MANAGING, DISPLAYING, AND SHARING CONTINUOUS MONITORING DATA VIA 52° NORTH SENSOR OBSERVATION SERVICE (SOS)

Jeffrey White
Center For Ecological Sciences
Tetra Tech, Inc.
10711 Red Run Blvd., Suite 105
Owings Mills, MD 21117
jeffrey.white@tetratech.com

Jon Harcum, Alex DeWire, James Bisese
Tetra Tech, Inc., Fairfax, VA

National Water Quality Monitoring Conference
Tampa Florida, May 2 - 6, 2016

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OUTLINE

- Background
- Examples
- Next Steps
- Conclusion, Summary, Questions, Comments

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BACKGROUND

- What this all About and What can it do for me?
- The SOS standard defines a Web Service Interface that allows querying sensor observations and managing the sensor data.
  - http://www.opengeospatial.org/standards/sos
- There is more to 52° North

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52° NORTH – SENSOR OBSERVATION SERVICE (SOS)

52° North is an initiative for open source geospatial software started in 2004, http://52north.org/.

- One project developed under the 52°North initiative is the Sensor Observation Service (SOS). SOS is designed to provide web access to observational data including both near real-time sensor data and more traditional discrete grab sampling data
- Key features include the following:
  - Allows data to be loaded from multiple sources.
  - Provides web and geospatial access to near real-time sensor data and discrete grab sampling data.
  - Allows for customization and add-ons.

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DATABASE - 52° NORTH – SENSOR OBSERVATION SERVICE (SOS)

- Challenge Statement: How to manage water quality data from different sources and sensor types including traditional discrete sampling as well as continuous monitoring?

- Potential Solution: The 52° North Sensor Observation System (SOS) is a web accessible interface that can aggregate traditional discrete monitoring data with continuously monitored data.

- Our experience: It's about the tools on top the data that help you get your work done.
  - Existing Tools
  - New Tools

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EQUIPMENT FOR CONTINUOUS WATER QUALITY MONITORING

Many different options!

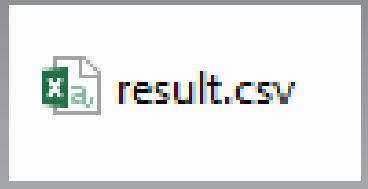
- Sensors & sondes have become more affordable
- Can be deployed year-round, seasonally, etc.
- Can measure single or multiple parameters:
  - Temperature, water level, DO, conductivity, turbidity, pH, nutrients
- Can be set to record measurements at desired intervals (15-minute, 30-minute, etc.)

SOS DATA UPLOAD

Data can be uploaded to SOS in a variety of formats:

1

From existing databases through simple upload of CSV files to FTP



Examples:

- archived discrete monitoring data
- field downloaded data

2

Data uploaded to servers

Examples:

- USGS stations
- Water Quality Portal (STORET/NWIS)

3

Sensors linked to web client

Examples:

- Sensors with telemetry

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52 NORTH - SOS AT A GLANCE

Data within the SOS web client can be viewed geospatially, as time series charts with multiple variables and monitoring stations, as a data table, or downloaded for further processing as CSV files

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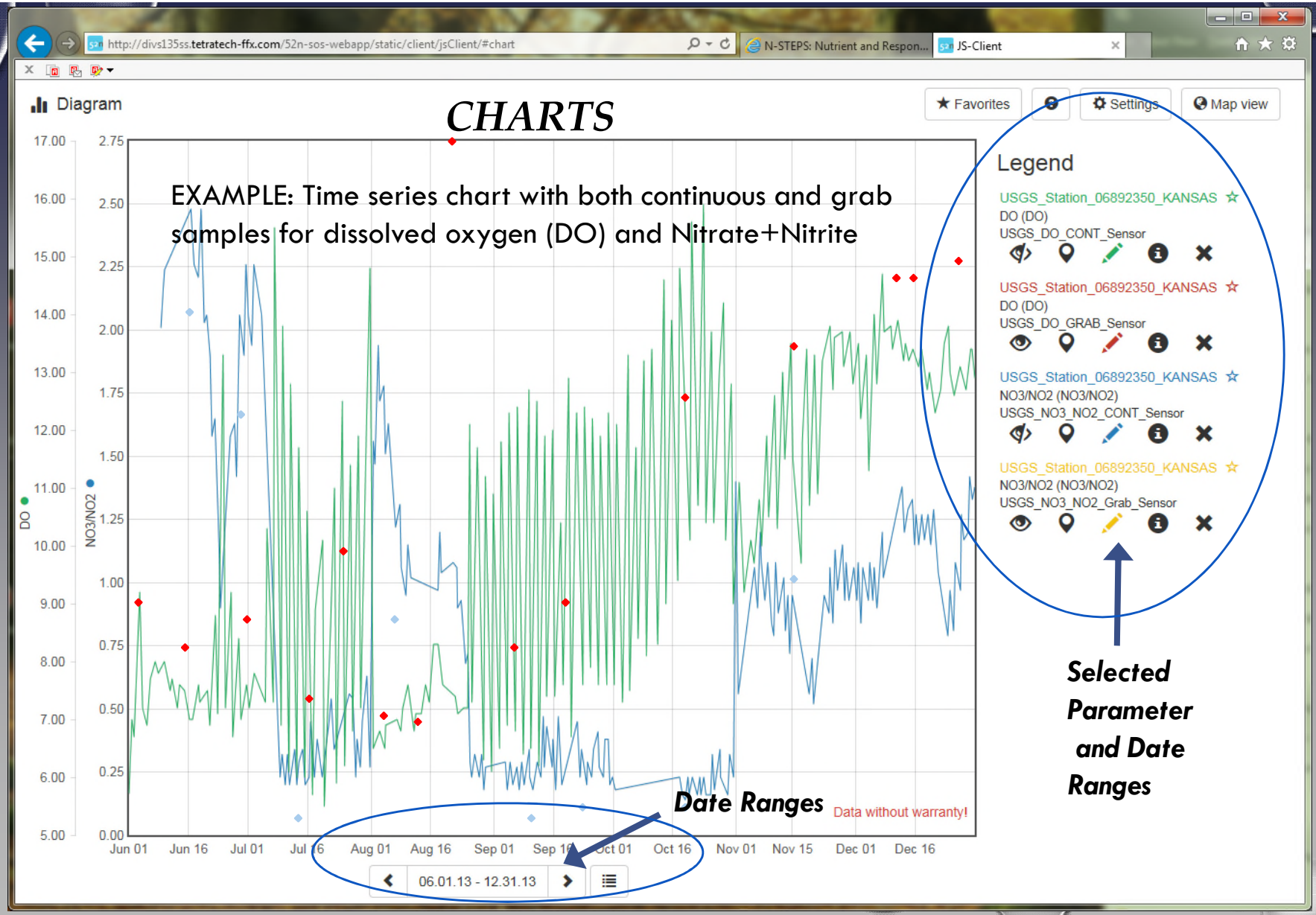
CHARTS



