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Surface Water Quality-Assurance Plan for the Hawaii District of the U.S. Geological Survey

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Surface Water Quality-Assurance Plan for the Hawaii District of the U.S. Geological Survey

By Richard A. Fontaine

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Honolulu, Hawaii
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U.S. DEPARTMENT OF THE INTERIOR

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By Richard A. Fontaine

Abstract

This District Surface Water Quality-Assurance Plan documents the standards, policies, and procedures used by the Hawaii District for activities related to the collection, processing, storage, analysis, and publication of surface-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 Hawaii District are part of the Water Resources Division's (WRD) overall mission of appraising the Nation's water resources. Surface-water data, including streamflow, stage, and sediment, are used at the Federal, State, and local levels for resources planning and management.

The purpose of this District Surface-Water Quality-Assurance Plan (QA Plan) is to document the standards, policies, and procedures used by the Hawaii District for activities related to the collection, processing, storage, analysis, and publication of surface-water data.

This plan identifies responsibilities for ensuring that stated policies and procedures are carried out. The plan also serves as a guide for all District 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 this District 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 are required to have a separate and complete quality-assurance plan.

This QA Plan is reviewed and revised at least once every 3 years in order that responsibilities and methodologies are kept current, and 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 District personnel involved in the collection, processing, storage, analysis, or publication of surface-water data.

The District Chief is responsible for:

1. Managing and directing the District program, including all surface-water activities.

2. Ensuring that surface-water activities in the District meet the needs of the Federal Government, the Hawaii District, 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 District personnel. This is accomplished by the District Chief's direct involvement or through clearly stated delegation of this responsibility to other personnel in the District.
4. Providing final resolution of any conflicts or disputes related to surface-water activities within the District.
5. Keeping subordinates briefed on procedural and technical communications from Regional Offices and headquarters.
6. Ensuring that technical reviews of all surface-water programs are performed on an ongoing basis.
7. Ensuring that all publications and other technical communications released by the District are accurate and are in accord with USGS policy.

The Hydrologic Surveillance (Data) Section Chief is responsible for:

1. Providing technical leadership regarding techniques, methods, and equipment for data-collection.
2. Maintaining a close working relationship with Field Office Chiefs.
3. Assuring data-collection and processing is in accordance with District, WRD, and USGS policy.
4. Meeting with cooperators to ensure the data program is viable and fulfills the mission of the USGS.
5. Serving as the District Flood Response Coordinator.
6. Serving as the District Sediment Specialist.
7. Assuring proper, property owner agreements and permits for all data collection activities.

The Surface-Water Specialist is responsible for:

1. Preparing future updates and revisions of this Quality-Assurance Plan.
2. Technically reviewing project proposals and the ongoing progress of projects with surface-water work elements.
3. Reviewing Data Section and project surface-water data-collection methods.
4. Reviews computed records for all surface-water data-collection stations at least once every three years.
5. Providing technical training of Data Section and Investigation Section personnel as needed.
6. Providing assistance or guidance as needed on indirect measurements of discharge.
7. Reviews surface-water technical aspects of all interpretive reports.
8. Serves as the alternate District Flood Response Coordinator.

The Hydrologic Investigation Section Chief is responsible for:

1. Assuring data collection and processing is in accordance with District, WRD, and USGS policy.
2. Meeting with cooperators to ensure the studies program is viable and fulfills the mission of the USGS.

The Data Management Unit (Data Base) Chief is responsible for:

1. Supervising the Data Management Unit and coordinating its activities with other sections in the District.
2. Providing technical assistance for National Water Information System (NWIS) and other data base systems.
3. Developing and implementing plans and guidelines for the effective management and dissemination of hydrologic data both within the District and in response to external requests.
4. Working with project chiefs to facilitate the development of data-management plans for hydrologic investigations.

5. Directing, conducting, and assisting in training sessions and technical meetings.
6. Creating all new sites in the data base and maintaining data descriptor (DD) instrument files.
7. Maintaining DECODES and writing configuration files for Data Collection Platforms (DCP's) and data loggers.
8. Providing assistance as needed for routine Automated Data Processing System (ADAPS) and DECODES questions from Project or Field Offices.

The Field Office, Duty Station, or Project Chief is responsible for:

1. Design and construction of data-collection gaging-stations.
2. Assuring the accuracy of gaging-station records in the field area.
3. Providing leadership for staff members.
4. Maintaining expertise in all phases of data collection, compilation, and computation.
5. Providing on-the-job and formal training for staff members.
6. Submitting site schedules for all data-collection stations to the Data Base Chief for input to GWSI and verifying the accuracy of the data once it is input.

The Field Hydrologic Technician or Hydrologist (field personnel) is responsible for:

1. Correctly and accurately making discharge and water-level measurements of various types.
2. Installing, servicing, and repairing gaging-station instruments and gage houses.
3. Entering data retrieved from gaging stations into the appropriate data base.
4. Developing stage-discharge ratings and entering them into ADAPS.
5. Computing discharge records and writing station descriptions and analyses.
6. Helping design and construct gaging facilities.

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 Hawaii District.

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 this District that all personnel involved in the collection of stage and discharge data shall be properly trained, well informed, and follow the surface-water data-collection policies and procedures established by the WRD.

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 or 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 consid-

ered by District 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 Field Office or Project Chief with assistance from the Surface-Water Specialist or the Data Section Chief as needed. The process of site selection includes discussions with cooperators on the purpose of the gage, a file search to determine if discontinued stations existed in the area, analysis of terrain using topographic maps and aerial photography, if available, review of tax maps to determine the classification and ownership of lands in the area, and detailed field reconnaissance to establish the relative merits of potential sites. The responsibility for ensuring proper documentation of agreements with property owners and completion of permits required by appropriate regulatory agencies is held by the Data Section Chief. Approval of site design is the responsibility of the Data Section Chief. Responsibility for construction of gages is held by the Field Office or Project Chief. Inspection and approval of the completed installation is the responsibility of Data Section Chief or the Surface-Water Specialist.

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 District policy that field personnel perform visual inspections during each site visit and conduct detailed safety inspections on an annual basis. To prevent the buildup of mud or the clogging of intakes, stilling wells are pumped or manually cleaned at least once a year and more often as site specific conditions require. Interim safety guidelines for work in stilling wells are provided in Water Resources Division memorandum 97.32. Other maintenance activities performed on a regular basis include rodding of intakes, clearing vegetation along the access trail and near the gage and control, oiling instruments and locks, and cleaning the inside of the gage house. Maintenance during each gage visit includes checking battery voltage, operation of solar panels, and appropriate cleaning of artificial controls

Field personnel are responsible for ensuring that gages and gage houses are kept in good repair. It is the responsibility of the Field Office or Project Chief to ensure these responsibilities are carried out and that any deficiencies are remedied. The Data Section Chief will inspect 20 percent of the gages in the District each year to ensure that maintenance practices are being adequately applied.

Measurement of Stage

Many types of instruments are available for measuring the water level, or stage, at gaging stations. There are nonrecording 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 Office of Surface Water (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 memorandums 93.07 and 96.05)

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 WRD policy on stage-measurement accuracy as it relates to instrumentation is provided in Office of Surface Water memorandums 93.07 and 96.05.

The types of instrumentation installed at any specific gage house operated by Hawaii District is dependent on the needs of the cooperator, the availability of utility lines, terrain, vegetation type and density, the expected range of stage, channel type, real-time data requirements, and accessibility. Types of water-level recorders operated by personnel in this District include electronic data loggers, satellite, radio, and cellular phone transmitters, and graphic recorders. Stage sensing instruments attached to recorders include floats (used in stilling wells) and pressure sensing systems such as submersible and non-submersible transducers.

The responsibility for determining what type of water-level recorders are operated at each gaging station is held by the Field Office or Project Chief. Due to the flashy nature of Hawaii streams, water-level recorders, with the exception of graphic instruments, will be set to record at a maximum interval of 15 minutes. Ensuring that new equipment has been installed correctly is the responsibility of the field personnel who service the gage. 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. The inside gage readings should equal outside readings, with the exception of instances in which the gages are not in the same pool at all ranges of stage. At stations equipped with a stilling well, the base or reference gage usually is an instrument installed inside the gage house, and other gages are installed outside the gage house to indicate whether or not the intakes, that connect the stilling well with the stream, are operating properly (Rantz and others, 1982, p. 53 and p. 64). For example, at most stilling-well gaging-stations in Hawaii, the recording gages are referenced to a staff plate attached inside the stilling well and outside readings are made on staff plates anchored securely along the streambank near the gage. At bubble and pressure-transducer gages there is no water level to read inside the gage and inside gage readings are represented by the counter on the manometer or the reading from the transducer. Outside water levels are read on a staff plate or determined by measuring from a point of know elevation, or reference point, that is located near the orifice. These readings provide the reference to which the recording bubble and pressure transducer gages are set.

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 or Project 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 field personnel. This responsibility is accomplished by conducting regularly scheduled field inspections of the gaging station, the instrumentation being used at the station, and the data being collected to determine when problems have already occurred or are about to occur. When deficiencies are identified, field personnel are expected to recalibrate, repair, or replace the defective equipment as soon as possible. Extra instruments and parts sufficient to make the majority of repairs or replacements are carried in the field vehicle or stored in the Field Office. Individuals who have questions related to the calibration and maintenance of water-level recorders should contact the Field Office or Project Chief. Technical questions beyond their level of expertise can be referred to others in the District familiar with the subject instrumentation, the USGS Hydrologic Instrumentation Facility, or the equipment manufacturer.

