**QUALITY ASSURANCE PROJECT PLAN**
**FOR FRSG MONITORING PROJECT**

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# QUALITY ASSURANCE PROJECT PLAN (QAPP) FOR FRSG MONITORING PROJECT

Version 1.0

Center for Watershed Science
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## QUALITY ASSURANCE PROJECT PLAN APPROVAL FORM

The attached quality assurance project plan has been reviewed and approved by the following administrative signatories:

Signature ______________________________ Date
Vern Knapp
Acting Director
Center for Watershed Science

Signature ______________________________ Date
Mary LeFaivre
Quality Assurance Specialist
Office of the Director

Signature ______________________________ Date
Misganaw Demissie, Ph.D. P.E.
Director
Illinois State Water Survey

Signature ______________________________ Date
Bruce Yurdin
IEPA Project Liaison
Bureau of Water
Illinois Environmental Protection Agency

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Version 1.0, August 2009

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## ACRONYMS AND ABBREVIATIONS

| | | |
|---|---|---|
| BMP | - | Best Management Practice |
| $BOD_5$ | - | Biological Oxygen Demand, 5-day |
| COC | - | Chain of Custody |
| CSO | - | Combined Sewer Overflow |
| DRP | - | Dissolved Reactive Phosphorus |
| FRSG | - | Fox River Study Group |
| HDPE | - | high density polyethylene |
| HSPF | - | Hydrological Simulation Program-FORTRAN |
| IDNR | - | Illinois Department of Natural Resources |
| IDOA | - | Illinois Department of Agriculture |
| IEPA | - | Illinois Environmental Protection Agency |
| ISWS | - | Illinois State Water Survey |
| $NH_3$-N | - | total ammonia as Nitrogen |
| $NH_4$-N | - | total ammonium as Nitrogen |
| $NO_2$-N | - | Nitrite as Nitrogen |
| $NO_3$-N | - | Nitrate as Nitrogen |
| QA | - | quality assurance |
| QC | - | quality control |
| SOP | - | Standard Operating Procedure |
| SRM | - | Standard reference material |
| TKN | - | total Kjeldahl Nitrogen |
| TSS | - | Total Suspended Solids |
| TWRI | - | Techniques of Water-Resources Investigations |
| USEPA | - | United States Environmental Protection Agency |
| USGS | - | United States Geological Survey |

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## GLOSSARY

**Accuracy** - The closeness of a measured or computed value to its true value.
**Bed Load** - That portion of the total sediment load transported along the stream bed.
**Bias** - A persistent positive or negative deviation of the mean value obtained by using a specific method or procedure from the true value. In practice, bias is expressed as the difference between accepted true value and mean value obtained by repetitive testing of homogeneous samples.
**Censored Data** - Concentrations less than the stated minimum reporting limits.
**Chain-of-Custody** - The procedures and forms used to trace and record samples through all stages of collection, shipping, and analysis, and reporting of analytical results.
**Churnsplitter** - A device usually made of Teflon® used for compositing samples with a minimum introduction of atmospheric oxygen.
**Completeness of Sampling** - A sampling program that captures the variability of flow and constituent concentrations coupled with a comprehensive analysis that meets the objectives of the project.
**Composite Sample** - A sample composed of two or more samples.
**Data Logger** - A device used to record and produce data from various instruments in a digital format.
**Datum** - An accepted or defined elevation of a point from which other elevations are subsequently determined and referenced to.
**Depth Integrated Sample** - A flow weighted sample collected from the water column of a stream using a uniform transit rate.
**Depth-Integrated Sampler** - A sampler designed to sample the vertical water column of a stream proportionally to the velocity at each depth.
**Detection Limit** - The lowest concentration of a chemical constituent able to be measured using a single measurement with a stated level of confidence.
**Dip Sample** - A sample that is taken at or near the water surface.
**Discharge** - The volume of water passing through an imaginary plane normal to the stream channel per unit time.
**Field Blank** - Uncontaminated DI water carried through the field data collection routine and sampling equipment in the same manner as a regular sample.
**Gaging Station** - A site where instrumentation has been installed to record water surface elevations and discharges.
**Isokinetic Sampling** - A sampling procedure where the water approaching the nozzle of a sampler undergoes no change in speed or direction as it enters the orifice.
**Mean** - The arithmetic average.
**Non-point Source** – In general, an unconfined or diffuse source of contamination such as storm water runoff or atmospheric deposition.

**Point Source** - Any confined, or discrete conveyance (pipe, ditch, channel, tunnel, etc.) from which pollutants are discharged.

**Price AA Meter** - A mechanical vertical axis current meter used to measure water velocity. It has been approved by the USGS.

**Pygmy Meter** - A small version of the Price AA meter used to measure velocity for shallow and low flow conditions.

**Quality Assurance** - A term used to describe programs and the sets of procedures, including quality control, which are necessary to assure the reliability of data.

**Quality Control** - A term used to describe the routine procedures used to control data collection, measurements, and analyses so that data of satisfactory quality are produced.

**Rating** - An equation that relates water surface elevation or stage at a monitoring station to discharge.

**Rating Curve** - A graphical representation of the relationship between stage and discharge for a specific location.

**Reference Point** - A defined point whose elevation has been determined from a specified benchmark. In stream gaging, reference points are often used as points of known elevation from which a manual tapedown to the water surface can be performed.

**Representativeness** - The collection of data of sufficient quantity and quality to accurately represent stream conditions.

**Single Vertical Sample** - A depth integrated sample that is collected as a single station in a cross section.

**Single Point Sample** - A sample that has been collected at a point in a cross section without depth or width integration.

**Site Log** - A form in which all significant repairs, modifications, observations, etc., at a gaging station are recorded.

**Sounding Reel** - A mechanical winch equipped with an indicator that displays the amount of cable that has been played out. In water resources investigations, it is used to determine depth and deploy meters and samplers at specific depths.

**Spin Test** - A test where the bucket wheel of a Price AA or Pygmy meter is spun and the time it takes to stop is measured and recorded. Used as a quality control test to determine if the meter is operating properly.

**Split Samples** - Split samples are prepared by withdrawing two subsamples from the full sample volume. The laboratory will analyze both samples and allowing for the comparison of analytical variability.

**Stage** - The elevation of the water surface above the datum at a monitoring station.

**Standard Reference Material** - A material or substance whose properties are sufficiently well established to be used for the assessment of a method or the calibration of an apparatus.

**Standard-reference Samples** - Standard-reference samples are used to document the ability of a laboratory to accurately analyze samples of known concentrations and to check for bias in analytical results. Standard-reference samples are prepared using standard reference materials at a different laboratory than where regular samples are analyzed.

**Suspended Sediment** - Sediment (soil) particles that are in suspension in the water column

**Tagline** - A cable, generally stainless steel, with demarcations at known intervals. It is used to determining distance across a stream cross section.

**Tapedown** - A measurement, using a steel tape and weight, from a point with a known elevation to the water surface. In stream gaging, it is used to verify the proper operation of stage sensing equipment.

**Unit Value Data** - The raw unedited data as it is downloaded from a data logger.

**Wading Rod** - A stainless steel rod onto which a Price AA or Pygmy current meter can be mounted during discharge measurements in shallow water.

**Width Integrated** - A sample that has been composited from two or more samples taken at different locations across a stream cross section.

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# I. PROJECT DESCRIPTION

## A. Background

The Fox River Study Group, Inc. (FRSG) is conducting a multi-phase project to research water quality issues within the Fox River watershed (Figure 1). FRSG includes a diverse coalition of stakeholders representing municipalities, county government, sanitary districts, and environmental and watershed groups along the Illinois portion of the Fox River. The current phase of the project involves a two year monitoring program that will supply verification and validation data to a Hydrological Simulation Program-FORTRAN (HSPF) watershed model and a QUAL2E river water quality model. These models allow for the simulation of land use, pollutant load, and hydrological scenarios, providing the basis for a watershed plan that ensures acceptable Fox River and tributary water quality.

The Fox River and several of its tributaries are included in the Illinois Environmental Protection Agency's (IEPA) list of impaired waters, or 303(d) list (IEPA, 2008). The entire length of the Fox River in Illinois is listed as impaired, and reaches of Ferson Creek, Poplar Creek, Tyler Creek, Blackberry Creek, and Flint Creek are listed. The prevailing potential sources for Fox River listing include: impacts from hydrostructure flow regulation/modification, streambank modification/destabilization, dam or impoundment, urban runoff/storm sewers, atmospheric deposition- toxics, and municipal point source discharge. Potential sources for tributary listing come from different sources of runoff as well as upstream impoundments. The most common potential causes for listing among the Fox River are: sedimentation/siltation, total suspended solids (TSS), fecal coliforms, polychlorinated biphenyls, alteration in streamside littoral vegetation covers, aquatic algae, other flow regime alterations and total phosphorous (IEPA, 2008).

Monitoring involves seven precipitation gages, five streamflow gages, and water quality sampling at twenty sites in addition to three combined sewer overflow (CSO) sampling locations. Project staff will install and operate seven precipitation gages and four stream gages to complement existing gages in the area. Data collection will occur bi-weekly. Staff will measure discharge bi-weekly and during high-intensity events to ensure that we obtain the range of values necessary for proper rating curve calculation. Stage data and discharge rating curves allow for the computation of streamflow. Streamflow data provides information needed in the evaluation of changes in hydrologic and constituent load response to various land use changes and management practice regimes.

Water quality sampling will also occur bi-weekly and during high discharge events. At tributary sites manual sampling will be supplemented during high flow events with automated pump samplers. A laboratory will analyze samples for the following constituents: nitrate, nitrite,

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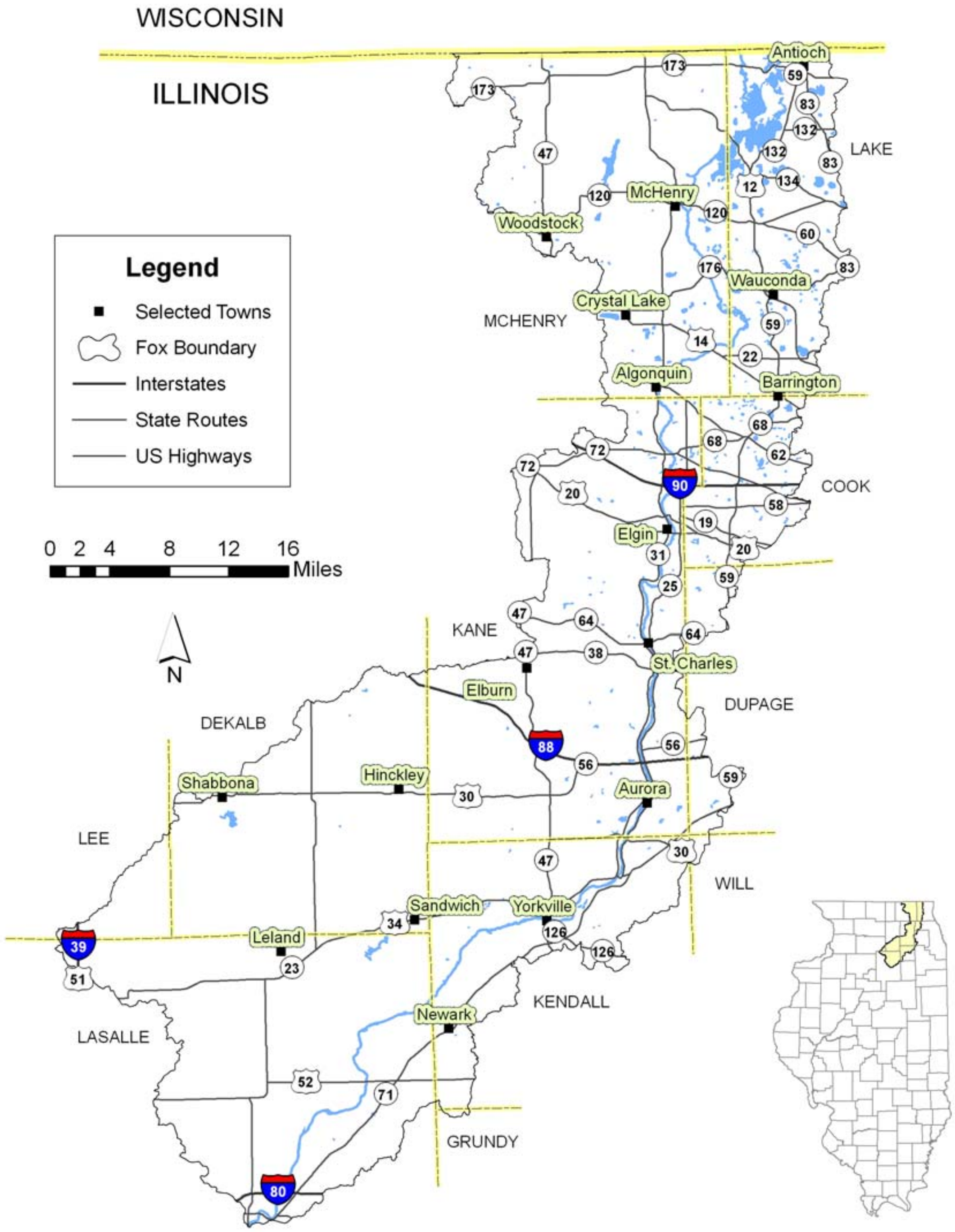


Figure 1. Illinois portion of the Fox River watershed

total Kjeldahl nitrogen (TKN), ammonia, dissolved reactive phosphorous (DRP), total phosphorous, chloride, $BOD_5$, TSS, fecal coliforms, and Chlorophyll-A. Three CSO sampling stations will operate in Elgin, supplementing the CSO monitoring efforts of Fox Metro Water Reclamation District. Automated samplers will be used exclusively at the CSO sites for water quality sampling for the same constituents listed above. Area velocity meters (AVMs) will also collect CSO flow data.

B. Objectives and Scope

The main objective of this project is to monitor precipitation, streamflow, and water quality for the Fox River, its tributaries, and contributing CSOs. A complete list of the sites, the data collection planned at each, and their specific equipment configurations are provided in Table 1. Monitoring locations are identified in Figure 2.

The specific objectives of the project are:

1. Monitor streamflow at five gaging stations; three on the Fox River and two on Fox River tributaries.
2. Collect water quality samples at twenty monitoring stations bi-weekly and during selected storm events.
3. Collect water quality samples and monitor flow at three CSOs during events.
4. Monitor precipitation for seven watersheds and calculate hourly and daily precipitation.
5. Evaluate quality assurance results in order to describe the quality of the analyses performed for the project.

Table 1: Site Locations and Equipment Configurations

| **Site ID** | **Stream & Location** | **ISWS Data** | **Installed Equipment** |
|---|---|---|---|
| 805 | Fox River @ Fox River Dr. | Q, WQ, Stage | CR10X, OTT CBS |
| 806 | Blackberry Creek @ Rt. 47 | WQ | ISCO 6712 |
| 810 | Fox River @ Rt. 34 (DS Waubansee) | WQ | N/A |
| 820 | Fox River @ Mill Street (Mongtomery) | WQ | N/A |
| 829 | Indian Creek | WQ | ISCO 6712/730 |
| 830 | Fox River at Aurora (Illinois Ave) | WQ | N/A |
| 836 | Mill Creek @ Deer Path Rd | WQ | ISCO 6712/730 |
| 840 | Fox River @ Geneva (Fabyan Forest Preserve) | WQ | N/A |
| 850 | Fox River @ St. Charles Pool (Pedestrian Bridge) | WQ | N/A |
| 851 | Ferson Creek @ Randall Rd. | WQ | ISCO 6712/730 |
| 854 | Brewster Creek @ Rt. 25 | Q, WQ, Stage | CR10X, OTT CBS, ISCO 6712 |
| 855 | Fox River @ State St. (South Elgin) | Q, WQ | N/A |
| 866 | Poplar Creek @ Villa St. | WQ | ISCO 6712/730 |
| 869 | FRWRD | WQ | N/A |
| 869-03 | CSO – Bluff City | Q, WQ | ISCO 6712/750 |
| 869-06 | CSO – Lord | Q, WQ | ISCO 6712/750 |
| 869-13 | CSO – Highland | Q, WQ | ISCO 6712/750 |
| 870 | Fox River @ Kimball St/Lawrence Ave | WQ | N/A |
| 876 | Tyler Creek @ Tyler Creek Forest Preserve | WQ | ISCO 6712/730 |
| 880 | Fox River @ I-90 (Footbridge) | WQ | N/A |
| 890 | Fox River @ Algonquin | WQ | N/A |
| 894 | Flint Creek @ Kelsey Rd. | Q, WQ, Stage | CR10X, OTT CBS, ISCO 6712 |
| 895 | Fox River @ Burton's Bridge | Q, WQ, Stage | CR10X, OTT CBS |
| | | | |
| RG82 | Blackberry Creek Watershed | Precipitation | CR200, OTT Pluvio² |
| RG83 | Waubansee and Morgan Creek Watershed | Precipitation | CR200, OTT Pluvio² |
| RG84 | Ferson Creek Watershed | Precipitation | CR200, OTT Pluvio² |
| RG85 | Brewster Creek Watershed | Precipitation | CR200, OTT Pluvio² |
| RG86 | Poplar Creek Watershed | Precipitation | CR200, OTT Pluvio² |
| RG87 | Spring Creek Watershed | Precipitation | CR200, OTT Pluvio² |
| RG88 | Sleepy Hollow Creek Watershed | Precipitation | CR200, OTT Pluvio² |

Note: Q = Flow record computed
WQ = Water Quality sampling

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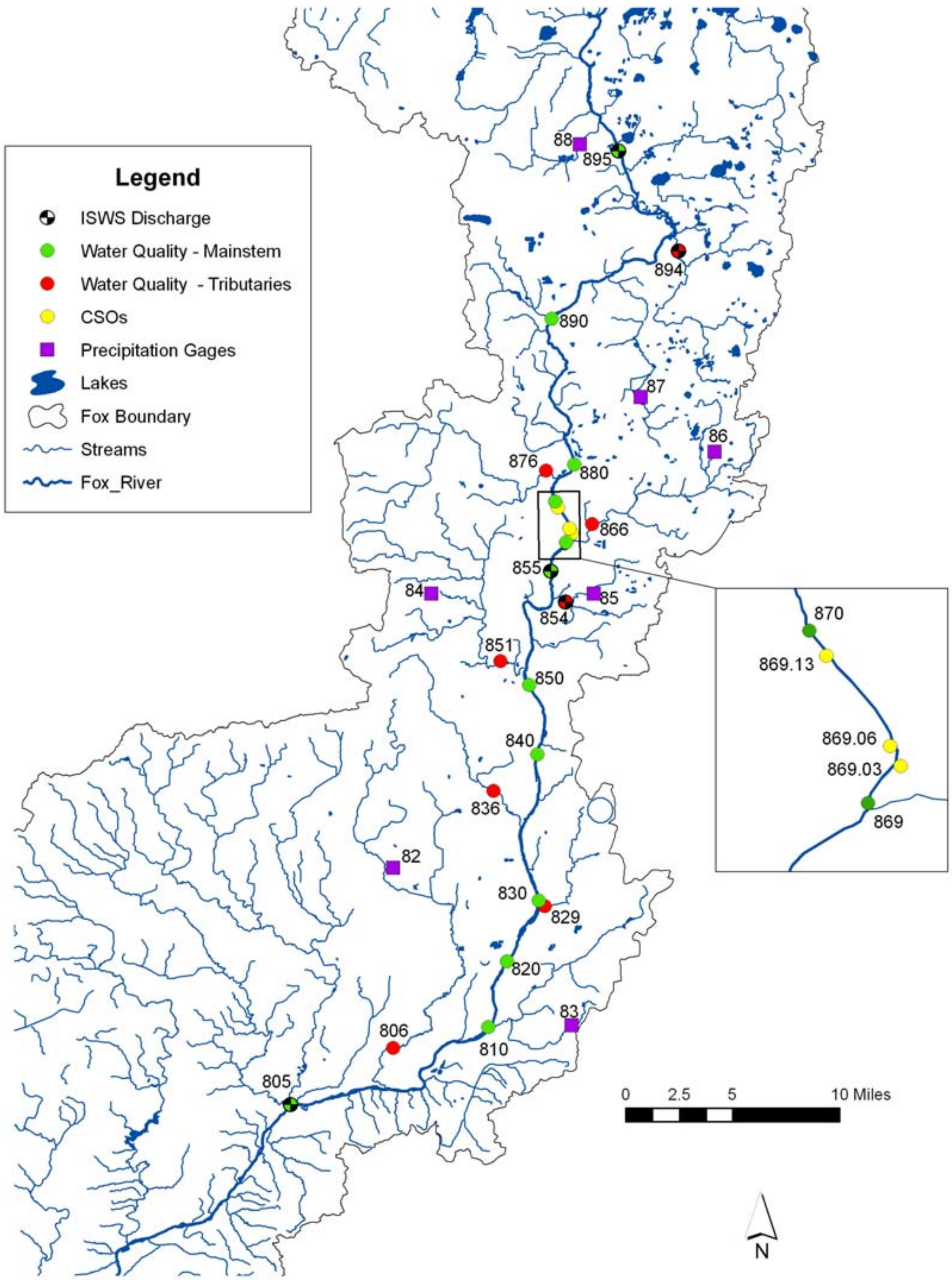


Figure 2: FRSG Monitoring Locations

C. Data Usage

The data collected during this two year monitoring program that will be used by the Illinois State Water Survey for calibration and validation of a HSPF watershed model and a QUAL2E river water quality model. These models can simulate the influence of land use change, nonpoint best management practices (BMPs), change in facility or tributary discharge, dam removal on flow regime, and climate change on Fox watershed hydrology and constituents. The HSPF model provides insight into nonpoint source pollutant delivery, watershed hydrology, and impacts of land use change. The QUAL2E model assesses the complex interaction of various instream chemical and biological constituents and simulates both pollutant concentrations and stream flow.

D. Study Design and Rationale

The monitoring efforts for this project are designed to complement and enhance existing monitoring programs while providing the additional data necessary for calibration and validation of the water quality models currently being developed at the ISWS. The monitoring strategies are consistent with those presented in the last Request for Proposals released by the Fox River Study Group (FRSG 2007).

*Fox River Watershed:*

The Fox River drains 938 square miles in Wisconsin and 1720 square miles in Illinois. The watershed is used for agriculture, industry, recreation, residences, and urban development. The river currently supports multiple water uses, including aquatic life, fish consumption, swimming, recreation, and public water supply. In addition, the river and its tributaries receive and assimilate various pollution sources, such as storm water and permitted discharges from municipal and industrial facilities (McConkey et al. 2004).

The Fox River watershed terrain varies between flat and hilly. The uplands are primarily flat, with marshes and lakes. The Fox River flows through the Chain of Lakes, which are regulated by Stratton Dam.

The watershed features a continental climate. Mean annual precipitation is about 37 inches, with most coming in spring and summer. Summer maximum temperatures range between 80s and lower 90s, while lows are in the 50s and 60s. Winter maximum temperatures average in the 20s and 30s, and lows fall in the teens and 20s (°*F*) (IDNR 1998b).

The mean estimated streamflow for the Fox River is 1818 cubic feet per second at Dayton for Water Years 1915-2002 (USGS 2003a). Monthly mean flows are highest in March and April and lowest in August, September and October (USGS 2003b).

The Fox River features an uncharacteristic stream gradient that increases in the downstream reaches. From the Chain of Lakes to Algonquin, the slope is nearly flat, averaging 0.06m/km. It increases from Algonquin to St. Charles to 0.38m/km and peaks between St. Charles and Yorkville at 0.85. From Yorkville onwards, gradient averages 0.51 m/km (Santucci and Gephard 2005).

The Fox River watershed is one of the most populous watersheds in Illinois, containing about 11 percent of the state's population. The Illinois part of the watershed had an average population density of 588 persons per square mile in 2000 (Census 2000). Lake, Kane, and McHenry Counties all rank among the top ten Illinois counties in population (Census 2000). The population in the watershed is expected to increase dramatically by year 2020, about 30 percent over the 2000 totals(NIPC 2000) and population has already increased 32 percent in the Illinois portion of the watershed from 1990 to 2000 (Census 1990, 2000). Much of the future growth is expected in McHenry and Kane Counties (NIPC 2000).

Along with associated population increases in past years, land use in the watershed has changed. Between about 1992 and 2000, urban areas increased to cover an additional 3 percent of the total watershed, while agricultural use declined. Population growth and increases in urban land cover are occurring along the Fox River corridor and several tributaries between southern McHenry County and northern Kendall County. Poplar Creek and Waubansee Creek watersheds experienced the largest percent conversion to urban land cover between 1992 and 2000 (IDNR 1998a, IDOA 2003, McConkey et al. 2004). See Figure 3 for a land use/land cover map as of 1999/2000.

Population growth increases demand on the Fox River for public water supply, and stormwater and effluent assimilation. A 1997 study of streams in northeastern Illinois (Dreher, 1997) showed that nearly all streams in urban/suburban watersheds (population density > 300 persons/square mile) exhibited signs of considerable fish community impairment.

