Surface Water Quality-Assurance Plan For the Iowa Water Science Center of the U.S. Geological Survey, 2006

Surface Water Quality-Assurance Plan For the Iowa Water Science Center of the U.S. Geological Survey, 2006

By Greg M. Nalley and Jon F. Nania
U.S. Geological Survey

U.S. DEPARTMENT OF THE INTERIOR
Gale A. Norton, Secretary

U.S. GEOLOGICAL SURVEY
P. Patrick Leahy, Acting Director

For additional information
write to:

Chief, Branch of Technical Development
and Quality Systems
U.S. Geological Survey
Box 25046, Mail Stop 414
Denver Federal Center
Denver, CO 80225-0046

Copies of this report can be
purchased from:

U.S. Geological Survey
Books and Open-File Reports Section
Box 25425, Mail Stop 517
Denver Federal Center
Denver, CO 80225-0425

Contents Page

Abstract 1
Introduction 1
Responsibilities 1
Collection of Stage and Streamflow Data 5
Gage Installation and Maintenance 5
Measurement of Stage 6
Gage Documents 7
Levels 7
Site Documentation 8
Station descriptions 8
Photographs 9
Direct Measurements 9
Field Notes 11
Acceptable Equipment 12
Alternative Equipment 12
Indirect Measurements 13
Crest-Stage Gages 14
Artificial Controls 15
Flood Conditions 15
Low-Flow Conditions 16
Cold-Weather Conditions 17
Processing and Analysis of Streamflow Data 18
Processing of Real-Time Streamflow Data 18
Web-Page Presentation Format 18
Review of Real-Time Streamflow Data 19
Error Handling 19
Data-Qualification Statements 20
Measurements and Field Notes 20
Continuous Record 20
Records and Computation 21
Procedures for Working and Checking Records 21
Gage height 21
Levels 22
Rating 22
Datum corrections, gage-height corrections, and shifts 23
Hydrographs 23
Station Analysis 24
Winter records and other Estimated Periods 24
Daily values table 25
Manuscript and annual report 25
Records Checkoff List 25
Review of records 25
Crest-Stage Gages 26
Office Setting 26
Work plan 27

File Folders for Surface-Water Stations 27
Iowa WSC Station Files 27
Crest-Stage Gage Current Files 27
Iowa WSC Backfiles 28
Field-Trip Folders 28
Levels 28
Station Descriptions 28
Job Hazard Analysis 28
Discontinued Stations 28
Map Files 29
Archiving 29
Communication of New Methods and Current Procedures 29
Collection of Sediment Data 29
Sampling Procedures 30
Field Notes 30
Equipment 31
Sample Handling and Storage 31
High-flow Conditions 31
Cold-Weather Conditions 31
Site Documentation 32
Processing and Analysis of Sediment Data 32
Sediment Laboratory 32
Sediment Station Analysis 32
Sediment Analysis Results 33
Sediment Data Storage 33
Database Management 33
Publication of Surface Water Data 34
Publication Policy 34
Types of Publications 35
Review Process 35
Safety 35
Training 36
Summary 36
References Cited 36
Appendix 1 - Office of Surface Water Memorandums 38
Appendix 2 - Procedures For Establishing New Gaging Stations 39
Appendix 3 - Field Trip And Gage Inspection Check List 40
Appendix 4 - Station Description With Bridge Plan 42
Appendix 5 - Job Hazard Analysis 48
Appendix 6 - Hydroacoustic Instrumentation—Standards, Policies, and Procedures 51
Appendix 7 - Iowa WSC Electronic Discharge Measurement Storage Policy 57

Figures Page

Figure 1. Organizational Chart of the Iowa Water Science Center, March 2006 2
Figure 2. Iowa Water Science Center Electronic Discharge Measurement Storage Structure 57

Abstract

This Surface Water Quality-Assurance Plan documents the standards, policies, and procedures used by the Iowa Water Science Center for activities related to the collection, processing, storage, analysis, and publication of surface-water data. The Hydrologic Data Section in the Iowa Water Science Center works is primarily responsible for the collection, processing, storage and publication of surface-water data as well as water-quality and ground-water data.

Introduction

The U.S. Geological Survey (USGS) was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to perform the systematic and scientific "classification of the public lands, and examination of the geologic structure, mineral resources, and products of the national domain." Surface-water activities in the Iowa Water Science Center (WSC) (fig. 1) are part of the USGS overall mission of appraising the Nation's water resources. Surface-water information, including streamflow, stage, and sediment data, is used at the Federal, State, and local levels for resources planning and management.

The purpose of this Surface-Water Quality-Assurance Plan (QA Plan) is to document the standards, policies, and procedures used by the Iowa WSC for activities related to the collection, processing, storage, analysis, and publication of surface-water data. The primary role of the Hydrologic Data Section in the Iowa WSC is the collection, processing, storage and publication of surface-water data as well as water-quality and ground-water data.

This plan identifies responsibilities for ensuring that stated policies and procedures are accomplished. The plan also serves as a guide for all Iowa WSC personnel involved in surface-water activities and as a resource for identifying memorandums, publications, and other literature that describe in more detail associated techniques and requirements.

The scope of this report includes discussions of the policies and procedures followed by the Iowa WSC for the collection, processing, analysis, storage, and publication of surface-water data. Specific types of surface-water data include stage, streamflow, sediment, and basin characteristics. In addition, issues related to the management of the computer data base and employee safety and training are presented. Although procedures and products of interpretive projects are subject to the criteria presented in this report, specific interpretive projects may require a separate quality-assurance plan. The guidelines and quality-assurance requirements for ground-water and water-quality also are mentioned in this report. More detailed quality-assurance plans for these disciplines are in preparation or are described in project quality-assurance documents.

Throughout the QA Plan, various Office of Surface Water (OSW) memorandums are cited; these memorandums are listed in Appendix 1. This QA Plan is reviewed and revised at least once every 3 years in order that responsibilities and methodologies are kept current and in order that the ongoing procedural improvements can be effectively documented.

Responsibilities

Quality assurance (QA) is an active process. Achieving and maintaining high-quality standards for surface-water data are accomplished by specific actions carried out by specific persons. Errors and deficiencies can result when individuals fail to carry out their responsibilities. Clear and specific statements of responsibilities promote an understanding of each person's duties in the overall process of assuring surface-water data quality.

The following is a list of responsibilities of Iowa WSC personnel involved in the collection, processing, storage, analysis, or publication of surface-water data.

Iowa Water Science Center
Organizational Chart

OFFICE OF THE DIRECTOR

Rob Middlemis-Brown*	Supervisory Hydrologist GS-14
Kaylene Carney	Information & Education Assistant GS-7

ADMINISTRATIVE OPERATIONS

Debra Malone*	Administrative Officer GS-11
Lawana Hixon	Admin Operations Asst GS-7
Jeff Henningfield	Admin Operations Asst GS-7

COMPUTER SERVICES

Shawn Noble*	Info Technology Spec GS-13
Brian Lehan Mackin	Info Technology Spec GS-7

HYDROLOGIC STUDIES SECTION

Bob Buchmiller*	Supervisory Hydrologist GS-13
Dana Kolpin	Research Hydrologist GS-14
Steve Kalkhoff	Hydrologist GS-13
Doug Schnoebelen	Research Hydrologist GS-13
Kymm Barnes	Hydrologist GS-12
Jim Caldwell	Hydrologist GS-12
Dave Eash	Hydrologist GS-12
Ed Fischer	Hydrologist GS-12
Greg Littin	Hydrologist GS-12
Dan Christiansen	Hydrologist GS-9
Jessica Garrett	Hydrologist GS-7
Erik Smith	Hydrologist GS-7
Bill Neumann	Hydrologic Technician (S) GS-4

HYDROLOGIC DATA SECTION

Greg Nalley*	Supervisory Hydrologist GS-13
Von Miller	Lead Hydrologic Technician GS-11
Sediment Laboratory	
Pam Smith	Hydrologic Technician GS-8
Julie Nason	Hydrologic Technician GS-7
Jeff Hansen	Hydrologic Technician GS-5
Kate Segreto	Hydrologic Technician (S) GS-4
Eastern Field Unit, Iowa City	
Doug Goodrich	Supervisory Hydrologic Tech GS-12
Mike Linhart	Hydrologist GS-11
Jon Nania	Hydrologist GS-11
Jim Cerveny	Hydrologic Technician GS-9
Jason McVay	Hydrologic Technician GS-9
Kevin Housel	Hydrologic Technician GS-9
Aimee Donnelly	Hydrologic Technician GS-8
Scott Strader	Hydrologic Technician GS-7
Clint Van Schepen	Hydrologic Technician GS-5
Kris Lund	GIS Student Intern
Western Field Unit, Council Bluffs & Fort Dodge	
Joe Gorman	Supervisory Hydrologic Tech GS-12
Al Conkling	Lead Hydrologic Technician GS-11
Dave Conell	Hydrologic Technician GS-11
Rich Kopish	Hydrologic Technician GS-11
Jim Sondag	Hydrologic Technician GS-11
Matt Noon	Hydrologic Technician GS-9
Jeff Harms	Hydrologic Technician GS-8
Scott Thul	Hydrologic Technician GS-7

Specialists and Coordinators

Kymm Barnes	GIS Specialist
Bob Buchmiller	Training Officer
Jim Caldwell	Ground Water Specialist
Kaylene Carney	Outreach Coordinator
Aimee Donnelly	Assistant Safety Officer
Ed Fischer	Reports Specialist
Kevin Housel	Database Manager
Greg Nalley	Flood Coordinator
Jon Nania	Surface Water Specialist
Matt Noon	Safety Officer
Doug Schnoebelen	Water Quality Specialist

Key to chart symbols
(S) student appointment

Center Management Team
Center Director
Administrative Officer
Chief, Hydrologic Studies Section
Chief, Hydrologic Data Section
Chief, Computer Services Section

Figure 1. Organizational Chart of the Iowa Water Science Center, March 2006

The Iowa WSC Director is responsible for:

1. Managing and directing the Iowa WSC program, including all surface-water activities.
2. Ensuring that surface-water activities in the Iowa WSC meet the needs of the Federal Government, the Iowa WSC, State and local agencies, other cooperating agencies, and the general public.
3. Ensuring that all aspects of this QA Plan are understood and followed by Iowa WSC personnel. This is accomplished by the Iowa WSC Director's direct involvement or through clearly stated delegation of this responsibility to other personnel in the Iowa WSC.
4. Providing final resolution of any conflicts or disputes related to surface-water activities within the Iowa WSC.
5. Keeping subordinates briefed on procedural and technical communications from Regional Offices and Headquarters.
6. Performing technical reviews of all surface-water programs on an annual basis.
7. Ensuring that all publications and other technical communications released by the Iowa WSC are accurate and are in accordance with USGS policy.
8. Implementing USGS and WSC safety policies

All Project Chiefs are responsible for:

1. Ensuring that surface-water data collected, computed, or interpreted as part of their project is done so in accordance with all applicable QA guidelines.
2. Obtaining information for the site header file at new stations.

The Data Base Administrator (SW) is responsible for:

1. Maintaining real-time station network such as reviewing "raw" and decoded data, obtaining PASS assignments for new stations, and setting up DECODES for formatting "raw" data.
2. Ensuring the integrity of the surface-water data base.
3. Review of surface-water records published in annual data report.
4. Handling requests related to surface water.
5. Entering new surface-water and water-quality stations into Station Header file.
6. Flagging all surface-water data "final" after records are reviewed and updating Peak Flow file.
7. Train staff on Iowa WSC policies and procedures.

The Surface-Water Specialist is responsible for:

1. Reviewing indirect measurements of flow.
2. Ensuring that the Peak Flow file is updated annually.
3. Providing technical assistance for surface-water data-collection and computation activities.
4. Providing technical assistance for data analysis and interpretation of surface-water hydrologic investigations.
5. Coordinating some activities such as historic data statistics.

The Water-Quality Specialist is responsible for:

1. Reviewing water-quality data collection activities.
2. Reviewing water-quality fact sheets and reports.
3. Providing technical assistance for water-quality data collection and data interpretation.
4. Training and workshops related to water-quality data collection.
5. Reviewing proposals for new water-quality data collection or interpretive projects.
6. Review of data collected in all Iowa WSC Water-Quality projects.
7. Ensuring the integrity of the water-quality data base.
8. Review of water-quality records published in the annual data report.
9. Handling requests for water-quality information contained in the NWIS data base.

The Ground-Water Specialist is responsible for:

1. Reviewing ground-water data collection activities.

2. Reviewing ground-water fact sheets, proposals, and reports.
3. Providing technical assistance for ground-water data collection and data interpretation.
4. Review and entry of ground-water data into GWSI.
5. Entering new ground-water stations into GWSI.
6. Ensuring the integrity of the ground-water data base (GWSI) and controlling access to data base.
7. GWSI training.
8. Handling requests for ground-water information from GWSI.

The Computer Specialist is responsible for:

1. Producing html files for new stations on the WWW.
2. Updating manuscripts and daily values tables for stations on the World Wide Web (WWW).
3. Controlling access to NWIS data base.
4. Controlling access to the surface-water data base to protect against unauthorized use.
5. Maintaining ADAPS programs and communicating problems to Site Administrator; training others in use of ADAPS.

The Field-Office Chiefs are responsible for:

1. Development of work plans and the assignment of work load to their staffs to complete scheduled work.
2. Reviewing real-time data in their area of responsibility.
3. For proper operation of all streamflow-gaging stations, crest-stage gages, reservoir gages, well water-level gages, and water-quality monitoring stations in their area of responsibility.
4. Training staff in surface-water data collection and interpretation techniques.
5. Monitoring status of surface-water records throughout the record-working cycle.
6. Completing surface-water records for their area of responsibility in order to complete the annual data report by April 1.
7. Participating in review of surface-water records.
8. Works in concert with the Hydrologic Data Section Chief and Project Chiefs to ensure that personnel are available for Project data collection activities.

The individuals who collect surface-water data are responsible for:

1. Being fully versed with the policies and procedures presented in this report.
2. Collecting, processing, analyzing, storing, and preparing for publication surface-water data in accordance with the policies and procedures presented in this report.
3.

The Field Hydrologic Technician or Hydrologist is responsible for:

1. Ensuring that streamflow-gaging stations operate in a manner that result in minimal loss of stage record.
2. Making discharge measurements of various types correctly and accurately.
3. Installing, servicing, and repairing instruments at streamflow-gaging stations
4. Storing all data retrieved into the Automated Data Processing System (ADAPS) database.
5. Developing ratings, computing discharge records, and writing station descriptions and analyses in a timely manner.
6. Helping to construct streamflow-gaging stations.
7. Surveying station levels, establishing and periodically confirming elevations of appropriate reference marks in accordance with USGS surveying procedures.
8. Reviewing data from field stations that are displayed on the Website on a daily basis when in the office.

The Hydrologic Data Section Chief is responsible for:

1. The overall operation of the Data Section and Field offices in Iowa City, Council Bluffs, and Fort Dodge.

2. The development of overall work plans designed to accomplish the work of collecting, processing, analyzing, and storing Iowa surface water data, and the day-to-day operation of the surface-water data collection network.
3. Publication of the annual data report for the state of Iowa.
4. Ensuring that all surface-water, ground-water and water-quality data are collected and processed to USGS standards and procedures by working in concert with the surface-water, ground-water, and water-quality specialists.
5. Reviewing computed surface-water records for compliance with proper procedures.
6. Compiling annual Iowa WSC updates into the Iowa WSC Flood Plan and Quality Assurance Plan.
7. Ensuring that employees receive the necessary training for safe and proper data collection and for proper computation of surface-water records.
8. Reviewing of annual data included in the Peak Flow file.
9. Coordinating flood activities, customer and media contacts during major flood events (see Iowa WSC Flood Plan).
10. Serve as principle contact between cooperators and the Iowa WSC in regards to the network of stream flow gaging stations.

The Iowa WSC Safety Officers are responsible for:

1. Assisting the Iowa WSC Director in implementing USGS and Iowa WSC safety policies.
2. Serving as a resource for Iowa WSC personnel seeking information pertaining to safety.
3. Assisting the Iowa WSC Director in making safety information and training available to Iowa WSC personnel.

Collection of Stage and Streamflow Data

Many of society's daily activities, including industry, agriculture, energy production, waste disposal, and recreation, are closely linked to streamflow and water availability; therefore, reliable surface-water data are necessary for planning and resource management. The collection of stage and streamflow data is a primary component in the ongoing operation of streamflow-gaging stations (referred to in the remainder of this report as gaging stations) and other water-resource studies performed by the USGS and the Iowa WSC.

The objective of operating a gaging station is to obtain a continuous record of stage and discharge at the site (Carter and Davidian, 1968, p. 1). A continuous record of stage is obtained by installing instruments that sense and record water-surface elevation in the stream. Discharge measurements are made at periodic intervals to define or verify the stage-discharge relation and to define the time and magnitude of variations in that relation.

It is the policy of the Iowa WSC that all personnel involved in the collection of stage and discharge data are informed of and follow the surface-water data-collection policies and procedures established by USGS and the Iowa WSC. The highest priority in collecting streamflow data is the safety of the employee and the public.

Gage Installation and Maintenance

Proper installation and maintenance of gaging stations are critical activities for ensuring quality in streamflow-data collection and analysis. Effective site selection, correct design and construction, and regular maintenance of a gage can make the difference between efficient and accurate determination of drainage-basin discharge and time-consuming, poor estimations of flow.

Sites for installation of gaging stations are selected with the intent to meet the purpose of each specific gage. Additionally, sites are selected with the intent of achieving, to the greatest extent possible, ideal hydraulic conditions. Criteria that describe the ideal gaging-station site are listed in Rantz and others (1982, p. 5). These criteria include unchanging natural controls that promote a stable stage-discharge relation, a satisfactory reach for measuring discharge throughout the range of stage, and the means for efficient access to the gage and measuring location. Other aspects of controls considered by Iowa WSC personnel when planning gage-house installations include those discussed in Kennedy (1984, p. 2).

The individual responsible for selecting sites for new gaging stations is the Hydrologic Data Section Chief. The process of site selection includes discussion with cooperators, Field Office Chiefs and project chiefs on the purpose of the gage, analysis of terrain with the use of topographic maps, field reconnaissance and file search to determine if discontinued stations or partial record stations existed in the area. Field and office procedures to be completed for field reconnaissance are listed in Appendix 2. The responsibility for ensuring proper documentation of agreements with property owners is held by the Field Office Chief. Approval of site design is the responsibility of the Field Office Chief. Responsibility for construction of gages is held by the Field Office Chief. Inspection and approval of the completed installation is the responsibility of the Field Office Chief.

A program of careful inspection and maintenance of gages and gage houses promotes the collection of reliable and accurate data. Allowing the equipment and structures to fall into disrepair can result in unreliable data and safety problems. It is Iowa WSC policy that a visual inspection is performed at sites by field personnel during each site visit. Maintenance activities performed on a regular basis include verification of inside versus outside gage differences, inspection of the orifice system, inspection of telemetry system, voltage check of the battery under load, cleaning the gage house, and cutting brush near the gage house and measuring section. Cableway inspection is performed prior to use of the cableway, and formal inspection by the Iowa WSC Cableway Safety Inspector are made annually where applicable. A check list for gage visits is shown in Appendix 3.

It is the responsibility of the Field Office Chief and the field personnel to ensure that gages and gage houses are kept in good repair. To ensure these responsibilities are carried out, annual inspections of 20 percent of gage houses are made by the Field Office Chief. Any deficiencies are communicated to field personnel who service the gage and are responsible for ensuring that they are remedied.

Measurement of Stage

Many types of instruments are available for measuring the water level, or stage, at gaging stations. There are non-recording gages (Rantz and others, 1982, p. 24) and recording gages (Rantz and others, 1982, p. 32). Because the uses to which stage data may be put cannot be predicted, it is OSW policy that surface-water stage records at stream sites be collected with instruments and procedures that provide sufficient accuracy to support computation of discharge from a stage-discharge relation, unless greater accuracy is required (Office of Surface Water memorandum 93.07).

In general, operation of gaging stations for the purpose of determining daily discharge includes the goal of collecting stage data at the accuracy of + or - 0.01 foot (Office of Surface Water memorandum 89.08). An explanation of USGS policy on stage-measurement accuracy as it relates to instrumentation is provided in Office of Surface Water memorandum 93.07.

The types of instrumentation installed at any specific gage house operated by the Iowa WSC are dependent on the types of data to be collected and the expected life of the gage. Types of water-level recorders operated by personnel in the Iowa WSC include data collection platforms, float-type recorders, submersible and non-submersible pressure transducers, and crest-stage gages.