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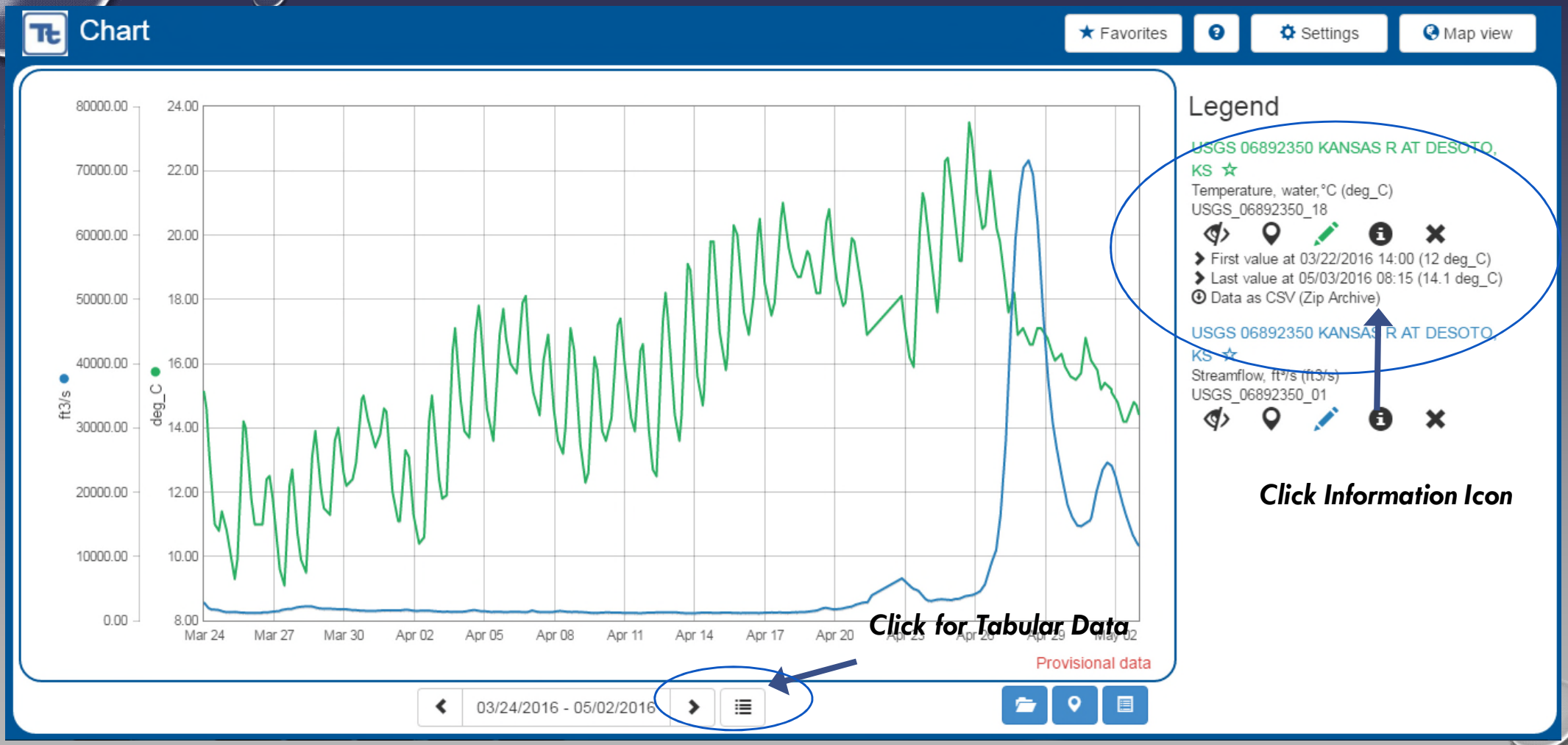
VIEWING DATA AND CHARTS



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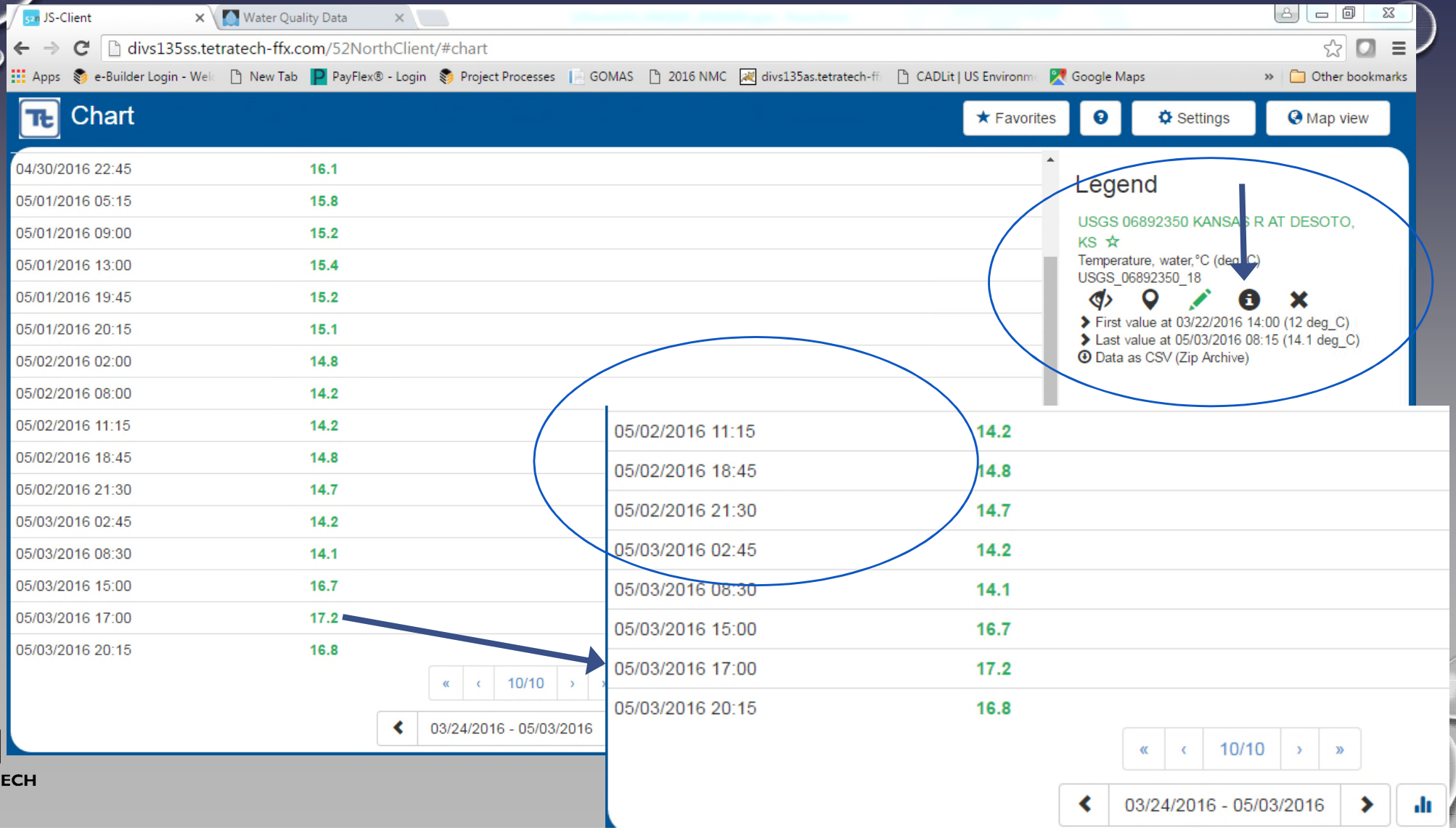
VIEWING TABULAR DATA



