January 1973

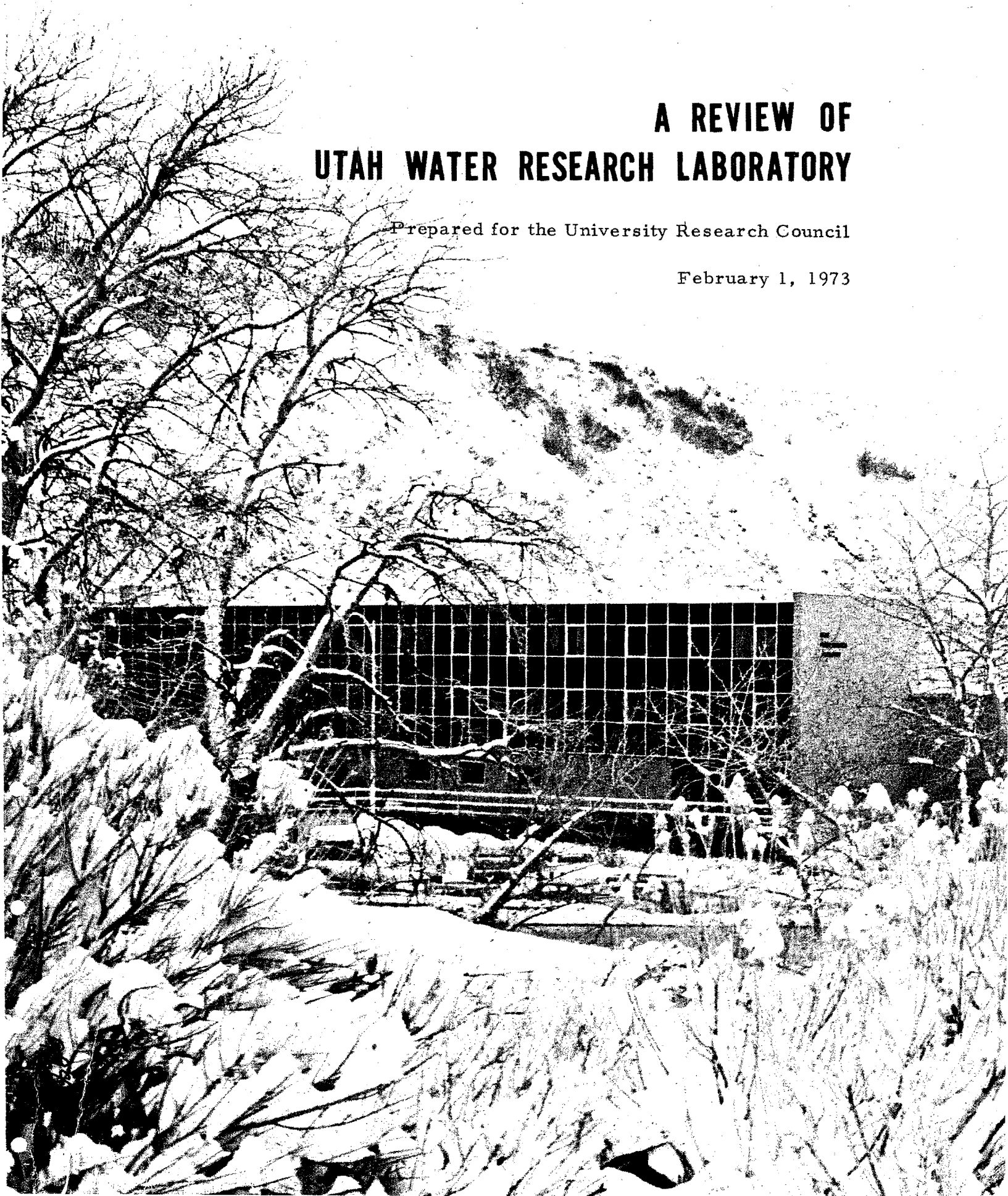
A Review of Utah Water Research Laboratory

Utah Water Research Laboratory

A REVIEW OF UTAH WATER RESEARCH LABORATORY

Prepared for the University Research Council

February 1, 1973



A REVIEW

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UTAH WATER RESEARCH LABORATORY

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HISTORICAL BACKGROUND

The concept of a centralized laboratory for water research on the campus of Utah State University evolved out of traditionally strong emphasis on water's role in plant-soil systems and the hydraulic and hydrologic problems related to the design, construction, and operation of storage, conveyance, and distribution works. The recognition that water constitutes a kind of "common denominator" for not only agricultural, but also municipal, industrial, recreational, and aesthetic pursuits as well, argued for an integrated water research focus.

The years following World War II through the middle 1950's were years of exploring, analyzing, and solidifying ideas about the nature and kind of physical facility needed. They were also years of refining and promulgating the concept of a regional laboratory and justifying it to federal and state agency heads and to legislators. The early appeal was beamed almost exclusively toward federal sponsorship. Because of the traditionally close ties with the research divisions within the Department of Agriculture, that agency was viewed as the prime source of support.

In 1956, Congressman H. Aldous Dixon (formerly President of USU) introduced H. R. 10663, a bill which proposed that the Secretary of Agriculture be

> "...authorized and directed to establish, maintain, and operate at such location as he deems desirable a regional

> water laboratory for the purpose of conducting research and study with respect to the physical laws, principles, and dominant variables affecting the source, supply, and use of water, including (1) water sources and their development, both surface and underground, (2) storage, control, measurement, and conveyance of water, (3) water requirements and uses, (4) methods of application of water, and (5) removal of excess from surface and subsurface."

Senator Arthur V. Watkins submitted a companion bill in the Senate. Their hope and intent, of course, was to get the proposed laboratory located in Logan.

As the idea of a regional water laboratory spread, interest was stimulated in assessing the emerging requirements for new and highly specialized kinds of research facilities to provide integrated research opportunities and services in appropriate regions. In 1958, the Senate requested a long range study of needed research facilities for soil and water research. USDA announced public hearings on Soil and Water Research Facilities, one of which was scheduled for October 15, 1958, in Salt Lake City. D. F. Peterson was the official representative of USU at those hearings and he filed a prospectus outlining the nature and need for a water research laboratory. Several organizations and individuals made statements in support of this need and the appropriateness of the Logan location. The document which resulted from these hearings and studies included in its listing a hydraulics laboratory to be located in Logan, Utah. Those at USU who had persistently pressed the water laboratory concept at Agency and Congressional levels were hopeful that the long sought-after facility would soom be a reality. Fate

and politics clouded that optimism when regional water conservation laboratories were authorized and funded, but instead of being located at Logan, they sprang up in Tempe, Arizona, and in Kimberly, Idaho. It soon became clear that the planting and nurturing of the laboratory idea was bearing fruit elsewhere, but that federal sponsorship of a water research laboratory at Logan was still rather remote. Although USU attention began turning toward state and/or private support, efforts continued in the federal arena. In 1961, Senator Wallace F. Bennett again introduced a bill to authorize the Secretary of Agriculture to

> "...establish, equip, and maintain a regional research laboratory to be located at or near the Utah State University of Agriculture and Applied Science, a Federal land-grant university at Logan, Utah, and, at such Laboratory, to conduct researches into problems relating to hydraulics of irrigation structures."

When prospects waned for getting a laboratory through USDA sponsorship, USU shifted its target to (1) support of a national system of water research centers administered by a new agency in the Department of the Interior, and (2) the Utah legislature for support of a wholly state owned and operated water research laboratory.

Although nothing came of Bennett's 1961 bill, a draft bill was introduced in Congress by Clinton Anderson of New Mexico the following year to establish water resources research centers at certain universities. Then, in 1963, after receiving much comment and suggestion, the bill was revised and introduced again. This legislation was eventually enacted and became known as the Water Resources Research Act of 1964. This act

provided for the establishment of Water Resources Research Centers at land grant universities. Utah State was one of the first universities to receive funding under this Act largely because of the existing research momentum. This momentum had been greatly increased when the Utah legislature in 1959 authorized the laboratory at USU and initiated architectural planning. The drought conditions of the late 1950's and the increasing problems of wastewater disposal and pollution probably helped to stimulate action. The next biennial legislature (1961) introduced legislation providing that there be

> "...appropriated to the State Building Board $1,200,000.00 or so much thereof, as may be necessary, from the General Fund for constructing the Utah Water Research Laboratory, on the Logan River, on property already acquired by the State of Utah for such purpose, the preliminary plans for which Research Laboratory have already been prepared by the Building Board..."

Subsequently, the building appropriation for USU for the 1961-63 biennium included a sum of $200,000 for a "Hydraulics Laboratory." The bill also provided that

> "...the university officials, the water and power board, water users and other interested agencies and individuals shall explore all possibilities of federal government participation and private subscriptions for the construction and operation of a hydraulic laboratory and report the findings to the 35th Legislature."

