AN EVALUATION OF THE NATIONAL HYDROLOGIC BENCH-MARK PROGRAM

by

Ad Hoc Evaluation Committee

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EXECUTIVE SUMMARY

The Chief Hydrologist appointed an ad hoc committee on December 5, 1980, to review WRD's Bench-Mark Program. The committee was directed to review the program, recommend applications of the existing data base, and prepare recommendations for the future direction of the program. The committee's recommendations were to be based on (1) no increase in funds and (2) an increase of no more than $100,000. This report presents the committee's findings and recommendations.

The Hydrologic Bench-Mark Program was proposed in 1962 by L. B. Leopold, then Chief Hydrologist, as a national network of basins where information was to be collected to study time trends and to serve as "controls" for separating natural from artifical changes in other streams. Basins were to be largely natural and/or not subject to significant change. Originally, a network of about 100 sites was envisioned. The actual program as it evolved under the constraints of limited funding and lack of suitable basins, was initiated in 1963 and grew to a network of 57 sites by 1970, with minor changes and substitutions to the present 58 sites since that time. Although the original proposal called for a wide set of data, the actual data collected has been primarily streamflow and water quality.

The committee could not find a clear statement of program objectives although a number of specific uses of the data from such a program were presented by Leopold (1962), Langbein (1968), and Cobb and Biesecker (1971). The committee offers the following statement of objective for the Hydrologic Bench-Mark Program: The purpose of the Hydrologic Bench-Mark Program is to provide consistent data on the hydrology, including water quality, and related factors in representative undeveloped watersheds nationwide, and to provide

analyses on a continuing basis to compare and contrast conditions observed in basins more obviously affected by the hand of man. This statement implies that the data provided will be suitable for a number of purposes such as: (1) development of regional models of water discharge and quality as a function of precipitation, land cover, soil type, ground-water storage, and other independent variables; (2) development of baseline information for natural systems; (3) detection of trends or changes in climate and in water quality as affected by changes in precipitation quality; (4) detecting or describing changes in flow or quality in other streams which are developed or changed by man; and (5) gaining a better understanding of the hydrology of undeveloped watersheds and using this understanding as a basis for comparison of conditions in more developed basins.

In terms of the simple objective "to provide data," the present program is successful. Data is being collected nationwide on a generally consistent basis and is being reviewed and stored in machine-readable form for analysis and application. However, it is the conclusion of the committee that the Hydrologic Bench-Mark Program as presently operating is only partially satisfying the program intent as envisioned by Leopold. Long-term streamflow and water-quality information has been collected on a nationally consistent basis, and some precipitation data are available for many bench marks. These data have been useful in solving significant problems. However, the program has not provided the scope of data for the basins that is needed to perform cause-and-effect analysis and to study complex hydrologic processes. Major areas of inadequacy are ground-water observations, consistent precipitation collection, land-use and land-cover information, monumented cross-section data, and geologic descriptions including soils data. These inadequacies are to some extent a result of program resource limitations. In addition, the interpretation

of the data has not been extensive, so there are few products available for review.

It is the position of the committee that the ratio of data analysis to data collection in the Hydrologic Bench-Mark Program has been far too low. Additional analyses should be undertaken, including the following in order of priority:

- A report should be prepared providing descriptions of common ranges of constituent concentrations and graphical display of the probability distribution of the data.
- Occurrences of hazardous substances should be summarized. Occurrences for different time periods should be compared in a search for trends.
- Trend testing for major ions and nutrients should be undertaken.
- Long-term loads of constituents should be estimated.
- Studies should be undertaken to search for trends in streamflow.

The final conclusions and recommendations by the committee are:

1. The Hydrologic Bench-Mark Program is a very important element of the overall program of water-resources investigations of WRD and should be continued to provide baseline information for the current and future assessment of the effects of man's activities on the Nation's water resources.

2. A primary deficiency of the program is a lack of inclusion of analytical studies using the data base as an integral part of the program. Assessment and analysis should be a continuing element of the program, and program funds should be provided.

3. Ground-water information available does not provide any basis for assessing the nature and extent of interrelationships between the ground-water and surface-water elements of the hydrologic system. A hydrogeologic reconnaissance of the watershed above each station should be made.

4. The data-collection program should be modified to include some observations of ground-water levels in each basin; a periodic, systematic determination of land use and cover in each basin; and additional data related to geomorphologic processes in selected basins.

5. District Offices should be an integral part of continuing assessments, and an appropriate feedback mechanism should be established.

6. Substantial efforts should be made to enhance the visibility of the program.

7. Steps should be undertaken to provide additional awareness in other water-related agencies regarding the Hydrologic Bench-Mark Program.

8. Hydrologic Bench-Mark Program data presently reside on some 57 separate magnetic tapes. A single file including all time-series data available for the stations should be established. In addition, a readily available file of non-time dependent information should be maintained at headquarters.

9. It was the opinion of the committee that the number of sites in the network should not be decreased and that continuous flow records were required. It was the opinion of the committee that the frequency of sampling and the roster of constituents analyzed could be modified and generally reduced at most stations without impairing the utility of the data in meeting the program objectives. We expect that perhaps $50,000 or more in funds can be made available in this manner. These funds, along with recommended additional program funds should be used to implement recommendations.

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INTRODUCTION

The Chief Hydrologist, by memorandum of December 5, 1980, appointed the authors to an ad hoc committee (hereafter referred to as the committee) to review WRD's Hydrologic Bench-Mark Program. The network of stations operated under this program is generally referred to as the Hydrologic Bench-Mark Network. The committee was asked to address, but not be limited to, the following questions:

1. In priority order identify the applications that should be undertaken with the existing data base.

2. Prepare recommendations for the future direction of the program. In developing recommendations, review the objectives of the program and, if necessary, restate them and recommend revisions that may be desirable. Develop strategy alternatives for meeting the program objectives. Assume two conditions: (1) no increase in program funds (current funding $543,000), or (2) an increase of no more than $100,000.

The work was accomplished under the general overview of the Assistant Chief Hydrologist, Research and Technical Coordination.

The committee requested input from the Regional and District Offices. A summary of available information for the Hydrologic Bench-Mark Program was sent to those offices for updating. Responses to the following five questions, as well as any other items deemed appropriate, were requested:

1. What uses, if any, are Districts making of data from the Hydrologic Bench-Mark Program for other hydrologic studies in the District? This should reflect only those uses that require a record from a basin which meets the Hydrologic Bench-Mark Program standards.

2. What uses, if any, are other agencies or organizations making of data from the Hydrologic Bench-Mark Program? This should include universities and consultants, as well as Federal, State, and local agencies. Copies of, or references to, reports resulting from such work would be helpful.

3. What other types of data collection or surveys should we be undertaking to meet the program objectives as stated in Circular 460-D?

4. What types of data collection or surveys have other agencies undertaken that will provide information to meet program objectives?

5. What are recommendations of the Districts and the Region for the future of the program, assuming a limited or no increase in funding?

Responses were received from 41 Districts and 2 Regions. The updated information summary, the summary of District responses, and responses from Regional Offices and several others are included in the appendix. All responses were considered in the committee's recommendations.

This report presents the committee's findings and recommendations.

PROGRAM HISTORY

In 1962, L. B. Leopold, then Chief Hydrologist, proposed (Circular 460-B) a national network of hydrologic bench marks, chiefly for the purpose of the study of time trends—as "controls" for separating natural from artificial changes in other streams. Data collection was to include runoff, dissolved solids and sediment, ground-water levels and temperature, precipitation and other climate variables. Channel measurements, pollen traps, and repeat

plant surveys were to be made to determine changes in growth and species. As Leopold well understood from his own research, plant cover and channel morphology are important variables even under natural conditions.

The actual program, as it evolved under financial and program constraints, was described by Cobb and Biesecker in 1971 (Circular 460-D). Begun in 1963, limited mainly by qualified sites, the network was built up to 57 sites by 1970, with a few changes since then. At present, there are 58 sites in the program, shown in figure 1. Data collected were essentially limited to streamflow (lake stage for one site) and water quality. Of the 57 currently active continuous streamflow stations that are a part of the program, more than 96 percent have over 10 years of record and 18 percent have more than 20 years of record. Precipitation data were collected at most but not all bench marks. A summary of available information from the program is given in the appendix.

Consideration was given to documenting any changes that may have occurred in the bench-mark basins. Aerial photographs of two basins (Mogollon Creek near Cliff, New Mexico, and Limpia Creek above Fort Davis, Texas) were used in 1971 to test whether these could be used to check on changes. Although it was generally agreed that aerial photographs could be used to document changes, due to the substantial costs involved, no further work was undertaken. District Offices were requested to field check the hydrologic bench-mark basins in 1977 for a qualitative assessment of land-use changes. Reports were received for 45 of the 57 basins, 9 were reported to have some changes. These reports are on file in the Surface Water Branch.