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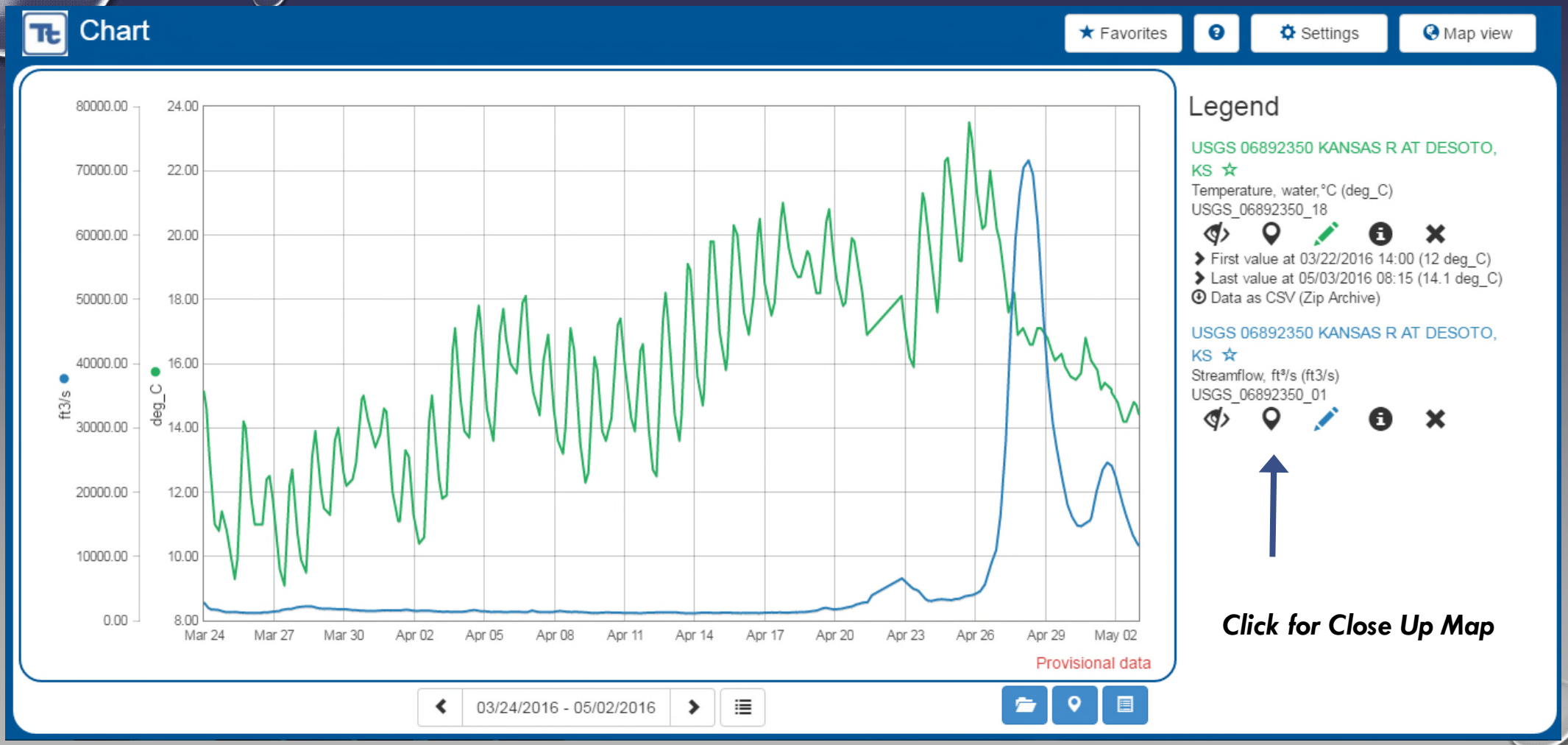
VIEWING DATA AND CHARTS



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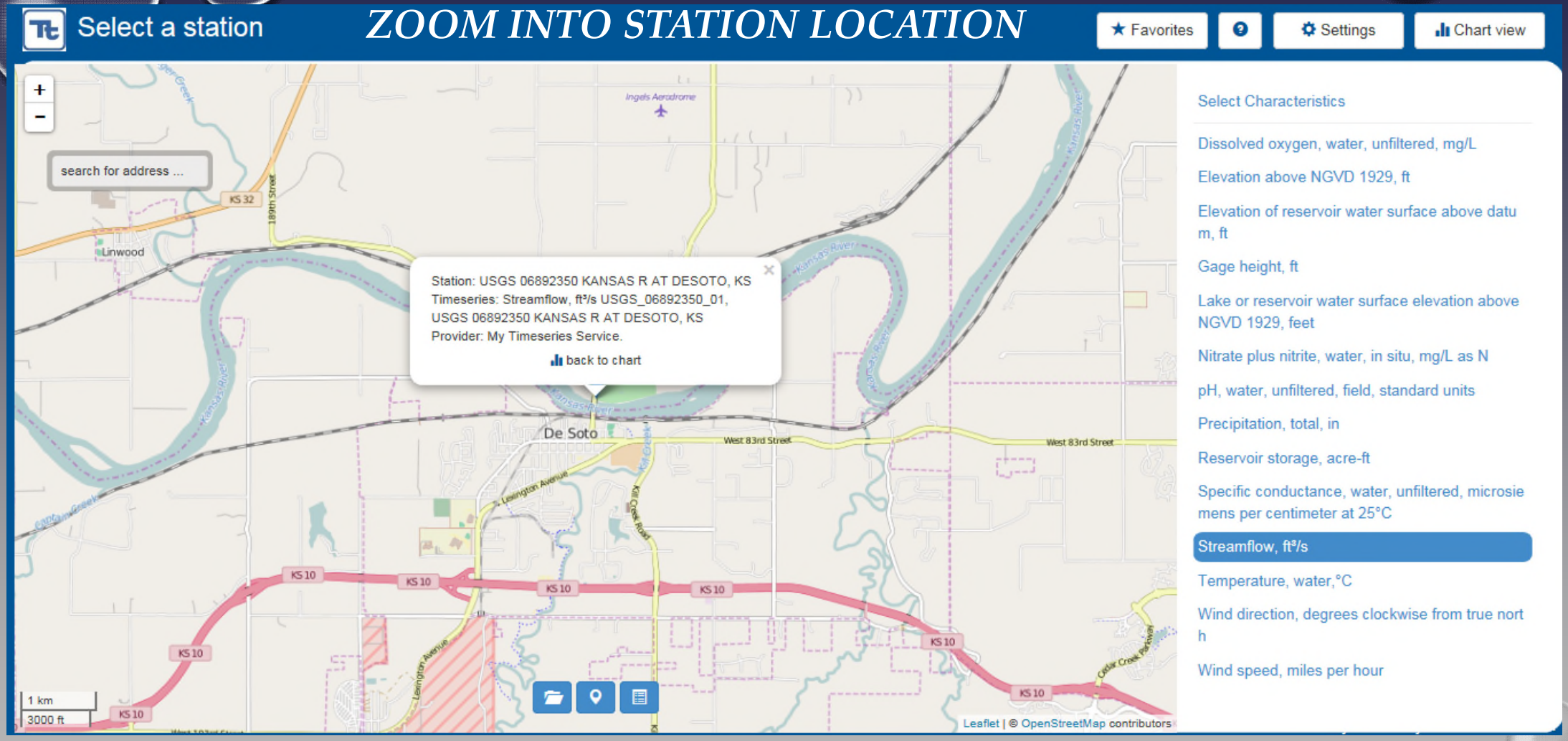
ZOOM INTO STATION LOCATION