Gage Documents

It is District 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 digital, stage-discharge relation (rating); (2) a graph of the rating upon which each new measurement is plotted; (3) the most recent station description listing all gages and reference marks at the site and associated elevations, location 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); (4) a log updated by field personnel upon each site visit describing control conditions and listing gage readings, measurement values, gage-house maintenance, and equipment maintenance; and (5) the current job hazard analysis for the station.

Field personnel are responsible for exchanging 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, remarks to that effect will be added to the field notes and the documents will be replaced during the next gage visit. 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 or Project 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, 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 floodborne 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 District policy that levels are run at newly installed gaging stations at the time that instrumentation is installed and data collection begins. Levels are run for established gaging stations as called for in the Hawaii District policy memo for frequency of station levels dated January 30, 1995. The basis for this policy memo can be found in the TWRI by Kennedy (1990, p. 14) and Office of Surface Water memorandum 90.10. Reference gages are reset to agree with levels when differences of greater than 0.010 feet are found. Gages should be reset when levels are run but only after the field notes have been checked. When gages are reset, field personnel repeat the levels to all adjusted gages to ensure they were correctly reset. Gage resets that are made are indicated on the analysis sheets for that set of levels and on the level-results summary-sheet for that station. In addition, gage resets need to be discussed in the station analysis when working the records for that water year.

Levels are run by use of field methods and documentation methods described in Kennedy (1990). Level procedures followed by District personnel pertaining to circuit closure, instrument reset, and repeated use of turning points and side shots are described in Kennedy (1990) and in Office of Surface Water memorandum 93.12. The level instruments are kept in proper adjustment by regularly running peg tests as described by Kennedy (1990, p. 13) or by Benson and Dalrymple (1967, p. 4). The leveling instrument should not have an error greater than 0.003 feet per 100 feet. The date and results of the most recent peg test will be noted on each survey's summary sheet. A summary of all peg test results will be maintained for each leveling instrument in the Field Office files. Telescoping fiberglass rods will not be used for station levels. Rods used for station levels should be kept dry and not used for work such as cross-section surveys and should be checked with a steel ruler each time they are used.

When running station levels the elevations of all reference marks, outside and inside staff gages, crest-stage gages, reference points, orifice tips, and if possible the point of zero flow will be determined. In addition the elevation of the water surface will be leveled and compared to the readings obtained from all recording instruments and reference gages. There should be a minimum of three reference marks at each gage. The marks should be located on two, or more, different features and at least one should be above expected peak-flood stages. Where feasible, gaging-station reference marks should be tied in to National Geodetic Vertical Datum. Cross sections at the gage control should be obtained a minimum of every other time that station levels are run and more frequently if significant changes to the control are suspected. Control cross-sections should be surveyed to cover the entire range of stage defined by the current rating curve for the station. Survey results should be plotted and compared to previous control cross-sections to determine if and when significant changes have taken place.

Field personnel are responsible for ensuring that all field levels that they run are computed and checked. The level information is entered in the level-summary form by field personnel. Ensuring that levels are run correctly and that all level notes are completed correctly is the responsibility of the Field Office or Project Chief. Ensuring that levels are run at the appropriate frequency is the responsibility of the Field Office or Project Chief. When station levels are run at a particular gage their adequacy and frequency will be checked as part of the surface-water records review for the year and station in question.

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 District policy that the station description is written prior to the time when the station's first records are computed and reviewed. The responsibility for ensuring that station descriptions are prepared correctly and in a timely manner is held by field personnel who are assigned to service the station. Station descriptions are updated whenever significant changes have been noted. It is the responsibility of the Field Office or Project Chief to ensure that updates are made as required. The adequacy of station descriptions will be determined and suggestions for improvement will be made as part of the annual review of each station's surface-water records.

Station descriptions are written to include specific types of information in a consistent format as illustrated by Kennedy (1983, p. 2). The goal of a well written station description is to provide an archive of knowledge we have gained regarding a particular gaging station over time. When a new gaging station is established its unique identification number is assigned by the Field Office or Project Chief and checked by the Data Management Chief. Locations of all new gaging stations and their drainage basins are delineated on the District's base maps and drainage areas are computed by the Field Office or Project Chief and checked by the Data Chief and Data Management Chief.

Photographs

Photographs are taken by field personnel for the purpose of documenting gage-house construction, changes in control conditions, floods, damage to gage features, or to supplement various forms of written documentation such as station descriptions. Detailed documentation of site conditions with photographs is also an important part of theoretical analyses such as slope-areas, culvert and flow over dam computations, and step-backwater studies. Field personnel should have access to cameras and have them readily available when servicing gage installations. Each photograph that becomes part of the station record is identified by date, location, view, and if applicable the gage-height and streamflow at the time the picture was taken. Photographs for the current year are placed in that year's file folder and provided as part of the review packet when the records are submitted for review. Older pictures are placed in the photograph file for the respective station. Photographs taken as part of special theoretical analyses are kept in folders prepared to hold all information associated with that particular effort.

Direct Measurements

Direct measurements of discharge are made with any one of a number of methods approved by WRD. The most common is the current-meter method.

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 measurement 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 and maintained equipment or the improper use of such equipment. To minimize the effects of any systematic errors, all field trips are rotated between field personnel on a regular basis. Field trip rotation plans, that are individually tailored to meet the needs and unique situations of each Field Office, are developed by each Field Office Chief and approved by the Data Section Chief. It is the responsibility of the Data Section Chief to ensure that

these plans are followed and updated as necessary. Whenever field data collected by one individual suggest the need for a new rating or an unusual pattern of shifts, the results will be field verified by at least one independent party. Field observations of discharge measurement techniques being used by field personnel will be made at a minimum of 20 percent of the gaging stations on an annual basis by either the Data Section Chief and/or the Surface Water Specialist.

District policies related to the measurement of discharge by use of the current-meter method, in accordance with WRD policies, include the following.

Depth and velocity criteria for meter selection.-- District personnel select the type of current meter to be used for each discharge measurement on the basis of criteria provided by the OSW, in memorandums 85.07 and 85.14. In most cases the choice of current meter to use is between the Price AA or pygmy meters. Depth criteria for choosing between the two meters is based on the knowledge that the AA meter will under register velocities when it is within 0.5 feet of a boundary (water surface or streambed) and the pygmy meter will under register velocities when it is within 0.3 feet of a boundary. The choice between meters also depends on the method used to determine mean velocity. Mean velocity in a given vertical section is generally determined as the average of readings taken at 20 percent of the depth (.2 depth) and 80 percent of the depth (.8 depth) or by taking a reading at 60 percent of the depth (.6 depth). According to data summarized by Sauer and Meyer (1992) determinations of mean velocity using the average of readings taken at the .2 and .8 depths are more accurate than those based on the .6 depth method. Also, point velocity readings, using the AA meter, have smaller errors than those made using the pygmy meter.

Using the above information results in the following recommendations for meter selection. When depths are greater than 2.5 feet, an AA meter should be used with mean velocity based on the .2 and .8 depth method. When depths are between 0.75 and 1.25 feet a pygmy meter should be used with mean velocity based on the .6 depth method. Meter selection at depths between 1.25 and 2.5 feet is a grey area. On the one hand, when depths are greater than 1.5 feet there is a gain in accuracy, because with a pygmy meter the .2 and .8 depth method can be used to determine mean velocity, while the AA meter still requires use of the less accurate .6 depth method. On the other hand individual velocities can be more accurately measured using the AA meter. As a practical matter streams in Hawaii typically have reasonably fast velocities when depths increase and in most instances use of the AA meter, with its smaller number of rotations per unit of water velocity, makes more sense for depths in this grey area.

There are several instances, for example when current meters are suspended from a cable using sounding weights, when the above criteria are not appropriate. Criteria specific to these individual instances are summarized by Rantz and others (1982). Stream depths less than 0.75 feet are common and alternate methods of discharge measurement such as the use of portable weirs and flumes and volumetric measurements are most often not feasible with such volumes of water. In such cases it is recommended to continue use of the pygmy meter and the .6 depth method for depths as shallow as 0.3 feet. 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 are noted on the front sheets of the measurement notes and the measurement accuracy is downgraded accordingly. All individuals involved with making discharge measurements should have a copy of the report describing how to determine the errors in individual discharge measurements by Sauer and Meyer (1992). Information in the report will give them the means to evaluate the relative accuracy of measurement options available to them in the field.

Rantz and others (1982, p. 144) recommend that neither the AA meter nor the pygmy meter be used to measure discharge when velocities are slower than 0.2 feet per second (ft/s). According to results summarized in Sauer and Meyer (1992) the instrument error, expressed as the standard error in percent, when measuring water velocities of 0.20 ft/s is 3.5 percent for the AA meter and 7.3 percent for the pygmy meter. As a practical matter standard rating tables for the AA and pygmy meters have been extended to about 0.1 ft/s and velocities between 0.1 and 0.2 ft/s are often encountered in the field. Extrapolation of the instrument errors to velocities of 0.1 ft/s (Sauer and Meyer, 1992) indicates that such measurements would have errors of 7.0 percent for the AA meter and 18.0 percent for the pygmy meter. The key point to note here is the rapid increase in instrument error for velocities less than 0.2 ft/s and the importance of following the 0.2 ft/s minimum criteria for velocity measurements whenever possible.

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. For example assume that an AA meter is being used and some of the subsections have depths less than 1.25 feet. In such a case continue to use the AA meter and the .6 depth method. If the computed discharge, in the subsections that fall outside the AA meter depth criteria, account for more than 10 percent of the total discharge, then a pygmy meter should be used for the entire measurement. Similarly, this 10 percent rule is a reasonable starting point for use in determining how much of the discharge being measured in a section can be allowed to fall outside the AA and pygmy meter selection criteria before a change to alternative measurement techniques, such as use of flumes, is considered. There are isolated situations when the use of more that one type of meter in the course of making a measurement is reasonable. Such situation would be when a very shallow overflow or secondary channel is to be measured along with a larger, deeper main channel. In such a case the AA meter would be used for the main channel and the pygmy meter would be used for the shallow overbank area.

