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December 28, 2005 (revised December 2009)

OFFICE OF SURFACE WATER TECHNICAL MEMORANDUM NO. 2006.01

SUBJECT: Collection, Quality Assurance, and Presentation of Precipitation Data

Executive Summary

This memorandum provides policy and guidance in collecting, processing, presenting, and archiving precipitation data and is to be implemented in the 2006 water year. Significant policy requirements described in the memorandum are summarized below:

1. "Permanent" daily and unit value precipitation data subject to archival and future retrieval, provided to cooperators, or displayed on the Internet must be quality assured and published in the Water Science Center's (WSC) annual data report. Requirements for such stations include annual calibration of precipitation gages and archival of station descriptions, annual station analyses, calibration forms, and original field inspection notes. More frequent calibrations are recommended at sites producing permanent data to avoid a situation where an entire year of data must be thrown out following a calibration test that exceeded allowable accuracy limits.
2. "Temporary" data not intended for archival/publication may be displayed on the Internet for 60 days when accompanied by a standard qualifier. Though temporary data will remain in the National Water Information System (NWIS) database, it should not be in a DD marked "Primary" and should never be adjusted or flagged as approved.
3. Every WSC that publishes precipitation data must have a pertinent section in their Surface Water Quality Assurance Plan that details procedures to be used to collect, process, review, and archive the data.
4. Station description documents must be developed and kept current for all sites (temporary or permanent data).
5. A separate station analysis (apart from streamflow) must be written each year for stations providing permanent data.
6. The recording interval for precipitation gages providing permanent data will be 15 minutes or less.
7. Minimal procedures for routine field inspections are provided for permanent data stations.
8. Calibration procedures for new and existing stations are provided. Adjustments at sites collecting permanent data should be made if tipping bucket gages are not within 5 percent of actual volume or if weighing bucket gages are not within 0.1 inch of actual volume.
9. Data corrections are discouraged in most cases.

10. Estimation of precipitation records where permanent data are missing for long periods of time (multiple events over a period of more than three days) is not recommended. If circumstances dictate, estimates may be made using approved techniques. When the total volume over a few days is known, the daily distribution should be estimated using nearby gages and the results published as estimated values.
11. No formal quality ratings will be assigned to published data based on calibration tests, site conditions, or the amount of estimated/missing record. Records associated with field calibration results having errors in excess of 10 percent (tipping bucket gages) or 0.1 inch (weighing bucket gages) should **not** be published.
12. Similar to streamflow policy, spurious precipitation data spikes during a major storm should not be displayed on the Internet and less obvious errors (detected by comparison with nearby gages) should be revised within a few weeks. ADAPS screening thresholds should be applied to all data presented on the Internet via NWISWeb. A standard disclaimer should accompany all real-time precipitation data. These minimal QA/QC requirements apply to both permanent and temporary data displayed over the Internet.

Introduction

The purpose of this memorandum is to provide policy and guidance in collecting, processing, presenting, and archiving precipitation data within the Water Resources Discipline. This policy applies to precipitation data (1) displayed on the World Wide Web (Internet) or (2) published in USGS reports (data or interpretive), provided to cooperators, or archived in the NWIS database. This policy is to be implemented in the 2006 water year.

Precipitation data have been collected by the USGS since the early 1900's. Collection of precipitation data is a logical and cost-efficient extension of the USGS streamflow data collection infrastructure. Routine publication and public display of precipitation data on the Internet has evolved to be commonplace within the USGS. Our precipitation data applications range from simple gaging station add-ons used only to direct internal operations during flood events (minimal accuracy requirements) to critical components of cooperative real-time flood warning networks. Though precipitation data prior to about 1990 were archived in office files or our database and is available upon demand, unit and daily value precipitation amounts were not published in our annual data reports. While precipitation monitoring has proliferated over the last few decades, a lack of guidelines has made it necessary for Water Science Centers (WSCs) to develop their own policies, many of which are not consistent with other WSCs or even within their own State over time. In order for precipitation records to be consistent across time and space, the Office of Surface Water (OSW) has formulated a policy that sets the minimum standards outlined below.

For the purposes of this memorandum, the term "**permanent data**" refers to all unit and daily value precipitation data that is quality assured and thus intended for public display, distribution, publication, and archival in the NWIS database. "**Temporary data**" (precipitation data that is only minimally quality assured, such as data used solely to facilitate decision support activities during flood operations) should not be modified, published, distributed to cooperators, or made available for retrieval by the public following the 60-day display period.

The purpose of a precipitation station should be to obtain a representative time series of precipitation values for a particular location. Unlike streamgaging, the principles of fluid mechanics do not apply. Thus, precipitation gages only a short distance apart may not give identical readings. For this reason, small errors are tolerable but all data (even temporarily-displayed data) should still be meaningful. Every WSC that publishes precipitation data must have a pertinent section of their Surface Water Quality Assurance Plan (QA) that details procedures to be used to collect, process, review, and archive the data. QA plan criteria can be more, but not less, stringent than those outlined in this memorandum.

This memorandum does not apply to data collected to National Weather Service (NWS) standards, which vary according to type of special purpose network. If cooperator requirements dictate monitoring precipitation to NWS standards, WSCs should refer to NWS directives instead of this memorandum. The NWS directives are available at the URLs below:

http://www.nws.noaa.gov/directives (directives)
http://www.weather.gov/om/coop/Publications/coophandbook2.pdf (cooperative program guidelines)

This Memorandum does not apply to data collected for the National Atmospheric Deposition Program (NADP). Data collected for this program should follow NADP protocols for site selection and installation at URL:
http://nadp.sws.uiuc.edu/lib/manuals/siteinst.pdf

and for station operation at URL:
http://nadp.sws.uiuc.edu/lib/manuals/opman.pdf

This memorandum does not cover other meteorological parameters (air temperature, solar radiation, etc.) or snow depth/snowpack measurement.

Specific topics covered in this memo include:

1. Precipitation data collection
    a. Siting (gage location and stability)
    b. Station descriptions, naming, and numbering conventions
    c. Standardization of recording interval
    d. QA/QC procedures for routine visits
    e. QA/QC procedures for calibration visits
2. Precipitation data processing
    a. Data corrections
    b. Estimation of missing record
    c. Use of cumulative versus incremental data as the measured input parameter
    d. Station analyses
3. Precipitation data presentation
    a. Annual data reports (EXPLANATION OF RECORDS section, statistics [daily, monthly, annual])
    b. Qualification of records
    c. Internet display and ADAPS storage
4. Precipitation data archival (supportive field notes, calibration forms, station analyses)

<u>Collection</u>

<u>Siting of precipitation gages</u>

The exposure of a precipitation gage is very important for obtaining accurate measurements. As a general rule, the windier the gage location, the greater the precipitation error will be. Gages should not be located close to trees and buildings, which may obstruct wind-driven precipitation or alter the amount of precipitation collected due to erratic turbulence. To avoid other problems related to excessive wind, it is recommended that gages not be located in wide-open spaces or on elevated sites, such as the tops of buildings. The best site for a gage is one that is protected in all directions, such as in an opening in a grove of trees. Ideally, the distance between the protection and the gage should be twice the height of the protection above the collector but not less than the height of the protection (top of building or canopy should leave an open cone of between 25 and 45 degrees above the collector). Gages should be installed as close to the ground as possible without being subject to splash and on a sturdy structure that does not shake in the wind causing unintentional bucket-tips or fluctuations in weight. Rarely will an ideal site be available and judgment must be exercised in choosing between sites, each of which may have shortcomings.