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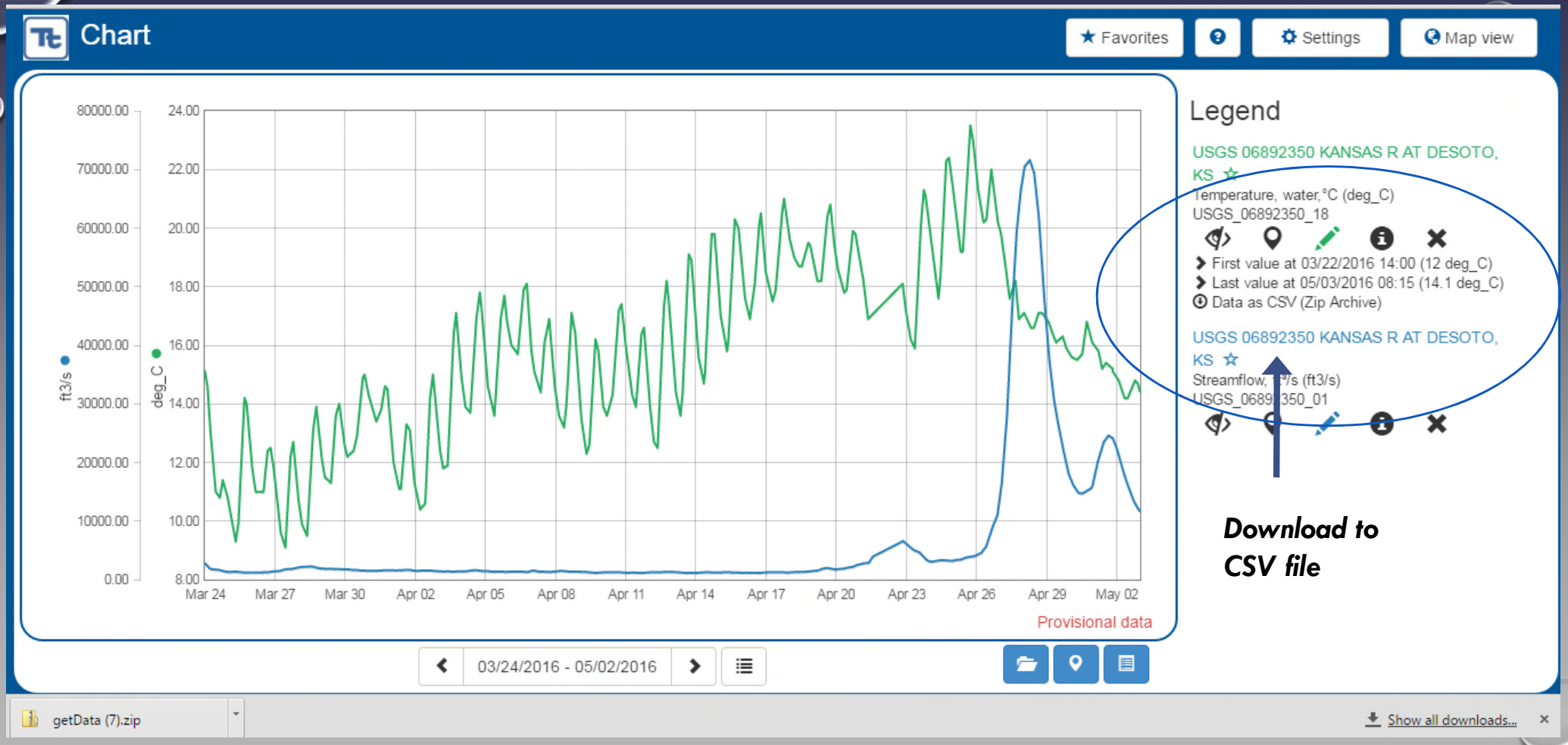
DOWNLOADING DATA



Download to CSV file

Downloaded CSV File

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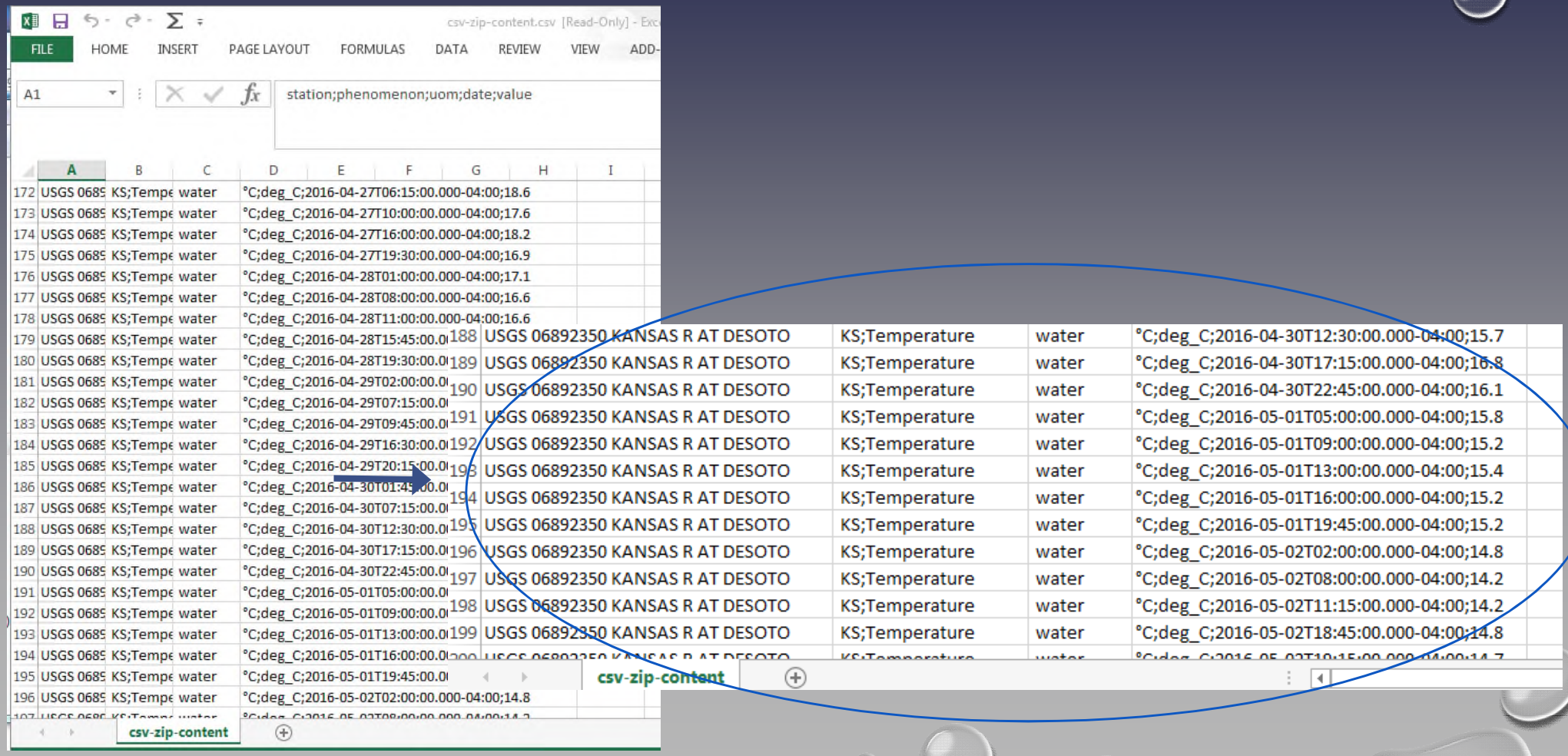
DOWNLOADING DATA



