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Streamlining and automating USGS water-quality time-series records processing

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May 3, 2012

U.S. Department of the Interior
U.S. Geological Survey

Streamlining and automating WQ time-series records processing

- Several tools developed in-house
- Users have a need and find a way to make it happen
- Some tools are supported nationally
- Most tools automate or simplify decision making

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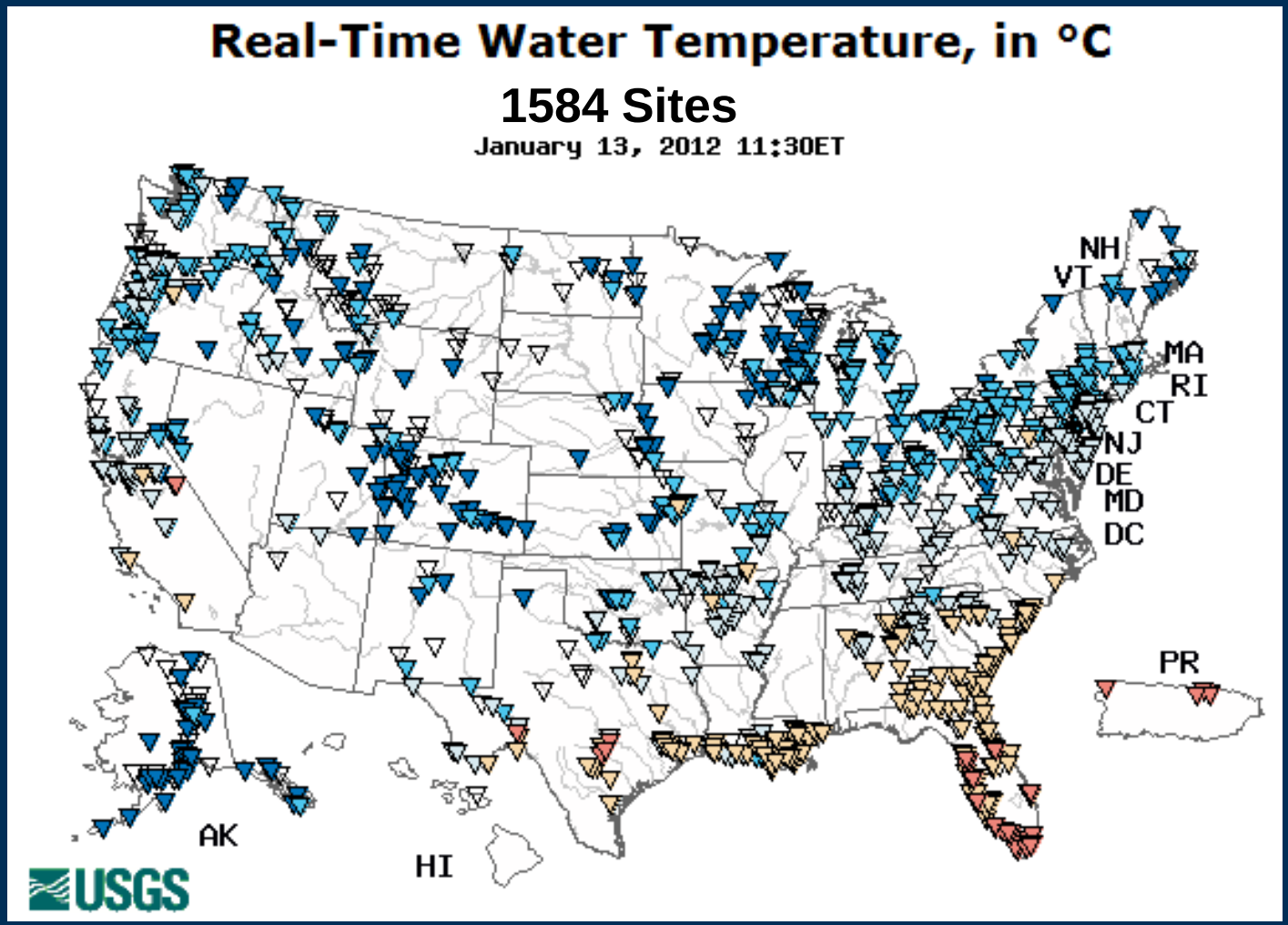
Growth in real-time water-quality



USGS http://waterwatch.usgs.gov/wqwatch/

Growth of monitors in USGS

Measurement	2006	2012
Temperature	941	1584
Conductance	553	799
pH	242	338
Dissolved oxygen	294	406
Turbidity	172	305
Other	--	60