With this start and incentive, USU personnel embarked in a rather vigorous search for non-state financial support. Armed with the legislative enactment and an initial appropriation indicating firm intent on the part of the state, the approach to granting agencies on the basis of "cost sharing" proved effective. Grants were obtained from the National

Science Foundation ($397,000) and the National Institutes of Health ($250,000). These were awarded subject to the state providing the balance of the estimated total cost of $1,500,000 for the structure. (The NIH grant was conditioned on the laboratory's willingness to conduct a significant amount of health-related water research -- a condition contemplated anyhow.) With the federal grants pledged, the 1963 legislature appropriated an additional $650,000 which financed the laboratory construction with the exception of the interior of one major section "roughed in" for completion in a later phase. The General Appropriations Bill included an item of $45,000 to Utah State University to 'administer' the Water Research Laboratory. Thus the laboratory began to operate as an entity in 1963. Significantly, also that legislative session amended the Uniform School Fund disbursement

> "...to provide that 3 1/3% of the amounts in the fund from sums paid for fees including grazing fees and all forfeitures and all penalties received in connection therewith; all amounts received from the United States under the provisions of the Act of Congress of February 25, 1920, known as "The Leasing Act" (41 Stat. 450) which are allocated to the uniform school fund; and all moneys received from sales, royalties, bonuses, leases, and rentals of minerals of all kinds in lands acquired through tax sales to the counties, together with all sums paid for fees, forfeitures and all penalties received in connection therewith "shall be apportioned to the water research laboratory at Utah State University ... such moneys to be used in furtherance of activities carried on by the laboratory having as a purpose the development and exploitation of water resources in the state of Utah."

Thus, in 1963 all the parts finally fell into place with full financing of the facility finally secured and the sources of basic support to sustain the research program provided for. Groundbreaking ceremonies for the

laboratory were held in November of 1963. Actually, certain preparatory work had commenced one year earlier with funds provided by the 1961 legislation. On July 12, 1964, the USU Board of Trustees approved the appointment of Vaughn E. Hansen as the first Director of the Utah Water Research Laboratory. The structure was completed during his tenure and the research program identity began to take form. The building was dedicated in December of 1965. Dr. Hansen resigned his position at the end of that fiscal year. He was succeeded by Jay M. Bagley who was appointed as Director in July 1966 and presently continues in that position. The Laboratory is administratively within the College of Engineering. The Dean of that college, Dean F. Peterson, Jr., has had general jurisdiction over the laboratory since its establishment.

PURPOSES OF UWRL

Briefly stated, the objectives which have guided UWRL activity over the years are:

(1) To develop and maintain a research capability which can respond quickly, efficiently, and effectively to a wide variety of water research opportunities.

   (a) To provide adequate facilities, equipment, and space commensurate with the needs of a dynamic and diversified staff and a balanced water research program.

   (b) To implement operational policies and organizational patterns which result in maximum creative contribution through streamlined project management, unfettered administrative support, and easy interdepartmental and interdisciplinary interaction.

(2) To provide a responsive and effective research arm for state agencies having concern with planning, management, development, allocation, and administration of water for any and all purposes.

(3) To provide support and stimulation to academic departments of USU in establishing balanced high quality training needed to meet the urgent manpower requirements in water science and engineering.

(4) To foster cooperation and coordination with federal agencies, and to contribute meaningfully to the solution of regional, national, and international water problems through contract and grant programs.

(5) To effectively disseminate the results of research to those having need for the information.

(a) High quality series of publications.

(b) Technical assistance to implementing groups.

FINANCIAL SUPPORT

General

The basic operating budget of UWRL comes from (1) a legislative appropriation as a line item in the Utah State University budget, and (2) an allocation of 3 1/3 percent of the mineral lease funds which are allocated to the uniform school fund. In addition, UWRL receives a proportion of the University overhead collections made from UWRL projects. Contracts and grants for conducting specific research (generally secured on a competitive basis) provides what has come to be the major source of funding. Past funding levels comprising the three major sources of financing are shown in Figure 1. The proportion of state to non-state funding has been steadily declining. The current pattern (FY 72) of research support is $100,000 (6%) mineral lease funds, $105,000 (6%) legislative appropriation and $1,500,000 (88%) from grants and contracts.

Contract Research Emphasis

Since its beginning, UWRL has followed a policy of vigorously seeking financial support outside the state appropriation and mineral lease allocation. The mineral lease funds (MLF) have been helpful in providing the non-federal matching required by most federal agencies having research grant programs. Some of the principal benefits to Utah and USU resulting from contract research are: (1) The problems

studied often coincide with specific Utah problem priorities; hence, a very substantial amount of research on state problems is conducted with non-state funding, (2) contract funds underwrite salaries for a more diversified and highly competent staff whose technical capabilities become available to academic departments and to state and local entities who seek advice; and (3) contract research provides an important problem experience and financial assistance for students.

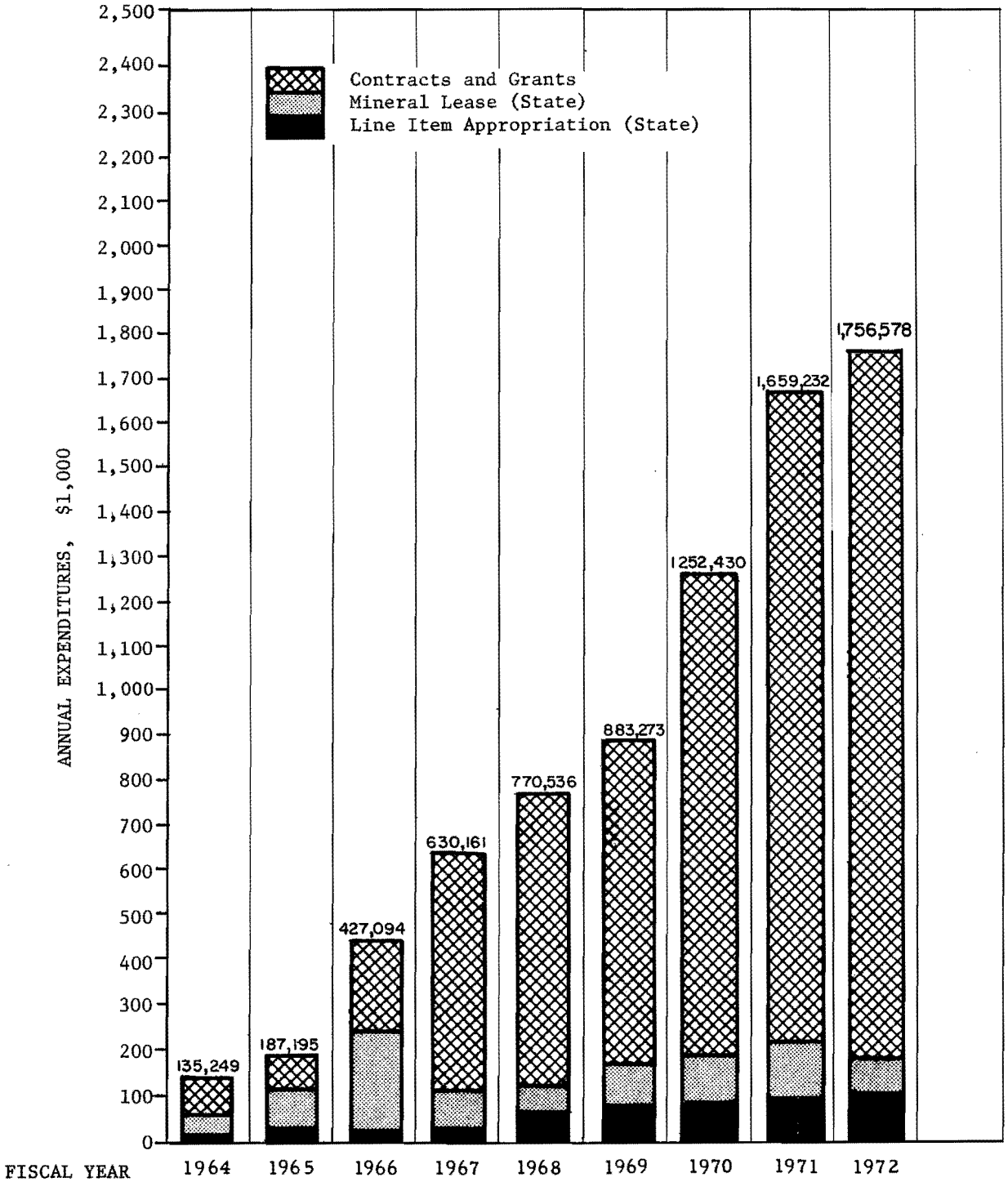
Over 100 contracts and grants have been secured since 1965 amounting to about $6 1/2 million. These contracts and grants represent 19 different federal agencies along with 5 state and 12 private organizations as listed in Table 1.

During any given year, UWRL may be administering 35 to 40 active contracts or research grants involving numerous agencies and clients. It is perhaps significant to note that each of these contractors have their peculiar set of regulations and policies and from a management standpoint it would be more correct to indicate that UWRL financing comes from some 40 sources. To represent these sources collectively as a single category in parallel with the state appropriation is an oversimplification so far as the management aspect is concerned.

Success in obtaining contract and grant funds requires awareness of critical research needs, and an imaginative and timely proposal to investigate the problem. Consequently, the preparation of research proposals and nursing them through to the award constitutes a highly significant UWRL activity. The number of proposals submitted and the number of awards made on a calendar year basis are shown in Figure 2.

UTAH WATER RESEARCH LABORATORY

ANNUAL EXPENDITURES BY SOURCE



(1/29/73) Figure 1. Annual expenditures by source.

Data from which Figure 1 was prepared.