In the absence of any other wind protection, wind shields may be used to minimize the loss of precipitation. This loss is much greater during snowfall than rainfall, so shields are seldom installed at stations unless at least 20 percent of the annual precipitation falls in the form of snow. In areas that are expected to have significant snow accumulations, gages should be mounted on towers at a height considerably above the maximum level to which snow accumulates.

Good exposures are not always permanent and site conditions should be evaluated at each routine site visit. Over time, alterations by humans or vegetative growth may make the exposure unsatisfactory, necessitating clearing of trees/brush or relocation to a better site. **Under no circumstances** should data be published or displayed on the Internet (includes temporary data sites) if gage readings are <u>severely</u> compromised by known conditions that could bias the data, such as roadway splash or drip from vegetation or overhead utility lines.

There are many types of instruments used by the USGS to collect precipitation data; a brief description of the principal types and limitations is provided in Appendix 1 of this memorandum. There are compelling site conditions and financial constraints which do not allow a single type of instrument to be recommended for all installations. In general, a tipping bucket type of installation (with a heater in climates where needed) would be the best choice for accuracy. However, if the AC power needed for the heater is not available, a weighing bucket (spring, strain, or wire strain type) may be the only economically feasible option. Although tipping bucket gages have been known to under-register during periods of intense precipitation, such as thunderstorms, there are inexpensive self-calibrating tipping bucket models with a post-processor that purportedly reduces or eliminates the error for rainfall intensities between 0 and 25 inches per hour by adjusting the number of tips according to intensity.

In addition to intensity, another common problem with tipping bucket or well/float rain gages is clogging from bird waste or other small debris. To address both problems, one might consider siphoning rainfall sensors, which have orifice sizes of about one inch instead of the more typical quarter-inch orifice. The unit has a larger-diameter funnel drain that does not clog easily and a siphon to control the flow so that the tipping mechanism will not under-register during intense storms, though there may be a short lag in response time.

The weighing rain gage has the advantage that all forms of precipitation are weighed and recorded as soon as they fall into the gage (snow and ice do not collect in the un-heated funnel undetected, as is the case with tipping bucket mechanisms or collection well float systems). However, the weighing gage requires more frequent maintenance than the tipping bucket gage, and older spring types are sensitive to strong winds, which can rock the gage, causing spurious readings.

Collector well/float system rain gages with siphons are discouraged because they can affect holding well volumes and may, themselves, become plugged or partially plugged, prolonging the siphon-draining period and thus increasing the likelihood that some rainfall may be missed.

Station descriptions, naming, and numbering conventions

Station descriptions containing details on location, deployment dates and methods, instrument type, model number, and calibration method and frequency must be developed and kept current for stations providing any type of data (temporary or permanent). Descriptions should be a living document containing a chronological history of the types of instrumentation that have been operated and any siting issues that affect(ed) the record. Be sure to note whether the data being collected is permanent or temporary and, if mixed, provide a listing of the time periods associated with each.

Some WSCs have assigned separate 15-digit station numbers and names to all precipitation sites in their database. Others simply have rain gages organized as a different parameter collected under the same station number and name as the streamgage it is co-located with. The more typical situation for WSCs is to have some combination of both of these systems, since at least some precipitation gages are not associated with or even near a streamgage. Logically, precipitation should not be tied to downstream station numbers, and the likely structure of our database in the future will be geared towards assigning separate station names and numbers to gages that monitor different parts of the hydrologic cycle, regardless of location. Although the current mix of station name and numbering schemes is acceptable for existing networks, future precipitation gage installations (after October 1, 2005) should be set up in the NWIS database with separate names and 15-digit station numbers. A separate electronic/paper filing system for precipitation gages (containing station descriptions, analyses, and archived records) should be set up for new stations as well. An example station description is provided as Appendix 2.

Standardization of recording interval

The recording interval for precipitation gages intended to produce permanent data must be 15 minutes or less, starting at the top of every hour. If the instrumentation being used is an event recorder, zero precipitation can be assumed between events (interim unit values do not need to be filled in with zero values). The recording interval at gages where the data will only be temporarily displayed can be established according to cooperating partner or science center objectives.

QA/QC procedures for routine visits

Temporary data -- Though the expectations for temporary data are much-reduced, no data should be displayed if collected by equipment that has been neglected or is in a state of disrepair. As such, many of the following procedures should be adhered to even though formal inspection records are not required.

Permanent data -- Routine maintenance visits to permanent data sites should be made approximately 6-8 times each year, similar to streamflow station measurements. A separate form (example inspection form is shown in Appendix 3) should be filled out during each site visit and filed with the analysis made at the end of each water year. Routine field inspections should document the following procedures:

Float system gages:

- Visual check for 45-degree clearance above collector.
- Note collector, funnel, and screen conditions.
- Clean or repair collector, funnel and screen, if necessary, and note.
- Inspect the tube connecting the storage well to the collector for leaks or blockages. Check the storage well for leaks and debris that may have fallen in.
- Record water levels in the storage well and drain storage well every visit to ensure that a maximum amount of cumulative precipitation can be recorded. Close the drain valve.
- Add antifreeze during winter months as needed.
- Fill out inspection sheet.

Weighing bucket gages (spring type):

- Visual check for 45-degree clearance above collector.
- Record bucket level.
- Note collector, funnel, and screen conditions.
- Clean or repair collector, funnel and screen, if necessary, and note.
- Empty and clean bucket as necessary and replace.
- Remove or replace evaporation shield at beginning and end of winter period, respectively.
- Check gage for proper movement throughout range of motion.
- Check dashpot oil level; refill if more than 0.25 inches from top.
- Clean inside of gage as necessary.
- Check to make sure gage is level in both directions. Level as needed.
- Add about 0.2 inches of oil Isopar or mineral oil (and antifreeze during winter visits) and record bucket level upon departure.
- Fill out inspection sheet.

Tipping bucket gages:

- Visual check for 45-degree clearance above collector.
- Note cup, screen, and funnel condition (clean or dirty).
- Clean cups, screen, and funnel, if necessary, and note.
- Re-level the instrument if necessary (collector must be vertical).