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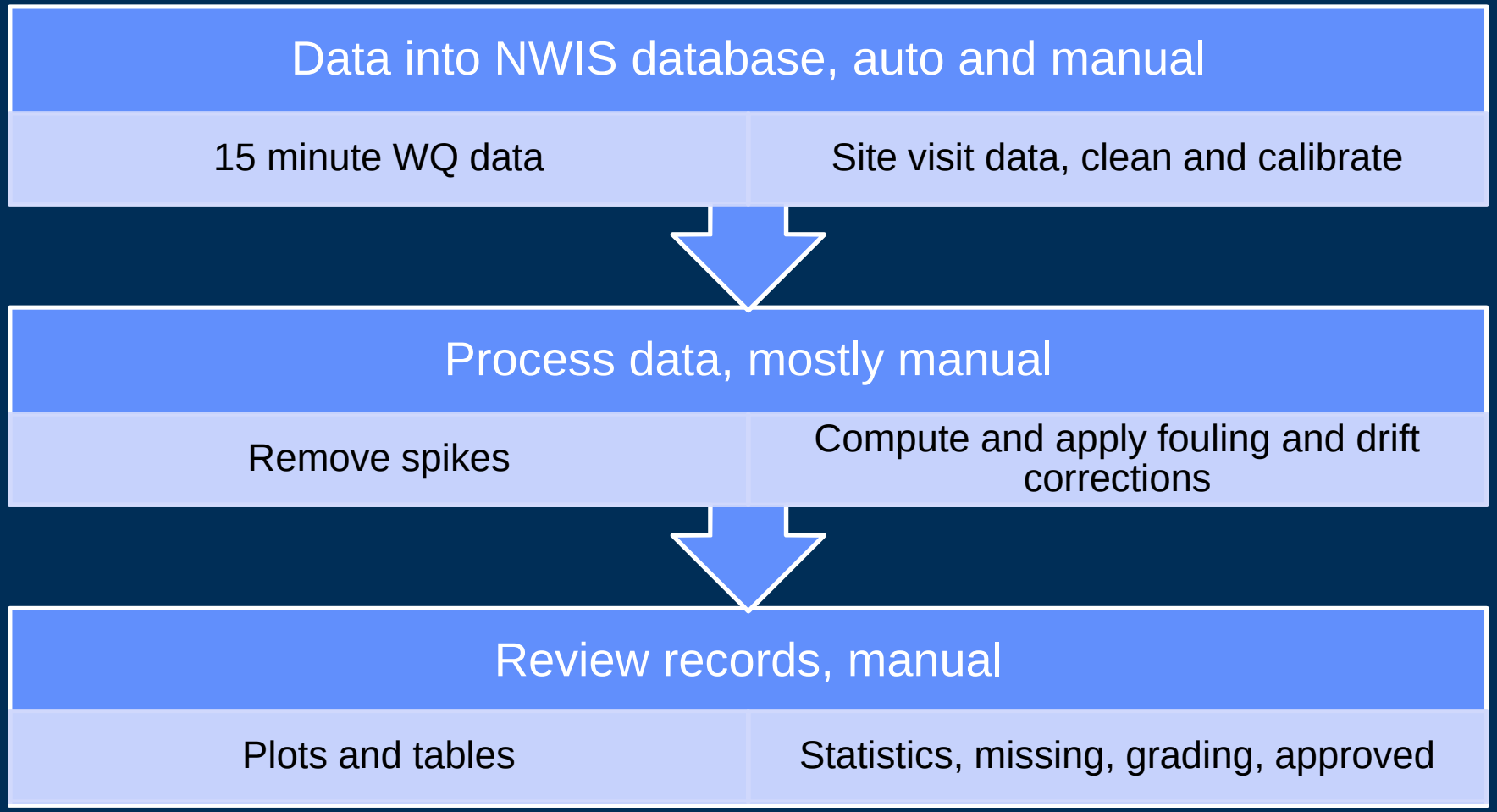
WQ record workflow



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WQ record tools

- CHIMP
  - PDA software for site visit data collection
  - Cleaning and recalibrating WQ monitors
- ACL – Automatic Correction Loader
  - Script that computes corrections
  - Loads the corrections to database and applies them to the time-series data
- WQMreview
  - Script that auto creates graphs and tables
  - PDFs are available to all

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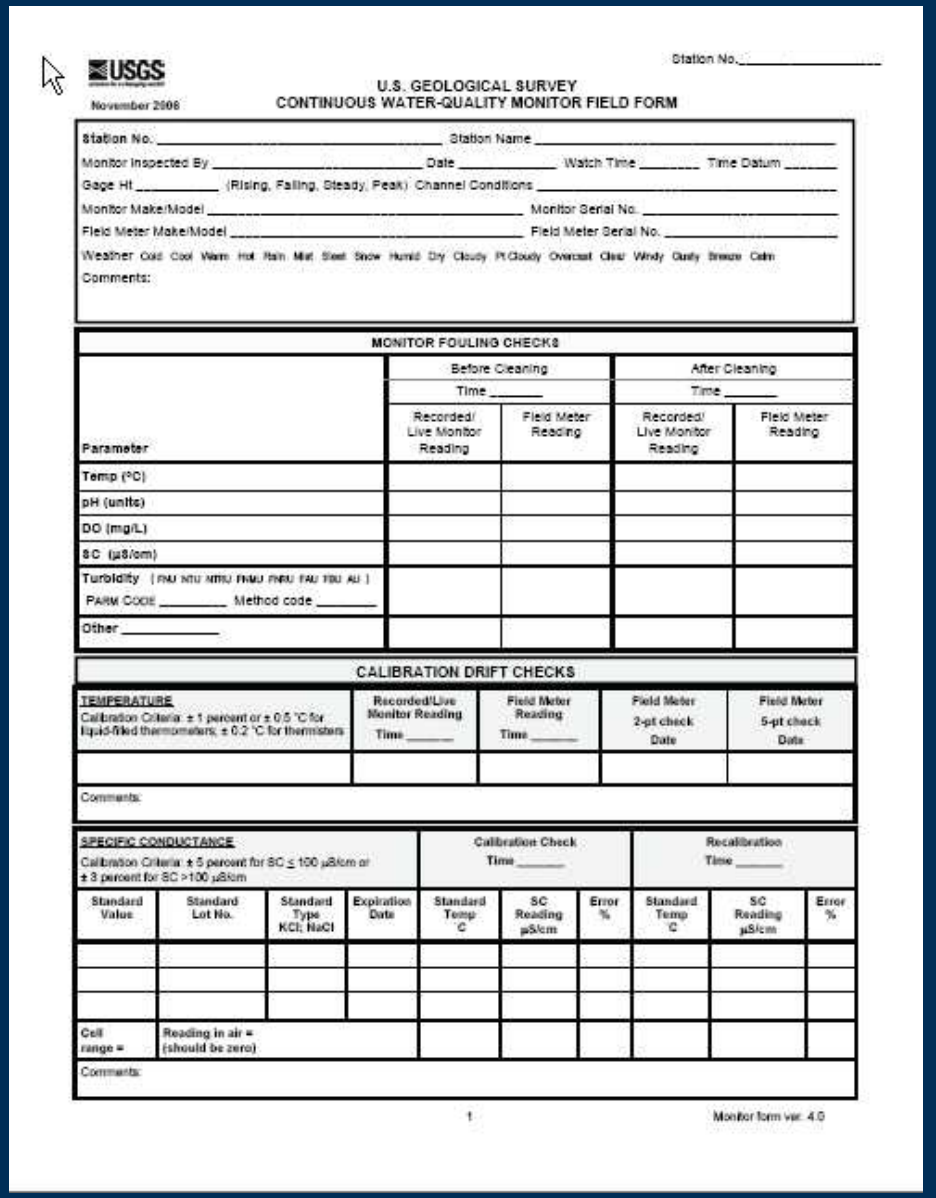
Old Way