The responsibility for determining what types of water-level recorders are operated at each gaging station is held by the Hydrologic Data Section Chief in consultation with the Field Office Chief. Ensuring that new equipment has been installed correctly is the responsibility of the Field Office Chief. Proper maintenance of gage instrumentation or replacement, if appropriate, of equipment is the responsibility of the field personnel who service the gage.

Accurate stage measurement requires not only accurate instrumentation but also proper installation and continual monitoring of all system components to ensure the accuracy does not deteriorate with time (Office of Surface Water memorandum 93.07). To ensure that instruments, located within the gage house, record water levels that accurately represent the water levels of the body of water being investigated, "inside" and "outside" water-level readings are obtained by independent means. For example, outside readings are made with a wire-

weight gage mounted on a bridge rail near the gage house or measurements at reference points of known elevation are made. The inside gage readings do not necessarily always equal outside readings, especially if the gages are not in the same pool at all ranges of stage. Whereas the inside and outside gage readings do not have to agree in all situations, the relation between the two at given ranges of stage should be consistent. It is the responsibility of the field personnel servicing the gage to note the difference, be aware when a malfunction has occurred, and correct the malfunction.

Personnel servicing the gage are responsible for comparing inside and outside readings during each site visit to determine if the outside water level is being represented correctly by the gages. If a deficiency is identified, the personnel servicing the gage are responsible for thoroughly documenting the problem on the field note sheet and either correcting the problem immediately or contacting the Field Office Chief so that corrective actions can be taken at the earliest opportunity.

Ensuring that instrumentation installed at gaging stations is properly serviced and calibrated is the responsibility of the Field Office Chief. This responsibility is accomplished by reviewing each field trip and any associated gage problem with the field personnel. The Field Office Chief also is responsible for reviewing all real-time data for their area of responsibility. Field personnel are responsible for reviewing their stations satellite transmissions each morning and taking any corrective actions, such as scheduling a site visit to repair the gage or removing erroneous spikes from the data set. The field personnel servicing the station is responsible for carrying out any corrective action in the field. All field personnel carry replacement pressure transducers and related equipment to repair any deficiencies found in the field. When the problem is repaired, the field person communicates this information to the Field Office Chief. Individuals who have questions related to the calibration and maintenance of water-level recorders should contact the Hydrologic Data Section Chief or their Field Office Chief.

Gage Documents

It is Iowa WSC policy that certain documents are placed in each gage house for the purpose of keeping an on-site record of observations, equipment maintenance, structural maintenance, and other information helpful to field personnel. Documents maintained at each gage house include: (1) the most recent stage-discharge rating curve upon which each new open water measurement is plotted; (2) the most recent station description listing all gages and reference marks at the site and associated elevations, locations of measurement cross sections, information related to extreme events including the potential for channel storage between the gage and measuring section during flood conditions, and other information (see the section “Site Documentation, Station Description” in this report); (3) a field log book is updated by field personnel upon each routine site visit describing measuring section location, control conditions and listing gage readings, measurement values, gage-house maintenance, and equipment maintenance; (4) important telephone numbers, (5) programming set-up sheet for data-collection platform, (6) summary of levels history showing elevations of reference points at the gage, and (7) Job Hazard Analysis (JHA).

It is the responsibility of personnel who run a field trip regularly to exchange outdated material with updated gage documents as needed. When field personnel visit a gage house and identify a need to update one or more of the documents, a note is made on the field note to bring along the updated documents on the next field trip. Individuals having questions related to what documents should be kept in a gage house, when the documents should be replaced with newer documents, or appropriate methods of appending logs or plotting measurements should contact the Field Office Chief.

Levels

The various gages at a gaging station are set to register the altitude of a water surface above a selected level reference surface called the gage datum. The gage's supporting structures--stilling wells, staff plate backings, shelters, bridges, and other structures--tend to settle or rise as a result of earth movement, static or dynamic loads, vibration, or battering by floodwaters and flood-borne ice or debris. Vertical movement of a structure makes the attached gages read too high or too low and, if the errors go undetected, may lead to increased uncertainties in streamflow records. Leveling, a procedure by which surveying instruments are used to determine the differences

in altitude between points is used to set the gages and to check them from time to time for vertical movement (Kennedy, 1990, p. 1). Levels are run periodically to all bench marks, reference marks, reference points, and gages at each station for the purpose of determining if any datum changes have occurred (Rantz and others, 1982, p. 545).

It is Iowa WSC policy that levels are run at newly installed gaging stations at the time of construction and every year until stability has been established. Levels are run to established gaging stations every 3 to 5 years at stilling wells and every 2 to 3 years at sites using pressure systems. When the need for large datum corrections are noticed, levels can be run any time of the year. Gages are reset to agree with levels when the levels indicate a 0.015-foot or more vertical change to reference gage. Level notes are checked in the field before resets are made. When gages are reset, field personnel document the reset by recording the changes on the level summary form. Included in the level field note should be weather conditions, traffic conditions, instrument number, and date of last peg test. Self-leveling levels are used in the Iowa WSC. Leveling parties are led by a trained hydrologic technician or hydrologist of the Iowa WSC.

Levels are run by use of field methods and documentation methods described in Kennedy (1990). Level procedures followed by Iowa WSC personnel pertaining to circuit closure, instrument reset, and repeated use of turning points are described in Kennedy (1990) and in Office of Surface Water memorandum 93.12. The level instruments are kept in proper adjustment by annually performing a peg test as described in Kennedy (1990). A log book showing the date and results of the peg test is kept with each instrument. The levels are sent to the manufacture for calibration and cleaning when it is apparent from peg tests that they are not working properly.

It is the responsibility of the level party chief to ensure that all field level notes are checked in the field. The level party chief is responsible for updating the level-summary form found in the field folder at the station. Once in the office, the levels are entered in the level summary in the current station file. Ensuring that levels are run correctly and that all level notes are completed correctly is the responsibility of the Field Office Chief. Ensuring that levels and instrument peg test are run at the appropriate frequency is the responsibility of the Field Office Chief.

Site Documentation

Thorough documentation of qualitative and quantitative information describing each gaging station is required. This documentation, in the form of a station description and photographs, provides a permanent record of site characteristics, structures, equipment, instrumentation, altitudes, location, and changes in conditions at each site. Information pertaining to where these forms of documentation are maintained is discussed in the section of this report entitled "Office Setting."

Station descriptions

A station description is prepared for each gaging station and becomes part of the permanent record for each station. It is Iowa WSC policy that the station description is written at the time the first year's records are computed. The responsibility for ensuring that station descriptions are prepared correctly and in a timely manner is held by the Hydrologic Data Section Chief. Station descriptions are written and updated by the personnel who run each station. Station descriptions are reviewed annually and updates made when appropriate. It is the responsibility of the Field Office Chief to ensure that station descriptions are updated as described. Station descriptions are reviewed when initially prepared and following each update by the Hydrologic Data Section Chief or their designee.

Station descriptions are written to include specific types of information in a consistent format (Kennedy, 1983, p. 2). An example of a complete station description is shown in Appendix 4. The description includes a sketch showing the location of all gages and alternate routes to take during high flow, a map of the gage location, and a description of the gage in paragraph format such as that found in Kennedy (1983, fig. 1 and 2). All station descriptions are stored in electronic version online.

Photographs

Photographs of newly installed gage houses, station controls, reference marks, and debris piles are made by field personnel for the purpose of documenting gage-house construction, changes in control conditions, to supplement various forms of written descriptions, and for use in reports or fact sheets. All field personnel carry cameras. Video cameras for use during extreme events are located at the Iowa WSC Office. Each Field Office has at least one digital camera and should be the first choice in taking photographs. Digital photographs are to be stored on the Iowa WSC network in the following directory: \ia\data\dcphoto\<water_year>\<site_name>\. If film is used, each photograph becomes part of the station record and is identified by writing the station number, station name, date, and discharge at time of photograph on the back of the photograph using a permanent ink marker. Photographs for the current year are placed in the current station folder. Older photographs are placed in the Iowa WSC back file with copies located in each field office. Photographs taken during indirect measurements of discharge are filed with the measurement in the Iowa WSC files.

Direct Measurements

Direct measurements of discharge are made with any one of a number of methods approved by USGS. The most common in the Iowa WSC is the use of hydroacoustics, replacing the current-meter method. The procedures used for hydroacoustic discharge measurements can be found in Appendix 6.

A current-meter measurement is the summation of the products of the subsection areas of the stream cross section and their respective average velocities (Rantz and others, 1982, p. 80). Procedures used for current-meter measurements are described in Rantz and others, 1982, p. 139; Carter and Davidian, 1968, p. 7, and Buchanan and Somers, 1969, p. 1.

When personnel make measurements of stream discharge, attempts are made to minimize errors. Sources of errors are identified in Sauer and Meyer, 1992. These include random errors such as depth errors associated with soft, uneven, or mobile streambeds, or uncertainties in mean velocity associated with vertical-velocity distribution errors and pulsation errors. These errors also include systematic errors, or bias, associated with improperly calibrated equipment or the improper use of such equipment. Field trips are rotated to different personnel every 2 to 3 years to minimize systematic errors.

A discharge measurement made using the Acoustical Doppler Velocity probe (ADV), in the manner similar to a measurement made using a mechanical current meter, also involves the summation of the products of the subsection areas of the stream cross section and their respective average velocities.

Iowa WSC policies related to the measurement of discharge by use of the current-meter method or ADV method, in accordance with USGS policies, include the following (see also Appendix 3, Hydroacoustic Instrumentation-Standards, Policies, and Procedures).

Depth criteria for meter selection.--Iowa WSC personnel select the type of current meter to be used for each discharge measurement on the basis of criteria provided in OSW technical memorandum 85.14. Meters are used with caution when a measurement must be made in conditions outside of the ranges of the method provided by OSW. Any deviation from those criteria is noted and the measurement accuracy is downgraded accordingly.

The ADV may be used for most wading measurements. The depth-sampling convention using the ADV is the same as a Price AA meter. ADVs, however, do not have a minimum-depth requirement (with the exception that the probes must be totally submerged). Furthermore, single velocity samples (.6) are used for depths below 2.5 feet, and double velocity samples (.2 and .8) are used for all depths greater than 2.5 feet. Therefore, ADVs can be used for all depth scenarios in place of the AA and the pygmy meters for wading measurements.

The ADV may not work in weed- or leaf-choked channels or clear streams where small signal-to-noise ratios may be a factor. QA for an ADV includes checking the temperature sensor for accuracy once each day. A

conventional meter must be used in place of the ADV if one of these problematic situations is encountered and the ADV fails to work.

Low velocities in a cross section traditionally have been a problem for some streamflow measurements because mechanical meters can be inaccurate at velocities below .2 ft/s (foot per second). An ADV meter should be used when velocities in more than five sample sections of a measurement are less than .2 ft/s.

Hydrographers should carry a pygmy and a Price AA meter for wading, and those meters are to be maintained and spin tested according to policies described in the "Acceptable Equipment" section of this quality-assurance plan. These meters are generally only used if the hydroacoustic meter fails to work. For a conventional meter, the following criteria should be followed. An AA current meter may be used to make direct streamflow measurements when depths average 1.5 feet and greater. When depths are less than 2.5 feet, a single velocity sample is taken at 0.6 total depth. When depths are greater than 2.5 feet, then .2 and .8 samples are taken. These guidelines all assume a standard velocity profile.

If bottom velocities are equal to or greater than the top velocity, a standard profile does not exist. In the case of a non-standard profile, the .2, .6, and .8 shots all must be taken. When average depths are less than 1.5 feet, the pygmy current meter is used. Hydrographers of the Iowa WSC make their meter selection for specific measurement conditions based on guidance provided by information found in OSW memorandum 85.14, Buchanan and Somers (1969), and Rantz and others (1982).

In shallow-depth/low-velocity situations, if an ADV is not available or will not function, the standard AA meter may be used where the velocities are too slow to be recorded by the pygmy. These situations are to be avoided by looking for cross sections where higher velocity exists. It is recognized, however, that at some sites, during low-flow periods, sections suitable for the pygmy meter cannot be found. A measurement made using an AA meter in these slow-velocity conditions must be downgraded; it is always preferable to use an ADV in these situations.

When using conventional meters, It is recommended that a change of meters is not made during a measurement in response to the occurrence of two or more subsections in a single measurement cross section that exceed the stated ranges of depth and velocity. A change of meter is allowed when multiple measurement methods are used. For example, one meter may be used from a cableway for the main portion of a channel and a second meter used for wading a shallow overflow reach.

Number of measurement subsections.--The spacing of observation verticals in the measurement section can affect the accuracy of the measurement (Rantz and others, 1982, p. 179). The USGS criteria are that observations of depth and velocity be made at a minimum of 25 to 30 verticals, which are normally necessary so that no more than 5 percent of the total flow is measured in any one vertical. Even under the worst conditions the discharge computed for each vertical should not exceed 10 percent of the total discharge and ideally not exceed more than 5 percent (Rantz and others, 1982, p. 140). Exceptions to this policy are allowed in circumstances where accuracy would be sacrificed if this number of verticals were maintained, such as for measurements during rapidly changing stage (Rantz and others, 1982, p. 174). Fewer verticals than are ideal are sometimes used for very narrow streams (about 12-feet wide when an AA meter is used and about 5 feet wide when a pygmy meter is used). Measurement of discharge is essentially a sampling process, and the accuracy of sampling results typically decreases markedly when the number of samples is less than about 25.

Other direct methods of measuring discharge.--It is the Iowa WSC policy that USGS and OSW techniques and guidelines are followed when discharge measurements are made with any selected method of measurement. These methods include volumetric measurements (Rantz and others, 1982, p. 262-263), methods involving portable flumes (Kilpatrick and Schneider, 1983), and discharge estimation methods such as use of floats and the static-stick method.

Computation of mean gage height.--Iowa WSC personnel use procedures for the computation of mean gage height during a discharge measurement presented in Rantz and others (1982, p. 170). Mean gage height is one of the coordinates used in describing the stage-discharge relation at a streamflow-gaging site.

Check measurements.--A second discharge measurement is made for the purpose of checking a first discharge measurement when the first measurement differs from the current stage-discharge relation by more than 25 per cent of the expected flow or if the field person has reason to believe the first measurement is in error. When a check measurement is made, as many factors influencing the measurement as possible are changed, including personnel, instruments, and measuring section in an attempt to minimize potential systematic errors (Rantz and others, 1982, p. 346).

Corrections for storage.--Corrections for storage applied to measured discharges for the purpose of defining stage-discharge relations are those discussed in Rantz and others, 1982, p. 177 and in Office of Surface Water memorandum 92.09.

Questions.--Personnel who have questions concerning the appropriate procedures for making stage and discharge measurements should address their questions to the Field Office Chief or the Hydrologic Data Section Chief.

Field Notes

Thorough documentation of field observations and data-collection activities performed by field personnel is a necessary component of surface-water data collection and analysis. To ensure that clear, thorough, and systematic notations are made during field observations, hydroacoustic and current meter are recorded by field personnel on appropriate standard USGS discharge measurement note sheet. If an electronic discharge measurement logger is used (such as an AquaCalc 5000) the logged file is attached to the inside of the standard discharge measurement form and the front sheet is computed as normal. Original observations, once written on the note sheet, are not erased. Original data are corrected by crossing the value out then writing the correct value. Some examples of original data on a discharge-measurement note sheet include gage readings, extreme indicator clip readings, depth, distance from initial point, water surface to bottom of ice, revolutions, vertical or horizontal angles, and time. Examples of information on a discharge-measurement note sheet that is derived from original data, but not in itself original data, include total discharge on the front sheet, mean gage height, width, area, and velocity. Derived data can be erased for the purpose of correction.

It is Iowa WSC policy that all discharge measurements are calculated in their entirety before field personnel leave the field site, unless emergency evacuation is required for reasons of safety. Information required to be included by field personnel on the measurement note sheet includes, at minimum, the initials and last name of all field-party members, date, times associated with gage readings and other observations, suspension weight used, coefficients used, type of meter used, meter number, meter spin test, location of measurement, measurement rating, and descriptions of the cross-section, flow, weather conditions, and control.

Notations associated with miscellaneous surface-water data-collection activities are to be documented on the standard measurement note or on a standard USGS gage inspection sheet. All miscellaneous notes are required to include, at minimum, initials and last name of field-party members, date, time associated with observations, purpose of the site visit, gage readings, description of the control, and why inspection was made, for example, gage maintenance.

A review of field note sheets is required after each field trip by the Field Office Chief on a periodic basis. Field notes are reviewed as part of the records computation to ensure that all computations have been checked and that numbers have been transferred correctly from the interior of the measurement form to the front sheet and to ensure numbers are correct in NWIS. Deficiencies found in the methodology, content, accuracy, clarity, or thoroughness of field notes are identified and communicated to field personnel by written means. The deficiencies are remedied by providing specific instructions from the Field Office Chief to individuals who fail to record notations that meet USGS and Iowa WSC standards.

Acceptable Equipment

Equipment used by the Iowa WSC for the measurement of surface-water discharge has been found acceptable by the USGS through use and testing. An array of acceptable equipment for measuring discharge includes current meters (conventional and acoustic), stop watches, discharge loggers, digitizers, wading rods, bridge cranes, tag lines, and others (Rantz and others, 1982, p. 82; and Smoot and Novak, 1968). Although an official list of acceptable equipment is not available, Buchanan and Somers (1969), Carter and Davidian (1968), and Edwards and Glysson (1988) discuss the equipment used by the USGS.

The meters most commonly used by Iowa WSC personnel for measuring surface-water discharge are the ADV and the Acoustic Doppler Current Profiler (ADCP). Price AA current meter and the Price pygmy current meter are rarely used, and methods followed by Iowa WSC personnel for inspecting, repairing, and cleaning these meters are described in Smoot and Novak (1968, p. 9), Rantz and others (1982, p. 93), and Buchanan and Somers (1969, p. 7). The Iowa WSC has implemented a QA/QC plan as Appendix 6 to this plan for the use of the ADV, ADCP, index Acoustic Velocity Meters (AVM), and other hydroacoustic devices.

When conventional current meters are used, the ultimate responsibility for the good condition and accuracy of a current meter rests with field personnel who use it (Office of Surface Water memorandum 89.07). A timed spin test made a few minutes before a measurement does not ensure that the meter will not become damaged or fouled during the measurement. Field personnel must assess apparent changes in velocity or visually inspect the meter periodically during the measurement to ensure that the meter continues to remain in proper operating condition.

Spin tests.--It is Iowa WSC policy that spin tests are required prior to each field trip when the meter will be used. Spin-test results are documented in a log that lists all spin tests for all current meters in chronological order. A log book is kept in each field office. This log is part of the archived data of the USGS (Office of Surface Water memorandum 89.07). Repairs are made to meters when deficiencies are identified through the spin test or inspection. Review of this log by the Field Office Chief is required annually. If deficiencies are observed during this review of the log, the person responsible for the meter is informed through oral communication and the problem is corrected immediately. All meters are spin tested by another employee not normally assigned to the meters during an annual meter inspection day (to begin October, 1998). All deficiencies are noted in the spin test log and corrected immediately.

Stop watches.--Stop watches are not only used for spin tests on current meters but are used during discharge measurements with conventional current meters. Stop watches should routinely be checked with a time cube or National Institute of Standards clock to confirm that they are operating correctly.

In addition to the timed spin tests performed prior to the start of each field trip day, field personnel are required to inspect the meter before and after each measurement to see that the meter is in good condition, that the cups spin freely, and the cups do not come to an abrupt stop. Descriptive notations are made at the appropriate location on the field-note sheet concerning the meter condition, such as “OK” or “free” or other such comments. A daily spin test at the end of each day should reflect the worst case scenario for that day and can be used as end time for all measurements that day. To ensure that field personnel carry out their responsibilities in maintaining the equipment they use, the equipment is inspected on an annual basis by another field person. Adjustments and repairs to the meters are documented in the current meter log. The Hydrologic Data Section Chief and his designee review all meters and logs during this annual current meter inspection day. Worn pivots are sent to the HIF for sharpening or replacement.

Alternative Equipment

New conditions and the development of new technology sometimes involve the collection of surface-water data with alternative equipment that has not been fully accepted by the USGS. To demonstrate the quality of surface-water data collected with alternative equipment, thorough documentation of procedures and observations must be maintained.

Indirect Measurements

In many situations, especially during floods, it is impossible or impractical to measure peak discharges by means of a direct discharge measurement. There may not be sufficient warning for personnel to reach the site to make a direct measurement, or physical access to the site during the event may not be feasible.