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 WRD criteria are that observations of depth and velocity be made at a minimum of about 25 verticals, which are normally necessary so that no more than 5 percent of the total flow is measured in any one vertical. Under most 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). 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. 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).

It is not recommended that a uniform width between measurement verticals be maintained across the entire measurement section unless the velocity and depth characteristics of the channel are relatively uniform. As a general rule the spacing between verticals should be closer in the parts of the measurement section that have greater depths and velocities. The USGS uses the midsection method of computing current-meter measurements (Rantz and others, 1982, p. 80). The basis of this method is that the depth and mean velocity measurements taken at a sampling vertical represent the mean depth and velocity conditions in the subsection that extends half-way to the adjacent sampling verticals. The locations for measurement verticals should be selected with this computational procedure in mind.

Fewer verticals than are ideal are used measuring low flows in streams and measuring in ditches when the channels are very narrow. In such circumstances the Hawaii District policy is that the minimum width of subsections to be used when making discharge measurements is 0.5 feet for an AA meter and 0.2 feet for a pygmy meter. These values were determined to be the first tenth of a foot increment that is greater than the widths of the respective meters (5 inches or 0.42 feet for an AA meter and 2 inches or 0.17 feet for a pygmy meter). As a result of the above policy there will be times when use of a pygmy instead of the AA meter is reasonable. For example when measuring in a ditch having depths that are all greater than 1.5 feet an AA meter would normally be selected, with the subsections 0.5 feet apart. However if the ditch is 4 feet wide the measurement would only include 9 subsections. Using a pygmy meter, with its recommended 0.2 feet spacing between verticals, the measurement would include 21 subsections and therefore result in a more accurate determination of discharge. Note that in some instances the velocities could be too fast to make the switch to a pygmy meter possible.

Other direct methods of measuring discharge.--It is District policy that WRD and OSW techniques and guidelines are followed when discharge measurements are made with any selected method of measurement. Other direct methods of measuring discharge that are used in the Hawaii District include use of (1) floats, (2) volumetrics, (3) portable weir plates, and (4) portable Parshall flumes. Instructions on the use of the above methods can be found in chapter 8 by Rantz and others (1982) and in Buchanan and Somers (1969, p. 57). The use of flumes to measure discharge is covered in the TWRI by Kilpatrick and Schneider (1983).

Computation of mean gage height.--District 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.--When a discharge measurement is made at a gaging station it is the responsibility of field personnel to compute the mean gage height and discharge and plot the results on the current rating before leaving the station. It is Hawaii District policy that the results should check a defined section of the rating curve or trend of departures shown by recent measurements within criteria associated with either the range of discharge being measured or the accuracy rating assigned to the measurement. Criteria associated with range of discharge are (1) within 10 percent for discharges less than 1.0 cubic feet per second (cfs), (2) within 7 percent for discharges of 1.0 through 10.0 cfs, and (3) within 5 percent for discharges greater than 10.0 cfs. Criteria associated with the accuracy rating assigned to the measurement are (1) within 5 percent for measurements rated good to excellent, (2) within 8 percent for measurements rated fair, and (3) within 10 percent for measurements rated poor. If the measured discharge does not meet criteria associated with either of the above categories then a second discharge measurement should be made. If a second measurement is called for and it is not made then an explanation as to why should be included on the measurement notes. One acceptable reason not to make a second measurement is if the first measurement confirms an obvious change in control conditions that would cause it to plot either plus or minus from the existing rating condition.

When making a check measurement the goal is to reduce the possibility of systematic error by changing the measurement conditions as much as possible (Rantz and others, 1982, p. 346). To the extent possible this means changing the equipment being used, the measurement section or spacing of measurement verticals, and the hydrographer. If the check measurement is within the percentages listed above from the first measurement, then the two measurements provide reliable evidence of the current status of the stage-discharge relationship. If a problem was found that caused the first measurement to be in error (for example current meter not spinning freely) and the check measurement is within allowable percentages, from either the current rating or trend of departures, then the first measurement will not be given consideration in records analysis and the second measurement will be used. If the check measurement does not fall within either of the above categories than a third measurement is made and the most consistent two of the three measurements are used for rating analysis.

Corrections for storage.--Corrections for storage changes in the reach of channel between the measurement section and the gage, 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 District Surface-Water Specialist.

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, discharge measurements are recorded by field personnel on standard USGS discharge-measurement notes. 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, depth, revolutions and time for velocity observations, and section stationing. 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 and mean gage height.

It is District policy that all discharge measurements made at gaging stations are calculated in their entirety before field personnel leave the field site, unless emergency evacuation is required for reasons of safety. In addition personnel should fill in all blanks on the front sheet of the standard USGS discharge-measurement notes at the field site. Depending on the situation, several entries are not applicable (for example questions that pertain to water quality measurements when none are taken) and in these blanks either a dash or the letters N.A. (for not applicable) should be shown. Particular emphasis should be given to obtaining (1) all appropriate recording and reference gage readings that describe stage conditions as found and as reset, during

the time when the discharge measurement is being made, and just prior to leaving the gaging station, (2) detailed documentation of any problems found at the gaging station (such as changes to the control or plugged intakes), any actions taken in response to these problems with associated times, and responses to the actions (such as the magnitude of stage change after cleaning of the control), (3) documentation of control conditions and any other factors that could have an effect on the stage-discharge relationship at the gage and, (4) documentation of highwater conditions that may have taken place subsequent to the previous gage visit including the determination of peak gage heights from peak stage indicators and highwater marks both inside and outside the gage stilling well. It is important to recognize that field observations play a key role in determining how records of streamflow are computed at the gaging station in question.

Notations associated with miscellaneous surface-water data-collection activities are to be documented on the either the front sheet of standard USGS measurement notes or on the USGS miscellaneous field-notes form. 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 and the four categories of information noted in the previous paragraph.

A review of field note sheets is required annually as part of the surface-water records review. The adequacy of field notes is also checked at random intervals by the Field Office or Project Chief. Deficiencies found in the content, accuracy, clarity, or thoroughness of field notes as part of the annual records review are identified and communicated to the Field Office or Project Chief and the responsible field technician in writing. Deficiencies found as part of random reviews conducted by the Field Office or Project Chief are communicated orally to the responsible field technician. The deficiencies are remedied by providing specific instructions from the Field Office or Project Chief and in some cases the District Surface-Water Specialist to individuals who fail to record notations that meet USGS and District standards.

Acceptable Equipment

Equipment used by the Hawaii District for the measurement of surface-water discharge has been found acceptable by the WRD through use and testing. An array of acceptable equipment for measuring discharge includes current meters, timers, 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 (2000) discuss the equipment used by the U.S. Geological Survey.

The meters most commonly used by District personnel for measuring surface-water discharge are the Price AA current meter and the Price pygmy current meter. Methods followed by District personnel for inspecting, repairing, and cleaning these meters are described in Smoot and Novak (1968, p. 9), Rantz and others (1982, p. 93), Buchanan and Somers (1969, p. 7), and Office of Surface Water memorandum 99.06.

The ultimate responsibility for the good condition and accuracy of a current meter rests with field personnel who uses it (Office of Surface Water memorandums 89.07 and 99.06). 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 and after the measurement to ensure that the meter continues to remain in proper operating condition.

Spin tests.--It is District policy that spin tests are required prior to each field trip. Spin-test results are documented in a log that is maintained for each instrument. Spin test logs for all current meters in use are kept together in a binder in each individual Field Office. This log is part of the archived data of WRD (Office of Surface Water memorandums 89.07 and 99.06). The minimum acceptable spin test times to qualify a meter for field use are 45 seconds for a pygmy meter and 2 minutes for an AA meter. Meters in good condition will provide spin test times of about 90 seconds for a pygmy meter and 4 minutes for an AA meter. Repairs are made to meters when deficiencies are identified through the spin test or inspection. Review of this log by the Field Office or Project Chief is required annually. If deficiencies are observed during this review of the log, the responsible field person in informed through oral communication and the problem is corrected as soon as possible.

In addition to the timed spin tests performed prior to field trips, 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. To ensure that field personnel carry out their responsibilities in maintaining the equipment they use, the equipment is inspected annually by the Field Office or Project Chief and at random intervals by the Surface-Water Specialist.

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 WRD. To demonstrate the quality of surface-water data collected with alternative equipment, thorough documentation of procedures and observations must be maintained.

At this time no alternative types of equipment are being used to make discharge measurements at gaging stations in the Hawaii District. If alternative types of equipment are to be used it will be the responsibility of the Hydrologic Surveillance (Data) Section Chief to ensure that proper procedures are established to document the accuracy of their operation.

Indirect Measurements

In many situations, especially during floods, it is impossible or impractical to measure peak discharges by means of a current meter. 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 District 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 District 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 District 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 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) and Barnes (1967). The computer-based tool, program SAC, available to assist in computations of peak discharge with the slope-area method is discussed in Office of Surface Water memorandum 96.03 and is documented in a report by Fulford (1994). 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, program CAP, available to assist in computations of peak discharge at culverts, is discussed in Office of Surface Water memorandum 96.04 and is documented in a report by Fulford (1998). 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 the Water-Surface Profile Computation model WSPRO (Shearman, 1990). Techniques for the determination of peak discharges at dams and weirs are described by Hulsing (1967). 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 ratings at gaging stations. District 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, (Shearman, 1990) is discussed in Office of Surface Water memorandum 87.05. An evaluation of the accuracy of step-backwater

techniques for use in establishing stage-discharge relations was made by Bailey and Ray (1966). Included in the evaluation are useful guidelines for application of step-backwater modeling techniques to gaging stations.