- Lubricate the pivot hinge with a plastic-safe lubricant or silicone oil (as recommended by the manufacturer).
- Make sure the small drain holes at the bottom of the gage are not plugged with dirt or other material (drill them larger if problem becomes chronic). Record water levels in accumulation can and empty it.
- During warm weather site visits, the collector funnel and tipping buckets should be waxed (liquid car wax). This will reduce corrosion and decrease the number of water droplets that might cling to the side/bottom of the collector.
- Perform a manual test tip procedure to check the integrity and operation of the gage sensor and wiring as follows:

  The gage cover is removed. The bucket mechanism is gently tipped ten times at a rate of about one tip every three seconds being careful not to allow a bounce that could create a double reading of the switch. This is repeated two additional times with a time period of about fifteen second between each set of tips. The number of tips from the data logger or field computer is recorded. If the number of recorded tips is not equal to 30, troubleshoot the system and rerun the test. If the gage fails a second time it must be replaced. Replace the cover being careful not to cause a tip. Delete test tips from the data logger while at the site.
- Turn on heater during winter months.
- Fill out inspection sheet

QA/QC procedures for calibration visits

Calibration of precipitation gages must be performed either in the field or office prior to extended field operation. Thereafter, calibration tests must be made at least annually for all types of gages (even those meant to collect only temporarily-displayed data). Additional calibrations during the year are recommended at sites producing permanent data to avoid a situation where an entire year of data must be thrown out following a calibration test that exceeded the allowable accuracy limits. Calibrations are also required when an ongoing pattern of unfavorable comparisons with nearby gages is discerned, or when physical damage to the instrument or its components is noted that would make testing prudent. Remedial actions at sites that collect permanent data should be taken when calibration test errors exceed 5 percent (tipping bucket gage) or 0.1 inch (weighing bucket gage). Adjustments at temporary data sites are indicated when calibration tests exceed 10 percent (tipping bucket gage) or 0.2 inch (weighing bucket gage). Each calibration should be documented on a separate form to be placed with the end-of-year station analysis (permanent data station) or station description (temporary data station) and archived. An example calibration form for a tipping bucket rain gage is provided as Appendix 4.

Calibrating float system gages

The inside diameter of float system storage wells (such as 3-inch galvanized pipes) may vary slightly by manufacturer. Therefore each gage needs to be calibrated before the gage is put to use. The general procedure for checking the accuracy of a float system is simply to pour a known volume of water into the collection well and compare the reading against the expected value. For example, the area for a standard 8-inch collector tube is 324.335 cm^2. If 2500 cm^3 (or milliliters) of water is poured into the collector funnel, the change in reading should be 3.03

inches (2500 cm^3 / (324.335 cm^2 x 2.54 cm/in) = 3.03 in.). If the above test was made and resulted in a reading of 2.85 in., the correction factor for all data collected at this site would be 3.03/2.85 = 1.06. This should be checked at least annually to ascertain float problems; generally the correction factor is constant, a function of varying manufacturer specifications related to volume, and is unaffected by intensity. For less sensitive, large-diameter storage wells, the diameter should be measured in two or three different locations to get an average diameter. The rise in the water level of the larger storage well should be equal to the number of inches put in the smaller 8-inch collector times the ratio of the area of the small collector to the area of the larger diameter holding well.

Calibrating weighing bucket gages

Spring type: Check calibration (with the bucket out) for the full range of the bucket. Using a set of precipitation calibration weights purchased from the manufacturer, record all of the values as you add one at a time to the gage (each weight represents 1 inch of precipitation) at 1-inch increments from 0.0 to 20.0 inches. Adjust the spring tension if the reading is off by more than 0.1 inch (0.2 inch at temporary data sites), being careful to adjust for trends as well. For example, if at a lower value, such as 3.0, the gage registers 2.9 and at a greater value, such as 18.0, the gage registers 18.1 you may want to make some adjustments to account for this trend even though neither error is greater than 0.1 inch.

Strain and vibrating wire-strain types: See instruction manual and follow suggested manufacturer procedure for calibration.

Calibrating tipping bucket gages

The accuracy of the tipping bucket precipitation gages should be determined using constant head bottles fitted with nozzles having orifice diameters representing a variety of rainfall intensities. Calibration kits with several nozzle sizes may be purchased from many companies, including NovaLynx Corporation and Qualimetrics. Every precipitation gage should be calibrated annually (at a minimum) using the nozzle that simulates a precipitation intensity of 2 inches/hour. <u>Even new instruments may be out of calibration</u>, despite manufacturer specifications, and should be checked before being placed into service at a site. If desired, additional calibration tests can be made with nozzles having different simulated precipitation intensities. The larger the orifice diameter used, the greater the represented rainfall intensity.

Using the NovaLynx kit as an example, several plastic orifices are provided, each with a different orifice diameter and nozzle length (the length is used only to assist in visually identifying orifice diameters):

Orifice Diameter (inches)	Nozzle Length (inches)	Simulated Precipitation Rate (inches/hr)
1/32” (smallest)	**3/16”**	**2**
1/16”	5/16”	6
3/32”	3/8”	12
1/8” (largest)	5/8”	26

Because higher intensity rainfall results in more splash and losses between tips, the amount of rainfall registered will usually decrease with increasing intensity unless you have a self-calibrating unit with a post processor that accounts for intensity differences. Instruments with software that compensates for rainfall intensity require data collected as a running total (as opposed to an incremental mode). Be sure to consult the calibration tables for the manufacturer and model you are using.

To calibrate a tipping bucket precipitation gage, the calibration bottle is filled with a known volume of water that will correspond to a certain number of inches of precipitation. The greater the volume used, the more confidence you will have in the calibration results. Please note that the filled ring lines on the calibration kit bottles are approximate only. It would be prudent to use either a graduated cylinder or a precision scale to measure the calibration water volume. The table below is for a rain gage funnel having a diameter of 8 inches. For other funnel sizes, the inches of precipitation may be computed by simply dividing the calibration volume by the volume of water per inch of funnel volume. For example, an 8-inch funnel will collect 824 mL for each inch of rainfall (7.874-inch funnel = 798 mL/inch; 8.214-inch funnel = 868 mL/inch; 12-inch funnel = 1853 mL/inch). Thus, 946 mL divided by 824 mL/inch equals 1.148 inches of rainfall (114 bucket tips with some water left in the last bucket).

mL of Water	inches of precipitation	# of bucket tips	allowable # of tips
450	0.546	54	51-57
501 (bottle line)	**0.608**	**60**	**57-63**
750	0.910	91	86-95
946 (full-bottle line)	1.148	114	109-120

The permissible error range in the number of tips in subsequent calibration tests for that gage must be no more than 5 percent (10 percent for temporary data sites). If the computed correction factor is between 0.95 and 1.05 (0.90 and 1.10 for temporary data sites), no recalibration is needed and no corrections should be considered.