A meeting was held in WRD headquarters in February 1980 at which it was agreed among the Quality of Water and Surface Water Branches to prepare a

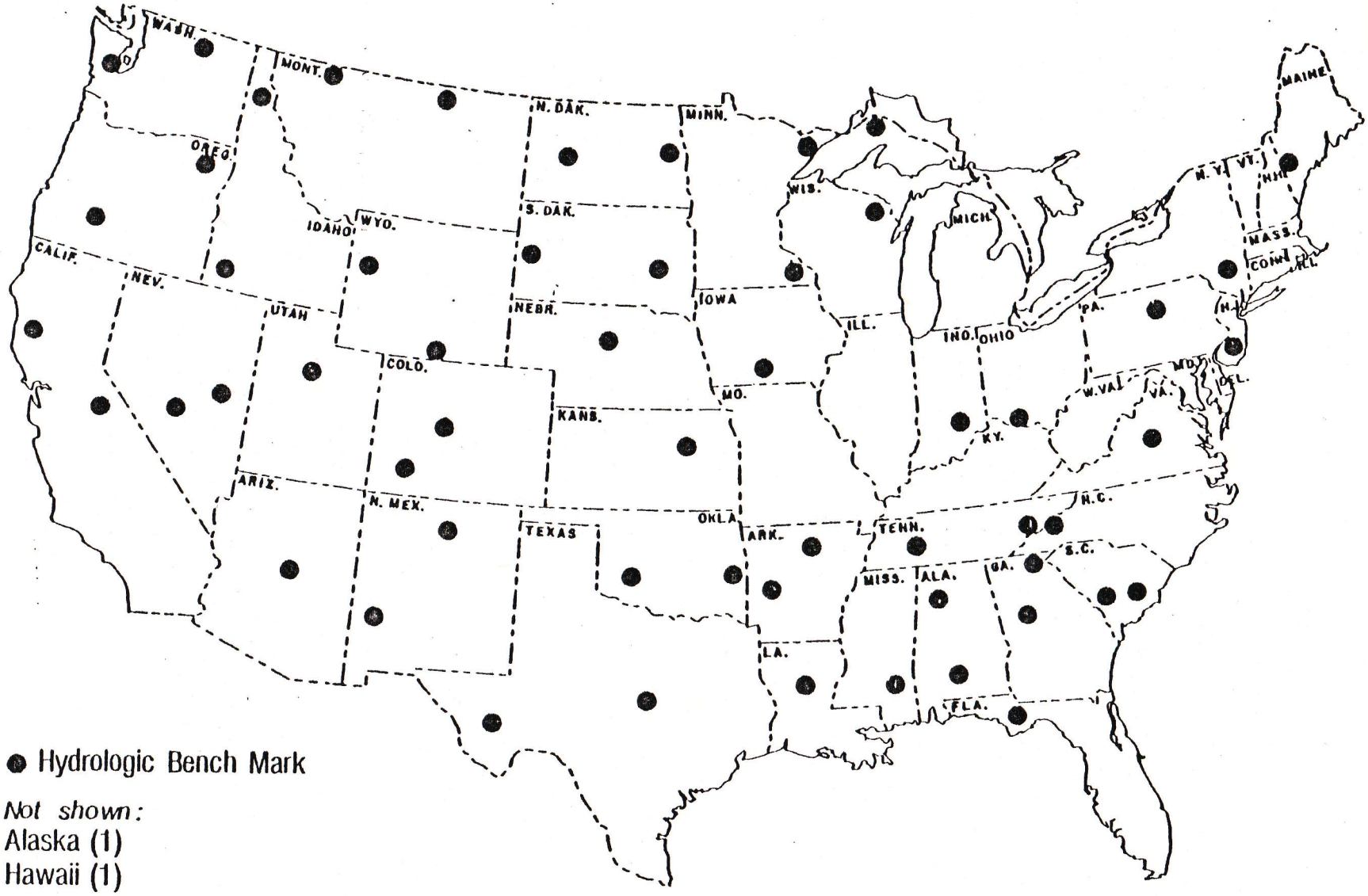

Figure 1.--Map showing locations of hydrologic bench marks as of June 1981.

circular on the Hydrologic Bench Mark Program, covering objectives and uses of the data, current network, descriptions of the individual basins (update of Circular 460-D), and of anticipated changes in the program. This project is underway.

Uses of Hydrologic Bench-Mark Data

A number of studies using Hydrologic Bench-Mark Program data have been or are currently being undertaken. The primary effort completed and published to date is a study by Biesecker and Leifeste (1975) of the water quality of hydrologic bench-mark stations as an indicator of water quality in the natural environment. Studies are currently underway under the direction of the Quality of Water and Surface Water Branches to summarize all information collected to date, analyze time trends, provide statistical information, and to attempt to regionalize hydrologic characteristics. The reports on these two studies should be available in FY 1982. Additional work in trend analysis is continuing in the Quality of Water Branch. In addition, studies to test the Hurst phenomenon—the tendency for hydrologic data to exhibit long-term persistence—is a continuing effort in the Systems Analysis Group. More detail on these efforts is provided in the section "Assessment of how well stated objectives are being met by existing programs."

Question of Naturalness

None of the hydrologic bench marks are natural areas in the strict sense nor did the criteria so specify. The conditions were these (Cobb and Biesecker, p. 1 and 2, Circular 460D):

1. No manmade storage, regulation, or diversion currently exists or is probable for many years.

2. Ground water within the basin will not be affected by pumping from wells.

3. Conditions are favorable for accurate measurement of streamflow, chemical, and physical quality of water, ground-water conditions, and the various characteristics of weather, principally precipitation.

4. The probability of special natural changes due to such things as major activities of beavers, overgrazing or overbrowsing by game animals, or extensive fires is small.

At the time, major attention was directed toward avoiding major changes which usually are those affecting the general run of stream-gaging stations—regulation, diversions, and major land-use changes. These considerations favored the selection of sites in national parks, and wilderness areas. Where these were lacking, areas were included where land use is likely to remain stable.

The size of drainage area was a factor in this decision. The smaller the area (such as the experimental watersheds of the Department of Agriculture), the greater is the response to some small area change. On the other hand, the larger the area, the greater the chance of some change, with less sensitivity in the response to change. The areas selected were of the order of 50 square miles.

It was understood at the time that the Hydrologic Bench Mark Network would be affected by man-induced atmospheric changes such as chemical and radioactive pollutants and the direct and inadvertent cultural effects on rainfall and temperature. Chemical changes in atmospheric fallout (dry or wet) were anticipated (Cobb and Biesecker, 1971, p. 3) and early establishment of the Hydrologic Bench-Mark Network was recommended to document the anticipated changes. Water-quality base-line data on stable natural areas were early recognized as part of water-quality documentation and various authorities

so recommended. It is probable that the Environmental Protection Agency withdrew its intentions along that line in favor of the USGS Hydrologic Bench-Mark Program.

Data Collection and Analysis

Leopold called for a wide set of data (Circular 460-B, p. 3), but the actual set of data became limited to those series customary to the USGS--streamflow and water quality. Only incidental attention was given to precipitation, little if any to soil-moisture data. Surveys of land cover, vegetal transects/quadrants, soils, and lithology were deferred until specific interests emerged. These omissions will seriously limit the usefulness of the bench marks for any intended studies of the relations among rainfall, runoff, water chemistry, and the terrain.

The programs of the WRD have progressed from one of collecting and archiving data, occasionally followed by some analyses of what took place, to understanding the hydrologic-geologic-chemical systems as a basis for anticipating future changes, especially those caused by man. The Hydrologic Bench-Mark Program, in contrast, has remained largely in the collecting and archiving phase.

VIGIL NETWORK

A separate but related program of WRD is the Vigil Network. The deficiency in detailed data on hydrologic and geomorphic processes led to the idea of establishing a network of small drainage basins and other selected sites where observations of basic processes would be made over long periods of time (Leopold, 1961; 1962). The network of observational areas has been named the Vigil Network. In esssence, a feature of the landscape is chosen, bench marked in a reasonably permanent manner at the time of initial survey, and resurveyed

at intervals sufficient to document changes in the landscape with time. Publications describing relatively simple observations of landscapes (Emmett, 1965; Hadley, 1965; Leopold and Emmett, 1965) have included suggestions for installation, maintenance, and techniques of observations, and instructions for reporting of data.

Two international repositories have been established to receive files of data pertaining to the Vigil Network (Emmett and Hadley, 1968). One repository is in Sweden; the other is the U.S. Geological Survey Library at the National Center. Files at the Geological Survey repository are kept in a fireproof safe on the basement level of the library. The system, though not individual files, is catalogued at the reference desk. Files are available for inspection or photocopying. At the present time, files occupy about a cubic foot of space and consist of about 50 separate entries, but some entries have data of more than one site. A sample file is included in the publication by Emmett and Hadley (1968). It is estimated that about 100 of the established Vigil Network sites in the United States are documented in the repositories.

Benefits are already being derived from the data collected. For example, one analysis (Emmett, 1974), using data from Vigil Network sites, has indicated the arroyo-cutting epicycle beginning about 1880 has reversed and channels in semi-arid Western United States are now aggrading in a period of valley alluviation. Such observations assume increased importance as this part of the United States plays an increasing role in development of energy resources and environmental impacts of this development are being assessed.

PROGRAMS OF OTHER FEDERAL AGENCIES

Agricultural Research Service

The U.S. Department of Agriculture maintains long-term data-collection networks which support watershed hydrology research. This activity is supported by the Agricultural Research Service (ARS). Watershed research is conducted at nine centers located throughout the United States (see figure 2), and the data-collection program is designed to meet specific research project requirements at the centers. Data are currently collected for about 200 study areas, which range in size from 0.5 acre to almost 5,000 square miles. More than two-thirds of the study areas are less than 1 square mile. A wide variety of parameters are collected including streamflow, water quality, sedimentation, precipitation, evaporation, air and soil temperature, wind, topography, soils, geology, land use, and land-cover conditions. Data are collected over short time intervals so that intensity variations during events are preserved for the record. The periods of record range from 40 years to less than 5 years. During the late 1960's, a national data storage and retrieval system, now known as the Water Data Laboratory, was developed for the hydrologic data collected at these research sites. The resulting Water Data Laboratory is a member of NAWDEX.