The responsibility for ensuring that indirect measurements are performed correctly is held by the District Surface-Water Specialist. It is required that a review of procedures and documentation be performed by the Surface-Water Specialist for all indirect measurements and all theoretical computations used to develop stage-discharge ratings. A memo summarizing this review will be prepared and included in the packet containing the documentation of the theoretical analysis. If deficiencies are found during the review, actions necessary to remedy the situations will be identified in the review memo. A copy of the review memo will be given to the party who submitted the analysis, the respective Field Office or Project Chief, and the Data Section Chief. It is the responsibility of the Field Office or Project Chief to make sure that the deficiencies identified are corrected. Measurements that are questionable and difficult to assess are reviewed by the Regional Surface-Water Specialist. The Field Office or Project Chief is responsible for ensuring that deficiencies identified by the Regional Specialist are corrected.

Determining when and where indirect measurements are made is the responsibility of the Field Office and Project Chiefs in conjunction with the Data Section Chief. A prioritization process has been established to document which gaging stations have the greatest need for indirect measurements. A prioritization code has been assigned to each gaging station and they are summarized in the District's Flood Plan. The prioritization for indirect measurements was based on several factors including the ability to make direct measurements at the gaging station, the stability of the current control and stage-discharge rating, and when the portion of the stage-discharge rating in question was last verified. The District's Flood Plan also identifies, for each gaging station, which type of indirect measurement should be done and where.

It is the responsibility of field personnel 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 materials such as nails, plastic markers, spray paint, wood stakes, and survey flagging that can be used to preserve the location of high-water marks for future analysis. 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 and the District's Flood Plan.

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 someone other than the compiler of the data. The information is organized and secured in a measurement folder and is then given to the District Surface-Water Specialist for final review. Once the work has been finalized each indirect-measurement package is stored in file cabinets set aside, in each Field Office, for this purpose. It is the responsibility of the Field Office Chief to make sure that indirect-measurement packages are properly filed.

The responsibility of maintaining the accuracy of the peak-flow data files, including computer data-base files, lies within the District (Office of Surface Water memorandum 92.10). It is the responsibility of the Data Management Unit (Data Base) Chief to ensure that appropriate peak discharge computations are entered into the peak-flow files. It is the responsibility of District 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 WRD 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).

Procedures followed by this District 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 of discharge, field observations of control conditions, or cross-section surveys of control structures are obtained on an annual basis to verify or adjust the rating as required. Levels are run to the gage at regular intervals as called for in the District policy memo for station levels dated January 30, 1995, 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 by levels at a later date.

Field observations are written on crest-stage gage inspection forms developed by the Hawaii District. All blanks on the inspection sheet should be filled in at the field site. If some of the entries are not applicable then either a dash or N.A. should be shown. When filling out the inspection forms, particular emphasis should be given to obtaining (1) all appropriate gage readings, showing the computations used to compute the peak gage-height, (2) detailed documentation of any problems found at the gage and any actions taken in response to these problems, (3) documentation of control conditions and any other factors that could have an effect on the stage-discharge relationship at the gage, especially at culvert controls where downstream conditions could change and thus alter the flow type and rating conditions, and (4) detailed observations of gage stability and evaluations of the need for updating station levels.

The responsibility for ensuring that correct data-collection procedures are used by personnel is held by the Field Office Chief. This responsibility is carried out by regularly reviewing field notes and field data-collection procedures. When a deficiency in data-collection activities is identified, the problem is remedied by providing oral comments and further on-the-job training as required. A review of field note sheets is required annually as part of the surface-water records review. Deficiencies found in the content, accuracy, clarity or thoroughness of field notes as part of the annual records review are documented in writing with copies of the comments provided to the appropriate Field Office Chief and field technician. Training or interaction is provided by the Surface-Water Specialist to remedy deficiencies on an as needed basis.

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 several gaging stations maintained by the Hawaii District. In situations where artificial controls are installed as permanent structures, it is District policy that stage-discharge relations are determined primarily by direct and indirect measurements of discharge. Design ratings, when calibrated by field measurements, are used to extrapolate between measurements and to extend ratings when required. Portable weir plates and flumes are used by District personnel primarily to make discharge measurement and not as gage controls. These portable devices are utilized 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 this District is the responsibility of the Field Office or Project Chief, with technical assistance from the Surface-Water Specialist as required. When installing an artificial control, District 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 (1) observations of scour or fill that might change conditions such as flow paths, velocity heads, and flow turbulence in the approach to the control, (2) the condition of the control itself, such as whether there is aquatic growth or debris on the control or has the control been altered in any way (chips or cracks), and (3) observations of downstream channel and stage conditions, are there new factors which might cause submergence of the control or scour which might cause underflow. Regular maintenance at artificial controls include cleaning of the approach sections, removal of aquatic growth and debris on the control, and when feasible, repair of damage to the control. When problems pertaining to artificial controls are encountered by field personnel the Field Office or Project Chief should be contacted.

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 District 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 District personnel, and codes for accessing streamflow gages equipped with telemetry. The flood plan also highlights the fact that safety is the Hawaii District's highest priority during flood operations and that no hydrologic data are worth an unnecessary risk of life. This important point was also recently emphasized in Water Resources Division memorandum 99.32.

The Data Section Chief is responsible for ensuring that the flood plan includes all appropriate information, including updated information. The flood plan is reviewed every 2 years or after significant flood events by the Data Section Chief. A copy of the flood plan is provided to all field personnel and other District staff and management who have a role identified in the plan. Each individual that receives a copy of the plan keeps it in a location where it is readily available for reference during a flooding condition. It is the responsibility of the Field Office and Project Chiefs 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 Flood Response Coordinator. This function is assigned to the Data Section Chief with the District Surface-Water Specialist as first alternate and the Honolulu Field Office Chief as second alternate. For personnel that are already in the field, as well as those who are not, their first responsibility during flood conditions is to contact their respective Field Office Chief to inform them of any flood conditions that they are aware of and to prepare to undertake work as assigned. Personnel who arrive at a gaging station to find that a flood has occurred are responsible for determining the magnitude of the flood peak as recorded and as documented by highwater marks both inside and outside the gage. With this information available, field personnel should then contact their respective Field Office Chief and if they are not available, the Flood Response Coordinator, to determine what their next course of action should be. If such contacts are not possible then the field personnel should use the priorities identified in the flood plan to make a determination as to what their next data-collection priority should be. The District personnel apply methods discussed in Rantz and others (1982, p. 60) for determining peak stage at gaging stations.

District 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 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 District Surface-Water Specialist. Questions regarding District policies and priorities as outlined in the flood plan should be referred to the Flood Response Coordinator.

Review of District activities related to floods is the responsibility of the Data Section Chief. This review includes seeing that guidelines and priorities spelled out in the flood plan are followed and that the guidelines appropriately address District requirements for obtaining flood data in a safe and thorough manner. A wide variety of deficiencies may be identified as part of this review. Personnel, equipment, and funding limitations should be brought to the attention of the District Chief. Procedural deficiencies should be brought to the attention of the Field Office Chiefs. Deficiencies in the flood plan itself should be remedied by updating the plan.

Communication with State and local agencies before, during, and after floods is an important part of USGS activities. The availability of the data collected may help prevent loss of life and property in both current and future events. As outlined in Water Resources Division memorandum 2000.12, communication with regional and headquarters USGS personnel as part of flood response is also necessary.

Low-Flow Conditions

Streamflow conditions encountered by District 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). The Hawaii District also operates a number of low-flow partial-record and spring-discharge measurement stations which require systematic discharge measurements during periods of low flow.

In many situations, low flows are associated with factors that reduce the accuracy of discharge measurements. These factors include algae growth that impedes the free movement of current-meter buckets 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 nonflowing 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 made to improve a discharge-measurement section should not be made at locations that will alter the control conditions at a recording gage.

The individuals responsible for ensuring that District personnel use appropriate equipment and procedures during periods of low flow are the Field Office and Project Chiefs. Determination that appropriate procedures are used for data-collection activities during low-flow conditions is accomplished by the oversight provided by the Field Office and Project Chiefs. In addition, low-flow records are reviewed each year as part of the annual review of surface-water records. The Surface-Water Specialist is responsible for providing answers to technical questions from District personnel pertaining to data collection during periods of low flow.

Cold-Weather Conditions

Surface-water activities in this District do not include making streamflow-discharge measurements during cold, winter-weather conditions. However it is common for Hawaii District field personnel to work in very rainy, windy, and high altitude settings. Prolonged exposure to these factors can place field personnel in danger of becoming hypothermic, even in Hawaii. The highest priority in collecting streamflow data under all conditions is employee safety.

PROCESSING AND ANALYSIS OF STAGE AND 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 data, including real-time streamflow data. The procedures followed by the Hawaii District 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 Hawaii District's policy is that rating analyses and shift applications will be performed using the following procedures, for data disseminated on the public Web page http://hi.water.usgs.gov/. Discharge measurements that verify continued use of the current stage-discharge rating only infrequently require checking (see next section on measurements and field notes). All discharge measurements that indicate the need for modifications to the current rating (temporary or otherwise) will be checked within two working days of the time they are made. Provisional shift adjustments, as indicated by the checked measurements, will be input into ADAPS within five working days of the time the measurement is made. In this way real-time discharge data being posted on the web will reflect the best estimates of the current stage-discharge rating in effect at the station.

At the present time (March 2001) none of the real-time data stations being operated by the Hawaii District have specific priorities established that document how soon they must be returned to service in the event of a disruption in their ability to furnish data to the web. As such priorities are established they will be included in this QA Plan, in the District's flood plan, and in written policy memos distributed to the responsible Field Office Chiefs. It will the responsibility of the appropriate Field Office Chief to make sure that all real-time data stations that malfunction be repaired within the specified time frame.