If small daily or event totals of a few hundredths of an inch are important to record accurately in addition to more significant events, WSC's may want to consider calibrating each bucket separately to be sure it tips when exactly 0.01 inch of rain is added. A laboratory pipette can be used to measure the amount of water that is equivalent to 0.01 inch of rainfall. For an 8-inch funnel, the amount would be 8.24 mL (7.874-inch funnel = 7.98 mL; 8.214-inch funnel = 8.68 mL; 12-inch funnel = 18.53 mL).

Field calibration procedure (for an 8-inch collector):

1. Note current precipitation readout.
2. The proper amount of water (501 mL, for example) should be measured in the office using a graduated cylinder and carried to the field in bottles. Carefully transfer the water into the calibration bottle.
3. Screw 1/32" (2 inches/hour) orifice on bottom of base plate, hand tight.
4. Screw base plate onto calibration bottle (base plate inverted), hand tight.

5. Plug orifice with finger and turn calibrator over (to prevent water from splashing out) and place in the bucket.
6. Allow the water to drain out completely.
7. Make sure all water has dripped out of the bottle and base plate into the funnel/bucket when removed.
8. Note the resulting precipitation reading.
9. If 0.57 to 0.63 inches (57 to 63 tips) of precipitation was recorded during the test, no adjustment is necessary and you may skip to step 11. Because you cannot read a fraction of a tip, the test should yield about 60 tips..
10. If the test results are outside of the allowable range on the first calibration, re-level the instrument and make appropriate adjustments to correct the instrument error (see the equipment manual for adjustment techniques). Repeat steps 1-9 after adjustment. If the test results of the second calibration are still outside the allowable range, replace the instrument with a spare unit and diagnose the problem back in the office.
11. Check one more time to be sure instrument is level. Then reset the DCP or other datalogger back to the reading observed before the calibration test (or remove test precipitation data from ADAPS upon return to the office).

A sample template for permanently documenting tipping bucket calibration tests is provided as Appendix 4 of this memorandum.

Processing

Data corrections

There are few instances when there will be sufficient data to support how and when data corrections should be applied. Therefore, in most cases, corrections should not be applied to a precipitation record even when calibrations indicate the record may be in error by more than 5 percent. Under no circumstances should data corrections be made to temporary data site records. If the tipping bucket gage has a cumulative precipitation collector, that information should be used to ascertain storm totals for short periods of missing record or to check for gross errors from instrument malfunctions; this should be checked even if the record appears to be complete.

Corrections are made to unit values. In the current version of ADAPS (4.5), small corrections may round off to zero correction by default (for example, a 9 percent correction to 0.05 inches would result in a 2-decimal place number that rounds back to the uncorrected value of 0.05 inches). Thus, daily values should be checked and edited as necessary to ensure proper adjustment. Edited values should be marked appropriately in the published record.

Estimation of missing or erroneous record

Two types of “missing” record at permanent data sites are addressed here: (1) long periods with multiple events wherein no data have been transmitted or recorded, and (2) short periods of up to 3 days in which the total volume is known but the timing is uncertain due to missed transmissions, plugged funnels, or snow/ice effects. This section does not apply to sites at which temporary data is being collected.

As a general rule, missing precipitation record in the first case should not be estimated. The period should be deleted and the record classified as missing. If however, cooperator or project needs dictate, daily precipitation may be estimated but supporting documentation must be archived and an appropriate/approved technique must be described somewhere in the station analysis and report. An acceptable method is the reciprocal-distance-squared equation used by the National Weather Service. This has been verified on both theoretical and empirical bases (U.S. Department of Commerce, 1972, p. 3-11). Other methods for interpolating missing daily values of point precipitation data may be used if approved by your Regional Surface Water Specialist. Additionally, the policies outlined in OSW Technical Memorandum 2005.07 providing guidance for the use of Program HYDRA to estimate or modify edited unit values from ADAPS are also applicable to precipitation data.

In the second case, publication of a known total for a short time period is considered to be measured (not a computed estimate). The volume is accurately measured and only the time distribution must be estimated. Non-heated tipping bucket records must be carefully analyzed for snow/ice effects. Event totals manually inserted on the last day of an event in order to make our database and annual data report totals match are discouraged. Daily distributions should be estimated using nearby unaffected gages, marking each daily value with an "e" remark code in order to maintain the correct monthly value. As before, in some cases (such as when snowfall exceeds the depth of the collector), a WSC may elect to simply delete those days and that period of record would be considered as missing.

<u>Cumulative versus incremental data as the measured input parameter</u>
A cumulative (running total) is preferred as the form for input data (though all <u>computed</u> unit values are incremental). The use of incremental values for input data is discouraged because of problems associated with lost data when transmitting them. Each WSC must decide which form is most appropriate for the location and type of equipment being used.

The resolution of some data loggers decreases when the cumulative precipitation reaches a particular value. Thus it is important to reset the cumulative precipitation value at each inspection or, at least, long before that value could occur. Resetting the gage on the first inspection of each year would facilitate the comparison of running annual totals with nearby sites.

<u>Station analyses</u>
A separate station analyses (apart from streamflow) must be written each year for permanent data sites and archived similarly to discharge records. A sample station analysis is provided as Appendix 5 and should minimally include:

- *Station* -- Provide station number, name, and location information.
- *Gage* -- Describe the current sensor, recorder, DCP, and shelter, including the height of the collector above the ground. Describe any changes to the site instrumentation made during the year.
- *Precipitation record* -- Describe any problems noted in periodic inspections. Note periods of missing or doubtful record and reasons.

- *Computations and calibrations* -- Provide the results of any calibrations performed, corrections made, and how they were applied.
- *Remarks* -- Describe any analyses or comparisons with nearby stations.
- *Extremes (optional)* -- For complete records, give the maximum daily precipitation total for the current year (and period of record) and associated date(s). Maximum intensity data also may be included.
- *Recommendations (optional)* – Note any impending work or site conditions that will potentially affect operation of the gage in the near future.
- *Names* of persons computing, checking, and reviewing the data and dates of analysis.

Presentation

Annual data reports

Data collected by the USGS and used in interpretive investigations, distributed formally to cooperators, or stored in the NWIS database must be quality assured and published in the WSC's annual data report. Where daily data are missing and not estimated, no monthly sum for that month will be presented and no annual amount will be given. Monthly and annual sums can only be provided when the record is complete or when missing daily values have been estimated or are known from accumulation totals.