Helpful comparisons can be made between the ARS watershed research data-collection program and USGS's bench-mark program. Data collection under the ARS program is designed to meet individual research project needs. The user is well defined, and analysis of the data from a study area is (for practical purposes) continuous. The USGS bench-mark network has generally stated objectives, but no specific user or project criteria. The bench-mark goal is to assure long-term field data is collected and available when any user

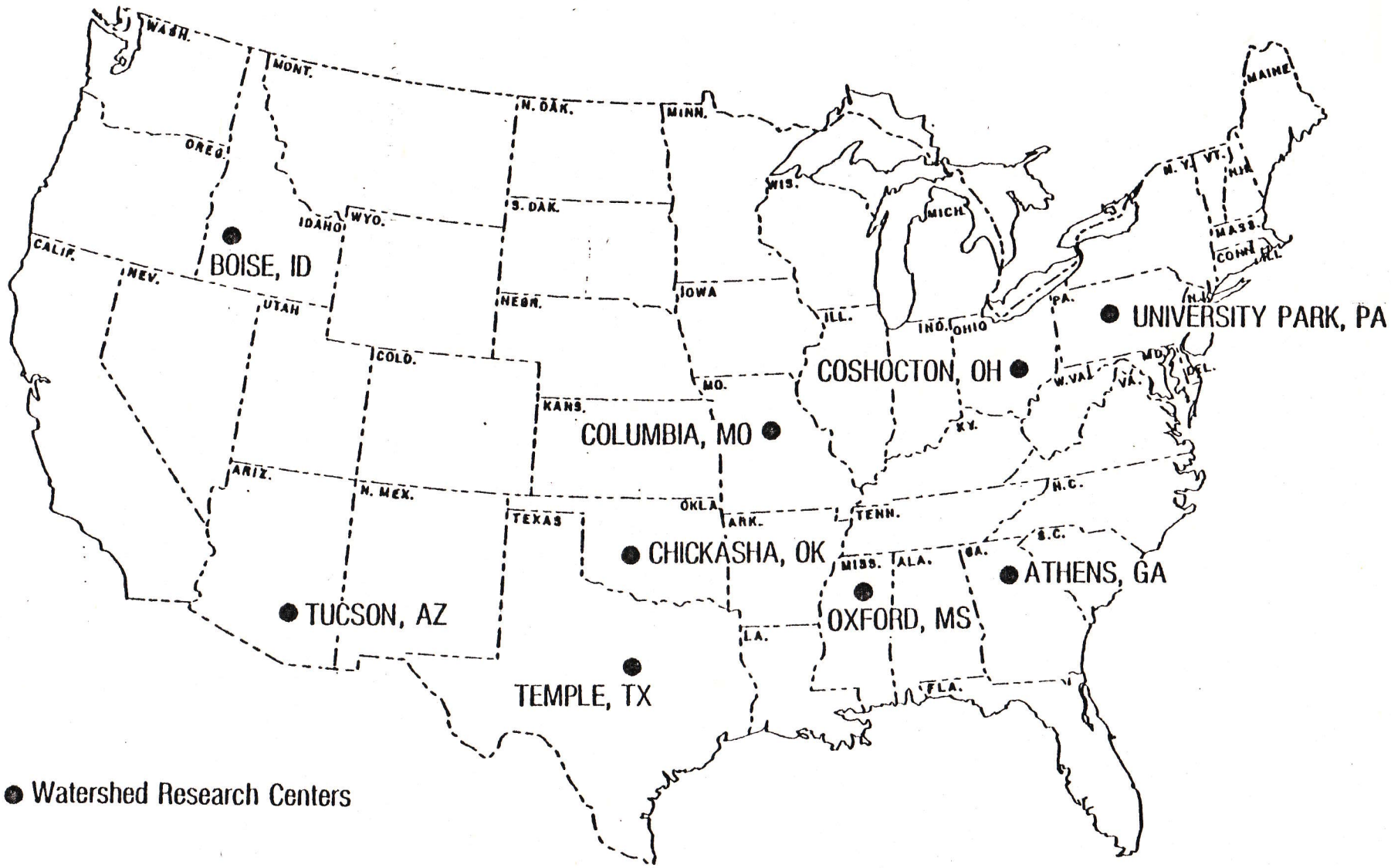

Figure 2.--Agricultural Research Service Watershed Research Centers

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recognizes a study requirement sometime in the future. This makes bench-mark network design and implementation much more challenging. The ARS basins are used to define relationships between agricultural practices and hydrologic regimes. This use of the data results in careful documentation of land-use and cover conditions over time. The bench-mark basins are intended to represent pristine watershed conditions unaffected by human activities. Since the basin conditions are assumed to be stable, the need for land-use and cover condition information is not widely recognized at bench-mark sites. Both networks are intended to provide data needed to determine cause-and-effect relationships and to define hydrologic processes.

Forest Service

At one time, the Forest Service implemented long-term data collection under a "barometer" watershed program. However, recent contacts with them indicate this program was terminated in the late 1970's. A major reason for discontinuing the program was that the data were not being processed and analyzed.

ASSESSMENT OF HOW WELL OBJECTIVES ARE BEING MET BY EXISTING PROGRAMS

Objectives of the Program

In the three publications most often cited in a description of the Hydrologic Bench-Mark Program (Leopold, 1962; Cobb and Biesecker, 1971; Biesecker and Leifeste, 1975) it is difficult to find a clear statement of objectives for the program.

Leopold's (1962) work which predated establishment of the Hydrologic Bench-Mark Program and, in fact, proposed the program implied that the purpose was to collect "* * * long-term observations of the natural hydrologic regimen * * *" (page 2).

The statement often quoted from Langbein (1968) which served as the statement of objectives in Cobb and Biesecker (1971) is; "These data could serve several purposes: (1) analyses of the hydrological structure of a natural catchment; (2) analyses of the statistical structure of hydrological time series; and (3) as a reference or comparative base for noting changes in the regime of streams whose catchment or flow are developed for use."

Biesecker and Leifeste (1975) did not offer a statement of objectives for the program.

It seems clear from the early literature that the intent of the designers was to collect data over an indefinite period in a consistent manner nationwide, on the hydrology, including water quality, and on the independent variables affecting them, in small watersheds that were as unaffected by man's activities as was possible to find and were not likely to be affected in the foreseeable future. The number of such watersheds was to be decided by the need to describe the range of hydrologic conditions and the factors that influence those conditions in undeveloped areas of the Nation. The anticipated uses of the data included those discussed by Langbein (1968), as noted above.

The analysis of the early literature suggest that the objective of the program is to provide data; not solely for the purpose of accumulating a data base, but also to allow the determination of new information about the hydrologic aspects of relatively undeveloped, stable catchments. To bring the program more in line with the modern objectives of the WRD (see p. 7), the program should include at least minimal analyses to maintain usefulness and relevance.

The committee offers the following statement of objective for the Hydrologic Bench-Mark Program: <u>The purpose of the Hydrologic Bench-Mark Program is to provide consistent data on the hydrology, including water</u>

quality, and related factors in representative undeveloped watersheds nationwide, and to provide analysis on a continuing basis to compare and contrast conditions observed in basins more obviously affected by the hand of man. This statement implies that the data provided will be suitable for a number of purposes such as: (1) development of regional models of water discharge and quality as a function of precipitation, land cover, soil type, ground-water storage and other independent variables; (2) development of baseline information for natural systems; (3) detection of trends or changes in climate and in water quality as affected by changes in precipitation quality; (4) detecting or describing changes in flow or quality in other streams which are developed or changed by man; and (5) gaining a better understanding of the hydrology of undeveloped watersheds and using this understanding as a basis for comparison of conditions in more developed basins.

Satisfying the Program Objective

In terms of the simple objective "to provide data," the present program is successful. Data is being collected nationwide on a generally consistent basis and is being reviewed and stored in machine-readable form for analysis and application.

An evaluation of whether the data being collected is proper data for the anticipated uses requires first that the data be used as anticipated and the results of that application be made known. This process of data application and feedback to the program has been largely lacking and, for that reason, an evaluation of the program in terms of data usefulness is incomplete.

The committee received responses from 41 of the 46 District Offices to a request (see p. 1 and 2) for information on use of the Hydrologic Bench-Mark Program data and recommendtions for change. Of those responding, 20 listed no District use and 19 no State or other Federal Agency use of the

data for any purpose. Of the 20 Districts listing no specific use of the data by the District, 5 did not have sites within their boundaries. Of those responding affirmatively, 21 District Offices and 22 other agencies, the uses of Hydrologic Bench-Mark Program data divided into the following categories:

	Districts	Others
Research on Watershed Processes	5	3
Baseline, Background, or Control Data and Statistics	12	6
Trend Analysis	4	1
Setting Water-Quality Standards		2
Surveillance of Pollution		1
Unspecified		9

Five Districts and three other agencies appear to be using Hydrologic Bench-Mark Program stations in comprehensive investigations of watershed processes attempting to develop, at least, conceputal models for the functioning of the undeveloped watersheds to compare with the functioning of developed ones. Twelve Districts and six other agencies appear to be using the data solely to obtain statistical information on the hydrologic and water-quality regimen in undeveloped watersheds to compare with those same statistics from streams in developed watersheds. In particular, the effects of coal mining and logging in other basins have been explored using hydrologic bench-mark information. Four Districts and one other agency are using the data for trend analysis, primarily investigating the effects of acid rain on stream quality. The uses by 12 other agencies were for surveillance, standard setting, or unspecified.

Of these uses, research on processes may be considered the highest form anticipated by the Hydrologic Bench-Mark Program designers. Trend analysis and development of statistics in an undeveloped watershed were anticipated and are valid uses. Use of the information by other agencies for surveillance and standard setting was not anticipated.

At the national level, a number of studies using Hydrologic Bench-Mark Program data have been concluded or are underway. The study by Biesecker and Leifeste (1975) was an extensive effort to establish the quality of water in the natural environment. The use of Hydrologic Bench-Mark Program data in this study provided the opportunity to compare quality of water from natural environments with the water from major streams draining the same hydrologic regions of the United States.