A peak discharge determined by indirect methods is in many situations the best available means of defining the upper portions of the stage-discharge relation at a site. Because extrapolation of a stage-discharge relation, or rating, beyond twice the measured discharge at a gaging station is undesirable and may be unreliable, discharge measurements made by indirect methods during periods of high flows are important forms of data (Rantz and others, 1982, p. 334).

The Iowa WSC follows data-collection and computation procedures presented in Benson and Dalrymple (1967). That report includes policies and procedures related to site selection, field survey, identification of high-water marks, the selection of roughness coefficients, computations, and the written summary. The Iowa WSC also follows procedures for measurement of peak discharge by indirect methods presented in Rantz and others (1982, p. 273).

In addition to the general procedures presented in Benson and Dalrymple (1967), the Iowa WSC follows guidelines presented in other reports that describe specific types of indirect measurements suited to specific types of flow conditions. The slope-area method is described in Barnes (1967) and Dalrymple and Benson (1967). The USGS applies the Manning equation in application of the slope-area method. Procedures for selecting the roughness coefficient are described in Arcement and Schneider (1989). The computer-based tool, Water-Surface Profile Computation model (WSPRO) (Shearman, 1990)WSPRO, is available to assist in computations of peak discharge with the slope-area method is discussed in Office of Surface Water memorandum 96.04. Procedures for the determination of peak discharge through culverts, based on a classification system which delineates six types of flow, is described in Bodhaine (1982). The computer-based tool, Culvert Analysis Program (CAP), available to assist in computations of peak discharge at culverts, is discussed in Office of Surface Water memorandum 83.07. At sites where open-channel width contractions occur, such as flow through a bridge structure, peak discharge can be measured with methods described in Matthai (1967) and with WSPRO. Debris-flow conditions, which are most common in small mountainous basins, are discussed in Office of Surface Water memorandum 92.11.

Determinations of water-surface profiles along a stream channel in association with selected discharges are made when studies are performed that involve delineations of flood plains or when extensions are made to stage-discharge relations at streamflow sites. Iowa WSC personnel are required to follow the procedures associated with step-backwater methods described in Davidian (1984). The computer-based tool used for assisting in the computations of water-surface profiles with step-backwater methods, WSPRO, is discussed in Office of Surface Water memorandum 87.05.

General guidelines that are followed by the Iowa WSC when making indirect measurements include those discussed in Office of Surface Water memorandum 92.10 and in Shearman (1990). Violation of any one of the general guidelines does not necessarily invalidate an indirect measurement (Office of Surface Water memorandum 92.10).

The responsibility for ensuring that indirect measurements are performed correctly is held by Surface-Water Specialist. It is required that a review of procedures and documentation be performed prior to publication of the data or use in any interpretive study. Reviews are usually conducted by the Surface-Water Specialist or another designated experienced surface-water hydrologist. All data associated with the indirect measurement is reviewed, including the high-water mark determinations, level notes, n-value determinations, and hydrologic computations. All indirect measurements done in the Iowa WSC are reviewed. Measurements that are questionable and difficult to assess are reviewed by specialists outside the Iowa WSC, and the Surface-Water Specialist is responsible for ensuring that deficiencies identified by the outside party are corrected.

Determining when and where indirect measurements are made is the responsibility of the Iowa WSC Director on recommendations from the Hydrologic Data Section Chief. For the Iowa WSC, it is a general rule that indirect measurements are made at sites when peak flow at a site is estimated to be at least twice the discharge of the greatest measured flow or when needed at ungaged sites in support of interpretive projects of flood documentation studies.

It is the responsibility of Field Office Chief or Chief-of-Party to identify and flag high-water marks. Because the quality and clarity of high-water marks are best soon after a flood, personnel traveling in the field are required to have available in their field vehicles nails and plastic markers, spray paint, paint sticks, survey flagging. Because selection of a suitable reach of channel is an extremely important element in making an indirect measurement, at some streamflow-gaging-station sites the stream reach for indirect measurements at specified ranges of stage has been preselected, and that information has been included in the station description.

After each indirect measurement is computed, the graphs, field notes and data, plotted profiles, maps, calculations or computer output, and written analysis associated with the measurement are checked by an experienced surface-water hydrologist. The information is organized in a single labeled folder and is then filed with the station records or with relevant project files. For long-term storage, the indirect measurement package is filed in the Iowa WSC backfile.

The responsibility of maintaining the accuracy of the peak-flow data files, including computer data-base files, lies within the Iowa WSC (Office of Surface Water memorandum 92.10). It is the responsibility of the Hydrologic Data Section Chief to ensure that appropriate indirect-measurement results are entered into the peak-flow files. It is the responsibility of the Surface Water Specialist to ensure that the peak-flow files are correct. For further discussion on the update and review of the peak-flow files, refer to the "Data-base Management" section in this QA Plan.

Crest-Stage Gages

Crest-stage gages are used as tools throughout the USGS for determining peak stages at otherwise ungaged sites, confirming peak stages at selected sites where recording gages are located, confirming peak stages where manometers or pressure transducers are used, and determining peak stages along selected stream reaches or other locations, such as upstream and downstream from bridges and culverts. The OSW requires quality-assurance procedures comparable to those used at continuous-record stations for the operation of crest-stage gages and for the computation of annual peaks at crest-stage gages (Office of Surface Water memorandum 88.07).

The operation of crest-stage gages is part of the Iowa WSC surface-water program. Procedures followed by the Iowa WSC in the operation of crest-stage gages are presented in Rantz and others (1982, p. 9, 77, 78). One or more gages are maintained at each selected site where peak water-surface elevations are required on a stream. Upstream and downstream gages are maintained at culverts or other structures where water-surface elevations are required to compute flow through the structure and to establish the resulting type of flow.

Except at sites where crest-stage gages are used only to confirm or determine peak stages, stage-discharge relations are developed in association with the gage based on direct or indirect high-water measurements. Direct or indirect measurements are obtained when possible to verify or adjust the rating. Levels are run to the gage every 2 years or as soon as possible after significant changes in the gage because of damage to the gage, reconstruction, or other such situation. When extremely high peaks occur, an outside high-water mark to confirm the gage reading is found when possible, is described on the note sheet, and is flagged by a durable indicator so that the elevation of the high-water mark can be determined the next time levels are run.

Field observations are written on the Iowa WSC Inspection of Crest-Stage Gage form. All field notes are required to include, at minimum, initials and last name of field personnel, date, time of observation, whether a peak occurred or not, gage height of peak, condition of gage, condition of control, and description of any significant changes to the control.

The responsibility for ensuring that correct data-collection procedures are used by personnel is held by the Hydrologic Data Section Chief or Field Office Chief. This responsibility is carried out by examining all field note sheets, or by examining all note sheets of personnel in their first 3 years of experience. When a deficiency in data-collection activities is identified, the problem is remedied by providing additional training when applicable.

Policies and procedures for computation of peak discharges at crest-stage gages and associated documentation are presented in this report in the section entitled "Processing and Analysis of Stage and Streamflow Data."

Artificial Controls

Artificial controls, including broad-crested weirs, thin-plate weirs, and flumes, are built in stream channels for the purpose of simplifying the procedure of obtaining accurate records of discharge (Rantz and others, 1982, p. 12). Such structures serve to stabilize and constrict the channel at a section, reducing the variability of the stage-discharge relation.

Artificial controls are used at some gaging stations maintained by the Iowa WSC. In situations where artificial controls are installed as permanent structures, it is Iowa WSC policy that stage-discharge relations are determined by making current-meter measurements throughout the range of stage. Where necessary, stage-discharge relations may be extended using theoretical ratings when direct measurements cannot be accurately or safely made. Portable Parshall flumes are used by Iowa WSC personnel when the depths are shallow and the velocities are low. Use of Parshall flumes in sand channels is discouraged because of the difficulty in stopping water from infiltrating through the sand and passing around the flume. Discharge estimation techniques may work better in these cases (float or static stick). These portable devices are applied according to methods described in Buchanan and Somers (1969, p. 57) and Rantz and others (1982, p. 263).

Ensuring the correct design and installation of artificial controls for the Iowa WSC is the responsibility of the Hydrologic Data Section Chief in consultation with the Surface-Water Specialist. When installing an artificial control, the Iowa WSC personnel take into account the criteria for selecting the various types of controls, principles governing their design, and the attributes considered to be desirable in such structures (Carter and Davidian, 1968, p. 3; Rantz and others, 1982, p. 15 and 348; and Kilpatrick and Schneider, 1983, p. 2 and 44).

When field inspections of artificial controls are performed, specific information pertaining to control conditions are written on the field note sheets for the purpose of assisting in analysis of the surface-water data. These notes include comments concerning scour or fill of the streambed immediately upstream from the control, debris on the control, and any damage to the structure. Regular maintenance at artificial controls includes cleaning the controls when needed. Any maintenance to the control is noted on the inspection sheet. When problems pertaining to artificial controls are encountered by field personnel, the Field Office Chief and Hydrologic Data Section Chief should be contacted as soon as possible for advice.

Flood Conditions

Flood conditions present problems that otherwise do not occur on a regular basis. These problems can include difficulties in gaining access to a streamflow gage or measuring site because roads and bridges are flooded, closed, or destroyed. Debris in the streamflow can damage equipment and present dangers to personnel collecting the data. Rapidly changing stage or conditions requiring measurements to be made at locations some distance away from the gage can create problems in associating a gage height to a measured discharge.

The Iowa WSC maintains a flood plan so that high-priority surface-water data associated with flood conditions are collected correctly and in a timely manner. The flood plan describes responsibilities before, during, and after a flood, informational-reporting procedures, and field-activity priorities. The flood plan serves as a central reference for emergency communications, telephone numbers for key Iowa WSC personnel, codes for accessing streamflow gages equipped with telemetry, lists of available equipment, and instructions for determining priority stations to be measured. Reference also is made in the Iowa WSC Flood plan to safe traffic control during bridge measurements.

It is the responsibility of the Hydrologic Data Section Chief for ensuring that the flood plan includes all appropriate information, including updated information. The flood plan is reviewed annually by the Surface Water Specialist and the Hydrologic Data Section Chief. A copy of the flood plan is provided to all Iowa WSC personnel. Each individual that receives a copy of the plan keeps one copy near their desk and another in their field truck. It is the responsibility of the Hydrologic Data Section Chief to ensure that individuals that receive a copy of the plan are fully versed on the content of the flood plan.

During a flood, coordination of flood activities is performed by the Hydrologic Data Section Chief acting as Flood Coordinator. The areas of responsibilities are shown in the Flood Plan for each of the three Field Office Flood Coordinators. For personnel that are not already in the field, their first responsibility during flood conditions is to call the Flood Coordinator before driving to the office. For personnel that are already in the field, their first responsibility during flood conditions is to immediately call Flood Coordinator. Personnel who arrive at a gaging station to find that a flood has occurred are responsible for immediately calling the Flood Coordinator. If a discharge measurement is needed, it should be completed, and then the person should proceed to find and document high-water marks. The Iowa WSC personnel apply methods discussed in Rantz and others (1982, p. 60) for determining peak stage at gaging stations.

Iowa WSC personnel follow policies and procedures stated in a number of publications and memorandums when collecting surface-water data during floods. Techniques for current-meter measurements of flood flow are presented in Rantz and others (1982, p. 159 to 170). Procedures for identifying high-water marks for indirect discharge measurements are presented in Benson and Dalrymple (1967, p. 11). Adjustments applied to make measured flow hydraulically comparable with recorded gage height when discharge measurements are made a distance from the gaging station are presented in Office of Surface Water memorandum 92.09 and in Buchanan and Somers (1969, p. 54). It is the responsibility of all personnel with questions about particular policies or procedures related to flood activities, or who recognize their need for further training in any aspect of flood-data collection, to address their questions to the Hydrologic Data Section Chief.

Review of Iowa WSC activities related to floods is the responsibility of the Iowa WSC Director. This review includes seeing that guidelines and priorities spelled out in the flood plan are followed and that the guidelines appropriately address Iowa WSC requirements for obtaining flood data in a safe and thorough manner. When deficiencies are identified by the reviewer, deficiencies are remedied by oral communication to the Hydrologic Data Section Chief who is expected to correct the problem.

It is Iowa WSC policy that all gaging station equipment remains operative during flood events since all sites can be view real-time on the internet. Because many cooperators make daily decisions on water management issues using these real-time data, the repair of any malfunctioning recording or telemetry equipment at these stations is second only to the safety of personnel and the public. Spare equipment should be carried in all field vehicles to make these repairs.

Low-Flow Conditions

Streamflow conditions encountered by Iowa WSC personnel during periods of low flow are typically quite different from those encountered during periods of medium and high flow. Low-flow discharge measurements are made to define or confirm the lower portions of stage-discharge relations for gaging stations, as part of seepage runs to identify channel gains or losses, and to help in the interpretation of other associated data. Additionally, low-flow measurements are made to define the relation between low-flow characteristics in one basin and those of a nearby basin for which more data are available (Office of Surface Water memorandum 85.17).

In many situations, low flows are associated with factors that reduce the accuracy of discharge measurements. These factors include algae growth that impedes the accurate acoustic measurements and larger percentages of the flow moving in the narrow spaces between cobbles. When natural conditions are in the range considered by the field personnel to be undependable, the cross section is physically improved for measurement by removal of debris or large cobbles, construction of dikes to reduce the amount of non flowing water, or other such efforts

(Buchanan and Somers, 1969, p. 39). After modification of the cross section, the flow is allowed to stabilize before the discharge measurement is initiated. Channel modifications are noted on measurement form stating whether or not the stage of the gage was affected by the modification.

Iowa WSC policy requires that point-of-zero-flow measurements be made by field personnel for wading measurements when an accuracy of 0.05 ft or less can be determined.

Controls are cleaned of debris or aquatic growth whenever the accumulation is significant. A discharge measurement is made prior to cleaning the control in order to document the effect of the debris or aquatic growth on the stage-discharge relation.

The individual responsible for ensuring that Iowa WSC personnel use appropriate equipment and procedures during periods of low flow is the Hydrologic Data Section Chief and appropriate Field Office Chief. Determination that appropriate procedures are used for data-collection activities during low-flow conditions is accomplished by discussion of field procedures by the Field Office Chief immediately following each field trip and review of all field notes at the end-of-year review by the Data Section staff. The Hydrologic Data Section Chief is responsible for providing answers to questions from Iowa WSC personnel pertaining to data collection during periods of low flow.

Cold-Weather Conditions

Surface-water activities in the Iowa WSC include making streamflow-discharge measurements during cold weather conditions. Cold temperatures, wind, snow, and ice can create difficulties in collecting data. These factors also can create dangers to field personnel. The highest priority in collecting streamflow data during winter periods is employee safety.

For gaging stations where the stream is subject to freezing during the winter, discharge measurements under ice cover and during periods of partial ice cover are useful for analysis and determination of flow throughout winter periods. Iowa WSC personnel are required to follow procedures for discharge measurements under ice cover presented in Buchanan and Somers (1969, p. 42). This same publication includes procedures for discharge measurements made by wading or discharge measurements from cableways and bridges when debris and ice are in the streamflow. Iowa WSC personnel also follow procedures to collect winter streamflow data as presented in Rantz and others (1982, p. 124). Additionally, guidelines on equipment for measurement of flow under ice are provided in Office of Surface Water memorandum 84.05.

Presently, OSW views the preferred metering equipment for discharge measurements for slush-free conditions under ice cover to be a type AA current meter built with a Water Survey of Canada (WSC) winter-style yoke with a conventional metal-cup rotor. For conditions where slush ice is present, the Office of Surface Water views the preferred metering equipment to be the WSC winter-style yoke with a polymer rotor (Office of Surface Water memorandum 88.18). Although polymer rotors are not allowed (Office of Surface Water memorandum 90.01) during all other conditions, the superior ability of the polymer rotor to shed slush ice and retard freezing in ice-covered streams is considered to be more important than the turbulent-flow-related inaccuracies associated with the rotor (Office of Surface Water memorandum 92.04). The OSW also views the ADV and the AA meters with conventional metal-bucket rotors to be acceptable for use in slush-free conditions if cutting the required larger holes through the ice is feasible (Office of Surface Water memorandum 92.04).

The Iowa WSC discourages measurement of discharge on ice-covered streams where slush ice is present. The Iowa WSC does not stock current meters approved under these conditions. Iowa WSC policy on the use of metering equipment on ice-covered streams where no slush ice is present is that the ADV be used.

The responsibility for ensuring the correct use of equipment and procedures for surface-water data-collection activities during periods of winter conditions is held by the Field Office Chiefs. This is accomplished by

discussion of procedures of field procedures after each field trip. Any questions related to proper measurement of discharge on ice-covered streams needs to be referred to the Hydrologic Data Section Chief.

Safety is extremely important when measurements are made under ice. Multiple-member crews should be used all streams. Any questions concerning how to safely make ice measurements should be discussed with the Iowa WSC Safety Office prior to the winter season.

Processing and Analysis of Streamflow Data

The computation of streamflow records involves the analysis of field observations and field measurements, the determination of stage-discharge relations, adjustment and application of those relations, and systematic documentation of the methods and decisions that were applied. Streamflow records are computed and published for each gaging station annually (Rantz and others, 1982, p. 544).

This section of the QA Plan includes descriptions of procedures and policies pertaining to the processing and analysis of data associated with the computation of streamflow records. The procedures followed by the Iowa WSC coincide with those described in Rantz and others (1982) and in Kennedy (1983).

Processing of Real-Time Streamflow Data

A necessary and critical element in maintaining accurate streamflow records on a real-time basis is the need for rating analysis and shift application as soon as practicable after a discharge measurement has been made. The Iowa WSC policy is that rating analyses and shift applications will be performed using the following procedures for data disseminated on the Iowa WSC public Web page http://ia.water.usgs.gov/.

The working days immediately following a routine field trip, record workers update ratings, shift analyses, and datum corrections using results of gage inspections or discharge measurements made during the site visit. The mean daily discharges for periods of bad or missing data will be estimated at this time. A station analysis will be written in the Records Management System (RMS) for each period the record is worked. Every gaging station in the Iowa WSC is assigned to an individual who will work the record when the data become available, and then to a different individual who will check the record after it is worked. It is the responsibility of the Field Office Chief to ensure the record worker is not scheduled to work on any other projects immediately after returning from a field trip, so that the record can be worked up-to-date. Upon working the record, the individual assigned to check the record will be notified by e-mail through the RMS that the record is worked, and is ready to be checked. Review of records will take place three times per year, about every 120 days, and record reviewer will be assigned by the Field Office Chief at the time of the review.

The real-time system serves no purpose to water-resources managers if the streamflow gages are not operational under normal conditions. It is policy in the Iowa WSC that malfunctioning stream gages are repaired as soon as possible from the day the malfunction occurred. During floods, streamgages must be functioning properly. There will be times when discharge measurements are needed at specific locations to help adequately define the upper end of the. The equipment malfunction takes priority over the discharge measurement. During floods, it is the responsibility of the Field Office Chief to divert personnel to repair malfunctioning equipment. If there are questions during these times, servicing personnel should contact the Data Section Chief.

Web-Page Presentation Format

Iowa WSC real-time data are served to the National Water Information System Web (NWISWeb) from computer servers located in the Iowa City office maintained by the Iowa WSC. The NWISWeb web site provides access to data from the Iowa WSC, and is used to conform to national USGS standards. Links to real-time streamflow data are displayed prominently on the Iowa WSC Home Page (http://ia.water.usgs.gov/). Users can click on gages located on the interactive map, which link directly to the real-time data for that site. Also from the Iowa WSC home page, real-time data can be accessed by clicking “Data Online,” then “Data for Iowa - NWISWEB System.” This will link to the Iowa WSC NWISWeb home page. Any modifications to the Iowa

WSC web site, whether it is the addition or deletion of web links, the posting of USGS publications, or the addition of new web pages, are approved and executed by the WSC Webmaster. It is the responsibility of the Webmaster to ensure that all WSC Web Pages conform to all USGS Web and publication policies. It is the Iowa WSC Director who holds the ultimate responsibility to approve the content of all pages posted on the Iowa WSC Web site.

Review of Real-Time Streamflow Data

Real-time streamflow data that are disseminated on the public Web page must be reviewed frequently to ensure their quality and to prevent the distribution of erroneous information. The Iowa WSC utilizes both automated and manual review procedures to meet this objective.

Automated procedures that have been implemented by the Iowa WSC include the setting of minimum and maximum threshold values for stage and discharge and their rates of change. If exceeded, these settings will initiate warnings of potential errors that will be delivered by e-mail to the appropriate WSC personnel. The WSC Director, the Database Manager, and the Hydrologic Data Section Chief are the Iowa WSC person designated to receive and act upon these messages.