Publication of intensity-duration-frequency statistics from unit value computations spanning more than one calendar day is meaningful and encouraged if the WSC has access to tested utility programs capable of such analyses. Publication of daily value extremes from ADAPS for the current year and for the period of record is discouraged. Such statistics have dubious value because they are arbitrarily constrained to reflect calendar day information instead of "true" 24-hour maximums.

Some WSCs currently publish precipitation records alongside of streamflow records with the same 8- or 10-digit station number with NWIS site type flags indicating both climatological and streamflow data as present. Those WSCs also may have precipitation gages that are operated independently of any streamflow station. In the latter instance, precipitation gages (1) have no river name associated with them, (2) are assigned separate 15-digit station numbers, and (3) are published in a separate section of the annual data report. Many WSCs have re-organized their databases and data reports, assigning separate 15-digit station numbers to all of their precipitation sites, which are published in a different part of the data book regardless of whether they are operated in conjunction with a streamgage or not. As with station names and numbers (see Station descriptions, naming, and numbering conventions section of this memorandum), the current mix of publication schemes is acceptable.

Precipitation records for stations installed after October 1, 2005 are to be identified and published separately from any streamflow station they may be co-located with. Be sure, however, to cross-reference any information collected at the same site by providing (in the REMARKS paragraph) the station number, name, and parameter published elsewhere in the annual data report.

A sample template of recommended wording for the Introduction of the annual data report and a sample manuscript are provided as Appendix 6.

Qualification of records

Site conditions, especially those which deviate from the criteria in the section on siting precipitation gages above, should be carefully described in the GAGE section of the station manuscript to assist the end-user in assessing the accuracy of the data. No quality ratings will be assigned based on the calibration test results, site conditions, or amount of estimated/missing record because any such rating would be subjective. The "e" flag, used to denote data that were either missing or of poor accuracy, will sufficiently alert the user to the fact that such data are of lesser quality than other daily values. If a uniform method is not used for all stations and cited in the DATA PRESENTATION section of the introduction, a statement should be made in the REMARKS paragraph of each station manuscript describing/citing the estimation method used for that individual station.

Records associated with calibration tests for tipping bucket gages having greater than 10 percent error should not be published. Weighing bucket gage records with calibration errors in excess of 0.1 inch should also not be published.

Internet display and storage in ADAPS

Permanent data – WRD Policy Memorandum 99.34 already requires all offices to review streamflow data served on the Internet at least once each business day under normal conditions and to establish "very-high-value" and "very-low-value" stage thresholds in ADAPS (see below). Similarly, a completely spurious precipitation data spike during a major storm/flood should not be displayed on the Internet for more than 24 hours. During more normal conditions, such a spike should not be displayed for more than a few hours into the next work day. Less obvious errors that can only be ascertained via careful comparison with nearby precipitation gages should be deleted or revised within 2 or 3 weeks.

ADAPS screening thresholds should be applied to all data presented on the Internet as follows:

If input is ***incremental precipitation***:

- Set the *very high* threshold to above the highest value possible in the recording interval (for example: 3 inches in 15 minutes).
- Set the *very low* value to -0.01 (negative values are not possible with incremental input and will always result in transmission/DECODES issues).
- Do not use the *very rapid increase* and *very rapid decrease* thresholds.

If input is ***cumulative precipitation***:

- Set the *very high* and *very low* thresholds to beyond the range of the counter. For example, for a 0-20 inch weighing-bucket set the *very high* threshold to 21 inches and the *very low* threshold to -0.5 (as readings slightly beyond the normal range are possible). For a tipping-bucket counter that can record up to 99.99 inches, set the *very high* threshold to 100 and set the *very low* threshold to -0.01.
- Set the *very rapid increase* and *very rapid decrease* thresholds to the maximum possible rate in inches per minute. For example, a *very rapid increase* setting of 0.2 would equal 3 inches of precipitation in a 15 minute period.

Temporary data – Precipitation data not intended for archival or publication may be temporarily displayed on the Internet for up to 120 days primarily for operational needs and uses. ADAPS screening thresholds should be applied as described immediately above. To limit the display time for temporary data to 120 days, such sites are to be set up to display unit values only. The display must be accompanied by the standard qualifier shown below. The absence of routine inspections throughout the year precludes reliable interpretation/adjustment of the data at a later date. Temporary data (1) must NOT be stored in a DD marked "Primary", and (2) must never be flagged as "Approved" (it can be protected from subsequent editing by flagging it "In Review"). It is further recommended that the DD description field contain the phrase "Temporary Data" to ensure that the temporary status is made clear in perpetuity.

A standard qualifier-disclaimer statement must accompany the NWISWeb real-time display of temporary data as follows:

> **The X-hour precipitation data for this station are temporary** and will only be displayed for 60 days. Time series of X-hour or cumulative daily values will NOT be available for retrieval following the 60-day display period. Although the instrumentation is calibrated at least once/year, the temporary classification means that documented routine inspections and other quality assurance measures are not performed that would make the data acceptable for archival, retrieval, or future use in general scientific or interpretive studies.

The standard qualifier-disclaimer above must be added to each individual temporary precipitation station real-time data page. The disclaimer text should be inserted following any cooperator acknowlegements at the top of the real-time station page. Instructions on how to insert the standard disclaimer are available from the NWISWeb Manual – Frequently Asked Questions web pages at URL:

http://waterdata.usgs.gov/nwis/news?nwisweb_manual_faq#site_text

The following standard disclaimer in HTML format can be cut-and-pasted directly into your site-text file as per the instructions in the NWISWeb FAQ:

```
<table border="1" cellpadding="5" width="576">
 <tr>
  <td><b>The X-hour precipitation data for this station are
  temporary</b> and will only be displayed for 120 days. Time
  series of X-hour or cumulative daily values will NOT be
  available for retrieval following the 60-day display
  period. Although the instrumentation is calibrated at least
  once/year, the temporary classification means that documented
  routine inspections and other quality assurance measures are
  not performed that would make the data acceptable for
  archival, retrieval, or future use in general scientific or
  interpretive studies.</td>
 </tr>
</table>
```

Other guidelines for quality assuring real-time data were distributed with OSW Technical Memorandum No. 99.07 as part of the addendum to Open-File Report 94.382, "A Workbook for Preparing Surface Water Quality-Assurance Plans for Districts of the U.S. Geological Survey, Water Resources Division."

Archival of supportive materials

Station descriptions, annual station analyses, calibration forms, and original field inspection notes must be archived as part of the permanent record.

References

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1972, Technical memorandum NWS HYDRO-14: National Weather Service river forecast system forecast procedures, Washington, D.C., 251 p.

Arvin, Donald V., 1995, A workbook for preparing surface water quality-assurance plans for districts of the U.S. Geological Survey: U.S. Geological Survey Open-file Report 94-382, 40 p.

Water Resources Division Policy Memorandum 99.34 – Quality assurance measures for serving real-time water data on the World Wide Web.