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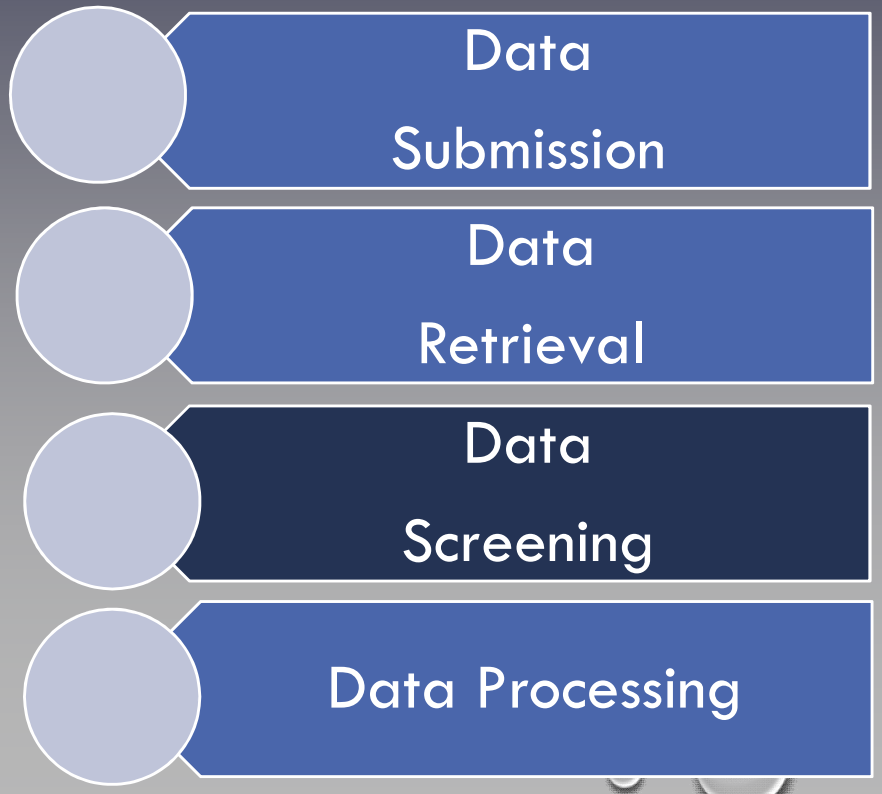
DATA MANAGEMENT

QC Data Before Submitting to the Database



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DATA MANAGEMENT AND SCREENING

Challenges

1. Data compilation uses large fraction of resources
2. Different data sources usually mean Different:
    - Parameter naming conventions
    - Units
    - Sample fraction (e.g., total, filtered)
    - Analytical methods
    - Inconsistent/undocumented procedures
- Which is Why we need Data Standards
- Which is Why we need Metadata

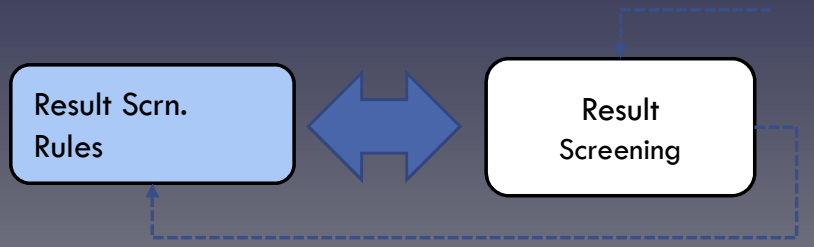
DATA SCREENING

	A	B	C	D	E	G	V	AM	AQ	AR	AS	AT	AU	AV	AW	AX
2	and methods pulled from the results table					Counts, min/ma			User Input--Opportunities to Update/Over Ride							
4	Parameter Name	Sample Fraction	PCODE	Units	Analytical Method	Num. Results	brk1	brk2	Apply Unif.?	Parameter Group	Parameter Name	Parameter Abbrev.	Units	Units Conv. Mult.	Sample Fracti	Method
6	CharacteristicName	ResultSampleFractionText	USGSPCode	ResultMeasure.MeasureUnitCode	ResultAnalyticalMethod.MethodIdentifier	N	brk1	brk2	unifyApply	parameterGroupA	parameterName Apply	parameterAbbrev	unitsFinal	unitsConvMult	sampleFra	methodEquivApplied
98	Ammonia	Dissolved	--	mg/l	350.1	223			TRUE	Nitrogen	Ammonia	NH3	mg/L	1	fil	EPA 350.1
99	Ammonia	Dissolved	--	mg/l	4500-NH3(G)	7			TRUE	Nitrogen	Ammonia	NH3	mg/L	1	fil	EPA 350.1
100	Ammonia-nitrogen	Total	--	mg/l	350.1	37			TRUE	Nitrogen	Ammonia	NH3	mg/L	1	tot	EPA 350.1
101	Ammonia-nitrogen	Total	--	mg/l	LEG_P00610	37			TRUE	Nitrogen	Ammonia	NH3	mg/L	1	tot	NA
102	Ammonia-nitrogen	Total	--	mg/l	4500-NH3(H)	20			TRUE	Nitrogen	Ammonia	NH3	mg/L	1	tot	EPA 350.1
103	Ammonia as NH3	Total	--	mg/l	MDEQ-EPA	4			TRUE	Nitrogen	Ammonia	NH3	mg/L	0.8224	tot	NA
104	Ammonia-nitrogen	Total	--	mg/l	4500-NH3(F)	3			TRUE	Nitrogen	Ammonia	NH3	mg/L	1	tot	SM 4500-NH3-F
105	Ammonia	Dissolved	--	--	350.1	277			FALSE	Nitrogen	Ammonia	NH3	NA	NA	NA	EPA 350.1
106	Ammonia-nitrogen	Total	--	--	350.1	41			FALSE	Nitrogen	Ammonia	NH3	NA	NA	NA	EPA 350.1
107	Ammonia	Dissolved	--	--	4500-NH3(G)	22			FALSE	Nitrogen	Ammonia	NH3	NA	NA	NA	EPA 350.1
108	Ammonia-nitrogen as N	Dissolved	--	ueq/L	350.1	3			FALSE	Nitrogen	Ammonia	NH3	NA	NA	NA	EPA 350.1
109	Ammonia	Total	--	mg/kg	4500-NH3(H)	3			FALSE	Nitrogen	Ammonia	NH3	NA	NA	NA	EPA 350.1
110	Ammonia	Total	--	mg/kg	4500-NH3(G)	2			FALSE	Nitrogen	Ammonia	NH3	NA	NA	NA	EPA 350.1
111	Ammonia	Total	--	--	4500-NH3(G)	2			FALSE	Nitrogen	Ammonia	NH3	NA	NA	NA	EPA 350.1
112	Ammonia	Total	--	--	4500-NH3(H)	2			FALSE	Nitrogen	Ammonia	NH3	NA	NA	NA	EPA 350.1
113	Ammonia	Total	--	mg/kg	350.1	1			FALSE	Nitrogen	Ammonia	NH3	NA	NA	NA	EPA 350.1

KNOWLEDGE BASE---DATA SCREENING

Result Screening Rules

keep	qcRemark	columnName	columnValue
FALSE	ActivityTypeCode: blank	ActivityTypeCode	blank
FALSE	ActivityTypeCode: calibration check	ActivityTypeCode	calibration check
FALSE	ActivityTypeCode: negative control	ActivityTypeCode	negative control
FALSE	ActivityTypeCode: Not determined	ActivityTypeCode	Not determined
FALSE	ActivityTypeCode: Quality Control Sample-Other	ActivityTypeCode	Quality Control Sample-Other



