pH sensor installed on the sonde.
 Deployment Notes:

Horizontal Offset Description: The sonde and the sensors were installed about 34' away from the data logger.
 Horizontal Offset Units ID:
 Horizontal Offset Value:
 Vertical Offset Description:
 Vertical Offset Units ID:
 Vertical Offset Value:
 Parent Equipment: [EX02Sonde](#)
 Deployment Schematic: [\[Image\]](#)

Measured Variables

[New Deployment Measured Variables](#)

No content found.

[View Equipment's Deployment History](#) [Go to Site Visit](#)

- Record site information, site visits, and field activity details
- Store information on physical equipment
- Track equipment deployments, calibrations, service events

Monitoring Equipment Management

Equipment

- Model
- Serial number
- Owner
- Vendor
- Manufacturer
- Service history



Calibrations



- Method
- Standard

Site Visits



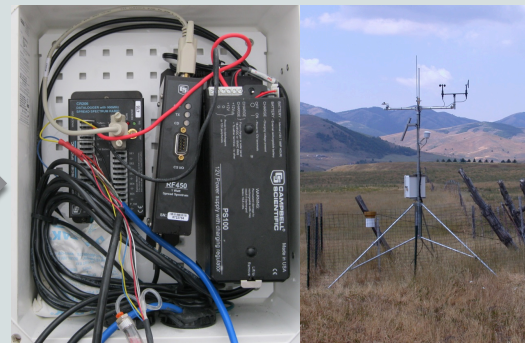
- Location
- Date
- People
- Conditions

Field Activities



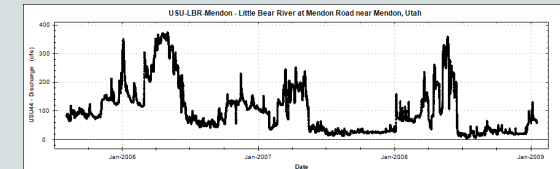
- Activity type
- Description
- Date

Deployments



- Deployment type
- Description
- Dates
- Offsets

Time Series Observations



Open Source Code Repositories

- **WEBTSA – Time series data visualization**
 - <https://github.com/UCHIC/WEBTSA>
- **ODM Streaming Data Loader**
 - <https://github.com/UCHIC/ODMStreamingDataLoader>
- **ODM Tools Python – Sensor Data Management**
 - <https://github.com/UCHIC/ODMToolsPython>
- **ODM2 Sensor – Sensor equipment management**
 - <https://github.com/UCHIC/ODM2Sensor>



Summary

- Researchers are using *in situ* sensors at multiple sites more commonly resulting in large datasets
- Data enhanced by metadata standards and descriptions
- Much of the data management workflow can (and should!) be automated
- The tools described have sped the time from collection to analysis and facilitate sharing and publication of the data
- Sustainability is enhanced by using community-developed standards and open-source tools
- Data reusability facilitated by ability to access data and metadata programmatically
- Data Available at <http://data.iutahepscor.org>

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