- Hand written on paper forms
- Paper forms stored in files
- Little or no data stored in NWIS DB
- Hand-enter values into spreadsheets to compute corrections



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November 2008

Station No. _____

U.S. GEOLOGICAL SURVEY
CONTINUOUS WATER-QUALITY MONITOR FIELD FORM

Station No. _____ Station Name _____
Monitor Inspected By _____ Date _____ Watch Time _____ Time Datum _____
Gage Ht _____ (Rising, Falling, Steady, Peak) Channel Conditions _____
Monitor Make/Model _____ Monitor Serial No. _____
Field Meter Make/Model _____ Field Meter Serial No. _____
Weather Cold Cool Warm Hot Rain Mist Sleet Snow Humid Dry Cloudy Pt Cloudy Overcast Clear Windy Gusty Breeze Calm
Comments:

MONITOR FOULING CHECKS

Parameter	Before Cleaning Time _____ Recorded/ Live Monitor Reading	Before Cleaning Time _____ Field Meter Reading	After Cleaning Time _____ Recorded/ Live Monitor Reading	After Cleaning Time _____ Field Meter Reading
Temp (°C)				
pH (units)				
DO (mg/L)				
SC (µS/cm)				
Turbidity (FNU NTU NTRU FNMU FNRU FAU FBU AU) PARM CODE _____ Method code _____				
Other _____				

CALIBRATION DRIFT CHECKS

TEMPERATURE Calibration Criteria: ± 1 percent or ± 0.5 °C for liquid-filled thermometers; ± 0.2 °C for thermistors	Recorded/Live Monitor Reading Time _____	Field Meter Reading Time _____	Field Meter 2-pt check Date	Field Meter 5-pt check Date

Comments:

SPECIFIC CONDUCTANCE Calibration Criteria: ± 5 percent for SC ≤ 100 µS/cm or ± 3 percent for SC >100 µS/cm				Calibration Check Time _____			Recalibration Time _____		
Standard Value	Standard Lot No.	Standard Type KCl; NaCl	Expiration Date	Standard Temp °C	SC Reading µS/cm	Error %	Standard Temp °C	SC Reading µS/cm	Error %
Cell range =	Reading in air = (should be zero)								

Comments:

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CHIMP

- Data collection during a WQ monitor site visit
  - Site conditions, weather, who…
  - Before and after cleaning readings
    - Field and site monitor
    - WT, SC, DO, pH, turb, and “other”
  - Calibration check and recal
    - All standards and calibration metadata
    - Sensor performance
  - Final readings