In addition to the automated procedures, WRD Technical memorandum 99.34 requires frequent and on-going screening and review of Web data, including the at least daily review of hydrographs during normal hours of operation. The Iowa WSC also requires that all Web pages containing real-time streamflow data are reviewed regularly for accuracy and/or missing data. The real-time streamflow data are scanned visually each work day by the Database Administrator, the Field Office Chief, and the Field Hydrologic Technician responsible for the site. The primary goal of the visual check is to identify stations that have failed to transmit real-time data and to identify real-time data that appear to be in some way erroneous. When problems are identified, the Field Office Chief initiates the actions necessary to correct specific problems. Another goal of the visual check is to identify high water, backwater, or other pertinent conditions so that special measurements can be made to improve the overall records-computation process for the streamflow network.

Error Handling

There are two general types of errors associated with streamflow data that are delivered by the real-time system and disseminated on the Internet. The first are persistent-type problems usually associated with some type of equipment failure whether in data collection or transmission, but could also be related to ice effects. Because of the nature of the problem they generally occur on a continuing basis for more than a single recording interval. The second are the intermittent-type problems, which are often the result of a data transmission error. These often show up as either a zero or an unreasonably large value. It is the policy of the Iowa WSC that intermittent-type errors, such as extremely large gage-height data transmission errors, are identified as soon as is reasonably possible, and the erroneous data are either deleted or corrected as soon as is reasonably possible. For example, when a data transmission error is identified during the daily visual check of the real-time data, actions are taken immediately by the Database Administrator or the Field Hydrologic Technician responsible for the site to delete or correct the value and update the real-time web site to reflect the corrected data. In regard to persistent-type problems, it is the Iowa WSC policy not to estimate corrected unit value discharges on an ongoing basis during periods of backwater caused by the effects of ice. Web users, however, are warned about the provisional nature of discharges during winter periods. When real-time data shown on the Web for a particular station are clearly in error— resulting from the malfunction of equipment, vandalism at the site, major control damage caused by beaver dam construction, or other similar problems—it is the responsibility of the Hydrologic Data Section Chief to decide when data for the site are removed from the Web page. After repairs have been made to the gaging station and the data are determined to be accurate, it is the responsibility of the Hydrologic Data Section Chief to decide when posting of the real-time data on the Web is to resume.

Data-Qualification Statements

WRD Technical memorandum 95.19 requires that streamflow data made available on the Web should be considered provisional until the formal review process has been completed. To ensure that everyone who accesses data from the Web are aware of this, data qualification statements must be included at key locations with a clickable heading Provisional Data Subject to Revision on all real-time data pages. It is the policy of the Iowa WSC that all Iowa WSC Web pages that contain real-time data, or contain data that have not been formally approved as final, present a prominent clickable heading that links to the following explanation:

> **Provisional data for Iowa**
> Recent data provided by the USGS in Iowa--including stream discharge, water levels, precipitation, and components from water-quality monitors--are preliminary and have not received final approval.
>
> Most data relayed by satellite or other telemetry have received little or no review. Inaccuracies in the data may be present because of instrument malfunctions or physical changes at the measurement site. Subsequent review may result in significant revisions to the data.
>
> Data users are cautioned to consider carefully the provisional nature of the information before using it for decisions that concern personal or public safety or the conduct of business that involves substantial monetary or operational consequences.
>
> Information concerning the accuracy and appropriate uses of these data or concerning other hydrologic data may be obtained from the station manager, whose name is shown on the single station data-summary pages, or from the USGS surface-water specialist in Iowa, care of the webmaster email: Iowa_NWISWeb_Maintainer@usgs.gov.

Measurements and Field Notes

The gage-height information, discharge information, control conditions, and other field observations written by personnel onto the measurement note sheets and other field note sheets form the basis for records computation for each gaging station. Measurements and field notes that contain original data are required to be stored indefinitely (Hubbard, 1992).

Measurements and other field notes for the water year that is currently being computed are filed in the current record folder or in the measurement file in the field offices. Measurements and notes for previous water year are filed in the WSC back files. Older measurements are no longer archived at the Federal Archives and Records Center located in Kansas City, Missouri due to national security.

It is the Iowa WSC policy that all measurements are checked. The measurements are checked by reviewing the mathematics and other items listed in Kennedy (1983, p. 7).

The measurement data are entered into computer files by use of standard USGS software and a paper printout of that information is filed in the current record. This printout is checked, reviewed, and filed as part of the computed record.

Continuous Record

Surface-water gage-height data are collected as continuous record (hourly, 15-minute, or 5-minute values, for example) in the form of electronic storage on data loggers and electronic transmissions by satellite. Streamflow records are computed by converting gage-height record to discharge record through application of stage-discharge relations. Ensuring the accuracy of gage-height record is, therefore, a necessary component of ensuring the accuracy of computed discharges.

Gage-height record is assembled for the period of analysis in as complete a manner as possible. Periods of inaccurate gage-height data are identified then corrected (see the section "Datum corrections, gage-height corrections, and shifts") or deleted as appropriate. Items included in the assembly of gage-height record and procedures for processing the data are discussed in Kennedy (1983, p. 6), and Rantz and others (1982, p. 560 and p. 587).

The primary gage-height record for each gaging station is that transmitted by the satellite telemetry. Satellite data are plotted to verify that there are no “spikes” or missing data. For missing periods of less than 4 hours and when stream gage height is nearly unchanging, good adjacent recorded data can be used to reconstruct the missing period. When necessary, these data are augmented by back-up data stored in electronic form in the data logger. Logged data are downloaded during each gage visit to verify that the gage is operating properly. Once in the office, the logged data files are transferred to a disk for that station for each year. The disk is kept with the current files so the data can be used when necessary. These back-up disks are stored at the field offices. Missing or “bad” periods of gage-height record may also be augmented using other back-up records, such as graphic recorders. The gage-height record from the recorder is either edited into the data base for short periods or discharge is worked up manually on a graphic chart for longer periods and appropriate daily values are updated. A plot of unit values for a nearby station of similar size and characteristics can be used to estimate long periods of missing gage-height record. A plot of unit values for the nearby station and the station with missing record are overlaid and the missing period is sketched in using high-water marks, field personnel’s’ instantaneous gage-height readings, or observer gage-height observations. Whatever method is used to augment missing or “bad” periods of gage-height record, the method used must be clearly described in the station analysis. Gage-height records recorded during periods of ice cover are usually not edited (see winter records). A short period when the gage height is affected by anchor ice can be edited using methods described in Rantz and other (1921, p. 362).

Records and Computation

Records are computed completely on a continual basis as soon as possible after the data are collected. The Iowa WSC uses the Record Management System (RMS) to track record progress and to update station analyses. RMS tracks record progress and allows checkers and reviewers to add comments that are E-mailed to the record worker. Comments may describe what needs to be reworked if the record was returned. All initial computation for a station is done by the individual responsible for the site visits unless other arrangements have been made by the Field Office Chief. Records also are checked on a continual basis by an assigned second hydrographer. Changes to the records by the checker are coordinated with the individual who computed the record. The Field Office Chief resolves any cases of disagreement. All records are reviewed by the Field Office Chiefs and other assigned senior technicians with attention paid to any modifications made by the checker as well as consistency among similar stations. Records will be reviewed after every analysis period so that data are finalized to comply with the requirements set by the Program Assessment Rating Tool (PART). At the end of each water year, the final review will consist of exchanging records between each Field Office in order to ensure consistency throughout the Iowa WSC.

Procedures for Working and Checking Records

Procedures for ensuring the thoroughness, consistency, and accuracy of streamflow records are described in this section of the QA Plan. The goals, procedures, and policies presented in this section are grouped in association with the separate components that are included in the records-computation process.

Gage height

The accuracy of surface-water discharge records depends on the accuracy of discharge measurement, the accuracy of rating definition, and the completeness and accuracy of the gage-height record (Office of Surface Water memorandum 93.07). Computation of streamflow records includes ensuring the accuracy of gage-height record by comparisons of gage-height readings made by use of independent reference gages, comparison of inside and outside gages, examination of high-water marks, comparisons of the redundant recordings of peaks and troughs by use of maximum and minimum indicators, examination of data obtained at crest-stage gages, and confirmation or updating of gage datum corrections by levels.

Records computation includes examination of gage-height record to determine if the record accurately represents the water level of the body of water being monitored. Additionally, it includes identifying periods of time during which inaccuracies have occurred and determining the cause for those inaccuracies. When possible and appropriate, inaccurate gage-height record is corrected. When corrections are not possible, the record worker will remove any erroneous gage-height data from the set of data used for streamflow records computation. If the primary satellite gage-height record is augmented by other recorded data, the method used must be clearly described in the station analysis. Data logs at a satellite telemetry station are considered as equivalent data and are stored in the same data descriptor in ADAPS as the transmitted data.

If gage-height record is augmented using some other recorder or electronic logger, proper documentation should be included in the primary record so it can be checked. For example, if the graphic chart is used to fill in a missing period, gage heights and times should be noted on the chart and a unit values table provided which can be checked to verify that the values were edited properly into the ADAPS.

Levels

Errors in gage-height data caused by vertical changes in the gage or gage-supporting structure can be measured by running levels. Gages can be reset or gage readings can be adjusted by applying corrections based on levels (Kennedy, 1983, p. 6).

Procedures for computing records for each station include ensuring that the front sheet has been completed and checked in the field for each set of levels, ensuring that the level information was listed on the historical levels summary form, and ensuring that information was applied appropriately as datum corrections. The individual computing the record is required to check field notes for indications that the gages were reset correctly by field personnel. If corrections are found to have been needed and not applied, or if a gage was reset incorrectly, the gage is reset on the next field visit. The individual computing the records makes appropriate adjustments to the gage-height record by applying datum corrections. All corrections are noted on the datum summary sheet and in the station analysis and checked.

Rating

The development of the stage-discharge relation, also called the rating, is one of the principal tasks in computing discharge record. The rating is usually the relation between gage height and discharge (simple rating). Ratings for some special sites involve additional factors such as rate of change in stage or fall in slope reach (complex ratings) (Kennedy, 1983, p. 14).

Iowa WSC personnel follow procedures for the development, modification, and application of ratings that are described in Kennedy (1984). Iowa WSC personnel also follow guidelines pertaining to rating and records computation that are presented in Kennedy (1983, p. 14) and in Rantz and others (1982, Chap. 10-14 and p. 549).

For each gaging station, the most recent digital rating table can be obtained from the station folder, the field folder, in the gage house folder, or in a computer file. A graphical plot of the most recent rating can be found in the station folder, field folder, or gage house folder. All measurements which are not affected by ice are plotted each year on the rating display curve. Ratings are checked immediately when developed.

As continual records are worked, the field person may choose to use variable-shift diagrams versus drawing a new rating. This is acceptable but a new rating should be drawn for the final record when appropriate for use in the following year (see datum corrections, gage-height corrections, and shift).

Each rating at a station is given a unique identification number beginning with 1. New ratings which are the result of a physical change in the stage-discharge relation, or are corrections to errors in old ratings are given a new identification number of the next unit higher. A rating which is extended or lowered is given the same whole number as the rating, but the next available 0.1 is added. For example, if rating number 5.0 is extended, the new rating is identified as 5.1, as long as any of the existing input points of rating number 5.0 were not altered. Any

questions related to station ratings should be directed to the Field Office Chief or the Hydrologic Data Section Chief.

Measurements are made at each site visit to continually document changes to the stage-discharge relation. It is beneficial to make measurements defining the full range of stage for each station. It is the responsibility of each field person to review current stage at their stations daily, and refer to the station rating to determine when and where measurements are needed.

If measurements plot within 5 percent of the rating in effect, the rating is presumed to be valid for the entire year. If any of the measurements are more than 5 percent different than the rating, additional measurements are made as needed to confirm and define the change in rating.

All measurements are used to define the new rating, as well as all historic measurements that define the high-end of the rating. The measurements are plotted on the rating display curve. The individual who develops the new rating is responsible to ensure that the rating is checked and is properly entered into ADAPS.

Datum corrections, gage-height corrections, and shifts

A correction applied to gage-height readings to compensate for the effect of settlement or uplift of the gage is usually measured by levels and is called a “datum correction” (Kennedy, 1983, p. 9). Datum corrections are applied to gage-height record in terms of magnitude (in feet) and in terms of when the datum change occurred. In the absence of any evidence indicating exactly when the change occurred, the change is assumed to have occurred gradually from the time the previous levels were run, and the correction is prorated with time (Rantz and others, 1982, p. 545). If there is evidence indicating exactly when the change occurred, runoff event or ice out, the change is put into place at that time. Datum corrections are applied when the magnitude of the vertical change is 0.02 foot or greater.

A correction applied to gage-height readings to compensate for differences between the recording gage and the base gage is called a "gage-height correction" (Rantz and others, 1982, p. 563). These corrections are applied in the same manner as datum corrections by use of the same computer software. To provide a clear picture of datum and gage-height correction changes throughout the year the difference between gage readings and the reference gage (corrected to the reference gage) is plotted on form 9-279D. Review of the gage-height record should point out when the change occurred and changes are drawn on this form. The corrections are then entered into ADAPS and an explanation written in the station analysis. Gage-height corrections are applied so the recorded data are made to agree with the base-gage or reference-gage data. These corrections are applied when the difference between the recording gage and the base gage is equal to or greater than 0.02 foot.

A correction applied to the stage-discharge relation, or rating, to compensate for variations in the rating is called a shift. Shifts reflect the fact that stage-discharge relations are not permanent but vary from time to time, either gradually or abruptly, because of changes in the physical features that form the control at the gaging station (Rantz and others, 1982, p. 344). Shifts can be applied to vary in magnitude with time and with stage (Kennedy, 1983, p. 35). The use of shifts is encouraged over development of a new rating until stability of the shift is established and enough data have been collected to develop a new rating. Shifts are documented through use of a variable-shift diagram, on which all measurements used to define the shift are plotted and which is placed in the primary station folder. The shift and distribution is summarized and explained in the station analysis.

Hydrographs

A discharge hydrograph is a plot of daily mean discharges versus time. In order to stream line real-time records processing, the Iowa WSC uses the Hydra tool within the USGS Automated Data Processing System (ADAPS). Daily discharges are plotted on the vertical axis with the date plotted on the horizontal axis. Using the Hydra tool, the hydrographer can quickly view and compare discharges from other sites with the site in question. Because each site is worked several times throughout a water year, a hydrograph plotted with a full water year of data is not necessary since much of the year has been worked, checked, and reviewed before the end of the water

year. Questions concerning the hydrographs are referred to the Field Office Chief or the Hydrologic Data Section Chief.

Station Analysis

A complete analysis of data collected, procedures used in processing the data, and the logic upon which the computations were based is documented for each year of record for each station to provide a basis for review and to serve as a reference in case questions arise about the records at some future date (Rantz and others, 1982, p. 580). Topics discussed in detail in the station analysis include equipment, hydrologic conditions, gage-height record, datum and gage-height corrections, when levels were run, rating, discharge, special computations, and remarks. New revisions of ADAPS allow users to add comments to gage height corrects and shifts, therefore, only comments that could not be included in ADAPS are written in the station analysis. The individual who works the record completes the station analysis in the RMS, which is then stored in the RMS database. Due to real-time records processing, there are several analysis periods for a water year per site. To eliminate redundancy, the equipment and hydrologic conditions are only included in the first analysis period of the water year, unless a change occurs to either of these. The station analysis is checked and reviewed along with the record for the period being analyzed, with modifications and additions to the analysis tracked the RMS using comments. The checker may update any changes to the station analysis prior to submitting it to RMS for review. All changes and modifications are discussed with the individual who wrote the analysis, with the Field Office Chief resolving any disputes. When the review is complete, the station analysis is updated and a copy stored with the final record.

Winter records and other Estimated Periods

Computing records that represent winter periods for gaging stations involves procedures that are not applicable to records that represent other times of the year. The formation of ice in stream channels or on section controls affects the stage-discharge relation by causing backwater; the effect varies with the quantity and nature of the ice, as well as with the discharge (Rantz and others, 1982, p. 360). During most conditions the recorded gage-height data may be accurate, although the actual stage-discharge relation may be undeterminable and unstable. An example of this condition would be when surface ice forms on the stream, but the orifice line remains unfrozen and the gage height represents the backpressure caused by the ice in the channel. During other conditions the recorded gage-height data are inaccurate, resulting in periods of missing gage-height record. An example of the latter would be when an orifice line is frozen. Other periods of missing gage-height record may be the result of equipment malfunction, vandalism, or destruction of the gage by ice or flooding.

The individual computing the station record is responsible for identifying ice-affected periods and determining estimated daily discharges for the affected period. The individual also identifies periods of no gage-height record and similarly estimates the periods and documents the estimated data on the primary printout and in the station analysis. The individual who checks the winter records or other estimated periods is responsible for confirming the validity of all data and methods used to assist in developing the estimates and to confirm that the estimates are reasonable. In addition, all similar stations are reviewed to ensure that ice-affected periods are estimated consistently. Inaccurate data or obvious “spikes” may be replaced with gage-height data from another recorder or logged data. These periods should be clearly described in the station analysis. Any corrected unit values are flagged in ADAPS.

Daily mean discharges for ice-affected and periods of inaccurate stage data are estimated through a variety of means. The Iowa WSC maintains ice-index stations for each field office, where the station is more frequently measured during periods of backwater from ice. The index station is worked prior to any other sites and is based on the discharge measurements and weather records. All other sites are estimated based on nearby weather records and hydrographic comparisons to the nearest ice index station. Estimates for some periods are developed using graphical plots of the unit stage data, which are used to help estimate the correct, or non ice-affected stage. Other estimated periods are developed directly on the discharge hydrograph using hydrographic comparison with similar stations. Both techniques may be aided by the availability of discharge measurements made during the estimated period, measurements at ice stations which are measured more frequently, temperature and precipitation records from nearby weather stations, and inspections of the control. In addition, certain stations in the Iowa WSC, are often unaffected by ice or have very little backwater effect and can be used as a base gage for

comparison. At stations affected by regulation, information on releases from upstream reservoirs is available to assist in estimating records. All materials used in the development of estimated periods at a station are explained and documented in the station analysis and filed in the primary station folder.

Daily values table

With few exceptions, for each gaging station operated by the USGS a discharge value is determined and stored for each day. The daily values table generated by use of the records-computation software represents what discharge values are stored for each day of the water year. The table is checked against the computed primary and the estimated record to ensure that the proper daily values have been stored. The printed daily value table is filed in the primary station folder for each station by the individual computing the records. The individual checking or reviewing the records prints a new copy of the daily value table to see if any daily values were updated in ADAPS as a result of the check or review process. The printed table is checked against the final manuscript prior to publication of the annual data report, and against the daily values stored in ADAPS prior to marking the values "final."

Manuscript and annual report

When records computation for the water year has been completed and the data collected and analyzed by Iowa WSC personnel have been determined to be correct and finalized, the surface-water data for that water year are published along with other data in the Iowa WSC annual data report. The annual data report is part of the series titled "U.S. Geological Survey Water-Data Reports." Information presented in the annual data report includes daily discharge values during the year in a table and as a plotted hydrograph, extremes for the year and period of record, and various statistics. Additionally, manuscript station descriptions are presented in the annual data report. Information contained in the manuscript includes physical descriptions of the gage and basin, history of the station and data, and statements of cooperation. The printed manuscript from the previous water year is updated in color pen and final updates are made by the Data Base Administrator once the record is approved as final. In preparing the annual data report for publication, the Iowa WSC follows the guidelines presented in the report, "USGS Data Reports Preparation Guide," by Charles E. Novak, 1985 edition.

Records Checkoff List

Throughout the year, progress of records worked, checked, and reviewed are tracked in RMS. Progress of records throughout the year are very visible in RMS, and this tracking system helps the Hydrologic Data Section Chief and Field Office Chiefs see if individuals are getting behind so appropriate actions can be taken.

Review of records

After streamflow records for each station have been computed and checked, records for all of the Iowa WSC gaging stations are reviewed by the data section personnel. The goal of the review is to ensure that proper methods were applied throughout the process of obtaining the surface-water data and computing the record. Emphasis is placed during the review on checking things that were changed or corrected by the individual checking the records, checking manuscript pages for the station, and reviewing all similar stations to ensure consistency of estimated periods. Deficiencies are reported to the Hydrologic Data Section Chief and the individuals who computed and checked the records. Necessary changes are coordinated among the parties with the Hydrologic Data Section Chief resolving any disputes. All reviews of records are done in the RMS.