Office of Surface Water Technical Memorandum 99.07 – Addendum to Open-File Report "A Workbook for Preparing Surface Water Quality-Assurance Plans for Districts of the U.S. Geological Survey, Water Resources Division."

Office of Surface Water Technical Memorandum 2005.07 – Use of the program HYDRA to estimate or modify edited unit values from ADAPS.

/signed/
Stephen F. Blanchard
Chief, Office of Surface Water

WRD Distribution: All Water Employees

Appendix 1

Types of Precipitation Monitoring Instruments Typically Used Within the U.S. Geological Survey

1. *Weighing bucket collectors (spring type, strain type, or vibrating wire strain type)* -- measure precipitation by recording the weight of accumulated precipitation in a container. The storage container for this type of gage is topped off with an oil to minimize evaporative losses and is also charged with a mixture of propylene glycol and ethanol during the winter months to ensure proper registration of snow. The drawback with older "*bucket-on-a-spring*" models is that precipitation may only be reported to the nearest 0.1 inch. Also, because positive increments are counted as precipitation, oscillations from wind, diurnal thermal expansion, etc. often result in record that requires extensive manual editing. The newer strain or vibrating wire strain models are designed to provide accuracy to 0.01 inch and can compensate for errors caused by evaporation or wind-induced gage movement. *Strain-type gages* have an elastic sensor whose electrical resistance is a function of applied strain. As pressure from the weight of accumulated precipitation increases, a pressure sensor measures the deflection of a membrane by monitoring the change in resistance of an attached strain gage, converting force into an electrical signal. In *vibrating wire strain gages*, a bucket is suspended by three vibrating wire sensors that continuously weigh the collection bucket. The vibrating wire, when excited with 12V DC, outputs a frequency relative to the weight of the water in the collection bucket. The frequency measured for each sensor is averaged each hour and the hourly frequency maximum and minimum is calculated for each of the three sensors and reported independently along with the precipitation calculated for each 15-minute period.

2. *Tipping bucket collector* -- measures precipitation through the use of two equal-sized chambers which alternately fill and drain. As each chamber fills, it tips, simultaneously draining it, bringing up the second bucket under the collector funnel and recording a known amount of precipitation, usually 0.01 inch. The precipitation total for each day is computed by summing the number of tips during the day. During winter months a heating device may be used to melt incoming snow or ice. Data from tipping bucket instruments are reported to the nearest 0.01 inch. Some models may only be accurate for intensities at or below the calibration rate – more intense storm amounts may be biased low. There are inexpensive self-calibrating tipping bucket models with a post-processor that purportedly reduces or eliminates the error for rainfall intensities between 0 and 25 inches per hour by adjusting the number of tips according to intensity.

   Some tipping-bucket collectors have only one bucket. The accuracy of those instruments has not been broadly established and their use is not recommended in a field setting.

3. *Collector well/ float systems* -- There are several types of float systems. In one type, a standard 8-inch diameter funnel diverts precipitation to a 3-inch diameter collector pipe. A float connected to a recorder pulley of specific diameter is used to convert the stage in the well to accumulated precipitation, measured to the nearest 0.01 inch. Such sites are usually drained each visit and are limited to about 10 inches of precipitation between

inspections. Antifreeze may be added to prevent freezing. A second type of float gage is similar to the one just described except that the ratio of collector-to-well diameters is much smaller, making it able to function in areas of high annual precipitation amounts but with much less sensitivity. Such data are only reported to the nearest 0.1 in.

4. *Non-recording collectors* – cumulative volume systems are normally used to verify tipping bucket type gages following intense storms or to provide monthly and annual totals. No guidance is provided for this type of instrumentation.

Appendix 2
Example Station Description

Prepared by: J.M. Smith (Oct. 16, 2000)
Revised by: W. J. Jones (Oct. 22, 2003)

PRECIPITATION STATION DESCRIPTION

373823103465601 Upper Storm Canyon Precipitation Station near Downpour, CO

LOCATION.--Lat 37° 38' 23", long 103° 46' 56" (NAD 1983), in SW 1/4, NW 1/4, sec. 3, T. 28S., R. 57W, Las Animas County (Sheep Canyon 1:24000 quadrangle), Hydrologic Unit 11020010, on Pinon Canyon Maneuver Site, approximately 80 feet north of Military Supply Road 1A, 1.2 miles above Stage Canyon, 6.7 miles west of Rourke Road 1, 12.9 miles east of Downpour, and 27 miles south of La Junta.

ROAD LOG.--

PRECIPITATION GAGE		
Leg mi.	Total mi.	Directions
0.0	0.0	Turn east through main gate at Pinon Canyon Maneuver Site (PCMS), mile marker 24.0 on State Highway Route 350. ENTRY PERMISSION REQUIRED. Preferably call PCMS Security at 984-611-2806 or check in at PCMS headquarters. Continue straight on gravel road MSR 1.
0.45	0.45	Turnoff to Cantonment precipitation gage. Stay straight.
0.4	0.85	Junction with MSR 2, which exits right. Stay straight, continuing east.
2.8	3.65	Cross Big Arroyo.
5.1	8.75	Road curves north.
0.45	9.2	Intersection with MSR 3 and Pipeline Road. Bear left on Pipeline Road and drive northwest.
2.05	11.25	Road makes series of sharp turns.
1.15	12.4	Cross branch of Lockwood Arroyo, continue straight.
2.6	15.0	Turnoff to Lockwood Arroyo precipitation gage, stay straight.
1.0	16.0	Cross gas pipeline.
0.7	16.7	Low-water crossing.
3.2	19.9	“T” in road, bear left and drive northeast.
1.1	21.0	Cross Red Rock Arroyo. Continue straight.
1.1	22.1	Intersection with MSR 1A, turn left and drive north on MSR 1A.
3.0	25.1	Low-water crossing (Stage Canyon Arroyo). Stay straight.
0.25	25.35	Turnoff to Stage Canyon precipitation gage. Stay straight.
2.25	27.6	Cross Storm Canyon Arroyo. Stay straight.
1.5	29.1	Park here. Site is 80 feet north of road.

GAGE.—An 8-inch Design Analysis H-340 tipping-bucket precipitation gage is located 100 feet north of a USGS ground-water well shelter (see sta. no. **373822103465601)**. The top of the collection funnel is 6 feet above the ground surface and is not equipped with a wind shield. Rainfall is recorded at a resolution of 0.01-inch. The data from both the ground water well and precipitation gage are transmitted every hour via Handar high data rate DCP transmitter. The station is solar-powered. Elevation of station is 4,860 feet above sea level, from topographic map.