Other studies in various stages of completion include:

1. Data have been examined in the search for streamflow and water-quality trends by:

(a) A current study is being conducted in the Wisconsin District for the Quality of Water Branch to summarize all water-quality data collected at each bench-mark site through the 1979 water year. Time trends are to be analyzed, and the nature of the frequency distributions of the various water-quality variables will be described. Ambient water-quality conditions will be determined, and a regionalization of these conditions will be attempted. The effects of man on water quality will be investigated. Report is due at the end of FY 1981.

(b) Another current study being conducted by the Wisconsin District for the Surface Water Branch will summarize all surface-water data collected at each bench-mark site through the 1980 water year. In

addition to describing streamflow characteristics at each site, the study will include an analysis of time trends in streamflow. Report is due in FY 1982.

(c) Trend detection methods developed by the Systems Analysis Group (Hirsch et al, 1981) have been applied to records of 13 chemical constituents (pH, major ions, suspended sediment) at 52 bench-mark water-quality stations in operation for at least 10 years. Of particular interest in this study were water-quality variables thought to be related to acid precipitation, including sulfate, nitrate, pH, alkalinity, and common cations. The bench-mark network is ideally suited to investigations of acid-rain effects on surface waters because interference from the effects of land use is minimized. Widespread increases in sulfate ion and apparent geographic patterns in trends in other constituents at bench-mark stations do suggest the influence of changing atmospheric conditions, but certain puzzling aspects of the results of the study have given rise to further questions. This work is being carried out in the Quality of Water Branch.

2. Test of Hurst phenomenon. The Hurst phenomenon—the tendency for hydrologic data series to exhibit long-term persistence—has been challenged by the suggestion that it is no more than the effect of nonhomogeneities on hydrologic records. The bench-mark data series, which are designed to be nearly homgeneous with respect to the techniques and of stable basin character, support the existence of the Hurst phenomenon. These studies are being carried out in the Systems Analysis Group.

It is clear that the Hydrologic Bench-Mark Program data are being used in the field and headquarters, but there is considerable question whether the

uses are as sophisticated as was originally intended. Moreover, a mechanism to feed back information to network managers on the results using Hydrologic Bench-Mark Program data in a field study is lacking. There is little information on which to base appropriate modifications to the program.

Data-collection programs operated without data analysis and interpretative components cannot remain operational for long without drawing criticism from the professional community and government oversight agencies. Criticisms generally focus on what information is not being provided. The General Accounting Office report on the NASQAN Program attacking fixed-station, fixed-frequency monitoring networks, complained that data from such networks had not demonstrated the effects of the massive water-quality control efforts of the past decade. The report goes further to suggest that since the data had not, it could not and therefore was of no value, a completely false conclusion. What has been lacking in the present programs, both in NASQAN and the Hydrologic Bench-Mark Program, is a continuing summary, analysis, and interpretation of the data by WRD. And, if that functional component is weak, the programs will be subject to justified criticism.

In the conceptual model for the National Water Data Network (Langford and Kapinos, 1979), the data collection or accounting functions, the surveillance function, and the interpretation or areal synthesis function are shown as separate operations. This is a workable arrangement, in terms of proper management of the functions to provide information in an efficient manner, so long as all three functions are operating and coordination and liaison between them is effective. The report of the Committee to Review the NASQAN Program (June 30, 1981) concluded that a serious problem with the NASQAN program, which is a major component of the data-collection or accounting function of the National Network, is that the surveillance and areal synthesis functions

are either not being effectively performed or not providing effective feedback to the data-collection function on the usefulness of the data. The Hydrologic Bench-Mark Program has an analogous problem. The analysis and interpretation function is not being systematically performed with the data base.

In summary, the Hydrologic Bench-Mark Program as presently operating is only partially satisfying the program intent as envisioned by Leopold. Long-term streamflow and water-quality information has been collected on a nationally consistent basis, and some precipitation data are available for many bench marks. These data have been useful in solving significant problems. However, the program has not provided the scope of data for the basins that is needed to perform cause-and-effect analysis and to study complex hydrologic processes. Major areas of inadequacy are ground-water observations, consistent precipitation collection, land-use and land-cover information, monumented cross-section data, and geologic descriptions including soils data. These inadequacies are to some extent a result of program resource limitations. In addition, the interpretation of the data has not been extensive, so there are few products available for review.

APPLICATIONS OF EXISTING PROGRAM INFORMATION: ENHANCED DATA ANALYSIS AND PUBLICATIONS

To date there has been only one published report of national scope (Biesecker and Leifeste, 1975) which reports on analysis of data from the Hydrologic Bench-Mark Program. It is the position of this committee that the ratio of data analysis to data collection effort in the Hydrologic Bench-Mark Program has been far too low. An enhanced data analysis and publication program would have three types of benefits:

1. An increase in available information about the characteristics of water resources in various natural environments.

2. An increase in awareness on the part of scientists in the Survey and elsewhere of this rather substantial body of data which can be put to use for various scientific and resource-management purposes.

3. A heightened level of interest in the Hydrologic Bench-Mark Program on the part of the WRD field personnel, leading to improvements in the data base: identification of erroneous values, and of lost data, and suggestions of changes in data collection that might enhance the value of the program.

Before describing some proposed analysis and publication plans, the question of how to organize the effort should be considered. There are two modes of organization to consider as well as a possible compromise mode. The first is a centralized approach: a few individuals who are located in the Districts but funded and directed by the Branches would perform some standardized analyses and prepare tables, graphs, maps, and text material covering all stations in the network. The second is a decentralized approach: one or two individuals in a number of Districts are encouraged to prepare a report on the hydrologic bench-mark basins in their District. The first approach has the advantage of efficiency and consistency and perhaps greater visibility. The latter approach has the advantage of greater site specificity, focusing on the interesting and answerable questions for the particular basin and bringing about the greater involvement of District personnel in the program. There is a possible compromise approach: have a small team in one office do a set of analyses on the national data base and produce certain maps, graphs, and tables resulting from those analyses. The team would publish a subset of these in national reports but supply all of them to the Districts to produce individual basin reports.

The following is a list of some types of analysis and presentation that the committee recommends be done nationally for the Hydrologic Bench-Mark Program. They are listed in order of priority.

1. Descriptions of the common ranges of constituent concentrations. The purpose of this work would simply be to organize the constituent concentration data at each station to display the probability distribution of the data and also show how concentration varies with discharge. This would illustrate the natural variability of water quality at a site, and to show differences between sites. Such a report would provide readers with a standard of comparison for values observed on other streams: do they fall in the middle of the range of natural values, are they out in the tails of the natural values, or are they well beyond the range of observed natural values (see examples in figure 3).

2. Summarize the record of occurrences of hazardous substances: pesticides, minor metals, and radiation. Biesecker and Leifeste (1975) did some tabulations of these data through 1970; it would clearly be desirable to update these tables. Tables should be for the entire hydrologic bench-mark network. For each constituent there should be a list of: total number of determinations, percent of determinations where substance was detected, and percent of determinations exceeding drinking water standards. This could be done for two time periods (say, pre-1975 and post-1975). Maps could be produced marking those stations with high frequencies of detection or of standard violation. Depending on the quality of the data record, one could perform trend tests for these substances where the null hypothesis is that the probability of exceedance of some threshold value has not changed over time.

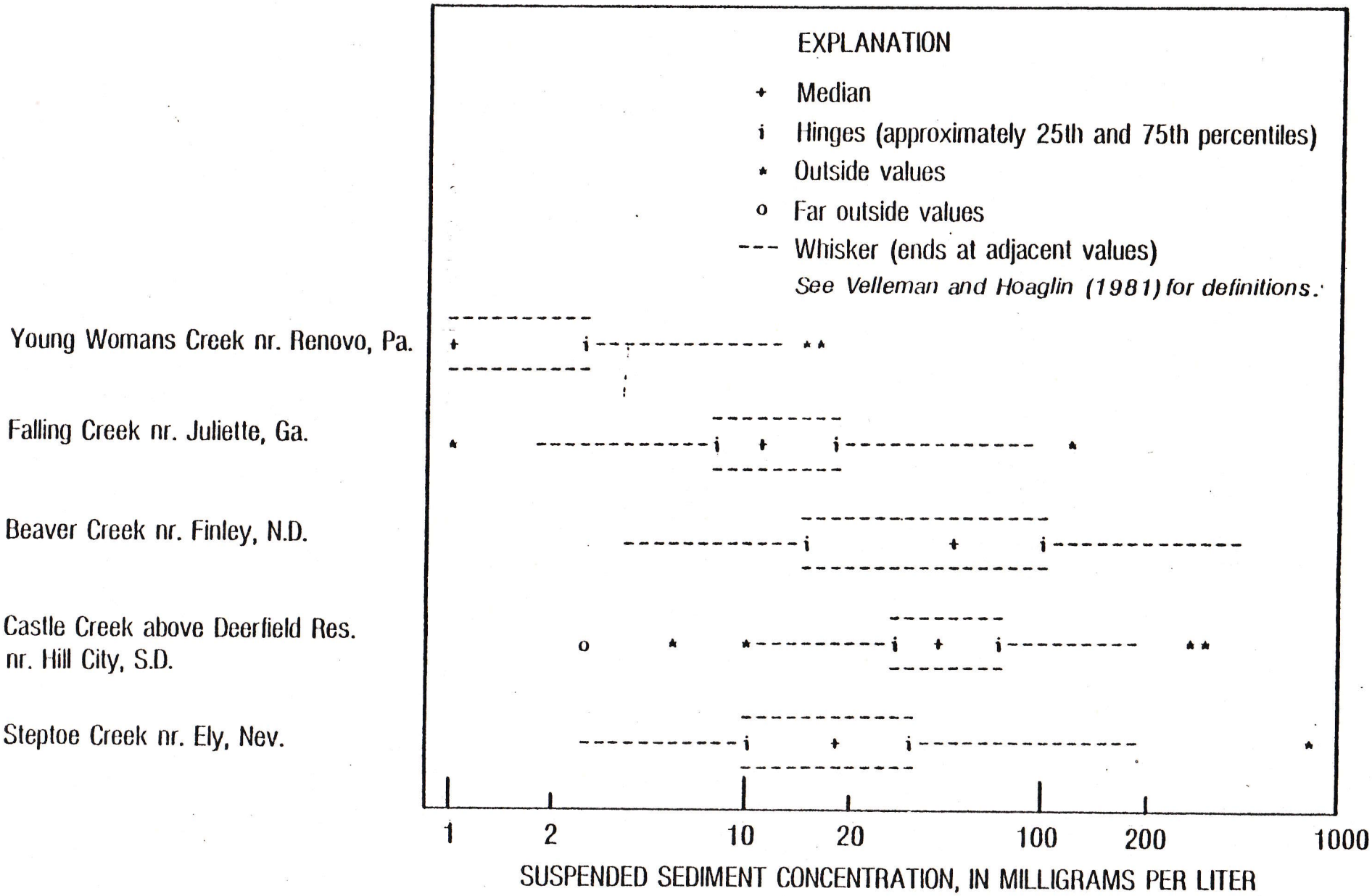

Figure 3.--Box and whisker plot of suspended sediment records at 5 hydrologic bench-mark stations.