Sources of Funds and Annual Expenditures: FY 1964-1972

UTAH WATER RESEARCH LABORATORY

Fiscal Year	1964	1965	1966	1967	1968	1969	1970	1971	1972	Total
Line Item Appropriation	14,255	28,035	25,015	25,031	64,560	84,782	90,227	98,103	105,002	535,010
Mineral Lease Apportionment	39,358	79,616	209,610	88,131	53,630	83,684	93,630	117,830	71,777	837,266
Contracts and Grants	81,636	79,544	192,469	516,999	652,346	714,807	1,068,573	1,443,299	1,579,799	6,329,472
TOTAL	135,249	187,195	427,094	630,161	770,536	883,273	1,252,430	1,659,232	1,756,578	7,701,748
Rate of Change	-	+38%	+28%	+48%	+22%	+15%	+42%	+33%	+6%	(ave.) 29%/year

Table 1. Utah Water Research Laboratory Agency Contracts and Grants

FEDERAL

Environmental Protection Agency
Forest Service
Soil Conservation Service
Bureau of Reclamation
Office of Water Resources Research
Agricultural Research Service
National Science Foundation
Office of Saline Water
Public Health Service
Agency for International Development
Dept. of Housing and Urban Development
Industrial Services Administration
Department of State
Geological Survey
Fish and Wildlife Service
Corps of Engineers
U.S. Navy
Federal Highway Administration
Organization of American States (CIDIAT)

State

Water Resources Division
Fish and Game Division
State Engineer
Highway Commission
Bureau of Environmental Health

Private

U & I Sugar Co.
U.S. Steel
Procter & Gamble
Thiokol Chemical Corporation
Metropolitan Water District
Delta Irrigation Company
Carl Nelson Construction
Ideal Cement Company
Johns - Manville
Detroit Metro Water Department
Del Monte Corporation
Brown & Root

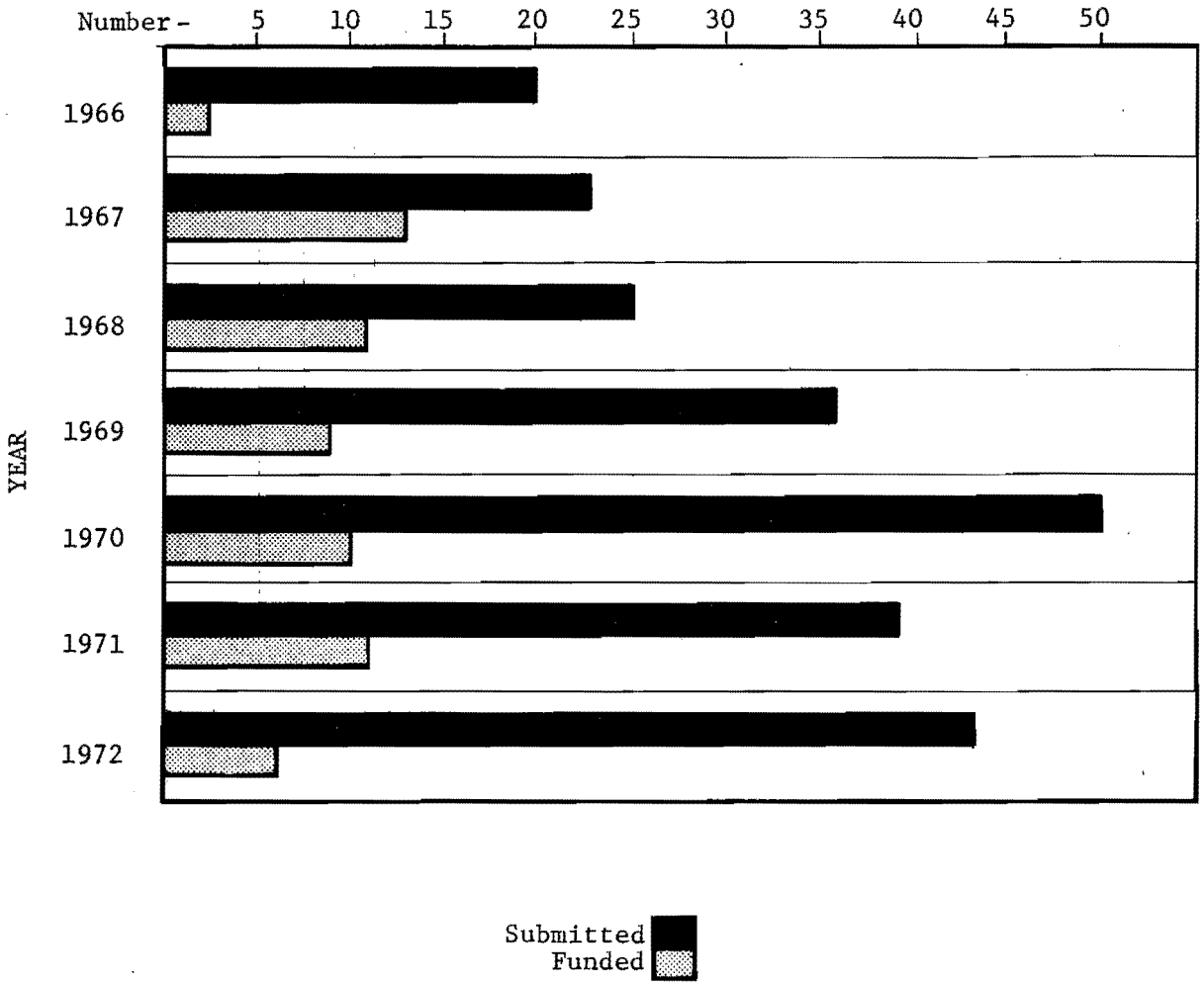


Figure 2. Proposals submitted and funded (1966-1972).

Overhead Return Utilization

Some amplification concerning the use of overhead return moneys may be useful. Prior to the current year (FY 73) overhead returns were mingled with mineral lease allocations and budgeted as a unit. The amounts expended out of this fund for supporting services and activities were listed as a part of the MLF budget. This year the overhead return moneys are separately managed although their use is the same as always. Overhead return funds are used for supporting services and activities commonly classed as overhead expenses, and for meeting matching requirements of certain research grants and contracts. They are expended under the following categories:

1. Contingencies, i.e., contract cancellations or cut-backs, cost overruns, etc.
2. Equipment Purchase and Rental, i.e., lab instruments, simulation facility, MTST, copy machines, office furniture, calculators, etc.
3. Laboratory Operation and Maintenance, i.e., general and emergency maintenance and repairs not covered by Physical Plant, postage, telephone, temporary construction and space renovation, miscellaneous technical and secretarial services.
4. Editorial and Printing, i.e., editing, drafting, illustration, preparation of reports, papers, brochures, newsletters, etc.
5. Public Service, i.e., response to requests from local, state, national groups, committee service, lectures, workshops,

seminars, conferences, tours, etc.

6. Staff and Program Development, i.e., promote research opportunities, participation in seminars, institutes, conferences, honoraria for visiting scientists, library subscriptions, etc.
7. Business and Program Management, i.e., special management support of research groups, review and coordination of financial reports, contract servicing, analyses and consultation.
8. Matching Requirements, i.e., to meet contractual oblications for selected research projects.

FUTURE POTENTIALS FOR FINANCIAL SUPPORT

State Appropriation

State appropriations for the laboratory have been used almost exclusively for basic program support--administering the program and providing certain essential services and equipment. Basic support requirements grow approximately in proportion to the growth of research expenditures. Yet legislative appropriations, which constitute the only legitimate source of administrative and facility support, have remained virtually level during the past 5 years, while research expenditures have more than doubled. Each year the UWRL budget request contains proposals for equipment and specific high-priority Utah research. These have been routinely eliminated at UCHE and legislative levels. While we remain hopeful that significant increases in the line item appropriation may be forthcoming, it would seem that state financial support will continue to be a minor part of the UWRL budget.

The FY 1974 budget recommendation forwarded to the Legislature by the Higher Board of Education, though proposing only a slight increase in basic support funds for the laboratory, contained $92,300 to finance three critically needed research projects specific to Utah problems.

Since the Legislature is currently in the process of considering the budget for FY 1974, it is uncertain what the outcome of this request will be. Although quantum increases in state appropriation seem absolutely necessary to operate the laboratory and respond to Utah's critical water

problems, it seems problematical that appropriations as a source of research support will grow at a rate sufficient for it to play a proportionately greater role in the near future.

Mineral Lease Funds

UWRL assignment of mineral lease funds is fixed by law and there would appear to be no compelling justification for a legislative change from the present percentage. The year to year fluctuations of this source of financing have not been extreme in recent years but have had fluctuations of 20 to 30 percent during the early years. A steady to rising trend would be expected, but no major change seems likely. Since MLF constitutes the principal source of funding to meet matching obligations, as contract and grant opportunities continue to grow their matching requirements could easily exceed available MLF. This reality has already forced UWRL to a policy seeking support under contract rather than grant arrangements where matching is not required.

Reimbursed Overhead

With static levels of state appropriation and a steadily growing total program, a substantial amount of basic support must be paid out of reimbursed overhead. Should there be any change in the policy of returning a portion of overhead earnings to the laboratory, increased appropriations would have to be made to offset the resulting deficit.

Contracts and Grants

Research grants and contracts will likely continue to constitute the main source of laboratory research funds. UWRL researchers have been quite successful in competing for available research money nationally. New and valuable staff additions have been made from time to time giving UWRL a competent and diversified staff with steadily increasing capability to compete for available research funds. Consequently, even though there has been and continues to be a diminution of research money nationally, UWRL has maintained a growing posture and will likely continue to capture a fair share of the water research funding. This may be an optimistic item in the face of cutbacks in many programs at the federal level.