Web Page Presentation Format

Hawaii District real-time data are served from computers located in Honolulu, Hawaii, maintained by the District. The National Water Information System Web (NWIS-W) software is used to conform to national USGS standards. In addition to real-time streamflow data, the District's public Web page also contains links to historic ground-water, surface-water, and water-use data, information on Hawaii District programs, publications, and resources, and links to Web pages of other USGS divisions (biology, geology, and mapping). Development and revision of Web pages is the responsibility of a District committee that includes representatives from District Senior Staff, the Computer Section, and Projects and Data Sections.

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 Hawaii District utilizes both automated and manual review procedures to meet this objective.

Automated procedures that have been implemented by the Hawaii District include the setting of minimum and maximum threshold values for stage and discharge. If exceeded, these settings will initiate warnings of potential errors that will prevent questionable data from being displayed on the Web while providing an indication that the threshold values have been exceeded. It is the responsibility of the appropriate Field Office or Project Chief to respond to any automated warnings. When unable to perform these functions the Field Office and Project Chiefs will designate a backup.

In addition to the automated procedures, Water Resources Division Technical Memorandums 97.17 and 99.34 require frequent and on-going screening and review of Web data, including the at least daily review of hydrographs during normal hours of operation. The Hawaii District also requires that all Web pages

containing real-time streamflow data are reviewed regularly for accuracy and/or missing data. The Hawaii District policy is that such manual reviews of real-time data on the Web will be conducted on a daily basis during normal business days. The Field Office and Project Chiefs will be responsible for these daily reviews. Any malfunctions that are not corrected within one working day should be brought to the attention of the Data Section Chief to determine what priority should be assigned to correcting the problem. The Data Section Chief will also spot check the real-time Web pages to ensure that proper quality-assurance practices are being followed.

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 or changes in the stage-discharge rating caused by significant changes in channel or control conditions. 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 result in zero or unreasonably large values being displayed on the Web site. Hawaii District Policy is that intermittent data errors will either be deleted from the data base or edited as appropriate whenever these errors cause data display graphs to be rendered virtually useless because of disruptions in the scales used on the plots. When persistent-type problems take place the erroneous data (stage, discharge, or both) will be removed from the Web page with appropriate qualifiers added to notify users of the problem. It is the responsibility of the Data Chief to decide when such actions should be taken. Changes to the Web page will be made by personnel in the District's Computer Section.

Data Qualification Statements

Water Resources Division 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. At this time the Hawaii District provides the clickable heading for all Web pages on which data that have not been through final review are displayed. No additional data qualification statements, indicating various levels of record revision and review, are included at this time.

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 folder. Measurements and notes for previous water years are filed in the back files for the gaging station in question. These notes are filed with the historic notes only after the records have been reviewed and final flagged.

It is District policy that all measurements are partially checked before records for the gage in question are worked. Partial checking includes comparisons of computed and recorded gage heights, comparisons of total width with summations of partial widths, and scanning the notes for sudden changes in subarea discharges that are not supported by corresponding changes in areas or velocities. Complete checking of every computation in a discharge measurement is done when the Field Office or Project Chief determines that one or more of the following conditions are met: (1) measurement indicates a new rating or shift curve that is not consistent with previous and subsequent measurements, (2) measurement represents the only data defining a significant portion of a rating, (3) measurement was computed by field personnel in the early stages of training until such time as they demonstrate the ability to produce correct, error-free work, and (4) measurement is randomly selected by the respective Field Office or Project Chief. All checks are completed by someone other than the person who computed the measurement.

Discharge measurements, including indirects, are numbered in chronological order. Summaries of pertinent discharge measurement and gage inspection data

(Kennedy, 1983, p. 12) are entered into the ADAPS discharge measurement file. Paper copies of this file are included with the station folder when the records for a given water year are submitted for review. A copy of the discharge measurement file is added to the master file for the station after the records for a given water year have been finalized. It is the responsibility of the person who computes the records for a given station to make sure the ADAPS discharge measurement file has been updated.

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 pen traces on graph paper, electronic information stored by data loggers, or electronic transmissions by satellites, radios, or cellular phones. 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. It is important to note that any such corrections or deletions are made as the data are processed and not to the original data records themselves. Items included in the assembly of gage-height record and procedures for processing the data are discussed in Kennedy (1983, p. 7), and Rantz and others (1982, p. 560 and 587).

Data are entered into USGS data bases by the field personnel who collect it, at the Field Offices where they work. In rare instances when computer or other equipment failures make this approach unreasonable, the original data are sent via certified mail to the District Office in Honolulu for processing. In the Hawaii District, graphic recorders are frequently used in gaging stations to provide backup record. In cases where the primary recorder fails to operate properly, backup data from the graphic recorder are used to compute the discharge record. When the use of backup graphic record is required for short periods of time, the data are processed manually in the responsible Field Office. In cases that require use of backup graphic records for extended periods (several weeks), the original charts are sent via certified mail to the District Office in Honolulu where the gage-height record will be digitized and stored in the appropriate data base. It is the responsibility of field personnel who service the gaging station, to ensure that entering of the gage-height record into the data bases has been done properly.

Records and Computation

It is the general practice in the Hawaii District that records are computed for each station as they are collected, by the field personnel who are assigned responsibility for servicing the particular gaging station. Records for each station are checked in detail by an independent person, after records for an entire water year are completed. The Field Office Chief is responsible for checking a sampling of the records work computed by each of the field personnel in the office and all of the records computed by field personnel who are in training. For new stations, before first-year records are worked, the Field Office or Project Chief is responsible for obtaining the data required to establish the site files. The Data Management Chief is responsible for establishing all required site files in the NWIS data bases.

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 memorandums 93.07 and 96.05). 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 datums 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 erroneous gage-height data are removed from the set of data used for streamflow records computation. Manual corrections of gage-height records are made only to the processed and not the original data, and all corrections are documented in the station analysis. It is common practice for such changes to be highlighted on preliminary versions of the primary computation sheets although this is not a requirement. Automated corrections to gage-height record, using procedures available in ADAPS, are stored in the data base and copies of the correction tables are also included as part of the station analysis.

It is not uncommon for a gage to have more than one means of recording data. Therefore designation of the primary recorder is important. The primary recorder is designated in the station analysis and data from it are used in the computation of records at a gaging station. In some instances data from the primary recorder may be either missing or faulty. In such cases data from a secondary recorder, where available, are used to replace data from the primary recorder when working the records. Documentation is added to the station analysis identifying all periods of time when secondary sources of data are used.

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 for each set of levels, checking levels, ensuring that the level information was listed in the historical levels summary, and ensuring that information was applied appropriately as datum corrections when necessary. The individual computing the record is required to check field notes for indications that the gages were reset correctly by field personnel. It should be brought to the attention of the Field Office Chief when the gages are not correctly reset to agree with levels. The Field Office Chief will then be responsible for ensuring that the required resetting of the gages is accomplished in a timely manner. The individual computing the records makes appropriate adjustments to the gage-height record by applying datum corrections when necessary. Copies of level notes for the water year and updated copies of the historical levels summary sheet are included with the records folder submitted for checking and final review.

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, 1984, p. 26).

District personnel follow procedures for the development, modification, and application of ratings that are described in Kennedy (1984). District 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 in the current year's station folder or by printing a copy from the ADAPS electronic data base. A graphical plot of the most recent rating can be obtained in several locations. The master rating curve can be found in the current year's station folder and copies of this rating curve are in the field folder for the station and in the appropriate gaging station. Electronic copies of the rating can also be printed from the ADAPS electronic data base. Use of rating plotting subroutines contained in ADAPS in conjunction with the large format plotter, located in the computer section in the District Office, is the preferred method for plotting master rating curves.

The development of new ratings, when required, is the responsibility of the field personnel who are assigned to service and work the records for a given station. It is the responsibility of the Field Office or Project Chief to check all new ratings before they are used to compute final records. Besides plotting current

discharge measurements, new master rating curves should include plots of all discharge measurements that define regions of the rating that have not been recently measured. This is especially appropriate for the extreme high and low ends of the rating curve. When developing new ratings it is important that field data in addition to discharge measurements are used in the analysis. Plots of the cross section of the control and knowledge gained from field observations, such as when the low-flow control drowns out or at what stage does bank overflow begin, are invaluable when developing new ratings. It is important to ensure that the curve as drawn is supported by the general hydraulic characteristics of the gaging station in question.

Rating curves should not be extended more than twice the highest direct or indirect discharge measurement without some type of supporting analysis. Examples of high-end rating-extension techniques include conveyance-slope methods, step-backwater modeling, and critical-depth analyses. Results from rating-extension analyses should be plotted on the master rating using unique symbols that are properly identified. Results from rating extension analyses need to be thoroughly documented (following the same types of procedures used for indirect discharge measurements) and reviewed by the Surface-Water Specialist. Care should also be used when extending ratings at the low end. In such cases rectilinear plotting of data using the point of zero flow should be used to support such extensions.

In Hawaii, rating curves commonly have large gaps between medium-flow discharge measurements and high-flow indirect measurements. When evaluating how large a gap in rating definition is considered acceptable the following rule of thumb can be applied. Use the adjacent discharge values and multiply the lower value by two and divide the upper value by two. If these calculated values overlap, then the gap, in most cases, is not considered to be excessive. Failure of the calculated values to overlap indicates that further rating definition is likely required using techniques such as those developed for rating extensions.

