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# THE CUAHSI HYDROLOGICAL MEASUREMENT FACILITY COMMUNITY SURVEY 2005

A Report to the Consortium of Universities  
for the Advancement of Hydrologic Sciences, Inc.

by

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# EXECUTIVE SUMMARY

The Consortium for the Advancement of Hydrologic Sciences, Inc. (CUAHSI) has undertaken establishment of a new facility to serve to advance hydrologic measurement within the research community: The Hydrologic Measurement Facility (HMF) (see *Eos*, 86 (47), November 22, 2005). To provide community guidance for this effort, a survey was conducted seeking the broad opinion of the research community. The survey assessed the level of support for community instruments and facilities, and sought out technologies and methodologies that could make major advances in the hydrologic sciences. Three hundred sixty-three responses were returned between November 1, 2005 and January 15, 2006, more than seven times that obtained in the 2002 HMF survey. This report provides a brief summary of the survey results and an annotated appendix containing all the responses received during to course of the survey. Broadly, the survey pointed to strong community interest in having instrumentation support. Participants focused on two themes: make high-cost, cutting edge equipment available and dedicate focused effort to develop new instrumentation dedicated to hydrologic applications.

# 1. SURVEY RESULTS

Three hundred sixty-three responses to the survey were recorded. Of those surveyed, scientists identified themselves with the following scientific categories: 45% hydrology, 15% soil science, 12% geophysics, 11% biogeochemistry, 3% ecology, 3% geomorphology, and 11% other. In terms of employment, 68% of those surveyed were from universities, 17% federal government, 10% private sector, and 5% from other places. Over 65% of those surveyed had been conducting research for more than 10 years and 67% recognized research as their major work responsibility. Eighty-six percent of the total number of respondents identified themselves with conducting field experimental work, 75% with mechanistic modeling, and 71% with applied modeling, indicating a response from the breadth of the community. Seventy percent had been involved routinely or actively with fieldwork for hydrology. A significant portion of the respondents had not received previous funding from NSF, with 32% having been Principal Investigators (PIs) and 39% having been Co-Principal Investigators (Co-PIs).

Respondents were asked what was most needed in order to make progress in hydrologic sciences. Of the 23 questions with possible scores ranging from a maximum of 100% to a minimum of -100% (positive indicating support, zero indicating neutral, and values below zero indicating the average degree of opposition). There was overwhelming support (>75%) for:

1. Improving the integration between measurement and modeling methods (80.6%);
2. Improving spatial resolution of measurements (79.7%);
3. The ability to make more/better measurements, for example, through distributed sensor networks (77.3%);
4. Improving our ability to measure and quantify the subsurface (76.4%).

There was more support for providing access to equipment costing over \$20,000 (with accompanying technical support for both deployment and data interpretation) than there was for standard equipment. There was general support (50–75%) for improving methods for determining measurement uncertainty (67.4%); improving temporal resolution of measurements (67.0%); the development of cross-scale, multi-process observational platforms (64.6%); improving hydrological models (56.4%); improving the methods of sensor calibration (54.0%) and developing new tracer methods (53.4%). Access to the only computational resource surveyed,—supercomputers—had low interest to the respondents (-7.4%).

Respondents identified and prioritized what the aims of an HMF should be. The strongest response was received for conducting research and development into new cutting-edge hydrological measurement devices (62.7%). Other areas drawing strong support were: development of new methods (59.1%) and instruments (57.6%); comparisons of sensors (56%); provision of a comprehensive handbook of measurement techniques (51.7%) and integration of measurement and modeling approaches (50.8%). Respondents had a low level of interest in standard equipment rental and servicing or a technical team to set up basic watershed monitoring.

There was strong support for a single HMF research and development center (59% of respondents), while less than 4% wanted a simple rental facility. Nearly half the respondents indicated that the HMF should put high priority on providing access to high-cost equipment for the community. The community also showed strong support for the HMF providing technical assistance, troubleshooting services, and assistance with experimental design and equipment choice. When asked if there were similar community facilities that served as a good model, the most common response was NCAR (National Center for Atmospheric Research). The Hydrologic Instrument Facility (HIF) of the U.S. Geologi-

cal Survey (USGS) was also suggested. It is noteworthy that CUAHSI has now signed a Cooperative Research and Development Agreement (CRADA) with HIF to provide access to standard hydrological measurement equipment, resolving a need that was ranked as a lower priority, at no direct cost to CUAHSI or the National Science Foundation (NSF). Additional aspects of the HMF that attracted the most interest were the provision of sabbatical/post-doc opportunities and the provision of measurement technique workshops. The latter was enthusiastically echoed in a number of write-in comments, including, “YES!!!! Training is important;” “... you have to learn this [equipment problems] the hard way;” and “A high priority would be training on high-tech equipment.”

The survey finally addressed the issue of developing a shared pool of equipment. The NSF has long held that this would be a highly desirable function of the HMF, allowing the NSF to purchase equipment that they could be assured would be broadly accessible to qualified researchers. The consensus view was that the instrumentation should be owned and maintained by CUAHSI under the HMF umbrella and that provision should be made to allow the entire community of individual PIs to lease or share this equipment. When asked if they had equipment they would be willing to share, 72 responded positively, representing a remarkable opportunity for broader use of existing instruments. Many of the respondents identified concern over lending equipment, due to the possibility of damage or misuse of the equipment. Researchers are keen to see equipment properly used, in the hands of properly qualified people, providing the correct interpretation of data. Other issues that were brought up as needing to be addressed were insurance (especially the cost), and routine maintenance and transportation costs. Sixty-six percent of respondents felt that the HMF structure should provide the logistical support for shared instruments of collaborative purchases. When asked what type of equip-

ment people would most like to have access to, some of the most common responses were, atmospheric profilers (RASS, LIDAR, SODAR), geophysical equipment (both ground-based and airborne), auto samplers, weather radar, and atmospheric flux towers. Interestingly, while limited support was found for standard equipment, numerous respondents identified standard equipment as what they would like to have access to, including, automated soil moisture sensors, weather stations, pygmy/flow meters, pressure transducers, data loggers, temperature probes, and rain gages. This corroborates the 2002 survey results where similar requests were prominent. The recent agreement with the Hydrologic Instrument Facility (HIF) of USGS should meet these needs.

The comments at the end of the survey give a unique insight into the thoughts of members of the water sciences community and helps identify areas where more effort is needed to support and strengthen research efforts. Based on these comments and the general survey responses, researchers seek a facility that can support and develop nationwide measurement capability that can be accessed by researchers whilst not competing with individual PIs. It is clear that in a diverse interdisciplinary subject like hydrology there is a need for advice and a common resource to help in choosing the right equipment. The development of a hydrology handbook will help to meet this need. However, the survey also shows that important consideration must be given to the development of methodologies. The comments of one of the respondents articulate this point, “We need to find a way to make research into measurement methods a recognized and fundable aspect of hydrology.” Funding agencies often seek the glamour of new discoveries and yet some of the most highly cited peer reviewed research papers describe new methods that allow science to progress into new areas using a standardized approach.

Many respondents highlighted the need for a facility that will promote their discipline and act as a place for the interdisciplinary synergy of ideas in hydrology, whilst being able to develop instruments and methodologies. One comment identifies the important role that national synchrotron facilities have had in the environmental sciences: “Again: The DOE Synchrotron facilities and the EMSL facility at PNNL have become the ‘go to’ places (i.e., user facilities) in environmental research and have advanced environmental research immensely over the past 10 years. I believe a well designed HMF would have the potential to become something similar.” Conversely, some of the respondents suggest that the development of such a facility would erode already dwindling resources for hydrological research. HMF must therefore seek to define itself in a way that can truly support and promote the discipline, without competing against those it seeks to serve. Innovative ways of supporting the research effort must be recognized and new ground broken in this search. A similar dilemma is identified with instrumentation: researchers would like to see instrument facilities that conduct research into new instrumentation, but recognize that if instruments are to be developed to the “off-the-shelf” stage, companies need to take on this role. Ways of improving the links between researchers with ideas and companies willing to invest in their development would serve to benefit the community as a whole.

This survey was extremely useful in providing guidance for the CUAHSI HMF. As a community, assuming the survey required 15 minutes to complete, the community invested almost one person-month of effort in providing its opinions. This remarkable grass-roots effort is heartening, and provides a mandate that defines the core of the HMF mission. The HMF must address the following needs:

1. Identifying and purchasing high-cost equipment for community use under the CUAHSI HMF umbrella, with support dedicated to developing the method and producing the correct interpretation of the data.
2. Providing a facility/laboratory for instrument research and development specifically targeted at hydrology.
3. Supporting distributed measurement of hydrologic parameters under the CUAHSI HMF umbrella.
4. Facilitating the development and dissemination of methodologies for hydrologic measurement in watersheds, including ways of better linking measurements and models, and ways of better assessing uncertainty in measurements.

The survey is a means to achieve a higher level of scientific productivity through the appropriate acquisition and application of measurement technology to hydrology. The survey supports and parallels many other HMF activities; the HMF team and CUAHSI would like to extend our deepest thanks for contributing to this survey and helping to direct the future of hydrological sciences in the United States.

# APPENDIX 1. SURVEY QUESTIONS

Twenty-four questions were posed. The first nine gave general background on the participants in the survey. Question 10 was designed to obtain the broad opinion of the community as to the pressing research needs. Questions 11–17 examined the style of center that the community felt was most needed. Questions 19–22 looked at additional aspects of the HMF and the sort of support services it should provide. The last two questions gave the opportunity to name instrumentation that researchers would like to have access to (Question 23), and comment on what they would most like to see from an HMF facility (Question 24).

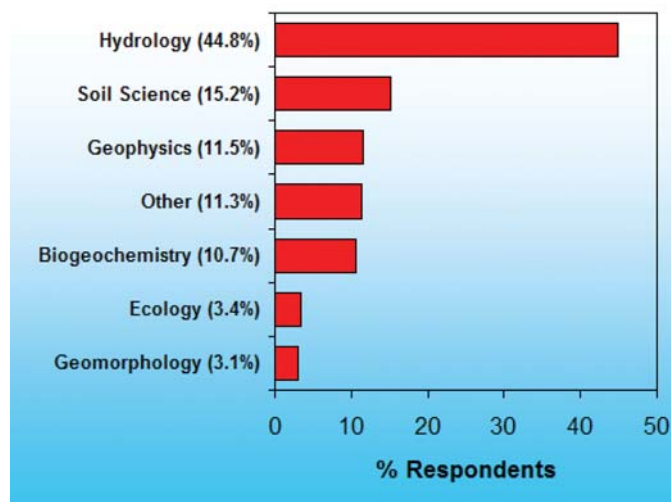
1. What is your primary field of expertise?
2. Where do you work?
3. How many years have you conducted research?
4. What is your main work responsibility?
5. Have you been the principal investigator on an NSF funded project?
6. Have you been the co-principal investigator on an NSF funded project?
7. Have you conducted routine field work either now or in the past?
8. Who is responsible for running your field experiments?
9. Into which categories does the main emphasis of your work fall?
10. In order to make progress in hydrological sciences we need:
11. The aims of the HMF should be to:
12. Please rank your first and second choice in order of priority; the following style of center would be most helpful to me in my work:
13. The Hydrological Measurement Facility should provide the following online:
14. Should the Hydrological Measurement Facility have scientific staff that could assist with trouble shooting in interdisciplinary projects, and/or help with a strategic plan for experimental design within a watershed?
15. Should the Hydrological Measurement Facility have a staff to design instrumentation or develop methodologies specifically for hydrological application?
16. Should the Hydrological Measurement Facility prioritize providing access to, or rental of, standard equipment (cost per item <\$20,000), or of high tech equipment (cost per item >\$20,000)?
17. Is there a community facility that you feel serves as a good example of your expectations for Hydrological Measurement Facility, or that contains certain elements you feel are important for a Hydrological Measurement Facility, please explain?
18. The following additional aspect of an HMF would be useful to me in my research:
19. Should the HMF develop a pool of shared equipment that is:
20. Do you have equipment that you would be willing to list as part of a shared equipment pool?
21. Indicate what level of constraint each of these are to you actively participating in a shared equipment pool, and providing equipment for that pool?
22. Should a Hydrological Measurement Facility provide logistical support for collaborative purchase of major equipment? (e.g. transport/shipping capability for equipment)
23. Name instrumentation that you would like to have access to through a shared pool for watershed studies:
24. Briefly describe, in no more than 250 words, what you want most from a Hydrological Measurement Facility:

# APPENDIX 2.

## INDIVIDUAL QUESTION RESPONSES

### Question 1: What is your primary field of expertise?

The survey drew 363 responses in total; numbers lower than this in the totals indicate questions that some respondents declined to answer. As expected the majority of respondents were from hydrology, however, there was strong input from soil science, geophysics and biogeochemistry indicating their interest and important role in the water sciences.