Satisfied customers usually can be counted as a good source of future funding. The laboratory, fortunately, has a good track record on this score. Recent new work developed with the Corps of Engineers, EPA, and the National Highway Administration for example, appear to have good possibilities for continuation and expansion.

The Office of Water Resources Research, one of the primary sources of grant money for UWRL research is expected to continue to provide funding for a wide range of projects. However, OWRR has never reached its authorized level of funding and budget cuts recently proposed by the President in federal scientific and research programs may further curtail this program as well as having some serious impacts on other sources of support. Although the last congress amended the Water Resources

Research Act to increase the allotment authorization from $100,000 to $250,000 and appropriated $140,000, the additional $40,000 have been permanently frozen and the President's recommendation for FY 74 calls for $100,000 once again.

The administration of water quality research program by the Environmental Protection Agency gives us some cause for concern although we have had some recent successes in research awards. Not only is research funding limited, but the tendency has been to make awards for extremely short term studies (of 6 month duration for example). Personnel assignments and experimental arrangements must be made quickly. It is often difficult to rearrange teaching and research schedules of needed individuals to meet the rigid start-up and wind-up requirements imposed.

STAFF

The research staff of the Utah Water Research Laboratory represents a wide spectrum of water science and engineering specialties required to conduct a diversified research program. Such specialties include fluid mechanics and hydraulics, hydrology, water resources planning and management, sanitary engineering, chemistry, microbiology, meteorology, electronics, statistics, applied mathematics, economics, political science and sociology.

Typically, UWRL senior staff have joint appointments with academic departments and/or other research divisions. Outside the "core" of personnel for which UWRL maintains primary responsibility, individuals from several different departments are involved intermittently and in varying time proportions in UWRL managed projects. UWRL staff are involved in seven different projects having the Environment and Man Program, the Ecology Center, the Agricultural Experiment Station or the Engineering Experiment Station as the management or cost center (see Table 2).

Most UWRL research projects involve research teams rather than individual effort. They are quite typically interdisciplinary in nature and currently involve staff from ten different academic departments in six colleges. Table 3 lists the professional personnel presently engaged in projects under the technical or fiscal management of UWRL. These are listed according to the broad program divisions being used by UWRL.

Table 2. UWRL Joint Research with Other Departments (FY 73)

Project No.	Title	Agency	Principal Personnel	Cost Center	UWRL Administered Funds*
V-58-28	An Airborne Infrared Thermal Mapper for Use in Environmental Studies	Rockefeller Foundation	F. W. Haws (UWRL) D. C. Goode (EDL) L. P. Summers (Aero.) D. G. Frodsham (EDL)	Env. & Man	$ 4,920
UTA-804	Management of Salt Load in Irrigation Agriculture	Ag. Exp. Sta.	J. P. Riley (UWRL) H. B. Peterson	Ag. Exp. Sta.	5,000
211-D	Computer Simulation of Hydrologic Systems	USAID	J. P. Riley (UWRL) E. K. Israelsen (UWRL) B. Palmer	Ag. Exp. Sta.	15,000
UTA-787	Biostimulatory Properties of Irrigation Return Flows and Feedlot Drainage	USDA	E. J. Middlebrooks (UWRL)	Ag. Exp. Sta.	7,454
YR-03-00	Brine Shrimp at Great Salt Lake	National Lead	D. B. Porcella (UWRL) J. E. Fletcher (UWRL) D. W. Goodall (NRZ) F. H. Wagner (NRZ)	Ecology	1,910
#313/#414	Nitrogen and Carbon Flux in a Soil-Vegetation Complex in the Desert Biome	NSF	D. B. Porcella (UWRL) J. A. Holman (NRZ)	Ecology	13,486
XEM-027-1	Air Strip Landing Mat Investigation	USAF	D. S. Woffinden (UWRL) F. W. Kiefer (CE)	Eng. Exp. Sta.	244
TOTAL	(7)				$48,014

*Additional to UWRL chart "Annual Expenditures by Source" (Fig. 1).

Table 3. UWRL Staff and Research Effort by Programs

Name	Specialty	Research Assignment (FTE's) UWRL	Non-UWRL
	Basic Program Support		
Dean F. Peterson	Dean - College of Engineering	.24	-
Jay M. Bagley	Director	1.00	-
Calvin G. Clyde	Associate Director	.36	-
Daniel H. Hoggan	Assistant Director	.62	-
Frank Dupree	Administrative Assistant	1.00	-
Donna Falkenborg	Editor	1.00	-
A. Leon Huber	Supervisor, Hybrid Simulation Facility	.50	-
Gilbert Peterson	Supervisor, Machine Shop	1.00	-
Peter A. Cowan	Supervisor, Water Quality Laboratory	.15	-
Barbara South	Supervisor, M.T.S.T. Service	.25	-
	Atmospheric Water Resources (Geoffrey E. Hill, Program Leader)		
Duane G. Chadwick	Electrical Engineering, Telemetry, Instrumentation, and Measurement of Hydrologic and Climatic Parameters	.26	-
Charles F. Chappell	Weather Modification, Synoptic Meteorology, Cloud Dynamics	.14	-
Geoffrey E. Hill	Weather Modification, Synoptic Meteorology, Cloud Dynamics, Numerical Modeling, Ionospheric Phenomena	1.00	-
Gene L. Wooldridge	Meteorology	.15	.42
Duard S. Woffinden	Electronics, Telemetry, Instrumentation, Computers	.19	-

Table 3. Continued

Name	Specialty	Research Assignment UWRL	Non-UWRL
	Atmospheric Water Resources (Continued)		
Lee K. Balick	Weather Modification, Meteorology, Cloud Physics	1.00	-
Don L. Griffin	Telemetry, Instrumentation, Electrical Engineering	.50	-
William N. McNeill	Meteorology	1.00	-
Ron Campbell	Meteorology	.50	-
Inge Dirmhirn	Meteorology	.00	.75
	Hydraulics & Fluid Mechanics (Calvin G. Clyde, Program Leader)		
Cheng-lung Chen	Hydromechanics, Hydraulics, Hydrology, Water Resources Engineering	.14	-
Roland W. Jeppson	Fluid Numerical Methods, Groundwater Movement, Hydrology, Hydraulics	.34	-
Calvin G. Clyde	Fluid Mechanics, Hydrology, Water Resources Planning, Groundwater, Systems Analysis and Simulation, Hydraulics	.10	-
	Hydroclimatic Measurements & Data Processing (Duane G. Chadwick, Program Leader)		
Duane G. Chadwick	Electrical Engineering, Telemetry, Instrumentation, and Measurement of Hydrologic and Climatic Parameters	.74	-
Duard S. Woffinden	Electronics, Telemetry, Instrumentation, Computers	.43	-
Ron Campbell	Meteorology	.50	-

Table 3. Continued

Name	Specialty	Research Assignment UWRL	Non-UWRL
	Hydroclimatic Measurements & Data Processing (Continued)		
Don Griffin	Telemetry, Instrumentation, Electrical Engineering	.50	-
A. Leon Huber	Optimization Algorithms, Analysis of Extreme Flow Data, Stochastic Hydrology	.24	-
	Hydrologic Systems Analysis & Simulation (J. Paul Riley, Program Leader)		
Cheng-lung Chen	Hydromechanics, Hydraulics, Hydrology, Water Resources Engineering	.05	-
Craig W. Colton	Sociology	.57	-
William H. Hawkins	Forest Science	.04	.43
Duard S. Woffinden	Electronics, Telemetry, Instrumentation, Computers	.03	-
J. Paul Riley	Systems Analysis, Computer Simulation of Water Resource Systems, Hydrology, Water Resources Planning	.36	.20
George Shih	Water Resources Hydrology, Instrumentation	.90	-
Eugene Israelsen	Hydrology, Simulation of Water Resource Systems	.60	-
Robert W. Hill	Hydrology, Water Resource Systems Analysis, Hydraulic Design	.35	.20
	Hydrologic Principles & Processes (Roland W. Jeppson, Program Leader)		
Cheng-lung Chen	Hydromechanics, Hydraulics, Hydrology, Water Resources Engineering	.72	-

Table 3. Continued

Name	Specialty	Research Assignment UWRL	Non-UWRL
	Hydrologic Principles & Processes (Continued)		
Calvin G. Clyde	Fluid Mechanics, Hydrology, Water Resources Planning, Groundwater, Systems Analysis and Simulation, Hydraulics	.15	-
Joel E. Fletcher	Hydrology, Atmospheric Water Resources, Soil Science	.79	-
Roland W. Jeppson	Fluid Numerical Methods, Groundwater Movement, Hydrology, Hydraulics	.10	-
Musa Najib Nimah	Soil Water Movement, Soil Science, Agronomy	1.00	-
Duard S. Woffinden	Electronics, Telemetry, Instrumentation, Computers	.35	-
Frank Haws	Water Resources and Institutions, Water Law, Remote Sensing of Environment, Hydraulic Design	.50	-
A. Leon Huber	Optimization Algorithms, Analysis of Extreme Flow Data, Stochastic Hydrology	.19	-
J. Paul Riley	Systems Analysis, Computer Simulation of Water Resource Systems, Hydrology, Water Resources Planning	.25	*
George Shih	Water Resources Hydrology, Instrumentation	.05	-
Eugene Israelsen	Hydrology, Simulation of Water Resource Systems	.17	-

*Non-UWRL research commitment shown elsewhere.