HISTORY.--*Temporary data* collected from March 1980 through June 1983. *Permanent data* collected from July 1983 to current year. July 1983 to September 1998, published as Bent Canyon Precipitation Gage above Stage Canyon near Delhi. Prior to 1992, the precipitation equipment type was a weighing bucket collector with a precision of 0.1 inch. The site was operated during the 1983-92 water years as part of a hydrologic study of the Pinon Canyon Maneuver Site, data published in various Open-File Reports. The site is operated year round.

COOPERATION.--The site is operated by the U.S. Geological Survey in cooperation with the U.S. Army Pinon Canyon Maneuver Site to provide data for the Land Condition Trend Analysis (LCTA) program, long-term climatic data, precipitation data for storm-runoff modeling, and to allow management of operations during training rotations.

JOB HAZARD ANALYSIS

373823103465601 Upper Storm Canyon Precipitation Station near Downpour, CO

Policy Exemptions at this Site
Ice measurements. PFD usage. Confined space.

Recommended Protective Clothing and Equipment
Survival gear for winter months. Adequate food rations. Adequate drinking water. Cell phone and 2-way radio for communication with military personnel.

JOB/Job Steps	**Potential Hazards**	**Recommended Safe Job Practices**
LIGHTNING	Danger from lightning strikes.	Avoid site during electrical storms.
ACCESS	Accessibility problems during military training operations. Site is remote despite being adjacent to military supply road (especially during winter storms).	Contact Pinon Canyon Maneuver Site range control during military operations. Carry adequate survival gear (primarily during winter, adequate food and water. There is cell phone coverage at the site. A 2-way radio is necessary for communication with military personnel. Although close to gravel road, during wet conditions the site will be marginally accessible with a 4-WD vehicle.

Prepared by: W.J. Jones (10-23-00)
Revised by: J.M. Smith (10-22-03)
Reviewed and approved by supervisor: R.D. White (11-07-03)

Appendix 3

Example routine field inspection form

PRECIPITATION STATION INSPECTION FORM

Station Number ____ Insp. No. _______
Station Name ____
Date ____________________, ______ Party ________________________________
Timing error: __________ F S Logger time: __________ Watch time:_________
Timing reset? Y / N Record Removed? Y / N Log File: ____________

Weather: Clear Partly cloudy Light Medium Heavy Snow Rain
Wind: Calm Light Breezy Very gusty other: _______________________
Wind Direction: ________________ Temperature _____^{o}F

Precipitation reading: Arrival _________ inches Departure ________inches
Check for 45^{o} obstruction-free cone above collector: ________________________
Funnel/screen condition: Plugged Plugged/draining Clear Frozen Other:__________
Instrument condition: Out-of-level Level Cups clean/dirty Other: ______________

Pivot hinge lubrictated (tipping bucket)?	Yes	No	N/A
Antifreeze and/or mineral oil added as necessary?	Yes	No	N/A
Dashpot oil level checked?	Yes	No	N/A
Collector well drained?	Yes	No	N/A
Alter shields intact?	Yes	No	N/A
Heater turned on?	Yes	No	N/A
Calibration made (on separate form)?	Yes	No	

Remarks:

____
____
____

Manual tip test		
No. of manual tips	**No. of tips recorded**	**Comments**
Initial test		
Additional test (if necessary)		

Appendix 4

Example calibration test form

Tipping Bucket Precipitation Gage Volumetric Test Calibration Form

Station No.: ________________________
Station Name: ____
Manufacturer: ________________________
Model No.: ________________________
Serial No.: ________________________
Party: ________________________
Calibration date: ________________________
Calibration time: ________________________

Test no.	Nozzle size	Volume (mL)	Start time	End time	Elapsed time	Desired no. of tips	Acceptable range of tips	Recorded no. of tips	Percent error	Correction factor needed
1										
2										
3										
4										

Was gage level on arrival? Yes____ No _____ On departure? Yes____ No _____

Was funnel free of obstructions on arrival? Yes____ No____ On departure? Yes____ No _____

DCP set back to initial value of _____ at _____.

Remarks (include any adjustments made to the instrument, if any):

Appendix 5
Example Station Analysis

2004 PRECIPITATION STATION ANALYSIS

373823103465601 Upper Storm Canyon Precipitation Station near Downpour, CO

LOCATION. — Lat 37° 38' 23", long 103° 46' 56" (NAD 1983), in SW 1/4, NW 1/4, sec. 3, T. 28S., R. 57W, Las Animas County (Sheep Canyon 1:24000 quadrangle), Hydrologic Unit 11020010, on Pinon Canyon Maneuver Site, approximately 80 feet north of Military Supply Road 1A, 1.2 miles above Stage Canyon, 6.7 miles west of Rourke Road 1, 12.9 miles east of Downpour, and 27 miles south of La Junta.

GAGE. — An 8-inch Design Analysis H-340 tipping-bucket precipitation gage is located 100 feet north of a USGS ground-water well shelter (see sta. no. **373822103465601)**. The top of the collection funnel is 6 feet above the ground surface and is not equipped with a wind shield. Rainfall is recorded at a resolution of 0.01-inch. The data from both the ground water well and precipitation gage are transmitted every hour via Handar high data rate DCP transmitter. The station is solar-powered. Elevation of station is 4,860 feet above sea level, from topographic map.

PRECIPITATION RECORD. — A small tree 30 feet north of the gage was removed on April 5th to prevent interference (though it is not believed to have had any effect). The gage had apparently been hit by a vehicle and was found leaning badly on July 8th. Calibration tests were made before and after the gage was re-leveled. Those tests showed that recorded precipitation since the previous visit (May 15th) may be in error by 10 percent, though the exact date is uncertain. Data for that period (May 15-July 8) should be considered less accurate than other periods but still useable. The instrument was within calibration standards upon departure on July 8th.

COMPUTATIONS AND CALIBRATIONS. — Calibrations were made on two occasions during the year – once on February 10th during a routine annual calibration and twice after the gage was found damaged on July 8th as shown in the table below. No corrections were made to the data and the record for the year was complete except for the period October 1-5 before the gage was installed. Record for that period was not considered missing (zero precipitation was inserted for those 5 days) since 3 NWS observation stations within 20 miles all reported no precipitation on those days (Sample City, Rivertown, and La Junta).

Date	Orifice flow rate (in/hr)	Volume (mL)	Desired no. of tips	Acceptable range of tips	Recorded no. of tips	Percent error	Remarks
Feb. 10	2	501	60	57-63	62	+3	Routine annual calibration check
July 8	2	501	60	57-63	66	+10	Found gage badly out of level.
July 8	2	501	60	57-63	61	+2	Calibration after re-leveling gage.

REMARKS. — Record good except for period May 15-July 8 [gage was damaged sometime during this period]. The records for that period were not estimated (revised) but are considered less accurate than the record for other periods. No other stations within 5 miles for comparison, but non-thunderstorm readings compare well with the NWS observation station 10 miles away in Sample City.