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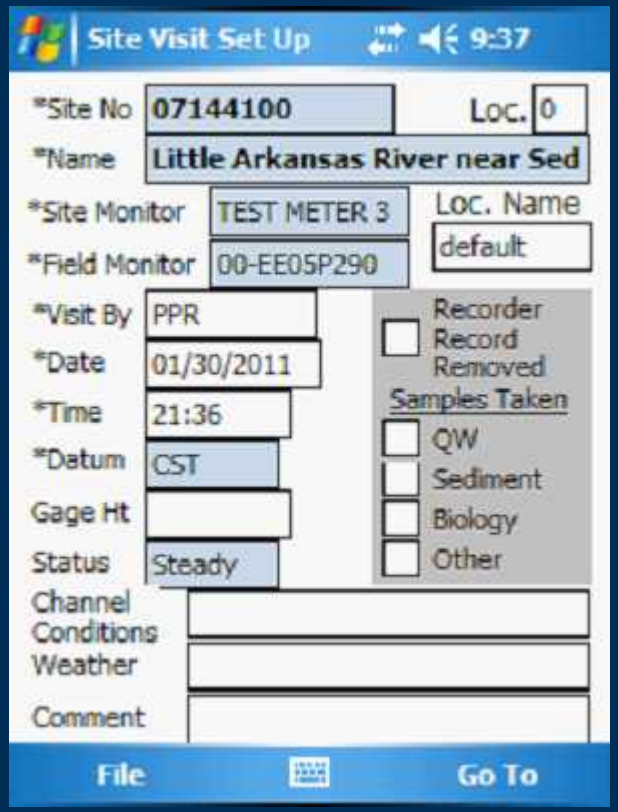
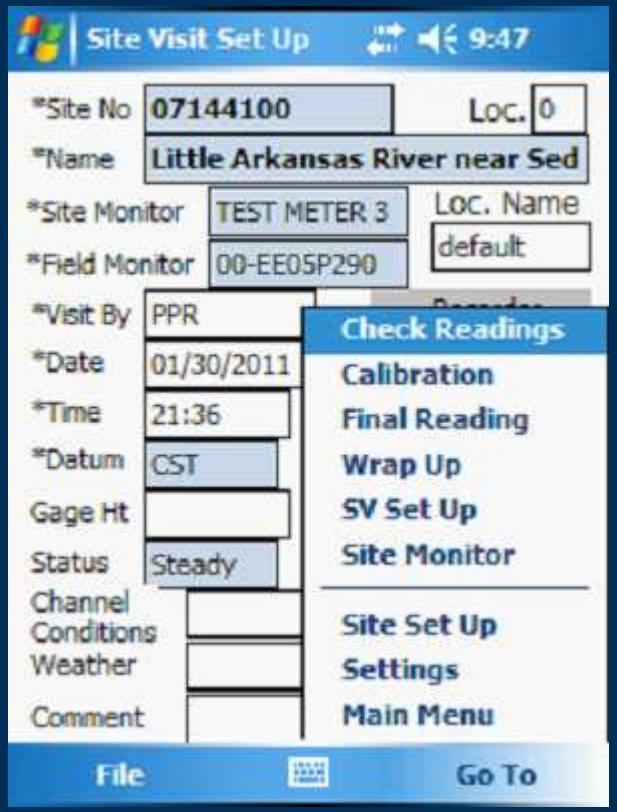
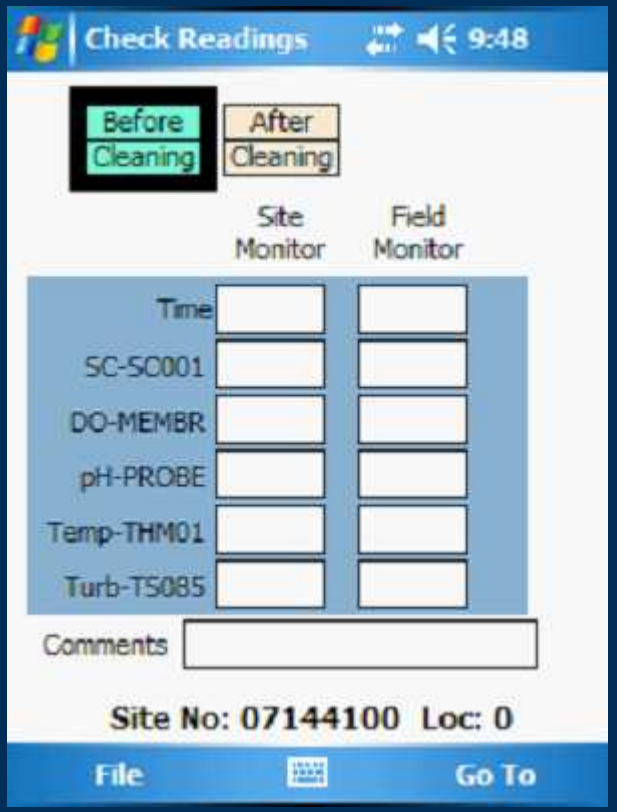
CHIMP – Site Visit