Table 3. Continued

Name	Specialty	Research Assignment UWRL	Research Assignment Non-UWRL
	Water Conservation & Augmentation (Howard B. Peterson, Program Leader)		
Roland W. Jeppson	Fluid Numerical Methods, Groundwater Movement, Hydrology, Hydraulics	.24	-
Larry G. King	Consumptive Use, Hydraulics, Mathematical Modeling, Irrigation Return Flow	.49	.24
J. Paul Riley	Systems Analysis, Computer Simulation of Water Resource Systems, Hydrology, Water Resources Planning	.05	*
George Shih	Water Resources Hydrology, Instrumentation	.05	-
Howard B. Peterson	Soil Chemistry, Water Quality	.17	.42
Jerald E. Christiansen	Irrigation and Drainage	.83	-
Richard Griffin	Irrigation and Drainage	.25	-
Edwin C. Olsen	Irrigation and Drainage	1.00	-
Byron C. Palmer	Sanitary Engineering, Irrigation Development	.83	.17
David R. Daines	Water Law and Institutions	1.00	-
Komain Unhanand	Irrigation and Drainage	.25	-
Lloyd Austin	Hydraulics, Irrigation	1.00	-
George Hargreaves	Irrigation Engineering	.75	-
N. Keith Roberts	Resource Economics	.08	-
Allen LeBaron	Resource Economics	.17	-

*Non-UWRL research commitment shown elsewhere.

Table 3. Continued

Name	Specialty	Research Assignment UWRL	Research Assignment Non-UWRL
	Water Conservation & Augmentation (Continued)		
Morris Whitaker	Economics	.50	-
David W. James	Agronomy, Soils	.17	-
Rex F. Nielson	Agronomy, Soils	.08	-
Kearn Stutler	Irrigation Engineering	1.00	-
Tom Fullerton	Agronomy	1.00	-
Norris Gilbert	Agronomy	1.00	-
Russell B. Bachus	Irrigation and Drainage, Water Quality	1.00	-
	Water Resources Planning & Management (Daniel H. Hoggan, Program Leader)		
Wade H. Andrews	Resource Sociology	.16	.57
O. William Asplund	Economics of Pollution Control and Eutrophication	.17	.14
A. Bruce Bishop	Engineering Economic Planning and Systems Analysis of Public Works (Water Resources, Transportation, Waste Management)	.51	.10
Perry Joe Brown	Forest Science	.08	.40
Calvin G. Clyde	Fluid Mechanics, Hydrology, Water Resources Planning, Groundwater, Systems Analysis and Simulation, Hydraulics	.21	-
Craig W. Colton	Sociology	.27	.09
William J. Grenney	Computer & Laboratory Simulation of Aquatic Ecosystems, Planning & Economics of Wastewater Treatment	.40	-

Table 3. Continued

Name	Specialty	Research Assignment UWRL	Non-UWRL
	Water Resources Planning & Management (Continued)		
Daniel H. Hoggan	Water Resources Development--Planning, Institutions, and Financing, Hydrology	.25	-
Trevor C. Hughes	Water Resources Planning, Systems Analysis, Hydrology	.44	-
Jim Mulder	Political Science, Public Administration, Political Theory, International Organization	.45	.51
Dean F. Peterson	Water Resources Planning, Institutions, Hydrologic Systems	.09	-
Robert M. Walkingshaw	Water Quality Engineering and Computer Programming Application	.50	-
Frank Haws	Water Resources and Institutions, Water Law, Remote Sensing of Environment, Hydraulic Design	.50	-
John E. Keith	Resource Economics	1.00	-
Jay C. Andersen	Relationship of Resource Development to Economic Growth, Policy Implications of Resource Use, Relationships among Sectors of the Economy	.27	-
J. Paul Riley	Systems Analysis, Computer Simulation of Water Resource Systems, Hydrology, Water Resources Planning	.04	*
George Shih	Water Resources Hydrology, Instrumentation	.05	-
Eugene Israelsen	Hydrology, Simulation of Water Resource Systems	.23	-
Robert W. Hill	Hydrology, Water Resources Systems Analysis, Hydraulic Design	.15	-

*Non-UWRL research commitment shown elsewhere.

Table 3. Continued

Name	Specialty	Research Assignment UWRL	Non-UWRL
	Water Quality Management & Protection (E. J. Middlebrooks, Program Leader)		
V. Dean Adams	Chemistry of Water & Wastewater	.86	.14
A. Bruce Bishop	Engineering Economic Planning and Systems Analysis of Public Works (Water Resources, Transportation, Waste Management)	.20	*
A. Berry Crawford	Socio-Educational Relationships of Pollutants & Pollution Control	.10	.81
William J. Grenney	Computer & Laboratory Simulation of Aquatic Ecosystems, Planning & Economics of Wastewater Treatment	.60	-
Jerome J. Jurinak	Analysis of Effects of Agricultural Practices on Water Quality	.10	.62
E. Joe Middlebrooks	Biological Kinetics, Eutrophication, Process Control, Water Quality	.06	.65
Donald B. Porcella	Environmental Biology; Eutrophication, Water Quality, Radio-ecology	.54	.05
Robert M. Walkingshaw	Water Quality Engineering and Computer Programming Application	.50	-
Peter A. Cowan	Eutrophication of Surface Waters, Water Chemistry	.73	.18
Robert Gearheart	Water Quality and Solid Waste Disposal	.10	-

*Non-UWRL research commitment shown elsewhere.

Division leaders identified immediately under each program heading have established themselves as program builders, organizers, and idea generators in their areas of specialty. While their leadership and group management function is generally recognized, they serve without formal administrative assignments or special compensation. As the program continues to grow, more overt recognition of this group leader's responsibility will become necessary. However, to this point in time considerations of personnel mobility to form interdisciplinary teams of differing makeup as specific research opportunities come and go, the need to pool and share equipment and supporting personnel, and other factors argue for an organizational structure with jurisdictional resiliency and flexibility.

Personnel in the supporting services at the laboratory include highly specialized technicians (4) who construct and maintain experimental apparatus and equipment; field and laboratory technicians (4) who help carry out the research programs; and capable secretaries and clerks (12) who aid in laboratory production.

EDUCATIONAL LIAISON AND ACTIVITY

Research at UWRL is closely coupled to academic programs through substantial support of graduate research and through joint staff appointments. Nearly all of the professional staff are affiliated with an academic department and the majority have specific teaching assignments in an academic department. They also advise students, direct thesis work, serve on departmental and university committees, etc. UWRL researchers have had a very major role in revising and improving curriculum of regular departmental programs.

Student Training and Assistance

As a result of the close coupling of UWRL research to academic programs, involvement and participation by students in research activities has been substantial. The experience and training in research methods, and the introduction to and the stimulation of new ideas, comprise valuable components of formal training programs. Some 38 Ph. D. and 80 M. S. theses have been supported by research projects of UWRL. During FY 1972, 48 graduate students and 40 undergraduates participated in UWRL projects. In many instances graduate students use their research results to fulfill thesis requirements. Financial support provided by research amounted to more than $116,000 last year.

Short Courses

UWRL staff members help plan and conduct special short courses and institutes in cooperation with academic departments and the Conferences and Institutes Division. Typical events from recent years are: Summer Institutes on Water Resources Planning (8 weeks), Short Course on Water Resource Systems Analysis (1 week), International Seminar for Hydrology Professors (1 week), Conjunctive Operation of Desalting Plants (3 days), Water Users Workshop (3 days), Seminar on Development of Groundwater in Desert Basins (1 day), and several others.

Seminars and Visiting Scientists

Many outstanding researchers in water and related fields visit USU because of UWRL. These individuals are usually invited to present one or more seminars to graduate students and staff while they are here. Thus, this UWRL supported activity brings to students and staff an enrichment and variety of professional information that would otherwise not be available.

National Programs

With the help of UWRL staff members, national professional societies have held important meetings at USU. In recent years, Annual Specialty Conferences of the Hydraulics Division, ASCE, the Irrigation and Drainage Division, ASCE, have been held here. The University Council on Water Resources will hold its annual meeting on USU campus in the summer of 1974.

International Programs

UWRL personnel have been active in the promotion, development, and management of research and training programs abroad. The character of these programs have been greatly influenced by the inputs from UWRL staff who have been drawn on for both short- and long-term assignments.

RESEARCH PROGRAMS

Steady and balanced progress has been made in evolving a research program responsive to user needs. A close cooperation and coordination with state and federal agencies has been fostered. The research projects at UWRL are grouped in eight primary program areas. These programs are briefly described below and a listing of the current and recent projects is included to indicate the breadth and scope of the research.

Atmospheric Water Resources

Weather modification holds great potential for augmenting water supplies and suppressing hail storms and lightning. Additional basic research relating to atmospheric processes is needed. In parallel, the development of techniques to modify weather and establish operational procedures as integral parts of overall water management programs has begun.

Examples of research projects

- Computerized method of precipitation data quality control (USBR)
- Development and evaluation of cold cloud seeding technology for use in precipitation management (USBR)
- Evaluating meteorological clearing index (Utah State Div. of Health, NAPCA)

Hydraulics and Fluid Mechanics

Principles of fluid mechanics and hydraulics form the basis for solution of innumerable hydraulic design problems concerning control, regu-

lation, conveyance, and measurement of water in municipal, industrial, agricultural, and other uses. Research results provide the design criteria for improved economy, efficiency, and safety in handling flows under widely varying situations. Along with the research work, the facilities and staff of the hydraulics laboratory are available to state agencies, counties, cities, other government units, and private firms for tests and analyses of valves, flow meters, current meters, sediment samples, and other special hydraulic instruments and devices.