Additional answers for other:

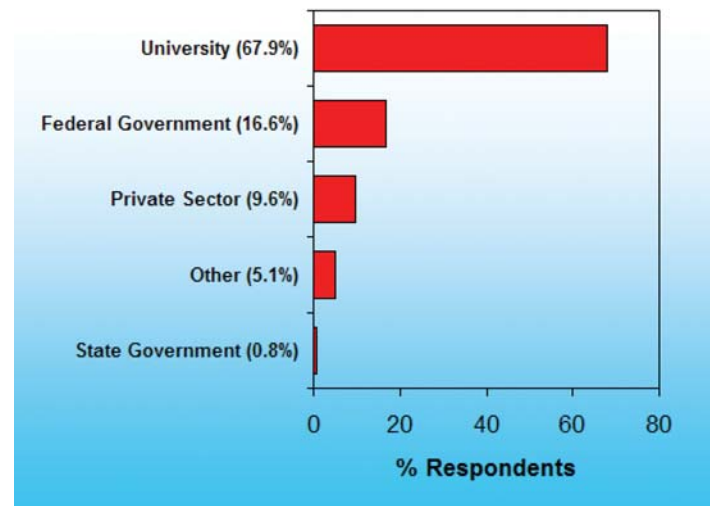
1. Economics
2. Hydrology, Soil Science, Ecology
3. Soil Erosion Processes
4. Land surface modeling
5. Geomicrobiology
6. Paleobiology
7. Biofilm Research
8. Soil Biophysics
9. Hydrogeology
10. Remote sensing
11. Environment
12. Limnology, Catchment Modeling
13. Remote Sensing, Pattern Analysis
14. Hydrology-Human Interactions
15. Engineering Geology
16. Soil and Water Science
17. Micrometeorology, Ecophysiology, Soils
18. Atmospheric Sciences
19. Atmospheric science
20. Isotope hydrology
21. Meteorology
22. Land-Atmosphere Interaction, Atmos. Sci.
23. Environmental Engineering
24. Hydrometeorology, Hydroclimatology
25. Oceanography
26. Hydrogeophysics/Soil Physics
27. Remote Sensing
28. Bedrock Geology and Hydrogeology
29. Hydrogeology
30. Hydrogeology
31. Site Characterization
32. Field & Sequence Stratigraphy/Hydrogeo
33. Hydrogeochemistry
34. Geochemistry
35. Integrated River Basin Management
36. Engineering
37. Environmental engineering
38. Hydrogeology
39. Geomorphology/Geochemistry/Geography
40. Hydrogeophysics
41. Hydrogeology
42. Soil Physics/Hydrology
43. Oceanography



## Question 2: Where do you work?

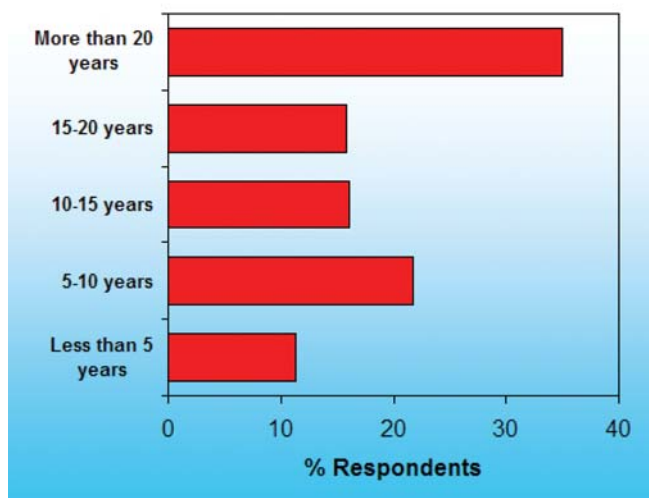
The survey drew wide support from across the water science community in terms of the response, attracting federal government employees as well as nearly 10% from the private sector.

1. University, federal government
2. Courtesy faculty
3. Graduate student
4. DOE National Laboratory
5. Federal retiree
6. National lab
7. University and NGO part time
8. Smithsonian Institution
9. Tribal government
10. County government
11. Community College
12. Regional government
13. Starting a business
14. University and private sector
15. Research institution
16. Consulting
17. Retired
18. Non-profit research institution



### Question 3: How many years have you conducted research?

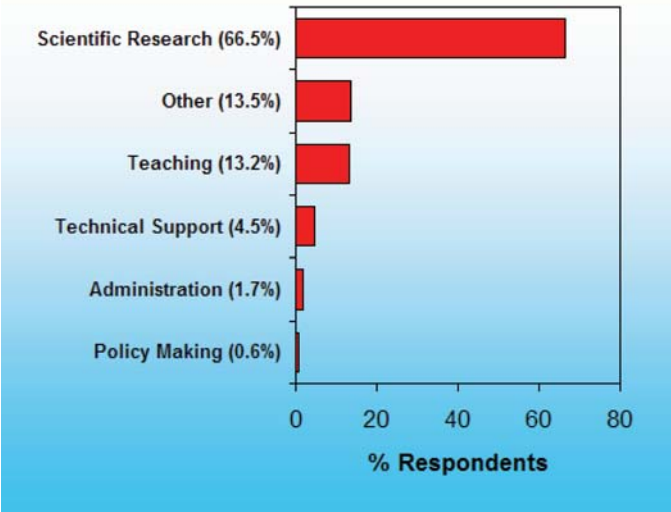
This question was aimed at determining how long the respondents had been engaged in research activities. Responses indicated that about one-third were in senior positions with more than 20 years experience, about the same number were in mid-career positions with 10–20 yrs experience, and the final third were in junior positions with less than 10 years experience. This indicates a good balance among respondents from different age groups. Individuals listed in the “other” category self-described their involvement as:



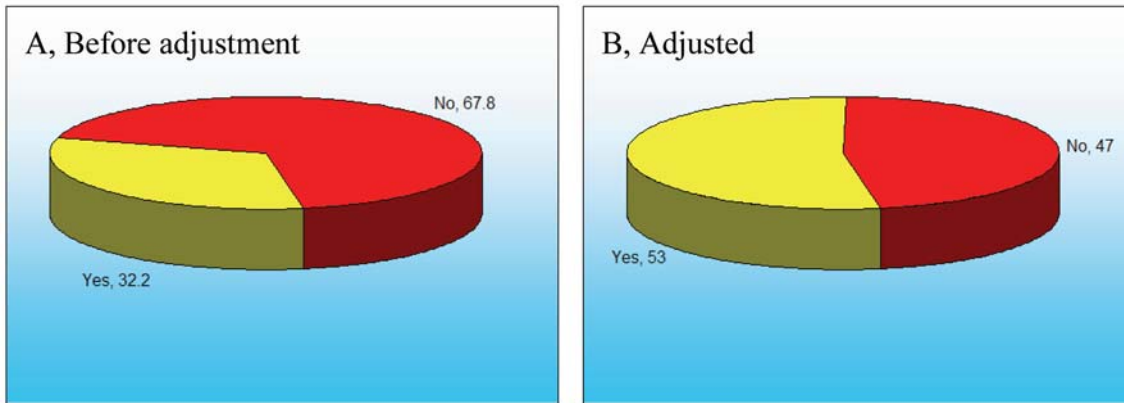
- |   |   |                                       |
|---|---|---------------------------------------|
| 1. Mix of tech support and research           | 21. Half research/half administration     | 35. Faculty=teaching+research+service |
| 2. Teaching and research are inseparable      | 22. Teaching and research                 | 36. Commercial                        |
| 3. Teaching and scientific research           | 23. Software development                  | 37. Consulting                        |
| 4. research and teaching                      | 24. Research and teaching                 | 38. Both teaching and research        |
| 5. ...and research                            | 25. Scientific research and teaching      | 39. Exploration                       |
| 6. Measurement method development             | 26. Teaching & scientific research        | 40. Applied multiple methods          |
| 7. Both teaching and research                 | 27. Ground water contamination consulting | 41. Consultant                        |
| 8. Grad student research                      | 28. 50% teaching and 50 % research        | 42. Teaching, consulting              |
| 9. Consulting services and project management | 29. 50/50 research/teaching               | 43. Business owner                    |
| 10. Even mix of teaching and research         | 30. Environmental consulting              | 44. Scientific research and teaching  |
| 11. Soil survey                               | 31. Site characterization and reporting   | 45. Teaching and Research 50/50       |
| 12. Research and teaching                     | 32. Instrument sales, training, support   | 46. Teaching AND Research             |
| 13. 50-50 teaching and research               | 33. Teaching and research equally         | 47. Retired                           |
| 14. Student                                   | 34. Geophysical contractor                | 48. Technical/Scientific Consulting   |
| 15. Science policy technical assessment       |   |                                       |
| 16. Adjunct Research Professor                |   |                                       |
| 17. 1/2 teaching, 1/2 research                |   |                                       |
| 18. Consulting                                |   |                                       |
| 19. Applied engineering and research          |   |                                       |
| 20. 50% teaching + 50% research               |   |                                       |

Question 4: What is your main work responsibility?

The majority of respondents were predominantly involved with research.

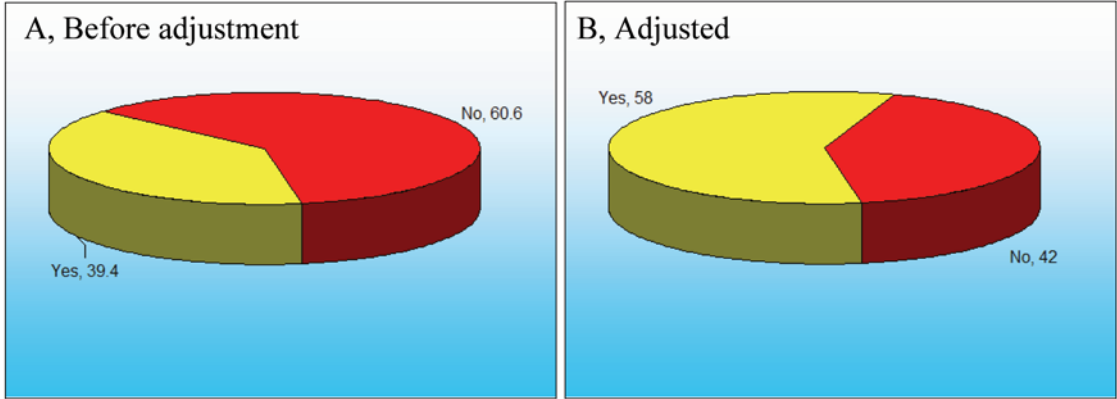


Question 5: Have you been the principal investigator on an NSF-funded project?



Responses to this question indicate that fewer than one-third of those taking part in the survey had been PIs on NSF grants. When the figures have been adjusted to remove those ineligible to receive grant money from NSF, just over half the eligible respondents had acted as PI on NSF-funded grants.

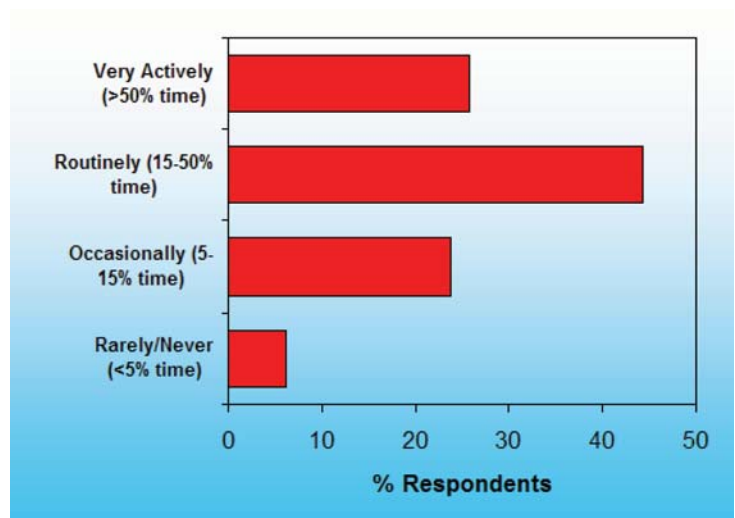
Question 6: Have you been the co-principal investigator on an NSF-funded project?



Responses to this question indicate that slightly more respondents had served as Co-PIs than as PIs on NSF grants. When the figures have been adjusted to remove those ineligible to receive grant money from NSF, nearly 60% of the eligible respondents had acted as Co-PI on an NSF-funded grant at some time in their career.

### Question 7: Have you conducted routine field work either now or in the past?

The answers to this question demonstrate that those responding to this survey are or have been actively engaged in research with fieldwork.



Question 8: Who is responsible for running your field experiments?

	% of total
Technicians – Specific knowledge in my area of work.....	33.1%
Technicians – Limited knowledge in my area of work .....	19.3%
Full-time Scientists .....	30.6%
Postdoctoral Scientists.....	23.7%
Graduate Students.....	62.5%
Undergraduates .....	31.1%
Just me.....	38.3%
Data come from databases.....	18.2%

### Question 9: Into which categories does the main emphasis of your work fall?

	% of total
Theoretical .....	50.2%
Mechanistic modeling (process-based).....	74.6%
Statistical modeling (data-based) .....	55.3%
Applied modeling (technique interpretation).....	71.3%
Geographic Information Systems.....	42.1%
Laboratory experimentalist.....	53.4%
Field experimentalist .....	86.3%

These results indicate that the survey respondents were strongly balance between those actively involved in modeling and those involved with fieldwork and experimental data collection. Strong responses to all the fields indicates that the survey attracted scientists from across the breadth of hydrology.



## Question 10. In order to make progress in hydrological sciences we need:

NOTE: Maximum possible score is 100%, minimum possible score is -100%. A positive score can be interpreted as the percent in favor and a negative score as the percent against.

	% of total
To improve integration between measurement and modeling approaches .....	80.6%
To collect measurements and/or samples with improved spatial resolution.....	79.7%
The ability to make more/better hydrological measurements.....	77.3%
To improve our ability to measure and characterize the subsurface .....	76.4%
To improve methods for assessing measurement uncertainties.....	67.4%
To collect measurements and /or samples with improved temporal resolution.....	67.0%
To develop cross-scale, multiple process observation platforms.....	64.6%
To develop improved hydrological models .....	56.4%
To improve methods for calibration and validation of sensors.....	54.0%
Development of new tracer methods and measurement techniques .....	53.4%
Development of more high-tech equipment .....	49.5%
To improve our ability to measure inputs (rainfall/snow) .....	48.0%
Affordable access to high-tech equipment through rental.....	47.7%
More technical support for operating of high-tech equipment .....	47.2%
Development of new chemical measurement techniques .....	44.7%
To improve our ability to measure outputs (gauge river and stream flows).....	43.5%
Development of new biological measurement techniques .....	42.6%
To make existing hydrological models more widely available .....	36.6%
Development of standard methods and practices .....	33.4%
To make existing hydrological models easier to use.....	32.4%
Affordable access to standard equipment through rental.....	29.2%
More technical support for operating of standard equipment .....	23.1%
Improved access to supercomputer time .....	-7.4%

These questions were aimed at identifying and prioritizing areas of interest to HMF. Those answers drawing the highest response indicate the importance of linking models and measurement methods and collecting relevant data with a strong spatial component. The need for subsurface measurements comes as a high priority and indicates that the geophysics component of HMF will be important. The respondents to this survey didn't feel that access to standard equipment was a problem, nor to supercomputer time. Many modelers responded to the survey, indicating that access to computing facilities must be reasonable.