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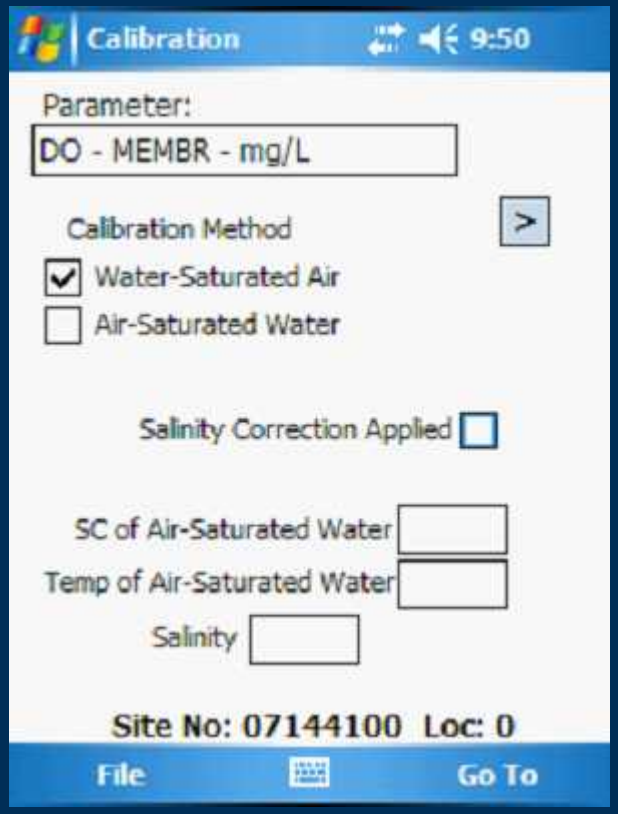
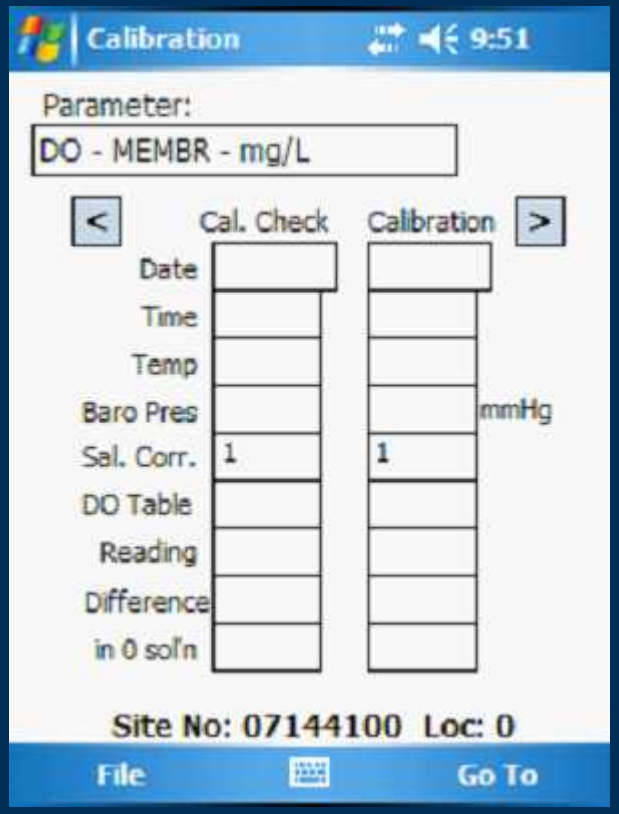
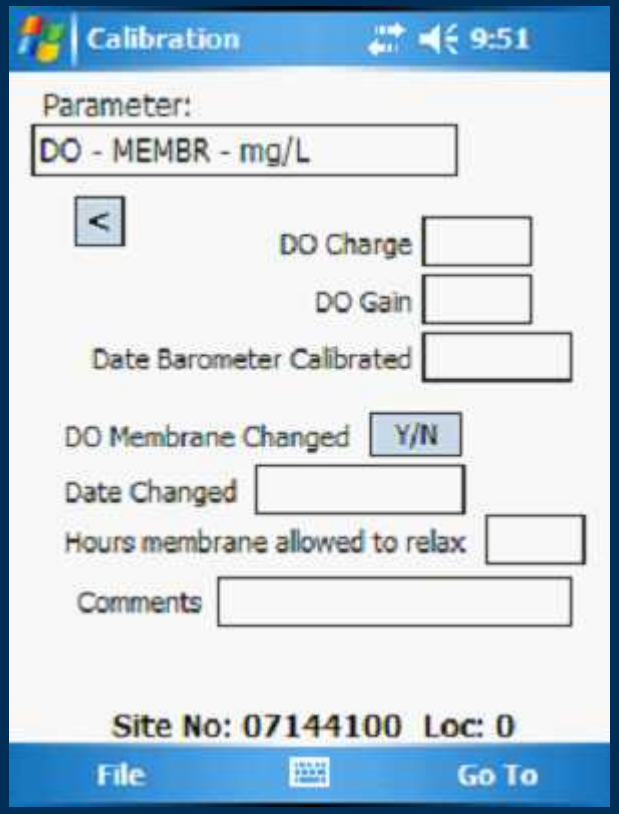
CHIMP – DO calibration







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CHIMP

- Data synchronization
  - CHIMP site visit file is uploaded to the database
  - Database is queried to retrieve site visit information

CHIMP ver. 4.10.w

Stylesheet ver. 1.1.3W

U.S. DEPARTMENT OF THE INTERIOR
U.S. Geological Survey

CONTINUOUS WATER QUALITY
FIELD FORM

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Site Visit Summary

CHIMP Meter Calibration

Site Visit Date: 2011-01-14 | Start Time: 14:57:00 | End Time: 15:08:00
Party: BP | Battery:

Field Meter (FM)

Make/Model: YSI / 6600 | Serial Number: Field Testing Sonde

Comment:

Temp Calibration

Water Temperature Calibration Drift Check

Monitor

Date/Time: 2011-01-14 / 15:02:00 | Reading: 1 | 2-pt Check Date:
NIST cert: 2011-01-14 / 15:02:00

NIST WTemp	Meter Wtemp
1	1
5	5
10	10
20	20
25	25

Field Meter

Date/Time: 2011-01-14 / 15:02:00 | Reading: | 5-pt Check Date:

Comment:

Temp Calibration

Specific Conductance Calibration Drift Check

				Cal Check 2011-01-14 / 15:01:00			Recal 2011-01-14 / 15:02:00			
Std	Lot No.	Exp	Std Type	Temp	Read	Error %	Temp	Read	Error %	Used for Recal
250	123	2011-01-14	KCL	20	250	0.000	20	250	0.000	Post-check
1000	123	2011-01-14	KCL	20	1000	0.000	20	1000	0.000	Post-check
1800	123	2011-01-14	KCL	20	1800	0.000	20	1800	0.000	Post-check

Comment:

SC Comments
Cell Range: 1 | Reading in Air: 0

Dissolved Oxygen Calibration Drift Check

Cal Check 2011-01-14 / 14:58:00

Temp.	BP mm Hg	DO Table Read	Salinity CF	Read	Error %	Read in 0 Soln
20	750	8.95	1	8.95	0.00	0

Recal 2011-01-14 / 14:58:00

20	750	8.95	1	8.95	0.00	0

Comment:

Coments on DO Calibration
Salinity: 0 | Sal Corr Applied: Yes | SC of Water:
Temp of Water: | DO Charge: 1 | DO Gain: 1
Membrane Changed: No
Barometer Calibrated Date:

pH Calibration Drift Check

				Cal Check 2011-01-14 / 14:59:00				Recal 2011-01-14 / 15:00:00				
Std	pH Table Value	Lot No.	Exp	Temp	Reading	Diff	mV	Temp	Reading	Diff	mV	Used for Recal
7.02	7.02	123	2011-01-14	20	7.02	1	1	20	7.02	0.00	1	Calibrated
4.00	4.00	123	2011-01-14	20	4.00	1	1	20	4.00	0.00	1	Calibrated
10.05	10.05	123	2011-01-14	20	10.05	1	1	20	10.05	0.00	1	Calibrated