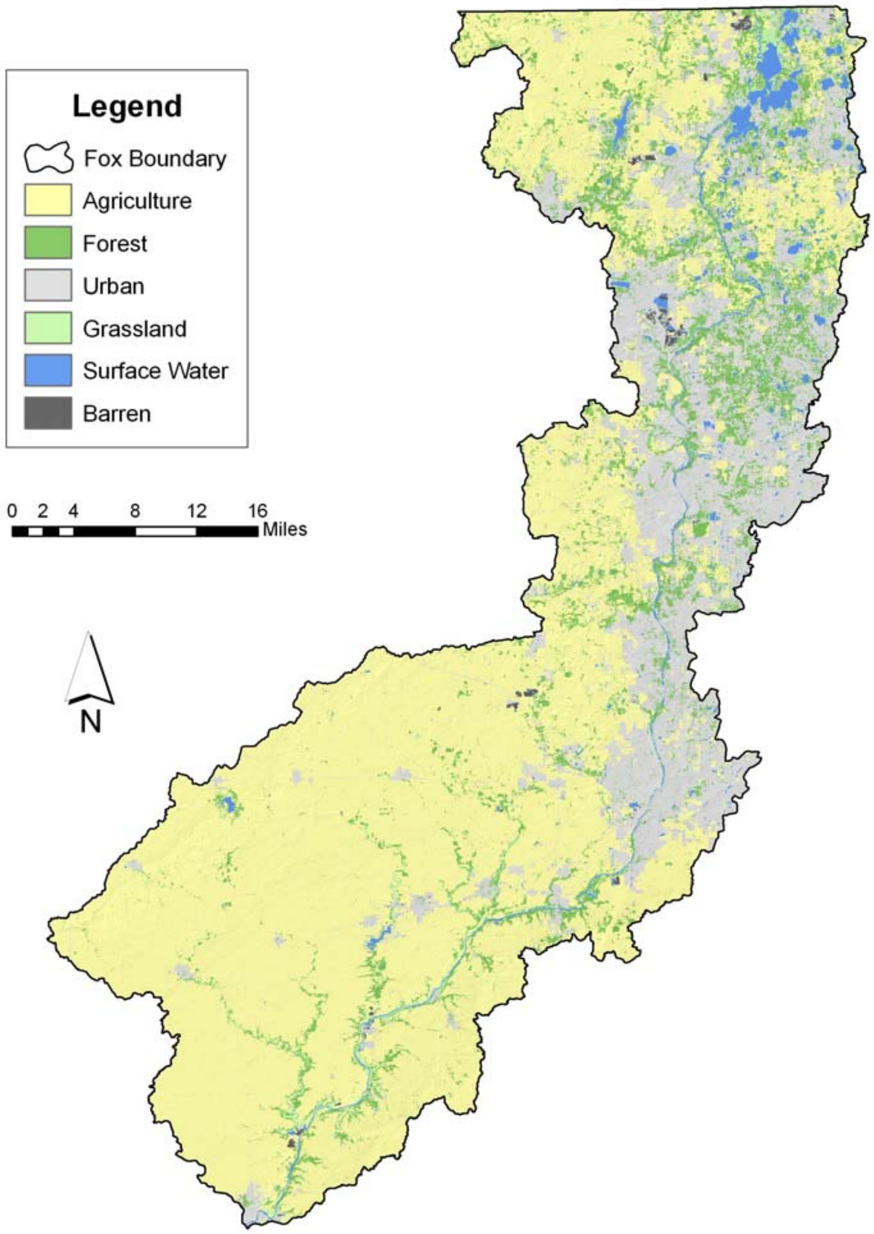


Figure 3: Fox River Watershed Land Use/Land Cover 1999/2000

E. Monitoring Parameters and Frequency of Collection

This project monitors three main groups of parameters: streamflow, precipitation, and water quality. Monitoring is anticipated to begin on September 1, 2009.

<u>Streamflow</u>

Streamflow data are obtained from records of stage at stream gaging stations. Stream gaging sites feature installed instrumentation that sense and record water surface elevation. Gaging stations for this project produce continuous stage records with a 15-minute interval. Staff will perform discharge measurements at or very near these sites at various water elevations (stages). Stream gages will operate under the accepted methodologies of Rantz et al. (1982), Buchanan and Somers (1968), Carter and Davidian (1968), Kennedy (1983), Oberg et al. (2005) and others. Personnel will use stage and discharge information to create a rating curve, a graph that allows for discharge computation with any stage value. (Additional information concerning what constitutes a discharge measurement is available in Standard Operating Procedure (SOP) No. 4 in Appendix A). Field specialists will make every attempt to get measurements that represent the full range of anticipated stages at the site. Discharge measurements are also made periodically to verify and refine the stage-discharge relation. Sometimes the relationship shifts with changes in the channel geometry and/or channel roughness, so personnel may need to redefine the relationship over time. Provided that we are able to sample a broad spectrum of stage, staff should be able to define the stage-discharge fairly quickly with our bi-weekly site visit routine. After establishing a discharge rating curve, staff will produce continuous streamflow records for the two year period of study.

<u>Precipitation</u>

Staff will install seven raingages in the study area. Gage locations are strategically located to supply hydrological data for major Fox River tributaries and supplement existing gages.

The FRSG project will utilize OTT Pluvio$^2$ precipitation gages. The gage determines the weight of the collecting bucket and converts the weight value into an amount of precipitation. The Pluvio$^2$ calculates bucket content every 6 seconds and uses a filter algorithm that prevents recording incorrect measurements from wind effects of bucket additions that exceed the natural rate of rainfall. Pluvio$^2$ gages are factory calibrated and require no further calibration. These gages operate year round and are successfully being used by The Illinois State Water Survey in other precipitation monitoring programs.

Each precipitation gage is equipped with a solar panel, CR200 datalogger, Bluetooth communication device, and 12v battery. Field staff will download data from the CR200 and conduct maintenance bi-weekly.

Water Quality

Staff will collect nitrate, nitrite, total Kjeldahl nitrogen (TKN), ammonia, dissolved reactive phosphorous (DRP), total phosphorous, chloride, $BOD_5$, TSS, and fecal coliform samples bi-weekly and during storm events. Personnel will also sample sestonic Chlorophyll A during routine site visits only. Ambient water quality sampling procedures will follow those outlined in Edwards and Glysson (1988, 1999), Ward and Harr (1990), Shelton (1994), Friedman and Erdmann (1982), and Clesceri et al. (1989) and others.

Field personnel will manually collect depth-integrated samples for water quality analyses. When water velocities are insufficient to allow proper operation of depth integrating samplers sub-surface grab samples will be collected either manually or using a Kemmerer if depths are too great to allow wading. Depth-integrated samples will normally be collected using a DH-76 although heavier gear may be required during high runoff events. Manual samples will be collected from multiple verticals across the cross-section then composited into a churn splitter from which sub-samples can be pulled.

ISCO 6712 automated pump samplers will also be used in collecting water quality samples. The 6712 maintains the USEPA recommended line speeds of 2ft/sec, making it a desirable model for FRSG needs. All ISCO samplers used on this project will be slaved to stage sensors which are used to initiate and control the sampling regime. Depending on the site, the ISCO sampler is slaved either to its' own stage sensor or to a Campbell CR10x datalogger which is configured with a stage sensor. The dataloggers record the reported stage and execute a series of programmed logic sequences based on stage, rate of change in stage, and direction of change in stage to determine if a pump sample should be taken. Although every effort will be made to manually sample storm events throughout the entire hydrograph, the automated pump samplers will ensure that samples are collected during the rising limb, falling limb, and peak of the storm hydrograph. Because the pump sampler draws a sample from a single point in the cross-section, field personnel will perform manual cross-sectional sampling at various stages to determine if the location of the ISCO intake is representative of the mean cross-sectional concentration. If the ISCO location is not representative of the mean cross-section, ISWS staff will compute a correction factor to ensure that the values reported are representative.

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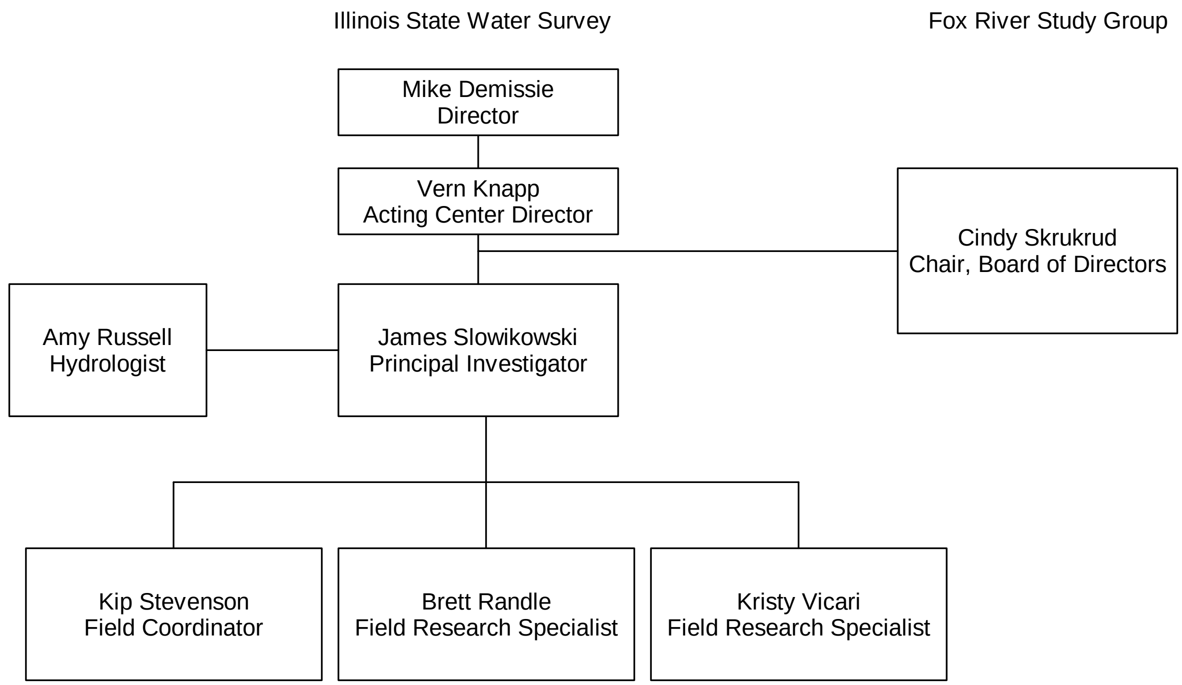
## II. PROJECT ORGANIZATION AND RESPONSIBILITIES

The organization, personnel, and their duties for the FRSG project are outlined below.




### A. Project Officer

Cindy Skrukrud
Chair, Board of Directors
Fox River Study Group
Phone: 815/675-2594
E-mail: cskrukrud@foxriverstudygroup.org

The project officer is responsible for general oversight of the project, including finances, coordination between departments and cooperating agencies and institutions, and implementation of the plan of study. The project officer determines and disseminates information concerning the project's goals, products, and progress and success in achieving these to all interested parties.

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B. Principal Investigators

Jim Slowikowski
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Center for Watershed Science
Illinois State Water Survey
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The principal investigators are responsible for producing and implementing the plan of study, conduct of the plan, and data analysis. The principal investigators will provide guidance and oversight to other key personnel and direct their efforts in the collection, organization, description, reduction, and interpretation of the results. The principal investigators have the ultimate responsibility for the quality assurance and timeliness for their portion of the project's results.

C. Field Sampling and Data Processing

Brett Randle
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Kristy Vicari
Field Research Specialist
Center for Watershed Science
Illinois State Water Survey
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A team composed of two field research specialists will perform field sampling and be responsible for maintaining all data collected for the FRSG monitoring project. The Principal Investigators are primarily responsible for the procurement, installation and initiation of all necessary equipment and the training and oversight necessary to ensure that all data and sample collection protocols are being correctly applied in the field. The field research specialists are responsible for the collection of samples and data in accordance with established protocols, the measuring of field parameters, and the collection of appropriate quality assurance data.

Field staff will undergo training to ensure knowledge and proper implementation of all data collection strategies. Field Research Specialists will read all sampling protocols mentioned in this document and will practice these methods under the supervision of the Field Coordinator and/or PI to ensure that the best quality data are collected.

D. Laboratory Analysis

*Water Quality*

PDC Laboratories, Inc.

Elaine Kaufman
Project Manager
PDC Laboratories, Inc.
2231 W. Altorfer Dr.
Peoria, IL 61615
Phone: 309-683-1755
E-mail: EKaufmann@pdclab.com

*Chlorophyll A*

Illinois State Water Survey Sediment Laboratory, Champaign IL

Laura Keefer
Laboratory Manager
Illinois State Water Survey
Phone: 217/333-3468
Fax: 217/333-2304
E-mail: lkeefer@illinois.edu

Yi Han
Sediment Chemist

The laboratories and individuals listed above are responsible for completing the analyses in a timely manner using accepted standard methods for the specific constituent. Laboratory staff will provide assistance with information concerning analytical techniques for selected constituents and proper field preparation and storage techniques for acquired samples.

E. Data Management and Interpretation

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Data Manager
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Illinois State Water Survey
Phone: 309/671-3196 x203
E-mail: kesteven@illinois.edu

Amy Russell, P.E.
Hydrologist
Center for Watershed Science
Illinois State Water Survey
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The project Hydrologist will develop database schemas and data processing protocols for the FRSG monitoring project. The Data Manager reviews all data from the Elgin field office including: site visit forms, discharge measurement notes, chain of custody documentation as well as digital files of all unit value, provisional and final data. The Data Manager facilitates data retrieval, collation, and transfer between co-operating agencies or groups and interested third parties.

The Principal Investigators and the project Hydrologist have primary responsibility for the interpretation of the data. However, the interpretive process for this project will be a team effort. The task will bring forth each team members' strengths to provide a unique understanding and innovative interpretation of the data. This understanding will include considering the processes and conditions under which the data were collected, and how this may interact with the fundamental hydrologic and hydraulic principles that govern the research.

F. Distribution List

All parties involved with the FRSG project will follow procedures outlined within this document. These individuals, including field staff and analytical laboratories, will have access to a copy of the most up-to-date QAPP.

## III. QUALITY ASSURANCE OBJECTIVES AND CRITERIA

Quality assurance measures are required to ensure that the models utilize accurate data.

A. Comparability of Results

The data collected for this project must be comparable and reproducible. The sampling methodologies and the sample analyses performed must be uniform and consistent between stations as well as personnel. This section defines methods for ensuring that field samples are representative of stream conditions.

1) Stage data collection and rating curve development will follow the accepted USGS methodologies as outlined by Rantz (1982), Buchannon and Somers (1982), Carter and Davidian (1977), Kennedy (1983), as well as others. Staff will archive all unit value data and make it available to all interested parties.

2) Field personnel will collect ambient water quality samples following approved USGS guidelines outlined by Guy and Norman (1982), Ward and Harr (1990) and others to ensure that collected samples are representative of the stream cross-section. To ensure that the single point samples are representative, staff will perform rigorous cross-section sampling at various stages to verify the point sampling, and if necessary, to develop a calibration. As data are collected, personnel will continually review results to ensure that sampling is performed adequately and represents the mean cross-sectional conditions within the stream.

3) Staff will use field blanks to verify that proper sampling equipment cleaning procedures are followed.

4) Sampling equipment criteria and procedures are documented for field staff over the entire range of anticipated flows. In addition the careful recording of field conditions and defined procedures will help ensure consistency between field personnel.

5) The field coordinator will perform unscheduled visits to verify proper sampling technique and monitoring equipment use.

6) Staff will document the variance of the analytical results with split field samples. Split samples are collected and prepared in the field by withdrawing two sub-samples of the full sample volume collected. They are processed in the field in the same manner as all samples.

7) Staff will report values in standard units, pay attention to rounding/significant digits, and use accepted and prescribed calibrations.

B. Completeness of Sampling

A complete data set is needed to meet the stated objectives of the project. The stage data must be free of significant time lapses and the sample coverage must capture the variability of constituent concentrations through time as well as stage. While the percentage of completeness should be 100%, equipment failure, broken or lost samples, etc. inevitably reduce the number of valid samples. While every effort will be made to prevent the loss of data, the minimum acceptable level of completeness for this project shall be 90%. Data collection practices, including instances that deviate from normal conditions, will be systematically documented in order to determine completeness. The following procedures will ensure the completeness of sampling:

1) The Data Manager and principal investigators will periodically check calculations for completeness and accuracy.

2) The Data Manager will assess the number of samples collected versus the number of samples received and sent to the laboratory. An ongoing list of samples sent to the laboratory is kept to verify that all results are received. Completeness is calculated with the following formula:

   %C = (V/T) * 100%
   where
   %C = Percent completeness
   V = Number of measurements judged valid
   T = Total number of measurements planned

3) The Data Manager will periodically review the field sheets and data results to ensure that sampling has covered all streamflow conditions.

4) The Data Manager will determine if field and quality assurance samples are collected on schedule.

C. Representativeness

Representative stage data and water samples are essential. Field personnel will collect data using approved USGS protocols for stage measurement and ambient water quality collection. This ensures that the stream conditions are represented as closely as possible.

1) Gaging techniques and the computation of discharge will follow the accepted procedures outlined by Rantz (Measurement and Computation of Streamflow: Vols. 1, 2, 1982).

2) Water quality samples are collected using accepted methodologies described by Edwards and Glysson (1998) and Ward and Harr (1990). For the automated pump samplers, staff will conduct a thorough verification/calibration sampling regime to validate the representativeness of these samples. All samples collected using an automated pump

sampler will conform to the USEPA recommended guidelines of a minimum 2ft/sec sample speed within the suction lines.

3) The equipment used to sample is of sufficient size and weight to properly collect a representative sample under ambient stream conditions. Field staff will understand what equipment is appropriate for various streamflow conditions. Methodologies will follow accepted USGS techniques outlined in Guy and Norman (1982), Edwards and Glysson (1998), and Ward and Harr (1990).

4) Staff will collect samples at both high and low flows to represent storm and ambient water quality conditions.

5) Field personnel will store samples according to established preservation guidelines and adhere to prescribed holding times.

## IV. SAMPLING PROCEDURES

Water quality samples are collected according to established U.S. Geological Survey sampling protocol for nutrients and suspended sediment. These methods are documented in publications:

*Field methods for measurement of fluvial sediment*, by H.P. Guy and V.W. Norman, 1970; U.S. Geological Survey Techniques of Water-Resources Investigations of the United States Geological Survey, Book 3, Chapter C2.

*Field methods for measurement of fluvial sediment*, by T.K. Edwards and D.G. Glysson, 1988; U.S. Geological Survey Open-File Report 86-531.

*Methods for collection and processing of surface-water and bed-material samples for physical and chemical analyses*, by J.R. Ward and Albert Harr, 1990, U.S. Geological Survey Open-File Report 90-140.

*Field Guide for Collecting and Processing Stream-Water Samples for the National Water-Quality Assessment Program*, by L. R. Shelton, 1994, U.S. Geological Survey Open-File Report 94-455.

Samples are collected in a manner ensuring that they are representative river conditions. This involves collecting samples with different methods depending on flow conditions: single point, single vertical, or depth and width integrated samples. Sampling equipment is made from non-contaminating materials for collection of water quality samples. Handling, storage and preservation requirements for ambient water quality samples are listed in Table 2, and detailed procedures for all data collection activities are presented in Appendix A. Samples are preserved on ice and picked up by a PDC Laboratories courier. Staff will make all efforts to perform the laboratory analyses within the allowed holding times. However, this may not always happen. If holding times are violated project personnel will document such occurrences in the final results.

Table 2. Sample Constituents, Analytical Methods, Container Size, Preparation, Storage, and Holding Times

| ***Parameter*** | ***Method Reference*** | ***Container*** | ***Preservation / Storage*** | ***Holding Time*** |
|---|---|---|---|---|
| Ammonia Nitrogen | SM 4500 NH3 B, H / EPA 350.1 | 500 mL HDPE | $H_2SO_4$ / Cool to 4° C | 28 days |
| $BOD_5$ | SM 5210 B | 1 L HDPE | Cool to 4° C | 48 hours |
| Chloride | SM 4500 CL E Or EPA 300.0 | 1 L HDPE | Cool to 4° C | 28 days |
| Fecal Coliforms | SM 9222 D | 100 mL sterile plastic | Cool to 4° C | 6 hours |
| Nitrate Nitrogen | SM 4500 F Or EPA 300.0 | 1 L HDPE | Cool to 4° C | 48 hours |
| Nitrite Nitrogen | SM 4500 F Or EPA 300.0 | 1 L HDPE | Cool to 4° C | 48 hours |
| Orthophosphorus | SM 4500 P E | 1 L HDPE | Cool to 4° C | 48 hours |
| Total Kjeldahl Nitrogen | EPA 350.3 | 500 mL HDPE | $H_2SO_4$ / Cool to 4° C | 28 days |
| Total Suspended Solids | SM 2540 D | 1 L HDPE | Cool to 4° C | 7 days |
| Total Phosphorus | SM 4500 P B, F / EPA 365.1 | 500 mL HDPE | $H_2SO_4$ / Cool to 4° C | 28 days |
| Chlorophyll | Hill, Fanta, and Roberts 2009 | Glass fiber filter | Frozen | 28 days |

## V. SAMPLE CUSTODY

Water quality samples are transported to PDC Laboratories, and Chlorophyll A samples will be delivered to the Illinois State Water Survey's Sediment Laboratory. Water quality samples are packed in ice or other cooling medium, such as "blue ice," and picked up by PDC Laboratories' courier. Chain of custody forms (Appendix B) are sent with each sample shipment, detailing the analyses the laboratory will perform. The field personnel will retain a copy of the chain of custody for project records and as a record of the samples collected. This record is used to check for final receipt of analyses, to record field measurements, date and time of collection, any unusual conditions, and for identifying QA samples from field notes.

Water samples are submitted to the laboratory in a variety of containers depending on the desired analysis. The details of these bottles and collection methods are noted in Table 2 and Appendix A. In general, manual ambient water quality samples are collected from each vertical using a DH-76 which collects the sample in a 1 liter glass bottle. Samples from the cross section are composited in a churnsplitter manufactured by Rickly Hydrological. Sub-samples are then transferred to one of three bottles. Samples are cooled and stored at 4˚C while being transported to the laboratory. Samples will be filtered or preserved with sulfuric acid as listed in Table 2. The laboratory will provide HDPE bottles for sample storage. Samples will be delivered with appropriate chain of custody forms, which include documentation of date and time of collection for each sample, sample ID, and analyses requested.

## VI. CALIBRATION PROCEDURES AND FREQUENCY

Field personnel will carefully calibrate equipment to ensure that the highest quality data are collected. Staff will perform all calibrations in strict accordance with accepted standard practices and guidelines from the manufacturer.

The factory calibrates Price AA and Pygmy meters with the assumption that manufacturing techniques are able to maintain strict tolerances between meters. However, the USGS developed an average standard rating by calibrating a large number of meters built to USGS specifications. The meter is inspected before each use and a spin test is done to ensure proper operation. Care and calibration of discharge measurement equipment, including current meters, is described in *Measurement and Computation of Streamflow: Volume 1. Measurement of Stage and Discharge*, by S.E. Rantz, 1982, U.S. Geological Survey Water-Supply Paper 2175, Chapter 5 and *Hydrologic Equipment Operation and Maintenance Guide,* Gurley Precision Instruments, 1994.

In the case of acoustic instrumentation such as the Flowtracker there are no calibration procedures. Each unit performs a self diagnostic upon start-up. In the event that the diagnostic self test fails the unit is returned to the factory for repair.

Field staff will check reference points used for manual tapedowns by leveling from an established benchmark at least once per year. Closed loops for these levels must close to within 0.01ft. Gaging station datum creation and verification is outlined in the report, *Techniques of*

*Water–Resources Investigations Chapter A7 Stage Measurement at Gaging Stations*, (Buchanan and Sommers, 1988).

## VII. ANALYTICAL PROCEDURES

Two laboratories will analyze collected samples: PDC Laboratory for ambient water quality and ISWS Sediment Laboratory for Chlorophyll A concentration.

Both laboratories perform selected quality assurance analyses of samples delivered to the facility. The analytical procedures used by the laboratories are standard for use in water quality studies, and are documented in their respective QAPPs or SOPs (PDC, 2008 and ISWS, 2009).

## VIII. DATA REDUCTION, VALIDATION AND REPORTING

The collected data stream consists of five main components: (1) Stage Data, (2) Discharge Measurement Notes, (3) Field Sheets, (4) Samples, and (5) Rain Gage Data. Data reduction, validation and reporting are outlined below. All field records, logs, and electronic data will be retained for a minimum of five years.

### Stage Data Collection

Stage data will be retrieved bi-weekly, either by swapping Storage Modules (SM) for the CR10X data logger or downloading the data from the SM to a laptop computer. Subsequent data review, verification, and adjustments follow a specified procedure to ensure the integrity of the data.

Each data download is recorded on a Stage Data Retrieval Log. As the data are converted from one format to another, all file names and locations are noted on the Data Retrieval Log. The retrieved file (*.dat) is the raw, unit value data. This data file is never deleted, modified or changed in any way Unit value data files are backed up on an external hard drive and an offsite server on a bi-weekly basis.

Using Campbell Scientific's Loggernet Split program, the *.dat files are then renamed as they are parsed into a file of 15 minute stage and temperature readings and a file of daily outputs (battery voltage, max/min temperature, etc.). These parsed files are then imported into Excel and renamed when saved as Excel files. Although the data are reviewed throughout the data retrieval process, the data are only edited and appended in this format. All file naming formats and guidelines are described in SOP No. 6, Appendix A.

When reviewing the data, staff will check for the following: (1) significant differences in time or stage between SM changes, (2) gaps in data, (3) obvious incorrect stages, etc. To aid in this review, a stage plot is created on a monthly basis. Personnel will note any modifications to the data and change justification on the Data Retrieval Log. The Logs are signed and dated upon completion.