Result Screening Rules -- Updated

Screening Outcome

keep	qcRemark	columnName	columnValue	beginCount	endCount	numFlag
FALSE	ActivityTypeCode: blank	ActivityTypeCode	blank	414352	414352	0
FALSE	ActivityTypeCode: calibration check	ActivityTypeCode	calibration check	414352	414352	0
FALSE	ActivityTypeCode: depletion	ActivityTypeCode	depletion	414352	414352	0
FALSE	ActivityTypeCode: negative control	ActivityTypeCode	negative control	414352	414352	0
FALSE	ActivityTypeCode: Not determined	ActivityTypeCode	Not determined	414352	414351	1
FALSE	ActivityTypeCode: Quality Control Sample-Other	ActivityTypeCode	Quality Control Sample-Other	414351	414351	0
FALSE	ActivityTypeCode: reference	ActivityTypeCode	reference	414351	414351	0
FALSE	ActivityTypeCode: spike	ActivityTypeCode	spike	414351	414351	0
TRUE	ActivityTypeCode: Field Msr/Obs	ActivityTypeCode	Field Msr/Obs	NA	NA	375319
TRUE	ActivityTypeCode: Sample-Routine	ActivityTypeCode	Sample-Routine	NA	NA	34961
TRUE	ActivityTypeCode: Quality Control Sample-Field Replicate	ActivityTypeCode	Quality Control Sample-Field Replicate	NA	NA	345
TRUE	ActivityTypeCode: Sample	ActivityTypeCode	Sample	NA	NA	180
TRUE	ActivityTypeCode: Quality Control Field Replicate Msr/Obs	ActivityTypeCode	Quality Control Field Replicate Msr/Obs	NA	NA	88
TRUE	ActivityTypeCode: Field Msr/Obs-Habitat Assessment	ActivityTypeCode	Field Msr/Obs-Habitat Assessment	NA	NA	66
TRUE	ActivityTypeCode: Quality Control Sample-Lab Duplicate	ActivityTypeCode	Quality Control Sample-Lab Duplicate	NA	NA	14

FALSE

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PARAMETER CONVERSION

includes manual review option

Data Screening

- Sites
- Results

Data Processing

- Parameters
- Units
- Sample Fraction
- Analytical Methods

A	B	C	D
keep	qcRemark	columnName	columnValue
FALSE	ActivityTypeCode: blank	ActivityTypeCode	blank
FALSE	ActivityTypeCode: calibration check	ActivityTypeCode	calibration check
FALSE	ActivityTypeCode: negative control	ActivityTypeCode	negative control
FALSE	ActivityTypeCode: Not determined	ActivityTypeCode	Not determined
FALSE	ActivityTypeCode: Quality Control Sample-Other	ActivityTypeCode	Quality Control Sample-Other
FALSE	ActivityMediaSubdivisionName: effluent	ActivityMediaSubdivisionName	effluent
FALSE	ResultCommentText: fail	ResultCommentText	fail
FALSE	ResultCommentText: holding time	ResultCommentText	holding time
FALSE	ResultCommentText: ice melted	ResultCommentText	ice melted
FALSE	ResultCommentText: improper	ResultCommentText	improper
FALSE	ResultCommentText: insufficient	ResultCommentText	insufficient
FALSE	ResultCommentText: malfunction	ResultCommentText	malfunction

Parameter Conversion

A	B	C	D	E
CharacteristicName	parameterGroup	parameterName	parameterAbbrev	parameterRemark
Chlorophyll a	Algal Biomass	Chl-a	CHLA	
Chlorophyll a, uncorrected for pheophytin	Algal Biomass	Chl-a	CHLA	
Chlorophyll	Algal Biomass	Chl-a	CHLA	
Chlorophyll a, corrected for pheophytin	Algal Biomass	Chl-a, corrected	CHLA_C	
Chlorophyll a, free of pheophytin	Algal Biomass	Chl-a, corrected	CHLA_C	
Biomass, periphyton	Algal Biomass	Biomass, periphyton	PERI	
Pheophytin a	Algal Biomass	Pheophytin a	PHEO	
Ammonia-nitrogen as N	Nitrogen	Ammonia	NH3	*confirm NH3
Ammonia-nitrogen	Nitrogen	Ammonia	NH3	*confirm NH3
Ammonia	Nitrogen	Ammonia	NH3	*confirm NH3
Ammonia as NH3	Nitrogen	Ammonia	NH3	*confirm NH3
Ammonia as N	Nitrogen	Ammonia	NH3	*confirm NH3
Ammonia-nitrogen as NH3	Nitrogen	Ammonia	NH3	*confirm NH3

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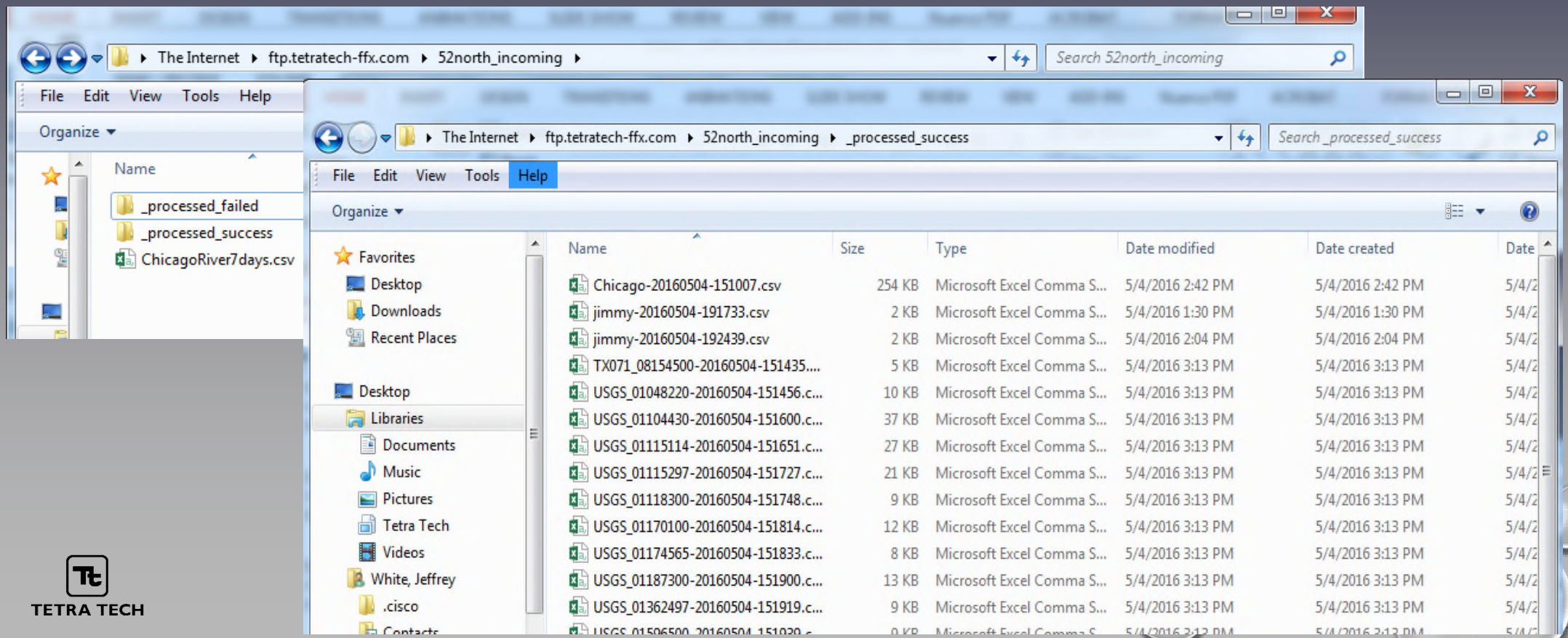
UPLOADING DATA

- How Do I get my Excel Files Uploaded?
- One option is to copy them to an FTP site