## Comments Received:

1. I “strongly” agree with everything. Some things above, I did not know what they were - like biological measurement techniques.
2. The above ignores economic activities and is therefore quite biased
3. To make it understandable to decision makers and politicians without technical backgrounds - strongly agree
4. Need an N/A column for your checklists....
5. Sensor web technology is a critical new area that must be strongly supported
6. I see our main difficulties as (1) measurement uncertainties, and (2) poor integration of measurements and theory/modeling
7. Here in the west, there is a severe lack of shallow (soil interface) hydrological measurements.
8. We need to get away from the politically-driven “global warming” hysteria and return to honest, objective science.
9. Low vote on the last issue because I don’t know what it really means.
10. Much more emphasis should be put on integrating heterogeneous data and on using modern statistical methods (Support Vector Machines, ...) to analyze comprehensive data sets and to identify first-order controls as a step towards a theoretical basis
11. How can we encourage groundwater practitioners to use even basic concepts from the well-established academic field of stochastic hydrogeology?
12. Improve dating of geomorphic surfaces
13. Rental of standard hydro-met equipment seems like an oxymoron. We need to have the equipment deployed for many, many years. We need to own it; help keeping it going would seem to be appropriate, unless you mean decadal rentals for many things.
14. Need to integrate with existing data-collection efforts
15. We need to make better use (and share) of what we have across the scientific community
16. We need more interdisciplinary teams that include micrometeorology (surface-atmosphere interaction/feedbacks), hydrology, and ecophysiology (plant use of water)
17. People are likely the biggest limitation. Some are doing cutting edge work; too many are mal-applying models and measurement techniques in “more of the same”; great enthusiasm for new tech, but not for new thinking!
18. Howdy, Rick Hooper has a long email on this topic from me. You are missing the atmospheric forcing so far. You don’t even have “meteorology” as a Primary Field and you will need them to help make sense of your research.
19. Source tracking of contaminants in water resources whether modeling or in field or integration of both, AND better methods for integrating biological criteria with chemical and physical standards
20. Many times I was neutral, but this was not a choice. All I could do was agree or disagree.
21. Hard to disagree with any of it...
22. Many of the questions I answered “agree” because I have no expertise in that area. A response of “no opinion” should have been included.

## Question 11: The aims of the HMF should be to:

	% of total
Conduct research into cutting edge hydrological measurement devices .....	62.7%
Develop new methodologies.....	59.1%
Develop new instrumentation for hydrology.....	57.6%
Provide comparative assessments and ratings of sensor systems .....	56.0%
Provide a comprehensive handbook of measurement techniques .....	51.7%
Integrate measurement techniques with modeling approaches.....	50.8%
Provide high-tech equipment rental.....	46.1%
Provide technical assistance online .....	43.0%
Provide high-tech equipment servicing.....	35.8%
Provide technical assistance in the field.....	23.6%
Provide standard equipment rental.....	14.0%
Provide standard equipment servicing.....	10.5%
Provide a team of technical people that can be hired to set up watershed monitoring.....	3.9%

Response to this question suggests that the community feels there is not enough research and development of instrumentation targeted at hydrological research. Surprisingly, respondents also indicate the need for the development of methodologies to be used in hydrology. As hydrology is a highly interdisciplinary subject, there doesn't appear to have developed a consistent set of methods for making and analyzing measurements. This outcome suggests some effort should be directed towards the development of a referenceable set of methods that can be updated.

- All seem important. I rated as "strongly agree" those that seem more important.
- I supervise the technical staff for HJ Andrews Experimental Forest and we should talk
- This assumes that an "HMF" is needed.
- Main issues are new/improved measurement techniques, and better integration of data and theory/modeling. A handbook would be nice. I don't think we need a hydrology SWAT team!
- Come up with a minimum set of standards that are desirable for long term, real time monitoring of soil hydrology
- Obtain consistency and limited micro-management from NSF
- Provide NIST-calibrated devices to all parties, all the time
- I don't agree that the HMF should have as an aim the development of new techniques (i.e., as an independent research body), but it should facilitate development of methodologies and devices
- no selection = no opinion
- large scale analysis makes it imperative to have well-intercalibrated systems operating with comparable expertise in maintenance and calibration (e.g. what we are trying to do with AmeriFlux)
- New methodologies should include new measurements and higher precision, BUT SHOULD NOT BE LIMITED TO THAT; even more than those advances, we need more economical, lower impact, more rugged ways of measuring and logging...oops, see final comment slot
- The facility should be oriented toward service rather than research.
- Provide hardware for installation with expectation that host institute would provide installation/maintenance/data downloading, similar to some of the seismic networks.
- Based on how NCAR staff/facilities are skewing field programs, I'm concerned about the direction of the HMF
- Why don't you operate like the NSF LAOF Deployment Fund. What's this rental stuff? Don't you want long-term (years not weeks) installations? Will they work under a rental agreement? Stay away from the word 'monitoring' use 'long-term observations'.
- Offer short-courses and workshops on instrumental techniques with training as special sessions
- A high priority would be training of high-tech equipment.
- The EPA is responsible for the CWA and watershed monitoring, we need to be sure are not reducing the clout of the EPA and CWA

19. I think it would be helpful to have a team of technical people to provide oversight and input in watershed monitoring projects...so people don't have to re-invent the wheel in every case throughout the country.
20. What about coordination with USGS' Hydrologic Instrumentation Facility? Or Bureau of Reclamation's Hydraulics Laboratories?
21. I don't feel I can comment on these items
22. Some of this is already done by the USGS hydrologic instrumentation facility
23. Comparative assessments are only effective if they relate to specific problems or applications (i.e. the local surface and below surface environment is very influential)

Question 12: Please rank your first and second choice in order of priority; the following style of center would be most helpful to me in my work:

	Rank	%
A single center incorporating all elements of the measurement facility	1	24
A combined research and development, and rental facility	2	23
A virtual center, run by a number of institutions	3	16
Three centers dealing with surface measurements, geophysical measurements, and biogeochemistry	4	15
A research and development facility	5	12
A center that focuses on measurement support only	6	6
A rental facility	7	3

The overwhelming response to this question combining the first two answers suggests the community would like to see a single facility with a strong research and development capability. This at first sight appears a little contradictory to responses later on that suggest that the community doesn't want a facility that will compete with individual PI's facilities. However, respondents appear to suggest that research and development of instrumentation do not compete greatly with individual PIs and is a complementary activity that would support individual PI science.

### Question 13. The Hydrological Measurement Facility should provide the following online:

	% of total
An up-to-date web page of activities and staff .....	71.0
A list of equipment suppliers with contact details .....	60.9
A match-making service for those with measurement needs and those with expertise .....	57.7
A list of pool equipment available from academic institutions .....	56.8
A list of measurement practitioners/consultants.....	51.9
A list of academic experts .....	50.9
A web-based marketplace for equipment rental .....	39.8
A web-based marketplace for auction of used equipment .....	27.4
A web-based marketplace for equipment sales .....	26.1

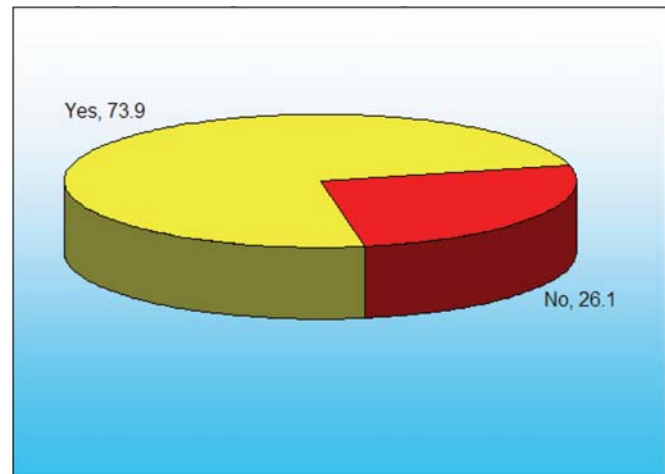
Respondents are clearly keen to see the endeavors of the HMF and have access through the web. This should be achieved through the hiring of a web programmer. There is also strong support the portal providing a single location with instrument suppliers and an equipment and expertise matchmaking service.

1. \*Willing\* academic experts could be listed if they don't mind being contacted for feedback
2. The focus here seems to be on academia only. The bulk of the field expertise and equipment lie within the Federal sector. The HMF should work at providing easy access through cooperative agreements to Federal expertise and equipment.
3. Most of these activities are administrative that do not really seem focused on advancing hydrologic science.
4. Many of these already available
5. This question and list of possible answers leads me to believe that the purpose will be to make money.
6. Add in: resources on equipment comparison, test, and calibration; ditto for models.
7. The match making idea is great
8. Where is the support for fundamental research in this view of the facility?
9. There must be a guarantee that the pool of equipment is NIST-calibrated before use
10. Academic experts should only be included as a means for networking or building collaborative relationships.
11. Question #12: Don't make three centers. The research world is fragmented enough already. That last thing we should do is build a structure that discourages surface, subsurface and biological people from communicating.
12. In this and other questions I used "strongly agree" to indicate priorities. You can't do everything listed, so must make choices.
13. I would like to see a range of "measurement" services, from fee-for-service to collaborative.
14. Please look at the ATM/LAOF Deployment Fund set up. What is wrong with it that you turn scientists into businessmen/women dealing with auctions, etc.
15. Item 13 is irrelevant
16. Of course, this does compete with the private sector.
17. Short courses, instructions. Most equipment sales don't tell you the actual problems with the equipment, you have to learn this the hard way. A web site where users could post actual experiences would help
18. Most of these tasks could be done with minimal effort.
19. Equipment comes and goes, ownership is required for durability sake. Renting is a short term gain and long term loss. Science is a progression and all equipment has a limited time span so planning needs to respond to this. Not sure I like it!
20. The above capabilities are a tragically watered-down version of the original HMF concept!
21. This sounds like a monthly newsletter
22. There is a strong enquiry about commercial "ideas" within the HMF, unless you are intending to employ individuals with this experience the HMF should not make it a priority.

## Question 14: Should the Hydrological Measurement Facility have scientific staff that could assist with trouble shooting in interdisciplinary projects, and/or help with a strategic plan for experimental design within a watershed?

The overwhelming response to this question suggests that the community is keen to have a support facility to help with the design of large-scale experiments. This facility would support individual PIs by providing expertise on scientific problems that are out of the area of expertise of the PI. This problem is a common in hydrology where it is impossible to keep up with advances in all the subdisciplines. Some of the comments indicate there is some concern over having a single reference source; it may encourage bias into the way that things should be done. The development of standard methods always introduces bias but at the same time reduces some poor practice; the right balance has to be found.

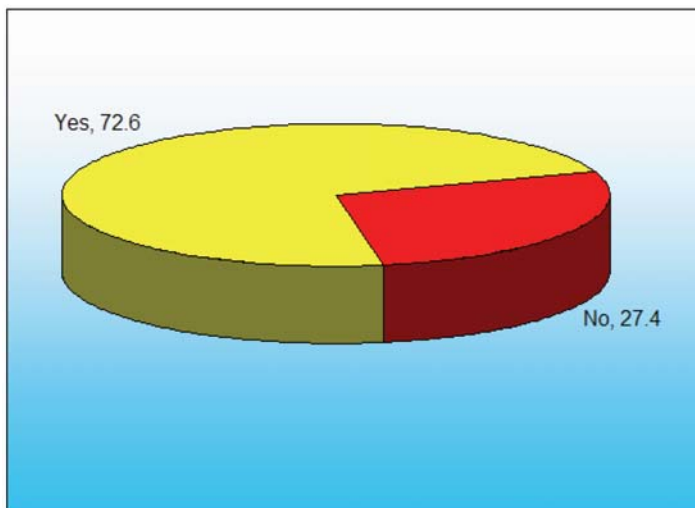
1. Generally this is best served by a network of experts working in the particular field of expertise. Often staff do not get the exposure and time needed to become experts and retain expertise.
2. I do not think that experimental design can be “contracted out” to HMF help. Investigators need to have ownership of their experiment. Trouble shooting may be useful, but you only gave me one choice to answer.
3. It cant be everything to everyone, but some expertise on experimental design would be good
4. Need more information. Would this be a free (NSF funded) service?
5. Yes, though I don't want too many of the resources tied up in scientific SWAT teams.
6. Would help to make observations from various places more comparable
7. Why limit experimental design to watersheds? Sand box/Column expt. are also important
8. The HMF can play a particularly important role in facilitating cross-disciplinary research methodologies.
9. Yes, but keep it limited. Groups that use the HMF should be capable of this already (a bar they must clear) for the most part. They just may need some consultation.
10. If NSF is going to pour money into instrumenting watersheds, this sort of position might be justified.
11. Absolutely. This will give us the greatest boost to improve the quality and comparability across regions
12. Support is needed, but needs to be limited. Could use all support time answering simple questions that should be directed elsewhere.
13. I would rather have been able to “vote” for halfway between yes and no on this one. This is a low priority for me.
14. Too much potential for conflict of interest.
15. Proposed staff function is too vague.
16. Please look at the NSF/UCAR/JOSS model. It appears you are not doing your homework.
17. If funds are available -- but not at the expense of instrument development.
18. I would rather see this decentralized.
19. Having technically trained people who both understand the science enterprise and can “do” things is a must.
20. My experience is that these staff have their own preconceptions about how research should be done and are not flexible in dealing with no problems.
21. The best science is competitively based - keep it that way. Watershed design is great.
22. Yes, if the staff were short-term (<2 yrs) appointments, to promote new methods and greater knowledge across the discipline. Why are people setting up watershed projects without any expertise?
23. Would be nice. What about hydrogeology?
24. Maybe. The point is that every watershed is different, and we need to be pushing the envelope for an integrated approach.
25. These are important aspects of the research process and should be the responsibility of the PIs. They should have a cooperator on their team to cover these needs. The HMF should not replace hydrologists or other physical scientists on lg. projects.
26. Scientists should be able to do this .
27. This gets too expensive and involved. Could not help enough of those with needs, so some ‘haves’ and some ‘have nots’.. Does not seem feasible.
28. Make use of retired people.