Examples of research projects

- Analysis of small water management structures (OWRR)
- Calibration of Parshall flumes with non-standard entrance transitions (Detroit Metro Water Department)
- Design and calibration of submerged open channel flow measurement structures (OWRR)
- Effect of seepage on hydrodynamic forces (NSF)
- Feasibility of rating current meters in a velocity field (USGS)
- Incipient motion of large roughness elements in turbulent open channel flow (NSF)
- Meter testing and calibration
- Numerical evaluation of wall effects of axisymmetric cavity flows (Navy)
- Pump discharge manifold model (Brown & Root, Inc.)
- Rating flow regulation structures in the Bear River canal system (Utah-Idaho Sugar Company)
- Relationship between channel forming flows, slope, and bed material in steep rough streams (Forest Service)
- Subcritical flow at open channel structures (OWRR)

- Three-dimensional free surface potential flows (NSF)
- Water hammer in varied PVC pipes (Johns Manville)
- Frictional and minor energy losses in PVC pipe (Johns Manville)

Hydroclimatic Measurements and Data Processing

Without adequate data the most sophisticated planning techniques are useless. Ways of collecting more data, obtaining it more efficiently, increasing its reliability, and presenting it in a format more compatible for decision-making deserves major emphasis. New instruments and methods of data acquisition through telemetry and remote sensing must be developed in support of important research and planning efforts.

Examples of research projects

- Computer simulation models to describe streamflow data (USDA)
- Detection of magnetic fields caused by groundwater (OWRR)
- Development of a portable direct reading open channel flow measuring system (USU)
- Digital data acquisition system (USU)
- Hydrologic Atlas of Utah (Utah DWR, OWRR)
- Measurement of sediment concentrations in streams by capacitance sediment probe (USDA, ARS)
- Measurement of soil moisture by attenuation of radio frequency waves (OWRR)
- Water quality telemetry (FWPCA)

Hydrologic Principles and Processes

Hydrology is a fundamental discipline concerned with the examination of the natural occurrences, movements, and distribution of water on,

above, or in the earth. A thorough understanding of the natural or hydrologic "flow system" and the effects of man's various uses upon its natural balance in terms of quantity, regimen, and quality, provides the underpinning for orderly and unified solution of almost all water problems.

Examples of research projects

- Hydrodynamics of hydrologic systems (USU)
- Hydrologic inventories of the Utah Lake Drainage Area, Uintah Study Units, and Weber Study Unit (WRD)
- Influence of mountain groundwater on streamflow (ESSA)
- Regional analysis of runoff characteristics for small urban watersheds (OWRR)
- Runoff estimates for small rural watersheds and development of sound design methods (FHA)
- Steady state plane seepage through porous media (NSF)
- Theoretical study of infiltration into range and forest soils (USDA)
- Urban storm runoff inlet hydrograph studies (FHA)
- Watershed infiltration phenomenon (ARS)

Hydrologic Systems Analysis and Simulation

A through understanding of the natural occurrence, movement, and distribution of water is basic to planning and underlies the orderly and unified solution to most water problems. Furthermore, the degree of understanding of the complex relationships between the physical watershed, precipitation, evapotranspiration, groundwater and flow of streams determines how well design floods, surface and underground reservoir yields forecasts, etc., can be calculated. As hydrologic phenomena and processes become better understood, they can be

described mathematically and/or modeled by computers so that the consequences of specific development alternatives can be projected.

Examples of research projects

- Application of an electronic analog computer to the simulation of the total hydrologic-economic flow system (OWRR)
- Applications of an electronic analog computer to the evaluation of the effects of urbanization on the runoff characteristics of small watersheds (OWRR)
- Computer simulation of urban hydrologic systems (OWRR)
- Development of a simulation model for the Bear River basin (OWRR)
- Development of hybrid computer models for the Upper Jordan River drainage (USBR)
- Electronic analog simulation of the salinity flow system within the Upper Colorado River basin (FWPCA)
- Hybrid computer simulation as applied to the management of water salinity within a hydrologic system (OWRR)
- Hybrid computer simulation of the hydrologic flow system within the Bear River basin (OWRR)
- Modeling the snowmelt process (ESSA)
- Modeling the total hydrologic-sociologic flow system (OWRR)
- New techniques of hydrologic analog modeling (ARS)
- Simulation model of the San Juan River basin (Clyde, Criddle, Woodward)
- Simulation study of the Upper Apure River basin of Venezuela (CIDIAT)
- Western coniferous forest biome model (USU Ecology Center)

Water Conservation and Augmentation

Utah's arid setting prescribes a major thrust of applied research directed toward improving our water supply situation through augmentation

techniques or by conserving the limited supplies available. A wide spectrum of possibilities need study and research to determine the most effective, efficient, and economic measures applicable to domestic uses, industry, and agriculture. Both structural and nonstructural measures are involved.

Examples of research projects

- Economics of large scale desalting plant (Department of State)
- Management practices for control of quality and quantity of irrigation return flow (EPA)
- Optimal operation of desalting plants as a supplemental source of firm yield (OSW)
- The effect of compacting snow on underlying soil and crops (Thiokol)
- Water management research in arid and sub-humid lands in less developed countries (AID)

Water Resources Planning and Management

A critical area of water research is the development of new methodology and criteria for water resources planning. Such procedures have not kept pace with the increasing complexity of the planning mix which interlinks physical, social, political, legal, and economic elements. It is important to quantify and relate these elements functionally to accurately project and predict the consequences of particular planning decisions. Modeling and simulation techniques which portray total river basin hydrology offer tremendous potential for rapidly testing alternate schemes for development. Once developed, such models provide excellent planning and operating tools for those having responsibility for

regulating, allocating, planning, and administering the water resources.

Examples of research projects

- Application of electronic analog device to solution of hydrologic and river-basin planning problems (OWRR)
- Application of operations research techniques for allocation of Colorado River waters in Utah (OWRR)
- Development of techniques for estimating the benefits of water resources development in achieving national and regional social goals (OWRR)
- Effective communications with the public in Corps of Engineers planning studies (Corps of Engineers)
- Evaluating potential integration of intertie of water resources project of the Bear, Weber, and Jordan Rivers (Utah DWR)
- Evaluating water reuse alternatives in water resource planning (OWRR)
- Evaluation of flood risk factors in the design of storm drainage systems for urban areas (OWRR)
- Inter-regional planning of water resource allocation (Corps of Engineers)
- Optimizing conjunctive use of surface and groundwater (OWRR, Utah DWR)
- Study of alternative methods to modernize water institutions and eliminate problems of multiple jurisdiction and conflicting objectives (OWRR)
- Study of the effectiveness of water resources planning groups (OWRR)
- Study of water institutions in Utah and their influence on the planning, developing, and managing of water resources (OWRR)
- Water related land use studies of the Utah Lake, Bear River, and Weber River drainage areas

Water Quality Management and Protection

Few problems are of broader concern, more complex, or of greater significance in terms of satisfying society's water demands and enhancing the natural environment than maintenance of good quality water. The detection and identification of pollutants, their sources and fate, their effects on uses of water by man and on the aquatic environment, waste treatment processes, water treatment processes, etc., all need attention, along with organizational mechanisms for efficient and effective quality management.

Examples of research projects

- Bacterial adsorption on soils (FWPCA)
- Biological effects on interchange of metals and of nutrients between sediments and water (OWRR)
- Destratification of Hyrum Reservoir (USU)
- Detergent and nondetergent phosphates in sewage (Procter and Gamble)
- Effect of carbon on algal growth--its relationship to eutrophication
- Effects of water temperature increases on toxicity of waste discharges (OWRR)
- Toxicity of Birkoline to Algae
- Eutrophication of surface waters (USU)
- Intermittent sand filtration to upgrade existing wastewater treatment facilities (OWRR)
- Quality of irrigation return flow (FWPCA)
- Quality standards for multiple use of water in arid regions (USU)
- Sequential water use (FWPCA)

. Sorption kinetics in flow through granular particles (PHS)

. Water and waste treatment processes (USU)

Future Plans for the Research Program

Future research plans at UWRL are more properly plans for expanding the horizons of the present research base rather than in initiating brand new thrusts. From a reasonably good base UWRL anticipates major emphasis in the following areas:

1. Problems of water quality protection and improvement will continue to grow in relative importance. UWRL hopes to expand its water quality work to include studies of water reuse and recycling, algae removal, control of salinity in river basins, modeling of water quality, groundwater pollution management, water quality carrying capacity of mountain watersheds, water quality of return flow, and others.

2. Urban water problems will be given increased emphasis, particularly the changing pattern of land use and the related changes in water requirements. Integrated urban land and water use planning studies are seen as an important part of the future research effort. UWRL has recently added an urban water resources expert who will be expected to promote research in this subject area.

3. Simulation and modeling applied to water problems will continue to be an important water research effort. Improvement in the time and spatial resolution of physical models will continue, but major emphasis will be given to interlinking the physical system to quality, economic and social systems.

4. Financial, operational, regulatory, and managerial policies of water institutions will need evaluation and study. Environmental considerations in planning and management will assume high priority. Evaluation of economic importance of various uses of water will still be stressed and the factors of cost allocation, cost sharing, pricing and repayment will receive even more attention than in recent years.

5. Systems analysis will be further developed as a water resource planning tool, but increased attention will be given to the effects of risk and uncertainty on decisions and to the use of multi-objective functions in practical, easy-to-use applications.