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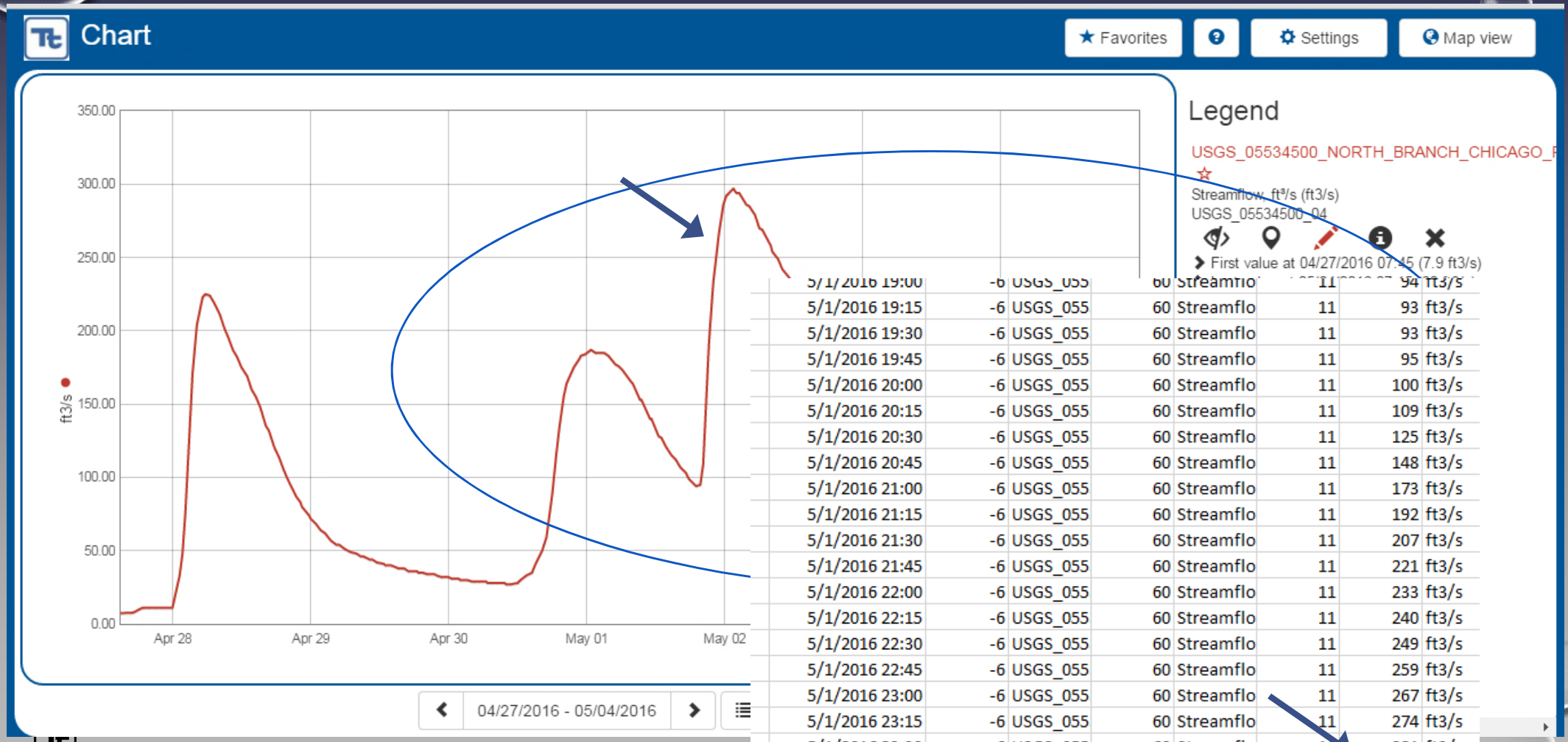
UPLOADED DATA - CHART



5/1/2016 19:00	-6	USGS_055	60	Streamflo	11	94 ft3/s
5/1/2016 19:15	-6	USGS_055	60	Streamflo	11	93 ft3/s
5/1/2016 19:30	-6	USGS_055	60	Streamflo	11	93 ft3/s
5/1/2016 19:45	-6	USGS_055	60	Streamflo	11	95 ft3/s
5/1/2016 20:00	-6	USGS_055	60	Streamflo	11	100 ft3/s
5/1/2016 20:15	-6	USGS_055	60	Streamflo	11	109 ft3/s
5/1/2016 20:30	-6	USGS_055	60	Streamflo	11	125 ft3/s
5/1/2016 20:45	-6	USGS_055	60	Streamflo	11	148 ft3/s
5/1/2016 21:00	-6	USGS_055	60	Streamflo	11	173 ft3/s
5/1/2016 21:15	-6	USGS_055	60	Streamflo	11	192 ft3/s
5/1/2016 21:30	-6	USGS_055	60	Streamflo	11	207 ft3/s
5/1/2016 21:45	-6	USGS_055	60	Streamflo	11	221 ft3/s
5/1/2016 22:00	-6	USGS_055	60	Streamflo	11	233 ft3/s
5/1/2016 22:15	-6	USGS_055	60	Streamflo	11	240 ft3/s
5/1/2016 22:30	-6	USGS_055	60	Streamflo	11	249 ft3/s
5/1/2016 22:45	-6	USGS_055	60	Streamflo	11	259 ft3/s
5/1/2016 23:00	-6	USGS_055	60	Streamflo	11	267 ft3/s
5/1/2016 23:15	-6	USGS_055	60	Streamflo	11	274 ft3/s
5/1/2016 23:30	-6	USGS_055	60	Streamflo	11	281 ft3/s
5/1/2016 23:45	-6	USGS_055	60	Streamflo	11	286 ft3/s
5/2/2016 0:00	-6	USGS_055	60	Streamflo	11	289 ft3/s

UPLOADING DATA – LOG FILE

Download to CSV file

feed_52north.log - Notepad

File Edit Format View Help

```
2016-04-29 14:22:43,006 - INFO  - local file size is 10.0KB
2016-04-29 14:22:43,006 - INFO  -       ../data/unit_values/USGS_06892350_version2.csv
2016-04-29 14:22:43,006 - DEBUG - the columns are:foi_name,epsg_code,lat_va,long_va,altitude,date_string,timeoffset,sensor_
2016-04-29 14:22:43,007 - DEBUG - found column for 'latitude' called 'lat_va'
2016-04-29 14:22:43,007 - DEBUG - found column for 'longitude' called 'long_va'
2016-04-29 14:22:43,009 - DEBUG - found column for 'epsg' called 'epsg_code'
2016-04-29 14:22:43,009 - DEBUG - found column for 'altitude' called 'altitude'
2016-04-29 14:22:43,009 - DEBUG - found column for 'date' called 'date_string'
2016-04-29 14:22:43,009 - DEBUG - found column for 'timeoffset' called 'timeoffset'
2016-04-29 14:22:43,009 - DEBUG - found column for 'sensor' called 'sensor_uri'
2016-04-29 14:22:43,009 - DEBUG - found column for 'parameter' called 'parameter_code'
2016-04-29 14:22:43,009 - DEBUG - found column for 'value' called 'value'
2016-04-29 14:22:43,009 - DEBUG - found column for 'units' called 'units'
2016-04-29 14:22:43,010 - INFO  - there are 53 lines in the input file
2016-04-29 14:22:43,023 - INFO  - created config file:
2016-04-29 14:22:43,023 - INFO  -       ../data/unit_values/USGS_06892350_version2.xml
2016-04-29 14:22:43,023 - INFO  - log for this station is:
2016-04-29 14:22:43,023 - INFO  -       ../data/unit_values/USGS_06892350_version2.log
2016-04-29 14:22:43,025 - DEBUG - starting to feed data to SOS for configuration file
2016-04-29 14:22:43,025 - DEBUG -       ../data/unit_values/USGS_06892350_version2.xml
2016-04-29 14:22:43,025 - DEBUG - shell_command=="C:\ProgramData\Oracle\Java\javapath\java.exe" -jar "C:\Data_and_Tools\usgs
2016-04-29 14:22:49,269 - INFO  - import complete. log file size == 102.1KB
2016-04-29 14:22:49,447 - INFO  - New Observations: 53
2016-04-29 14:22:49,448 - DEBUG - finished feeding data to SOS for configuration file
2016-04-29 14:22:49,448 - DEBUG -       ../data/unit_values/USGS_06892350_version2.xml
2016-04-29 14:22:49,450 - DEBUG - renamed data file to
2016-04-29 14:22:49,450 - DEBUG -       ../data/unit_values/USGS_06892350_version2-20160429-142249.csv
2016-04-29 14:22:49,450 - INFO  - finished processing file (0:00:06.444 seconds elapsed)
2016-04-29 14:22:49,450 - INFO  -       ../data/unit_values/USGS_06892350_version2.csv
```