Once the record is reviewed at the end of the water year, a copy of the station manuscript and the daily values table is given to the staff member with the responsibility of compiling the pages of the annual data report. The completed manuscript of the data report receives an editorial review, which is reviewed by the Hydrologic Data Section Chief, with final review from the Iowa WSC Director.

Crest-Stage Gages

Records for crest-stage gages are computed with goals and procedures similar to those for other gaging stations. The field notes are examined for correctness and accuracy. Peak stages recorded by crest-stage gages are cross referenced with other available information; the dates of the peaks are determined by analyzing available precipitation data and peak data from recording gages within the same basin or from nearby basins.

A discussion on the policies and procedures used for field aspects of collecting data at crest-stage gages is included in this report in the section "Collection of Stage and Streamflow Data." The discussion in this section describes the analysis and office documentation of crest-stage data. This section does not pertain to data collected at crest-stage gages installed solely for the purpose of confirming peak stages at sites where manometer or pressure-transducer gages are used.

At sites where crest-stage gages are used to compute peak discharges, an initial stage-discharge relation, or rating, is developed for the site by direct or indirect high-water measurements. The rating is verified or adjusted on the basis of subsequent direct or indirect high-water measurements.

For each station, a list of all measurements is maintained and each measurement is assigned a chronological number. For each station, a graphical plot of the current rating along with each recent and each notably high stage-discharge measurement is made readily available to those who check and review the station record by keeping a current plot in the current-record station folder. Current station descriptions and a summary of levels are maintained in the office field folder and are available to personnel working the record. A brief station analysis is written each year in RMS describing computation of the annual peak, identifying which rating was used and the type of flow condition, describing how the dates of the peaks were determined, and discussion of any problems related to data collected.

Responsibility for assigning the personnel for each crest-stage-gage station is with the Field Office Chief. Computations are checked by another hydrographer who verifies the computations and where changes are necessary, they are brought to the attention of the record worker. The record is checked in the RMS.

Responsibility for ensuring the correct computation of annual peaks at crest-stage gages is held by the Hydrologic Data Section Chief. Review of the crest-stage gage computations is performed by the Hydrologic Data Section Chief, their designee or a senior technician. All crest-stage records are reviewed in RMS. The peak stages and discharges are compared to past data collected to verify accuracy. When incorrect actions or procedures are identified during the review, the problems are remedied by discussing the problems with the record worker.

Responsibility for updating the Peak-Flow File promptly after peak data have been finalized is held by the Surface Water Specialist or their designee. A current listing of annual peaks is maintained at the Iowa WSC for review purposes (Office of Surface Water memorandum 88.07).

Office Setting

Maintaining surface-water data and related information in a systematic and organized manner increases the efficiency and effectiveness of data-analysis and data-dissemination efforts. Good organization of files reduces the likelihood of misplaced information; misplaced data and field notes can lead to analyses based on inadequate information, with a possible decrease in the quality of analytical results.

This section of the QA Plan includes descriptions of how station folders, reference maps, levels documentation, and other information related to surface-water data are organized and maintained. Additionally, this section provides an overview of how work activities are designed to be carried out within the office setting.

Work plan

The Iowa WSC office is located in Iowa City with field offices in Council Bluffs and Fort Dodge. The staff of the Iowa WSC Hydrologic Data Section includes 3 hydrologists, and 19 hydrologic technicians, and 2 student aides. Each employee has a work plan which outlines the areas of work for which the employee is responsible, and criteria which are used to rate the employee's performance each year. Specific work loads are established by the Hydrologic Data Section Chief in consultation with the Field Office Chiefs. Consultations are sometimes needed with the WSC Studies Chief because many of the technicians in the Data Section have tasks related to project work. Scheduling conflicts between sections and units are resolved at the lowest possible levels to the mutual benefit of those involved while maintaining the highest standards possible.

All stations are grouped into field trips which cover a specific portion of the WSC. Field trips are assigned to individual field personnel who are responsible for all site visits. All field personnel are expected to perform all required measurements, sampling, maintenance, levels, and minor construction at stations assigned to them. Priority also is given to processing collected data immediately after field trips. It is the responsibility of the Field Office Chief to ensure that field personnel have the required office time to do this. Scheduling of site visits is done by the Field Office Chief. During periods of hydrologic extremes (floods or droughts), or conflicting schedules, site visits may be scheduled by the Hydrologic Data Section Chief. Additional field duties may be communicated orally by the Field Office Chief. Each field person is expected to compute completely the records at the stations in their field area for the annual data report, and to check records of other field people as assigned by the Field Office Chief. Some senior technicians may be asked by the Hydrologic Data Section Chief to review records.

File Folders for Surface-Water Stations

This section of the QA Plan describes the location and makeup of hard-copy files associated with surface-water data. Information pertaining to files maintained in computer storage can be found in the "Data-base Management" section of this report.

For each gaging station, a separate set of file folders is maintained by station in alphabetical order. These files are located in the Iowa WSC Data Section near the office of the Hydrologic Data Section Chief and include files of the previous year and files of historic back files. Current station record files with copies of appropriate historic records are located in the field offices. Extraneous items are removed from the current files after records are finalized and appropriate documents filed in the backfile.

Iowa WSC Station Files

Located in the Iowa WSC Data Section are the files for the most current finalized records and backfiles. Two station files with information filed by downstream station number are located near the office of the Hydrologic Data Section Chief. The first file contains the graphic chart, if available, discharge measurement forms, and the final primary printout. When records for the current year are finalized, this file is updated and its contents archived at the Federal Archives and Records Center (FRC) in Kansas City, Missouri. The second station file (current file) contains a current rating display curve, station analysis, discharge daily value table, datum and shift tables, rating table, level summary, discharge hydrograph, an historic list of all discharge measurements made, the most current station description, and the Job Hazard Analysis (JHA). When a new record is finalized, this file is updated and appropriate documents from the previous year's file are moved to the Data Section backfiles.

Crest-Stage Gage Current Files

Crest-stage gage station files also are located in the Iowa WSC. These files contain a rating display curve, station analysis, list of inspections made and discharge measurements, a rating table, station description, and level summary. Crest-stage gage inspection sheets and level field notes are filed in appropriate file cabinets near the station files.

Iowa WSC Backfiles

The Iowa WSC backfiles are located near the Hydrologic Data Section Chief. The stations are filed by station number in downstream order and contain several parts. Subfiles are labeled general (correspondence, indirect measurements, etc.), station analysis, daily value table, rating tables and curves, and miscellaneous (hydrographs, level summaries, etc.).

All Iowa WSC data files are maintained by the Hydrologic Data Section Chief or their designee. Once final records are approved, copies of the station analysis, updated station descriptions, JHAs, daily values table, rating curve and table, level summary, and miscellaneous items are returned to the field offices for filing in their station files.

Each field office maintains a current station folder and backfile which contains most of the items listed in the Iowa WSC station files. It is the responsibility of the Field Office Chief or their designee to maintain these files.

Field-Trip Folders

A field trip folder is maintained for each station in the Iowa WSC containing a copy of the station description, JHA, the current rating table and rating display curve, a level summary, a data collection platform set-up sheet, and any other material of use. At each gaging station there also is a container having the station information. This container includes the field log book, station description, current rating display curve, a level summary, a data collection platform set-up sheet, and any other materials of use. It is the responsibility of the hydrographer running the field trip to make sure these files are maintained and updated at the end of each year.

Levels

Levels notes are filed with the measurement notes in the primary station file until publication of the annual report. At this time the level notes are transferred to the level backfile. The results of each set of levels are transcribed to the level summary sheet which is filed with the station files in the Iowa WSC and each field office. Original level field notes should remain in the field office files and a copy placed in the Iowa WSC level backfile. The Iowa WSC uses electronic forms for historical level summaries, and is stored on the Iowa WSC network at \ia\data\records\levelsums\<station_name>\.

Station Descriptions

Copies of current station descriptions are kept in each station file and in a computer directory which is accessible by USGS cooperators. The station descriptions also include the site specific bridge safety plan which has been approved by the Iowa Dept. of Transportation and the USGS Safety Officer. It is the responsibility of the Field Office Chief or their designee to make sure that the station descriptions located in the station files and the computer are updated when appropriate. Copies of historic station descriptions at both current and discontinued sites are kept in the Iowa WSC files or backfiles.

Job Hazard Analysis

Copies of the current Job Hazard Analysis (JHA) are kept in each station file and in a computer directory which is accessible by USGS field personnel. It is the responsibility of the Field Office Chief or their designee to make sure that JHAs are updated on a yearly basis for on-going stations and new JHAs are written for any new installation of surface-water gaging stations. An example Iowa WSC JHA can be found in Appendix 5.

Discontinued Stations

Files for discontinued stations are handled similarly to the file for active stations. All primary folders, ratings, list of discharge measurements, level summaries, rating curves and tables, station analysis, and station descriptions are maintained in the Iowa WSC backfiles. No separate file is maintained for discontinued stations.

Map Files

The Iowa WSC Office keeps complete sets of 7.5 minute topographic and 1:250,000 county maps for the State of Iowa. Multiple copies of each map are available in alphabetical order in map files near the Hydrologic Data Section Chief. Each field office maintains a similar map file for their area of responsibility. The Iowa WSC map files are maintained by the Publication Section Chief. Personnel who use one of the few remaining copies of a specific map should notify the Publications Section Chief. Field Office Chiefs are responsible for maintaining their map files.

Archiving

All USGS personnel are directed to safeguard all original field records containing geologic and hydrogeologic measurements and observations. Selected material not maintained in field offices are placed in archival storage. Detailed information on what records have been removed to archival centers should be retained in the Iowa WSC or project office (Water Resources Division memorandum 77.83). The types of original data that should be archived include, but are not limited to, recorder charts and tapes, original data and edited data, observer's notes and readings, station descriptions, analyses, and other supporting information (Water Resources Division memorandum 92.59 and Hubbard, 1992, p. 12). At this time, material cannot be sent to the Federal Records Centers (FRC) of the National Archives and Records Administration to be archived due to security risk. All material must be archived in the Iowa WSC backfiles. All electronic measurement data must be stored and archived on the Iowa WSC computer network according to the policy in Appendix 7.

Surface-water information is sent to the FRC from the Iowa WSC annually at the end of the surface-water record cycle. Surface-water information from Iowa WSC Projects is sent to the FRC as needed. The Hydrologic Data Section Chief or appropriate Project Chief is responsible for deciding what information is sent to the FRC, for ensuring that the information is properly packed and logged, and for ascertaining that the information is received by the FRC. Records of exactly what has been archived are maintained in files maintained by the Hydrologic Data Section Chief or their designee. Personnel who have questions concerning archiving procedures should address their questions to the Hydrologic Data Section Chief or the Studies Section Chief. Personnel who receive requests for information that require accessing archived records should refer the request to the Hydrologic Data Section Chief.

Communication of New Methods and Current Procedures

In house training sections are to be held as needed to communicate any new methods or procedures relating to the performance of data collection activities. Formal training is provided to all employees whenever the need arises.

Collection of Sediment Data

Surface-water activities in the Iowa WSC include the collection, analysis, and publication of sediment data. The Iowa WSC operates in adherence to policies related to sediment set forth by the OSW.

Responsibility for the sediment discipline was transferred from the Office of Water Quality (OWQ) to the OSW in 1985 (Office of Surface Water memorandum 92.08). The policies and procedures related to sediment followed by the Iowa WSC are described in selected USGS publications and in memorandums issued by OSW, the Office of OWQ, and USGS. Techniques adopted by the USGS and followed by the Iowa WSC are presented in Knott and others (1992). The Iowa WSC also follows procedures presented in three publications for the series "Techniques of Water-Resources Investigations of the U.S. Geological Survey" (TWRI):

Book 3, Chapter C1--"Fluvial Sediment Concepts" by H.P. Guy (1970),
Book 3, Chapter C2--"Field Methods for Measurement of Fluvial Sediment" by H.P. Guy and V.W. Norman (1970),
Book 3, Chapter C3--"Computation of Fluvial-Sediment Discharge" by George Porterfield (1972).

Although no additional TWRI chapters have been written to supersede the above-mentioned reports, Open-File Report 86-531 “Field Methods for Measurement of Fluvial Sediment” by T.K. Edwards and G.D. Glysson (1988) essentially replaces Book 3, Chapter C2 (Water Resources Division memorandum 71.73, Office of Surface Water memorandum 88.17, and Office of Surface Water memorandum 93.01).

A summary of memorandums issued since 1971 related to sediment and sediment transport is provided in Office of Surface Water memorandum 92.08. A summary of documentation that describes instrumentation and field methods for collecting sediment data is provided in Office of Surface Water memorandum 93.01.

Sampling Procedures

Iowa WSC personnel collect suspended-sediment data by using sampling methods that include the single vertical method, the Equal Discharge Increment (EDI) method, the Equal Width Increment (EWI) method, and the point-sample method]. Automatic pumping-type samplers are not used.

Observers are hired for most sites where sediment is collected. They are shown the techniques of sampling with bridge-mounted and hand samplers. They are then observed by the field technician for correctness. They routinely get one sample daily except for run-off events; these they sample several times during the event. Their samples are compared to those collected by the field technicians during routine field trips. Most compare well with the technicians sample results. The sediment records technician and the field technician ensure quality of samples.

Field methods for sediment sampling are documented in Office of Surface Water memorandum 93.01. Water samples obtained for the analysis of sediment concentration and particle size are not composited (Office of Surface Water memorandum 93.01 and Office of Water Quality memorandum 76.17). For samples that are split, the cone splitter is used (Office of Water Quality memorandum 80.17).

Policy for the collection and publication of bed load data is provided in Office of Surface Water memorandum 90.08. This memorandum supersedes policy and guidelines provided in previous Office of Water Quality memorandums 76.04, 77.07, 79.17, and 80.07, as well as Water Resources Division memorandum 77.60. Among the policies stated in Office of Surface Water memorandum 90.08, which are followed by the Iowa WSC, is one stating that three cross-sectional procedures are used for bed load sampling: the Single Equal Width Increment (SEWI) method, the Multiple Equal Width Increment (MEWI) method, and the Unequal Width Increment (UWI) method. Additionally, it is stated in Office of Surface Water memorandum 90.08 that it is the responsibility of the field personnel to select the procedure that is optimal for the local condition. Bed load samples in some situations are analyzed individually and in other situations are analyzed as a composite. Until sampling variability for a particular site is understood by those analyzing the data, all samples are required to be analyzed individually.

The individual in the Iowa WSC responsible for scheduling sediment-collection activities at specific sites is the Field Office Chief. The individual responsible for ensuring that Iowa WSC personnel use correct procedures to collect sediment data is Sediment Specialist. This individual establishes whether or not correct procedures are being used by going on site visits with the field technician and reviews the samples collected. Discussion throughout the year with field technicians ensures that procedures are correct. If deficiencies are found, a control set of samples are taken in addition to the regular sampling to determine the problems encountered. Answers to questions from Iowa WSC personnel concerning sediment-sampling techniques are provided by Sediment Specialist.

Field Notes

Iowa WSC personnel are required to fill out note sheets each time a site is visited for the purpose of sediment sampling. The employee completes the note sheet in its entirety before leaving the site. Original observations written on the note sheets are not to be erased; data are corrected by crossing out the original observations and writing the correct information near the original value. The goal of placing information on the field note sheet is to describe the equipment and methods used during the site visit as well as to describe relevant conditions or

changes (Office of Surface Water memorandum 91.15). For each site visit, when a sediment sample is collected, a measurement of discharge also is made and the information included on the note sheet includes, at minimum, site identification, field personnel name, date, time, sampling equipment, method, type of event.

Upon completion of each field trip, field notes are placed in station folder in the office. Field notes are checked when the discharge measurements are checked.

Equipment

Care and maintenance of the sediment-data-collection equipment is the responsibility of the field personnel that use the specific equipment. Parts replacement and repair of damaged equipment is accomplished by replacement of nozzles and seals which are obtained from FISP. Damaged equipment is returned to FISP for repair. It is the responsibility of Sediment Specialist to ensure that appropriate equipment is used at all sampling sites. Sampling equipment is selected based on the constituents that are being investigated, the type of analyses that are to be performed, and site conditions, including velocity and maximum depth of water. The Iowa WSC follows equipment-design criteria and guidelines referenced in Office of Surface Water memorandum 93.01.

Sample Handling and Storage

The quality of sediment data provided by a sediment laboratory is affected by the quality of the samples received from the field (Knott and others, 1992, p. 2). Iowa WSC personnel are required to prepare sample labels, analysis instructions, and sample documentation according to guidelines presented in Knott and others (1992).

Prior to when sample containers are obtained for use on field trips, they are stored in the sediment lab cage area with the lids in place. During field trips and prior to use, sample containers are stored in the field vehicle with the lids in place. Once the containers have been filled with sediment samples, the samples are stored for the remainder of the field trip in the field vehicle or in the motel room. After the field trip, samples are logged with sediment lab log sheets and are stored until analyzed.

High-flow Conditions

High-flow conditions at most streams, unless the streams are subject to the effects of backwater, are associated with high-energy conditions. The sediment load and particle sizes associated with high flows are significant factors in sediment studies performed by the Iowa WSC. To ensure that field personnel are aware of their responsibilities in obtaining sediment samples at appropriate sites during high-flow conditions, a list of sediment sites and sampling requirements are provided to the field technician as well as kept in the field folders and the Iowa WSC Flood Plan. The individual responsible for ensuring that sediment samples are obtained during opportunities provided by high-flow conditions is the Flood Coordinator, the Hydrologic Data Section Chief, Field Office Chief, and the Field Technician responsible for the individual station. The individual responsible for ensuring that the proper sampling equipment and methods are used during high-flow conditions is the Sediment Specialist. The Sediment Specialist is also responsible for providing answers to Iowa WSC personnel who have questions concerning high-flow sampling equipment or sampling procedures.

Cold-Weather Conditions

Sediment-sampling activities in Iowa WSC include obtaining samples during periods of subfreezing temperatures. During cold-weather conditions, field personnel should take every precaution to ensure their personal safety. Additionally, field personnel should attempt to ensure that equipment is not damaged by floating slabs of ice and that nozzles are not clogged with ice crystals.

When floating slabs of ice pose the danger of damaging sampling equipment, such as during spring breakup, field personnel may manage only to obtain surface samples between the floating slabs of ice (Edwards and Glysson, 1988, p. 86). The procedure is noted on the field note sheet and sample label. When anchor ice and frazzle ice are present, it may be necessary to move the sampling equipment quickly through ice crystals to avoid clogging the nozzle. This procedure is also noted on the field note sheets and sample label.

Site Documentation

A station description is prepared for each new sediment-sampling site. At sampling sites where streamflow-gaging activities occur, the description of sediment activities is included in the streamflow-gaging-station description. A list of elements included in each station description, along with an explanation of what items are included with each element, and is presented in the attachment to Office of Surface Water memorandum 91.15. At sites where sediment samples are collected but other streamflow data are not collected, the station descriptions are structured similarly to those for streamflow-gaging stations, and contain similar informational items (Kennedy, 1983, p. 2). At sampling sites where gage houses have been installed, station descriptions are kept in the gage house for the purpose of providing field personnel with information pertinent to sediment-sampling procedures for that particular site. Station descriptions are included in the field folder and are maintained in the office files. Each description includes specific information explaining where the site samples are to be taken and what method is to be used.

The responsibility of ensuring that field copies of station descriptions located at gage houses are kept current is held by the field personnel assigned to regularly run specific field trips. Station descriptions are kept current by annual review and updating by the field person assigned to that station. Station descriptions are reviewed to ensure that they are current by Field Office Chief and the Sediment Specialist. These reviews are made once each year. When a deficiency is identified during the review of station descriptions, the deficiency is corrected by Field Office Chief or Sediment Specialist and the field technician is informed of the deficiency.

Processing and Analysis of Sediment Data

Sediment and associated streamflow data are compiled to produce sediment records for specific sites. Data processing of periodic measurements consists of four steps: tabulation, evaluation, editing, and verification (Office of Surface Water memorandum 91.15). The Iowa WSC follows the considerations and guidelines presented in Porterfield (1972), Guy (1969), and Office of Surface Water memorandum 91.15 in carrying out these four steps.

Sediment records are worked at intervals when analyses are completed by lab and as time allows. Check lists are included with each record folder to document progress. All records are checked by the Sediment Specialist in the Iowa WSC. Any deficiencies are corrected before publishing the records.