PROGRAM REVIEWS AND CHANGES

Program reviews and changes constitute a continuous, but oftimes subtle, process at UWRL. The general program areas noted in the previous section have served quite well to accommodate the broad-based program that has been UWRL's goal. Under the operating mode imposed by the predominence of "soft" money support, program changes may be somewhat automatic and perhaps quite responsive to current user needs.

Perhaps one of the most important assessments of programs takes place in the review of the research proposal itself. Since UWRL submits many different proposals to a variety of state, federal, local, and private groups, their reviews constitute valuable guides as to what problems are critical and what kind of research thrust must be formulated. To a very substantial degree, awards from granting and contracting groups dictate the direction the research program takes. This has its good and bad aspects. If UWRL is to remain competitive for available outside funding, it must respond to the priorities commonly specified by those underwriting the costs of the research. Thus, staff are constantly alert to research needs and have good opportunity to help define these with potential clients. On the other hand, the ability to consciously manage to achieve a prescribed kind of balance in the UWRL research program is curtailed.

All research in UWRL, regardless of funding source, is conducted according to individually budgeted and managed projects. Each project

has a specified duration and budget. Projects phase in and out constantly and thus changes in program emphasis takes place accordingly. Monthly meetings are scheduled with each project leader to review fiscal and technical management of the project. These regular meetings provide good opportunity to review individual progress and follow-on opportunities. Meetings with project leaders and general staff are scheduled at irregular intervals with one of the principal agenda items being that of new research opportunities. As new research opportunities are identified, selected staff are invited to discussion sessions where preliminary scoping of research approaches are attempted. In recent years, nearly all of these research opportunities have centered around particular problems of an interdisciplinary nature. Consequently, lines between designated program areas become rather indistinct.

The annual budgeting process provides occasion for program review and assessment. Justifying budget requests which are proposed for state legislative action results in a good deal of introspection and reappraisal about orientation of research effort. (While the exercise has been helpful in terms of self appraisal of programs and the dialogue during administrative scrutiny of budgets is valuable, the ultimate intent of gaining an increased state appropriation has met with limited success.)

It could be said in summary that the UWRL research program has been characterized by steady growth and expanded horizons since its beginning. The early emphasis on hydraulics and fluid mechanics has expanded to include a series of viable programs such as hydrology,

hydrologic and climatologic instrumentation and telemetry, precipitation enhancement, water quality and pollution control, water system modeling, water resources planning techniques and methodology, and perhaps others. Advanced tools and techniques from mathematics, statistics, operations research, and systems engineering have been routinely incorporated. Computers and computer technology have been adopted from the beginning and the hard and software advances have been utilized just as rapidly as available. In fact, UWRL personnel have made some novel uses and adaptations which were well ahead of the general art. The melding of the "hard" and "soft" sciences in formulating research approaches to problem situations constitutes a significant change from earlier approaches. The UWRL has matured as a campus centrality for water research in all its dimensions and ramifications.

PRODUCTIVITY

Publications*

The Utah Water Research Laboratory has established five categories of publications. (See Figure 3 and Table 4 for summaries.)

(1) Project Reports are preliminary, continuing, and final reports of projects being studied, developed, and investigated by the staff. These publications are reviewed by a manuscript review committee before being printed to help maintain technical as well as editorial quality. There have been 178 project reports published since the laboratory was opened, and an average of 300 copies each have been disseminated.

(2) Occasional Papers are papers worthy of publication prepared for presentation at a symposium or conference, but not published in a proceedings of that symposium or conference. They might also be papers of general information about certain aspects of the Utah Water Research Laboratory program.

(3) Proceedings are papers presented at symposiums or conferences sponsored entirely or in part by the Utah Water Research Laboratory.

(4) Reprints are articles contributed by staff members to professional journals and magazines, and are available for distribution from the laboratory. Two hundred copies of each of these are ordered and made

*Publications included are those by staff housed in UWRL. No attempt has been made to include reports or reprints of staff outside the laboratory.

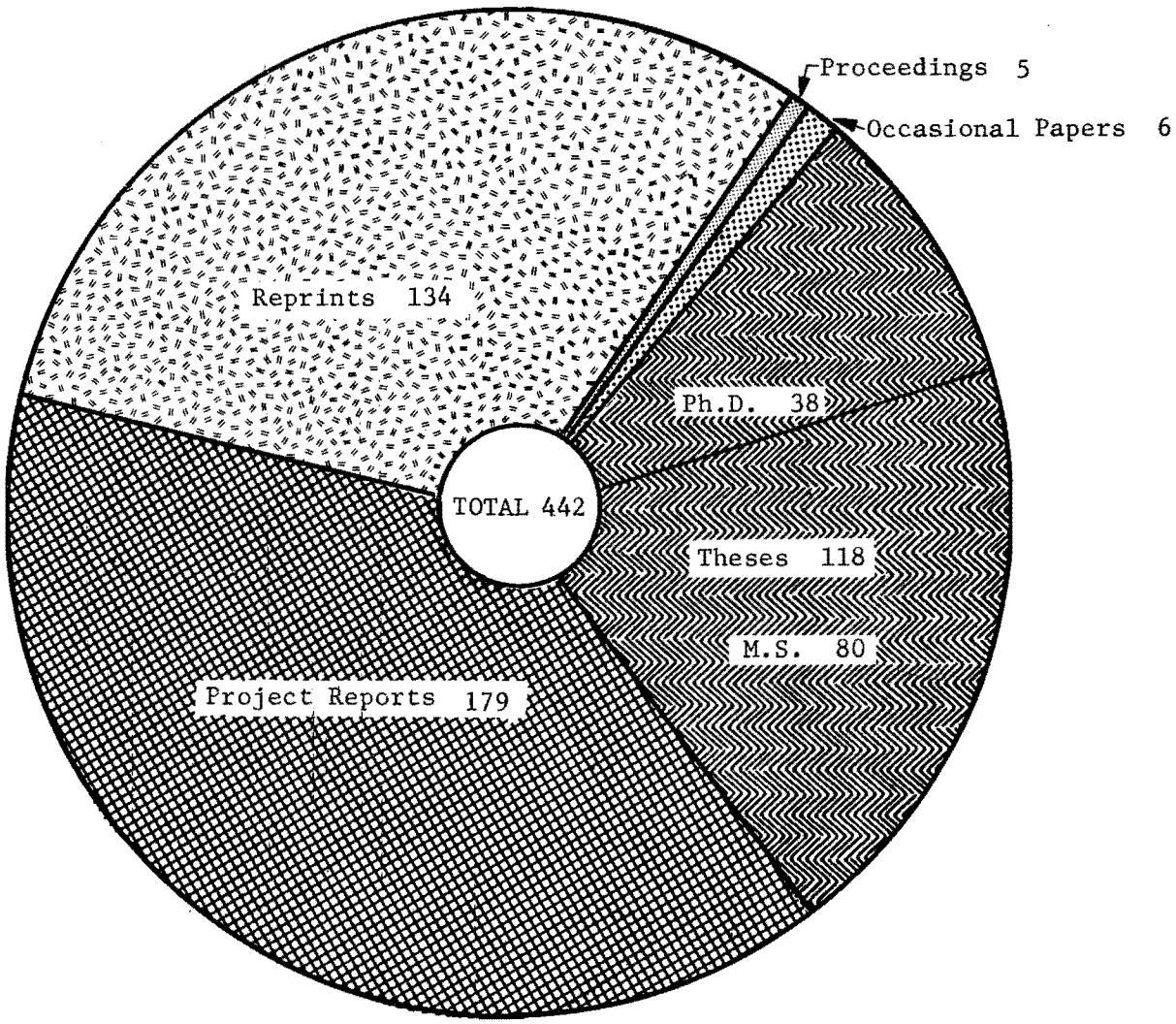


Figure 3. UWRL publications, 1964-1972.

Table 4. Utah Water Research Laboratory publications summary sheet to 1972.

Publication Category \ Date	To 1964 *	1965	1966	1967	1968	1969	1970	1971	1972	Total
Project Reports	39	14	12	24	11	24	24	16	15	179
Theses										
Ph.D.	1	3	1	3	4	8	6	6	7	118
M.S.	8	9	11	11	5	8	11	7	9	
Reprints	32	10	10	12	14	13	15	18	10	134
Occasional Papers				1	1	1	2	1		6
Proceedings			1	2	2					5
TOTAL	80	26	45	53	37	54	58	48	41	442

* Includes publications of water research conducted in Engineering Experiment Station after authorization of UWRL (1959), but prior to official functioning.

available to fill requests, or to disseminate at the author's discretion.

(5) Theses are also sponsored in full or in part by the laboratory, or are supervised by laboratory personnel. There have been 118 publications in this category. (See Figure 4.)

The Aquarius Newsletter is also a publication of the Utah Water Research Laboratory and the Utah Center for Water Resources Research. Aquarius is sent to 2600 in-state and out-of-state people who have shown an interest in water research activities at the Utah Water Research Laboratory. The newsletter is published every other month and each issue highlights at least one research activity at the laboratory.

All of the Utah Water Research Laboratory publications are prepared and printed in-house. An MTST type system is used to give UWRL publications a professional appearance with a choice of type sizes and styles, justified right margin, etc.

The publications are disseminated to each state water resource center as well as to many libraries and other research centers. Publications are rarely of a general nature, but their availability is announced to those who may be concerned with the research, and the titles are placed in national indexing systems.