RECOMMENDATIONS. — Two or three protective posts should be cemented around the gage to prevent damage from traffic to/from a nearby storage yard.

Computed by: A.B. Black 1-1-05
Checked by: C.D. White 1-5-05
Reviewed by: E.F. Gray 1-10-05

Appendix 6

<u>Example text for annual data report -- EXPLANATION OF RECORDS – RECORDS OF PRECIPITATION QUANTITY</u>

Data Collection and Computation

Precipitation data generally are collected using weighing bucket gages, collector well/float systems, or tipping-bucket precipitation gages coupled with electronic data loggers that record precipitation amounts every 5 to 15 minutes.

A weighing bucket collector measures precipitation by recording the weight of accumulated precipitation in a container. The precipitation total for each day is simply the difference in recorded values between the beginning and ending daily values. This type of collector is topped off with an oil to minimize summertime evaporative losses and, during the winter months, is charged with a mixture of propylene glycol and ethanol to ensure proper registration of snow. Precipitation data from weighing bucket gages are reported to the nearest ***X.XX* inch *depending on type of instrumentation used by the WSC**.*

Collector well/float gages are usually one of two types. In one type, a standard 8-inch diameter funnel diverts precipitation to a 3-inch diameter collector pipe. A float connected to a recorder pulley of specific diameter is used to convert the stage in the well to accumulated precipitation, measured to the nearest 0.01 inch. Such sites are usually drained each visit and are limited to 10 or 15 inches of precipitation. Antifreeze may be added to prevent freezing. A second type of float gage is similar to the one just described except that the ratio of collector to well diameters is much smaller, making it able to function in areas of high annual precipitation amounts but with much less sensitivity. Such data are only reported to the nearest 0.1 in.

Tipping bucket type instruments measure precipitation through the use of two equal-sized chambers, which alternately fill and drain. As each chamber fills, it tips, simultaneously draining it, bringing up the second bucket under the collector funnel and recording a known amount of precipitation, usually 0.01 inch. The precipitation total for each day is computed by summing the number of tips during the day. During winter months a heating device may be used to melt incoming snow or ice. Data from tipping bucket instruments are reported to the nearest 0.01-inch. Most tipping-buckets are calibrated to a two inches per hour rainfall intensity and data may be biased low when storm amounts exceed this rate. Certain models, however, have a post-processing module that adjusts values to eliminate under-registration.

Twenty-four hour precipitation totals (in inches) are tabulated and presented from data having a recording interval of 15 minutes or less. A 24-hour period extends from 00:00:01 of the current day through [including] the 00:00:00 hour reading for the next day (to include rainfall from the next-to-last recording interval observation through midnight. The total precipitation for each complete month is shown on a line below the daily-sum table. Missing daily or monthly values are indicated by the symbol "---"in the table. Daily values for periods of missing record were estimated by ***cite uniform methodology used within Water Science Center* OR *state that method used at each site will be documented in the REMARKS section of the manuscript**.* The collection, computation, and publication of precipitation data do not necessarily conform to standards used by the National Weather Service. Records published in this report are for general scientific use. Original purposes for collecting this data include, for example, (1) interpretive studies such as watershed modeling and estimation of aquifer recharge, (2) flood warning networks in metropolitan basins subject to flash-flooding, or (3) flood forecasting or daily operational decisions by other Federal agencies.

Several factors can affect the precipitation recorded at a site, including the elevation of the collector above the land surface, the presence of vegetation, buildings or other barriers near the collector, or wind around the collector. Snowfall-affected data can result during cold weather when snow fills the precipitation-gage funnel and then melts as temperatures rise. Snowfall-affected data are subject to time distribution errors and total volume errors when snowfall depths exceed the collector funnel height.

Data Presentation

Precipitation records collected at surface-water gaging stations may be identified with the same station number and name as the stream-gaging station. Where a surface-water daily-record station is not available, the precipitation record is published with its own name and latitude-longitude identification number.

Information pertinent to the history of a precipitation station is provided in descriptive headings preceding the tabular data. These descriptive headings give details regarding location, period of record, and general remarks.

The following information is provided with each precipitation station. Comments that follow clarify information presented under the various headings of the station description.

LOCATION.--See Data Presentation in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

PERIOD OF RECORD.--See Data presentation in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

REVISED RECORDS.--See Data presentation in the EXPLANATION OF STAGE- AND WATER-DISCHARGE RECORDS section of this report (same comments apply).

GAGE.--This paragraph provides information on the current and historic types of instrumentation used at the station, including the height above land surface and elevation above National Geodetic Vertical Datum of 1929 (NGVD of 1929); it is reported with a precision dependent on the method of determination.

REMARKS.--Remarks provide added information pertinent to the collection, analysis, computation, or accuracy of records.

EXTREMES FOR PERIOD OF RECORD (optional).-- Maximum daily precipitation value for period of record.

EXTREMES FOR CURRENT YEAR (optional).-- Maximum daily precipitation value for current year.

Example manuscript for body of annual data report

(Example for a combination streamflow and precipitation monitoring site with a common name and station number)

SAMPLE RIVER BASIN
2003 Water Year

05998877 EXAMPLE RIVER AT DOWNPOUR ROAD, NEAR BIG CITY, ND

LOCATION.—Lat 32°38'56", long 81°50'27" referenced to North American Datum (NAD) of 1983, Screven-Jenkins County line, Hydrologic Unit 03060202, on downstream side of Downpour Road bridge, 2.1 miles west of Big City, ND.

DRAINAGE AREA.—240 square miles.

COOPERATION.—USGS National Streamflow Information Program (NSIP).

WATER-DISCHARGE RECORDS

PERIOD OF RECORD.—September 26, 2002 to current year.

GAGE.—Satellite telemetry with a water-stage recorder. Datum of gage is 134 feet above National Geodetic Vertical Datum (NGVD) of 1929 (from topographic map).

REMARKS.—Records fair.

WATER-STAGE RECORDS

PERIOD OF RECORD.—September 26, 2002 to current year.

GAGE.—Satellite telemetry with a water-stage recorder. Datum of gage is 134 feet above National Geodetic Vertical Datum (NGVD) of 1929 (from topographic map).

REMARKS.—Records fair.

EXTREMES FOR CURRENT YEAR.—Maximum gage-height recorded, 13.92 feet, March 23; minimum height recorded, 2.74 feet, October 8, 10, and 11.

PRECIPITATION RECORDS

PERIOD OF RECORD.—September 26, 2002 to current year.

GAGE.—Unshielded, standard 8-in. diameter, tipping-bucket precipitation gage, mounted on top of gage house with the top of the collector 8 ft above the ground.

REMARKS.—No record January 2-10, 2003. Records for July 15-August 30 may be less accurate than other periods (gage damaged but operational and within ten percent of calibration limits).