3. Trend testing for major ions and nutrients. Much of this has been done already by Smith and Alexander (Quality of Water Branch) using methods developed by the Systems Analysis Group. Dennis Wentz (Wisconsin District) is also working on this. In addition to publishing these results for the entire hydrologic bench-mark network, it is important to disseminate them to the Districts for their comments and analysis. Some exploration of causes for these trends should be made and reported on; the investigators would be expected to consider the following possible causes: (1) human activities on the land, (2) atmospheric inputs, (3) changes to geochemical process rates due to changes in rainfall chemistry, and (4) changes from natural causes.

4. Estimation of long-term loads of constituents. Use record extension techniques which rely on statistical relationships of the instantaneous load values versus one or more of the continuously measured variables (flow, conductivity, and temperature). From these analyses produce tables and maps showing long-term average annual load per unit area for each of the constituents for which an estimation accuracy of ± 25 percent is possible. Also perform sensitivity analysis in selected cases to evaluate the effect on accuracy of having more limited constituent loads data or more limited continuous measurements. This will prove useful for making decisions about future cost cutting at these and other stations.

5. The relationship between precipitation and runoff is such that generally small percentage changes in precipitation result in larger percentage changes in runoff. Thus, testing the existing flow records for trends (monotonic change over time) should provide a fairly sensitive indicator of climatic trend. (It may be that these drainage basins are better indicators of climatic change than rain gages are.) Some investigations to carry out at

each station: (1) trends in flow in individual months—parametric (linear) regression) and non-parametric; Kendall's (1978) tau methods, (2) trends in the time series of monthly flows by parametric methods patterned after Box and Jenkins (1970) and non-parametric (seasonal-Kendall) methods. These results could be summarized over regions and over the Nation: one could then consider the distribution of trend slopes over all stations and months.

Other applications of the Hydrologic Bench-Mark Program data would fall in the area of research. Building and verification of models, both deterministic and stochastic, depend on the availability of high-quality stationary records. Of all our records, the hydrologic bench mark, as a group, should be the most stationary. The basins should be ideal for modeling of regional water budget and of geochemistry and solute transport. If monumented channel cross sections exist, they should be ideal for channel geomorphology studies. Many of these research efforts are dependent on data collection in the areas of precipitation chemistry, ground-water levels, and chemistry and channel morphology, and relatively little of these data have been collected to date.

RECOMMENDATIONS FOR FUTURE DIRECTION OF PROGRAM

The response of the Districts, Regions, and others was very helpful to the committee in evaluating the status of the Hydrologic Bench-Mark Program and in developing recommendations for the future direction thereof. The responses and suggestions underscored many of the thoughts of committee members and pointed out several new ideas.

A review of the responses, shown in the appendix, leads to the following conclusions:

- The program needs enhanced visibility. The existence of this uniform set of relatively homogeneous data is unknown to many potential users. Additional efforts should be made at both national and State levels to publicize the information through reports on studies using the Hydrologic Bench Mark Program data base. More use of the information should be made by WRD research scientists and by academic research institutions.

- The program is considered to be a very important one and is assigned a very high priority by the Districts, Regions, and by some elements within the National Research Program.

- Cooperating agencies are highly supportive of the program. The availability of base-line information collected on a national basis to uniform standards is very important to State and local agencies charged with setting standards. There is no substitute for such an information base. No comparable data base exists.

- The availability of precipitation and precipitation quality data at all sites would significantly enhance the utility of the program. The network is ideally suited for further studies of acid-rain problems.

- A systematically collected set of land-use and land-cover information for each basin is required in order to document changes, if any. This information should be collected at specified intervals and be an integral part of the data base.

- The lack of at least minimal amounts of information regarding changes in ground-water levels is a serious deficiency in many of the basins. Every effort should be made to rectify this situation.

- Changes in water-quality sampling frequency could be made. A reduction in periodic sampling frequency for a number of parameters could be implemented without impacting program objectives. Event sampling for selected parameters should be considered.

The conclusions and recommendations by the committee are:

1. The Hydrologic Bench Mark Program is a very important element of the overall program of water-resources investigations of WRD and should be continued. The operation of a network of hydrologic stations to provide base-line information for the current and future assessment of the effects of man's activities on the Nation's water resources is believed to be an absolute necessity for a technologically advanced society.

2. A primary deficiency of the program is a lack of inclusion of analytical studies using the data base as an integral part of the program. Assessment and analysis should be a continuing element of the program, rather than a periodic effort such as we now have. Some program funds should be provided for analytical studies. Proposals from Districts and the National Research Program should be requested to enrich the program. Such an effort, patterned after this year's "Little Bit Extra" program, could yield excellent results.

3. Ground-water data are lacking in most of the Hydrologic Bench Mark Program watersheds. The few data that have been collected as part of the program generally consist of water-level data for a single well in the watershed. This meager information does not provide any basis for assessing the nature and extent of interrelationships between the ground-water and surface-water elements of the hydrologic system.

A hydrogeologic reconnaissance of the watershed above each station should be made to define at least the principal geologic units that influence the geochemistry of runoff and govern the flow-recession characteristics and chemical quality of base flow.

4. The data-collection program should be modified to include some observations of ground-water levels in each basin; a periodic, systematic determination of land use and cover in each basin; and additional data related to geomorphologic processes in selected basins. Geomorphologic data could also be included in the Vigil Network Program.

5. District Offices should be an integral part of continuing assessments. There should be a feedback mechanism to keep Districts informed of various studies being undertaken with the Hydrologic Bench-Mark Program information. One individual in each Branch should be appointed to be responsible for the program and District feedback.

6. Substantial efforts should be made to enhance the visibility of the program. This should include mention in the State Water Resources Investigations pamphlets, annual State progress reports, and other WRD publications. Additional efforts should be made to make known the availability of this information to the academic community. Effort within the National Research Program should be directed to studies involving Hydrologic Bench-Mark Program information. Special effort should be made to present research findings at technical society meetings.

7. Steps should be undertaken to provide additional awareness in other water-related agencies regarding the Hydrologic Bench-Mark Program. Efforts should be made to incorporate the needs of other agencies in the program. If this can be accomplished on a reimbursable basis, the program could be significantly enhanced.

8. One deterrent to expanded use of Hydrologic Bench-Mark Program data is that at present streamflow and water-quality data for stations in the programs reside on some 57 separate magnetic tapes. A single file including all time-series data available for the stations should be established. In addition, a readily available file of non-time dependent information should be maintained at headquarters.

9. A number of recommended actions will require additional funds, either by program redirection or additional appropriations. The committee reviewed in depth the existing data-collection program. It was the opinion of the committee that the number of stations in the networks should not be decreased and that continuous flow records are required. This leaves only the water-quality portion of the program, representing appproximately one-half of the total expenditures, as a possible source of redirection of effort. It was the opinion of the committee that the frequency of sampling and the roster of constituents analyzed could be modified and generally reduced at most stations without impairing the utility of the data in meeting the program objectives. It is our recommendation that upon completion of the current study for the Quality of Water Branch by the Wisconsin District, an assessment be made by that Branch on a station-by-station basis for the purpose of defining a reduction in frequency of sampling and roster of constituents to be analyzed. In particular, given the length of record already existing, a decrease in sampling frequency from monthly to quarterly would not likely result in a significant loss of information. We expect that perhaps $50,000 or more in funds can be made available by changes in the water-quality sampling program.

It is the firm conviction of the committee that implementation of the nine recommendations will lead to a considerably improved program. Of the nine specific recommendations, numbers 2, 3, and 4 will require additional

program funds. We urge that additional funds be provided. These additional funds, along with redirected Hydrologic Bench-Mark Program funds, will provide for accomplishment of the recommended work in a reasonably timely fashion. In any event, the priority for the additional work items under numbers 2, 3, and 4 is:

1. Analytical studies using the data base should be an integral part of the program.

2. Land use and cover must be documented on a periodic, systematic basis.

3. More ground-water information, including a hydrogeologic reconnaissance, is required.

4. Additional data on geomorphologic processes should be collected in selected basins.

All other recommendations can be implemented by directive at headquarters level without additional funds.