All files are verified and backed up along each step of the data retrieval process. On a monthly basis, staff will compile and back up completed Data Retrieval Logs, monthly stage plots and all associated files. Next, staff will check all edits and revisions to the stage data and ensure validity. Personnel will further verify data by comparing the stage plots with precipitation records and stage plots from prior data collected. When all data are reviewed and validated, staff will prepare the data for input to the ISWS-IDAPP hydrologic program to produce tables suitable for reporting purposes.

Discharge Measurement Notes

For all discharge measurements field staff will provide a completed discharge measurement to a second staff member to review. After being reviewed and approved, the staff member who performed the measurement will enter the stage and total discharge into the discharge record, scan the measurement notes if necessary, and back-up all information on an external hard drive and offsite server.

Field Sheets

During each field site visit, staff complete a site log/ISCO log, describing all aspects of the site conditions (Appendix B), methods followed and sample times. Once field personnel have returned to the office, they review site logs and ISCO logs for completeness and accuracy. All corrections are made in red liquid-ink pen and initialed. These sheets are scanned for archival purposes as well as to facilitate offsite review by the Data Manager. The Data Manager will review the documents, paying close attention to revisions made by the field personnel.

Samples and Chain of Custody Records

Collected samples are transferred from the field sheets to the appropriate chain of custody sheet. Completed chain of custody documentation is included when samples are sent to the appropriate laboratory. Upon receipt of the samples, a laboratory staff member signs the chain of custody record and retains the originals. Signed photocopies are maintained at the originating field office and scanned for electronic storage on an offsite server. Sample chain of custody forms are found in Appendix B.

Laboratory staff will deliver results electronically to appropriate project staff in order to update the respective database. The results are reviewed and verified by the field personnel, who are responsible for notifying appropriate project and laboratory staff of any corrections in sample information so that all parties may correct their records.

Rain Gage Data

Field staff will retrieve rain gage data on a bi-weekly basis. Personnel will import their data into an Access database where hourly and daily rainfall totals will be computed. All associated paperwork is scanned and backed up with the data itself on an external hard drive and an offsite server.

## IX. INTERNAL QUALITY CONTROL CHECKS

The internal quality assurance practices of the field procedures are both numerous and robust. These practices start with the initial data collection effort, are maintained through the data download/reduction effort, and culminate in the final data analysis.

The initial data collection effort undergoes an internal QC check with the unscheduled visits to the gaging stations by the field coordinator. These visits are scheduled to include those times when the technician responsible for the gage is present and times they are not. The status and condition of all equipment at the site is reviewed, as well as all techniques used in the data collection process.

Once the technicians download the data or calculate a discharge, they perform an initial QA check in the office. If edits are required after the initial check any changes are made to an appended file; initial or unit value data are never edited. All edits are marked, initialed, and the reason for the edit is described. Once this step is complete, the provisional data, original data, site visit logs, and chain of custody forms are made available to the Data Manager. The Data Manager rechecks the files for gaps in the record and reviews the initial QC check. All discharges are recalculated and any rating development is rechecked. Any actions by the Data Manager are transmitted to the field staff responsible for that record as an added QC check.

Redundancy is present in both the data storage format and the automated sample collection time step. The time from the pump sampler is used as the sample time unless there is reasonable doubt. In such cases the data file from the datalogger will be interrogated and a decision made as to the correct sample time. Time stamp agreement between the datalogger and pump sampler is verified at least once a week during the routine site visits and is noted on the site visit log.

Quality assurance practices for chlorophyll analyses are documented in *Quality Assurance Plan for the Illinois State Water Survey Sediment Laboratory* by Laura Keefer (in progress) and the lab's Chlorophyll SOP (ISWS, 2009).

Quality assurance practices for water quality analyses are documented by PDC in the 14th Revision of their *Quality Assurance Plan* (2008). This publication includes detailed descriptions of laboratory quality assurance/quality control, error correction, shipping and receiving, organization and job responsibilities, and document control among other topics.

Quality assurance monitoring and quality control is incorporated into the analytical laboratory results through the use of laboratory procedures that protect the integrity of the data including: data entry and capture, data storage, data transmission, and data processing. The analyst should conduct a personal review to check for transcription and calculation errors. Individual instrument operators will review all computer-generated calibration and sample data for correct analyte identification and computations. The field person requesting the analysis and Data Manager will perform quality-assurance monitoring as well. If an error is found or suspected with the analysis, the Data Manager can request a re-run of the particular analysis or sample.

## X. PERFORMANCE AND SYSTEM AUDITS

Staff will hold internal annual project reviews and as needed. The entire staff obligated to the project will attend these reviews. Field staff will have the opportunity to relay equipment needs, problems, or anticipated shortcomings to principal investigators and other supervisory staff. Staff will discuss out of control situations and solutions applied so that all staff will benefit from the experience and minimize downtime. Those personnel involved with the data reduction and analysis can use this time to address unexplained gaps or other discrepancies in the data set. We anticipate that station-specific information and time-stamped ambient conditions information will help ensure successful data interpretation of the data and improve quality assurance.

Field coordinators will conduct unscheduled monitoring stations visits. These visits occur when the field staff are both onsite and offsite. Visits performed when the field personnel are absent will focus on the general operating condition and maintenance of the site. Audits that occur when the field staff are present will focus on the consistency of the field procedures used with those described within this document and referenced literature. The audit will also examine the general condition and maintenance of equipment. We will keep the results of these audits and a description of any resultant action along with the site visit log for each station.

Project staff will prepare a yearly report for other ISWS staff and the FRSG detailing the overall progress and conditions, number of samples collected per site and any problems associated with sampling or analysis. This report will also include all QA results for that year from both PDC Laboratories and ISWS-Sediment Laboratory.

## XI. PREVENTATIVE MAINTENANCE

Field staff will routinely perform preventative maintenance on all equipment. Regular maintenance helps ensure the best possible product while minimizing downtime and providing a margin of safety to the user. Each piece of equipment is maintained in accordance with the manufacturer's guidelines, USGS protocols, or in the case of some water quality sampling equipment, the requirements of a specific analytical method. Some procedures for specific equipment commonly used on the FRSG project are outlined below.

### *Price AA and Pygmy Current Meters*

A spin test is performed before and after all measurements. The spin tests for Price AA will usually exceed 3 minutes; however, field staff will not use any meter that does not freely rotate for a minimum of 90 seconds. Spin tests for the pygmy meter will least at least 60 seconds. Spin tests results are recorded on the discharge measurement notes. After each use, the field staff dries the meter and oils the pivot bearing, top of the vertical shaft, steady bearing, worm gear and gear bearing. Before each measurement, personnel should inspect the bucket wheel for dents and misalignment and check the pivot for excessive wear. When traveling, field staff should keep the pivot and pivot bearing should by using the raising nut.

### *Acoustic Meters*

Quarterly zero velocity "bucket tests" will be performed on all acoustic Flowtrackers used in this monitoring effort. The results of all zero velocity checks will be archived along with all other pertinent calibration/repair logs. Any meters not meeting factory default values for zero velocity checks will be returned to the factory for inspection and/or repair.

### *Sounding Reels*

Staff should keep the sounding reel contacts clean and free of corrosion. They must also lubricate the depth indicator periodically and check the drive gear for proper alignment. In order to determine accurate depth, the cable should lie tight to the drum and immediately next to other strands. Staff should inspect the electrical conductor wrapped within the Ellsworth cable because it is fairly fragile.

*Dataloggers*

CR10X data loggers require no periodic maintenance with the exception of replacing the lithium backup battery every 5-7 years. Staff should exchange or rejuvenate desiccant packs and humidity indicators in each enclosure as required.

*Automated Pump Samplers*

Staff should replace pump sampler intake tubing at the first sign of fouling or algal growth. Strainers, if deployed, need to be periodically checked and, if necessary, cleaned of any algal growth. The manufacturer recommends pump tubing replacement every 1,000,000 flexes. The number of flexes is automatically tabulated within the controller of each unit. Staff should replace the lithium backup battery every five years. The ISCO 6712 has a robust self-diagnostic routine that staff should utilize to verify that the unit is functioning properly.

*Reference Points*

Staff should inspect reference points at each use for mechanical/structural damage. Field specialists should run levels from an associated benchmark at least once a year in order to verify the reference point elevation has not changed. Staff will keep a record of these levels in the station description maintained for each gage.

*Deep Cycle Batteries*

Staff will swap out deep cycle batteries at each site visit as needed. Back at the office, staff will recharge the batteries and clean the terminals. All FRSG project batteries are gel cell batteries, so there is no need for electrolyte maintenance. Loggers record battery voltages daily within the data file. Staff should check these values regularly and any investigate appreciable change in the rate of discharge, replacing batteries when necessary.

## XII. ASSESSMENT OF DATA VARIABILITY, ACCURACY, REPRESENTATIVENESS AND COMPLETENESS

*Accuracy*

Accuracy is the degree of congruity between a measured value and the true, or accepted, reference value. Accuracy is influenced by: contamination, sample preservation, sample handling, sample matrix, sample preparation, and analytical techniques. Field staff will periodically collect field blanks to identify sources of contamination. The laboratory will analyze lab blanks (reagent water) and lab control samples (LCS) (spiked with known concentrations of target analytes) to determine bias. (A complete description of laboratory procedures is found in PDC's QAPP). Bias is evaluated by taking the spiked samples and calculating percent recovery as follows:

Percent Recovery = [(S - C) / T] *100
where
S = Measured spiked sample concentration
C = Sample concentration
T = True or actual concentration of the spike

*Precision*

Precision concerns the variability among independent measurements performed under the same process in similar conditions. Split samples, or samples pulled from one larger sample, are used to test the precision of field practices under the influence of sample preservation, handling, and storage. Split samples can also provide insight into the precision of the analytical process. Up to 10% of all samples will be field blanks or split samples. Further analysis of the analytical precision is obtained by comparing analysis of control samples (e.g. deionized water).

*Representativeness*

Representativeness refers to the ability of a sample to precisely and accurately represent traits of the population of interest, variability at a discrete sampling point, or characteristics of a stream condition. Laboratory staff will ensure and evaluate representativeness using appropriate preservation techniques, adhering to holding time limits, and by analyzing lab blanks for contaminants. Finally, FRSG staff will compare data to available historical data and related FRSG project data. Data considered un-representative may be used only with qualifiers and limits of uncertainty.

*Completeness*

Laboratory staff will also perform a variety of tasks to ensure completeness. The labs will perform all requested procedures or document reasons for non-performance, record all pertinent dates, perform QC checks on each batch of samples, and ensure that constituents are within lab reporting limits (Table 3).

Principal investigators will examine data quality to verify that the type, quantity, and quality of the data needed for project objectives are obtained.

Table 3. Measurement Quality Objectives

| Analysis | Method Reference | RDL (mg/l) | MDL* (mg/l) | LCS Limits (%Recovery) | MS/MSD Limits (%RPD) | ICV/CCV (%Recovery) | Dup (%RPD) |
|---|---|---|---|---|---|---|---|
| Ammonia-N | SM 4500 NH3 B,H / EPA 350.1 | 0.1 | 0.0096 | 90 - 100 | ≤20 | 90 - 100 | NA |
| $BOD_5$ | SM 5210 B | 4 | NA | 167.5 - 228.5 mg/l | NA | NA | ≤20 |
| Chloride | SM 4500 CL E | 2 | 0.342 | 80 - 120 | ≤20 | 90 - 100 | NA |
| Chloride | EPA 300.0 | 1 | 0.0788 | 80 - 120 | ≤20 | 90 - 100 | NA |
| Fecal Coliforms | SM 9222 D | 10 cfu | NA | NA | NA | NA | NA |
| Nitrate-N | SM 4500 F | 0.02 | 0.01 | 90 - 110 | ≤20 | 90 - 100 | NA |
| Nitrate-N | EPA 300.0 | 0.02 | 0.0155 | 80 - 120 | ≤20 | 90 - 100 | NA |
| Nitrite-N | SM 4500 F | 0.02 | 0.011 | 90 - 110 | ≤20 | 90 - 100 | NA |
| Nitrite-N | EPA 300.0 | 0.03 | 0.0031 | 80 - 120 | ≤20 | 90 - 100 | NA |
| Ortho P | SM 4500 P E | 0.02 | 0.0091 | 90 - 110 | ≤20 | 90 - 100 | NA |
| TKN | EPA 350.3 | 0.2 | 0.0096 | 80 - 120 | ≤20 | 90 - 100 | NA |
| TSS | SM 2540 D | 4 | NA | NA | NA | NA | ≤20 |
| Total P | SM 4500 P B,F / EPA 365.1 | 0.1 | 0.0459 | 80 - 120 | ≤20 | 90 - 100 | NA |

RDL = Reporting Detection Limit
MDL = Method Detection Limit
LCS = Laboratory Control Sample
MS/MSD = Matrix Spike/Matrix Spike Duplicate
ICV/CCV = Initial Calibration Verification/Continuing Calibration Verification
NA = Not Applicable
* Limits, as provided by the contract laboratory, are current and subject to change.

## XIII. CORRECTIVE ACTION FOR OUT-OF-CONTROL SITUATIONS

Out-of-control situations are defined as those times when instrumentation utilized in the data collection process fails to collect the data, or produces data or results that seem out of range. Despite careful planning and close attention to protocols and procedures, out-of-control situations may arise at any time in the field or laboratory due to malfunctioning equipment or human error.

When out-of-control situations occur in the field, personnel must recognize the situation, identify the problem, and initiate corrective action. Corrective action in the field generally consists of the repair, adjustment, reprogramming and/or re-calibration of the malfunctioning equipment. If this cannot be satisfactorily accomplished, then personnel will replace the equipment in question. Log book and site log entries are made in the field to clearly define the situation as it was discovered, and to describe the corrective actions taken. No data are ever deleted or edited at this time.

Out-of-control situations in the laboratory are most often indicated by results from conditions at the site at the time the of data collection. If the situation still cannot be resolved, staff should contact the laboratory to verify the concentration results and to ask for any bench observations that might influence the concentration. Personnel will not modify data without a logical, fact-based and verifiable reason for doing so. Staff should clearly mark any changes to the data or field sheets with a red liquid-ink pen, include a rationale for the change, and include initials by the Data Manager and person initiating the change.

## XIV. QUALITY ASSURANCE REPORTING PROCEDURE

The field coordinator will make unscheduled visits to the gaging stations. These visits will include those times when the technician is operating/servicing the gage as well as times when the technician is absent. The field coordinator will write the results of these visits into the station's site visit log. The field coordinator will also provide a copy to the technician and brief he/she on all items covered within the review. The two will discuss any items that call for action, so that all interested parties understand and agree upon the corrective action.

The gaging personnel will keep a running log that clearly records those times when the station was inoperable. This log will also include the reason for the gap in the record (if known) and detail the corrective action taken. The staff will note any changes in reference points or reference marks used in conjunction with the gage in addition to any changes in offsets, conversion factors, or programs used in the collection of the data. Staff will also include an inventory of the equipment used on site and the time and date of any replacements or other changes.

PDC laboratories will analyze all ambient water quality samples. ISWS staff will examine laboratory performance and document laboratory performance results in the interim report required under the contract.

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# APPENDIX A

## STANDARD OPERATING PROCEDURES

# FRSG STANDARD OPERATING PROCEDURE: CAMPBELL SCIENTIFIC CR10X DATALOGGER, OTT CBS BUBBLER AND ISCO 6712 SAMPLER

## 1.0 Scope and Application

1.1 These procedures are recommended for the setup and data downloading at FRSG project sites featuring a Campbell Scientific Inc. (CSI) CR10X datalogger, OTT CBS Bubbler and ISCO 6712 sampler.

## 2.0 Summary of Method

2.1 The CR10X is a sophisticated datalogger/controller capable of executing a variety of measurement and control functions, executing programmed logic sequences, and recording outputs. At FRSG sites, the CR10X queries an OTT CBS bubbler on a given interval, stores the response, and uses this information in determining whether to initiate a sample routine with the ISCO 6712 pump sampler. Data are stored in the CR10X itself and also within an optional storage module. This redundancy serves as a proactive measure to guard against lost data and facilitates data downloads since the storage modules are easily exchanged.

## 3.0 Equipment

3.1 CSI CR10X datalogger; assumed to consist of one CR10X control module and an associated CR10X wiring panel.

3.2 CSI SM192 storage module.

3.3 CSI SC12, a double-ended 9-pin serial cable used for attaching peripherals to the CR10X. The SC12R is a robust version of this same cable.

3.4 CSI CR10KD, a handheld keyboard cable for communicating with the CR10X. The CR10KD has no data storage capabilities, although it can be used to initiate data or program transfer between the CR10X and the SM192.

3.5 Laptop computer, with the CSI proprietary software Loggernet (Windows).

3.6 CSI SC32A, an optically-isolated RS232 interface for use between the CR10X and a computer’s conventional 9-pin serial. The SC32A will also require a 25 pin (male) to 9 pin (female) adapter or cable. It is recommended that the cable be used in the field as it facilitates situating equipment when downloading.

3.7 CSI SC532, a self powered RS232 interface for use with a peripheral, such as the SM192, and a computer. This typically will be used when the SM192 is taken back to the office for data download.

**FRSG STANDARD OPERATING PROCEDURE:**
**CAMPBELL SCIENTIFIC CR10X DATALOGGER, OTT CBS BUBBLER AND ISCO 6712 SAMPLER**

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3.8 OTT CBS Bubbler, a device working on the air bubble principle that measures stage.

3.9 ISCO 6712 Portable Sampler, an automatic pump sampler which utilizes a free swinging suction line and peristaltic pump to draw samples from an elevated orientation. The ISCO 6712 can to store up to 24 separate samples.

3.10 ISCO 601394023 Connection Cable for External 12v DC Source

3.11 ISCO 602544044 Interrogator Cable

3.12 12 volt DC battery. For the remainder of this SOP it is assumed that field situations are occurring at a site that is operational and powered up.

4.0 Downloading stage data at the field site.

4.1 Do manual tapedown and determine stage. Attach CR10KD to open terminal on the SC12R. Compare the stage reading from the tape down to CR10x output using a CR10KD and the *6 (view data) command. Compare readings, determine the difference and take appropriate actions. Record all data and calculations on field sheet. If the data logger value is 0.05 ft or greater, the reason for the discrepancy should be determined and rectified. The *6 command will also yield current battery voltage and water temperature at the proper storage locations, these values are entered in the proper field on the site visit log. Verify that the CR10X has the correct time and date stamp using the *5 command and enter results on the site visit log. If the time/date stamps are incorrect, determine the reason and rectify.

4.2 Disconnect the CR10KD and replace with SC32A (complete with 25pin to 9 pin adapter cable) and attach the 9 pin cable end to the 9 pin serial port on the laptop. Open the Loggernet software on your laptop and chose **Connect.** Once the connection screen comes up, click **Connect**.

4.3 Check to make sure the **connect** button has morphed to **disconnect** to ensure you have established a link between the CR10X and the computer. Click **Custom.** The file format should be **ASCII, Comma separated**, Collect option should be **Collect All Since Last Collection** and the File Mode should be **Append To End Of File.** Make sure the **File Storage Area 1** box is checked. The file naming format is as follows: '3-digit station ID'_stage_'4-digit year 2-digit month 2-digit day'. For example, the file for station 889 downloaded on April 5, 2009 would be: 889_stage_20090405.dat. Choose **Collect**. Perform an initial data review and complete the appropriate fields on the site visit log.

## 5.0 Recording the 6712 sample report

5.1 Hit the red button twice on the 6712 keypad. Choose **View Data**. Choose **Sampling Report**. Scroll through with the yellow enter button. Record sample date, time, and bottle information on the FRSG ISCO Sample Site Log. Note changes to the CR10X's *4 values, if applicable.

## 6.0 Downloading storage module data directly to computer

6.1 Make sure the data logger is not in the process of a 15 min write execution and exchange storage modules. The date and time when the module was swapped should be noted on the site visit log sheet.

6.2 Use the SC532 when downloading at the office directly from the storage module to a computer. In order to connect, you'll have to add a SM to the CR10X in the **Setup** program of Loggernet. Right click on the **CR10X** icon and add **SM**. Use the **Status** program of Loggernet. Click the **SM** and choose **Collect Now**. Perform and initial data review and record all necessary fields on the site visit log that pertain to data.

## 7.0 Changing the program's operational parameters (*4 table)

7.1 Attach the CR10KD as described in sec 4.0 of this document. If unit is operating correctly, **Log 12** will appear in the LED screen.

7.2 Key in *4. Then press advance (A) to bring the program to the first location, Field 0, in the *4 table. There are eight fields used with the CR10X program. They are:

0) Anticipated base flow stage (ft): Site specific.
1) Daily sample time (minutes past midnight): 1441 for all sites.
2) Timed sample interval, once above trigger stage (minutes): Site specific.
3) Height above base stage to trigger samples (ft): Site specific.
4) Change in stage (+ or -) in one hour (ft): Site specific.
5) Change in stage (-) in 15-minute interval (ft): Site specific.
6) Station ID number (3-digit code): Site specific.
7) Pump sampler status. Entered as either a 1 (enabled) or 0 (disabled).

7.3 To change any of the values, advance to the selected field and key in the new value. Press A to advance and accept the new value. Press *0 to begin logging. The program will have to recompile. Once this is complete and data is being logged, the **Log 12** value will appear. The time, date, previous value, and entered value should be recorded on the site log.

## 8.0 Wiring

8.1 A 12V battery powers the CR10X. Black wiring connects the CR10X's Battery - terminal to the battery's negative terminal. The red wire connects the CR10X's Battery + terminal to the battery's positive terminal. The same 12V battery powers the 6712. Connect the black wire's clip to the negative battery terminal and the red wire's clip to the positive battery terminal. Plug the other end of these wires directly in the battery port on the 6712's connection panel.

8.2 Between the OTT CBS bubbler and CR10X:

| **Cable** | **Bubbler** | **CR 10X** |
|---|---|---|
| Red | A1: Ubat | +12V |
| Black | A4: GND | C3 |
| White | B3: SDI-12 Data | G |
| Brown | B4: SDI-12 GND | G |

8.3 Between the ISCO 6712 sampler control cable and the CR10X:

| **Cable** | **CR10X** |
|---|---|
| White | C1 |
| Red | C2 |
| Black | G |
| Green | taped off |
| Shield | G |

# FRSG STANDARD OPERATING PROCEDURE: ISCO 730 BUBBLER AND ISCO 6712 SAMPLER

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1.0 Scope and Application

1.1 These procedures are recommended for the setup and operation of an ISCO 6712 Portable Sampler equipped with a 730 bubbler module used in the FRSG project. All equipment and models listed in this SOP are proprietary to ISCO unless otherwise noted.

2.0 Summary of Method

2.1 The 6712 is a sophisticated sampler/datalogger/controller capable of executing a variety of control functions, executing programmed logic sequences, and recording the resultant outputs. At the FRSG sites, the 6712 sampler equipped with a 730 bubbler module is used to record stage data, and sample according to specific logical sequences based on stage and time.

3.0 Equipment

3.1 ISCO 6712 Portable Sampler

3.2 ISCO 730 Bubbler Module

3.3 ISCO 601394023 Connection Cable for External 12v DC Source

3.4 ISCO 602544044 Interrogator Cable

3.5 Laptop computer with ISCO proprietary software, Flowlink (Windows).

3.6 12 volt DC battery. For the remainder of this SOP it is assumed that field situations are occurring at a site that is operational and powered up.

4.0 Battery Connection

4.1 A 12V battery powers the 6712. Connect the black wire's clip to the negative battery terminal and they red wire's clip to the positive battery terminal. The other end of these wires gets plugged directly in the battery port on the 6712's connection panel.

5.0 Downloading data at the field site.

5.1 Attach the 9-pin cable to the ISCO's interrogator port and the serial port on the laptop. Open Flowlink on the laptop.

**FRSG STANDARD OPERATING PROCEDURE:**
**ISCO 730 BUBBLER AND ISCO 6712 SAMPLER**

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5.2 In Flowlink, choose **4100/4600/6700 Instruments** from the Connect screen. Click **Retrieve Data.** After downloading the data, click the + sign next to Sites in the main menu on the left of the screen. Then click the + next to the site number of interest. Double click on Level.

5.3 A new graph will appear. We want to turn the graph into a table in order to download the data. Double click on the background.

5.4 The Properties box will appear. Select **Table** for Type.

5.5 Select the **Time Scale** tab. Select **Absolute** and enter the desired start date and time.

5.6 Select the **Series** tab. Uncheck the **Display Summary** box. Click OK.

5.7 Your table will appear. Go to **File → Export**.

5.8 **Browse** to: C:\Projects\FRSGmon\Data\Stage\Stn###\RawData. Name the file as follows: '3-digit station ID'_stage_'4-digit year 2-digit month 2-digit day'. For example, the file for station 889 downloaded on April 5, 2009 would be: 889_stage_20090405.dat.

5.9 Back in the main site window, click **Site Setup** tab, so you can download the ISCO's sampling report.

5.10 Click **Report.** Click **Save to file** and **Browse** to: C:\Projects\FRSGmon\Data\Stage \Stn###\RawData. Name the file as follows: '3-digit station ID'_SmplRpt_'4-digit year 2-digit month 2-digit day'. For example, the file for station 889 downloaded on April 5, 2009 would be: 889_SmplRpt_20090405.txt.

5.11 To view this report manually, go to the main menu on the 6712. Choose **View Data**. Choose **Sampling Report**. Scroll through with the yellow enter button. Record sample date, time, and bottle information on the FRSG ISCO Sampling Site Log.