The responsibility for ensuring that appropriate procedures are correctly applied in processing sediment data is held by Sediment Specialist. During the time the sediment data are being processed for the year, field notes and work sheets for each site are maintained in the field office out of which that station is maintained. After the record has been completed, field notes and work sheets are maintained in the Iowa WSC backfiles.

Sediment Laboratory

A sediment laboratory is operated in the Iowa WSC. The laboratory is equipped to perform full concentrations and size analysis. A separate quality assurance plan is maintained for Iowa WSC sediment laboratory, and can be found in Open File Report 91-467, Quality assurance Plan for the analysis of fluvial sediment by laboratories of the USGS.

Sediment Station Analysis

A sediment station analysis is written for each sediment station operated by the Iowa WSC each water year. The sediment station analysis is a summary of the sediment activities at the station for a given year. The analysis describes the coverage of sampling, the types of samples and sampling, changes that might affect sediment transport or the record, and the methods and reasoning used to compute the record. Information included in the sediment station analysis is presented in a thorough manner, such that the checker and the reviewer can determine from the analysis the adequacy of the activities in defining the record and in accomplishing the objectives defined for the station (Office of Surface Water memorandum 91.15).

Elements included in each sediment station analysis are listed in Office of Surface Water memorandum 91.15 along with descriptions of the elements and examples. Analyses are kept online and a hardcopy is filed with each record. All records are backfiled when the records have been published. Currently, there are no specific guidelines as to what is retained in the backfile. The Iowa WSC keeps all plots, concentration tables and printouts, and load computation printouts with the records. The Sediment Specialist is responsible for the sediment stations while project chiefs are responsible for their sites, if they differ from the regular sediment stations.

Sediment Analysis Results

The end results of the sediment work are the publishing of the daily concentrations and daily loads (tons/day). The Sediment Specialist has the final approval and ensures quality of product. The Iowa WSC also publishes the lab parameter value of specific conductance and the field parameter of water temperature of each sediment sample. All this data is published in the Annual Water Data Report, with the same quality guideline as discharge data.

Sediment Data Storage

Data files for sediment are stored in paper form for each water year and are filed with the sediment computation printouts. In addition, all lab analyses of concentration and size are in computer files which are stored on CD backup disc. The Sediment Specialist ensures the data on file is complete, entered in the database and reviews the data for errors at the time of records processing.

Database Management

Surface-water data have been collected by personnel of the USGS and stored in computer databases for more than 20 years. Proper storage and maintenance of surface-water data are critical components in the effective utilization of those data. Surface-water data in the Iowa WSC are stored in the NWIS database. The following is a list of responsibilities of employees involved in database management.

All Project Chiefs are responsible for:

1. Ensuring that surface-water data collected, computed, or interpreted as part of their project is done so in accordance with all applicable QA guidelines.

The Database Administrator (SW) is responsible for:

1. Maintaining real-time station network such as reviewing “raw” and decoded data, obtaining PASS assignments for new stations, and setting up DECODES for formatting “raw” data.
2. Ensuring the integrity of the surface water database.
3. Review of surface-water records published in annual data report.
4. Handling any requests related to surface water, ground water, and water quality and general information.
5. Entering new surface-water and water-quality stations into the Ground Water Site Inventory System (GWSI).
6. Flagging all surface-water data “final” after records are reviewed.
7. Providing training and technical assistance for the Iowa WSC databases.
8. Updating manuscripts and daily values tables for stations on the Web.
9. Advising the System Administrator as to when new users have been trained on Iowa WSC policies for database use.

The Surface-Water Specialist is responsible for:

1. Providing technical assistance for surface-water data collection and data interpretation.
2. Ensuring that peak-flow file is updated annually.
3. Ensuring the integrity of the surface-water data base.

The Water-Quality Specialist is responsible for:

1. Providing technical assistance for water-quality data collection and data interpretation.
2. Ensuring the integrity of the water-quality data base.

3. Handling requests for water-quality information contained in the NWIS data base.

The Ground-Water Specialist is responsible for:
1. Providing technical assistance for ground-water data collection and data interpretation.
2. Review and entry of ground-water data into GWSI.
3. Ensuring the integrity of the ground-water data base (GWSI) and controlling access to data base.

The System Administrator is responsible for:
1. Verify and updating html files for new stations on the Web.
2. Controlling access to NWIS database.
3. Controlling access to the surface water database to protect against unauthorized use.
4. Maintaining ADAPS programs and communicating problems to Site Administrator; training others in use of ADAPS.

The Field-Office Chiefs are responsible for:
1. Ensuring the quality of data to be entered and maintained in the various databases are of the highest quality.

The Hydrologic Data Section Chief is responsible for:
1. Ensuring that all surface-water data is collected and processed to USGS standards and procedures.
2. Works in concert with surface-water, ground-water, and water-quality specialists to ensure that all surface-water, ground-water, and water-quality data are collected and processed to USGS standards and procedures.
3. Reviewing computed surface-water records for compliance with proper procedures.

Publication of Surface Water Data

The act of Congress (Organic Act) that created the U.S. Geological Survey in 1879 established the Survey's obligation to make public the results of its investigations and research and to perform, on a continuing, systematic, and scientific basis, the investigation of the geologic structure, mineral resources and products of the National domain (U.S. Geological Survey, 1986, p. 4). Fulfilling this obligation includes the publication of surface-water data and the interpretive information derived from the analyses of surface-water data.

Publication Policy

The USGS has created specific policies pertaining to publication of data and interpretation of those data. All personnel, including those of this WSC, are required to abide by those policies. A brief summary of goals, procedures, and policies are presented in U.S. Geological Survey (1986, p. 4-37).

All information obtained through investigations and observations by the staff of the USGS or by its contractors must be held confidential and not be disclosed to others until the information is made available to all, impartially and simultaneously, through Director-approved formal publication or other means of public release, except to the extent that such release is mandated by law (U.S. Geological Survey, 1986, p. 14). With the approval of the Director, hydrologic measurements resulting from observations and laboratory analyses, after they have been reviewed for accuracy by designated USGS personnel, have been excluded from the requirements to hold unpublished information confidential (U.S. Geological Survey, 1986, p. 15).

All interpretive writings in which the USGS has a proprietary interest, including abstracts, letters to the editor, and all writings that show the author's title and USGS affiliation must be approved by the Director before release for publication. The objectives of the Director's review are to final-check the technical quality of the writing and to make certain that it meets USGS publication standards and is consistent with policies of the USGS and Department of the Interior. Director's approval ensures that (1) each publication or writing is impartial and objective, (2) has conclusions that do not compromise the USGS's official position, (3) does not take an

unwarranted advocacy position, and (4) does not criticize or compete with other governmental agencies or the private sector (U.S Geological Survey, 1991, p. 10).

Types of Publications

Various types of book publications released by the USGS are available in which surface-water data and data analyses are presented. Publications of the formal series include the Water-Supply Paper, the Professional Paper, the Bulletin, the Circular, the Techniques of Water-Resources Investigations, Special Reports, and Selected Papers in the Hydrologic Sciences (U.S. Geological Survey, 1986, p. 42). Publications in the informal series include the Water-Resources Investigations Report, the Open-File Report, USGS fact sheets, and the Administrative Report (U.S. Geological Survey, 1986, p. 52). Included in the Open-File Report series are data reports. Surface-water data collected by the Iowa WSC are published each year in a hydrologic data report that belongs to the annual series titled "U.S. Geological Survey Water-Data Reports." Factors considered by the Iowa WSC when deciding which form of publication should be utilized in presenting various types of information are presented in Green (1991, p. 14).

Review Process

Procedures for publication and requirements for manuscript review by USGS are summarized in U.S. Geological Survey (1991, p.36-41). The Iowa WSC fulfills those requirements for review and approval of reports prior to printing and distribution. All reports written by USGS scientists in connection with their official duties must be approved by the originating Division and the Director. At least two technical reviews of each report are required by USGS (U.S. Geological Survey, 1991, p. 36). Competent and thorough editorial and technical review is the most certain way to improve and assure the high quality of the final report (Moore and others, 1990, p. 24). Principles of editorial review and responsibilities of reviewers and authors are presented in Moore and others (1990, p. 24-49). Open-File Reports are not required to receive editorial review, but are reviewed for policy and reproducibility (U.S. Geological Survey, 1991, p. 36).

Prior to sending the annual data report to the printer, the report is reviewed by the Hydrologic Data Section Chief, a person from outside the data section, the Publication Section Chief, and the Iowa WSC Director. The Iowa WSC Director approves the report for printing and distribution. Two proof copies of the report are obtained from the printer and reviewed for errors and print quality by the authors and Publications Section Chief prior to final printing. If problems are found, the Publication Section Chief contacts the printer. After final printing, a subset of the printed reports is reviewed by the Hydrologic Data Section Chief prior to distribution.

Safety

Performing work activities in a manner that ensures the safety of personnel and others is of the highest priority for the USGS and the Iowa WSC. Beyond the obvious negative impact unsafe conditions can have on personnel, such as accidents and personal injuries, they also can have a direct effect on the quality of surface-water data and data analysis. For example, errors may be made when an individual's attention to detail is compromised when dangerous conditions create distractions. So that personnel are aware of, and follow, established procedures and policies that promote all aspects of safety, the Iowa WSC communicates information and directives related to safety to all personnel by in-house training classes, memorandums, showing videos, verbal and written communication between supervisors and staff, and safety posters. Specific policies and procedures related to safety can be found in the "Occupant Emergency Plan" for the Iowa City Federal Building where the Iowa WSC Office is located, site specific JHAs, site specific bridge plans, and the Iowa WSC Flood Plan. It is the responsibility of each employee to attend scheduled safety training, read all assigned safety material, and practice safe work habits at all times.

An individual has been designated as Safety Officer by the Iowa WSC Director. The Safety Officer's duties include knowing all safety requirements, organizing all safety inspections, conducting needed in-house safety classes, organizing needed safety training, and assisting in filing all required safety forms, including accident forms. The Safety Officer attends regularly scheduled meetings with other Safety officers in order to share information and review and discuss safety policy.

Personnel who have questions or concerns pertaining to safety, or who have suggestions for improving some aspects of safety, direct those questions, concerns, and suggestions to the Iowa WSC Safety Office, Hydrologic Data Section Chief, or the Iowa WSC Director.

Training

Ensuring that personnel obtain knowledge of correct methods and procedures is a vital aspect of maintaining the quality of surface-water data and data analysis. By providing appropriate training to personnel, the Iowa WSC increases the quality of work and eliminates the source of many potential errors.

Available training is communicated to all employees in the Iowa WSC through the use of electronic mail and other oral or written means. In addition, training needs are discussed twice annually at each employee's performance interviews. Personnel are encouraged to seek appropriate training at all times and to identify needs or specific requests for training to the Hydrologic Data Section Chief or Iowa WSC Director. In August of each year, the Iowa WSC senior staff meets to discuss and prioritize training for the following year. The result of this meeting is the Iowa WSC training plan. Room for contingency training exists in this plan and requests for training other than that on the Iowa WSC training plan should be communicated to the Hydrologic Data Section Chief or Iowa WSC Director. Needed safety training should be included in the annual training plan. New or inexperienced employees are given on-the-job training under the direction of the Hydrologic Data Section Chief, Field Office Chief, and other experienced field hydrographers.

Summary

Information included in the Iowa WSC Surface-Water Quality-Assurance Plan documents the policies and procedures of the Iowa WSC that ensures high quality in the collection, processing, storage, analysis, and publication of surface-water data. Specific types of surface-water data discussed in this report include stage, streamflow, sediment, and basin characteristics. The roles and responsibilities of Iowa WSC personnel for carrying out these policies and procedures are presented, as are issues related to management of the computer data base and issues related to employee safety and training.

References Cited

Arcement, G.J., and Schneider, V.R., 1989, Guide for selecting Manning's roughness coefficients for natural channels and flood plains: U.S. Geological Survey Water-Supply Paper 2339, 38 p.

Barnes, H.B, 1967, Roughness characteristics of natural channels: U.S. Geological Survey Water-Supply Paper 1849, 213 p.

Benson, M.A., and Dalrymple, Tate, 1967, General field and office procedures for indirect discharge measurements: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A1, 30 p.

Bodhaine, G.L., 1982, Measurement of peak discharge at culverts by indirect methods: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A3, 60 p.

Buchanan, T.J., and Somers, W.P., 1969, Discharge measurements at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A8, 65 p.

Carter, R.W., and Davidian, Jacob, 1968, General procedures for gaging streams: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A6, 13 p.

Dalrymple, Tate, and Benson, M.A., 1967, Measurement of peak discharge by the slope-area method: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A2, 12 p.

Davidian, Jacob, 1984, Computation of water-surface profiles in open channels: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A15, 48 p.

Edwards, T.K., and Glysson, G.D., 1988, Field methods for measurement of fluvial sediment: U.S. Geological Survey Open-File Report 86-531, 118 p.

Green, J.H., 1991, USGS project and report management guide: U.S. Geological Survey Open-File Report 91-224, 152 p.

Guy, H.P., 1969, Laboratory theory and methods for sediment analysis: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. C1, 58 p.
Guy, H.P., 1970, fluvial sediment concepts: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. C1, 55 p.
Guy, H.P., and Norman, V.W., 1970, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. 2, 59 p.
Hubbard, E.F., 1992, Policy recommendations for management and retention of hydrologic data of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 92-56, 32 p.
Kennedy, E.J., 1983, Computation of continuous records of streamflow: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A13, 53 p.
____ 1984, Discharge ratings at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A10, 59 p.
____ 1990, Levels at streamflow gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A19, 31 p.
Kilpatrick, F.A., and Schneider, V.R., 1983, Use of flumes in measuring discharge: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A14, 46 p.
Knott, J.M., Glysson, G.D., Malo, B.A., and Schroder, L.J., 1993, Quality assurance plan for the collection and processing of sediment data by the U.S. Geological Survey, Water Resources Division: U.S. Geological Survey Open-File Report 92-499, 18 p.
Knott, J.M, Sholar, C.J., and Matthes, W.J., 1992, Quality assurance guidelines for the analysis of sediment concentration by the U.S. Geological Survey sediment laboratories: U.S. Geological Survey Open-File Report 92-33, 22 p.
Matthai, H.F., 1967, Measurement of peak discharge at width contractions by indirect methods: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. A4, 44 p.
Moore, J.E, Aronson, D.A., Green, J.H., and Puente, Celso, 1990, Report planning, preparation, and review guide: U.S. Geological Survey Open-File Report 89-275, 81 p.
Novak, C.E., 1985, USGS data reports preparation guide, Water-Resources Investigations, book 3, chap. C3, 66 p.
Porterfield, George, 1972, Computation of fluvial-sediment discharge: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. C3, 66 p.
Rantz, S.E., and others, 1982, Measurements and computation of streamflow, volumes 1 and 2: U.S. Geological Survey Water-Supply Paper 2175, 631 p.
Sauer, V.B., and Meyer, R.W., 1992, Determination of errors in individual discharge measurements: U.S. Geological Survey Open-File Report 92-144, 21 p.
Schroder, L.J., and Shampine, W.J., 1992, Guidelines for preparing a quality assurance plan for the district offices of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 92-136, 14 p.
Shampine, W.J., Pope, L.M., and Koterba, M.T., 1992, Integrating quality assurance in project work plans of the U.S. Geological Survey: U.S. Geological Survey Open-File Report 92-162, 12 p.
Shearman, J.O., 1990, User's manual for WSPRO-- A computer model for water surface profile computations: U.S. Federal Highway Administration Report, FHWA-IP-89-027, 187 p.
Smoot, G.F., and Novak, C.E., 1968, Calibration and maintenance of vertical-axis type current meters: U.S. Geological Survey Techniques of Water-Resources Investigations, book 8, chap. B2, 15 p.
U.S. Geological Survey, 1986, Water Resources Division publications guide; Volume I, Publications policy and text preparation, 2d ed., *revised by* D.W. Alt and K.T. Iseri: U.S. Geological Survey Open-File Report 87-0205, 429 p.
U.S. Geological Survey, 1991, Suggestions to authors of the reports of the United States Geological Survey, 7th ed., *revised and edited by* W.R. Hansen: U.S. Geological Survey special book publication, 289 p.

Appendix 1 - Office of Surface Water Memorandums

The following memorandums were cited in this report. The memorandums are provided in their entirety in a separate report by the Office of Surface Water.

- Office of Surface Water memorandum 93.12
- Office of Surface Water memorandum 93.11
- Office of Surface Water memorandum 93.07
- Office of Surface Water memorandum 93.01
- Office of Surface Water memorandum 92.11
- Office of Surface Water memorandum 92.10
- Office of Surface Water memorandum 92.09
- Office of Surface Water memorandum 92.08
- Office of Surface Water memorandum 92.05
- Office of Surface Water memorandum 92.04
- Office of Surface Water memorandum 91.15
- Office of Surface Water memorandum 91.09
- Office of Surface Water memorandum 90.10
- Office of Surface Water memorandum 90.08
- Office of Surface Water memorandum 90.01
- Office of Surface Water memorandum 89.08
- Office of Surface Water memorandum 89.07
- Office of Surface Water memorandum 88.18
- Office of Surface Water memorandum 88.17
- Office of Surface Water memorandum 88.07
- Office of Surface Water memorandum 87.05
- Office of Surface Water memorandum 85.17
- Office of Surface Water memorandum 84.05
- Office of Surface Water memorandum 83.07
- Water Resources Division memorandum 92.59
- Water Resources Division memorandum 77.83
- Water Resources Division memorandum 77.60
- Water Resources Division memorandum 71.73
- Office of Water Quality memorandum 80.17
- Office of Water Quality memorandum 80.07
- Office of Water Quality memorandum 79.17
- Office of Water Quality memorandum 77.07
- Office of Water Quality memorandum 76.17
- Office of Water Quality memorandum 76.04
- Memorandum from the Chief, Branch of Operational Support, May 7, 1993.

Appendix 2 - Procedures For Establishing New Gaging Stations

1. Select a site that is hydrologically reasonable.

A. Check maps.
B. Talk with local residents.
C. Locate control, controls, tributary influence, diversions, backwater, etc....
D. Would site be a good location for indirect measurements?
E. Would an auxiliary site be required to measure extreme high water and if so could it be reached by road vehicle?
F. Refer to Traffic Control Plan to verify that safe high-flow measurements can be made.

2. Office requirements

A. Determine station number.
B. Determine location, lat-long, legal description, county, hydrologic unit, stream mile.
C. Determine drainage area --contributing area
D. Is the natural flow of stream affected by diversions, reservoirs, ponds, backwater, etc. Use maps for checking these items.
E. Insert station in site file
F. Obtain PASS assignment.
G. Base discharge if required.
H. Create data descriptors in ADAPS.
I. Add station to DCP network list.
J. Add station to plot programs/lookup tables.
K. Notify NOAA/NWS/COE and local and state cooperators.
L. Create station description.
M. Make file folders.

3. Field requirements

A. Obtain permission to install shelter, wire-weight, etc....
B. Purchase needed equipment and supplies.
C. Make special effort to talk with local residents for history of stream, high-flow events, low-flow events, etc...., explain reason for installing the gaging station and how data is obtained and used, and funded by taxpayers.
D. Install equipment in a reasonable location for collecting good data; solar panel, rain gage, sensors, DCP antenna, CSI.
E. Install RM'S with at least one located off the bridge. Run levels. Obtain nearest official benchmark elevation, and run mean sea level.
F. Paint bridge marks from left end of bridge.
G. Obtain cross section and bridge geometry with elevations, also elevations of flow over the road and road profile.
H. Clear measuring section.
I. Make discharge measurement.
J. Take pictures of shelter, equipment, wire-weight gage, bridge, upstream-downstream, and the control.
K. Notify appropriate personnel that the gage has been installed and transmitting.
L. Return to site to check to see if equipment is working and all tools have been picked up and area policed.
M. Another routine gaging station is on

Appendix 3 - Field Trip And Gage Inspection Check List

PRIOR TO FIELD TRIP

1. Look at sites on computer to check transmit time, battery voltage, etc.
2. Review last field trip notes to see what's needed
3. Load up spare equipment (DCP's, pressure transducers, batteries, control units, antennas, etc.)
4. Let spouse (and/or supervisor) know that you'll be out of town - (trip itinerary)

GAGE VISIT

1. Outside gage reading—wire weight, staff, or of tape down from reference point
2. Clean and lube wire weight gage if necessary
3. Record DCP readings and compare with outside gage--gives information about condition of orifice and gages. Record other pertinent information in the field log book, wading section, depth, suspension, etc.
4. Download logged data.
5. Check nitrogen tank pressure, line pressure, and bubble rate, write on field sheet and field log book and compare with previous visits--indicates gas loss, regulator problems, varying bubble rates indicate possible Safepurge problems
6. Clean battery terminals if needed, and load test battery or amp test using volt meter, under load: if battery voltage is <10 volts or if battery is more than 5 years old, replace. If you've replaced several batteries, check solar panel and regulator and current draw of gaging equipment
7. Visually check all wiring, antenna cables, power leads, and ground wires for proper connection.
8. Clean and sweep inside gage if necessary.
9. After measurement record discharge and shift in field log book and plot measurement on rating curve.