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APPENDIX

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Information Available and Remark
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
Northeastern Region						
03276700 South Hogan Cr. at Dillsboro, IN	C, 1961- , Low Flow-1960	I, 1 well, 1958-	P, 1968-	P, 1968-	C, 1967-	
01054200 Wild R. at Gilead, ME	C, 1964-	-	P, 1967- , C, water temp., 1967-	P, 1967-	C (Apr-Oct), 1964-	Snow depth, precip. (4 ga and climatological data collected by USFS, 1967-
0400100 Washington Cr. at Windigo, MI	C, 1964-	-	P, 1964- , C, water temp., 1964-	P, 1964-	-	Daily precip., 1965- by USFS; air temp., C, 1964- by WRD; snow depth and wa content measured once per in Feb. or March by WRD precip. and wet/dry fall station on Isle Royale operated by NPS
05124480 Kawishiwi R. nr. Ely, MN	C, 1966-	-	P, 1967- , C, water temp., 1967-	-	-	Precip., continuous and climatological data, inte mittently, 1966- , snow and water content, 1967- by USFS; daily precip., EPA
05376000 N.F. Whitewater R. nr. Elba, MN	C, 1939-41, 1967-	-	P, 1967-	P, 1967-	-	Daily precip., 1941- , for NWS

ABBREVIATIONS USED

C - Continuous

I - Intermittent

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Information Available and Remar
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
Northeastern Region (cont.)						
01466500 McDonalds Br. in Lebanon State Forest, NJ	C, 1953-	C, 1 site, 1955- , C, 2 sites, 1955-67, I, 53 sites, 1955-67	P, 1967- , C, water temp., 1960-	P, 1967-	C, 1955-1966 (1 site) C, 1955- (1 site)	Air temp., C, 1963- , Weekly precip., 1955-196
01362198 Esopus Cr. at Shandaken, NY	C, 1963-	-	P, 1967- , C, water temp., 1963-	P, 1967-	-	Precip., C, 1953- , NWS Precip., daily, 2 sites, 1940- , and 1943- , NW
03237280 Upper Twin Cr. at McGraw, OH	C, 1963-	-	P, 1967- , C, water temp., 1963-	P, 1967-	C (2 gages), 1963-	
01545600 Young Woman's Cr. nr. Renovo, PA	C, 1964-	-	P, 1967-	P, 1967-	C, 1964-	
02038850 Holiday Cr. nr. Andersonville, VA	C, 1966-	P (4 wells), 1971-	P, 1967- , P (4 wells), 1971-	P, 1967-	-	Water quality informatio collected at various frequencies
04063700 Popple R. nr. Fence, WI	C, 1963-	I (2 wells), 1966-	P, 1967- , C, water temp., 1964-	P, 1967-	C, 1965-67	Mineral exploration in progress in basin

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Informatio Available and Rema
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
Southeastern Region						
02369800 Blackwater R. nr. Bradley, AL	C, 1967- , I, low flow at 36 sites	I, (3 wells), 1968-	-	-	C, 1967-	
02450250 Sipsey Fork nr. Grayson, AL	C, 1966-	C (1 well), 1969- I (5 wells), 1968	P, 1967-	P, 1967-	C, 1969-	
02327100 Sopchoppy R. nr. Sopchoppy, FL	C, 1964- , I, peak flow, 1961-64	C, 1967-	P, 1967-	P, 1967-	C (2 gages), 1966-	
02212600 Falling Cr. nr. Juliette, GA	C, 1964-	-	P, 1967- , C, water temp., 1965-79	P, 1967-	C, 1964-68	Daily precip., 1964- , (5 mi NE)
02178400 Tallulah R. nr. Clayton, GA	C, 1964-	-	P, 1967-68, C, water temp., 1964-79	-	C, 1964-71	Daily precip. and air te 1964- , NWS (10 mi E)
02479155 Cypress Cr. nr. Janice, MS	C, 1966-	-	P, 1967-	P, 1967-	-	Daily precip. and climat data, 1965-present, by U
03460000 Cataloochee Cr. nr. Cataloochee, NC	C, 1933-52, 1962-	-	P, 1967- , C, water temp., 1962-	P, 1967-	Daily, 1964	Climatological data, 196 present, by WRD; water q data, P, collected by NC of Natural Resources

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Information Available and Remarks
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
utheastern Region (cont.)						
2135300 Scape Ore Swamp nr. Bishopville, SC	C, 1968-	-	P, 1970-	P, 1970-	-	
2197300 Upper Three Runs nr. New Ellenton, SC	C, 1966-	-	P, 1967-	P, 1967-	-	
3604000 Buffalo R. nr. Flatwoods, TN	C, 1920- , P, numerous low-flow, misc., and spring sites in basin	-	P, 1967-	P, 1967-	-	Long-term precipitation, a and water temperature (196 data available from NWS an TVA
3497300 Little R. above Townsend, TN	C, 1963-	-	P, 1963-68, C, water temp., 1963-	P, 1967-68	-	
Central Region						
7340300 Cossatot R. nr. Vandervoort, AR	C, 1967-	-	P, 1967-68	-	-	
7060710 North Sylamore Cr. nr. Fifty Six, AR	C, 1965-	-	P, 1967-	P, 1967-	C, 1968-78	

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Information Available and Remarks
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
tral Region (cont.)						
830000 Halfmoon Cr. r. Malta, CO	C, 1946-	-	P, 1966- , C, water temp., 1967-	P, 1966-	C, 1966- (except winter)	Climatological data availabl from NWS and USBR. Snow course information available SCS
52900 Vallecito Cr. r. Bayfield, CO	C, 1962-	-	I, 1963- , C, water temp., 1962-	I, 1962-67	C, 1962- (except winter)	Climatological data availabl from NWS and USBR. Snow course information available SCS
97950 Elk Cr. nr. ecatur City, IA	C, 1967-	-	P, 1968-	P, 1968-	-	Daily precipitation and air temperature available from NWS, 1956-
79650 Kings Cr. nr. anhattan, KS	C, 1979-	-	P, 1979-	P, 1979-	C, 1980-	KGS operates QW monitor at site. KSU operates 1 recording and 1 non-recordin precip. gage near basin
73000 Big Creek at ollock, LA	C, 1942-	-	P, 1967- , C, water temp., 1964-	P, 1967-	C, 1964- (2 gages)	
14500 Swiftcurrent r. at Many Glacier, T	C, 1959- , I, 1912-58	-	P, 1963-68, 1970-71 C, water temp., 1963-70	P, 1963-68	C, 1956- (May-Oct. only)	Snow surveys 1960-present, Daily precipitation, continuous air temperature, other precipitation information available in basin

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Information Available and Remarks
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
Central Region (cont.)						
6169500 Rock Creek below Horse Creek, nr. International Boundary, MT	C, 1978-, Seasonal - 1916-26, Seasonal - 1956-78	-	P, 1977-	P, 1977-	-	
6288200 Beauvais Cr. nr. St. Xavier, MT	C, 1966-78	-	P, 1967-78	P, 1967-78	-	Discontinued 1978. Daily precipitation and climatological data, 1965-78, by US
6775900 Dismal R. nr. Thedford, NE	C, 1967-	-	P, 1967-	P, 1967-	-	Only 30 sq. mi of 960 sq. mi drainage area contributes to runoff
8377900 Rio Mora nr. Terroero, NM	C, 1963-	-	P, 1967-	P, 1967-	-	
9430600 Mogollon Cr. nr. Cliff, NM	C, 1967-	-	P, 1968-	P, 1968-	-	
5064900 Beaver Cr. nr. Finley, ND	C, 1964-	-	P, 1967-	P, 1967-	C, 1965-	
6332515 Bear Den Cr. nr. Mandaree, ND	C, 1966-	-	P, 1967-	-	-	

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Information Available and Remarks
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
ıtral Region (cont.)						
111200 Blue R. nr. Cache, OK	C, 1964-	-	P, 1967-	-	-	
135700 Kiamichi R. ır. Big Cedar, OK	C, 1965-	-	P, 1967-	P, 1967-	-	
09000 Castle Cr. nr. 111 City, SD	C, 1948-	-	P, 1967- , C, water temp., 1964-	P, 1967-	C, 1964-77, (3 gages, no record in winter)	Also precipitation at two storage gages, 1964-present
78500 Little ermillion R. nr. alem, SD	C, 1966-	-	-	-	-	
03900 South Fork ocky Cr. nr. Briggs, X	C, 1963-	-	P, 1967-	P, 1967-	C, 1963- , (3 gages)	
31700 Limpia Cr. bove Fort Davis, TX	C, 1965-	-	P, 1967-	-	C, 1965-	
72200 Red Butte Cr. t Fort Douglas, UT	C, 1963- , monthly only, 1942-63	-	P, 1967- , C, water temp., 1964-	P, 1967-	C, 1965-	Precipitation from storage gages available 1941-65, by USCE. Climatological data collected in vicinity by University of Utah

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Information Available and Remar
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
Central Region (cont.)						
06623800 Encampment R. above Hog Park, nr. Encampment, WY	C, 1964-	-	P, 1965-	P, 1970-	-	I, snow surveys, 1964-p Climatological data, 19 present, by USFS
13018300 Cache Creek nr. Jackson, WY	C, 1962-	-	P, 1965-	P, 1968-	-	I, snow surveys, 1967-p
Western Region						
15292700 Talkeetna R. nr. Talkeetna, AK	C, 1964-	I, 1967-78 (one well)	P, 1967-	P, 1966-	-	
09508300 Wet Bottom Cr. nr. Childs, AZ	C, 1967-	-	P, 1967-	P, 1967-	-	Several precipitation g operated by NWS in vici
11264500 Merced R. at Happy Isles Bridge nr. Yosemite, CA	C, 1915-	-	P, 1967- , C, water temp., 1965-	P, 1967-	-	
11475560 Elder Cr. nr. Branscomb, CA	C, 1967-	-	P, 1967- , C, water temp., 1967-	P, 1967-	C, 1969- , (2 gages)	
10250600 Wildrose Cr. nr. Wildrose Station, CA	C, 1960-75	-	-	-	C, 1964-75, (6 gages)	Climatological data ava 1964-75. Discontinued