At some gaging stations there are consistent differences between inside or recorded gage-heights and outside gage-heights during high flows. Once this relationship has been defined and shown to be consistent a rating can be developed. In such cases the high end of the rating should first be developed using the outside gage-heights associated with each high-flow measurement. This will allow consistent hydraulic interpretations of the rating-curve shape to be made. Once the high end of the rating is developed gage-heights associated with high-flow rating-definition points are adjusted to equivalent inside or recorded gage-heights. These adjusted gage-heights are then used for the final version of the rating. In this way recorded or inside gage-height data can be used directly to compute discharge at the gage. At all gaging stations it is important to verify the correspondence between recorded or inside and outside gage-heights during high flows. This verification process is especially important at gages where the rating has been adjusted to account for known differences. Changes in inside-outside gage-height relationship will alter the rating in use.

Any changes to a previously defined rating, even if it is just a rating extension, are treated as new ratings and are given a new number. Currently, as many as three different offsets can be used in the development of a rating curve. Current practice is for the master rating to be plotted using the single offset found to be the most appropriate by the person who is responsible for developing the new curve. In cases where multiple offsets are used, the rating segments defined by alternate offsets should be plotted separately, either on the master curve or on a worksheet attached to it. Technical questions regarding rating curves can be addressed to the District Surface-Water Specialist as required.

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). Datum corrections are applied when the magnitude of the vertical change is greater than 0.010 feet.

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. Gage-height corrections are applied so the recorded data are made to agree with base-gage data. These corrections are applied when the difference between the recording gage and the base gage is greater than 0.010 feet. Where the base gage is affected by surging, sudden changes in stages, or other factors that compromise the data, the above standard can be relaxed. When field personnel determine that use of less stringent criteria is appropriate, the decision should be supported by field observations recorded at the gaging station. For example it might be reported that the recorded gage height was 1.00 feet and the base gage reading was 1.02 +/- 0.04 feet. In such a case it would be a reasonable decision not to apply a gage-height correction.

A temporary 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). It is Hawaii District policy that the variable shifts program in ADAPS is to be used to apply shifts. Shifts based on individual discharge measurements are not required when criteria associated with either the range of discharge measured or the accuracy rating assigned to the measurement are met. Criteria associated with range of discharge are (1) within 10 percent for discharges less than 1.0 cfs, (2) within 7 percent for discharges of 1.0 through 10.0 cfs, and (3) within 5 percent for discharges greater than 10.0 cfs. Criteria associated with the accuracy rating assigned to the measurement are (1) within 5 percent for measurements rated good to excellent, (2) within 8 percent for measurements rated fair, and (3) within 10 percent for measurements rated poor. If the measured discharge does not meet criteria associated with either of the above categories then a shift curve should be applied. Where possible the existence of a shift or temporary change in the rating should be supported by field observations of the control and gage pool.

Shifts are defined as temporary changes in the stage-discharge rating. When discharge measurements and field observations indicate that the change in control condition has stabilized, then a new rating curve should be developed. Where both plus and minus rating changes routinely occur because of unstable control conditions, it is best to develop an average or base rating and apply shifts, as necessary, from this rating. In both cases Field Office personnel are most familiar with control conditions at a given gaging station and should be the ones to choose between a new rating or use of a shift.

Shifts should be defined on both variable-shift diagrams (V-diagrams) and on work copies of the current rating curve. Descriptions of datum and gage-height corrections and shifts that were applied in a given year should be included in the station analysis for the water year in question.

Hydrographs

A discharge hydrograph is a plot of daily mean discharges versus time. The date is aligned with the horizontal axis and the discharge is aligned with the logarithmic vertical axis. In the process of computing station records, this hydrograph is a useful tool in identifying periods of erroneous information, such as incorrect shifts or datum corrections. Additionally, hydrographs are helpful when estimating discharges for periods of undefined stage-discharge relation, such as during backwater conditions, and in estimating discharges for periods of missing record.

Information placed on the hydrograph for each station includes station name, station number, water year, date the hydrograph was plotted, plot of daily mean discharge data, plot of discharge measurements, stations with which the hydrograph was compared, and auxiliary data such as daily rainfall totals. On the hydrograph, shifts and gage-height corrections should be identified and periods of estimated record flagged. Hydrographs are included in the current year's folder when it is sent for review. There is no need to archive hydrographs after the review process is completed because they can be generated as needed from the ADAPS data base.

Hydrographic comparison is a valuable quality-control process which is used to test the consistency of computed records, especially those for periods of shifting controls or gage-height corrections when conditions are less than optimal. Hydrographic comparison is also used as an aid in estimating periods of missing record. The general procedures and goals of hydrographic comparison are outlined by Rantz and others (1982, p. 572

and p. 575). The stations used for hydrographic comparison are identified in the station analysis.

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. The station analysis provides a basis for review and serves 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 corrections, rating, discharge, special computations, remarks, and recommendations (Rantz and others 1982, p. 582 and Kennedy 1983, p. 46). The station analysis is written by the field personnel working the records for a station.

Station analyses are prepared using word processing software made available to field personnel in the District. Electronic copies of the analysis are used as templates for the following year's document. During the records computation process, station analyses are kept with the station folder. During the review process, both the checker and the final reviewer need to sign off on the analysis after their respective reviews are completed. It is the general practice that any changes required, based on the checking and review steps, are to be completed by personnel working the records. In cases where differences of opinion occur, resolution will be provided by the Field Office Chief. In cases where the Field Office Chief is a party to the difference of opinion, resolution will be provided by the Data Section Chief. In cases where the changes called for in the final review step are significant, the reviewer has the option of requesting to see the records again, after the suggested changes are made.

Upon completion of record review a copy of the final station analysis is provided to the Data Base Chief for inclusion in the station master file. It is the responsibility of the Field Office or Project Chief to ensure that final copies of the analysis for each station are provided to the Data Base Chief. Each year either the Field Office Chief or Lead Technician from each office does the final review of at least one record from each of the other offices in the District. Such reviews foster exchange of the best ideas from each office and encourage consistency of the station analyses.

Furnished Records

Surface-water data collected by other agencies, organizations, or institutions are received by this office. Field personnel are provided by cooperating agencies on distant Pacific islands to make discharge measurements and service USGS gaging stations. These field data are used by the Hawaii District personnel to compute records at both continuous and partial-record stations. These records are used in various ongoing surface-water investigations and are published in the annual data report.

USGS guidelines, as outlined in Water Resources Division Memorandum 85.129, form the basis for quality assurance procedures applied to field data collected by cooperator personnel. Personnel assigned to collect field data receive training and follow techniques provided and approved by the USGS. At least twice a year USGS staff accompany cooperator field personnel to all the stations they service. During these field trips, field procedures used to make discharge measurements and collect stage data are reviewed, and corrections in technique are made as required. During these field trips USGS personnel also make independent discharge measurements, run levels to check gage datum, and verify gage structure, control, and channel conditions. USGS personnel also conduct theoretical computations and indirect measurements as required for rating analysis.

Daily Values Table

With few exceptions, for each gaging station operated by the WRD 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. Data included in the daily values table are cross checked against the final primary and manual computations made for the water year to ensure correct data values are being stored. Daily values that are either estimated or manually computed are flagged in ADAPS to ensure that they do not get automatically revised each time new primary computations are done.

When the discharge records for a water year have been completely checked and reviewed and therefore approved, the data are final flagged in the data base. It is the responsibility of the Field Office or Project Chief to ensure that all data are properly flagged after they are finalized. Final flagging of the data prevents any

subsequent changes unless the flags are first removed by the Data Base Chief. Subsequent retrievals of daily value tables from the data base will no longer have the "provisional data" banner printed in the heading. There is no need to archive daily value tables after the review process is completed as they can be generated as needed from the ADAPS data base.

Manuscript and Annual Report

When records computation for the water year has been completed and the data collected and analyzed by District 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 District's 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, 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.

In preparing the annual data report for publication, the District follows the guidelines presented in the report, "WRD Data Reports Preparation Guide," by Charles E. Novak, 1985 edition. Field Office and Project Chiefs are responsible for providing the Data Section Chief with annotated updates to the manuscripts once the data are finalized. The District's Reports Unit updates the manuscripts and assembles all the final pages for the report. The Data Section Chief and selected discipline specialists review the final draft of the annual data report to ensure all required updates and the correct data are included prior to publishing.

District Check Lists

The Hawaii District uses two different check lists to support the records computation process. The first list is an outline of all the steps required to compute and check records in the order they should be accomplished. Each step has a blank space next to it for the initials of the individual completing that phase of the computation or checking process. Once the records are finalized the summary sheet is stored in the station folder. The second list is maintained by the District Surface-Water Specialist. This list includes the station numbers of all the gaging stations being operated by each Field Office in the District. Records for each of these stations should be computed, checked, final reviewed, and published in the annual data report. Once a station on the list has been final reviewed, the name of the reviewer and date are added next to the station number. This list is used to track the status of records finalization, to ensure that no individual final reviews a given station more than 2 years in a row, and to ensure that a Field Office Chief or Lead Technician from each office final reviews at least one record from each of the other offices in the district.

Review of Records

After streamflow records for each station have been computed and checked, records for all of the District's gaging stations are reviewed by either a Field Office Chief or Lead Technician from an independent office, the Surface-Water Specialist, or the Data Section Chief. When selecting final reviewers, the policy is to avoid having the same person review records for a given station more that 2 years in a row and for each Field Office to have at least one of their records reviewed by someone from all of the other Field Offices each year. 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.

Results from the final review are summarized in writing and returned with the records. The person who computed the record in question is responsible for correcting any deficiencies identified in the review. If there are a significant number of revisions, the final reviewer has the option of asking to see the records again. Copies of the final review comments are kept with the station folder. A copy of the review comments are included with the records for the following year so that subsequent data reviewers can see if suggestions for improvement, provided as part of the final reviews, are being put into action.