Comment:

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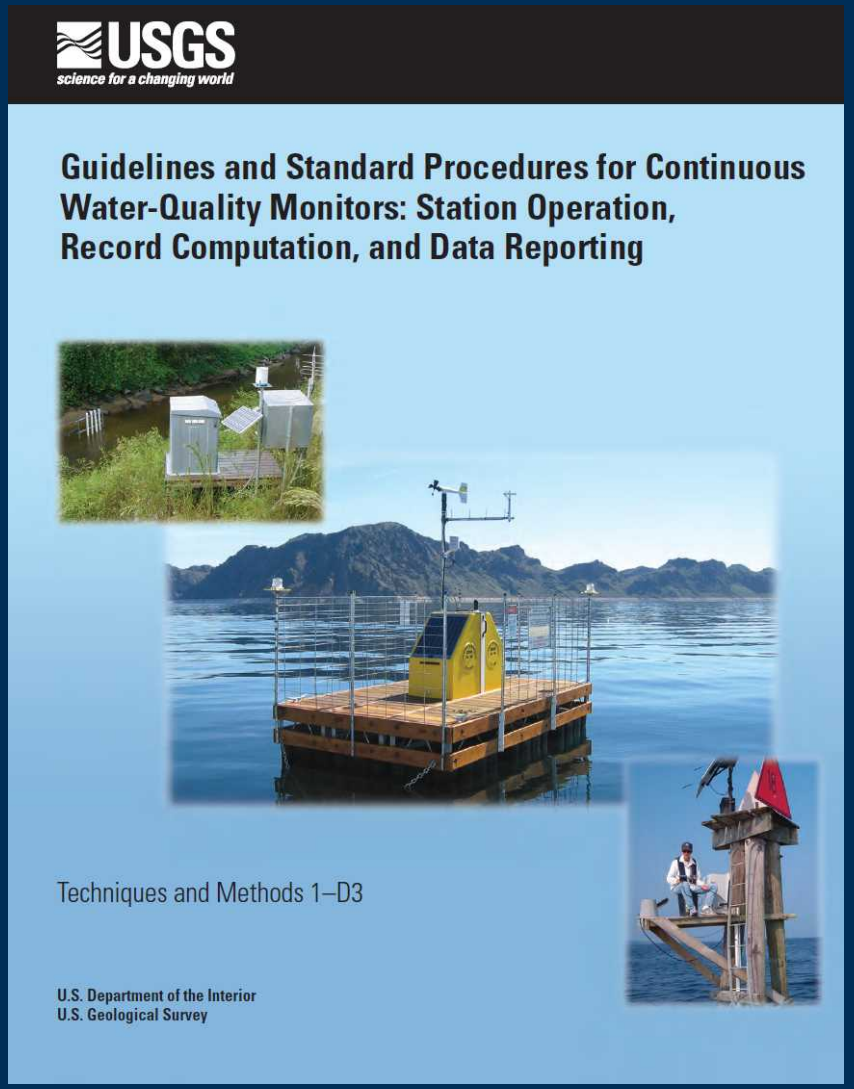
What is ACL

- A script that automatically computes fouling and drift corrections and applies them to the time-series data
- Correction computations and thresholds are based on USGS TM1D3



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ACL Benefits

- Saves record working time
- Is the beginning of automating record work
- Starting point for a more comprehensive data correction algorithm
- Runs automatically in the background, very little maintenance
- Nationally consistent
- Streamline record working

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ACL workflow

Table 17. Maximum allowable limits for continuous water-quality monitoring sensors.

[±, plus or minus value shown; °C, degree Celsius; %, percent; mg/L, milligram per liter; pH unit, standard pH unit. Data corrections that exceed the maximum allowable limits should not be stored in the database]

Measured field parameter	Maximum allowable limits for water-quality sensor values
Temperature	±2.0 °C
Specific conductance	±30%
Dissolved oxygen	±2.0 mg/L or 20%, whichever is greater
pH	±2 pH units
Turbidity	±3.0 turbidity units or ±30%, whichever is greater