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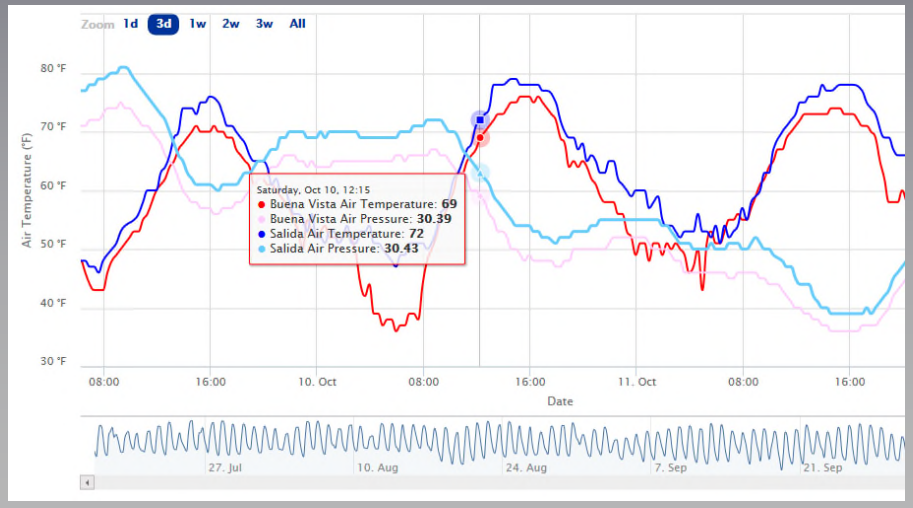
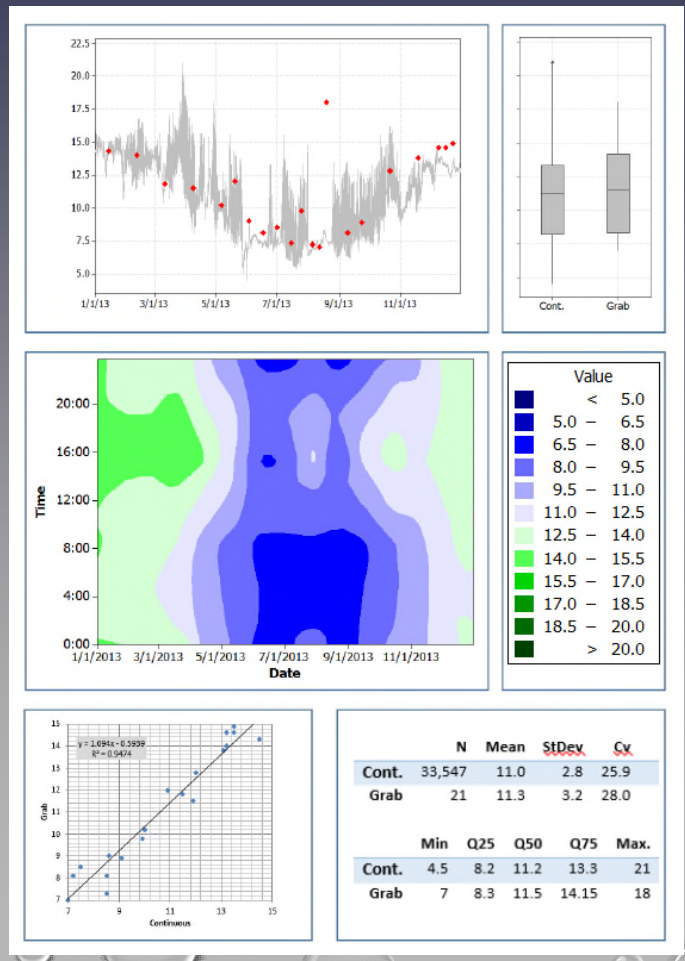
NEXT STEPS

- Tools and Procedures for QCing, Formatting and Deriving Summary Outputs
  - R Scripts, K9, L9 Workshops
  - Enhanced Charts and Visualization tools
- Join Discreet Sampling Data With Continuous Monitoring Data
  - Example, Benthic Macroinvertebrates Requires Field Visits
    - Collect field samples, Process samples in the laboratory, Calculate indicator terms.
  - Discreet Sampling Data from the Water Quality Portal

52 NORTH SOS CUSTOM CONFIGURATION

- Open source platform allows for a tremendous amount of customization from the 'out-of-the-box' configuration (example below)
- The SOS web client has capabilities to integrate with statistical packages like R to produce statistics and graphics such as those provided to the right





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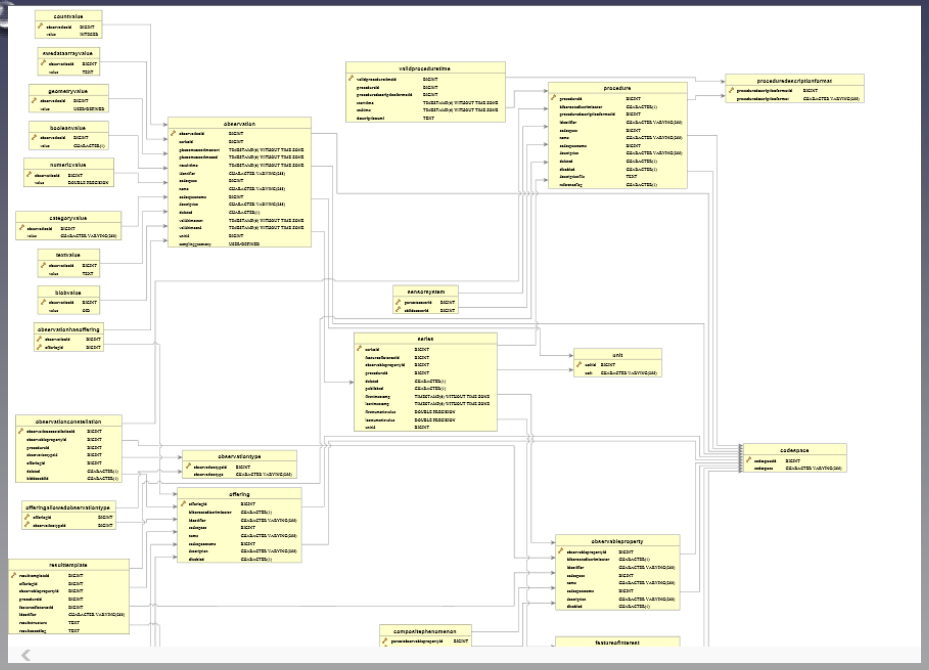
SUMMARY

- 52 North provides a platform for continuous monitoring data sharing.
- The 52 North (SOS) data model and client appear to be capable of storing and hosting both discrete grab and continuous data including near-real time sensor data from multiple sensor-types and monitoring organizations in a standardized, accessible format.
- 52 North allows for add-ons and customization leveraging statistical software such as R to compute summary statistics or other desired metrics.
- Plans to further develop capabilities to allow for hosting state and regional water quality monitoring data.

QUESTIONS, REFERENCE, CONTACT



https://wiki.52north.org/bin/view/SensorWeb/SensorObservationServiceDatabaseModel

http://www.opengeospatial.org/standards/sos

Jeffrey White
Center For Ecological Sciences
Tetra Tech, Inc.
10711 Red Run Blvd., Suite 105
Owings Mills, MD 21117
jeffrey.white@tetratech.com

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