The District Surface-Water Specialist will either review records or read the review summaries from other reviewers for each of the stations. Patterns in the comments are indicative of training needs that may be related to certain individuals, Field Offices, or District Data Section personnel in general. Where possible the review comments should provide guidance sufficient to correct minor deficiencies. Identified training needs that are broader will be discussed with the Data Section

Chief, who will in turn establish the priorities for addressing them.

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. At some stations it may be appropriate to develop the initial rating based on theoretical culvert or step-backwater modeling techniques. The initial 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 high stage-discharge measurement is made readily available to those who check and review the station record by keeping the master rating curve in the station folder. Current station descriptions are kept in the station folder and in the District's master file. A summary of levels are maintained in either the station folder or in a binder with those for all the other crest-stage gages operated by the Field Office. A brief station analysis is written each year 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 when the gage datum and rating were last verified.

Responsibility for assigning the personnel for each crest-stage-gage station is held by the Field Office Chief. Computations are checked by either the Field Office Chief or Lead Technician from the office in question.

Responsibility for ensuring the correct computation of annual peaks at crest-stage gages is held by field personnel assigned to service the station and work the records. Review of the crest-stage gage computations is performed by either the Surface-Water Specialist or the Data Section Chief. A written summary of the final review comments are returned with the records to the originating Field Office. When incorrect actions or procedures are identified during the review, the problems are remedied by the individual who worked the records. Based on the overall nature of the final review comments either on-the-job or formal group training is provided. In cases where technical assistance is needed, it will be provided by the Surface-Water Specialist.

Responsibility for updating the Peak-Flow File promptly after peak data have been finalized is held by the Data Base Chief. A current listing of annual peaks is maintained in the station folder 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

In the Hawaii District, Field Offices are aligned by island or groupings of islands. In large part the work loads assigned to individual Field Offices are based on

this pattern of subdivision. All of the Field Offices, except for the Honolulu Office, are staffed by two people. As a result there is a high degree of shared work. Formal work plans are not very practical in such settings and use of an informal system where duties are assigned verbally throughout the year are utilized. The Field Office Chief has the primary responsibility of ensuring that all work assignments are shared equitably and completed within deadlines established by the Data Section Chief.

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. These folders are referred to as station folders and they are grouped initially by water year and downstream order number. These folders contain all the information that has been collected or processed in a given year for a station along with the current versions of station descriptions, rating curves, and rating tables.

When all records for a given water year have been finalized, the station folders are reorganized and moved to the backfiles where the station folders are grouped by station and downstream order number. Before the station folders are moved, all discharge measurements and inspection notes are placed in files with those previously made at that station. Measurement and inspection note files are arranged by station and downstream order number. In addition all extraneous items are removed and the current versions of the station descriptions, rating curves, and rating tables are placed in the station folders for the water year in progress. It is the responsibility of the Field Office Chiefs to send all station folders and discharge measurement and inspection notes that are more than 5 years old to the National Archives. This activity should be coordinated with the Data Section Chief to ensure that the index of all records sent to the archives, which is maintained in the District Office, is properly updated.

In addition to the current and backfile station folders, the Hawaii District maintains several other types of files for each station. Picture files are kept for each station and all historic pictures related to the gage are kept there. Field personnel are encouraged to regularly take pictures to document conditions at gaging stations. All indirect measurements and theoretical modeling study reports that are done in support of rating documentation are kept together in files organized by station in the respective Field Offices. These reports are not sent to the Archives. Master files are kept for each station and these files are maintained by the Data Base Chief in the District Office. Included in the master file, in the District Office, are folders containing (1) copies of all historic station descriptions, (2) all memoranda and correspondence, including right-of-entry agreements, permits, and safety related documents such as job hazard analyses, (3) discharge measurement listings, (4) station analyses, (5) rating tables, (6) original rating curves, and (7) copies of any special reviews or studies that resulted in significant revisions to previously published data.

Field Office Chiefs are responsible for maintaining all of the office files. In addition they are responsible for removing unnecessary items from the current station folders when the records have been finalized and published and moving the remaining information to the backfiles. The Field Office Chief is also responsible for sending all required information to the Data Base Chief for inclusion in the District master files.

Field-Trip Folders

A separate field folder should be maintained for each station. The primary purpose of these folders is to compile maps, station descriptions, information from recent gage visits, copies of current ratings and shift curves, copies of control section plots and other pertinent information, allowing field personnel to run the trips effectively at a moment's notice and with a minimum of time spent on last-minute preparations. The field personnel responsible for each station are to keep the field-trip folders current.

Levels

Level notes are kept in the current station folders until such time as those records are finalized and the folder is moved to the backfile. All station level notes are then filed together, chronologically by station. A summary of levels and their results are kept for all active stations. The summaries are filed by downstream

order number in a separate folder or can be kept with the station folder.

Station Descriptions

Station descriptions provide a location where knowledge gained during the operation of a gaging station is summarized. Copies of the station descriptions are kept in the current station and field folders that reside in the Field Offices. Copies of all the historic versions of the station description are kept in the District's master file. It is the responsibility of the Field Office Chief to ensure that copies of updated station descriptions are sent to the Data Base Chief so that they can be added to the master files. Field personnel who operate a gaging station are responsible for updating the descriptions as new information is available. At a minimum, updates will take place each time new station levels are done. The current status of station descriptions are determined annually as part of the final records review. Deficiencies noted as part of the review will be summarized in the review memo that is returned with the records.

Discontinued Stations

At this time no special procedures are followed with regard to the files for discontinued stations. After a station is discontinued the backfiles, master files, measurement and inspection, levels and photograph files are still maintained in the Field and District Offices. These files will subsequently be sent to the National Archives during the next archiving cycle (see section on "Archiving" below). A notice that the station has been discontinued is added to the station manuscript in the annual data report when the last data collected for the station are published. A notice of discontinuance should also be added to the station master file.

Map Files

The District's Reports Unit maintains a map file that contains unused copies of topographic maps for the entire area in which the Hawaii District operates. These maps are filed alphabetically by island in file drawers that are located in the District Office. These maps are available for use by district personnel. In addition each Field Office keeps working copies of topographic maps for the islands on which they work. The Data Base Chief maintains a set of maps on which the locations and drainage basins of all gaging stations that have been operated in the district are shown. These maps are then used to determine drainage areas for the gages. These maps and the information added to them are considered to be original data. As such no erasures should be made on them and the addition of new information should be made only with the approval of the Data Base Chief.

Archiving

All WRD personnel are directed to safeguard all original field records containing geologic, hydrogeologic and hydrologic measurements, and observations. Hawaii District policy on archiving original unit-values of gage height that are collected electronically, is outlined in a District memorandum dated April 3, 1998. 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 District 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 there is an agreement between WRD and the Federal Records Centers (FRC) of the National Archives and Records Administration to archive original-data records (memorandum from the Chief, Branch of Operational Support, May 7, 1993).

Surface-water information is sent to the FRC from the Hawaii District approximately every 5 years. The Data Section 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 by the Data Base Chief in paper files in the District Office. Personnel who have questions concerning archiving procedures should address their questions to the Data Section Chief. Personnel who receive requests for information that require accessing archived records should submit their request, with supportive

justification, through their supervisor to the attention of the Data Base Chief. The Data Base Chief will coordinate all requests and track the status of the requested records once they are received to ensure that they are properly protected while in the District and ultimately properly returned to the FRC.

Communication of New Methods and Current Procedures

The responsibility to keep current on new methods and current procedures lies with the individual. Pertinent information from headquarters, in the form of memorandums from the Water Resources Division and the Office of Surface Water, are now provided electronically to all employees in the District. Information in the form of District memos and reports (such as this Quality Assurance Plan) are also made available to all employees. To further the communication process, the Data Section and Project Section Chiefs hold regular meetings with their staffs to discuss, among other topics, new developments. The District also maintains an in-depth process of data and project reviews, through which discussions of new methods and procedures take place.

The format of this Quality Assurance Plan was established to facilitate regular updates as new methods are introduced and current procedures change. The Hawaii District also supports a Surface-Water Specialist who is responsible for providing support to District employees regarding technical issues.

COLLECTION OF SEDIMENT DATA

Surface-water activities in the District include the collection, analysis, and publication of sediment data. The District 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 District are described in selected WRD publications and in memorandums issued by OSW, OWQ, and WRD. Techniques adopted by the USGS and followed by this District are presented in Knott and others (1992). The District also follows procedures presented in three publications from 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 T.K. Edwards and G.D. Glysson (2000),

Book 3, Chapter C3--"Computation of Fluvial-Sediment Discharge" by George Porterfield (1972).

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. A compilation of memorandums and other materials concerning office procedures for sediment records is provided in Office of Surface Water memorandum 94.04.

Sampling Procedures

District 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. When field conditions permit, a second sample will be taken at the same stage and within 5 minutes of the first sample. This second sample is used to provide a measure of quality assurance for both field and laboratory procedures. Automatic pumping-type samplers are used by the Hawaii District. For installation and use of automatic pumping-type samplers, the District follows the criteria described in Edwards and Glysson (2000). Some specific policies for the operation of daily sediment stations are (1) samples will be collected at least once a day, except during periods of base flow, (2) during storms, samples will be collected at intervals of 90 minutes or less, (3) samples will be obtained as nearly as possible for the entire range of flow measured during each year, and (4) a minimum of 6 EWI or EDI samples will be collected each year for computation of box coefficients.

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).