## Question 15: Should the Hydrological Measurement Facility have a staff to design instrumentation or develop methodologies specifically for hydrological application?

Again, overwhelming support for this question shows that the community is keen to have a facility that develops instrumentation and they don't view this as a threat to PI science.

1. The facility should focus on new kinds of measurements that will allow us to observe what has not been observed before.
2. Like a consulting firm?
3. Not staff - do this via competitive grants. There are good instrumentation people out there already: they should be encouraged to make their work more available.
4. The real need is to get people, not just researchers, tuned to the idea of instrumenting as many sites as possible for better statistical distribution
5. Methods: yes; instruments: no--> Market drives instrument development
6. To facilitate or assist this process in collaboration with external researchers - yes; to conduct research as an independently body - no
7. Don't leave the vendors out of this; they can do a lot of good work.
8. This item is more important than item 14
9. This should be a consortium with industry (e.g. Intel)
10. If there are a good system for determining priorities.
11. My experience is that university folks usually manage more methods development than govt facilities
12. The HMF could potentially put out RFPs, but the R&D should remain distributed throughout the community.
13. Of course.
14. Equipment development should be by PIs, not a center.
15. They would be best served by getting suggestions for instrument improvement and communicating this information to companies like Isco and Campbell
16. If all NSF monies go to this unit at the expense of research elsewhere, then I am opposed.
17. but they could offer support to projects working on new methodologies and instrumentation
18. I'm not sure...
19. Again - competition is best here. HMF staff should be mid-senior level to ensure work is completed, reported and paid that's all.
20. Ideally this would happen with any staff
21. And hydrogeologic problems
22. Maybe.
23. For example, across phases (interactions)
24. But the HMF should support scientists at institutions in accomplishing that kind of work. e.g. technology transfer. hire outside experts -- researchers or companies
25. No again scientists are capable of this.
26. A widely distributed array of scientists with this expertise exists, and is the best way to develop excellent sensors and methods. Need FUNDING in support of this, not a single center with a few folks emphasizing this aspect.
27. Develop tools for the community.

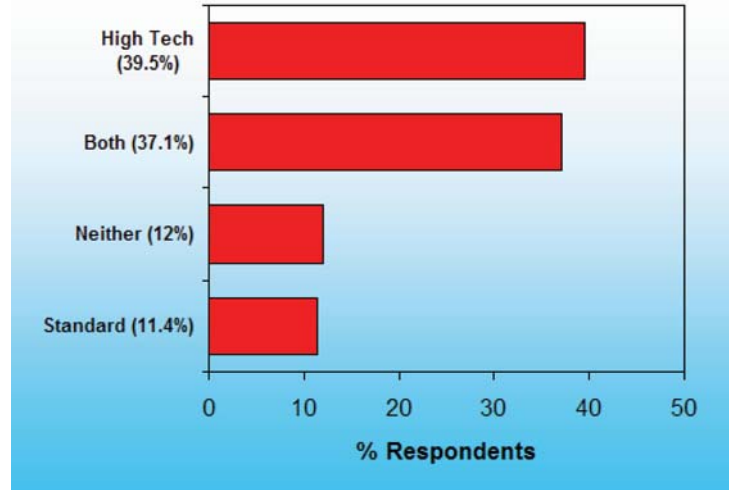




## Question 16: Should the Hydrological Measurement Facility prioritize providing access to, or rental of, standard equipment (cost per item <\$20,000), or of high-tech equipment (cost per item >\$20,000)

This response shows greatest interest in working with high-tech equipment, beyond the reach of individual PIs. However, many respondents are happy for the facility to serve a wide range of standard and high-tech equipment.

1. Obviously, there are potential problems with both, but greater access to such equipment is a step in the right direction
2. 20,000 is too high for split
3. Many existing commercial vendors
4. Access to standard equipment may be easier to obtain from small grants, whereas the high tech equipment may only be widely available if accessed through an HMF
5. I do not think rental is a good idea
6. Standard equipment is very off-the-shelf these days and affordable
7. Good idea, but not the top need - don't put too much time and money into this part.
8. Good idea, but not the top need - don't put too much time and money into this part.
9. It depends on how things would be prioritized
10. There are many low cost systems that are adequate for hydrologic data, IF we could get more sites instrumented
11. Not sure how such a prioritization would/should take place. Would a "priority" person be able to take instrumentation already reserved by a non-priority activity?
12. Ensure NIST-traceable calibration
13. With assistance for using this equipment (which is typically tricky to implement)
14. Standard equipment is the backbone. High-tech equipment is more application specific and should be funded through regular grants.
15. Many of us really want better hydrologic measurements to accompany our other measurements, but cannot afford the instrumentation and don't have a hydrology colleagues who are interested in working with us
16. But this should not be the main goal of the Facility. Better to house an ongoing ebay style matchmaking/auctioning service, rather than wasting money being a rental service.
17. Focus on big ticket items beyond what PIs can provide
18. You should provide instruments to support good peer-reviewed science. That's it. I often need a mix of standard and hi-tech. HydroKansas will be a good model for you folks.
19. But the majority of work with standard equipment.
20. Would need to be extremely careful with high-tech rental, better to have both people and equipment for rent to minimize damage to expensive equipment
21. Would be hard for a facility to evaluate science
22. I think both should be available, but priority on high tech not available elsewhere
23. The cost of leasing standard equipment for projects quickly adds up to the cost of the equipment
24. But support for high-tech instruments must be provided.
25. Penny wise dollar poor - drop the rental concept and the USGS if you want to free up funds first come first serve... big projects, should notify HMF with plenty of lead time.
26. Two areas here. Small schools like ours can't afford hardly any equipment, but the larger groups already have the standard stuff.
27. If any equipment is offered by the HMF, then high-tech might be an option, but I truly do not believe this is an appropriate service to offer.
28. The individual researchers should be obtaining funding for equipment so that they are not limited by what's at the HMF.
29. People, who don't own equipment, rarely take care of it. Having equipment for rent is a waste of resources. It could also encourage the irresponsible use of equipment. I have seen non-professionals borrow equipment from Universities and conduct work
30. Standard equipment is standard and expensive to ship around. Focus on high-tech, or better, on re-sale between researchers. Also, well priced training sessions would be most helpful for established or beginning researchers.
31. better for a range of universities having access to facility and finding use for it
32. Some of the 'standard' items are easily-obtainable, some in that price range is not; both may require shorter-term access that does not justify purchase.



## Question 17: Is there a community facility that you feel serves as a good example of your expectations for Hydrological Measurement Facility, or that contains certain elements you feel are important for a Hydrological Measurement Facility, please explain?

The USGA Hydrologic Instrument Facility (HIF) and the National Center for Atmospheric Research (NCAR) are mentioned the most. The new CRADA with USGS will provide access to the HIF by university staff for the first time once implemented.

1. USGS Hydrologic Instrument Facility is an example of a facility that both 'rents' and tests hydrologic equipment, and is also involved in methods development. While the HIF maintains GW equipment, their primary focus is surface-water. My office (USGS Office of Ground Water, Branch of Geophysics) runs a geophysical equipment pool of surface and borehole equipment. We use this equipment for program development and train users on field use and interpretation, etc.
2. Within the USGS the combination of the Hydrologic Instrumentation Facility and the Office of Surface Water and Office of Water Quality provide this function for streamflow and water quality.
3. Nat Sed Lab Oxford MS
4. I am not aware of one
5. not aware of one
6. Yes, the Atmospheric Technology Division at NCAR - only place I know of.
7. NA
8. No.
9. University of Waterloo - It is a forum for applied research (for example, their work on denitrification of wastewater in septic tanks), software (now marketed by Schlumberger), equipment (good competition for In-Situ which considers its equipment the best on the market), and applied education (through its connection with Schlumberger).
10. Forest Research Stations
11. At the university, the hydrologic community (which are located in different departments) works together to insure everyone has adequate resources and equipment through loans. Unfortunately, there is not a community facility that works in this capacity.
12. Federal and Univ. researchers have shared data loggers on numerous occasions. In a recent study, U of ID added additional data loggers to a Forest Service research project, and all gained.
13. NCAR National Center for Atmospheric Research
14. No. I hope that we can form a facility that has less overhead and is much more focused on bringing together researchers to work together rather than bringing them to work with the "facility scientists". I would like us to fall somewhere between NCAR and IRIS in this regard.
15. No. I hope that we can form a facility that has less overhead and is much more focused on bringing together researchers to work together rather than bringing them to work with the "facility scientists". I would like us to fall somewhere between NCAR and IRIS in this regard.
16. NA
17. no
18. Reynolds Creek Idaho
19. NCAR ATDD
20. No idea what is available in the US
21. Look at the Synchrotron Radiation Facilities and the Environmental and Molecular Sciences Laboratory at Pacific Northwest National Laboratory which are all run by DOE. They provide lots of support (Staff and Instrument/Facilities).
22. I wish!
23. I wish!
24. None
25. Western climate center and NRCS snow survey
26. The BMP pivot irrigation in Oakes ND has been intensively instrumented with lysimeters, multi-level wells, tile drainage, etc. and has had water quality and quantity monitored from the vadose and saturated zones for almost 20 years.
27. No
28. Not that I am aware of
29. IRIS/PASSCAL
30. The Hydrologic Instrumentation Facility of the USGS works well for its somewhat limited scope.
31. The Hydrologic Instrumentation Facility (HIF) of the U.S. Geological Survey.
32. USGS Equipment rental for standard equipment/data loggers
33. Do not know.
34. N/A
35. No comment.
36. I don't have sufficient experience with other facilities similar to really draw a parallel here.
37. Not aware of one - National Environment Research Council in UK has geophysical equipment pool - same concepts as being thought of here.
38. Probably not
39. No
40. I'm not aware of a good example.
41. See AmeriFlux web page <http://public.ornl.gov/ameriflux/> for example of strategic plan, calibration guidelines, recommended core measurements, manufacturers. We have some spare equipment to loan to reduce down-time at sites while their instruments are being repaired, but this is minor compared to what we wish we could have. Hydro

- could do a better job with shared equipment than we are able to do (high-end instruments are hard to get for network-wide sharing).
42. HIF seems well regarded. NSF has had a program that provided free or cheap LIDAR.
  43. USGS water resources offices are good models but too expensive to get help from because of high overhead costs.
  44. Perhaps the HJA Experimental Forest, where there are three hydrology technicians that can help you with setting up measurement equipment and data logger problems. Also basic measurements (streamflow and meteorology) is maintained by these technicians. At Oregon State University sharing of equipment (auto-analyzer, ISCO samplers, fluorometer etc.) between groups and departments happens all the time, only disadvantage is: you can only borrow it when the equipment is not used.
  45. I recently learned about the Weston Observatory at BU and it struck it as an interesting approach that might be applicable in hydrologic sciences. The 'Observatory' provides the hardware to an institution in exchange for upkeep. Seismic monitoring is much simpler than environmental monitoring, but I think the benefit to the institutions is also much greater. <http://www.bc.edu/research/westonobservatory/>
  46. I thought there was an existing geophysics facility that is similar...
  47. NCAR RAL is an example of how an excellent facility with many of the capabilities that the HMF might have but funding pressures to keep equipment in the field is skewing research programs with too much control on direction of field programs by NCAR scientists through review of equipment requests and participating in the field programs as scientific investigators
  48. Almost any certified water quality lab
  49. NCAR's shared field observing facilities provide some nice models.
  50. Hydrologic radar described in Neusse prototype study. HydroKansas and HydroKansas 2007 (Whitewater basin, Kansas) contact Vijay Gupta at Univ. of Colorado for details.
  51. NCAR instrumental facility (at least it used to)
  52. No such facility currently exists.
  53. Not really. Perhaps ATD without the financial implications of having development and support staff. These should be funded independently by NSF in support of projects.
  54. I still go back to the NCAR facility as the model for this sort of thing.
  55. Not that I am aware of.
  56. The USGS Hydrologic Instrumentation Facility is a good example of some of the services that could be provided by an HMF
  57. The USGS Hydrologic Instrumentation Facility and the set-up for sharing equipment at NIWA in New Zealand
  58. No.
  59. None presently that we use.
  60. Yes, I like the NEON set-up and feel HMF should be part of that so we truly get the big picture. This funding competition within NSF is not good for science in general but dismantling the USGS and transparent competition will move us through to transforming our understanding of N. America
  61. No NCAR is too self contained and does not involve collaboration with university scientists enough. HNF should have a strong collaborative mission .
  62. The web-based information- and knowledge transfer of SAHRA (NSF funded), e.g. [www.sahra.arizona.edu/software](http://www.sahra.arizona.edu/software).
  63. NO
  64. Unknown
  65. USGS Hydrologic Instrumentation Facility, Stennis Space Center, Mississippi
  66. Some of the facilities of the Florida Department of Environmental Protection and Florida's Water Management Districts would come as close to this.
  67. USGS Their facilities are nationwide—every state.
  68. No
  69. No
  70. The Borden experiment, both the first solely hydrogeological one and the subsequent geophysical one.
  71. Seismic equipment release could be coordinated through IRIS
  72. KANSAS GEOLOGICAL SURVEY HYDROLOGY SECTION AND GEOPHYSICAL SECTION
  73. No. Not to my knowledge. Most such attempts become self-serving by the organization operating the facility.
  74. Boise State's Borehole facility Probably, but not familiar to me.
  75. The USGS hydrologic instrumentation facility in Bay St Louis, MS is a start
  76. The UK system is very good. Operated by NERC. Look to the Southampton Oceanographic Equipment pool, as well as the other equipment pools they run. Excellent, with decent access with a suitable but no onerous amount of paperwork.
  77. equipment rental companies such as Fett
  78. Don't know one.
  79. NCAR ATD
  80. Rental- The Seismic Network Intellectual - NCEAS
  81. A testing facility that allows researchers to bring their own ideas and equipment works for me. You provide management of a control site. Sounds like some want this to be a national training center, which strikes me as inefficient. Let the universities teach. Government can help facilitate independent research, but shouldn't get bogged down managing and/or training on specific methods and equipment.
  82. UNAVCO
  83. I am not aware of such a facility in hydrology. In seismology IRIS has a Data Management Center (both physical and virtual) and a facility center (Passcal equipment center) for servicing of high-tech instruments
  84. None that I know of.
  85. The USGS Hydrological Instrumentation Facility (HIF) co-located at the NASA Stennis Space Center, Mississippi, contains potentially desirable elements for a NSF-supported HMF. HIF receives regular input on needs from a national board composed of experienced hydrologic technicians. HIF supports USGS hydrologic data-collection activities through identification of needs, development of technical specifications, design and development of specialized equipment, management of contracts and procurements, testing and evaluation of off-the-shelf and custom-built field equipment. HIF provides repair, calibration, QA-QC, storage, and distribution services for a broad range of hydrologic instruments.