# FRSG STANDARD OPERATING PROCEDURE: CAMPBELL SCIENTIFIC CR200 DATALOGGERS AND OTT PLUVIO² RAINGAGES

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## 1.0 Scope and Application

1.1 These procedures are recommended for the setup and downloading of precipitation data collected using a Campbell Scientific Inc (CSI) CR200 datalogger and OTT Pluvio² raingage for the FRSG project. All equipment and models listed in this SOP are proprietary to CSI unless otherwise noted.

## 2.0 Summary of Method

2.1 The CR200 is a datalogger/controller capable of executing a variety of different measurements and control functions, executing programmed logic sequences, and recording the resultant outputs. At the FRSG sites the CR200 queries the OTT Pluvio² raingage on a 15-minute interval and stores the response. Precipitation and gage status data are stored on a CR200 datalogger in an instantaneous and daily table, respectively.

2.2 Data retrieval occurs on a bi-weekly basis. The downloaded files from the CR200 are imported into an Access database where hourly and daily precipitation totals are calculated.

## 3.0 Equipment

3.1 CR200 datalogger

3.2 OTT Pluvio² Raingage

3.3 SC12, a double-ended 9-pin serial cable used for attaching peripherals to the CR200. The SC12R is a robust version of this same cable.

3.4 Laptop PC (set to Central Standard Time) with CSI proprietary software, Loggernet.

3.5 12 volt DC battery. For the remainder of this SOP it is assumed that field situations are occurring at a site that is operational and powered up.

3.6 Solar panel

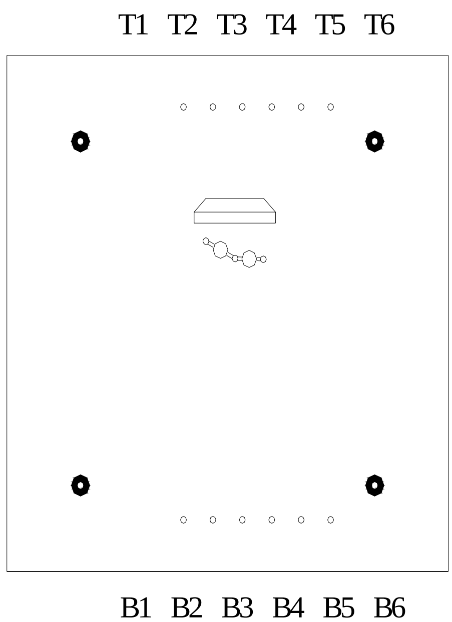
3.7 IOGear Bluetooth

**FRSG STANDARD OPERATING PROCEDURE:**
**CAMPBELL SCIENTIFIC CR200 DATALOGGERS AND OTT PLUVIO² RAINGAGES**

4.0 CR200 & OTT Pluvio Wiring

4.1 A 12V battery powers the CR200. Black wiring connects the CR200's Battery - terminal to the battery's negative terminal. The red wire connects the CR200's Battery + terminal to the battery's positive terminal.

4.2 Connections:




Circuit Board

| | |
|---|---|
| T1 | Battery Negative |
| T2 | Blue Tooth Negative |
| T3 | Blue Tooth Positive |
| T4 | Battery Positive |
| T5 | Rain Gauge Positive |
| T6 | Rain Gauge SDI signal to Campbell |
| B1 | Rain Gauge Ground |
| B2 | Rain Gauge Data Ground |
| B3 | Not Used |
| B4 | Rain Gauge +12 VDC |
| B5 | Not Used |
| B6 | Rain Gauge SDI 12 |

CR 200 Data Logger

| | |
|---|---|
| Battery - | Battery Negative |
| Battery + | Battery Positive |
| Charge - | Solar Panel Negative |
| Charge + | Solar Panel Positive |
| C1/SDI 12 | Rain Gage SDI (T6) |
| RS 232 | Blue Tooth Serial |
| Ground Lug | Earth Ground |

5.0 Procedure - Setting Up The Data Logger

5.1 If needed, upload your program to the CR200.
- 5.1.1 From LoggerNet, click **Connect**.
- 5.1.2 **Connect** to the datalogger and click **Send**
- 5.1.3 Browse to your file and click **Open,** confirm that you want to delete existing data.

5.2 Set the Station ID.
- 5.2.1 From Loggernet's Connect box, click on one of three **Numeric Data Displays**.
- 5.2.2 If you have values in your numeric field already, click **Delete All**, then click **Add**
- 5.2.3 Select the **Public** table, then click **Paste**, then click **Close**
- 5.2.4 Double click in the **StationNumber** field. Type in your station number and press return (enter). Your station number should appear.
- 5.2.5 Close the numeric display and disconnect from the CR200.

6.0 Procedure - Downloading Data at the Field Site

6.1 Data is retrieved from the dataloggers on a bi-weekly basis by downloading the data to a laptop. Attach the 9 pin cable to the CR200 and the serial port on the laptop. Open Loggernet.

6.2 Use Loggernet's Connect application to download the data. Check to make sure the **connect** button has morphed to **disconnect** to ensure you have established a link between the CR200 and the computer.

- 6.2.1 Click **Custom.**

- 6.2.2 Choose **Data Since Last Collection** for the Collect Mode.

**FRSG STANDARD OPERATING PROCEDURE:**
**CAMPBELL SCIENTIFIC CR200 DATALOGGERS AND OTT PLUVIO² RAINGAGES**

6.2.3 Choose **Append to End of File** for File Mode.

6.2.4 Choose **Array Compatible CSV** for File Format.

6.2.5 Check both boxes for Inst and Daily.

6.2.6 Click once on the filename path for the daily table.

6.2.7 Click **Change File Name** to rename the file. Rename the daily file using the following format: 'RG2-digit station ID'_'DailyStatus'_'4-digit year 2-digit month 2-digit day'. For example, the file for station 89 downloaded on April 15 2009 would be: RG89_DailyStatus_20090415.dat. The file should be saved to: C:\Projects\FRSGmon\Data\Precipitation\RG##\RawData\DailyStatus

6.2.8 Click once on the filename path for the Inst table. Click **Change File Name** to rename the file. Name the instantaneous file using the following format: 'RG2-digit station ID'_'Precip'_'4-digit year 2-digit month 2-digit day'. For example, the file for station 89 downloaded on April 15 2009 would be: RG89_Precip_20090415.dat. The file should be saved to: C:\Projects\FRSGmon\Data\Precipitation\RG##\RawData\Instantaneous

6.2.9 Choose **Start Collection** to download the data.

6.3 Perform initial review of the data and the fill in the appropriate fields on the site visit log.

7.0 <u>Procedure – Uploading Files to the Database</u>

7.1 All associated paperwork is scanned and backed up with the unit value data (*.dat files) on an external hard drive and an offsite server on a bi-weekly basis.

7.2 Personnel will import the unit value data into an Access database where hourly and daily rainfall totals will be computed.

# STANDARD OPERATING PROCEDURE (SOP) FOR DISCHARGE MEASUREMENTS

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## 1.0 Scope and Application

1.1 These procedures are to be used for all discharge measurements taken at ISWS monitoring stations in the study watersheds.

## 2.0 Summary of Method

2.1 A discharge measurement is performed using an appropriate USGS approved velocity meter, most commonly either a Price AA or Pygmy meter. Deployments can include wading rod, bridgeboards, and three or four wheeled bases. All information is recorded on a standard USGS discharge measurement sheet regardless of instrumentation used. All appropriate fields are to be completed and checked. If an AquaCalc 500 is used, the appropriate information is entered and stored for later download to verify the discharge sheet.

2.2 The resulting discharge measurement is plotted in Excel with the corresponding stage. Multiple measurements plotted at various stages will be used to develop a stage-to-discharge rating curve. After the rating curve is developed, new measurements are taken to verify and refine the rating curve. More points will reduce the confidence interval of the curve.

## 3.0 Equipment

3.1 Price AA current meter (or other approved instrumentation), A-reel and bridgeboard or appropriate wheeled base (bridge measurements).

3.2 Sounding weights of sufficient weight for anticipated velocities (bridge measurements).

3.3 AquaCalc Pro (for Price or Pygmy meter) and 9 volt and lithium batteries, or headset if not using an AquaCalc.

3.4 Pygmy meter or Sontek Flowtracker and wading rod (for wading measurements).

3.5 Discharge measurement sheets, pencils and calculator.

3.6 Traffic cones to help direct traffic (bridge measurements).

3.7 Other equipment that would commonly be included are; waders or hip boots, 100’ measuring tape, wrenches, screwdrivers, pliers, cotter pins, stakes, folding engineer’s rule.

**STANDARD OPERATING PROCEDURE (SOP)**
**FOR DISCHARGE MEASUREMENTS**

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## 4.0 Preparation for the Measurement

4.1 Complete a routine site visit including the notation of stream and weather conditions, logger reading, and tapedown measurement. It is important to note on the Site Log any observations regarding the measurement section or observed land use in the area that may affect stream discharges.

4.2 Decide on the measurement location. For a bridge measurement make sure that 3 to 5 foot intervals are marked along the bridgerail. These markings can be on either the up or downstream side of the bridge. There are benefits to each and each site will require the streamgager to evaluate the site and determine which is preferable. For a wading measurement, determine a location that provides an adequate cross-section and mark this location by stringing a tagline across the stream. Low flow measurement sections should be marked with stakes to facilitate both speed and consistency between measurements.

4.3 Perform a spin test on the current meter. This is accomplished by placing the meter in a stable position with axis of the bucket wheel vertical. The bucket wheel is then manually spun and the time it takes to return to a complete stop recorded. Spin times for the Price AA and pygmy meters are 90 and 60 seconds respectively. If the current meter fails the test then detach the current meter and check its' assembly, pivot play and contact wire adjustment and lubrication. After any corrective action another spin test must be performed.

4.4 Assemble the equipment necessary for the measurement. If performing a wading measurement, mount the selected meter to the wading rod and attach the contact wire. Then attach either the headset or AquaCalc to the brass stereo plug at the top of the rod. If performing a bridge measurement, first mount the sounding reel to the bridgeboard or base, then attach the handle. Install the hanger bar in the selected weight, using a weight pin suited for that size weight. Mount the current meter to the hanger bar. Some hanger bars are designed for use with more than one size weight; as such there may be more than one place to attach the current meter. Mount the meter at the appropriate point so that an accurate offset can be obtained for use in determining depth. Position the equipment next to the bridge rail and then attach the current meter and weight to the cable from the sounding reel. It is recommended that all sounding reels be equipped with either Canfield or B-type connectors as these substantially reduce strain and wear on the cable. The wire from the cable is attached to the current meter post. Most Price AA meters are equipped with two binding posts. The top post provides one contact per revolution while the bottom post yields one contact for every five revolutions to facilitate measurements in extremely high velocities. The headset or AquaCalc is then attached to the two posts on the A-reel using the hand-screws.

4.5 AquaCalc Setup: Press the ON button and the startup and self-test will begin and then the Date and Time will be displayed. Note: When using the AquaCalc, an item may be selected by pressing the associated key on the numeric key pad.

4.5.1 Select **1) Measure**. Hit the middle Soft Key to enter Setup and modify other settings. Press **1) Section Setup**.

4.5.1.1 Select **1) GID**. Enter in your station number, followed by a decimal, then the discharge number.

4.5.1.2 Select **2) UID** and enter your name.

4.5.1.3 Press **3) Meter** to select the appropriate meter type. Choose **1) PAA11 Std2** for a Price AA, or **2) PYGMY std2** for a Pygmy meter.

4.5.1.4 Select **5) Equip** to toggle meter suspension method. Choose **TopSet Rod** for a wading measurement or **SusP.Cab**le for a bridge measurement.

4.5.1.4.1 If performing a bridge measurement, hit **6) Sound Wt** to toggle to the appropriate sounding weight and distance from the middle of the meter cups to the bottom of the sounding weight.

4.5.1.5 Select **8) Meas.** to change the vertical measurement settings. .2 - .8 should be used whenever depth is greater than 2.5 ft. Otherwise, use .6.

4.5.1.6 Select **9) Meas. Time(s)** to change the measurement time to 40 seconds if it is not set properly. Hit 0 to change percentage Q limit to 5 if another value is present. Hit enter to return to main menu.

4.5.2 Back in the main measurement section, select **2 )Vertical Setup**.

4.5.2.1 Key **2** to use previous width.

4.5.2.2 Key **6** to copy the horizontal angle coefficient.

4.5.2.3 Key **7** to apply the horizontal angle coefficient to measurements in the same vertical only.

4.5.2.4 Hit enter to go back to the main measurement screen.

4.6 Next, fill out a discharge measurement sheet. Enter all fields, including the date, station number, personnel performing the measurement, type of meter used, size of sounding weight, and location of measurement. Note the start time, logger reading (recorder), and pin reading (inside), and tapedown measurement. Additional stage measurements should be noted as often as is practical while the measurement is being performed in order to determine a mean gage height for the discharge. If the AquaCalc 5000 is to be used, always note the Transect number that the measurement is to be recorded as.

## 5.0 Taking the Measurement Using the AquaCalc

5.1 From the measurement screen you should be at Distance 1. Hit **Distance/3** and enter in the tag line distance at the edge of water. Hit enter to accept your distance. Leave all the rest of the information for Station 1 set at 0's. Measure and Depth should be zero because there is no flow at the edge of water.

5.2 Hit the **New Vertical** button and move the equipment to the first measurement location (where the depth will be great enough).

5.2.1 Determine the distance along the bridgerail (usually 3 foot intervals are marked– use these to determine distance to the nearest foot). Hit **Distanc/3** to set your new tag line distance.

5.2.2 Lower the current meter to the water surface so that the buckets are half in and half out of the water. Set the depth indicator on the sounding reel to zero, then lower the meter to the stream bottom. Read the depth indicator. Hit **Stream Depth/6** and enter the value on the depth indicator (reel reading). The Autocalc automatically adds the difference between the meter cups and the sounding weight, which was specified earlier. This value is called "Depth" on the screen. After entering the reel value, look for the "Set Reel to:" value appropriate for your observation depth (2, 6 or 8). Crank the meter up to this height on the reel's depth indicator.

5.2.3 Press the **Measure** button to initiate the measurement. After 40 seconds, you will be able to view your velocity measurement for the appropriate observation depth. The value on the top right of the screen should begin recording to indicate the measurement is working. If no velocity value appears, abort the measure and raise the meter so that the meter can be seen and verify that the bucket wheel is rotating. If not, retrieve the meter and inspect the raising nut and for mechanical obstructions. If the bucket wheel is rotating but no signals are being received then retrieve the meter and check all connections. Verify proper operation then return the meter to the proper depth and retry the measurement. If your measurement completes properly and depth is less than 2.5 ft, go to instruction 5.3.5 before moving to the next vertical. Otherwise, use the arrow key to move to the next observation depth for that vertical, set reel to the proper depth, let the meter stabilize at the new depth, and hit measure to begin the next measurement.

5.2.4 If the meter lies at an angle in the water during a measurement, determine a cosine correction then press the **Horiz Angle/.** button and enter this number (example = +0.96). A cosine correction is most easily determined by using a folding engineer's rule. Unfold the rule to 2.5 ft and place the 2 ft. mark on the streamside edge of the bridge rail or tagline. Orient the rule so that it is parallel to the stream lines in the current. Break the rule at the one ft. mark and position the zero to one ft portion so that it is normal (perpendicular) to the rail or tagline. The reading from where the rule intersects the streamside edge of the rail or tagline subtracted from one is equal to the cosine correction.

5.2.5 Move to a new vertical and press the **New Vertical** button to enter the new tagline distance. If the bridge surface you're measuring from changes height relative to the water surface, you may need to re-zero your reel's depth indicator. Otherwise, complete the measurement(s) as described above.

5.2.6 When complete, use the **Display Total** Soft-Key to review the Section summary. Write the total discharge on the discharge measurement sheet and download the file back at the office. Turn the AquaCalc off.

5.3 Perform a spin test after the measurement and record the results in the appropriate field on the discharge sheet.

5.4 Discharge measurement procedures when not using an AquaCalc are identical with the obvious exception that the; cosine correction, distance, depth, observation point, revolutions, time, and area are only entered on the discharge sheet and the velocities are determined from a rating sheet or formula. Segmental discharges are then manually calculated and summed for the total discharge.

6.0 <u>Uploading from the Aqualcalc to the Computer</u>

6.1 Configure the Aqualcalc for uploading by connecting the upload cable onto the AquaCalc and then connect the 9 pin end to the COM 1 port on the field computer. Turn the AquaCalc ON. Open AquaCalc DataLink software and choose Com1 and 9600 for Com Port and Baud Rate, respectively.

6.2 Select the New button from toolbar. Browse to C:\Projects\FRSGmon\Data\Discharge\Stn###\Qmeas and name it as follows: '3-digit site ID'_'3-digit discharge number'.

6.3 A dialog box appears telling you to press Enter on the AquaCalc. Close the box by hitting cancel.

6.4 Press 3 on the AquaCalc for 3) Download Section. Information will fill the screen and the AquaCalc will beep twice when it has sent all the data.

6.5 Go to the file's directory and open it. Print out the file and staple it to the discharge measurement sheet.

6.6 If an error is found in an AquaCalc measurement, many of these can be corrected on the AquaCalc. The discharge can be recalculated and the corrected measurement can be uploaded and printed out. Go to the Transect # that has an error. The following parameters can be edited: Distance, Depth, the .2, .6, .8 Toggle, and the Cosine Correction. The actual measurement of velocity at the point is the only parameter that cannot be edited. When all corrections have been made, use the **Display Total** Soft-Key to review the Section summary. A copy of the corrected measurement should then be uploaded and printed out and stapled to the discharge measurement sheet. Any edited field that differs from the original discharge sheet should be highlighted, initialed and accompanied by an explanatory note.

# FRSG STANDARD OPERATING PROCEDURE: WATER QUALITY SAMPLING

## 1.0 Scope and Application

1.1 This SOP covers the recommended procedures for collecting ambient water quality samples in the FRSG monitoring project. This document is not intended to cover all the conditions, methodologies, or equipment with which water quality sampling may occur, but attempts to cover anticipated conditions and equipment needs. For those situations not covered in this SOP, refer to the various USGS publications cited in this and other SOPs associated with this QAPP.

## 2.0 Summary of Method

2.1 The equipment and methods described in this SOP are designed to yield a sample representative of the water-constituent mixture present at the sampling site. A laboratory will analyze the sample for nitrate, nitrite, total Kjeldahl nitrogen (TKN), ammonia, dissolved reactive phosphorous (DRP), total phosphorous, BOD5, total suspended solids, fecal coliforms, and chlorophyll. The Federal Interagency Sedimentation Project (FISP) standardized the techniques and equipment used to collect these samples. The samplers designed by FISP are designated by the following code: US- United States Standard Sampler; D- depth integrating; P- point integrating; H- hand-held either by rod, rope, or cable (designation is omitted when referring to a reel suspended sampler); year- last two digits of the year in which the sampler was developed (non Y2K compliant).

2.2 Various samplers and techniques are used depending on the depth and velocity of the waters to be sampled. All samplers and techniques used will be FISP approved. During extreme low or high flows, a simple dip sample may be the only sampling strategy available. Normally a depth-integrating hand sampler, such as the DH-76, is used for velocities less than 5 feet/sec (fps) and depths less than 19 feet. Depth-integrating samplers are designed to isokinetically and continuously accumulate a representative sample from a stream vertical while transiting the vertical at a uniform rate (FISP, 1952). The sampler is lowered to the surface of the water and allowed to orient into the flow without the nozzle being immersed. The sampler is then lowered using an equal transit rate during each leg (lowering and then raising) of the column.

2.3 No matter which sampler or technique is used, take care not to overfill the sample bottle. This results in water circulating through the sample bottle via the nozzle and exiting the exhaust port. The nozzle water moves slower than the ambient stream water, allowing the heavier particles to settle out and gradually biasing the sample.

2.4 Remove the sample from the sampler, and deposit it in a churnsplitter. Fill the two larger bottles just below the brim. Fill the smaller fecal sample bottle half-way to just below the brim. Label samples with site number and sample number. Place in cooler for transport to the laboratory. Make appropriate notations on the site visit log and the ISCO sample sheet.

2.5 Contact carrier for shipment to lab. The fecal samples need to be analyzed within 6 hours, so plan accordingly.

## 3.0 Equipment

Available ambient water quality sampling equipment is outlined in Table 1.

3.1 Epoxy-coated US-DH-76, which is a hand line or cable deployed sampler used for sampling moderate depths and low to moderately high velocities.

3.2 Kemmerer 1200-E32, which is a hand line deployed sampler used for sampling moderate depths at low velocities.

3.3 Quart sample bottles.

3.4 ISCO 6712, an automatic pump sampler that utilizes a free swinging suction line and peristaltic pump to draw samples from an elevated orientation. The ISCO 6712 can to store up to 12 separate samples.

3.5 Churnsplitter

## 4.0 Collecting an Ambient Water Quality Sample

4.1 Inspect, assemble, and prepare the equipment that will be utilized. Gaskets, nozzles, and exhaust ports should be inspected on all samplers. If suspected of being plugged a short piece of flexible wire is usually sufficient to clear the blockage.

4.2 The following instructions are for a single vertical. Methodology depends on the velocity and depth of the water being sampled and the particle size the suspended sediment being transported. Usually conditions will fall into one of four generalized categories, which are outlined below. The following is taken directly from Edwards and Glysson, *Field Methods for Measurement of Fluvial Sediment.* 1988.

4.2.1 Procedure for velocities <2.0 ft/sec:

4.2.1.1 When velocity is <2.0 ft/s, the velocity is low enough that no sand is being transported as suspended sediment; only particles <0.62 mm are in suspension. The distribution of sediment (silt and clay) is relatively uniform from the stream surface to bed (Guy, 1970, p. 15). The sampling error for this case is small, even with intake velocities somewhat higher or lower than the ambient mean stream velocities. Therefore, it is not as important to collect the sample isokinetically with fines in suspension as it is when particles >0.062 mm are in suspension.

4.2.1.2 In shallow streams a sample may be collected by submerging an open-mouthed bottle into the stream by hand. The mouth should be pointed upstream and the bottle held at approximately a 45° angle from the streambed. The bottle should be filled by moving it from the surface to the streambed and back. Care should be taken to avoid touching the mouth of the bottle to the streambed. An unsampled zone of about 3 inches should be maintained in order to obtain samples that are compatible with depth-integrated samples collected at higher velocities.

4.2.1.3 If the stream is not wadable, a weighted-bottle type sampler may be used. Remember that these samples are not discharge-weighted samples and that, if possible, their analytical results should be verified by or compared to data obtained using a standard sampler and sampling technique.

4.2.2. Procedure for velocities 2.0<V<12.0 ft/s and the depth is less than 15 feet.

4.2.2.1 When 2.0<V<12.0 ft/s and the depth is less than 15 feet, the standard depth-integrating samplers, such as DH-48, DH-76, DH-59, D-49, D-77, and D-74, may be used. The method of sample collection is basically the same for all these samplers, whether used while wading or from a bridge or cableway. Insert a clean sample bottle into the sampler and check to see that there are no obstructions in the nozzle or air-exhaust tube. Then lower the sampler to the water surface so that the nozzle is above the water and the lower tail vain or back of the sampler is in the water for proper upstream-downstream orientation. After orientation of the sampler, depth integration is accomplished by traversing the full depth and returning to the surface with the sampler at a constant transit rate.

4.2.2.2 When the bottom of the sampler touches the streambed, immediately reverse the sampler direction and raise the sampler to clear the surface of the flow at a constant transit rate. The transit rate used in raising the sampler need not be the same as the one used in lower, but both rates must be constant in order to obtain a velocity- or discharge-weighted sample. The rates should be such that the bottle fills to near its optimum level (approximately 3 inches below the top or 350 to 420 mL for the pint bottle, or 2 inches below the top or 650 to 800 mL for the quart bottle).

4.2.2.3 For streams that transport heavy loads of sand, and perhaps for some other streams, at least two complete depth integrations of the sample vertical should be made as close together in time as possible–one bottle for each integration. Each bottle then constitutes a sample and can be analyzed separately or, for the purposes of computing the sediment record, two or more bottles can be averaged whereby they are called a set. This set is then a sample in time with respect to the record. Sample analyses from two or more individual bottles for a given observation are useful for checking constituent variations among bottles–an obvious advantage in the event the constituent oncentration in one bottle is quite different from the concentration in the other bottles for the same observation. Immediately after collection, every bottle or sample should be inspected visually by swirling the water in the bottle and observing the quantity of sand particles collected at the bottom. If there is an unusually large quantity or a difference in the quantity of sands between bottles, another sample from the same vertical should be taken immediately. The sample suspected of having too much sand should be discarded. If it is saved, an explanation such as “too much sand” should be clearly written on the bottle.

4.2.2.4 If by chance a bottle is overfilled or if a spurt of water is seen coming out of the nozzle when the sample is raised past the water surface, the sample should be discarded. A clean bottle should be used to resample the vertical.

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4.2.2.5 To help avoid the problem of striking the nozzle into a dune or settling the sampler too deeply into a soft bed, it is recommended that a slow downward integration be used followed by a more rapid upward integration. Because most of the sand is transported near the bed, it is essential that the transit direction of the sampler be immediately reversed as the sampler touches the bed.

4.2.2.6 Empty sample into churnsplitter.

4.2.3. Procedure for depths > 15 ft and velocities 2.0<V<12.0:

4.2.3.1 When depths are greater than 15 ft and velocities are high (2.0<V<12.0), the depth-integrating samplers cannot be used because the depth exceeds the maximum allowable depth for these samplers. In this case, one of the point-integrating samplers must be used.