OUTSIDE OF GAGE HOUSE

1. Check ground rod/wire connections
2. Repair gage house leaks--ALL GAGE HOUSES are to be VENTED.
3. Check and clean rain gage--funnel, buckets, flush if applicable, calibrate annually.
4. Check antenna cable connections and antenna (azimuth and elevation).
5. Visually check solar panel and wiring--replace if damaged
6. Cut weeds and brush around gage house if needed.

INSPECTIONS IN WATER

1. Orifice pipe secure? Clean if necessary.
2. Pump well point where applicable.
3. Note control conditions.
4. Verify peaks with HWM's or check CSG pipe.
5. Obtain Point of Zero Flow (PZF) if possible, two per year are desired.
6. Winterize prior to cold weather.

APPENDIX 3 -- Continued

POST FIELD TRIP

1. Clean truck
2. Repair damaged wading rods, bridge cranes, reels, etc.
3. Restock truck with any supplies used during field trip
4. Send equipment in need of repair to manufacturer

DAY AFTER FIELD TRIP

1. Enter measurements, shifts, datum, etc. into computer
2. Process records until completed in order to keep records current.

Appendix 4 - Station Description With Bridge Plan

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Station Number: 05421740
Date Revised: 10/27/2005
Prepared By: J.C.McVay
Date Reviewed: 10/27/2005
Reviewed by: S.R. Strader

Wapsipinicon River near Anamosa, IA

Description of Gaging Station: Wapsipinicon River near Anamosa, IA

Location: Lat 42°05'00", long 91°16'02", in SW 1/4 NW 1/4 SW 1/4 sec. 13, T.84N, R.04 W, Jones County, Hydrologic Unit 07080103, on the left bank, 6 ft. upstream of bridge on Shaw road, 1.5 miles below the dam at Anamosa, and 700 feet above the confluence with the mouth of Dutch Creek, and an unnamed creek. Shaw road is a two lane dirt road, the bridge is an overhead steel bridge.

Road Log: From Iowa City, travel north on State Hwy 1 for 32 miles to U.S Hwy 151, travel east on U.S Hwy 151 app. 4 miles, turn right (south) on Shaw Road travel 1500 ft. to intersection of Shaw road and Lead Mine Road, gage is before the bridge that crosses the Wapsipinicon River.

Alternate Route: From Dubuque travel southeast on U.S. Hwy 151, 47 miles to Shaw Road, turn left (south) on Shaw Road travel 1500 ft. to intersection of Shaw road and Lead Mine Road, gage is before the bridge that crosses the Wapsipinicon River.

Bridge Plan: Bridge Safety Plan F: Rural road with low traffic flow and moderate encroachment.
Ten or more cones will be placed along the bridge, no more then 100 feet apart. The signs that are furthest away from the bridge will read, “Bridge Work Ahead”. The next sign that is closer to the bridge will read, “One Lane Road Ahead”. The sign closest to the bridge on the work side will read “Prepare To Stop”. The truck may be on the roadway with minor encroachment and the light bar turned on. The cones will be no closer than 10 ft. from the opposite side of the bridge. The worker will be wearing a reflective vest at all times that they are on the bridge. See Sketch Attached.

Drainage Area: 1575 sq. mi.

Establishment: Gage established July 10, 2002.

Gage: Gage is a 2’ X 1.5’ metal shelter. It is accessed on the left bank upstream end of the bridge. The gage houses these instruments including a Sutron Accubar Pressure Sensor, a Design Analysis H500XL DCP and H222 transmitter. Base gage is the wire-weight. Check bar elevation 33.761 ft. by levels. 33.752 ft. by dial. It is located on the upstream side of the bridge, 70 ft. from the left bank bridge pier. The orifice line is located on the left bank upstream side of the bridge. The CSG is located on the left bank downstream side of the bridge, attached to the concrete pier. There is also a U.S.G.S rain gage located on the gage.

Reference and Benchmark:
RM1: (Basic) Chiseled Square on top of left downstream wing wall. Elev. 30.766ft. gage datum.

RM 2: Chiseled square on top of right downstream wing wall. Elev. 36.048 ft. gage datum.

RM 3: Chiseled square on left upstream wing wall. Elev. 31.278 ft. gage datum.

RM 4: Chiseled X on right upstream wing wall curb. Elev. 36.493 ft. gage datum.

RM 5: Chiseled X on left upstream wing wall. Elev. 30.768 ft. gage datum.

RP1: Four hash marks on downstream steel rail on bridge at station 55 from the left bank. Elev. 33.630 ft. gage datum.

CSG 1: Top of stick, Elev: 25.845 ft. gage datum. Pin, Elev: 15.784 ft. gage datum. Stick length: 10.061 ft.

Zero of gage is 755.000 ft. NGVD of 1929.

Level Last Run: **April 29, 2003**.

History: No previous gage at site.

Channel Control: The Wapsipinicon River runs through the town of Anamosa just before it reaches the gage south of town. Upstream of U.S. Highway 151, the right bank is very steep leading to a cliff which is 150 ft high. The left bank is next to a small quarry which may store water during high flows. It takes a fairly sharp turn to the left bank side about 800 ft upstream. Downstream of the gage, the channel is mostly straight for about 800 ft., where it starts to bend to the right slightly. The left bank is followed by a road (Lead Mine Road), and is 20 feet high in places, and lightly wooded. On the left bank next to road is another rise in elevation which has some residential homes, while the right bank is sloping slowly up to a residence and livestock facility. Two creeks enter the river from either side approximately 800 ft. downstream of the gage.. A power dam 1.5 miles upstream will show fluctuations in flow at the gage.

Discharge Measurements: Low water and ice measurements are made by wading 800 ft., downstream of the gage, at the confluence of the two creeks entering the river. The section is a rock riffle, which is obvious at wading stages. Make sure that the two creeks are not influencing the total discharge of the river before measuring at this location. Wading measurements can also be made 100 ft. upstream of the gage, but at about 0.5 ft. less of a stage as the riffle downstream. Bridge measurements are made from the downstream side of the bridge on Shaw Road. Maximum wading stage is approximately 6.20 ft. gage datum. This may change as more measurements are made. ACDP tethered boat measurements can be made at the US Hwy 151 bridge 0.5 miles upstream with caution being taken with reference a moving bed.

Sediment Samples: None are taken here.

Floods: Flood of May 26, 2004 reached a stage of 22.73 ft. with a discharge of 22,000 cfs. Floods occurred on July 18, 1968, and May 18, 1999. No gage height or discharge was determined. Gage height and discharge information is available for these floods at other sites on the river.

Point of Zero Flow: Undetermined.

Winter Flow: Affected by ice during winter months and ice jams during breakup periods in the spring.

Regulation and Diversion: Dam upstream at Anamosa.

Accuracy: Records good except those for periods of ice effect.

Cooperation: NSIP site.

Sounding Weights:

15c to
30c 6.2 to 9.0 ft.
50c 9.1 to 12.0 ft.
75c 12.1 to 15.0 ft.
100c over 15.0 ft.

Instruments: (Descriptions & Serial Numbers)

Design Analysis H500XL DCP	S/N
Design Analysis H222 transmitter	S/N
Sutron Accubar Pressure Sensor (Model 6)	S/N 013119

Sign Distances:

Speed Limit	A (ft)
25	100
35	250
45	350
55	500

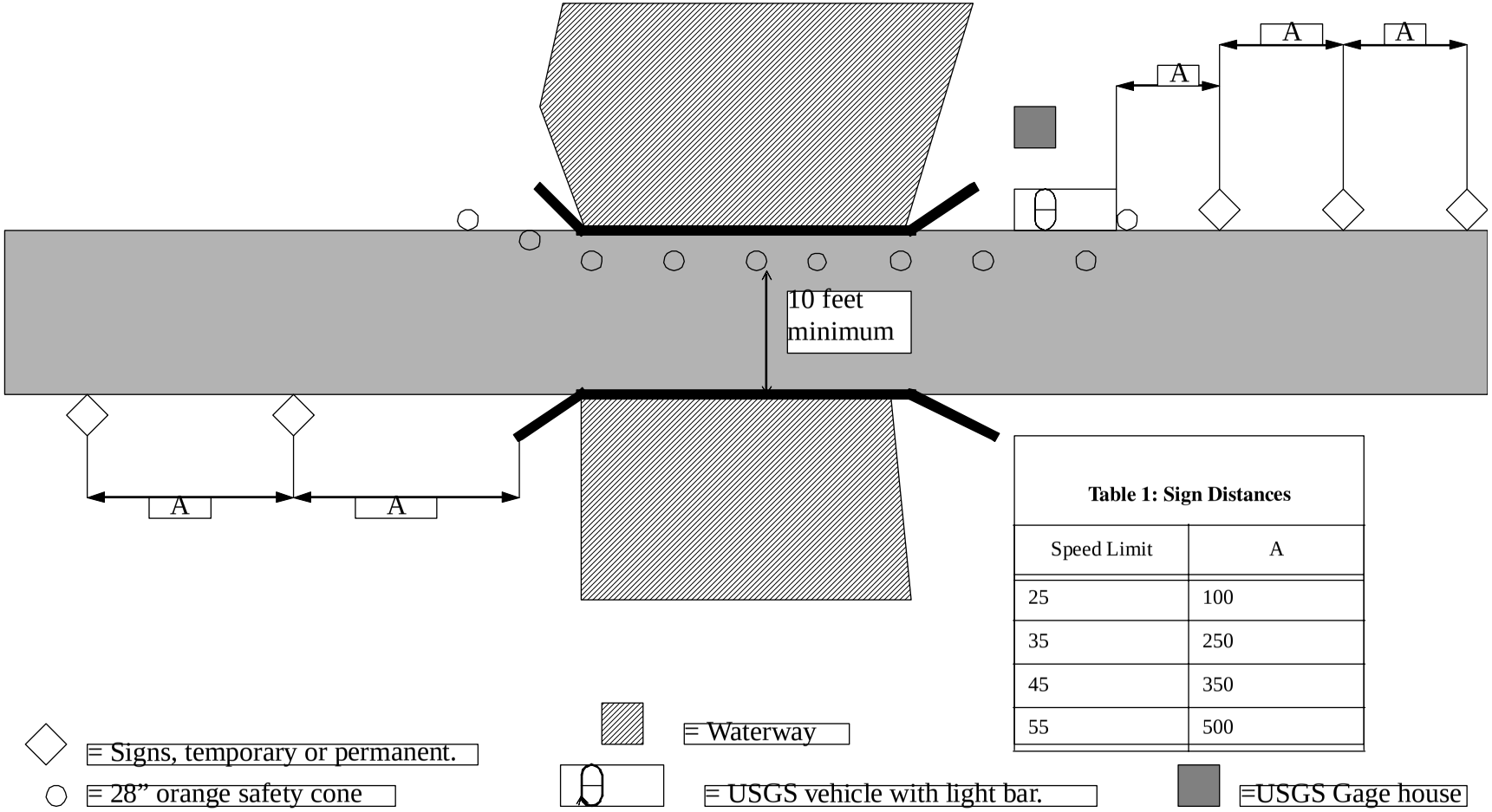
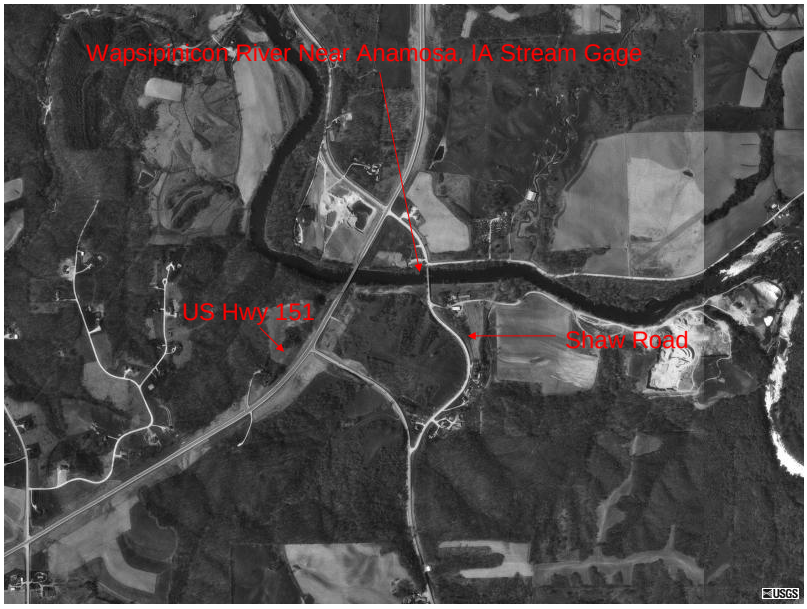
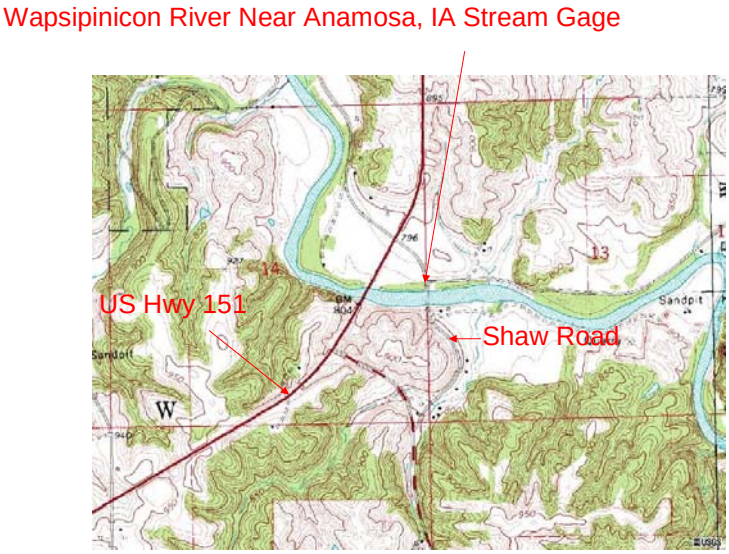


Table 1: Sign Distances

Speed Limit	A
25	100
35	250
45	350
55	500


Wapsipinicon River Near Anamosa, IA Stream Gage
US Hwy 151
Shaw Road


Wapsipinicon River Near Anamosa, IA Stream Gage
US Hwy 151
Shaw Road
14
13
Sandpit
Sandoff
W

Error!

MAPQUEST
0
600m
1800ft
E Mill St
Cemetery Dr
Buffalo Creek
2nd St
E 2nd St
E 4th St
64
E 2nd St
Breca Ridge Dr
Jordan Dr
Tower Rd
115th St
120th St
S Elm St
Lower Park Rd
Fawn Creek
Hidden Valley Rd
64
E34
212th Ave
Red Fox Rd
Upper Park Rd
Grant Wood Rd
Edinburgh Rd
202th Ave
Lead Mine Rd
Dear Trl
Dutch Creek
Shaw Rd
151
215th Ave
White Tail Rd
Forest Chapel Rd
X40
Landis Rd
90th St
©2003 MapQuest.com, Inc.; ©2003 GDT, Inc.

Appendix 5 - Job Hazard Analysis

SITE SPECIFIC JOB HAZARD ANALYSIS		
SITE and ID: 05454300 Clear Creek near Coralville, Iowa		DATE: December 3, 2003
Recommended Protective Clothing Cell Phone, gloves, Flashlight, steel-toed shoes, back support, shovel, broom, cable cutters, sounding cable markers, marine radio, air horn, Safety glasses, personal flotation device (PFD), Foul weather gear, ice auger, ice chisel, hard hat, waders, cable puller, two way radios, appropriate traffic control devices.		**Clear Creek is a wading measurement below a stage of 4.2 ft. +/-** **Wading is usually done 50-100 feet upstream or downstream of the gage. Depths are fairly even all the way across. Wading section is generally sand that is usually firm with a few soft spots. Watch for possible debris in channel.**
Prepared by: R.D. Goodrich		
Reviewed by:		
Sequence of Basic Job Steps	**Potential Accidents/Hazards**	**Recommended Safe Job Procedures**
		PFD'S MUST BE WORN WHEN "ON, IN OR OVER THE WATER"
Wading Measurements: Bridge Plan A for wading, cableway or ice measurements Use Bridge Plan "G" for Bridge measurements.		**BRIDGE PLANS FOR EVERY SITE ARE IN GAGE HOUSE.**
Bridge Plan G Rural road with low traffic flow and minimal encroachment.		
	Ice on bridge roadway.	Assess traffic problems associated to poor driving conditions.
	Fog or reduced visibility.	Assess traffic problems associated to poor driving conditions.
Making measurement - Wading, Ice, and Bridges		**Wear your PFD, Make yourself visible**
FLOOD CONDITIONS	ROAD OVERFLOW-	DO NOT DIRVE INTO FLOWING WATER, ROAD DAMAGE CAN BE CONCEALED. Watch stage carefully, make sure you have a safe

		escape route off of the bridge. Be alert to any unusual span motion (bridge)
SEQUENCE OF JOB STEPS	Nitrogen tank at gage	Nitrogen tank is secured to gage with chain attached to bolts in the wall.
Inspect Gage, Determine measurement method.	Traffic	Use VEHICLE WARNING LIGHTS, WEAR YOUR PFD
Bridge		Wear Your PFD
	Bad road conditions	Do not measure from bridge if the road is iced over or if the road is slick from rain.
	Lightning	Do not measure if lightning in area
	Road or shoulder damage.	Test footing carefully.
	Floating or submerged debris.	All reels must have the Retrofit (B and modified A reels) for a breakaway cable. Be alert to debris. Have cutters ready, if sounding cable needs to be cut.
	Boat traffic.	Be aware of surroundings. Have cutters ready if sounding cable needs to be cut.
Wading or Ice		Wear your PFD
	Measuring section	Test footing carefully, be prepared for submerged hazard.
	Storm damage	Check for downed power lines.
	Deep or swift water	Depth x velocity>10 No wading measurement.
	Lightning	Do not enter the stream during an electrical storm
	Floating or submerged debris.	Select wading section carefully. Watch for changing conditions.
Test Ice Conditions	Thin or rotten ice.	Ice measurements require TWO personnel and rescue plans with gear. If the wading section is open then 1 person can make the measurement.
Emergency numbers		**Police/ Sheriff**: 911

		Hospital: 911
Parking.		Truck can be pulled off on side of road near gage. Cones should be put out to alert drivers of the vehicle and overhead lights on.
	Communication from site	Phone at site: 319-339-0256
Maximum wading stage of 4.2 ft. +/-		Do not attempt to wade at stages above 4.2 ft. Stages at this site are routinely below 3.0 ft.
Release from PFDs' for measurement activity	Requires signature of two supervisors. Does not apply to bridge or cableway work.	1st signature _____*for wading measurements below a stage of _____ ft. 2nd signature._____

Appendix 6 - Hydroacoustic Instrumentation—Standards, Policies, and Procedures

This addendum to the Iowa WSC Surface Water Quality-Assurance Plan presents standards, policies, and procedures used by the Iowa WSC specifically related to hydroacoustic instrumentation. Many standards, policies, and procedures documented in the main body of the Surface Water Quality-Assurance Plan apply to the use of hydroacoustics. These include, for example, maintenance of gaging-station infrastructure, site documentation, and general records-working procedures. This addendum documents standards that are unique to the hydroacoustic instruments used by the Iowa WSC. It is expected that this addendum will be updated as the use of hydroacoustics increases and as new instruments, software, and firmware are introduced. This addendum is subdivided by instrument category:

1. Acoustic Doppler current profiler (ADCP)
2. Acoustic Doppler velocity meter (ADV)
3. Acoustic Doppler velocity meter (ADVM)
4. Other hydroacoustic discharge measuring devices.

General

The Iowa WSC Hydroacoustic Specialist is responsible for:

1. Advising the Hydrologic Data Section Chief, the Iowa WSC Surface-Water Specialist, and Project Chiefs on all aspects of the use of hydroacoustic current meters.
2. Updating Iowa WSC users of hydroacoustic instruments on new policies and recommended procedures pertaining to the use of those instruments.
3. Updating Iowa WSC users of hydroacoustic instruments on instrument software and hardware upgrades.
4. Updating Iowa WSC hydroacoustic quality-assurance documents.
5. Advising the Hydrologic Data Section Chief on personnel training.
6. Helping users of hydroacoustic instruments to troubleshoot malfunctions and take corrective actions.
7. Reviewing data, procedures, methods, and documentation regarding hydroacoustics.