86. My expectations is that this facility will fall into the common category of turf battles and will land at a Berkeley or similar. This will likely lead to only tier 1 institutions considering the use of the facility. If the facility is used to move the science forward, the more it is used by scientists in the range of institutions, the better it will be to provide interaction with the public and thus serve the purpose it may be designed for.
87. The USGS HIF
88. IRIS
89. We might be able to learn from the oceanographic community but am not aware of an existing facility like a proposed HMF.
90. Similar to the IRIS Pascal facility in Socorro, New Mexico
91. You're doing a fine job David!
92. The USGS rental facility; except that I believe one needs to be working on a project with USGS to use the equipment there.
93. Not that I am aware of. I strongly believe that the best expertise is scattered out across many institutions. This initiative should work as the peer review scientific approach does: involve as many folks as possible; do not concentrate into a small handful of so-called 'experts'. The 'good old boy/girl network' will always tend to restrict obtaining the best products.
94. NCAR offers several examples, through their distributed centers.
95. USGS has something like that in-house
96. NO
97. I am not aware of any, possibility because my work is mostly laboratory scale.
98. Not to my knowledge No
99. Not Really
100. The Alabama Agricultural Experiment Station at Auburn University used to have a Research Instrumentation facility that built equipment, often in cooperation with the private sector, tailored towards specific needs. Although this facility still exists, it was essentially killed when the director required you started to pay as soon as you walked into the door. This eliminated the development of new ideas which often evolved through brain storming sessions.

## Question 18: The following additional aspect of an HMF would be useful to me in my research:

Provide measurement technique workshops .....	62.5%
Provide one-day training courses before or after national meetings .....	47.9%
Provide sabbatical/postdoc opportunities to focus on developing new methodologies .....	47.1%
Provide sabbatical/postdoc opportunities to focus on developing new equipment .....	34.5%

Of the additional activities suggested the development of workshops draws the most interest.

- |  |  |
|--|--|
| 1. These things more than anything else so far   | 11. Good professional ideas  |
| 2. Include "visiting scientist" along with post-doc and sabbatical.  | 12. YES!!!! Training is most important. There is presently no where that a researcher can learn how to dye trace, or conduct borehole geophysics, etc. Once in a research position, many of us are stuck learning by trial and error, which is wasteful. |
| 3. It is not the role of government to develop equipment   | 13. Done by the company that makes the equipment   |
| 4. We are doing this training and it is improving the tech skills at each site for high-end tech operation and maintenance, as well as analysis. It is crucial to expanding skills in the community. | 14. Web-based information would also help since workshops don't always coincide with temporal needs  |
| 5. I like these ideas  | 15. Also need funding through research programs to support sensors and methods (sabbaticals are a good idea, but too limited in scope).  |
| 6. These are better goals than the primary ones listed above   | 16. Provide basics for spatial and temporal analysis of variability  |
| 7. All very good ideas.  |  |
| 8. What is the difference between 2 and 3?   |  |
| 9. Competition at the needed funding level will solve the training part.   |  |
| 10. I don't feel I can comment on these items  |  |

## Question 19: Should the HMF develop a pool of shared equipment that is:

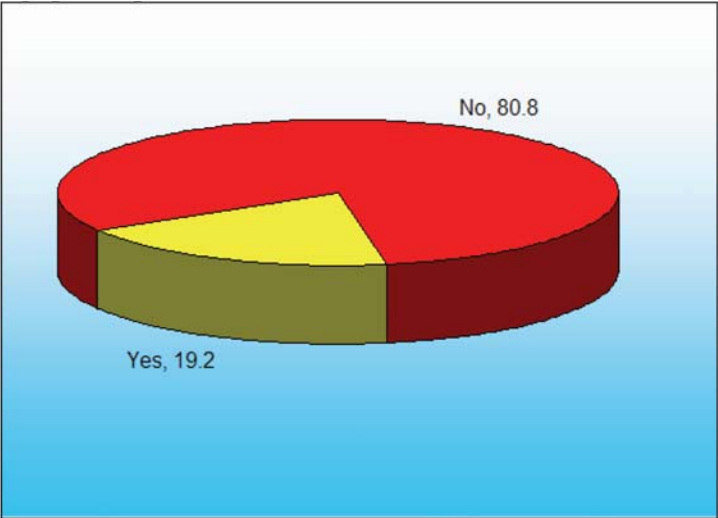
Should develop a shared pool .....	85.6%
Owned and maintained by the HMF .....	74.7%
Allows individual PIs to lease out unused equipment to other projects.....	72.8%
Owned and maintained by individual institutions.....	12.6%

Respondents would appear keen to see some sort of shared pool of equipment, however, they would like the equipment to be owned and maintained by CUAHSI. The Instrumentation Marketplace should allow PIs to rent out or sell equipment to other researchers and so meet this need.

1. Some mix thereof
2. Again, don't eliminate the federal sector.
3. Requires a good insurance plan for the equipment
4. This is a pandora's box of an issue!
5. But how to avoid the tragedy of the commons?
6. We can already rent most equipment.
7. This would be a real headache to manage and cost
8. Owned by institution, maintained by HMF
9. You can't trust most institutions to provide calibrated equipment for use: HMF should fill this role, if any
10. This feels like voting on a CA Initiative at the polls: Not sure I have enough facts to judge this one.
11. HMF could maintain a pool of standard equipment. HMF should not pay for specialized high-tech equipment.
12. Pooling is a good idea
13. Major concern is any modifications made to equipment by prior users - how long will it take to "get the instrument to work as we want it to work"
14. I feel that the shared pool should not consume the Facility's efforts or time, but the existence of one would be helpful...I just don't think that it should be THE achievement of the Facility.
15. I think a shared pool for expensive high tech equipment (e.g. a portable mass spec or spectrofluorometer would be good
16. "Owned and maintained by individual institution' provided that it is in active use by the institution and providing real-time data to the community
17. NOT a good idea
18. More like it. On item 3, I considered specialized PI equipment (like a Raman lidar) that could be used episodically.
19. We never have excess equipment setting around. Maybe rent out high-tech stuff.
20. This training and renting by HMF is short sighted and will only hamper the process through time
21. Removes sense of responsibility in many cases
22. The HMF will need to access equipment for its own purposes. The contacts gained and equipment accessed (hire/purchase) should be utilized, by itself (as a priority) or outside individuals. But supplying to outside should be a matter of excess capacity
23. There is a huge amount of equipment that just sits in storage around the country. Lets get this circulating!
24. 50% disagreement because who will maintain the equipment?
25. need to work out carrots to having people put equipment into pool (have some ideas on this)

**Question 20: Do you have equipment that you would be willing to list as part of a shared equipment pool?**

Though many people are keen to see a shared pool of equipment, only about 20% have equipment that they would put into a pool. This result either indicates a reluctance to place equipment in such a pool or that there isn't much surplus equipment out there.



## Question 21: Indicate what level of constraint each of these are to you actively participating in a shared equipment pool, and providing equipment for that pool?

Concern over damage/misuse .....	77.2%
Inaccessible to me while on loan .....	56.1%
Insurance .....	52.2%
Cost of transportation .....	46.7%
Other.....	37.4%

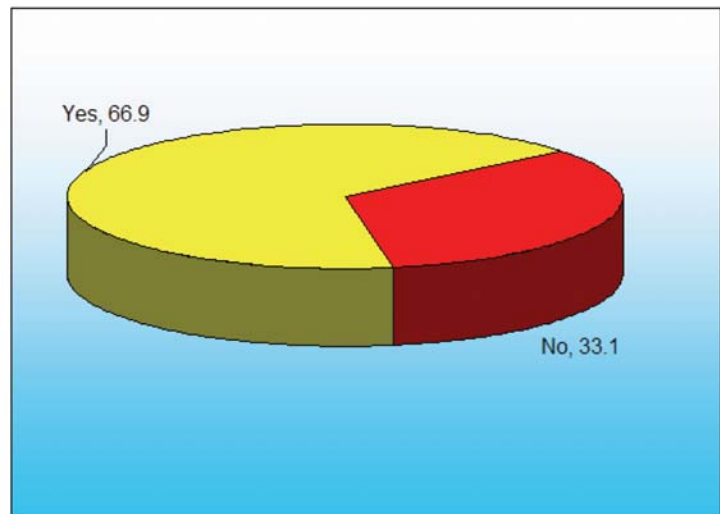
Response to this question perhaps indicates that people are reluctant to share equipment without some guarantee of it returning in good condition.

1. Routine maintenance - assuming insurance covers a catastrophic loss, who deals with paying for a routine repair (and shipping to/from vendor)?
2. Cooperative agreements must be in place.
3. Extremely odd question; am surprised such a poorly phrased? could
4. This is a headache no one wants/ let's have an HTD like ATD at NCAR - EXCEPT for a few top items like radar than can be easily shared.
5. Shorten life of equipment
6. Univ or fed labs don't have insurance for equipment!
7. See response to 20
8. Developing a community ethic of taking responsibility - it takes time for something like this to work.
9. Government constraints on sharing
10. Would need to have standard contracts and be able to specify a length of time that an item was on loan
11. Have no equipment
12. Not Applicable
13. Wear and tear should also be addressed as increased use of equipment will require more frequent replacement. (this will also allow updated equipment to always be kept in the pool)
14. I don't insure as it's too expensive. I'm happy to loan/rent gear provided the client agrees to return it in the same or better condition.
15. Must use company rental center
16. No Equipment to share
17. I assume borrower will pay transportation
18. I checked these anyway because of issues I have had with loaning AmeriFlux high-end sensors
19. I assume the renter would pay for access to equipment and would certainly pay transportation cost.
20. Just all around a bad idea
21. Technical capabilities /support for those borrowing
22. The HMF should accept total responsibility for instruments 'loaned' to it. Should not impact the owner. This is only for specialized equipment, not standard stuff.
23. N/A
24. My greatest concern is researchers who do not return equipment
25. Demand exceeds supply



Question 22: Should a Hydrological Measurement Facility provide logistical support for collaborative purchase of major equipment? (e.g., transport/shipping capability for equipment)

Overwhelming support for the HMF providing logistical support for moving equipment around the United States.



## Question 23: Name instrumentation that you would like to have access to through a shared pool for watershed studies:

A simple grouping of the instrumentation that people suggest that they'd like to have access to includes:

Interpretation of responses by sub discipline:

	Count
Precipitation	12
Rain radar	6
Snow sensors	6
Evapotranspiration	34
Portable eddy flux towers	9
Light Detection And Ranging (LiDAR)	25
Portable weather stations	11
Soils	13
Soil moisture sensors	11
Geophysical equipment	29
Ground Penetrating Radar (GPR)	14
ElectroMagnetic Induction (EMI)	10
Stream flow measurement	18
Doppler velocity systems	18
Water quality	30
Isotope measurement systems	14
Autosamplers	9

LiDAR and the Doppler velocimeters, which will be available through the HIF and GPR, attract the most interest.