4.2.3.2 The point samplers may be used to collect depth-integrated samples in verticals where the depth is greater than 15 feet. For streams with depths between 15 and 30 feet, the procedure is as follows:

- Insert a clean bottle in the sample and close the sampler head.
- Lower the sampler to the streambed keeping the solenoid closed and note the depth to the bed.
- Start raising the sampler to the surface using a constant transit rate. Open the solenoid at the same time the sampler begins the upward transit.
- Keep the solenoid open until after the sampler has cleared the water surface. Close the solenoid.
- Remove the bottle containing the sample, check the volume of the sample, and mark the appropriate information on the bottle. (If the sample volume exceeds allowable limits, discard the sample and repeat depth integration at a slightly higher transit rate.)
- Insert another clean bottle into the sampler, and close the sampler head.
- Lower the sampler until the lower tail vane is touching the water allowing the sampler to align itself with the flow.

- Open the solenoid and lower the sampler at a constant transit rate until the sampler touches the bed.
- Close the solenoid the instant the sampler touches the bed. (By noting the depth to the streambed in step 2 above, the operator will know when the sampler is approaching the bed.)

4.2.3.3 The transit rate used when collecting the sample in the upward direction need not be the same as that used in the downward direction.

4.2.3.4 If the stream depth is greater than 30 feet, the process is similar, except that the upward and downward integrations are broken into segments no greater than 30 feet. Samples collected by this technique may be composited in the laboratory for each vertical and a single mean concentration is computed for the vertical. In addition to the usual information, the label on each bottle should indicate the segment or range of depth sampled and whether it was taken on a descending or ascending trip.

4.2.3.5 Samples much be obtained at a given vertical for both the downward and upward directions. Tests in the Colorado River, United States (F.I.S.P., 1951, p. 34), have shown an increase in the intake ratio of about 4 percent when descending versus a decrease in the intake ratio of about 4 percent on ascent. These differences may affect sample concentrations at some sites.

4.2.4. Procedure for velocities > 12 ft/sec:

4.2.4.1 When velocities are greater than 12.0 ft/s, circumstances are often such that surface or dip sampling is necessary. When the velocities are to high to use the depth- or point-integrating samplers or when debris make normal sample collection dangerous or impossible, surface or dip samples may be collected.

4.2.4.2 A surface sample is one taken on or near the surface of the water with or without a standard sampler. At some locations stream velocities are so great that even 100-lb samplers cannot penetrate the water more than a short distance before they are dragged downstream and out of the water into an erratic movement. Under such conditions it can be expected that all except the largest particles of sediment will be thoroughly mixed within the flow and therefore a sample near the surface is representative of the entire vertical. Extreme care should be used, however, because often such high velocities occur during floods when large debris is moving, especially on the rising part of the hydrograph. This debris may strike or become entangled with the sampler and thereby damage the sampler, break the sampler cable, or injure the field person. Of course, a full explanation of sampling conditions, including the depth to which the sample was taken, should be noted on the bottle and in the field notes in order that special handling may be given the samples in the laboratory and in computing the records.

4.2.4.3 Because of the many problems associated with surface and dip sampling, these samples should be correlated to regular depth-integrated samples collected as soon as possible after the high flow recedes enough to allow collection of a full depth-integrated sample. Along with the full depth-integrated sample, a sample should be collected in a manner duplicating the sampling procedure used to collect the surface or dip sample. These samples will be used to adjust the analytical results of the surface or dip sample collected during the higher flow, if necessary, to facilitate the use of these data in constituent-discharge computations and data analyses.

## 5.0 Multi-vertical Cross-sectional Sampling

There are two methods that are accepted for use when doing cross-sectional sampling. The Equal Width Increment (EWI) method is recommended for those sites that are shallow and wadable, sand bed, or where insufficient information exits to be certain of the distribution of flow. It is anticipated that this will be the predominate method used for determining sample vertical spacing on the FRSG project. The following is taken from Edwards and Glysson, *Field Methods for Measurement of Fluvial Sediment.* 1988. If it should become desirable to use the Equal Discharge Increment (EDI) method then the techniques outlined in the aforementioned publication regarding this method will be employed. Both EWI or EDI methods can be employed to obtain sample sets to be analyzed for both suspended sediment content (SSC), and particle size distribution (PPS).

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5.1 Equal Width Increment method (EWI)

5.1.1 A cross-sectional sample obtained by the EWI method requires a sample volume proportional to the amount of flow at each of several equally spaced verticals in the cross section. This equal spacing between the verticals (EWI) across the stream and sampling at an equal transit rate at all verticals yields a gross sample volume proportional to the total streamflow. It is important, obviously, to keep the same size nozzle in the sampler for a given measurement. This method was first used by B.C. Colby in 1946 (F.I.S.P., 1963b, p. 41) and is used most often in shallow, wadable streams and/or sand-bed streams where the distribution of water discharge in the cross section is not stable. It is also useful in streams where tributary flow has not completely mixed with the main stem flow.

5.1.2 Sample at ten equally-spaced verticals across the stream, unless the stream is less than 5 feet wide. For streams less than 5 feet wide, as many verticals as possible should be used as long as they are spaced a minimum of 3 inches apart to allow for discrete sampling of each vertical and to avoid overlaps. .

5.1.3 Determine the width of the increments to be sampled, or the distance between verticals, by dividing the stream width by the number of verticals necessary to collect a discharge-weighted sample representative of the constituent concentration of the flow in the cross section. For example, if the stream width determined from the tagline, cableway, or bridge-rail markings at the sample cross section is 160 feet, and the number of verticals necessary is 10, then the width (W) of each sampled increment would be 16 feet. The sample station within each width increment is located at the center of the increment (), beginning at a location of 8 feet from the bank nearest the initial point for width measurement. The verticals are then spaced 16 feet apart, resulting in sample stationing at 8, 24, 40, 56, 72, 88, 104, 120, 136, and 152 feet of width. However, in the event the width increment results in a fractional measurement, the width can be rounded to the nearest integer that will yield a whole numbered station for the initial sample vertical. That is, if the increment computation yields a width of 15.5 feet, the nearest integer width would be 16 feet, and the initial vertical would be located at 8 feet from the bank; the stationing would be similar to the previous example. Results of samples obtained using this non-ideal stationing will not be measurably affected since alterations in width occur in the increments nearest the streambank where flow velocity is normally low compared to midstream increments.

5.1.4 The EWI sampling method requires that all verticals be traversed using the same transit rate. The descending and ascending transit rates must remain constant during the sampling traverse of each vertical and among verticals. By using this equal-transit-rate technique with a standard depth- or point-integrating sampler at each vertical, a volume of water proportional to the flow in the vertical is collected.

5.1.5 It is often difficult to maintain an equal transit rate when collecting samples while wading. The authors have found the following procedure to overcome this difficulty. The field person should hold the sampler at a reference point on the body (for example, the hip) at which level the downward and upward integration is started and finished (even though part of the traverse is in air). The same reference point should be used at each vertical, allowing the same amount of time to elapse during the round trip traverse of the sampler (regardless of the stream depth encountered). In this manner the transit rate will remain constant for the entire cross section. It should be remembered that the reference point at which the sampler traverse is started and stopped must be located above the water surface at the deepest vertical sampled and must be the same for each vertical.

5.1.6 The transit rate used for all verticals is limited by conditions at the vertical containing the largest discharge per foot of width (large product of depth times velocity). This is true because the maximum transit rate must not exceed 0.4 $V_m$, while the minimum rate must be sufficiently fast to keep from overfilling any of the sample bottles. A discharge measurement can be made to determine where this vertical is located, but generally it is estimated by sounding for depth and acquiring a "feel" for the relative velocity with an empty sampler or wading rod. The transit rate required at the maximum discharge vertical must then be used at all other verticals in the cross section and is usually set to fill a bottle to the maximum sample volume in a round trip. It is possible to sample at two or more verticals using the same bottle if the bottle is not overfilled. If a bottle is overfilled, it must be discarded and all verticals previously sampled using that bottle must be re-sampled using a sufficient number of bottles to avoid overfilling. Note: a sample bottle is "overfilled" when the water surface in the bottle is above the nozzle or air exhaust with the sampler held level.

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6.0 Churn Splitter

A polyethylene churn splitter will be used to composite the samples collected from multiple individual verticals across the stream. Contents of the EWI collected bottles are poured into the splitter where they are composited into one representative cross section sample. Sub-samples can be pulled from this composite for the required water quality analysis.

6.1 Cleaning - Prior to taking it into the field the churn should be washed with a non-phosphate laboratory detergent and thoroughly rinsed with tap water followed by distilled water. Wash it the same way after a field trip. Before using it at a station, rinse the churn thoroughly with native water. Cleaning between station visits while in the field may be accomplished by thorough rinsing with distilled water followed by a rinse with native water from the site where sampling is to be done

6.2 Sub-Sampling - Churn the sample at a steady pace. Do not allow the wand to break the water surface while churning. Continue to churn the sample while filling the sample bottles. Samples should not be dispensed if the water level is less than 1.5 inches above the spigot.

7.0 Intake Efficiency Sampling

In order to determine whether or not the ISCO 6712 is sampling isokenetically, simultaneous integrated samples at approximately the same position in the stream are taken. To obtain an Intake Efficiency sample set, simultaneous ISCO 6712 and point integrated samples are required. This is accomplished by using an integrated sampler to obtain a water sample at approximately the same intake position and time that an ISCO 6712 grab sample is being taken. These samples can then be compared for constituent concentration. A calibration to the ISCO 6712 samples can then be determined.

7.1 Load a sample bottle into an integrated sampler. Next, note the ISCO 6712 intake location. Lower the integrated sampler to a position as near to the ISCO intake as is possible. Obtain an ISCO 6712 grab sample at the same time that the integrated sample is being obtained. Label the pair as Intake Efficiency (IE) samples and note them on the site log and chain of custody as such. These samples will be taken four times a year and the laboratory will only analyze TSS.

7.0 Box Samples

Box samples allow for the comparison of constituents from a multi-vertical cross-sectional sample with a single “box sample,” which is taken as close to the ISCO intake as possible. By comparing the two, we can determine if the ISCO is taking a reasonably representative sample of the cross-section's constituents.

7.1 Perform a box sample with an integrated sampler. Sample as close to the ISCO intake as possible. Label the bottle as a "box sample." Perform a multi-vertical cross-sectional with instructions described previously.

Table 1. Sampler Designations and Characteristics
(Epoxy-coated versions of all samplers are available for collecting trace metal samples)

| Sampler desig-nation US | Construction material | Sampler dimensions: length (in.) | width (in.) | weight (lb) | Nozzle distance from bottom (in.) | Suspension type | Maximum velocity (ft/s) | Maximum depth (ft) | Sampler container size: Pint | Quart | Intake size (in.) | Nozzle color |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DH-48 | aluminum | 13.0 | 3.2 | 4.5 | 3.5 | rod | 8.86 | 8.86 | X | – | 1/4 | yellow |
| DH-75P | Cd-plated | 9.25 | 4.25 | 1.5 | 3.27 | rod | 6.6 | 16 | X | | 3/16 | white |
| DH-75Q | Cd-plated | 9.25 | 4.25 | 1.5 | 4.49 | rod | 6.6 | 16 | X | | 3/16 | white |
| DH-75H[1] | Cd-plated | 9.25 | 4.25 | 1.5 | -- | rod | 6.6 | – | (2 liter) | | 3/16 | white |
| DH-59 | bronze | 15 | 3.5 | 22 | 4.49 | handline | 5.0 | 19 | X | – | 1/8 | red |
| DH-59 | do. | 15 | 3.5 | 22 | 4.49 | do. | 5.0 | 16 | X | – | 3/16 | red |
| DH-59 | do. | 15 | 3.5 | 22 | 4.49 | do. | 5.0 | 9 | X | – | 1/4 | red |
| DH-76 | bronze | 17 | 4.5 | 22 | 3.15 | handline | 6.6 | 16 | – | X | 1/8 | red |
| DH-76 | do. | 17 | 4.5 | 22 | 3.15 | do. | 6.6 | 16 | – | X | 3/16 | red |
| DH-76 | do. | 17 | 4.5 | 22 | 3.15 | do. | 6.6 | 16 | – | X | 1/4 | red |
| DH-81 | plastic | 47.5 | 4.0 | 0.5 | (5) | rod | 8.9 | (6) | (7) | – | 3/16 | white |
| DH-81 | do. | 7.5 | 4.0 | 0.5 | (5) | do. | 8.9 | 9 | (7) | – | 1/4 | white |
| DH-81 | do. | 7.5 | 4.0 | 0.5 | (5) | do. | 8.9 | 9 | (7) | – | 5/16 | white |
| D-49 | bronze | 24 | 5.25 | 62 | 4.0 | cable reel | 6.6 | 19 | X | – | 1/8 | green[8] |
| D-49 | do. | 24 | 5.25 | 62 | 4.0 | do. | 6.6 | 16 | X | – | 3/16 | green[8] |
| D-49 | do. | 24 | 5.25 | 62 | 4.0 | do. | 6.6 | 9 | X | – | 1/4 | green[8] |
| D-74 | bronze | 24 | 5.25 | 62 | 4.06 | cable reel | 6.6 | [1]19,16[2] | X | X | 1/8 | green |
| D-74 | do. | 24 | 5.25 | 62 | 4.06 | do. | 6.6 | [1]19,16[2] | X | X | 3/16 | green |
| D-74 | do. | 24 | 5.25 | 62 | 4.06 | do. | 6.6 | [1]19,16[2] | X | X | 1/4 | green |
| D-74AL | aluminum | 24 | 5.25 | 42 | 4.06 | cable reel | 5.9 | [1]19,16[2] | X | X | 1/8 | green |
| D-74AL | do. | 24 | 5.25 | 42 | 4.06 | do. | 5.9 | [1]19,16[2] | X | X | 3/16 | green |
| D-74AL | do. | 24 | 5.25 | 42 | 4.06 | do. | 5.9 | [1]19,16[2] | X | X | 1/4 | green |
| D-77 | bronze | 29 | 9 | 75 | 7 | cable reel | 18.0 | 15.5 | (3 liter) | | 5/16 | white |
| P-61 | bronze | 28 | 7.34 | 105 | 4.29 | cable reel | 16.6 | [1]180,120[2] | X[3] | X | 3/16 | blue |
| P-63 | bronze | 37 | 9 | 200 | 5.91 | cable reel | 6.6 | [1]180,120[2] | X[3] | X | 3/16 | blue |
| P-72 | aluminum | 28 | 7.34 | 41 | 4.29 | cable reel | 5.3 | [1]72.2,50.9[2] | X[3] | X | 3/16 | blue |

[1]Depth using pint sample container.
[2]Depth using quart sample container.
[3]Pint milk bottle can be used with adapter sleeve.
[4]Without sample bottle attached.
[5]Depends on bottle size used.
[6]Refer to transit-rate determination graph construction (in section "Transit Rates for Suspended-Sediment Sampling) with specific nozzle and bottle size used.
[7]Any size bottle with standard mason jar treads.
[8]The green nozzles used with the D-74 can be used to replace calibrated brass nozzles no longer available.

# FRSG STANDARD OPERATING PROCEDURE FOR STAGE DATA MANAGEMENT

1.0 Scope and Application

1.1 These procedures are to be used for downloading and processing data collected using a Campbell Scientific CR10x datalogger or an ISCO 6712 Sampler.

2.0 Summary of Method

2.1 Data is retrieved from the field on a bi-weekly basis.

2.1.1 The downloaded file from the CR10x is parsed, edited and appended to create a monthly file of 15 minute interval data and an annual file of daily outputs.

2.1.2 The downloaded file from 6712 is edited and appended to create a monthly file of 15 minute interval data and an annual file of daily outputs.

2.2 Filenames for each of the resulting files follow a specific format and are maintained in specific directories.

2.3 Several steps are taken to review and verify data completeness and accuracy.

3.0 Equipment

3.1 Campbell Scientific CR10x datalogger.

3.2 Campbell Scientific Storage Module (SM).

3.3 ISCO 6712 Sampler

3.4 PC with Campbell Scientific Loggernet and ISCO Flowlink software installed.

4.0 Stage Data Retrieval

4.1 Retrieve the data from the Campbell Scientific CR10x loggers on a bi-weekly basis, either by swapping SMs or downloading the data from the SM to a laptop. Complete instructions for downloading stage data are found in SOP 1.

4.2 When downloading data from a SM, save the new data as comma separated and append to one file. The filename is as follows: '3-digit station ID'_stage_'4-digit year 2-digit month 2-digit day'. For example, the file for station 889 downloaded on April 5, 2009 would be: 889_stage_20090405.dat.

4.3 The data is retrieved from the ISCO 6712 on a bi-weekly basis by connecting directly to a laptop.

4.4 When downloading data from the ISCO, the new data should be comma separated and appended to one file. The filename is determined as follows: '3-digit station ID'_stage_'4-digit year 2-digit month 2-digit day'. For example, the file for station 889 downloaded on April 5, 2009 would be: 889_stage_20090405.dat.

4.5 Take a tapedown measurement at each site visit for stage data verification.

5.0 Procedure – Initial Data Review

5.1 Record each data download on a Stage Data Retrieval (DR) Log (See Figure 11.1). As the data is converted from one format to another, note all file names and locations on the Stage DR Log.

5.2 Obtain a DR Log and record the site name, site ID, and the CR10x program in use, if applicable. Record the retrieved data filename, using the naming procedure outlined in step 4.2. This *.dat file is the raw, unit value data. It is never deleted, modified or changed in anyway.

5.3 Back up all *.dat files on an external hard drive and Illinois server on a bi-weekly basis.

5.4 Open up the CR10X's *.dat file using Loggernet's View or Windows Explorer. An example of a retrieved *.dat file is shown in Figure 11.2. Make an initial review of the data, noting the start and stop information on the Log. Scan the data to determine the array IDs contained in the file. The array ID is simply the first value in each row. Note these on the DR Log.

5.5 Open up the ISCO's *.csv file using Excel. An example of a retrieved *.csv file is show in Figure 11.3. Make an initial review of the data, noting the start and stop information on the Log.

6.0 Procedure – CR10X Data Reduction Using PC208's Split Program

6.1 Using Campbell Scientific's Loggernet Split program, parse the *.dat files into a file of 15 minute stage and temperature readings and a file of daily outputs (battery voltage, max/min temperature, etc.). In Loggernet, click on the Split icon to open the Split window. (See Figure 11.3)

6.2 15 minute CR10X Data Reduction

6.2.1 Open the parameter file Stage4-0.par to parse the 15 minute interval data.

6.2.2 In the Split window's Input File tab, click the browse button and find the desired .dat file.

6.2.3 Enter the array ID associated with the 15 minute data in the Start Condition field.

6.2.4 In the Split window's Output file tab, click the browse button and go to: C:\Projects\FRSGmon\Data\Stage\Stn###\ParsedData. Name 15 minute interval data files as follows: 'S'_3-digit station ID'_'4-digit year 2-digit month 2-digit day'. For example, the file for station 889 downloaded on April 15 2009 would be: S_889_20090415.prn

6.2.5 Record the parsed data filename and location on the DR Log.

6.2.6 After filling in the three fields of the Split template, select **Run | Go** from the menu. The parsed data will scroll down the screen; this window can be closed since the data has been saved as the *.prn file.

6.3 Daily Outputs CR10X Data Reduction

6.3.1 To parse the daily outputs data, open the parameter file Daily.par.

6.3.2 In the Split window's Input File tab, the click the browse button and find the desired .dat file.

6.3.3 Enter the array ID associated with the daily data in the Start Condition field.

6.3.4 In the Split window's Output file tab, click the browse button and go to: C:\Projects\FRSGmon\Data\Stage\Stn###\ParsedData. The daily data files are renamed as follows: 'D'_3-digit station ID'_'4-digit year 2-digit month 2-digit day'. For example, the file for station 889 downloaded on April 15 2009 would be: D_889_20090415.prn

6.3.5 Record the parsed data filename and location on the DR Log.

6.3.6 After filling in the three fields of the Split template, select **Run | Go** from the menu. The parsed data will scroll down the screen; this window can be closed since the data has been saved as the *.prn file.

6.4 When quitting Split, a prompt will appear about saving changes to the file. Click **No**. The only changes made were the three fields and these will be changed every time a file is parsed.

## 7.0 Procedure – Editing and Appending Data Files

7.1 To edit and append the *.prn files, open them in Excel as space delimited data.

### 7.2 Editing and Appending CR10X Stage Data

7.2.1 Open the Stage 4-0 template. Return to the *.prn file, copy the data from the year column to the last column and down to the last line of data. Paste in the year column of the template. Enter the appropriate site name and site ID in Row 1. Change the data in columns F and G (Hour, Min) to Custom (00). Copy the equation from cell A4 down through all rows of data.

7.2.2 As an Excel file, append the 15 minute data into monthly files using the following naming format: 3 digit site ID, then "s" for stage, then 2-digit month, and 2-digit year: 802s0199.xls. Save the file as an Excel workbook (*.xls). Save to the following folder: C:\Projects\FRSGmon\Data\Stage\Stn###\FinalData

7.2.3 Open new templates at the beginning of each month. Cut and paste *.prn data as needed to create the monthly files. An example of data imported into the Stage 4-0 template is shown in Figures 11.4.

### 7.3 Editing and Appending ISCO Stage Data

7.3.1 Append the 15 minute data into monthly files using the following naming format: 3 digit site ID, then "s" for stage, then 2-digit month, and the 2-digit year: 802s0199.xls. Save the file as an Excel workbook (*.xls). Save to the following folder: C:\Projects\FRSGmon\Data\Stage\Stn###\FinalData

### 7.4 Appending Daily Outputs File

7.4.1 Open the Daily Outputs template. Open the daily outputs *.prn file as space delimited data. Copy the data from the year column to the last column and down to the last line of data. Paste in the year column of the template. Enter the appropriate site name and site ID in Row 1.

7.4.2 Append the daily outputs into an annual file using the 3 digit site ID, "dly" then the last 2 digits of the year: 802dly99.xls. Save to the following folder: C:\Projects\FRSGmon\Data\Stage\Stn###\FinalData

7.4.3 After the first file of the year is created and saved, all future data are simply appended to the end of this annual file. An example of data appended to the annual file is shown in Figure 11.5.

7.5 Record the appended data filenames and locations on the DR Log.

8.0 Procedure – Stage Data Review and Verification

8.1 One advantage of having the data in an Excel format is that it is easily plotted. At the end of each weekly download, create a hydrograph for the month before any revisions are made to the data. Use column A (Date/Time (CST)) as the x-coordinates and column H (Stage) as the y-coordinates. (Refer to Figure 11.6)

8.2 When reviewing the data, check for (1) significant differences in time or stage between SM changes, (2) unusual or unexplained jumps of greater than 0.10 ft between 15 minute readings, (3) any gaps in data, (4) obvious incorrect stages, etc.

8.3 Describe any problem with the stage data (even a single missed reading), and document the action needed and/or taken on the Data Retrieval Log. (Reminder: Revisions are only made in the Excel files. The *.dat files and *.prn files remain untouched.)

8.4 If only one reading is missing, you may fill in the data with the average of the readings immediately prior to and after the missed reading. This may be done as long it did not occur during a period of rapidly changing stage. If there are more than a few missed readings or they occurred during storm events, explain the cause of the loss of data and the method used to recreate the missing data. All supplemental or estimated data will be reviewed.

8.5 If there is substantial missing stage data, revisions are more involved. There are many tools available to assist with this process. Check the sitelogs for notes regarding whether the stream was rising or falling. Use the converted tapedown measurements to supplement missing data. Check the stage records from other sites, and check the precipitation record from project raingage(s) or a nearby station of the Midwest Climate Center or other meteorological network. As the project continues to collect data, you should consult site data from a previous month or year to provide assistance in determining hydrograph peak characteristics. Make the best assessment after considering all available data.

8.6 When revisions are complete, back up all data files, and sign and date DR Logs.

8.7 At the end of the month, prepare the stage files for input into the ISWS hydrologic program, IDAPP. IDAPP produces tables and plots suitable for reporting purposes.

## 9.0 Procedure – Preparing Stage Data for IDAPP

9.1 Obtain a Stage Data Review and Verification (R&V) form. (See Figure 11.7) Complete the top of the form with the Project name, Station ID and Month of data to be processed.

9.2 After all data point estimations are explained on the DR Log and the stage data (prior to revisions) is plotted and printed, mark these tasks as completed. If substantial revisions were made to the monthly stage file, briefly explain in the "Comments" section.

9.3 Convert the monthly appended file to the Standard or CR10x format using the Excel macros (Ctrl+Shift+S or Ctrl+Shift+X). Enter the correct site information in the top 5 rows, being sure to leave a space after each colon. Save this Excel workbook with the Standard or CR10x worksheet.

9.4 Go to **File | Save As** and select **Space Delimited Text** (*.prn). Change the file extension to *.std or *.crx and enclose the filename in quotes. Excel informs you that you are only saving the current worksheet; click "ok". It will then tell you that the file contains some features that are not compatible with the file type; click "yes". Upon closing the file, Excel asks if you would like to save changes to the file; click "no". On the R & V form, note the format and filename of the new file.

## 10.0 Procedure – Using IDAPP

10.1 Launch the IDAPP program, IDAPP.exe.

10.2 Open a new IDAPP input file: (STN)s(MMYY).crx(or std)
Project, station and file type will auto-detect. Select data type that is being processed, by choosing **stage** from the drop down menu. Select **hourly** from the output format drop down menu. Units should be in **feet** and delimit should be **comma**. Create output file name: ph(STN)s(MMYY).idp then click the **create file** button (See Figure 11.8). This process, starting from Select output format menu is

**FRSG STANDARD OPERATING PROCEDURE**
**FOR STAGE DATA MANAGEMENT**

repeated for "Daily Table". Output file name: dt(STN)s(MMYY).idp (See Figure 11.8).