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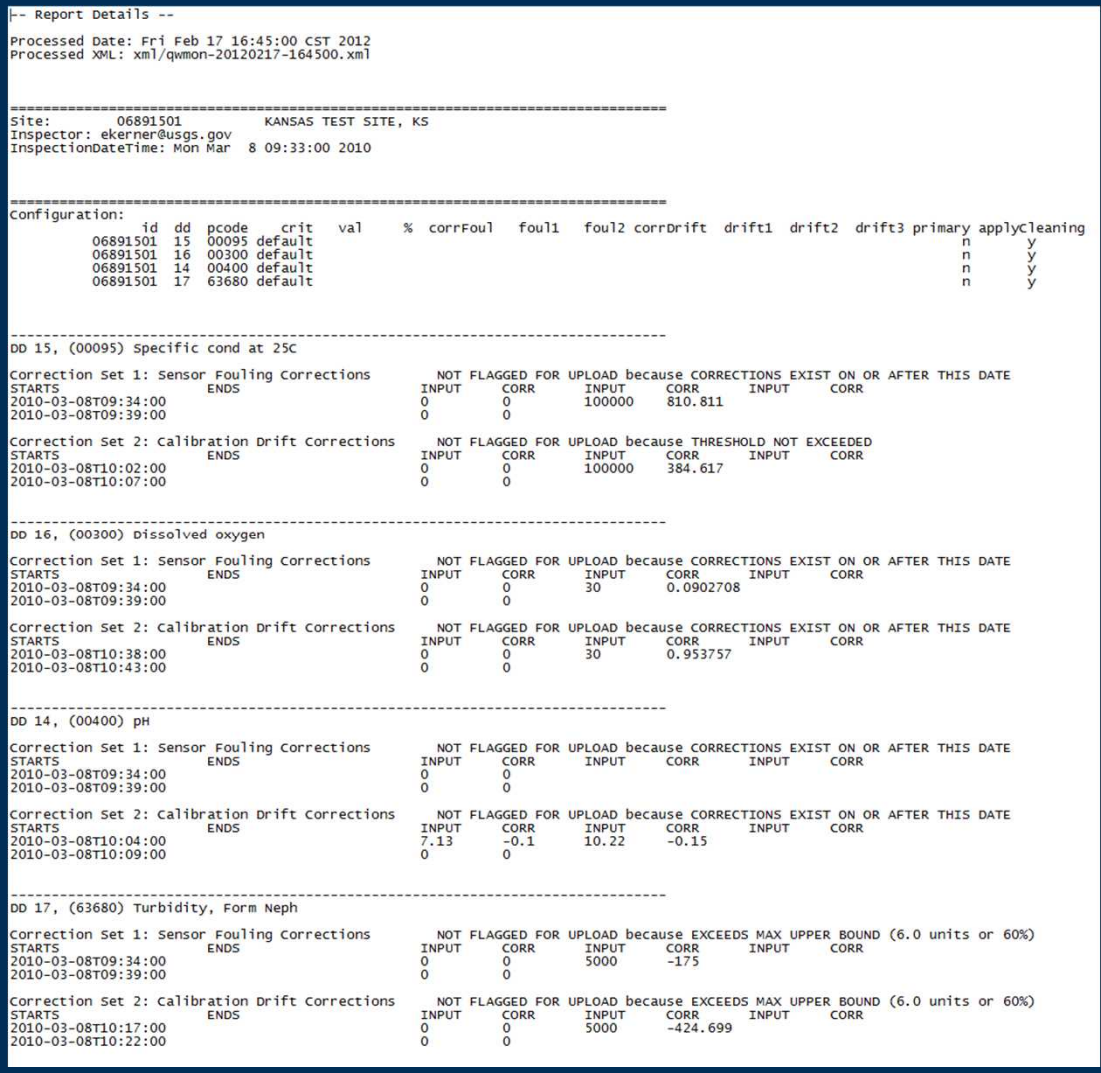
ACL workflow

- Report emailed to the user and any other interested person



```
-- Report Details --

Processed Date: Fri Feb 17 16:45:00 CST 2012
Processed XML: xml/qwmon-20120217-164500.xml


================================================================================
Site:       06891501          KANSAS TEST SITE, KS
Inspector: ekerner@usgs.gov
InspectionDateTime: Mon Mar  8 09:33:00 2010


================================================================================
Configuration:
          id  dd  pcode    crit   val     %  corrFoul   foul1   foul2 corrDrift  drift1  drift2  drift3 primary applyCleaning
    06891501  15  00095 default                                                                      n       y
    06891501  16  00300 default                                                                      n       y
    06891501  14  00400 default                                                                      n       y
    06891501  17  63680 default                                                                      n       y


--------------------------------------------------------------------------------
DD 15, (00095) Specific cond at 25C

Correction Set 1: Sensor Fouling Corrections       NOT FLAGGED FOR UPLOAD because CORRECTIONS EXIST ON OR AFTER THIS DATE
STARTS              ENDS                  INPUT     CORR      INPUT     CORR      INPUT     CORR
2010-03-08T09:34:00                       0         0         100000    810.811
2010-03-08T09:39:00                       0         0

Correction Set 2: Calibration Drift Corrections    NOT FLAGGED FOR UPLOAD because THRESHOLD NOT EXCEEDED
STARTS              ENDS                  INPUT     CORR      INPUT     CORR      INPUT     CORR
2010-03-08T10:02:00                       0         0         100000    384.617
2010-03-08T10:07:00                       0         0


--------------------------------------------------------------------------------
DD 16, (00300) Dissolved oxygen

Correction Set 1: Sensor Fouling Corrections       NOT FLAGGED FOR UPLOAD because CORRECTIONS EXIST ON OR AFTER THIS DATE
STARTS              ENDS                  INPUT     CORR      INPUT     CORR      INPUT     CORR
2010-03-08T09:34:00                       0         0         30        0.0902708
2010-03-08T09:39:00                       0         0

Correction Set 2: Calibration Drift Corrections    NOT FLAGGED FOR UPLOAD because CORRECTIONS EXIST ON OR AFTER THIS DATE
STARTS              ENDS                  INPUT     CORR      INPUT     CORR      INPUT     CORR
2010-03-08T10:38:00                       0         0         30        0.953757
2010-03-08T10:43:00                       0         0


--------------------------------------------------------------------------------
DD 14, (00400) pH

Correction Set 1: Sensor Fouling Corrections       NOT FLAGGED FOR UPLOAD because CORRECTIONS EXIST ON OR AFTER THIS DATE
STARTS              ENDS                  INPUT     CORR      INPUT     CORR      INPUT     CORR
2010-03-08T09:34:00                       0         0
2010-03-08T09:39:00                       0         0

Correction Set 2: Calibration Drift Corrections    NOT FLAGGED FOR UPLOAD because CORRECTIONS EXIST ON OR AFTER THIS DATE
STARTS              ENDS                  INPUT     CORR      INPUT     CORR      INPUT     CORR
2010-03-08T10:04:00                       7.13      -0.1      10.22     -0.15
2010-03-08T10:09:00                       0         0


--------------------------------------------------------------------------------
DD 17, (63680) Turbidity, Form Neph

Correction Set 1: Sensor Fouling Corrections       NOT FLAGGED FOR UPLOAD because EXCEEDS MAX UPPER BOUND (6.0 units or 60%)
STARTS              ENDS                  INPUT     CORR      INPUT     CORR      INPUT     CORR
2010-03-08T09:34:00                       0         0         5000      -175
2010-03-08T09:39:00                       0         0

Correction Set 2: Calibration Drift Corrections    NOT FLAGGED FOR UPLOAD because EXCEEDS MAX UPPER BOUND (6.0 units or 60%)
STARTS              ENDS                  INPUT     CORR      INPUT     CORR      INPUT     CORR
2010-03-08T10:17:00                       0         0         5000      -424.699
2010-03-08T10:22:00                       0         0
```