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Information Available and Remarks
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
estern Region (cont.)						
5717000 Honolii Stream nr. Papaikou, HI	C, 1911-13, 1967-	-	P, 1969-	P, 1969-	-	C, Precipitation and sedim data, collected by USFS since 1978
2416000 Hayden Cr. below North Fork nr. Hayden Lake, ID	C, 1948-53, 1958-59, 1965- , I, Annual Peak, 1961-65	-	P, 1967-	P, 1967-	-	Climatological data, daily precip. and air temp. by N at Cour d'Alene Ranger Sta
3169500 Big Jacks Cr. nr. Bruneau, ID	C, 1938-49, 1965-	-	P, 1967-	-	-	Daily precip., air tempera by NWS nearby
0244950 Steptoe Cr. nr. Ely, NV	C, 1966-	-	P, 1967- , C, water temp., 1966-	-	-	
0249300 South Twin R. nr. Round Mountain, NV	I, 1964-65, C, 1965-	-	P, 1967- , C, water temp., 1966-	P, 1967-	-	
492200 Crater Lake nr. Crater Lake, OR	Lake Elevation I, 1878-1961, C, 1961-	-	P, 1967- , C, water temp., 1963-	-	-	Daily and continuous precipitation available, 1919-41, 1949- , by NWS

Hydrologic Benchmark Program
Information Summary
June 1981

Station	Data Collected by WRD					Other Information Available and Remarks
	Streamflow	Ground Water	Water Quality	Sediment	Precipitation	
:ern Region (cont.)						
331500 Minam River : Minam, OR	C, 1912-14, 1965-	-	P, 1966- , C, water temp., 1965-	P, 1967-	-	
39300 North Fork ıinault R. nr. Amanda ark, WA	C, 1964-	-	P, 1967- , C, water temp., 1965-	P, 1967-	2 storage gages, 1965-	
47390 Andrews Cr. r. Mazama, WA	C, 1968-	-	-	-	-	

District	District use of HBM data for other hydrologic studies	Use of HBM data by other agencies or organizations	What other types of data should WRD collect to meet program objectives	Data collection or surveys by other agencies	Recommendations for future of program, assuming limited or no increase in funding
Northeastern Reg.					
Connecticut	No HBM stations in District	None known	No comment	No comment	None
Illinois	No HBM stations in District	None known	Annual basin land-use survey, with in-depth assessment at 5-year intervals	None known	Could change program to collect data in 1 year out of 5, to assess long-term trends, permitting expansion of effort and upgrading of station facilities
Indiana	No specific use of HBM data	None known	Collect land-use information at 5-year intervals, with aerial photography or Landsat	SCS is completing soil surveys that include HBM station	Evaluate QW data. Design QW programs to address significant or indicator parameters. Reduce sampling frequency as a minimum to coincide with 6-week field trips.
Maryland-DC-Delaware	No HBM stations in District	None known	Transferability of data to surrounding areas should be tested	None known	Analyze existing data to prioritize in case of funding reduction
Michigan	None to date. Anticipate using as part of study of chemical characteristics of runoff into Great Lakes. Only QW station in Michigan draining pristine area.	Extensive use by Great Lakes Resource Studies Unit, NPS, for research on small river basins	Need GW data on Isle Royale. GW data is of significant interest to NPS.	Yale and Purdue Universities have wildlife studies on Isle Royale, HBM data utilized	Continue and expand program if possible

District Questionnaire Response Summary
June 1981

District	District use of HBM data for other hydrologic studies	Use of HBM data by other agencies or organizations	What other types of data should WRD collect to meet program objectives	Data collection or surveys by other agencies	Recommendations for future of program, assuming limited or no increase in funding
Minnesota	Used in QW and hydrology of NE Michigan study. Anticipate use for RASA Study and GW quality of Karst area study.	EPA using data for U.S./Canada transboundary air pollution study, effects of acid rain. EPA is using for long-term QW trends. Minnesota DNR uses data for base line QW and acid-rain studies.	Need chemical quality of precipitation data. Need data on ground-water levels and quality.	EPA, USFS, and COE measure information on precipitation and snow depths	Continue operation of HBM stations even if it means cutting back on other activities
New Jersey	Used as base line information for comparison with highly developed areas of NE	Used to describe statistically the SW flow at station. QW data used to develop base line condition for Coastal Plain.	Need systematic collection of GW data	Several studies by other agencies, including one data age by tritium analyses	Base line information is extremely important for comparison purposes. Should look at basins in their entirety to evaluate relations between various portions of hydrologic cycle. Accomplish by collecting, compiling, and analyzing: (1) synoptic streamflow QW data throughout basin to describe areal variability; (2) synoptic GW level data to determine GW/SW relations; (3) basin characteristics synoptic measurements to be made every 3-5 years.
New England (Maine Subdist.)	None known	None known	No comment	None known	No comment
New York	QW data used for analyses of trends in acidity in precipitation and surface waters	No known studies. State agencies and New York City use data for water management.	GW levels and quality as well as additional biologic surveys	State supports collection of water temperature data	Consider reducing frequency of QW sampling and analysis. Consider operating SW stations as PR site.

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Ohio	Comparison study with strip-mined basin	Information used by consultants and universities	GW quality data. Collect radio-chemical data twice annually. Increase organic sampling.	USFS collects rainfall data. State collects QW data.	Keep program at least at present level. Information no doubt will be very important in the future.
Pennsylvania	Used for acid precipitation study	None known	Acid precipitation data	None known	Continue at least at present level if possible. QW data collection frequency could be reduced if necessary.
Virginia	No specific use of HBM data	Data used by several agencies; no known reports	Include other physio-graphic provinces if possible	QW and other hydrologic data by USFS in nearby areas	Continue at present level if at all possible
West Virginia	No HBM station in District	None known	No comment	None known	Funding cutbacks would not hurt overall WRD mission
Wisconsin	Used in several comparison studies, particularly for pre-mining conditions	Used by State for back-ground QW description	Precipitation QW and ground water QW	None specific to HBM program	Include precipitation quality program. Dis-continue fecal coliform and fecal strep determinations. Continue remainder of programs as is.
Southeastern Reg.					
Alabama	Background information for coal basin hydrology reports	USDA uses Q_p and QW data, USFS uses pesticide data to track spraying efforts	Present program adequate	None known	Could reduce frequency of QW sampling
Georgia	No specific use of HBM data	Used by State to establish base line water quality criteria	Need GW level and quality data, as well as pre-cipitation QW data. Land use should be documented with Landsat.	Several needs expressed by other agencies but no known activity	Could consider "interrupted data collection" at selected sites. QW data should be collected on an "event" basis rather than routine time sampling.

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Mississippi	Background information for DOE nuclear waste storage study	None known	No recommendations	None known	Continue program as it has significant value for benchmark comparison and trend analysis
North Carolina	Used to characterize base line QW and comparison with developed basins, several interpretive reports	State collects data at site for background purposes, BOD, COD, phenols, mercury, etc.	Should sample during flood events to cover hydrograph	None known	If funding is reduced, consider operating stations on a rotating basis, on/off at 3-5 year intervals
South Carolina	None specific to HBM program	None known	No recommendations	None known	Program is very important and should be continued. Information will become increasingly more valuable to assess the effect of man's activities on water resources. Place more emphasis on periodic evaluation of data.
Tennessee	Used for hydrograph separation to estimate ground water volumes in carbonate rocks. Also index station for low-flow partical record correlations.	None known	Conduct intensive basin studies to define hydrologic framework and characteristics of main stream and primary tributaries	TVA has collected water temperature data	Continue network indefinitely to provide time trend information
<u>Central Region</u>					
Arkansas	None	None specific to HBM	Need additional basin characteristics information	None known	Continue program in its present form indefinitely
Colorado	Used for base line information for mining studies	USBR has used data for several purposes	Need GW and land-use information for basins	Climatological, geologic, soils, and vegetation type information collected by other agencies	Maintain stream gaging as is, reduce QW sampling, shift funds to GW assessment. Assess available information, modify program accordingly.

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Iowa	Used for coal hydrology study	None known	Need GW level data	Aerial photos and chemical usage information, USDA	Continue present data-collection program, undertake nationwide assessment of data
Kansas	None - only 1 year of data available	State agencies and universities are making extensive use of information and facilities	Need more frequent sediment samples, and aerial photos for land-use information	State and university collect precipitation and QW data	Maintain program and increase visibility of same. Encourage outside researchers to use benchmark information.
Louisiana	Used for several hydrologic studies, including comparison of organics with those in Mississippi River	Information requested from time to time by State and Federal agencies	No additional data needed. Need report on basin analyzing available data with respect to changes in basin.	None known	Program should be continued, even at the sacrifice of other programs. Data is extremely valuable to assess hydrologic changes, particularly QW.
Missouri	No HBM stations in District	None known	Precipitation chemistry data	None known	Continue program, examine data critically to determine if objectives of program are being met
Montana	Used for regionalization of streamflow characteristics	No known reports. Data used by USFS and several consultants.	Need more meteorological data	None known. USFS barometer watersheds meet HBM criteria	Continue operation of all sites, reduce visit schedule if necessary. Long-term data from unaltered basin is badly needed.
Nebraska	Will be used for geohydrology study of Sandhills	No specific use known. Information is useful to many agencies for base line conditions.	GW levels should be measured and assimilated periodically	None known	Program should be continued as is in view of long-term objectives

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New Mexico	Used for flood-frequency and acid-rain studies	Limited use by State, university, and USFS for QW and water yield studies	Rainfall volume, intensity and quality should be monitored. Expand QW coverage equivalent to NASQAN. Automatic samplers for remote sites.	No specific programs known, some short-term studies	Continue program, review network carefully, QW sampling frequency could be reduced. District strongly supports objectives of program
Oklahoma	Used for statistical analysis of streamflow and QW	State agencies use data for management purposes	No changes recommended	None known	Continue existing program
South Dakota	None specific to HBM program	None known	Should collect QW and precipitation data, including dry fall samples	State has collected GW level data and has done geologic mapping	QW sampling frequency could probably be reduced
Texas	None specific to HBM program	None known	No changes recommended	None known	Review network station for transfer values. Some objectives of program (long-term trends) could be achieved using regular stream gaging network.
Utah	Used for base line comparison in Salt Lake County urban hydrology program	Information used by numerous State, university, and Federal agencies	Use mini-monitors for continuous QW data. Monitor cloud seeding programs in area. Monitor geomorphological changes. Monitor GW levels.	University of Utah collects climatological data in vicinity	Continue program with update of QW instrumentation. Contact university research director for input.
Wyoming	Used for EIS for mineral exploration project	Information used by Federal and local agencies for EIS and water supply studies	Should document drainage basin characteristics	Snow surveys by SCS	Continue program as data are extremely valuable in establishing base line conditions. Frequency of measurements could be reduced if necessary.