10.3 Examples of the four output file types are shown in Figures 11.9 – 11.12.

10.4 Open the Dtable file in Excel. Click **Tools | Macros | Run** and select the **Dtable macro** (or use the keyboard shortcut Ctrl + Shift + D). Select the "dt*.idp" file for the current month. Save the file as an Excel file, retaining the original filename. (See Figure 11.13) Print out the table, paper clip it to the R&V form and record that this task has been completed.

10.5 In Excel, open the STNshMMYY.xlt template, by selecting **File | New**. Open the PH files in Excel as comma delimited. Highlight all the data in Columns A and B. Copy this data and paste it in Column A of the template.

10.6 A graph is automatically created in the template. Change the x-axis scale for the appropriate month. Do this by formatting the x-axis, selecting the **Scale tab**, changing the minimum value to the first of the month (say 5/1/98) and changing the maximum value to the first of the next month (say 6/1/98). Change the chart title to represent the correct station and month. Name the file using the format outlined in template name. So October 2009 data from Station 802 would have the filename: 802sh1099.xls.

10.7 The plot should look like Figure 11.14. Printout the plot and paper clip it to the R&V form and mark this task completed.

10.8 Inspect the peaks in the plot for errors and compare the stage with converted tapedowns. Record the stage according to the tapedowns on the daily table next to the nearest logger reading. Explain any further revisions needed on the review and verification form.

10.9 Perform edits on the STANDARD or CR10x sheet of the monthly appended Excel file. Save after making revisions.

10.10 After making any revisions, process the *.crx or *.std file again, beginning with step 9.4. After re-running IDAPP, print out the new PH and daily table files to make sure the edits are correct. Note the revision dates on the R&V form. Keep the new printouts with the original printouts so that all changes are documented. Check that this task is complete. When accepted as final data, the form is signed, dated and delivered to the data manager.

11.0 <u>References</u> (See Figures 11.1 – 11.14)

## Stage Data Retrieval Log for Site ______ ___________________

CR10x Program _________________ Data Filename _____________________

**According to *.dat (CR10X) or *csv (ISCO) file**

Starting Day __________ (Date __________) Time __________ Stage __________

Ending Day __________ (Date __________) Time __________ Stage __________

*.dat15 minute interval array ID(s) __________ __________

*.dat Daily Levels array ID __________

**Data Organization**

C:\Projects\FRSGmon\Data\Stage\Stn###\

| **CR10X & ISCO** | **CR10X Only** | **CR10X & ISCO** |
|---|---|---|
| RawData\WY _____\ | ParsedData\WY _____\ | FinalData\WY _____\ |
| ____________________ | ____________________ | ____________________ |
| | | ____________________ |
| | ____________________ | ____________________ |

**Excel File Revisions**

Gaps in Data? _____ Obvious Incorrect Stages? _____

Comments/Adjustments Made/Explanations:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

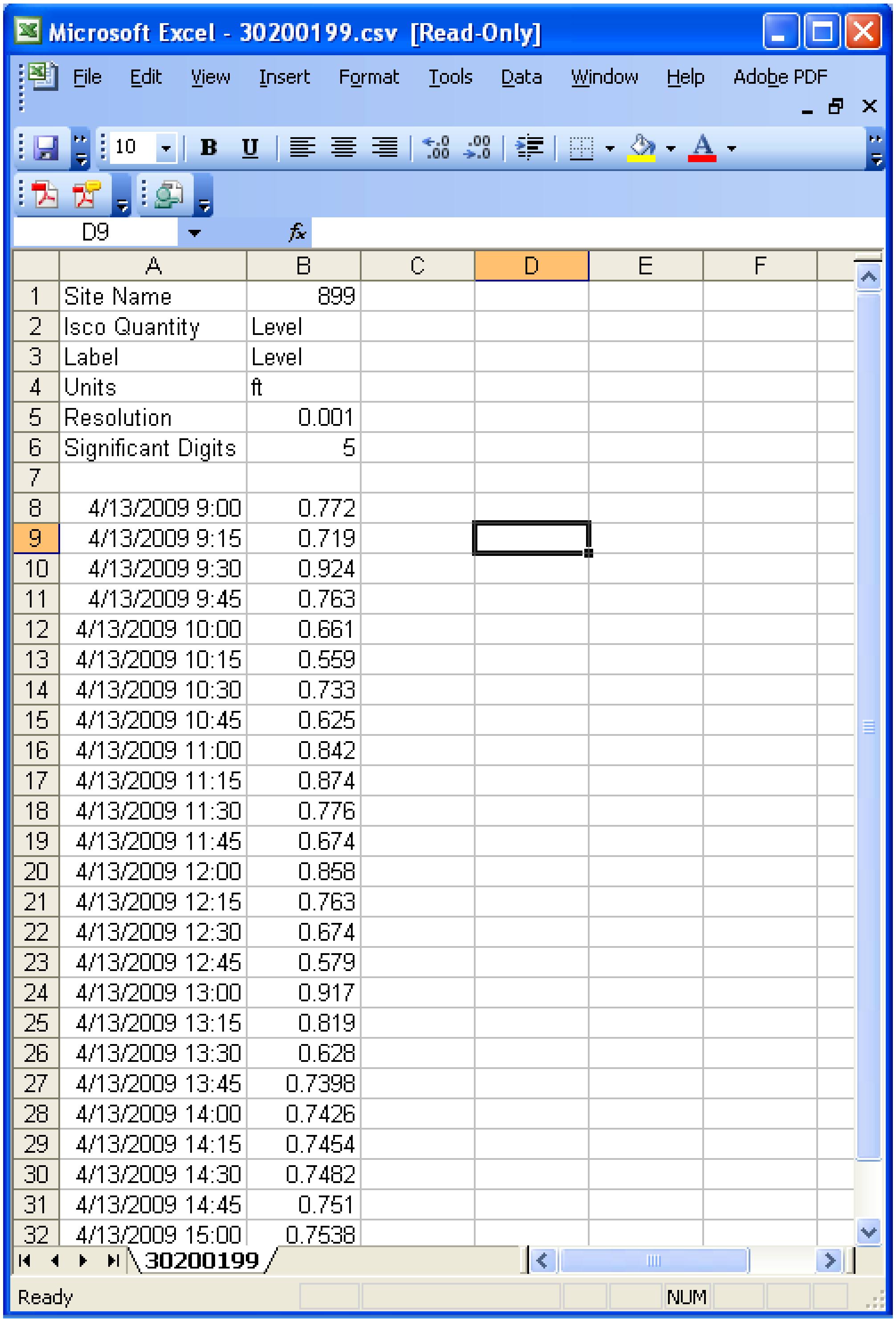
Date _____ All Files Backed Up _____ Location ____________________________

Rev. 7
4/22/09 (BAR)

**Figure 11.1 – Stage Data Retrieval Log**

```
301,1999,293,2000,75.153,8.6,0,0,0,0,0,0,0
301,1999,293,2015,75.154,8.6,0,0,0,0,0,0,0
301,1999,293,2030,75.156,8.6,0,0,0,0,0,0,0
301,1999,293,2045,75.155,8.6,0,0,0,0,0,0,0
301,1999,293,2100,75.155,8.6,0,0,0,0,0,0,0
301,1999,293,2115,75.156,8.6,0,0,0,0,0,0,0
301,1999,293,2130,75.154,8.6,0,0,0,0,0,0,0
301,1999,293,2145,75.155,8.7,0,0,0,0,0,0,0
301,1999,293,2200,75.155,8.7,0,0,0,0,0,0,0
301,1999,293,2215,75.156,8.7,0,0,0,0,0,0,0
301,1999,293,2230,75.155,8.8,0,0,0,0,0,0,0
301,1999,293,2245,75.155,8.8,0,0,0,0,0,0,0
301,1999,293,2300,75.155,8.9,0,0,0,0,0,0,0
301,1999,293,2315,75.154,8.9,0,0,0,0,0,0,0
301,1999,293,2330,75.154,8.9,0,0,0,0,0,0,0
301,1999,293,2345,75.154,9,0,0,0,0,0,0,0
301,1999,294,0,75.155,9,0,0,0,0,0,0,0
212,1999,294,0,12.759,17.244,2115,12.252,2359,76,715,180,2,1,.5,1
301,1999,294,15,75.155,9,0,0,0,0,0,0,0
301,1999,294,30,75.155,9,0,0,0,0,0,0,0
301,1999,294,45,75.156,9,0,0,0,0,0,0,0
301,1999,294,100,75.156,9,0,0,0,0,0,0,0
301,1999,294,115,75.157,9,0,0,0,0,0,0,0
301,1999,294,130,75.159,9,0,0,0,0,0,0,0
301,1999,294,145,75.159,9,0,0,0,0,0,0,0
301,1999,294,200,75.159,9,0,0,0,0,0,0,0
301,1999,294,215,75.158,9,0,0,0,0,0,0,0
301,1999,294,230,75.157,9,0,0,0,0,0,0,0
301,1999,294,245,75.156,9,0,0,0,0,0,0,0
301,1999,294,300,75.154,9,0,0,0,0,0,0,0
301,1999,294,315,75.154,9,0,0,0,0,0,0,0
301,1999,294,330,75.154,9,0,0,0,0,0,0,0
301,1999,294,345,75.153,8.9,0,0,0,0,0,0,0
301,1999,294,400,75.154,8.9,0,0,0,0,0,0,0
301,1999,294,415,75.154,8.9,0,0,0,0,0,0,0
301,1999,294,430,75.154,8.8,0,0,0,0,0,0,0
301,1999,294,445,75.154,8.8,0,0,0,0,0,0,0
301,1999,294,500,75.153,8.8,0,0,0,0,0,0,0
301,1999,294,515,75.153,8.7,0,0,0,0,0,0,0
301,1999,294,530,75.154,8.6,0,0,0,0,0,0,0
301,1999,294,545,75.154,8.6,0,0,0,0,0,0,0
301,1999,294,600,75.154,8.5,0,0,0,0,0,0,0
```

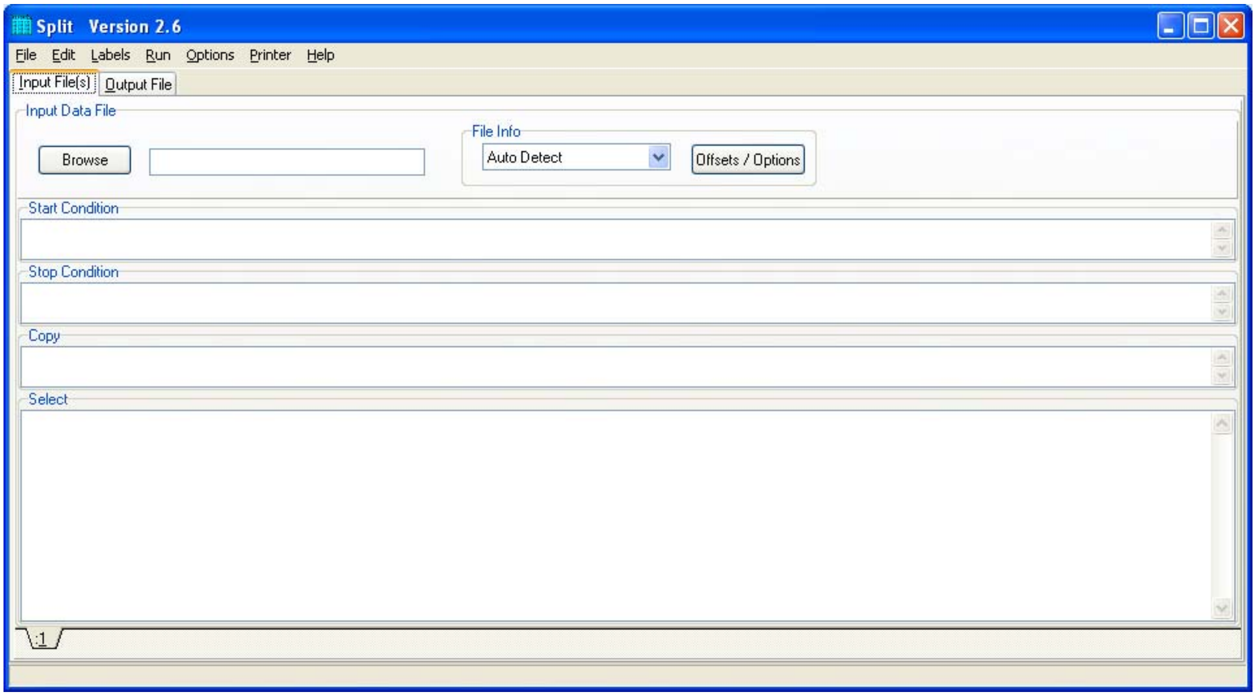
**Figure 11.2 – A sample *.dat file**



Microsoft Excel - 30200199.csv [Read-Only]

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | Site Name | 899 | | | | |
| 2 | Isco Quantity | Level | | | | |
| 3 | Label | Level | | | | |
| 4 | Units | ft | | | | |
| 5 | Resolution | 0.001 | | | | |
| 6 | Significant Digits | 5 | | | | |
| 7 | | | | | | |
| 8 | 4/13/2009 9:00 | 0.772 | | | | |
| 9 | 4/13/2009 9:15 | 0.719 | | | | |
| 10 | 4/13/2009 9:30 | 0.924 | | | | |
| 11 | 4/13/2009 9:45 | 0.763 | | | | |
| 12 | 4/13/2009 10:00 | 0.661 | | | | |
| 13 | 4/13/2009 10:15 | 0.559 | | | | |
| 14 | 4/13/2009 10:30 | 0.733 | | | | |
| 15 | 4/13/2009 10:45 | 0.625 | | | | |
| 16 | 4/13/2009 11:00 | 0.842 | | | | |
| 17 | 4/13/2009 11:15 | 0.874 | | | | |
| 18 | 4/13/2009 11:30 | 0.776 | | | | |
| 19 | 4/13/2009 11:45 | 0.674 | | | | |
| 20 | 4/13/2009 12:00 | 0.858 | | | | |
| 21 | 4/13/2009 12:15 | 0.763 | | | | |
| 22 | 4/13/2009 12:30 | 0.674 | | | | |
| 23 | 4/13/2009 12:45 | 0.579 | | | | |
| 24 | 4/13/2009 13:00 | 0.917 | | | | |
| 25 | 4/13/2009 13:15 | 0.819 | | | | |
| 26 | 4/13/2009 13:30 | 0.628 | | | | |
| 27 | 4/13/2009 13:45 | 0.7398 | | | | |
| 28 | 4/13/2009 14:00 | 0.7426 | | | | |
| 29 | 4/13/2009 14:15 | 0.7454 | | | | |
| 30 | 4/13/2009 14:30 | 0.7482 | | | | |
| 31 | 4/13/2009 14:45 | 0.751 | | | | |
| 32 | 4/13/2009 15:00 | 0.7538 | | | | |

**Figure 11.3- A sample *.csv file**


**OR**

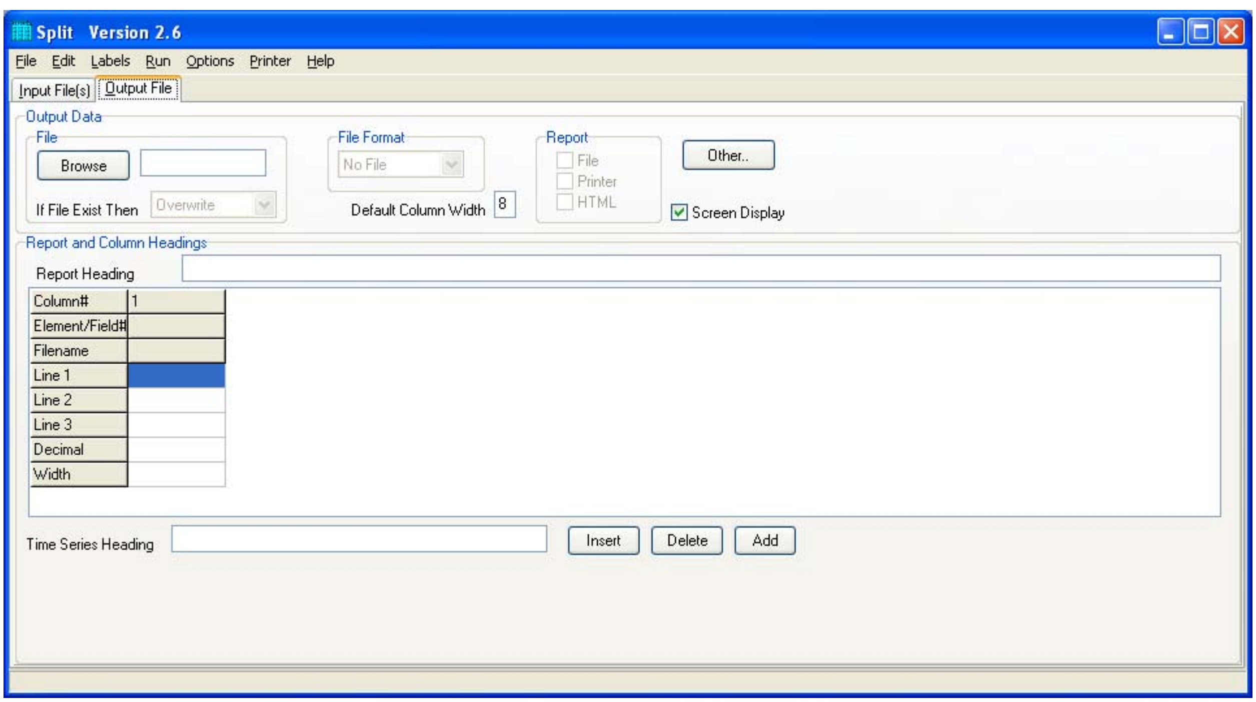



**Figure 11.4 – PC208's Split input and output file templates**

**Station (301)** **Court Creek**

| Date/Time (CST) | Year | Month | Day | Hr | Min | Stage | Temp (C) | Flag 1 | Flag 2 | Flag 3 | Flag 4 | Flag 5 | Flag 6 | Flag 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11/01/1999 06:00 | 1999 | 11 | 1 | 06 | 00 | 75.138 | 13.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 06:15 | 1999 | 11 | 1 | 06 | 15 | 75.138 | 13.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 06:30 | 1999 | 11 | 1 | 06 | 30 | 75.138 | 13.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 06:45 | 1999 | 11 | 1 | 06 | 45 | 75.138 | 13.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 07:00 | 1999 | 11 | 1 | 07 | 00 | 75.138 | 13.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 07:15 | 1999 | 11 | 1 | 07 | 15 | 75.138 | 13.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 07:30 | 1999 | 11 | 1 | 07 | 30 | 75.139 | 13.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 07:45 | 1999 | 11 | 1 | 07 | 45 | 75.14 | 13.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 08:00 | 1999 | 11 | 1 | 08 | 00 | 75.141 | 13.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 08:15 | 1999 | 11 | 1 | 08 | 15 | 75.143 | 13.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 08:30 | 1999 | 11 | 1 | 08 | 30 | 75.143 | 13.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 08:45 | 1999 | 11 | 1 | 08 | 45 | 75.142 | 13.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 09:00 | 1999 | 11 | 1 | 09 | 00 | 75.14 | 13.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 09:15 | 1999 | 11 | 1 | 09 | 15 | 75.14 | 13.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 09:30 | 1999 | 11 | 1 | 09 | 30 | 75.14 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 09:45 | 1999 | 11 | 1 | 09 | 45 | 75.139 | 12.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 10:00 | 1999 | 11 | 1 | 10 | 00 | 75.14 | 12.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 10:15 | 1999 | 11 | 1 | 10 | 15 | 75.139 | 12.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 10:30 | 1999 | 11 | 1 | 10 | 30 | 75.139 | 12.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 10:45 | 1999 | 11 | 1 | 10 | 45 | 75.139 | 12.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 11:00 | 1999 | 11 | 1 | 11 | 00 | 75.139 | 12.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 11:15 | 1999 | 11 | 1 | 11 | 15 | 75.139 | 12.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 11:30 | 1999 | 11 | 1 | 11 | 30 | 75.138 | 12.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 11:45 | 1999 | 11 | 1 | 11 | 45 | 75.139 | 12.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 12:00 | 1999 | 11 | 1 | 12 | 00 | 75.14 | 12.3 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| 11/01/1999 12:15 | 1999 | 11 | 1 | 12 | 15 | 75.141 | 12.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 12:30 | 1999 | 11 | 1 | 12 | 30 | 75.142 | 12.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 12:45 | 1999 | 11 | 1 | 12 | 45 | 75.142 | 12.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 13:00 | 1999 | 11 | 1 | 13 | 00 | 75.142 | 12.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 13:15 | 1999 | 11 | 1 | 13 | 15 | 75.141 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 13:30 | 1999 | 11 | 1 | 13 | 30 | 75.142 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 13:45 | 1999 | 11 | 1 | 13 | 45 | 75.141 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 14:00 | 1999 | 11 | 1 | 14 | 00 | 75.14 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 14:15 | 1999 | 11 | 1 | 14 | 15 | 75.14 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 14:30 | 1999 | 11 | 1 | 14 | 30 | 75.14 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 14:45 | 1999 | 11 | 1 | 14 | 45 | 75.139 | 12.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 15:00 | 1999 | 11 | 1 | 15 | 00 | 75.14 | 12.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 15:15 | 1999 | 11 | 1 | 15 | 15 | 75.139 | 12.3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 15:30 | 1999 | 11 | 1 | 15 | 30 | 75.139 | 12.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 15:45 | 1999 | 11 | 1 | 15 | 45 | 75.14 | 12.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 16:00 | 1999 | 11 | 1 | 16 | 00 | 75.14 | 12.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 16:15 | 1999 | 11 | 1 | 16 | 15 | 75.141 | 12.7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 16:30 | 1999 | 11 | 1 | 16 | 30 | 75.142 | 12.8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 16:45 | 1999 | 11 | 1 | 16 | 45 | 75.142 | 12.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11/01/1999 17:00 | 1999 | 11 | 1 | 17 | 00 | 75.142 | 12.9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Figure 11.5 – Stage data copied into the Stage 4-0 template**

**Haw Creek (303) Daily Outputs**

| Year | M | D | Hr_Min | battery | Int_Temp MAX | Int_Temp Hr_Min MAX | Int_Temp MIN | Int_Temp Hr_Min MIN | initial stage | daily time | timer | Above stage | Delta stage | Delta neg. | ONOFF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1999 | 9 | 1 | 0 | 12.583 | 34.392 | 1900 | 10.802 | 1214 | 82 | 720 | 180 | 2 | 1 | 0.5 | 0 |
| 1999 | 9 | 2 | 0 | 12.579 | 42.969 | 2133 | 37.801 | 2359 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 3 | 0 | 12.573 | 44.209 | 2031 | 14.33 | 1205 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 4 | 0 | 12.554 | 41.963 | 2001 | 18.74 | 1205 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 5 | 0 | 12.547 | 45.128 | 2020 | 17.288 | 1221 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 6 | 0 | 12.515 | 39.012 | 0 | 16.327 | 1139 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 7 | 0 | 12.508 | 38.44 | 2027 | 13.141 | 1223 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 8 | 0 | 12.495 | 37.788 | 2209 | 9.8414 | 1210 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 9 | 0 | 12.464 | 34.317 | 1940 | 16.349 | 737 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 10 | 0 | 12.433 | 29.548 | 0 | 8.3546 | 1221 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 11 | 0 | 12.613 | 32.155 | 2015 | 23.531 | 1620 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 12 | 0 | 12.605 | 39.154 | 2019 | 6.4647 | 1220 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 13 | 0 | 12.554 | 34.789 | 0 | 15.04 | 1015 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 14 | 0 | 12.545 | 23.381 | 2300 | 8.1443 | 1229 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 15 | 0 | 12.536 | 30.003 | 1925 | 4.2124 | 1214 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 16 | 0 | 12.519 | 31.912 | 1915 | 5.3575 | 1227 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 17 | 0 | 12.509 | 34.245 | 2007 | 3.9624 | 1206 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 18 | 0 | 12.489 | 34.393 | 2014 | 3.6526 | 1225 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 19 | 0 | 12.481 | 36.884 | 2005 | 5.3575 | 1228 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 20 | 0 | 12.434 | 30.136 | 0 | 9.456 | 908 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 21 | 0 | 12.41 | 22.998 | 0 | 10.522 | 1238 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 22 | 0 | 12.414 | 28.921 | 2000 | 3.7763 | 1229 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 23 | 0 | 12.405 | 29.938 | 2000 | 0.90154 | 1224 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 24 | 0 | 13.141 | 34.32 | 2015 | 28.95 | 1827 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 25 | 0 | 13.066 | 30.958 | 0 | 12.4 | 1236 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 26 | 0 | 13.03 | 37.788 | 2001 | 6.9645 | 1245 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 27 | 0 | 12.981 | 36.167 | 1950 | 14.439 | 954 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 28 | 0 | 12.901 | 27.848 | 0 | 14.747 | 2358 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 29 | 0 | 12.837 | 14.77 | 0 | 12.616 | 1658 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |
| 1999 | 9 | 30 | 0 | 12.964 | 23.661 | 2215 | 20.569 | 2359 | 82 | 720 | 180 | 2 | 1 | 0.5 | 1 |