Acoustic Doppler Current Profiler

Acoustic Doppler current profilers are used by the Iowa WSC to make medium- and high-water discharge measurements. The Center has eight RD Instruments Rio Grande ADCPs (four 1200 kHz and four 600 kHz). All ADCP operators must read and become familiar with the information contained in the following policy memorandums and reports:

- Scientific Investigations Report 2005-5183, Quality Assurance Plan for Discharge Measurements Using Acoustic Doppler Current Profiles, K.A. Oberg, S.E. Morlock, and W.S. Caldwell.
- Open-File Report 01-01, Discharge Measurements Using a Broad-Band Acoustic Doppler Current Profiler, Simpson
- OSW Technical memorandum 96.02, Interim Policy and Technical Guidance on Broadband ADCPs
- OSW Technical memorandum 2000.03, Software for Computing Streamflow from Acoustic Profiler Data
- OSW Technical memorandum 2000.07, National Coordination and Support for Hydroacoustic Activities
- OWS Technical memorandum 2002.01, Configuration of Acoustic Profilers (RD Instruments) for Measurement of Streamflow
- OSW Technical memorandum 2002.02, Policy and Technical Guidance on Discharge Measurements using Acoustic Doppler Current Profilers
- OSW Technical memorandum 2005.04, Release of WinRiver Software version 10.06 for Computing Streamflow from Acoustic Profiler Data

Field Procedures

Prior to going into the field, the operators ensure that: the ADCP is in working order with the latest approved firmware; their laptop contains the latest approved software; they have sufficient space on a data backup device, such as a USB flash drive, and they have a working laser range finder for measuring edge distances.

1. Each day the ADCP is used, a diagnostic test is performed and the results are recorded. The filename of the diagnostic test is included on notes of any measurement made with the ADCP that day.
2. For each measurement, a moving-bottom check is performed by holding the position of the ADCP in the part of the river thought most likely to have the largest sediment load (usually near the zone of largest flow). The moving-bottom check is recorded and archived with the rest of the measurement-data files. The test should last at least 5 minutes. If the position of the ADCP cannot be held precisely, a moving-bottom check of 10 minutes or more might be needed to differentiate actual boat movement from apparent upstream movement caused by a moving-bottom condition.
3. The estimates used for edge distances shall always be measured. Distance may be measured, using a laser range finder, tag line, or rule.
4. Operators must use the Configuration Wizard feature in WinRiver to set up the measurement. If any settings other than the Configuration Wizard settings are used, the reasons for the user settings are explained on the measurement note sheet.
5. The depth to the transducer below water surface shall always be verified before each measurement.
6. In accordance with OSW requirements, if all of the first four transects are not within 5 percent of the mean, at least four additional transects shall be made. Note: There are exceptions for unsteady flow, equipment malfunction, or operator error.
7. After each measurement, or at least once a day, all measurement data and diagnostic tests are backed up temporarily on a removable medium such as a USB flash drive if the user will not be able put the files on the Iowa WSC network.

Office Post-Field Procedures

ADCP measurements are processed, archived, and reviewed within 5 working days after returning from the field. Data are archived in accordance with the Hydrologic Data Section Archiving Addendum. The ADCP operator is responsible for archiving all ADCP measurement and diagnostic files, processing all measurements, entering the measurement data into the database, and finding a trained ADCP operator to review each measurement.

The reviewer of an ADCP measurement is responsible for ensuring that correct methods were used to collect and process the measurements, measurement notes are accurate, measurement data have been archived correctly, and that the measurement notes have been filed. If any changes are made during the review process, the changes should be discussed with the original ADCP operator, the database updated, and measurement notes filed.

Acoustic Doppler Velocimeter

Acoustic Doppler Velocimeters (ADV), designed for use with a standard USGS top-setting wading rod, are used by the Iowa WSC to make wading discharge measurements. The make and model ADV used for this application is the SonTek Flowtracker. Users are required to follow the policies and guidelines in OSW technical memorandum 2004.04, Policy on the use of the Flowtracker for discharge measurements. The following recommendations are taken from the memorandum.

Field Measurements

1. Prior to use of the Flowtracker, the users familiarize themselves thoroughly with the instrument by reading the Flowtracker Handheld ADV Technical Documentation, including the Introductory Documentation, Operation Manual, and Principles of Operation. Users also familiarize themselves with the Flowtracker handheld controller, including all keypad operations, prior to collecting field data.
2. Prior to and after a field trip, the users perform a full diagnostic test on the ADV, called an ADVCheck, using the manufacturer's Flowtracker Software. The test procedures are described in the Flowtracker Operations Manual. The software displays signal-strength plots for each ADV receiving transducer. The Flowtracker Operations Manual describes the ADVCheck and provides examples of good and problem

signal-strength plots. If signal-strength plots indicate a possible malfunction, the Flowtracker is not used to collect field data. In all instances every diagnostic test is logged to a file. All diagnostic files are archived electronically according the Hydrologic Data Section Archiving Addendum. In the event of an instrument malfunction, diagnostic files can be provided to the manufacturer for troubleshooting. If a malfunction is suspected or if there has been a shock to the probe (such as striking a hard object), an ADVCheck is performed prior to further collection of field data.

3. Prior to each discharge measurement or velocity-collection run, the user checks the ADV, using the handheld controller Systems Functions Menu. The following items are checked:
    - System clock—the clock displays the correct date/time.
    - Recorder status—there is adequate data-storage capacity for the discharge measurement or velocity data run.
    - Temperature data—the ADV probe is immersed in the stream and the temperature noted. At least once daily, the temperature recorded by the ADV is checked against a temperature reading from an independent source, such as a digital thermometer. It is very important for velocity and discharge accuracy for the ADV to record water temperature accurately. A 5-degree (Celsius) error in temperature would result in a 2-percent error in velocity and discharge measurement. The user ensures that the temperature has stabilized prior to start of data collection. The temperature is noted on the discharge measurement note sheet.
    - Battery data—the battery voltage is checked to ensure adequate capacity for the discharge measurement or velocity data run.
    - Signal-to-noise ratios—the Flowtracker technical memorandum recommends that SNRs be greater than 10. Analysis of field data indicates that SNRs can be as low as 3 and adequate data still can be collected. However, data collected with SNRs below 10 are scrutinized carefully, using other quality-assurance parameters described in the Measurement Quality-Assurance section of this memorandum. If low SNRs appear to be causing data-quality problems, a different measurement section might be investigated. Backscatter can change with measurement location.
4. The Flowtracker is designed for mounting on a standard top-setting wading rod. It is recommended that an offset bracket available from the Flowtracker manufacturer be used to mount the Flowtracker probe head to the wading rod. Without the bracket, the Flowtracker sample volume is located about 4 inches from the wading rod. With the bracket, the sample volume is located about 2 inches from the wading rod, closer to the point of depth measurement. The bracket was designed to move the sample volume as close to the wading rod as possible while remaining outside the flow disturbance caused by the wading rod.
5. When mounting the Flowtracker, special care is taken to protect the cable from abrasion. The cable is very prone to environmental noise that can degrade measurement quality.
6. The Flowtracker probe head should be oriented so that the longitudinal axis passing through the center transmitting transducer is parallel to the tagline, and the receiving arm with the red band should be downstream. Effort is made to hold the wading rod level so that the sample volume does not strike a boundary.
7. To avoid striking a boundary, the user should have a sense of where the sample volume is located. Special attention should be paid to depths below 0.3 ft, where boundary conditions can deteriorate.
8. All policies and recommendations for making wading discharge measurements with Price-type current meters are followed when using Flowtrackers, with the exception of the minimum recommended velocity thresholds and the application of alternative means of measuring velocities in the vertical (Rantz, 1982, p. 132).
9. The minimum recommended velocity threshold for the Flowtracker is 0.1 ft/s; the instrument velocity error at 0.1 ft/s is approximately 4 percent. If measured velocities are less than 0.1 ft/s, the measurement should not be rated better than "fair."
10. The one-point (0.6 times depths) vertical-velocity method is used for depths equal to or less than 2.5 feet. For depths greater than 2.5 feet, the two-point (0.2 and 0.8 times depth) method is used. If, when using the two-point method, the 0.2 measured velocity is less than the 0.8 velocity, or if the 0.8 velocity is less than half of the 0.2 velocity, the handheld controller screen informs the user, and the user then has the option to measure the velocity at the 0.6 position (three-point method). The user, in this situation, should measure velocity at the 0.6 position.

11. Special care is taken with the Flowtracker to protect the probe head. If the probe receiver arms are bent or the transducers scratched, the unit is no longer usable and needs to be repaired by the manufacturer. The unit always should be transported by securing it in the manufacturer's carrying case to prevent damage. Other maintenance considerations included Operator's Manual also are followed.
12. It is recommended that measurement files recorded on the handheld controller be downloaded at least once a day for backup purposes.
13. Standard USGS measurement notes may be used to document the discharge measurement. It is Iowa WSC policy that measurement notes be filled out the same as a conventional current meter measurement with the following changes: the ADVcheck file names be noted where the spin test values would be placed, meter type noted as ADV, the serial number be written for the meter number, and the firmware version be noted for the rating used.

Measurement Documentation

For each measurement run of discharge or velocity, a file with a .WAD extension is generated and stored on the handheld controller. The .WAD file is downloaded from the controller, and then the Flowtracker software is used to extract four files from the .WAD file:

1. .CTL file—an ASCII file containing the Flowtracker configuration.
2. .DAT file—an ASCII file containing 1-second velocity component and signal-to-noise ratios.
3. .SUM file—an ASCII file containing station information and summary statistics from each measurement.
4. .DIS file—an ASCII file containing a discharge-measurement summary.

A paper copy of the .DIS file is printed and attached to the measurement note sheet for filing. All four extracted electronic files plus the .WAD file are archived permanently as specified in the Iowa WSC Electronic Discharge Measurement Storage Policy found in Appendix 7. The .WAD file contains important data that are not extracted with any of the four files and could be valuable for instrument diagnostics in the event of malfunctions.

Measurement Quality Assurance

The following is a list of recommendations for using Flowtracker parameters to help assess the quality of discharge measurements. These parameters are not available with Price-type meters. Guidelines for using the parameters are:

- Velocity standard error—If the average standard error for the measurement exceeds 8 percent of the mean measurement velocity, the measurement should be rated no better than "fair." If the standard error exceeds 10 percent of the mean measurement velocity, the measurement should be rated no better than "poor."
- Boundary flag—There are four possible boundary flags assigned to each station: "best," "good," "fair," and "poor." A boundary flag of "best" does not guarantee a lack of boundary interference (see the Flowtracker Technical Documentation). If the ADV sample volume was striking a solid boundary, a "best" flag likely still would be displayed, but the measured velocity could be biased toward zero.
- Velocity spikes—An excessive number of velocity spikes (more than 10 spikes per measurement) could be cause to downgrade the measurement.
- Flow angles—A good measurement section typically shows some flow-angle variations, but with angles less than 20 degrees.

Periodic Quality-Assurance Checks

Each Flowtracker must be checked for discharge-measurement accuracy at least annually and also after any hardware or firmware changes. The check consists of making a discharge measurement at a site where the Flowtracker-measured discharge can be compared with a known discharge derived from some other source. Appropriate sources of comparison discharge would be discharge obtained from a stable discharge rating, or discharge measured with a second Flowtracker or mechanical meter known to meet USGS calibration standards.

Index-Velocity Meter

The Iowa WSC at times uses acoustic Doppler velocity meters (ADVMs) installed at gaging stations to index mean channel velocities for the computation of records of discharge. Personnel who use index-velocity

instruments for the production of discharge records obtain training by attending the Office of Surface Water class "Streamflow Records Computation using Hydroacoustic Current Meters and Index-Velocity Methods" that is offered periodically.

Installation

1. A thorough site reconnaissance is required prior to installation of an index-velocity meter at an existing gaging station or establishment of a new index-velocity-meter station. The site reconnaissance includes channel surveys and the collection of velocity and temperature profiles. The channel bed is characterized for stability. The site hydraulics are analyzed carefully for factors that potentially could cause rating instabilities. Other considerations include protection of the instrument, power/communications cable-length limitations, and adequate power supply. The data collected from the reconnaissance are used to ascertain the success of using an index-velocity meter. For ADVMs, aspect ratios (range/depth) and bridge-pier wake-turbulence zone can be computed to see if the ADVM sample volume will reach a zone of stable velocities. ADVM installation considerations are documented in Morlock, Nguyen, and Ross (2002, p. 8–10).
2. Gage-site-selection criteria documented in Rantz and others (1982, p. 5–9) remain applicable for index-velocity sites.
3. The index-velocity-meter deployment program is recorded and archived. If the index-velocity- meter deployment program can be saved, the deployment program is archived. Some index-velocity-meter programs cannot be saved directly. In these instances, a screen capture of the instrument deployment can be used to save the program parameters. A paper copy of the pertinent parameters is placed in the gage-house folder.

Field Procedures

The following procedures are followed during visits to stations equipped with index-velocity meters:

1. A temperature reading from an independent source, such as a digital thermometer, is taken near the instrument. The temperature is recorded in the field notes along with the time of the reading.
2. For ADVMs, a beam-amplitude diagnostic test is run and logged in a file. All such files are archived on the Iowa WSC network. Beam-amplitude checks are an invaluable diagnostic and quality-assurance tool. The beam-amplitude checks must show that the ADVM sample cell is free of obstructions and is sized so that beam amplitudes at the end of the sample cell are a minimum of 5 counts above the instrument noise level. If these criteria are not met, the ADVM sample cell must be adjusted until the requirements are met. All sample-cell changes must be noted on the station log and in field notes and the new instrument deployment saved. If the sample-cell size changes significantly, a new index-velocity rating likely is needed.
3. At least once annually, the standard cross section is checked to ensure that the channel geometry has not changed significantly. For channels with known scour or fill potential or for channels with the potential for dredging, the standard cross section may need to be checked more frequently. If possible, discharge measurements can be made at the standard cross-section location. The advantage of this approach is that for every measurement, the standard cross section is checked.

Data Quality Assurance

All data-quality parameters available are used to assess the quality of the velocity (and stage) record used to generate discharge records. For ADVMs, these parameters can include cell end, velocity standard deviation, velocity-component, water temperature, and signal strength (average backscatter amplitude). Unit-value plots are valuable for examining these quality-assurance parameters.

Discharge Computation

The same general USGS policies and recommendations that apply to stage-discharge methods used to produce discharge records apply to index-velocity methods. Thus, guidelines for the production of stream flow records presented in the section entitled Processing and Analysis of Streamflow Data outlined in the Iowa WSC

Surface Water Quality-Assurance Plan apply to index-velocity methods. Polices and recommendations regarding stage data, such as the editing or deleting of unit values, apply to velocity unit values as well. Likewise, guidelines for records documentation, including the station analysis, daily-values tables, and other supporting materials, are applicable to index-velocity records.

Other Hydroacoustic Discharge Measuring Devices

The Iowa WSC at times uses other hydroacoustic devices to measure streamflow. The Nortek QLiner and Boogie Dopp are mainly used. These devices use the USGS midsection method for measuring discharge as described in Rantz and others (1982), with the exception that the entire water column is profiled, rather than a single point in each vertical. Due to the limited testing on theses devices from OSW, it is Iowa WSC policy that side-by-side comparisons measurements frequently be made using an OSW approved device, such as an ADCP. These comparison measurements are document in a file on the Iowa WSC computer network in the directory \ia\data\hydroacoustic_QA\. It is necessary to make concurrent measurements with approved devices under a wide range of scenarios in order to prove the validity of this equipment.

Appendix 7 - Iowa WSC Electronic Discharge Measurement Storage Policy

All electronic data associated with a discharge measurement will be stored in the same location on the Center's computer network. This applies to all site types (continuous gages, miscellaneous sites, or CSG sites). A directory hierarchy has been created to comply with OSW memo 2005.08 (http://water.usgs.gov/admin/memo/SW/sw05.08.html). This data will be backed up according the WSC network backup policies. The directory storage structure format is shown in Figure 2.

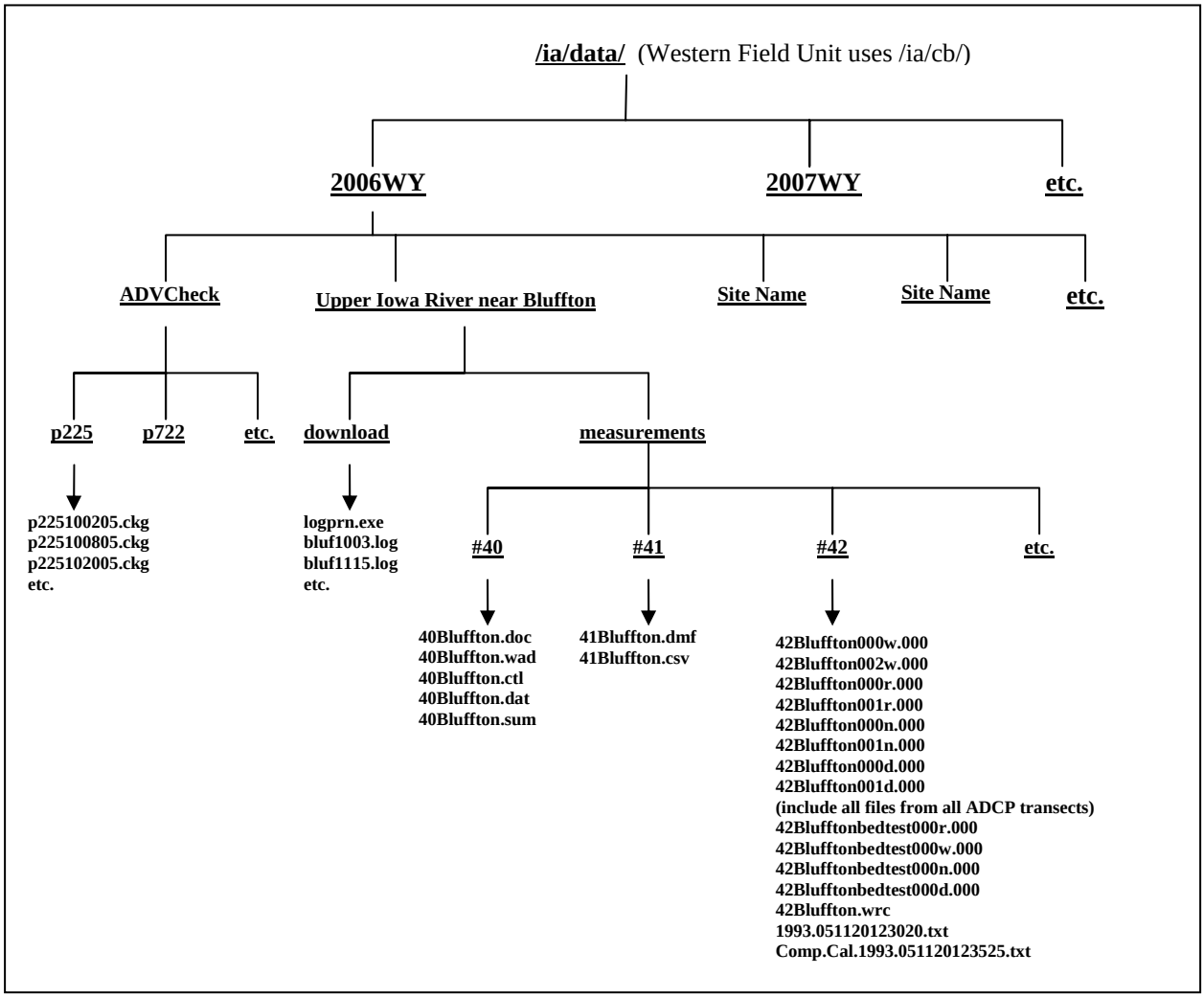


Figure 2. Iowa Water Science Center Electronic Discharge Measurement Storage Structure

Hard copies of discharge measurements and gage inspections will be filed in the current records cabinet located in the Data Section. The files are organized alphabetically by site name. For miscellaneous sites, there is folder at the top front of the cabinet titled "Miscellaneous Discharge Measurements." Measurements are kept in this location for two years, then they are removed from record's folder and filed in the discharge measurement back file drawers located in Data Section. The files are organized alphabetically according to site name.