District Questionnaire Response Summary
June 1981

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Western Region					
Arizona	None known	State uses QW data to establish base line natural concentrations of mercury	No change	None known	No changes recommended
California	Key data base for projects in area. Educational exhibit accessible to 1 million plus National Park visitors annually. Also used in national research programs to characterize erosional processes in North Coastal California.	Very important for studies by State agencies and by NPS. Primarily used for QW studies as base line information and for environmental studies.	Land use and changes, water budget. Assess changes in QW. Need sediment samples for high flow events and acid precipitation data. Diversity program to include lakes, ponds, marshes, estuaries, and lagoons. Expand data collection to include organics on EPA priority pollutant list.	Some data is collected by other agencies and should be included in HBM data base	Visibility of program needs to be enhanced, with publications for wide readership. Need time trend analyses for QW parameters, comparative analyses with other watersheds, and hydrologic analyses such as rainfall-runoff model calibration, etc. Sampling frequency of QW parameters could be reduced if necessary to reduce program.
Hawaii	None specific to HBM	USFS using streamflow and sediment data for watershed research	Should collect rainfall and evaporation data at each site	USFS is collecting rainfall and sediment data for short-term study	Consider consolidating some of NASQAN and HBM stations where possible
Idaho	None specific to HBM	Used for studies by USFS and BLM	Need annual aerial reconnaissance and photography to document land-use changes. Apply channel geometry techniques to sites for flood-frequency analysis.	Some information on land-use changes	A valid and important program which should be continued with a high priority

District Questionnaire Response Summary
June 1981

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Nevada	None specific to HBM. Plan SW quality study for HBM and NASQAN sites.	Some requests for information from State and USFS	Need mini-monitor for continuous QW information. Need trace element analyses of streambed materials and background biologic data.	None known	Sampling scheme could probably be changed after an in-depth analyses of QW parameters
Oregon	None specific to HBM	Extensive requests for data from streams under natural conditions	Precipitation quantity and quality data. Need current land-use surveys and biological data.	None known	Any changes in program should be based on in-depth statistical analysis of data collected to date. Districts should be involved in recommending changes.
Washington	Key stations in District long-term trend network. Also used for acid-rain, acid-lake studies. QW data used for base line information in effects of logging studies.	Numerous requests for HBM type data from universities and State agencies. Specific use unknown.	No recommendations	None known	Sampling frequency could probably be reduced if necessary. District considers HBM program (SW and QW) at or near highest priority in Federal CBR program, which should be continued at the expense of other elements if necessary.

UNITED STATES GOVERNMENT

memorandum

DATE: May 19, 1981

REPLY TO ATTN OF: Regional Hydrologist, NR

SUBJECT: PROGRAMS AND PLANS--Hydrologic Benchmark Basin Program

TO: Stanley Sauer, Surface Water Branch, Reston, VA

This memorandum is in reply to your February 25, 1981, memorandum on the same subject. Included, as you requested, are individual District responses. Summary remarks by the Regional Staff follow.

1. It is apparent from District responses that the Hydrologic Benchmark Basin Program is useful now and will become increasingly important in the future.

2. An assessment of the network is necessary to evaluate station distribution, optimal length of record at stations, sampling frequency of constituents, and the relationships of the stations to other parameters of the basins that they are monitoring. (See suggestion by Don Vaupel, New Jersey). In particular, the schedule of constituents can probably be modified to reduce collection of some inorganic constituents from monthly to quarterly analysis. Dennis Wentz, Wisconsin, is presently evaluating Hydrologic Benchmark data from all stations. A summary or progress report of his work should be included in the ad hoc Committee review.

3. An assessment of the effects of land use, or changing land uses, on the quality of the water in each benchmark basin should be made.

J. E. Biesecker

Attachment

RECEIVED

MAY 19 1981

Surface Water Branch

OPTIONAL FORM NO. 10
(REV. 1-80)
GSA FPMR (41 CFR) 101-11.6
5010-114

UNITED STATES GOVERNMENT

memorandum

DATE: April 22, 1981

REPLY TO ATTN OF: Regional Hydrologist, WRD, SR

SUBJECT: Hydrologic Benchmark Basin Program

TO: Stan Sauer, Surface Water Branch, Reston, Va.
MS 415

In reply to your memo of February 25, 1981, same subject, you will find attached responses from six SR districts. We believe the general consensus of the districts is to continue the program at its present level if at all possible. A couple of districts suggest a rotating type of operation if additional funds are not available to continue the full operation of the stations. This may have merit. As you will note in the memos there have been several instances of using the data even though not much has been done toward trend analysis. The lack of trend analyses is not disturbing, because in our opinion useful trend analyses will require much longer records than presently available at most of the stations. It is for this reason we should make every effort to continue the stations indefinitely. This is without question one of our most valuable data collection efforts, and the value will become more and more apparent as time progresses. As man continues to disturb natural runoff processes there will be less and less information to provide a base of comparison. The HBM program will fill at least a part of that need. At the present time we can probably make some preliminary trend analyses at some of the longer record stations but the real value will not become apparent for many years. The continuation of the program should be based largely on this premise. In the meantime some research efforts could be devoted toward defining techniques of trend analyses.

We hope these comments, plus those from the districts will be helpful.

FOR THE REGIONAL HYDROLOGIST

Vernon B. Sauer

RECEIVED

APR 24 1981

Surface Water Branch

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

OPTIONAL FORM NO. 10
(REV. 7-76)
GSA FPMR (41 CFR) 101-11.6
5010-112

STATE OF CALIFORNIA-RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

STATE WATER RESOURCES CONTROL BOARD
P.O. BOX 100, SACRAMENTO, CALIFORNIA 95801
Surveillance & Monitoring Section
(916) 322-0214

May 14, 1981

Gil Bortleson
U.S. Geological Survey
855 Oak Grove Avenue
Menlo Park, CA 94025

Dear Mr. Bortleson:

HYDROLOGIC BENCHMARK PROGRAM (HBM)

Thank you for your letter of April 30, 1981 providing the opportunity to comment on the U.S. Geological Survey's HBM questionnaire.

The station at Happy Isles Bridge on the Merced River (11264500) is a monitoring site in the California Statewide Primary Water Quality Monitoring Network. Data from this site, and 72 other locations statewide, is used by the Board to report on the water quality conditions in 28 priority streams. One such report is the biennial Water Quality Inventory prepared in fulfillment of the U.S. Environmental Protection Agency requirements of Section 305(b) of the Clean Water Act.

Traditional water quality measurements of nutrient and standard mineral concentrations as well as the bacteriological and toxic substances analyses from the Happy Isles site are important to us.

The other HBM station in California (Elder Creek near Branscomb-11475560) is located in a very small, remote drainage area, uninfluenced by human development. It may be truly considered a "benchmark" station but quite frankly we have not had occasion to utilize information from this site.

If HBM program changes become necessary due to resource constraints I would suggest reductions in frequency of sampling and some deletion of the more costly analyses based upon no detection at levels reported from past analyses. Some toxics/trace metals and mineral analyses could be done every two to five years instead of annually resulting in, I believe, substantial cost savings.

Thank you for this opportunity to comment on the U.S. Geological Survey HBM program.

Sincerely,

John M. Youngerman, Chief
Surveillance & Monitoring Section
Division of Technical Services

Enclosure/Questionnaire

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Water Resources Division
345 Middlefield Road
Menlo Park, CA 94025

May 6, 1981

Memorandum

TO: Ken Lee - Menlo Park Subdistrict

FROM: K. Michael Nolan

SUBJECT: Continuation of the Elder Creek Hydrologic Benchmark Station.

Records of water and suspended-sediment discharge collected at the Elder Creek Station have been extremely valuable in helping to characterize erosional processes operating in natural environments of North Coastal California. The scarcity of data from unimpacted terrane coupled with rapid decreases in the amount of unimpacted terrane in North Coastal California make data collected at Elder Creek invaluable. Data collected from disturbed watersheds must be compared to those from undisturbed watersheds (such as Elder Creek) to assess man's impacts on the rates and styles of naturally occurring processes. Researchers who continue to try to understand erosional and sedimentological processes operating in North Coastal California must continue to have data such as those collected at Elder Creek available to them. I see very few oportunities to collect such data elsewhere and hope the record at the Elder Creek Station will continue to be collected. It would be tragic if the available data base at Elder Creek was not permitted to lengthen and the response of the watershed to future hydrologic events was not monitored.

Sincerely,

Mike

K. Michael Nolan