**Figure 11.6 – Data copied into an annual file created with the Daily Outputs template**

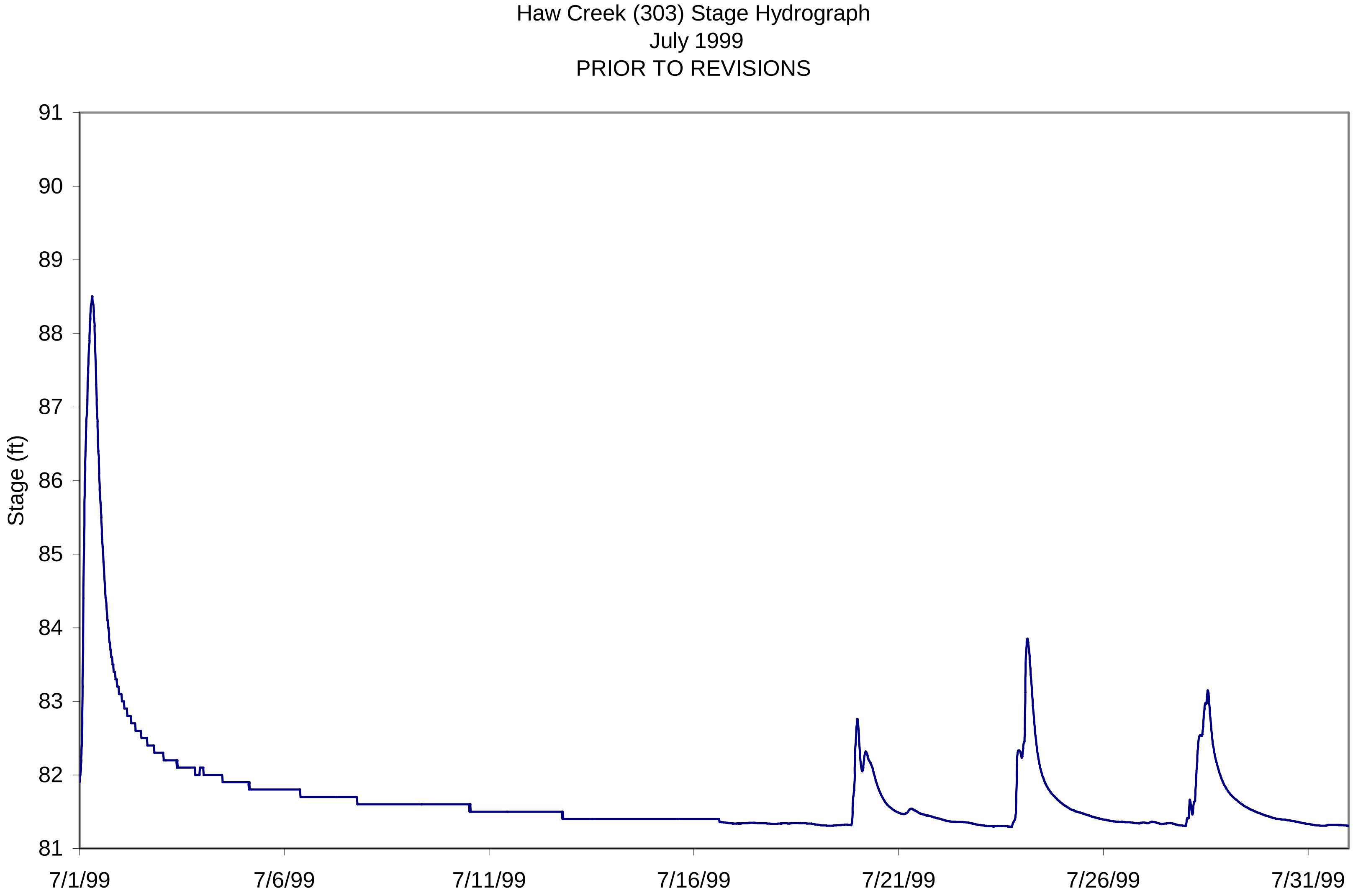



**Figure 11.6 – Hydrograph of stage data prior to any revisions**

**FRSG Stage Data Review and Verification**

**Station ________ for the Month of ____________________**

Files were appended into the monthly file: ______________________.xls

____ Missing data point estimations were reviewed.
____Stage data (prior to revisions) was plotted.

Comments:
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

File was saved in __________________ format as: _____________________

| **IDAPP Program** | (filename) | (date) | (rev. date) |
|---|---|---|---|
| _____ Stage - Daily Table format: | dt __________.idp | __________ | __________ |
| _____Stage – PH format: | ph __________.idp | __________ | __________ |

_____Attach Daily Table in EXCEL (using Dtable macro) dt______________.xls

_____ Paste PH file in EXCEL template (STNshMMYY.xlt) _____________.xls

_____ Idapp output files reviewed.

Revisions Needed? ____Yes ____ No

Comments:______________________________________________________________
________________________________________________________________________
________________________________________________________________________

Revisions Made __________(date) Revisions Reviewed? ___Yes ___No

All tables and plots attached? ____Yes ____ No

Rev. 4/22/2009 (BAR) **FINAL DATA** Date _________ Initials _________

Date _________ Initials _________

**Figure 11.7 – Stage Data Review and Verification Form**

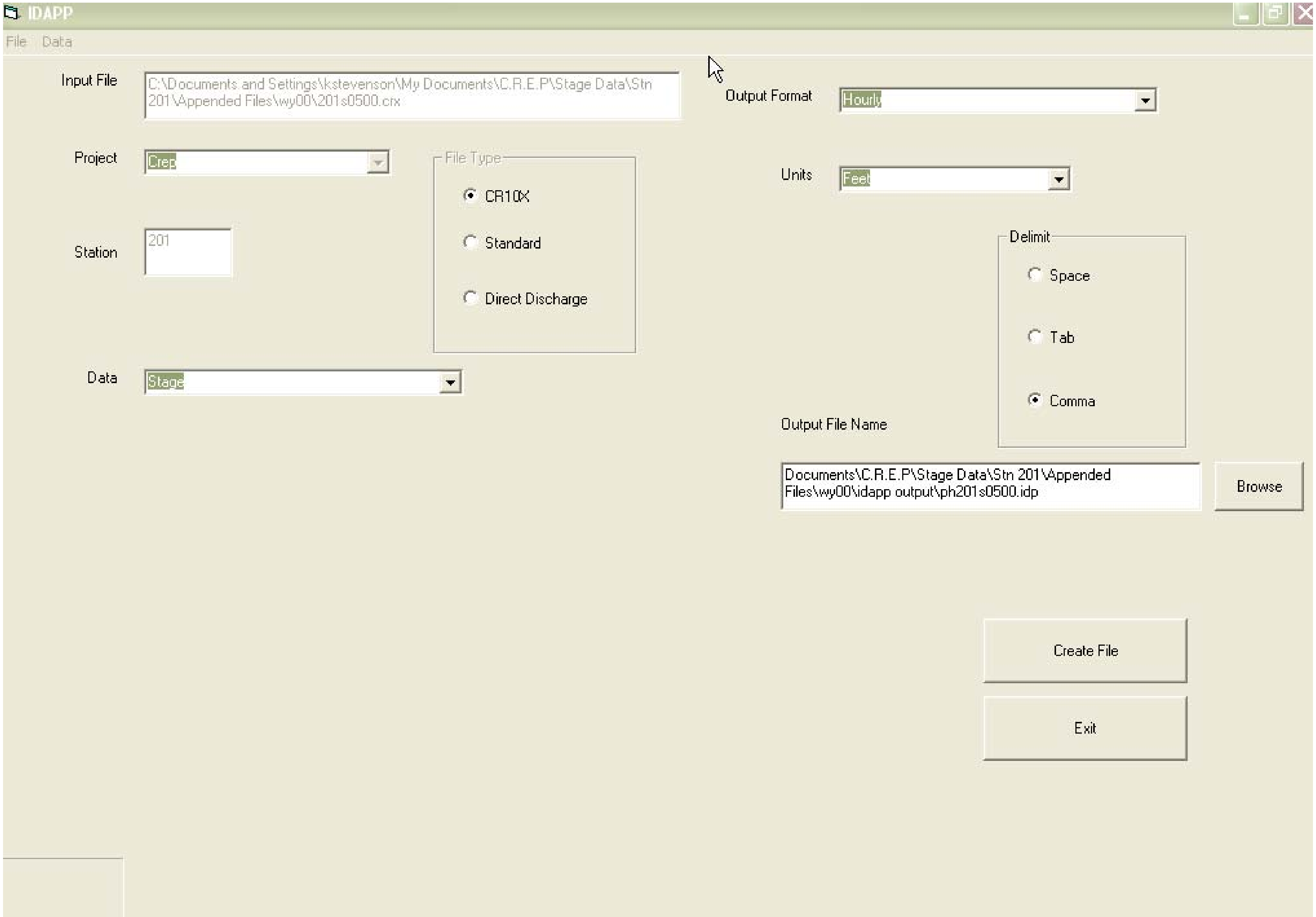



**Figure 11.8 – Data processing through IDAPP.**

STATION 201, STAGE (FT)

```
10/01/2000 00:00:00,   82.27
10/01/2000 01:00:00,   82.27
10/01/2000 02:00:00,   82.27
10/01/2000 03:00:00,   82.27
10/01/2000 04:00:00,   82.27
10/01/2000 05:00:00,   82.27
10/01/2000 06:00:00,   82.27
10/01/2000 07:00:00,   82.27
10/01/2000 08:00:00,   82.27
10/01/2000 09:00:00,   82.27
10/01/2000 10:00:00,   82.27
10/01/2000 11:00:00,   82.27
10/01/2000 12:00:00,   82.27
10/01/2000 13:00:00,   82.26
10/01/2000 14:00:00,   82.26
10/01/2000 15:00:00,   82.26
10/01/2000 16:00:00,   82.26
10/01/2000 17:00:00,   82.26
10/01/2000 18:00:00,   82.26
10/01/2000 19:00:00,   82.26
10/01/2000 20:00:00,   82.26
10/01/2000 21:00:00,   82.26
10/01/2000 22:00:00,   82.26
10/01/2000 23:00:00,   82.26
10/02/2000 00:00:00,   82.26
10/02/2000 01:00:00,   82.26
10/02/2000 02:00:00,   82.26
10/02/2000 03:00:00,   82.26
10/02/2000 04:00:00,   82.26
10/02/2000 05:00:00,   82.26
10/02/2000 06:00:00,   82.26
10/02/2000 07:00:00,   82.26
10/02/2000 08:00:00,   82.26
10/02/2000 09:00:00,   82.26
10/02/2000 10:00:00,   82.26
10/02/2000 11:00:00,   82.26
10/02/2000 12:00:00,   82.26
10/02/2000 13:00:00,   82.26
10/02/2000 14:00:00,   82.26
10/02/2000 15:00:00,   82.26
10/02/2000 16:00:00,   82.26
10/02/2000 17:00:00,   82.26
10/02/2000 18:00:00,   82.25
10/02/2000 19:00:00,   82.26
10/02/2000 20:00:00,   82.26
10/02/2000 21:00:00,   82.25
10/02/2000 22:00:00,   82.26
10/02/2000 23:00:00,   82.26
```

**Figure 11.9 – Sample of the PH output file format**

```
STATION 301,MEAN DAILY STAGE (FT)
10/1/99,75.18
10/2/99,75.16
10/3/99,75.23
10/4/99,75.39
10/5/99,75.23
10/6/99,75.20
10/7/99,75.18
10/8/99,75.17
10/9/99,75.17
10/10/99,75.17
10/11/99,75.16
10/12/99,75.15
10/13/99,75.15
10/14/99,75.14
10/15/99,75.15
10/16/99,75.17
10/17/99,75.20
10/18/99,75.16
10/19/99,75.16
10/20/99,75.16
10/21/99,75.16
10/22/99,75.16
10/23/99,75.15
10/24/99,75.14
10/25/99,75.14
10/26/99,75.15
10/27/99,75.15
10/28/99,75.17
10/29/99,75.16
10/30/99,75.17
10/31/99,75.11
```

**Figure 11.10 – Sample of the PD output file format**

Crep, GAGING STATION 202
ILLINOIS STATE WATER SURVEY
STAGE, IN FEET, AT INDICATED HOURS

Wed May 17 14:09:31 2000

| MM DD YY | TIME | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 09 01 99 | AM | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | 78.39 | 78.39 | 78.39 | 78.39 | 78.39 | 78.39 | 78.39 | |
| | PM | 78.39 | 78.39 | 78.39 | 78.39 | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | 78.39 | 78.38 | 78.38 | 78.39 |
| 09 02 99 | AM | 78.38 | 78.38 | 78.38 | 78.38 | 78.39 | 78.39 | 78.39 | 78.39 | 78.40 | 78.40 | 78.40 | 78.40 | |
| | PM | 78.39 | 78.39 | 78.39 | 78.39 | 78.38 | 78.38 | 78.38 | 78.38 | 78.37 | 78.37 | 78.37 | 78.37 | 78.38 |
| 09 03 99 | AM | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | |
| | PM | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | 78.37 | 78.38 | 78.37 | 78.37 | 78.37 | 78.36 | 78.36 | 78.37 |
| 09 04 99 | AM | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.37 | 78.37 | 78.37 | 78.37 | |
| | PM | 78.37 | 78.38 | 78.38 | 78.37 | 78.38 | 78.37 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.37 |
| 09 05 99 | AM | 78.35 | 78.36 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.36 | |
| | PM | 78.36 | 78.36 | 78.36 | 78.37 | 78.36 | 78.36 | 78.36 | 78.36 | 78.35 | 78.35 | 78.35 | 78.36 | 78.35 |
| 09 06 99 | AM | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.34 | 78.34 | |
| | PM | 78.34 | 78.34 | 78.35 | 78.35 | 78.35 | 78.34 | 78.35 | 78.35 | 78.35 | 78.34 | 78.34 | 78.34 | 78.35 |
| 09 07 99 | AM | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | |
| | PM | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.36 | 78.36 | 78.35 | 78.35 | 78.35 | 78.35 |
| 09 08 99 | AM | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.35 | 78.34 | |
| | PM | 78.34 | 78.34 | 78.34 | 78.34 | 78.33 | 78.33 | 78.34 | 78.34 | 78.34 | 78.34 | 78.33 | 78.33 | 78.34 |
| 09 09 99 | AM | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.32 | 78.32 | 78.32 | 78.33 | |
| | PM | 78.33 | 78.33 | 78.32 | 78.32 | 78.32 | 78.32 | 78.33 | 78.33 | 78.33 | 78.33 | 78.32 | 78.32 | 78.33 |
| 09 10 99 | AM | 78.32 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | |
| | PM | 78.31 | 78.31 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.33 | 78.33 | 78.32 |
| 09 11 99 | AM | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.31 | 78.32 | |
| | PM | 78.32 | 78.32 | 78.32 | 78.32 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.32 |
| 09 12 99 | AM | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | |
| | PM | 78.32 | 78.33 | 78.36 | 78.38 | 78.39 | 78.39 | 78.39 | 78.39 | 78.38 | 78.38 | 78.37 | 78.37 | 78.34 |
| 09 13 99 | AM | 78.36 | 78.36 | 78.37 | 78.37 | 78.37 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | |
| | PM | 78.35 | 78.35 | 78.35 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.33 | 78.33 | 78.33 | 78.33 | 78.35 |
| 09 14 99 | AM | 78.33 | 78.32 | 78.32 | 78.32 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | |
| | PM | 78.33 | 78.33 | 78.33 | 78.33 | 78.32 | 78.32 | 78.32 | 78.33 | 78.32 | 78.33 | 78.33 | 78.32 | 78.33 |
| 09 15 99 | AM | 78.32 | 78.32 | 78.32 | 78.32 | 78.33 | 78.33 | 78.33 | 78.33 | 78.32 | 78.32 | 78.32 | 78.32 | |
| | PM | 78.32 | 78.32 | 78.32 | 78.32 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.32 |
| 09 16 99 | AM | 78.31 | 78.30 | 78.30 | 78.30 | 78.30 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | |
| | PM | 78.30 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.30 | 78.31 |
| 09 17 99 | AM | 78.30 | 78.30 | 78.31 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.31 | |
| | PM | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 |
| 09 18 99 | AM | 78.31 | 78.31 | 78.30 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | |
| | PM | 78.31 | 78.31 | 78.31 | 78.32 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 |
| 09 19 99 | AM | 78.31 | 78.30 | 78.30 | 78.30 | 78.30 | 78.31 | 78.31 | 78.31 | 78.32 | 78.32 | 78.33 | 78.35 | |
| | PM | 78.36 | 78.37 | 78.37 | 78.38 | 78.38 | 78.38 | 78.38 | 78.39 | 78.38 | 78.38 | 78.38 | 78.38 | 78.35 |
| 09 20 99 | AM | 78.38 | 78.38 | 78.38 | 78.37 | 78.37 | 78.37 | 78.36 | 78.36 | 78.36 | 78.35 | 78.35 | 78.35 | |
| | PM | 78.36 | 78.36 | 78.37 | 78.36 | 78.37 | 78.36 | 78.36 | 78.36 | 78.36 | 78.35 | 78.35 | 78.35 | 78.36 |
| 09 21 99 | AM | 78.35 | 78.35 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.35 | |
| | PM | 78.35 | 78.35 | 78.35 | 78.35 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.33 | 78.33 | 78.34 |
| 09 22 99 | AM | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | |
| | PM | 78.33 | 78.33 | 78.33 | 78.33 | 78.32 | 78.32 | 78.33 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.33 |
| 09 23 99 | AM | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.33 | 78.33 | |
| | PM | 78.33 | 78.33 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.31 | 78.32 |
| 09 24 99 | AM | 78.31 | 78.31 | 78.31 | 78.31 | 78.32 | 78.32 | 78.32 | 78.31 | 78.31 | 78.31 | 78.31 | 78.32 | |
| | PM | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.32 | 78.31 | 78.32 | 78.32 | 78.31 | 78.32 |
| 09 25 99 | AM | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | |
| | PM | 78.31 | 78.31 | 78.30 | 78.30 | 78.30 | 78.30 | 78.31 | 78.31 | 78.31 | 78.31 | 78.30 | 78.30 | 78.31 |
| 09 26 99 | AM | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.29 | 78.29 | 78.29 | |
| | PM | 78.30 | 78.30 | 78.29 | 78.30 | 78.29 | 78.29 | 78.29 | 78.29 | 78.29 | 78.29 | 78.29 | 78.30 | 78.29 |
| 09 27 99 | AM | 78.30 | 78.30 | 78.30 | 78.31 | 78.31 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.30 | 78.29 | |
| | PM | 78.29 | 78.29 | 78.29 | 78.29 | 78.29 | 78.29 | 78.29 | 78.29 | 78.29 | 78.29 | 78.30 | 78.30 | 78.30 |
| 09 28 99 | AM | 78.30 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.31 | 78.32 | |
| | PM | 78.34 | 78.38 | 78.41 | 78.42 | 78.43 | 78.44 | 78.44 | 78.43 | 78.42 | 78.42 | 78.43 | 78.43 | 78.36 |
| 09 29 99 | AM | 78.43 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.43 | 78.42 | 78.41 | 78.41 | 78.40 | 78.40 | |
| | PM | 78.40 | 78.42 | 78.44 | 78.43 | 78.43 | 78.43 | 78.42 | 78.42 | 78.41 | 78.41 | 78.42 | 78.41 | 78.42 |
| 09 30 99 | AM | 78.41 | 78.41 | 78.40 | 78.40 | 78.40 | 78.40 | 78.39 | 78.39 | 78.39 | 78.39 | 78.39 | 78.39 | |
| | PM | 78.39 | 78.38 | 78.38 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.36 | 78.38 |

**Figure 11.11 – Sample of the Daily Table output file format**

Crep, GAGING STATION 202
ILLINOIS STATE WATER SURVEY
STAGE, IN FEET, AT INDICATED DATES
Mon Oct 23 11:12:08 2000

| DAY | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | DAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 78.35 | 78.40 | 78.37 | 78.44 | 78.40 | 78.51 | 78.48 | 78.45 | 78.45 | 78.94 | 78.41 | 78.51 | 1 |
| 2 | 78.34 | 78.39 | 78.38 | 78.45 | 78.40 | 78.51 | 78.50 | 78.46 | 78.41 | 78.89 | 78.45 | 78.52 | 2 |
| 3 | 78.42 | 78.39 | 78.40 | 78.46 | 78.41 | 78.49 | 78.49 | 78.44 | 78.39 | 78.85 | 78.45 | 78.53 | 3 |
| 4 | 78.46 | 78.40 | 78.48 | 78.44 | 78.41 | 78.49 | 78.48 | 78.43 | 78.39 | 78.96 | 78.37 | 78.51 | 4 |
| 5 | 78.39 | 78.40 | 78.70 | 78.43 | 78.42 | 78.49 | 78.48 | 78.42 | 78.39 | 80.27 | 78.61 | 78.48 | 5 |
| 6 | 78.36 | 78.40 | 78.49 | 78.41 | 78.42 | 78.49 | 78.47 | 78.43 | 78.39 | 79.59 | 78.48 | 78.45 | 6 |
| 7 | 78.35 | 78.41 | 78.44 | 78.39 | 78.43 | 78.51 | 78.50 | 78.47 | 78.41 | 79.30 | 78.41 | 78.43 | 7 |
| 8 | 78.38 | 78.40 | 78.42 | 78.40 | 78.45 | 78.53 | 78.49 | 78.44 | 78.34 | 79.15 | 78.47 | 78.40 | 8 |
| 9 | 78.40 | 78.41 | 78.44 | 78.41 | 78.51 | 78.52 | 78.49 | 78.47 | 78.33 | 79.05 | 78.50 | 78.35 | 9 |
| 10 | 78.38 | 78.39 | 78.45 | 78.41 | 78.58 | 78.52 | 78.48 | 78.42 | 78.34 | 78.96 | 78.42 | 78.31 | 10 |
| 11 | 78.37 | 78.38 | 78.42 | 78.42 | 78.57 | 78.52 | 78.49 | 78.42 | 79.01 | 79.72 | 78.44 | 78.30 | 11 |
| 12 | 78.36 | 78.38 | 78.42 | 78.43 | 78.53 | 78.53 | 78.47 | 78.42 | 78.78 | 79.33 | 78.42 | 78.53 | 12 |
| 13 | 78.36 | 78.39 | 78.42 | 78.42 | 78.50 | 78.54 | 78.45 | 78.46 | 78.87 | 79.19 | 78.46 | 78.41 | 13 |
| 14 | 78.35 | 78.39 | 78.41 | 78.41 | 78.47 | 78.54 | 78.45 | 78.40 | 78.75 | 79.10 | 78.44 | 78.47 | 14 |
| 15 | 78.36 | 78.38 | 78.44 | 78.41 | 78.45 | 78.55 | 78.45 | 78.37 | 78.68 | 79.01 | 78.46 | 78.47 | 15 |
| 16 | 78.38 | 78.37 | 78.42 | 78.42 | 78.45 | 78.57 | 78.47 | 78.36 | 78.59 | 78.93 | 78.45 | 78.41 | 16 |
| 17 | 78.39 | 78.37 | 78.42 | 78.42 | 78.44 | 78.56 | 78.53 | 78.37 | 78.55 | 78.87 | 78.43 | 78.37 | 17 |
| 18 | 78.40 | 78.38 | 78.41 | 78.43 | 78.45 | 78.56 | 78.47 | 78.35 | 78.53 | 78.82 | 78.51 | 78.33 | 18 |
| 19 | 78.39 | 78.38 | 78.41 | 78.40 | 78.47 | 78.64 | 78.50 | 78.34 | 78.51 | 78.79 | 78.45 | 78.28 | 19 |
| 20 | 78.39 | 78.38 | 78.41 | 78.37 | 78.48 | 78.65 | 78.55 | 78.36 | 79.62 | 78.74 | 78.44 | 78.31 | 20 |
| 21 | 78.39 | 78.38 | 78.39 | 78.34 | 78.50 | 78.59 | 78.52 | 78.36 | 79.98 | 78.70 | 78.43 | 78.46 | 21 |
| 22 | 78.38 | 78.39 | 78.37 | 78.33 | 78.51 | 78.55 | 78.46 | 78.37 | 79.30 | 78.65 | 78.46 | 78.42 | 22 |
| 23 | 78.38 | 78.40 | 78.38 | 78.34 | 78.49 | 78.54 | 78.49 | 78.44 | 79.24 | 78.61 | 78.53 | 78.38 | 23 |
| 24 | 78.39 | 78.39 | 78.39 | 78.34 | 78.49 | 78.53 | 78.53 | 78.39 | 79.86 | 78.57 | 78.54 | 78.52 | 24 |
| 25 | 78.39 | 78.38 | 78.40 | 78.35 | 78.50 | 78.52 | 78.49 | 78.34 | 79.46 | 78.54 | 78.49 | 78.62 | 25 |
| 26 | 78.39 | 78.38 | 78.41 | 78.33 | 78.50 | 78.52 | 78.46 | 78.46 | 79.55 | 78.51 | 78.44 | 78.54 | 26 |
| 27 | 78.40 | 78.38 | 78.42 | 78.31 | 78.50 | 78.53 | 78.47 | 79.56 | 79.30 | 78.48 | 78.47 | 78.49 | 27 |
| 28 | 78.41 | 78.38 | 78.42 | 78.30 | 78.50 | 78.52 | 78.48 | 78.64 | 79.17 | 78.45 | 78.51 | 78.48 | 28 |
| 29 | 78.40 | 78.37 | 78.43 | 78.32 | 78.50 | 78.50 | 78.47 | 78.55 | 79.09 | 78.45 | 78.50 | 78.44 | 29 |
| 30 | 78.40 | 78.37 | 78.43 | 78.36 | -- | 78.49 | 78.45 | 78.52 | 79.00 | 78.44 | 78.50 | 78.42 | 30 |
| 31 | 78.40 | -- | 78.44 | 78.39 | -- | 78.48 | -- | 78.48 | -- | 78.42 | 78.52 | -- | 31 |
| MAX | 78.46 | 78.41 | 78.70 | 78.46 | 78.58 | 78.65 | 78.55 | 79.56 | 79.98 | 80.27 | 78.61 | 78.62 | MAX |
| MIN | 78.34 | 78.37 | 78.37 | 78.30 | 78.40 | 78.48 | 78.45 | 78.34 | 78.33 | 78.42 | 78.37 | 78.28 | MIN |
| AVG | 78.38 | 78.39 | 78.43 | 78.39 | 78.47 | 78.53 | 78.48 | 78.46 | 78.86 | 78.91 | 78.47 | 78.44 | AVG |