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ACL Limitations

- Hydrographer must evaluate DCs
- Data must be in database
- Does not process WT corrections
- Is not interactive with user
- Does not evaluate time-series data

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WQMReview

- New script, 2012
  - Automatically creates reports and plots from ADAPS and SiteVisit
  - Includes WT, SC, pH, DO, and turbidity
  - Parameter specific PDFs

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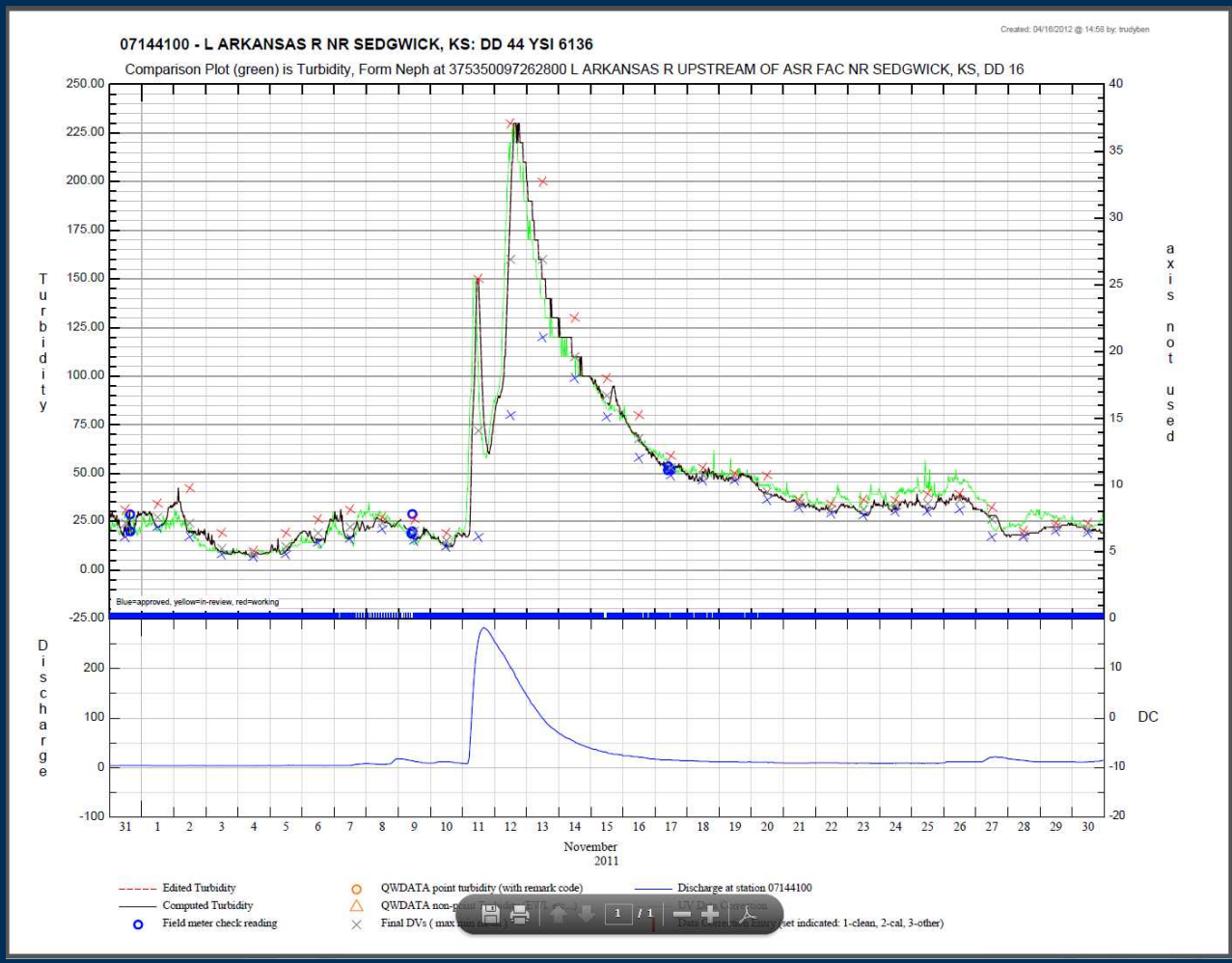
WQMReview

Includes –

- 4 reports
- 2 tables
- Monthly hydrographs of parameter and streamflow



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Conclusions

- WQ records can be streamlined and automated
- Automation improves efficiencies and National consistancy
- Tools need to be seamless to the users
- Lots more to do…

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Questions?

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785-832-3542

http://pubs.usgs.gov/tm/tm3c4/

http://waterwatch.usgs.gov/wqwatch/

http://nrtwq.usgs.gov

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