1. Large-channel seismic and resistivity/IP systems and ancillary equipment Deep sounding EM equipment (e.g. AMT) Telemetry solutions / equipment
2. LIDAR, airborne and ground based. Mobile radar. Mobile geophysical soil moisture and soil depth capability. Mobile gravity survey capability if precise enough to quantify variations in water storage.
3. Geophysical instruments (geoelectric) isotope analysis instruments
4. Lidar (raman), radar, sodar, rass, wireless systems, eddy correlation, weather stations, geophysical sensors, etc.
5. Portable climate stations with data loggers. Sensor arrays (e.g. radiometers, precipitation gauges, soil moisture sensors, snow depth sensors) ideally with wireless communication. Subsurface characterization equipment (e.g. EM probes)
6. Spectrofluorometer, pygmy meters, downhole transducers, water quality meters (pH, DO, TDS), dataloggers, ISCO-type samplers, well sounders
7. Laser mass spectrometer helicopter
8. Field sensors
9. Bureau of Land Management
10. Autosamplers data loggers pressure transducers
11. ISCO autosamplers and flow meters, HOBO data loggers, access to remotely sensed data and /or a way to collaborate to plan and obtain specialized data from remote sensing platforms by sharing costs.
12. LIDAR technology / data sets
13. Sensor web + new instrumentation for monitoring snow water equivalent and temperature

14. Could possibly be anything, depending on the project.
15. Short-term eddy covariance flux field measurements, water vapor lidar (ground or airborne), radar (dual-doppler, polarimetric, etc.), micronet/mote telemetry products/sensor arrays
16. Geophysical equipment, on line field data systems (satellite connected web based), new optical measurement systems
17. Soil psychrometers with datalogger ISCO automated samplers for a variety of sampling types (i.e. precip, discharge, lysimeters) Dataloggers Rain gauges Tensiometers
18. Samplers such as Isco samplers
19. Solution gas analyzers, micro hydraulic measurement of soil aggregates
20. Lidar
21. Soil moisture TDR for piezometer readings
22. Event sampler, flow meter, Mt. rose snow tube, dataloggers
23. Snow measurement gear
24. LIDAR, various geophysics equipment, large-scale tracer test equipment
25. Pressure transducer dataloggers flow meters in situ nutrient monitors water quality sondes telemetry systems
26. LiDAR support for smaller items - e.g., best way to cheaply and easily gage a watershed - what sensors to use, etc.
27. My work is inherently inter-watershed. large numbers of very simple instruments would supplement my own hi-tech equipment
28. ISCO samplers Campbell data loggers rain gauges lysimeters tensiometers
29. Ground based lidar
30. Acoustical measurement equipment. Non-contact measuring devices.
31. Why is the focus on watershed studies only? This doesn't make any sense.
32. Multi-level well sampling instrumentation. Infrequently used, but critical, tools (e.g., borehole loggers). Advanced survey equipment (e.g., laser theodolite, differential GPS). Ready to go (simple to use) meteorological stations. Ruggedized field computers (??) EQUIPMENT THAT IS CALIBRATED (or can be easily calibrated in the field)!
33. Lidar drill rig airborne hyperspectral scanners isotope analyses geophysical measurements radar
34. Geophysics: GPR, Seismic, borehole geophysics. Drill rigs, including Geoprobe. Weather station. Advanced (as yet undeveloped?) methods of measuring rainfall throughout a watershed at high spatial resolution (but not necessarily high local accuracy).
35. Any high-tech equipment.
36. Portable weather stations
37. Ground-based LIDAR High precision GPS
38. GPR LIDAR
39. Portable radar
40. Satellite data, airborne geophysics, helicopter support for getting to remote areas (e.g. peatlands)
41. None
42. Ground-Penetrating Radar, Electro-Magnetic System, LiDAR, FLIR
43. GPR with various antenna options.
44. A dye-dilution seepage meter
45. Perhaps LIDAR, but most interested in this on the international stage. Beyond that, subsurface geophysics equipment.
46. Hi-tech stuff, such as LIDAR, balloon-sondes.
47. USGS
48. Autosamplers, dataloggers
49. Snowfall gauges, automated capacitance probes for soil moisture profiles LIDAR; GPR
50. Isotope mass spec for water, in-situ device if possible
51. Isotope sensors, flow profilers, continuous chemical analysis.
52. 3d Acoustic Doppler Velocimeter (surface water velocity) Acoustic Doppler Profiler (surface water velocity) survey-grade GPS equipment Instantaneous Profile Laser Scanner (for use in laboratory flume or field settings) LIDAR
53. Data loggers water quality automatic samplers recording transducers in situ water chemistry loggers
54. Portable mass spec -spectrofluorometer -different chemical probes (Cl etc) -tensiometers -dataloggers
55. Differential GPS to obtain accurate elevations of wells and ground surface anywhere in the world. Drill rig and cone penetrometer rig.
56. Multichannel resistivity meter (e.g. Stinger), increase our permanent installation of met stations and stream gages in the area, data loggers, water sampling pumps, water quality meters
57. Geoprobe and/or drilling rig, with operators equipment for field chemical analyses (e.g. field GC)
58. Geophysical equipment data loggers / with various download/upload options
59. Remote sensing and lidar equipment
60. LIDAR Mobile Doppler Radar Weather Stations Soil Monitoring stations (temp, moisture at depths) Flux/Radiation measurement stations (air sensible and latent heat flux)
61. 1. surface and gw flow measurements 2. surface and gw field water-quality measurements
62. Portable radar, new instrumentation for measuring streamflow
63. See HydroKansas website in about 6 weeks. google it. under construction.
64. Groundwater tracing technologies.
65. New Mexico Tech, UNM, Highlands Univ.
66. Tethersonde highspeed cameras
67. Eddy flux system micromet tower high-quality dataloggers isotope analysis capability
68. Sub-bottom acoustic profiler TDEM Seismic (regular and surface waves)
69. Ground-based gravitometric (GRACE) Acoustic Doppler Current Profilers (big and small) Acoustic bedload sampler
70. Auto Samplers, Temperature Sensor, Data Loggers...Field Equipment..
71. Exploration geophysics equip (GPR, EM)
72. Airborn LIDAR GPR/EM survey Eddy Flux Covariance Station Network precise energy balance stations
73. Ground penetrating radar In-situ measurement systems such as the new NO3 analyzers that have recently come on the market
74. Field water quality probes

75. More dataloggers
76. Autonomous, continuous chemical sensors for remote deployment, e.g. nitrate, C, silica
77. ICP-MS laser diffraction particle size analyzer microwave digestion system coring system (e.g. vibra core, split spoon)
78. Experimental high-tech equipment.
79. LIDAR
80. Tracer capability on landscapes using isotopes or other passive tracers.
81. Magnetic resonance sounding. Real-time isotopic measurements (tunable diode laser). Ground-based LIDAR. Eddy-correlation flux measurements.
82. Geophysical equipment
83. High-end equipment, e.g. lidar or flux towers
84. Aquifer test equipment Geophysical equipment (GPR, resistivity)
85. Ultrasonic Velocity Meters
86. Flow Meters Quality Probes....
87. GPS, stream velocity and depth instrumentation, and GIS software.
88. None
89. Crosshole non-invasive methods
90. GPR DC resistivity High-frequency seismic multi-channel.
91. Flow meters, salinity, TDS, dissolved Oxygen, chemical & hydrocarbon sensors/detectors/samplers
92. EM and Electrical equipment (EM34, EM31, EM38, PROTEM, EM63) and GPR.
93. Acoustic doppler current meter
94. Groundwater sensors, advanced met. sensors
95. High resolution (0.01 °C) submersible temperature loggers ie VEMCO. YSI or Hydrolab multiparameter probes ie MS5 or 600XLM. all sorts for borehole geophysics Submersible fluorometers, such as the ones from Switzerland/Germany. Oceanographic quality flow meters - Aanderaa, InterOcean, etc.
96. Well logging equipment (gamma, density, resistivity (induction) hydrological equipment (pressure, flow) surface geophysical equipment (resistivity, EM, magnetics, GPR etc)
97. Mobile network of X-band radars LIDAR flights (NCALM) multiple isco, campbell set-ups
98. Stream measurement instrumentation
99. None
100. Integrated portable stage recorders and met stations Telemetry equipment
101. Ground-penetrating radar, time-domain electromagnetics, downhole logging equipment -- natural gamma, conductivity, etc.
102. Stream velocity meters and rods automatic water samplers tapes measuring water levels in wells Water-quality field parameter meters
103. Automated water quality sensors and samplers, rain gauges and flow recorders with remote control and satellite broadcasting (Internet access to the data) capabilities.
104. None
105. Airborne geophysics Drill rigs
106. LIDAR, GPR, soil mapping probe truck, various remote sensing
107. Automated sensor systems for continuous geochemical measurements with cyber data transmission capabilities
108. Automated TDR
109. High spatial and temporal resolution (automated) sensor networks. Measure soil water status, hydraulic properties, atmospheric inputs, vegetation responses, etc.
110. A portable, polarimetric X-band weather radar.
111. Lidar
112. Remote sensing of elevations, aerial photography, landuse. GPR, EM Hydrogeophysical Pygmy/AA meters Portable PCR
113. Probably the "high-tech" equipment as defined in this survey.
114. Soil water and water quality measuring equipment
115. Modern sediment and streamgauging equipment
116. Highly dependent upon type of studies in which I might become active.
117. Tunable diode laser
118. LIDAR chemical sensors eddy correlation devices nanosensors geophysical subsurface sensors
119. Lidar

## Question 24: Briefly describe, in no more than 250 words, what you want most from a Hydrological Measurement Facility:

These responses indicate a broad interest in a facility that supports and does not compete with individual PI science.

1. I would like to see a facility that supports research by (1) reducing the capitalization costs for major equipment purchases needed to conduct research (esp. by young investigators); (2) maintains that equipment/software in good repair; (3) provides training in the appropriate use/standards related to that equipment/software; and (4) develops new methods/standards and transfers existing and emerging expertise to the scientific community.
2. It seems to me that the HMF should be a clearing-house for sources of equipment, expertise, completed research, relevant problems, and data. Serve as a multi-agency multi-disciplinary coordinator to facilitate cooperative research between federal, academic, and private sectors.
3. Facilitate in application of process-based runoff models with existing and proposed field measured data
4. The focus should be on new ways of measuring things. Much of hydrologic science measurement capability is old and needs to be modernized.
5. I would value short-term (< 6 months) access to field instruments the most with value ~>\$5000.
6. What ATD offers: 1. Technical people who can help with designing/setting up/running/ post data organization for complex field experiments. 2. Technical people who have instruments and labs at their disposal to help people on their NSF projects. 3. A center that pushes the envelope in development of new sensors, data acquisition/communication (e.g. wireless), data storage and access. 4. Change the culture of hydrology - allow more people to be in the field in a significant way.
7. Inexpensive access to basic equipment that can be used to assess the hydrologic variability over a range of scales. Educational sessions for new or in-development high-tech instrumentation. Training sessions and access to high-tech equipment and support technicians for difficult to quantify environmental states and fluxes.
8. Tech support/workshops for project components such as programming loggers or troubleshooting data sets that I will otherwise need to learn from scratch.
9. Expertise on equipment, operation of equipment and limitations of equipment and techniques would be very valuable!
10. While the field of “hydrology” could be well served if improved measurement techniques, models, etc. are attained, there are greater needs at doing so for tackling interdisciplinary problems. That is, the integration of hydrology with biological sciences is strongly needed to attack a wide range of issues that require both sound physical and biological measurements/assessments. Simply focusing on the “physical” system is short-sighted and ultimately inefficient for making major strides in science/management that addresses major problems of concern to society.
11. I would like a way to access / rent equipment that is costly to purchase and that I'd prefer not to have to store (e.g., ISCO samplers), but may be needed for a 2 or 4 year project. It would also be useful to have assistance in deploying equipment. In addition, if there were the capability of obtaining LIDAR data, or collaborating with others for obtaining remotely sensed data (RADARSAT time etc.) these can be cost-prohibitive as part of grant proposals unless they have a maximum award amount of around \$500,000 or more.
12. Access to (1) training (workshop/visiting positions), (2) equipment/data, and (3) resources (grant/equipment use program)
13. Develop a facility that can focus on the development of equipment for hydrology and provide opportunities for training. Provide a team of experts and field staff that can help with the design and implementation of water-

- shed studies. A single center with satellite facilities near designated watersheds would serve well.
14. Instrument development in conjunction with development of innovative methodologies. information source for high tech equipment rental of high tech equipment
  15. Help me afford advanced equipment (or quantities of equipment) that I cannot justify on a 3 year grant - i.e. 60 Level loggers, or an injection tracer system, or air-borne geophysical eqpt. Things I cannot buy, but need to use for 3-4 months, etc. The issue is likely that many of us will need these items in the summer...
  16. I don't think HMFs will function as envisioned. Equipment rental is already possible from commercial vendors. Would the HMF compete with these?
  17. Networking - help connect people with similar interests/areas of research Reviews of equipment (consumer report like analysis)
  18. Evaluation of measurement methods, techniques and sensors by collaborative body of independent investigators with results readily available to rest of investigators in hydrological sciences.
  19. Coordination of measurement/monitoring efforts. That is, we need to find a way to make research into measurement methods research a recognized and fundable aspect of hydrology. This has more to do with leveraging and community building than simple lending of equipment. I would be very concerned if the HMF made it more likely for more people to (mis)use indirect measurement methods by providing simple equipment outsourcing services.
  20. Measurement advice and examples of applications, suggestions on equipment and rental service.
  21. Information on techniques and development of new instrumentation, access to expertise, access to high-tech equipment by rental
  22. Cohesive leadership for the field. A center that would be nationally and internationally recognized as an entity that could serve as a rallying point for the community.
  23. Should be available not only to scientists in the US but for international scientists as well. Current state of the art resources are hard to fund and support so having them available to anyone in the wider world is important. This is especially true for developing hydrological strategies and high quality research in countries that have a greater need for accurate hydrological methodology due to burgeoning population and subsurface resource overuse.
  24. I would hope for pooled expertise in the form of associated faculty and Staff Scientists open to collaboration with 'outside' parties (i.e. 'users') so as to truly allow for interdisciplinary teamwork which is focused towards the development of better subsurface mapping/characterization and modeling techniques. Again: The DOE Synchrotron facilities and the EMSL facility at PNNL have become the 'go to' places (i.e. user facilities) in environmental research and have advanced environmental research immensely over the past 10 years. I believe a well designed HMF would have the potential to become something similar.
  25. "One-stop shopping" resource base: info on people, methods, equipment, models, and so on. Collaboration with modelers, biochemists, hydrologists and field programs to develop a methodology to evaluate water resources and water quality with cross disciplinary approach on a basin wide scale, and provide resources to monitor, model, and remediate problems.
  26. The ability to talk to experts to review the design of field studies to make sure that the data being collected represents the pool of information trying to be evaluated
  27. The HMF is a great concept that needs to develop a wide base of potential users that serve as consultants to the development a central facility. Initially there should be one HMF that is fully equipped and staffed with the best. Once the equipment, models, etc. have been fully tested then two to four additional regional facilities should be established. These regional facilities should be the centers that develop, test and locate industries to manufacture and sell or rent for various other locations. Once these have been established, then from 2-10 of the HMF should become mobile units that can be transported to the sites omitted by the stationary regional facilities and set up for short term, eg.,