The individual in the District responsible for scheduling sediment-collection activities at specific sites is the Field Office or Project Chief. The individual responsible for ensuring that District personnel use correct procedures to collect sediment data is the Data Section Chief. This individual establishes whether or not correct procedures are being used by scheduling trips to field sites with responsible field personnel and by reviewing results of their field work in the office. Answers to questions from District personnel concerning sediment-sampling techniques are provided by the Data Section Chief.

Field Notes

District personnel are required to fill a field inspection sheet specific to sediment work, each time a site is visited for 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, information included on the note sheet should include those discussed in OSW memorandum 91.15.

Upon completion of each field trip, field notes are placed in the current folder for the station. Field notes are checked as part of field trip reviews conducted by the Field Office or Project Chief and as part of the review process for results of sediment records computation.

Equipment

Care and maintenance of the sediment-data-collection equipment is the responsibility of the field personnel assigned to operate the sediment stations. Parts replacement and repair of damaged equipment is accomplished by field personnel. Equipment adequacy should be verified as part of annual data reviews. It is the responsibility of the Field Office or Project Chief 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 District 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). District 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 covered crates in the Field Office. During field trips and prior to use, sample containers are sealed and stored in covered crates in the field vehicle or gaging station. Once the containers have been filled with sediment samples, the samples are stored for the remainder of the day in protected carrying containers. By the end of the day, samples are taken to the District's laboratory for storage until analyses are run. Prior to analysis, samples are stored for a minimum of 10 days to allow sediment to settle. During this time samples are kept in darkness to inhibit algal growth.

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 District. To ensure that field personnel are aware of their responsibilities in obtaining sediment samples at appropriate sites during high-flow conditions, these points are emphasized in written comments provided each year as part of the final records review. The individual responsible for ensuring that sediment samples are obtained during opportunities provided by high-flow conditions are the field personnel assigned responsibility for the operation of the station in question. The individual

responsible for ensuring that the proper sampling equipment and methods are used during high-flow conditions is the Field Office or Project Chief. The Data Section Chief is responsible for providing answers to District personnel who have questions concerning high-flow sampling equipment or sampling procedures.

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, 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 field personnel assigned to service the station in question. Station descriptions are kept current by field personnel and are reviewed to ensure that they are current by the Field Office or Project Chief and by the Data Section Chief as part of the annual records review. When a deficiency is identified during the review of station descriptions, the deficiency is corrected by the responsible field personnel.

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 District 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. The Hawaii District also has suggested procedures for computation of suspended-sediment records that were written for the H-3 project and summarized in an informal document dated January 28, 1994.

Sediment records are generally worked at the completion of the water year. The field personnel assigned to operate the station are responsible for the records computation. The Hawaii District currently uses the computer program SEDCALC to compute sediment records. These results are checked by either the Field Office or Project Chief. The Data Section Chief reviews all of the sediment records computed each year. As part of the review, written comments are provided so that those who worked and checked the records can correct any deficiencies found.

The responsibility for ensuring that appropriate procedures are correctly applied in processing sediment data is held by the field personnel who work the records. During the time the sediment data are being processed for the year, field notes and work sheets for each site are maintained in the current station folder. After the record has been completed, field notes are placed in station specific field-note files chronologically by station number. Work sheets are maintained with the station folder in the backfiles.

Sediment Laboratory

A sediment laboratory is not operated in this District.

Sediment Station Analysis

A sediment station analysis is written for each sediment station operated by the District 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. Station analyses, after they have received final review by the Data Section Chief, are filed in the station folders. A copy of the final station analysis is also stored in the station master file.

Sediment Analysis Results

The end products of sediment computations and analyses are mean concentrations of suspended sediment. For stations where water discharge records are available, computations also include total suspended-sediment discharge expressed in tons per day. It is the primary responsibility of the field personnel who collected and analyzed the data to ensure the quality of the data. Secondary responsibility lies with the Field Office or Project Chief who checks the data and the Data Section Chief who provides the final reviews. Sediment data are published in the District's annual data reports following documented publication guidelines (Novak, 1985 and Office of Surface Water memorandum 91.15).

Sediment Data Storage

Initially, sediment data reside primarily on field note sheets and laboratory analysis forms. Paper files are initially stored in the station folders. Ultimately, as these data are processed and computations are completed, daily values of mean sediment concentration and suspended-sediment discharge are entered into electronic data bases. The field personnel who computes the record is responsible for the entry of this data into the data bases. The Hawaii District uses SEDCALC to maintain electronic files of sediment concentration data. Concentration data for samples collected by automatic samplers are not logged into the QWDATA data base but all EWI and EDI results are. The Field Office or Project Chief is responsible for checking the computations and entry of the data. The Data Section Chief provides a final review of the data. When errors are detected in the checking process, the errors are verbally brought to the attention of the responsible field personnel. The final reviewer provides a written memo summarizing the findings of his overview of the field work, office computations, and data bases.

DATA-BASE MANAGEMENT

Surface-water data including recorded unit values of stage and computed daily values of stage and discharge are stored in electronic data bases maintained in the District Office. In addition to the above, electronic copies of discharge measurement information, rating and shift curves, datum and gage-height corrections, station header and basin characteristics, and annual peak flow data are stored in the same data bases. Hard copy files are also maintained for the original recorded stage data, discharge measurements, level notes, theoretical computations, photographs, computations by station and water year, and master files which contain paper copy summaries of the most significant data for each station.

The Field Office and Project Chiefs are responsible for all of the paper files that are maintained in each of the individual offices. One exception are the master files, which are overseen by the Data Base Chief. All electronic files are maintained under the direction of the Data Base Chief. Initial input of the field data and ensuring that the data are entered correctly is the responsibility of the field personnel. The checking and review process is intended to quality control this system and ensure the accuracy of the electronic data. Once these data are finalized in the data base changes can only be made through the Data Base Chief. The Data Base Chief oversees the entry of data into station header, basin characteristics, and peak-flow files.

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 and WRD have created specific policies pertaining to publication of data and interpretation of those data. All WRD personnel, including those of this District, 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 or an approved designee, hydrologic measurements resulting from observations and laboratory analyses, after they have been reviewed for accuracy by designated WRD 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 or an approved designee 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, 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 Hawaii District 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 District 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 WRD are summarized in U.S. Geological Survey (1991, p.36–41). This District 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 or an approved designee. At least two technical reviews of each report are required by WRD (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).

All data in the annual data report are computed by trained and competent field personnel who collect the data. All data collected and computed are checked and then reviewed by independent parties to ensure the quality of the work. Manuscripts for each data station are annotated and checked as part of the review process. The Reports Unit updates all the electronic files associated with the annual data report based on information submitted from the above review process. When copies of the final report are completed they are given to the Data Section Chief to coordinate the final review. The Data Section Chief and appropriate discipline specialist in the District will review the report, checking all data pages and updated manuscripts to ensure that the proper

updates and data have been entered. Once this process has been completed the final product is routed from the Data Section Chief through the District Chief for publication. At the present time the annual data reports for Hawaii are available in paper copy and on the District's web page at http://hi.water.usgs.gov/pubs/online.html.

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 Hawaii District. Beyond the obvious negative impact that 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 and employee morale. 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 District communicates information and directives related to safety to all personnel through regularly scheduled training classes, memorandums, videotapes, and posters. Specific policies and procedures related to safety can be found in the materials provided to all District personnel. It is the responsibility of each employee to keep current, work in a safe manner, and to bring to the attention of supervisors any safety concerns they may have so that corrective actions can be undertaken.

The positive attitudes of Hawaii District management toward safety related issues is of paramount importance. In support of safety the District has designated Co-Safety Officers. The Safety Officer's duties include tracking and coordination of all routine and required safety training, keeping current on safety issues and disseminating appropriate materials and memorandums to appropriate District personnel. The Safety Officers are also responsible for keeping District management appraised of potentially unsafe conditions and practices that exist so that corrective actions can be initiated as appropriate. In addition to the Safety Officers, the District also maintains a safety committee which meets as a group to discuss safety issues and develop recommendations for action. The committee includes the Co-Safety Officers and representatives of Data and Project Sections and District management.

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 their supervisors or either of the Co-Safety Officers. The Co-Safety Officers report directly to the District Chief.

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 District increases the quality of work and eliminates the source of many potential errors.

Training needs of District personnel are identified through the ongoing performance appraisal process. All employees are encouraged to take an active role in mapping out appropriate plans for their respective positions. Employees are encouraged to seek out formal training opportunities provided through the USGS as well as through local schools and businesses. The ongoing review of data collection and records-computation processes often points out individual or shared needs and weaknesses that require training. In such cases the Field Office and Project Chiefs, the Surface-Water Specialist, or the Data Section Chief may suggest specific programs. In the Hawaii District an emphasis is placed of the value of a variety of training opportunities ranging from on-the-job training, to in-house training classes, to formal training classes at offsite locations like the USGS National Training Center.

SUMMARY

Information included in this District Surface-Water Quality-Assurance Plan documents the policies and procedures of the Hawaii District that ensure 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 District 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.

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APPENDIX 1. U.S. GEOLOGICAL SURVEY MEMORANDUMS CITED

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. Copies of the memorandums are also available at the following web site: http://water.usgs.gov/admin/memo/

Office of Surface Water memorandum 99.06
Office of Surface Water memorandum 96.05
Office of Surface Water memorandum 96.04
Office of Surface Water memorandum 96.03
Office of Surface Water memorandum 94.04
Office of Surface Water memorandum 93.12
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 91.15
Office of Surface Water memorandum 90.10
Office of Surface Water memorandum 89.08
Office of Surface Water memorandum 89.07
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 85.14
Office of Surface Water memorandum 85.07
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Water Resources Division memorandum 99.34
Water Resources Division memorandum 99.32
Water Resources Division memorandum 97.32
Water Resources Division memorandum 97.17
Water Resources Division memorandum 95.19
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