**Figure 11.12 – Sample of the Monthly Table output file format**

TABLE ? - HOURLY STAGE FOR COX CREEK (202), MAY 2000
STAGE, IN FEET, AT INDICATED HOUR

| DATE | TIME | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | MEAN DAILY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 05 01 00 | AM | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.45 | 78.45 | 78.45 | 78.45 | 78.46 | |
| | PM | 78.46 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.46 | 78.46 | 78.46 | 78.45 |
| 05 02 00 | AM | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | |
| | PM | 78.47 | 78.46 | 78.46 | 78.46 | 78.46 | 78.46 | 78.45 | 78.45 | 78.44 | 78.44 | 78.44 | 78.44 | 78.46 |
| 05 03 00 | AM | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.45 | 78.45 | 78.45 | 78.45 | 78.45 | 78.44 | |
| | PM | 78.45 | 78.45 | 78.45 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.43 | 78.44 | 78.44 | 78.44 |
| 05 04 00 | AM | 78.44 | 78.44 | 78.43 | 78.43 | 78.43 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | |
| | PM | 78.44 | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.42 | 78.42 | 78.42 | 78.43 |
| 05 05 00 | AM | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.43 | |
| | PM | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 |
| 05 06 00 | AM | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | |
| | PM | 78.42 | 78.42 | 78.42 | 78.41 | 78.41 | 78.41 | 78.41 | 78.41 | 78.42 | 78.58 | 78.55 | 78.54 | 78.43 |
| 05 07 00 | AM | 78.52 | 78.51 | 78.49 | 78.49 | 78.51 | 78.52 | 78.52 | 78.51 | 78.49 | 78.48 | 78.47 | 78.46 | |
| | PM | 78.46 | 78.45 | 78.45 | 78.44 | 78.44 | 78.43 | 78.43 | 78.44 | 78.43 | 78.43 | 78.43 | 78.43 | 78.47 |
| 05 08 00 | AM | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | |
| | PM | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.43 | 78.44 |
| 05 09 00 | AM | 78.43 | 78.44 | 78.44 | 78.45 | 78.46 | 78.46 | 78.46 | 78.46 | 78.46 | 78.45 | 78.46 | 78.46 | |
| | PM | 78.47 | 78.48 | 78.50 | 78.51 | 78.51 | 78.50 | 78.49 | 78.49 | 78.47 | 78.47 | 78.46 | 78.45 | 78.47 |
| 05 10 00 | AM | 78.45 | 78.44 | 78.44 | 78.44 | 78.43 | 78.43 | 78.43 | 78.43 | 78.42 | 78.42 | 78.42 | 78.42 | |
| | PM | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.41 | 78.41 | 78.41 | 78.41 | 78.41 | 78.41 | 78.41 | 78.42 |
| 05 11 00 | AM | 78.41 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.43 | 78.43 | 78.43 | |
| | PM | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 | 78.42 |
| 05 12 00 | AM | 78.42 | 78.41 | 78.41 | 78.41 | 78.41 | 78.41 | 78.41 | 78.42 | 78.41 | 78.41 | 78.41 | 78.40 | |
| | PM | 78.40 | 78.40 | 78.40 | 78.43 | 78.43 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.44 | 78.42 |
| 05 13 00 | AM | 78.45 | 78.45 | 78.45 | 78.45 | 78.45 | 78.44 | 78.43 | 78.42 | 78.45 | 78.51 | 78.52 | 78.51 | |
| | PM | 78.51 | 78.50 | 78.48 | 78.48 | 78.47 | 78.46 | 78.46 | 78.45 | 78.45 | 78.45 | 78.44 | 78.44 | 78.46 |
| 05 14 00 | AM | 78.43 | 78.43 | 78.42 | 78.43 | 78.43 | 78.43 | 78.43 | 78.43 | 78.42 | 78.42 | 78.42 | 78.41 | |
| | PM | 78.41 | 78.40 | 78.40 | 78.39 | 78.39 | 78.38 | 78.38 | 78.37 | 78.37 | 78.37 | 78.36 | 78.36 | 78.40 |
| 05 15 00 | AM | 78.36 | 78.36 | 78.35 | 78.35 | 78.35 | 78.36 | 78.36 | 78.36 | 78.37 | 78.37 | 78.37 | 78.38 | |
| | PM | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 |
| 05 16 00 | AM | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.36 | 78.37 | 78.37 | 78.36 | 78.36 | 78.37 | |
| | PM | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 |
| 05 17 00 | AM | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.37 | 78.37 | |
| | PM | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 |
| 05 18 00 | AM | 78.37 | 78.37 | 78.37 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | |
| | PM | 78.35 | 78.35 | 78.34 | 78.35 | 78.35 | 78.35 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.35 |
| 05 19 00 | AM | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | |
| | PM | 78.33 | 78.34 | 78.33 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.35 | 78.36 | 78.36 | 78.34 |
| 05 20 00 | AM | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | |
| | PM | 78.36 | 78.36 | 78.37 | 78.37 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 |
| 05 21 00 | AM | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | 78.36 | |
| | PM | 78.36 | 78.36 | 78.36 | 78.36 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.38 | 78.38 | 78.36 |
| 05 22 00 | AM | 78.38 | 78.38 | 78.38 | 78.37 | 78.36 | 78.36 | 78.36 | 78.36 | 78.37 | 78.37 | 78.37 | 78.37 | |
| | PM | 78.37 | 78.37 | 78.38 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 | 78.37 |
| 05 23 00 | AM | 78.40 | 78.47 | 78.48 | 78.50 | 78.49 | 78.48 | 78.47 | 78.46 | 78.46 | 78.46 | 78.46 | 78.46 | |
| | PM | 78.45 | 78.45 | 78.44 | 78.43 | 78.42 | 78.41 | 78.41 | 78.40 | 78.39 | 78.39 | 78.38 | 78.38 | 78.44 |
| 05 24 00 | AM | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | 78.39 | 78.39 | 78.40 | 78.40 | 78.40 | 78.40 | |
| | PM | 78.40 | 78.39 | 78.39 | 78.39 | 78.39 | 78.39 | 78.38 | 78.38 | 78.38 | 78.38 | 78.38 | 78.37 | 78.39 |
| 05 25 00 | AM | 78.36 | 78.36 | 78.37 | 78.37 | 78.36 | 78.35 | 78.35 | 78.35 | 78.35 | 78.34 | 78.34 | 78.34 | |
| | PM | 78.34 | 78.34 | 78.34 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.33 | 78.32 | 78.34 |
| 05 26 00 | AM | 78.32 | 78.33 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.34 | 78.35 | 78.36 | 78.38 | |
| | PM | 78.39 | 78.41 | 78.42 | 78.42 | 78.43 | 78.54 | 78.69 | 78.69 | 78.69 | 78.66 | 78.67 | 78.85 | 78.46 |
| 05 27 00 | AM | 80.90 | 81.54 | 81.63 | 81.41 | 80.90 | 80.34 | 79.91 | 79.61 | 79.41 | 79.27 | 79.18 | 79.10 | |
| | PM | 79.04 | 78.99 | 78.95 | 78.91 | 78.88 | 78.86 | 78.83 | 78.82 | 78.80 | 78.78 | 78.76 | 78.73 | 79.56 |
| 05 28 00 | AM | 78.71 | 78.71 | 78.70 | 78.69 | 78.69 | 78.68 | 78.67 | 78.66 | 78.65 | 78.64 | 78.63 | 78.62 | |
| | PM | 78.62 | 78.63 | 78.63 | 78.62 | 78.62 | 78.61 | 78.61 | 78.60 | 78.60 | 78.59 | 78.59 | 78.59 | 78.64 |
| 05 29 00 | AM | 78.58 | 78.58 | 78.57 | 78.57 | 78.57 | 78.57 | 78.56 | 78.56 | 78.56 | 78.56 | 78.55 | 78.55 | |
| | PM | 78.55 | 78.55 | 78.55 | 78.54 | 78.54 | 78.54 | 78.54 | 78.54 | 78.54 | 78.53 | 78.53 | 78.53 | 78.55 |
| 05 30 00 | AM | 78.53 | 78.53 | 78.53 | 78.53 | 78.52 | 78.52 | 78.52 | 78.52 | 78.52 | 78.52 | 78.52 | 78.52 | |
| | PM | 78.51 | 78.51 | 78.51 | 78.51 | 78.51 | 78.51 | 78.51 | 78.51 | 78.51 | 78.51 | 78.50 | 78.50 | 78.52 |
| 05 31 00 | AM | 78.50 | 78.50 | 78.50 | 78.50 | 78.50 | 78.49 | 78.49 | 78.49 | 78.49 | 78.48 | 78.49 | 78.49 | |
| | PM | 78.48 | 78.48 | 78.48 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.47 | 78.46 | 78.48 |

**Figure 11.13 – A daily table file in Excel (dt202s0500.xls)**

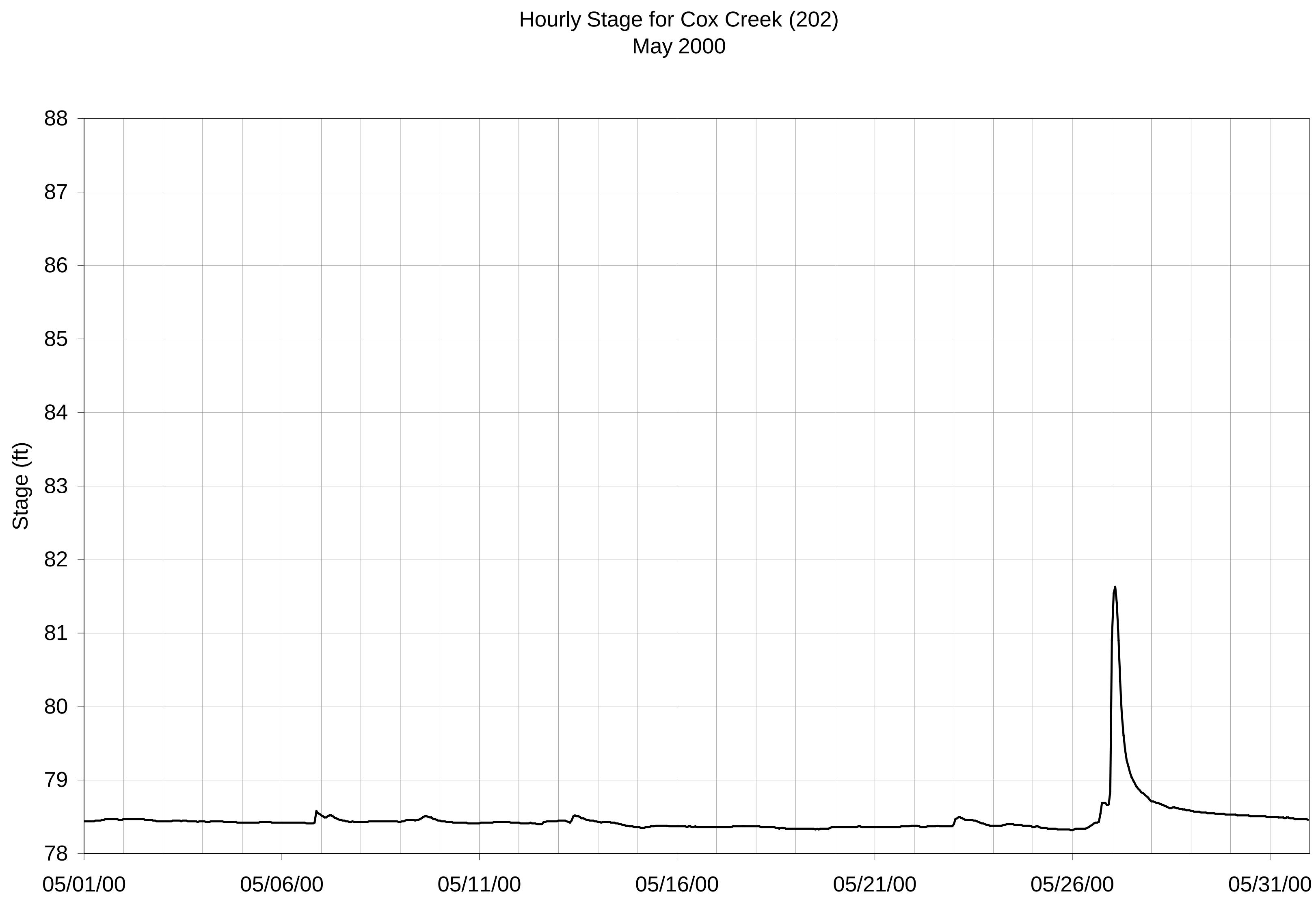



**Figure 11.14 – A plot of hourly stage data in Excel (202sh0500.xls)**

## APPENDIX B

## LOGS and FORMS

| Form | Revision Date |
|---|---|
| Site Log | 08/14/09 |
| ISCO Sampling Site Log | 04/16/09 |
| Rain Gage Site Log | 08/11/09 |
| PDC Lab Chain of Custody | 06/19/09 |
| ISWS-Sediment Lab Chain of Custody | Under Revision |
| Stage Data Retrieval Log | 08/14/09 |
| Stage Data Review and Verification Form | 08/11/09 |

SITE LOG

WATERSHED: ______________________________ DATE_____/_____/_____ YRDAY ______

Site ID: _______ Site Name: ____________________ CST Time In ________ Time Out _______

Personnel: ___________________________ Weather: ___________________________________________

Appearance of water: ______________________________ Debris: ________________________________

**Site Information**

☐ OTT bubbler/CR10x/ISCO ☐ OTT bubbler/CR10x ☐ ISCO bubbler/ISCO ☐ WQ only

☐ **Stage Information**

RP___ Elev. __________ft - Tape Down __________ ft = STAGE __________ft @ ______ (time)

Logger Reading: __________ft STAGE - Logger =__________ (should be zero)

ISCO/CR10X DATE or YRDAY ____________ Time (CST): ______________

Actual: DATE or YRDAY ____________ Time (CST): ______________

Storage Module #: ______________ Battery # _______ Voltage __________

NEW Storage Module #: ______________ NEW Battery # _______ Voltage __________

Comments/Remarks/Adjustments made: Retrieved data filename: ________________________

_____________________________________________________________________________

_____________________________________________________________________________

_____________________________________________________________________________

☐ **Discharge Measurement** No. ______________ Mean GH ______________ Calculated Q _____________

☐ **Sample Information**

Thermometer Water Temp: __________

| Sample No. | Time (CST) | Station (s) | Sampler Used | Remarks |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

☐ **ISCO Site Log Completed?** ______**Yes** ______**No** (See ISCO site log for individual sample information)

Display Message

Base # __________ Out __________ Samples Collected

Base# __________ In __________ Samples Missed

Comments ___________________________________________________________________________

___________________________________________________________________________

*Initial* _____ Marked bottles with site-ID, date, time.

_____ Logged samples on to chain of custody record.

Rev. 8/14/2009 (BR)

# FRSG ISCO SAMPLING SITE LOG

Date: _______________ Site ID: ____________ Site Name: _____________________________

Tray # Out: ______ ISCO #: ____________ Watershed:_____________________________

| Date Collected | Time collected | Bottle # | Comment | Sample ID |
|---|---|---|---|---|
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Tray # _________ In Check: Bottle 1 After 1 Pulse Time: ___________

Comments:________________________________________
________________________________________
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________________________________________
________________________________________
________________________________________
________________________________________
________________________________________
________________________________________
________________________________________

Bubbler: ISCO or OTT (circle one)

*4 or 6712 Values Updated

Base Stage 00:_________

Daily Sample Time 01:_________

Timer 02:_________

Above Base Stage 03:_________

Change In Hour 04:_________

Drop in 15 Min 05:_________

Station ID 06:_________

Sample On/off 07:_________

6712 Stage Enable _________

Values Changed By:_______(initials)

Values Changed On:_______(date)

Underline Indicates fields associated
CR10X *4 table & 6712 programming.

Rev. 4/16/2009

# Rain Gage Site Log

WATERSHED: ____________________________ DATE_____/______/_____ Time In ________ Time Out ________
Personnel: ___________________________ Weather: ____________________________________________________

**Rain Gage Information** Gage ID: _________ Battery ID:______________ Solar Panel Info:_____________________

**File Renamed to:** RG_____Precip______________________ & RG_____DailyStatus______________________

Repairs/Adjustments/Comments: ________________________________________________________________

**Wedge Rain Gage Total** = _________ Raining during download: _____ Yes _____ No

WATERSHED: ____________________________ DATE_____/______/_____ Time In ________ Time Out ________
Personnel: ___________________________ Weather: ____________________________________________________

**Rain Gage Information** Gage ID: _________ Battery ID:______________ Solar Panel Info:_____________________

**File Renamed to:** RG_____Precip______________________ & RG_____DailyStatus______________________

Repairs/Adjustments/Comments: ________________________________________________________________

**Wedge Rain Gage Total** = _________ Raining during download: _____ Yes _____ No

WATERSHED: ____________________________ DATE_____/______/_____ Time In ________ Time Out ________
Personnel: ___________________________ Weather: ____________________________________________________

**Rain Gage Information** Gage ID: _________ Battery ID:______________ Solar Panel Info:_____________________

**File Renamed to:** RG_____Precip______________________ & RG_____DailyStatus______________________

Repairs/Adjustments/Comments: ________________________________________________________________

**Wedge Rain Gage Total** = _________ Raining during download: _____ Yes _____ No

WATERSHED: ____________________________ DATE_____/______/_____ Time In ________ Time Out ________
Personnel: ___________________________ Weather: ____________________________________________________

**Rain Gage Information** Gage ID: _________ Battery ID:______________ Solar Panel Info:_____________________

**File Renamed to:** RG_____Precip______________________ & RG_____DailyStatus______________________

Repairs/Adjustments/Comments: ________________________________________________________________

**Wedge Rain Gage Total** = _________ Raining during download: _____ Yes _____ No

WATERSHED: ____________________________ DATE_____/______/_____ Time In ________ Time Out ________
Personnel: ___________________________ Weather: ____________________________________________________

**Rain Gage Information** Gage ID: _________ Battery ID:______________ Solar Panel Info:_____________________

**File Renamed to:** RG_____Precip______________________ & RG_____DailyStatus______________________

Repairs/Adjustments/Comments: ________________________________________________________________

**Wedge Rain Gage Total** = _________ Raining during download: _____ Yes _____ No

<u>Pluvio/CR200 Connection Info</u>
Data RS485-A/SDI12 → C1/SDI-12; Datagnd → G; +12…34vde → SWBattery; Gnd → G

Rev. 8/11/09 (BAR)

PDC LABORATORIES, INC.
2231 WEST ALTORFER DRIVE PHONE # 309-692-9688
PEORIA, IL 61615 FAX # 309-692-9689

# CHAIN OF CUSTODY RECORD

State where samples collected IL

*ALL HIGHLIGHTED AREAS MUST BE COMPLETED BY CLIENT (PLEASE PRINT)*

**1**

| CLIENT | PROJECT NUMBER | P.O. NUMBER | MEANS SHIPPED |
|---|---|---|---|
| ISWS | FOX RIVER | | |
| ADDRESS: 2204 GRIFFITH DRIVE | PHONE NUMBER: 217-244-3820 | FAX NUMBER: | DATE SHIPPED: |
| CITY STATE ZIP: CHAMPAIGN, IL | SAMPLER (PLEASE PRINT): | | MATRIX TYPES: SW-SURFACE WATER, WW- WASTEWATER, DW- DRINKING WATER, GW- GROUND WATER, WWSL- SLUDGE, NAS- SOLID, LCHT-LEACHATE, OTHER: |
| CONTACT PERSON: JIM SLOWIKOWSKI | SAMPLER'S SIGNATURE: | | |

**3** ANALYSIS REQUESTED: NH3, TKN, Total P; BOD, Cl, NO2, NO3, SS, Ortho P; Fecal Coliform

**4** (FOR LAB USE ONLY)
LOGIN # ____
LOGGED BY: ____
LAB PROJ. #
TEMPLATE: ISWS_FOX
PROJ. MGR.: EAK

**2**

| ISWS SAMPLE ID | ISWS SITE ID | DATE COLLECTED | TIME COLLECTED (CST) | SAMPLE COMPOSITE OR DISCRETE | SAMPLING EQUIPMENT | MATRIX TYPE | BOTTLE COUNT | NH3, TKN, Total P | BOD, Cl, NO2, NO3, SS, Ortho P | Fecal Coliform | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | |
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**5**
TURNAROUND TIME REQUESTED (PLEASE CIRCLE) NORMAL RUSH
(RUSH TAT IS SUBJECT TO PDC LABS APPROVAL AND SURCHARGE)
DATE RESULTS NEEDED
RUSH RESULTS VIA (PLEASE CIRCLE) FAX PHONE
FAX # IF DIFFERENT FROM ABOVE: PHONE # IF DIFFERENT FROM ABOVE:

**6**
*The sample temperature will be measured upon receipt at the lab. By initialing this area you request that the lab notify you, before proceeding with analysis, if the sample temperature is outside of the range of 0.1-6.0°C. By not initialing this area you allow the lab to proceed with analytical testing regardless of the sample temperature.* ______

**7**

| RELINQUISHED BY: (SIGNATURE) | DATE / TIME | RECEIVED BY: (SIGNATURE) | DATE / TIME |
|---|---|---|---|
| | DATE | | DATE |
| | TIME | | TIME |
| RELINQUISHED BY: (SIGNATURE) | DATE | RECEIVED BY: (SIGNATURE) | DATE |
| | TIME | | TIME |
| RELINQUISHED BY: (SIGNATURE) | DATE | RECEIVED BY: (SIGNATURE) | DATE |
| | TIME | | TIME |

**8** COMMENTS: (FOR LAB USE ONLY)

SAMPLE TEMPERATURE UPON RECEIPT ______ °C

| | |
|---|---|
| CHILL PROCESS STARTED PRIOR TO RECEIPT | Y OR N |
| SAMPLE(S) RECEIVED ON ICE | Y OR N |
| PROPER BOTTLES RECEIVED IN GOOD CONDITION | Y OR N |
| BOTTLES FILLED WITH ADEQUATE VOLUME | Y OR N |
| SAMPLES RECEIVED WITHIN HOLD TIME(S) (EXCLUDES TYPICAL FIELD PARAMETERS) | Y OR N |
| DATE AND TIME TAKEN FROM SAMPLE BOTTLE | ______ |

# Stage Data Retrieval Log for Site ______ __________________

CR10x Program _______________ Data Filename __________________

**According to *.dat file (CR10X) or *.csv (ISCO) file**

Starting Day _________ (Date _________) Time _________ Stage _________

Ending Day _________ (Date _________) Time _________ Stage _________

*.dat 15 minute interval array ID(s) _________ _________
*.dat Daily Levels array ID _________

**Data Organization**

C:\Projects\FRSGmon\Data\Stage\Stn_____\

| **CR10X & ISCO** | **CR10X Only** | **CR10X & ISCO** |
|---|---|---|
| RawData\WY _____\ | ParsedData\WY _____\ | FinalData\WY _____\ |
| __________________ | __________________ | __________________ |
| | | __________________ |
| | __________________ | __________________ |

**Excel File Revisions**

Gaps in Data? _____ Obvious Incorrect Stages? _____

Comments/Adjustments Made/Explanations:

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Date _____ All Files Backed Up _____ Location __________________________

8/14/09 (bar)

# FRSG Stage Data Review and Verification:

**Station ________ for the Month of ____________________**

---

Files were appended into the monthly file: ______________________.xls

____ Missing data point estimations were reviewed.
____Stage data (prior to revisions) was plotted.

Comments:
______________________________________________________________________
______________________________________________________________________
______________________________________________________________________

File was saved in __________________ format as: _____________________

| **IDAPP Program** | (filename) | (date) | (rev. date) |
|---|---|---|---|
| _____ Stage - Daily Table format: | dt __________.idp | __________ | __________ |
| _____Stage – PH format: | ph __________.idp | __________ | __________ |

_____Attach Daily Table in EXCEL (using Dtable macro) dt______________.xls

_____ Paste PH file in EXCEL template (STNshMMYY.xlt) _____________.xls

_____ Idapp output files reviewed.

Revisions Needed? ____Yes ____ No

Comments:____________________________________________________________
______________________________________________________________________
______________________________________________________________________

Revisions Made __________(date) Revisions Reviewed? ___Yes ___No

All tables and plots attached? ____Yes ____ No

Rev. 8/11/09 (BAR) **FINAL DATA** Date __________ Initials __________

Date __________ Initials __________