- 1-3 years measurements before being moved. Members of the regional HMF should serve as training sites for the use of stationary regional resources by the expanded Hydrological Research Community. A consultation committee, constructed from among the stationary regional HMF (35%) and the greater user community (65%) should review proposals and identify where the mobile units should be employed. My personal research interests include measurements of biogeochemical mechanisms controlling stabilities of aggregates at soil surfaces located onsite at one or more of the regional or mobile HMF.
28. A national facility that would concentrate hydrologic research and provide opportunities for interaction with scientists, especially through sabbatical visits to the facility. Secondly, I'd like a facility that would provide workshops/training on measurement techniques and protocols.
  29. Better understanding of near surface hydrology and a concise methodology/support to add data to the catalogue of information available to modelers.
  30. Clearinghouse for cutting-edge techniques and equipment. One place for all answers!
  31. Measurement facility showing standard and high tech instrumentation being used in an integrated hydrological study (eg soil, groundwater, and surface water). Thus both the instrument and the application could be studied. The center would be more a resource for knowledge rather than just a simple rental store.
  32. Expert technicians with equipment who could help with set-up or perform one-time tasks (e.g. geophysical survey, lake bathymetry, etc.) at individual research sites, inexpensively.
  33. A research organization focusing on development of better measurement techniques, integration of data into hydrological modeling philosophy, and a central source of data-related expertise.
  34. The idea of renting out high tech and expensive equipment is great. I also like the idea of the HMF being clearing house for equipment and workshops for equipment use. It would also be great to provide people with places to buy equipment and list of experts who can run such equipment. Finally, the idea of having a handbook of field techniques is great.
  35. An institution that is forward-thinking. e.g. helping the community think beyond individual watersheds to hydrology as an element of the Earth system or as a regional system.
  36. Rental equipment and personnel pool, graduate and postdoc opportunities, investment in long term measuring and data gathering set-up. Thanks.
  37. An evaluation facility that provides expert feedback on the capabilities and limitations of new and emerging technologies.
  38. Improved quality of data produced by academia through a strictly enforced calibration program One-stop shop for identifying instrumentation/methodology experts
  39. I would like access to equipment, expertise, and innovations that would allow for seed, large-scale, or long-term projects that would otherwise be difficult to implement. I like the idea of forming partnerships with the HMF (or facilitated by the HMF) that would allow for innovation in measurements and methodologies. Access to lab facilities for non-standard measurement of physical and chemical parameters for rocks and water. In addition to a focus on devices and methodologies, a partnership between the HMF and the other CUAHSI programs to establish a database (of data) for use by modelers would also be of great benefit and seems natural. Inclusion of collected data in the database could be a precondition for use of HMF equipment (though standardization or documentation could be difficult).
  40. 1. A group of researchers developing and testing improved measurement theories and methods. 2. Rental service for both standard and high-end equipment that are either too difficult for me to acquire and maintain or too difficult to use without expert help.
  41. A working cooperative facility that has friendly cooperative personnel willing to help rather than simply doing their own thing.



42. A community that allows new researchers, especially non-hydrologists, to “plug into” hydrology research and expertise.
43. Improved access to expensive equipment. Access to experts knowledgeable about using the equipment.
44. I feel the HMF should first provide cutting edge equipment as a primary goal. These are the tools that are hardest to come by. Second emphasis can be on more mundane tools (data loggers, etc), but it should have the cutting edge equipment first and foremost.
45. Improvements in high-tech sampling, including spatial and temporal resolution, as well as combining of instruments at monitoring points to provide more parameters measured.
46. The opportunity to conduct in situ experiments in a well-understood and relevant aquifer setting that integrates different measurements (chemical, physical, biological). The facility should permit subsurface manipulation with guidance from those responsible for the facility’s long-term use.
47. improved measurement devices and access to this equipment for estimating watershed fluxes in space and time
48. Training on application/implementation on specialized equipment to improve hydrological aspects of my research. Access to same equipment through rental facility.
49. Measurement Facility should be organized (if at all) in the broadest possible manner, and collaboratively with other initiatives where possible (e.g, critical zone group at Penn state is proposing something similar), including other Federal Agencies (DOE, EPA, USDA-ARS?). I am concerned about the cost-effectiveness, the institutional controls and memory (how long is this going the last before another initiative pops up?), and who is going to run it (a small closed group running and benefiting from this?). I am not necessarily supportive of this initiative. I think the best would be a facility as a think-tank where fresh minds can think of ideas for new measurements but no necessarily build the instrument. Instead they can partner with industry to build some. The proposal to fund post-docs to brain storm on ideas would be an excellent idea. Maintaining a warehouse or serving as a clearinghouse or matching facility does not come even close to thinking of new instrument measurement techniques!
50. Leadership in the hydrologic community around with future studies, research, and learning can be developed.
51. A source for technologies and applications appropriate for characterizing and measuring 1) ground water systems, and 2) ground water-surface water interactions.
52. Primarily the support and development of advanced technologies to answer key questions. Secondarily, the development and assistance of monitoring plans for researchers across various climatic regimes (arid, semi-arid, humid, hot/cold, etc.). Not all technologies are applicable to all climates.
53. A center dedicated to designing, testing, and verifying new instrumentation techniques and demonstrating these in application at multiple field scales.
54. Hi-tech instrumentation available at a relatively inexpensive rental rate for the hydrologic community. Development of new instruments/techniques so we can address hydrologic questions. I’d love to spend a sabbatical working there.
55. Advice on equipment (someone tests and lets me know best options) info on emerging techniques (so I can find out what’s new out there); access to rental (and ability to loan unused equipment)
56. Assistance in experimental design for measurements of inputs and outputs of water at flux sites that are generally in 2nd to 4th order streams (not in mountainous terrain, which isn’t conducive to water vapor exchange measurements by eddy covariance). Also need equipment advice and rental for intensive measurements for e.g. 1 yr.
57. Not sure. Maybe I think too small, or am too disappointed by “big science”. Seems such a center should be something out of the ordinary, not facilitating standard equipment use or answering questions for grad students because their advisors are “too busy”. Should be research question based rather than technology in search of science.



58. New methodologies should include new measurements and higher precision, **BUT SHOULD NOT BE LIMITED TO THAT. EVEN MORE** than those advances, we need more economical, lower impact, more rugged ways of measuring and logging (or communicating) “almost-standard” measurements: e.g., we need cheap, invisible, rugged ways of measuring streamflows at a LOT of places in a watershed; we need cheap and long-term ways of monitoring precipitation and precipitation form at high altitudes; we need cheap and largely invisible ways of measuring and logging solar radiation at LOTS of places. These aren’t hard measurements (mostly) but they are constrained by high prices, large labor requirements, and fragile technologies. If we are going to scale the “scale barriers” that limit our science, we need to be able to make LOTS of measurements at lots of places, affordably and without a team of 100 techs.
59. NEON will be funding new stable isotope labs. I would like to see the HMF coordinate with NEON to try and make these isotope facilities open to CUAHSI folks -- on both a fee-for-service AND collaborative basis. I really like the idea of having a “marketplace” where equipment and expertise are listed.
60. I envision HMF to be a facility involved in cutting edge research in developing and evaluating new sensors and devices for hydrologic sciences.
61. 1) A place to tell me what I should buy for my project? 2) A place to get help on troubleshooting and experimental design. 3) A place to acquire and trade used equipment.
62. The idea of being able to access information about measurement techniques and equipment, as well as the equipment itself, is very attractive.
63. Group available to assist in field projects by providing equipment and expertise that might be lacking at KGS.
64. To provide standard and especially high tech equipment (rental and servicing). Also to develop new methods and techniques.
65. High-tech measurement equipment: Development, Rental, Training, Technical Assistance in the Field
66. An increase in the availability of meteorological and hydrological observations through a coordinated effort with NOAA and the USGS. Is the USGS approach to stream gauging the most cost effective? Is there a set of standard meteorological/gauging stations that could be manufactured, programmed, and deployed throughout the country (maybe with some areas have higher density than others) that would complement the existing NOAA/USGS network? Thanks for your efforts!
67. Equipment and technique development for subsurface hydrologic studies
68. Lists of equipment that can do certain things -- low flow stream gauges, etc., with user critiques. Standard operating procedures -- similar to what USGS does, but for hydrologic measurements. A facility where scientists could work on developing new technologies such as sensors.
69. To support scientific investigation of watersheds without dominating the deployment of equipment through control of the number, type, characteristics of equipment. NCAR RAL facility is beginning to have too much impact and conflicts of interest on atmospheric science research through participation in evaluation of NSF field equipment requests of academic PIs as well as participation in field programs through direct deployment of equipment for their funded research.
70. Knowledgeable staff that can explain capabilities of instruments, arrange equipment rental, assist in field installation or train people to properly install, and provide a updated manual on measurement techniques including accuracy and practical consideration.
71. An ability to conduct collaborative, intensive hydrometeorological field measurements, and an ability to consider development of a new baseline for climate studies of hydromet interest.
72. Truthfully, I don’t think it is applicable to my work as I am doing applied research in individual basins. Each basin has its own hydrogeology and land use that a national center could not feasibly support
73. A stimulus for major advances in hydrologic experimentation. See <http://www.joss.ucar.edu/cases/>

74. Development of new methodologies and maintenance of high-end technology infrastructure for common use.
75. Access to integrated measurement facilities and high-tech instruments that single PIs cannot possibly access.
76. Someone to “go to” other than the company who built the equipment or friends you might know who have used it before -- someone to call when it breaks in the field who is sympathetic and practical. Actually owning and lending the equipment should be secondary to support.
77. I think that a facility such as HMF should not exist. Instead, individual institutions (departments, PIs) should develop and maintain equipment. And sharing of equipment should be done by establishing collaborations between PIs.
78. Equipment management, some technical support and repair. Training.
79. A forum to discuss experimental design and efficiency of data collection. Also, an equipment pool would be very useful.
80. I want the opportunity to characterize several aspects of the water cycle in detail across climatic settings. This will require access to spatially extensive (EM survey), spatially extensive and intensive (airborne LIDAR) or temporally intensive and moderately spatially extensive (energy and water flux stations) measurements.
81. Much of what is described here is already provided to me through the USGS HIF. The best place for new instrumentation to be developed is at the companies who currently make the instrumentation, an HMF should be used to facilitate development of new tools through existing companies. An HMF that focuses on linking field measurements with modeling needs would be useful.
82. Sharing of information and expertise on cutting-edge measurement technologies
83. Calibration and Testing, much like the HIF, but more effective.
84. I would like the HMF to provide the basics of a monitoring system. I am less excited about asking the HMF to develop techniques, especially cutting edge technology. I feel that is research and should be left to researchers. However the HMF should be involved with transition of techniques to routine measurements.
85. Access to state-of-the-art field instrumentation that is hard to get via grants. Plus, technical support using these instruments.
86. Ability to access high-tech working equipment for hydrologic measurements and have someone around to troubleshoot it when it does not work.
87. A facility focused specifically on the development, testing, and application of new innovative hydrologic instruments, sensor networks and monitoring methodologies.
88. i) Modest equipment availability ii) spur collaborative development of wireless sensor networks.
89. I want a facility that will SUPPORT the work of individual research groups in various universities and institutes. This facility can be justified only on the basis that it achieves economies of scale and synergies. It should never be allowed to develop into a monopoly that will absorb resources from other efforts.
90. Low cost access to instrumentation with capable technicians.
91. I would like to share my expertise and instruments in microwave remote sensing with other researchers, but I am concerned about insurance and repair/maintenance of instruments. I could benefit most from the availability of a technician that I could share with other groups. I need a technician to help maintain my instruments. This technician would have to have skills at the B.S. level in electrical engineering.
92. New/improved equipment that reduces the measurement error. Training on the use of new high-tech equipment. Access to expensive high-tech equipment.
93. Should be open to and available for all researchers and institutions and not just serve the large and “elite” group of institutions and researchers!
94. 1) The exact same protocols used to collect basic watershed information across the country. 2) Easy to use web-based data access. 3) Competitive funding for global to molecular research to push advancement. 4) Dismantle the USGS and place those funds in the NSF for competition so we remove the congressional-science

- bias that is killing this nations public lands natural science programs
95. Equipment for in-situ monitoring solute flux in soil. Equipment for measuring runoff.
  96. The HMF could lead the field in cutting edge measurement and modeling capability by having some science staff and a larger technical staff and working closely with scientists in the field who do modeling or measurements. Scientists can get the standard instrumentation but high tech is more difficult and collaboration with HMR would facilitate this. Cutting edge experiments and modeling could be done with HMF, perhaps at sites that are agreed on by all collaborators-university and HMF scientists. HMF scientists should not be able to do experiments without collaborators so HMF does not simply extract resources from the hydrology community.
  97. Expertise in setting up and initial trouble shooting of unfamiliar equipment. High quality data. An HMF seal of approval for any data that are disseminated. This seal of approval could include many things related metadata, documentation and other data stewardship activities. The next most important aspect would be high resolution data for hydrologic variables, both spatially and temporally.
  98. Development of measurement techniques and technical expertise on instrumentation, both through staff as well as on-line
  99. Integration between Hydrological and Geophysical techniques both in field and lab scales.
  100. Information about equipment: what to use - how to use - uncertainty in results - comparison of equipment. and training regarding how to do it: workshops - help in setting up field experiments
  101. Standard methods and equipment for hydrologic monitoring and experimentation, new equipment and methods, user friendly models, integration of hydrology and other areas of study - ecology, biogeochemistry, engineering etc., experienced and motivated staff, internships and training for students and professionals.
  102. Collaboration and partnership between private sector and USGS
  103. The facility should focus on advancing methods and equipment for characterizing hydrological conditions. If more effective and accessible methods can be developed then our abilities to model and understand systems will be successful. Renting or selling existing technologies does not provide significant new advances and there are many for-profit businesses already doing that. In addition, the HMF should work towards assuring the continuance of long-term monitoring programs throughout the US and, if possible, abroad.
  104. I don't want one or need one but recognize the needs for university researchers and graduate students. I would recommend contacting the USGS Hydrologic Instrumentation Facility or the Bureau of Reclamation's Water Resources Research Laboratory for advice. Both of these organizations do what you are proposing for federal government agencies.
  105. Support for good research and measurement.
  106. Graduate Students would be able to conduct much better research if accessibility to technology, and field assistants was available to all through the Hydrological Measurement Facility. It would be nice if this facility could fund some graduate (MS thesis) research. Funding in this area seems to be sparse.
  107. High quality R&D
  108. The ability for me to contribute to a major integrated collaborative project that pushes what we do and how we do it. We must not isolate the separate disciplines, because they inform, constrain and drive the others.
  109. Testing of new and 'old' equipment and techniques. Manufacturers tend to make claims which provide their equipment with glowing reviews but rarely expound on the system limitations or pitfalls. Development of standardized methodologies and manuals on data collection and interpretation. The industry needs high quality standards resulting from uniformity of correct procedures from practitioners. This is the only way clients will request the high-tech solutions, which in-turn will lead to better funding of new developments.
  110. I have been developing seismic techniques for locating fractures by scattering inversion, and tracking water migration in 4-D using surface waves. Doing the re-

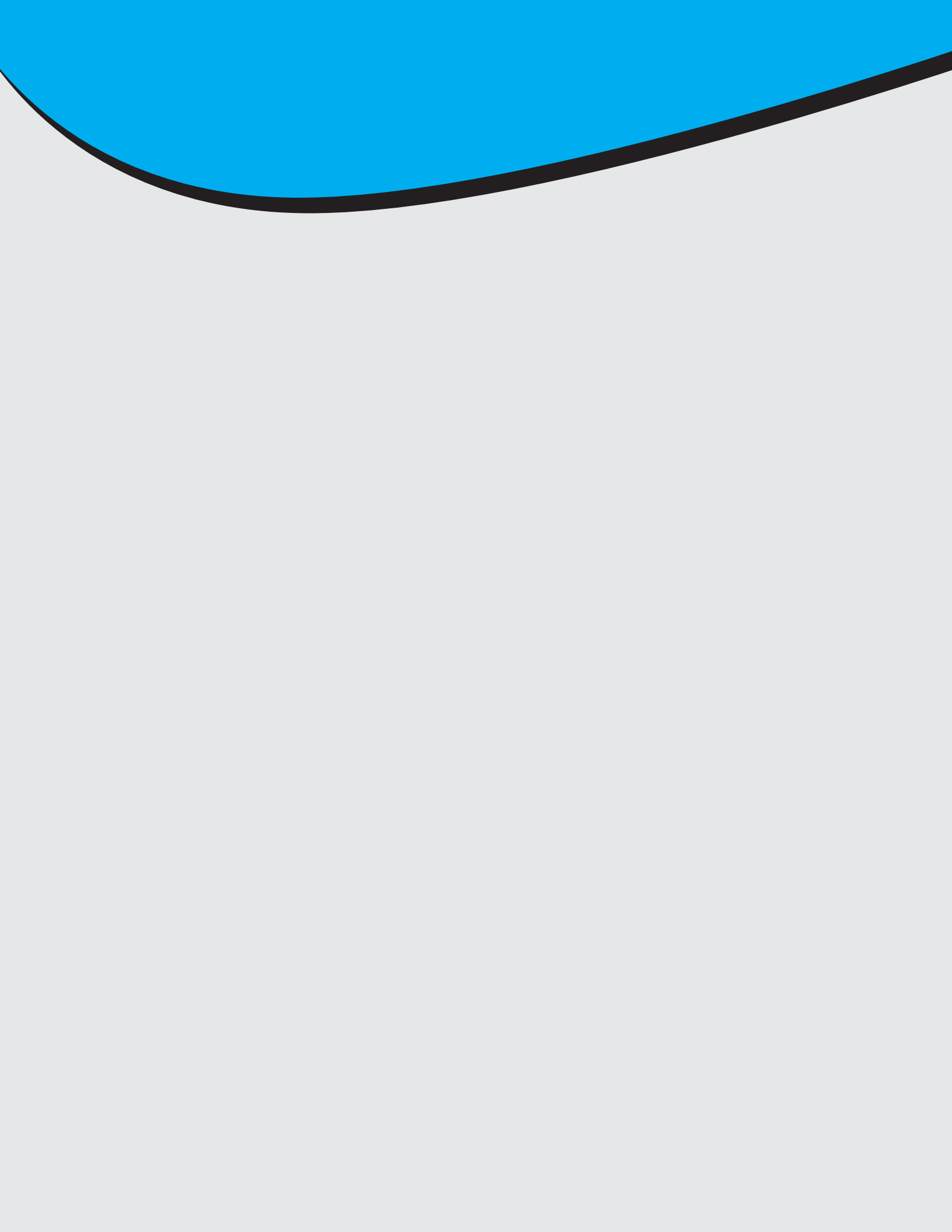
search has been easy compared to learning enough “hydrology speak” to sell the project. The best contribution of a center would be to provide a forum for discussing geophysical applications to hydrological measurements. Another point; the simple application of geophysics rarely works. It takes development of new analysis techniques to get the right kind of data. This is something that has to be done by someone who really knows the geophysical technique, all its measurement problems and theoretical background. That person rarely also know enough about hydrology.

111. Fresh water is becoming scarce and population demands are increasing. There may be important discoveries or insights that this facility could make.
112. Specialized and regional research
113. I am concerned that the HMF will draw much needed funds from individual research projects. A few universities will gain much and most will lose greatly.
114. The ability to detect streams and well locations and also flow of contaminants
115. In concept, this is a good idea. It remains to be seen if it can be accomplished in practice. My concern is with the question of access, cost, and co-opting of a dwindling supply of funding for groundwater and watershed research. It is clear that only those funded by NSF will probably be able to afford equipment rental, but if you have NSF funding, then you may not need the equipment. The overhead in this facility could be very high, and it could consume much of the budget -- many top universities (e.g., Stanford) have very high overhead rates. I see this as useful as a clearing house for information and general assistance for equipment access, but not as a “hub” for all equipment R&D. If this facility is the end-all, be-all for hydrological and geophysical equipment, then funding well may dry up for individual researchers. I also question the underlying assumption here that most people really want to conduct field work, but they lack the equipment -- I am not convinced that this is the case. If people want to conduct field work, then they seek the funding and conduct the work.
116. A focused group who can collectively address issues related to measurements of hydrological systems using multiple techniques that includes hydro, geophysics, biogeochem, soil science and ecology.
117. Information clearing house
118. A marketplace for ideas and instruments; help with programming devices; help with telemetry issues e.g. satellite relays; lower cost rentals of equipment; straight talk and advice on optimal instrumentation for available funding; colleague assistance on projects of joint interest;
119. The HMF is a great concept and I believe should have the following; a) Develop and maintain technical standards. b) Provide new interpretation methods/ideas to existing data c) Better understand the uncertainties and limitations of current equipment and acquisition methodologies. d) Provide processes to integrate data into multidisciplinary models e) Develop new instrumentation and associated commercialization protocols. f) Increase the awareness of standards and methodology to non specialists g) Increase technical skills of industry specialists h) Provide a global network to facilitate getting people with hydrological problems, to meet people with possible solutions/ideas.
120. Basic equipment use, maintenance, and instructional assistance in its use. A thorough on-line description of equipment application, use, maintenance, and tips for operation.
121. A HMF would serve 3 purposes to me: 1 EQUIPMENT- ability to buy used equipment so that more research can be done overall with the limited research funding we all face AND access to rent larger quantities or specialized (high-tech) equipment for specific deployments of short to mid-term deployment (one off situations). 2 Professional level hands-on training. 3 a professional approach to documenting and standardizing modern field practices. The center should be a place mostly that users can come to for advice and review. Many users in this business suffer more from lack of expertise than equipment. The center should have some equipment, but mainly it should have expertise. Equipment can often be obtained through existing rental companies, the center could fill in gaps here. It could also serve as a the first place where users can come to

- get equipment (through referrals) training (again mostly through referrals but it should also offer this) and advise on how to design and carry out experiments.
122. Access to data shared by others
  123. Access to expertise I don't have among my closest collaborators. Access to a group of experts I share interest with in hydrology that I can influence and stimulate intellectually regarding hydrologic measurement issues. Access to logistical support for larger field experimentation projects. Access to expensive high-tech equipment.
  124. I'm not sure that I know. I can pick from the menus above, but realistically a lot of my desire depends on implementation. If you guys can subvert some of the "ownership society" tendencies in hydrologic science I'm all for it. That's it. Change the culture. That's what I want.
  125. To provide access to the data and models through web. Being an experimentalist, my main interest is to design and implement the HMF.
  126. A control site where researchers can bring their methodology and equipment to collect data that can be compared against known features would be great.
  127. A manual on standard methods of practice
  128. Deploy nested instrumentation (full water balance) system for a limited period in a basin of choice. UNAVCO = good model. Must involve USGS, NCALM, and link to nascent CSDMS initiative.
  129. (1) Sharing of hydrological data -- particularly subsurface measurements such as water levels or hydraulic conductivity values. Much of this information is currently buried in reports of consultants and governmental agencies. (2) A pool of equipment that could be shared or loaned out at minimal cost -- particularly high-tech equipment such as geophysical sensors.
  130. Equipment rental and support.
  131. Instrumentation support that could enhance PI success in major research proposals.
  132. The Hydrological Instrumentation Facility (HIF), which supports operational research throughout the USGS, could be used as a starting point (but adapted for supporting basic research).
  133. The primary limit in my research in ground water is the lack of public interest or understanding. What I don't want from the facility: - simply a resource for high level research institutions to have someone fund and maintain equipment - having the facility divided along traditional disciplinary lines and not provided the fertilization for interdisciplinary research required - no true public interaction What I want most from the facility is to provide interaction with the public in understanding hydrologic measurements. The morning news shows all have weathermen, but none have an earth scientist that can provide understanding of how our science impacts their lives. The facility would need: - a strong component of outreach to both smaller institutions for undergraduate and graduate research - assigned staff to interact and reach out to the media to provide the interaction that is required with the public - a limit on academic elitism
  134. Information for selecting appropriate equipment. Assistance in designing equipment with needed improvements and disseminating findings. Marketing newly patented designs.
  135. A collaborative laboratory environment where visiting scholars and students can spend weeks/months focusing and working on a new sensor or measurement technique.
  136. To make my field measurements/monitoring easier to implement, reliable, cutting-edge, consistent, and usable to the community science advancement
  137. A facility [real, virtual, multiple] where hydrological measurement capabilities and knowledge can be focused; provide training and workshops; develop new and innovative measurement technologies where such are currently lacking.
  138. Access to experts on how to do measurements -- equipment suggestions, equipment development, measurement strategies. You should fund good ideas -- in other words fund people with good ideas on how to improve measurements. Do not become an equipment rental agency.
  139. Opportunities to expand measurement capability, but I see this as helping a group, not necessarily myself.



140. The facility should serve as a source of information and equipment for use by individual researchers and research groups. There are various methods for measuring hydrological variables, but the facility should be able to help researchers to choose the best method. And the facility should serve as a focal point for researchers to go to for discussion on the development of new measurement and research methodologies. The facility should make equipment available to researchers for rent so that there risk of purchase of equipment unfamiliar to the researcher can be reduced. This way the researcher can try equipment without having to commit to it permanently.
141. A means to provide support for sensor/instrumentation/methods development (widely-distributed model), and to encourage integration of research by those with expertise in measurements with those that need it. Long-term instrumented sites spread across the country; many smaller ones better than a few more intensive ones.
142. The ability to have a single point of contact when I have an instrumentation question. This is particularly true for instrumentation that I am not familiar with, or when I want to ask someone “how do I measure X?”
143. The facility should be directed to hydrological research capabilities on both large and small scales. In my judgment it is most important that integrated research be conducted in the landscape.
144. Look at it as at Home Depot. You have customers who are knowledgeable and who are not. They have the do-it-yourself workshops and they can install stuff. They have the one-fits-all solutions and they have a rare plumbing lubrication that was popular in 1910. Learning a means of competing two home improvement companies could help.
145. Runoff collector Water quality equipment Soil chemical properties equipment. The main reason that my research has focused mostly in laboratory is because the difficulties involved in conducting field scale experiments. These difficulties include lack of experimental sites, the cost associated with field operation and lack of technical support. It is unrealistic to expect a single PI (or even a few PI) to effectively to support field projects. Having a Hydrological Measurement Facility with the kind of support envisioned by the organizers would allow me to conduct studies that would otherwise be impossible. Such a Facility would also significantly enhance collaboration among participating scientists.
146. A facility that will develop and standardize methodology for measurements and integration of data and model results across scales, from edge of the field to watershed outlet.
147. I would envision the HMF to act in support of citizen groups addressing local problems of stream water quality, groundwater pollution, land use and environmental safety.
148. A fully instrumented small watershed with modern up-to-date equipment that can serve as an instruction laboratory for young scientists. A facility that enables scientists to become familiarized with new measurement techniques, technologies, and methodologies on a wide front of hydrologic and hydraulic disciplines.
149. I foresee the HMF being a resource center where many of the field problems encountered particularly in a consulting environment can be integrated into productive research activities. Think it would be important to have the facility at more than once location because of the highly differentiated hydrologic environments encountered.
150. Development of new, easy-to-use, equipment for the measurement of hydrological properties and variables. In case of sophisticated equipment, provide details on best to use it and, if expensive, allow for rental equipment.
151. Enhance the ability to make comprehensive hydrologic and pollutant measurements in watersheds at multiple points within a watershed
152. Access to expertise opportunities for collaboration assistance with sensors and other technologies shared data





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