Research Proposals

Some 250 proposals have been written and submitted by laboratory staff and are responsible for a major portion of the research financing. During the last fiscal year 42 research proposals were prepared and

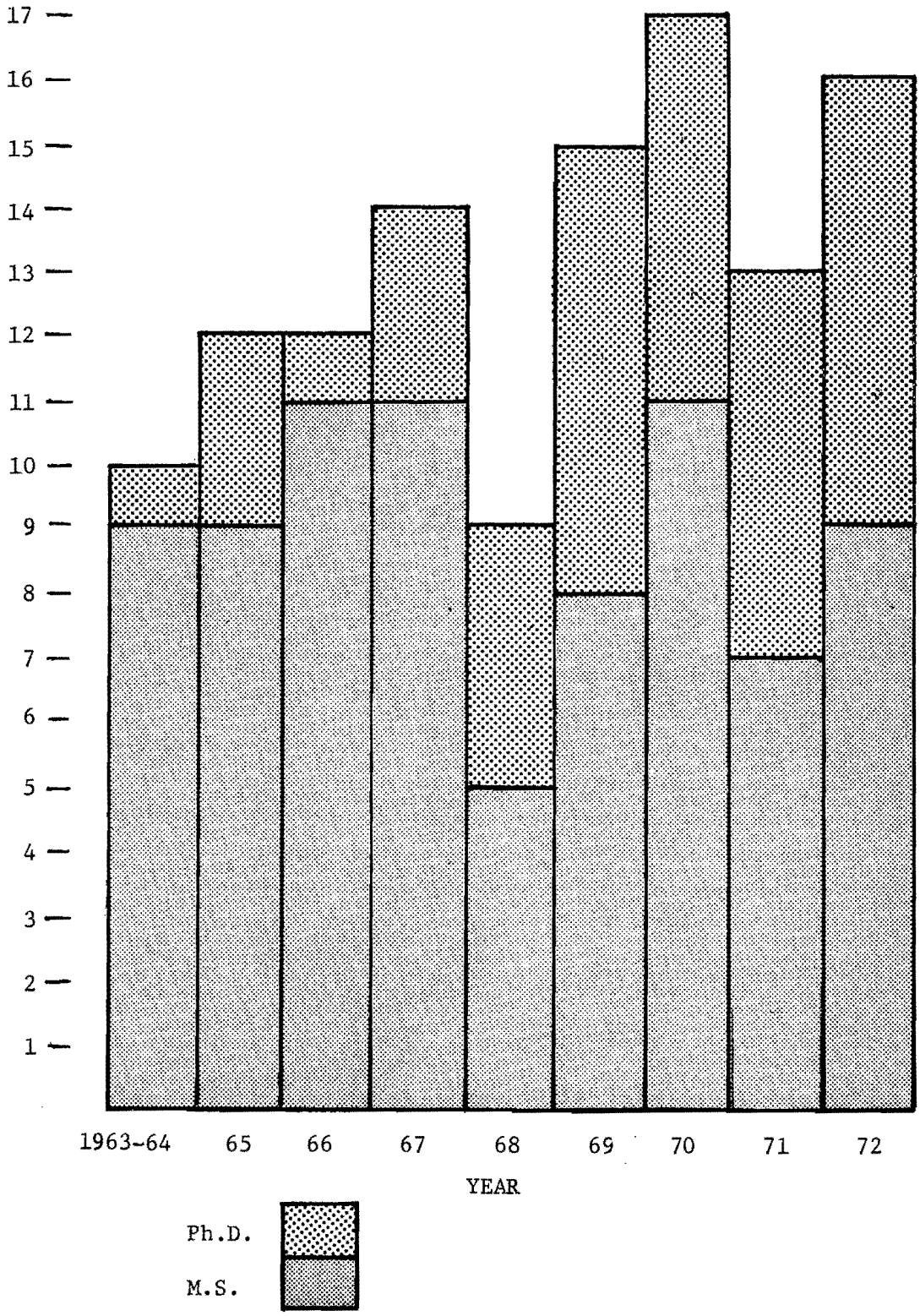


Figure 4. Theses sponsored by UWRL or supervised by UWRL staff.

$1,450,000 was secured in non-state funds for research. The number of proposals submitted annually over the past several years is shown in Figure 2.

Public Relations and Services

The most effective influence the Utah Water Research Laboratory has on the public is probably through direct contacts between the public and the laboratory and/or the staff. These personal contacts come from such things as seminars, laboratory tours, short courses, committee envolvement, and public speeches. (See Table 5.)

During the past fiscal year the laboratory:

. Planned, organized, and presented a short course for 36 participants on the application of systems engineering principles to water resource systems planning. This was for the purpose of improving and up-grading the analytic tools and skills of private, state, and federal planners.

. Provided special advice and counsel to state and local entities on a wide range of water problems through more than 1600 individual letter and telephone inquiries and participation in numerous meetings of committees, councils, boards, etc. UWRL staff members delivered 29 technical lectures and made 50 semi-technical talks.

. Sponsored 18 seminars for staff, students, and agency personnel to provide forums for consideration of timely water issues and new research directions.

. Met requests for 35 laboratory tours to familiarize interested groups in the research activity underway.

The laboratory also has an influence on the public through the news media--television, newspapers, and radio. Releases and features are sent to these media throughout the year.

Table 5. UWRL-to-Public Communication FY 72.

Item	Number of Events	Numbers Issued or Audience Size
Aquarius Newsletter	6	15,600
Press Releases	20	150,000 (each release)
Technical Lectures	29	1,425
Popular Talks	50	1,860
Sponsorship of Seminars	18	460
Correspondence and Telephone Inquiries (est)	1,615	1,615
Laboratory Tours	35	1,750

NEED FOR UWRL BUILDING, FACILITIES, AND EQUIPMENT

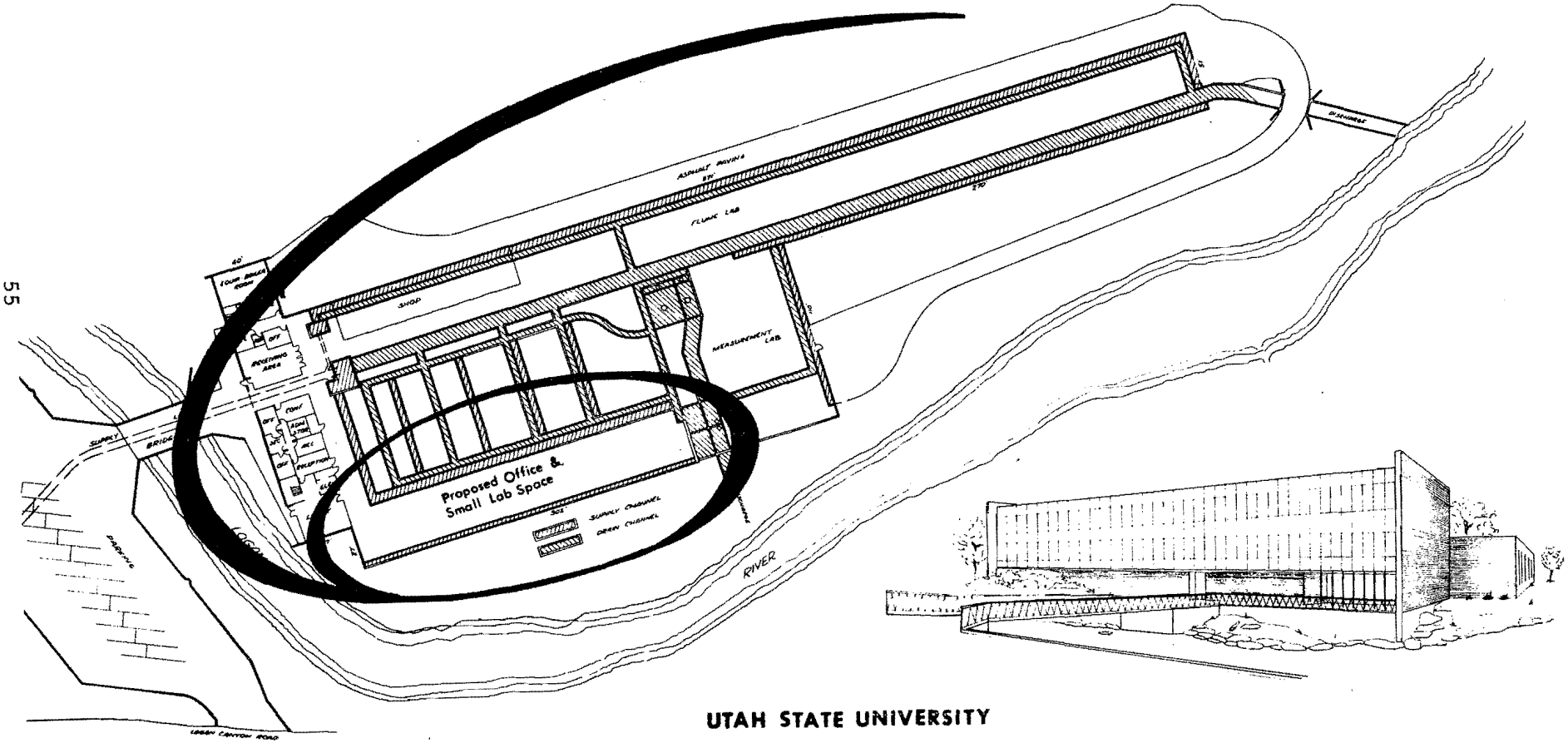
Building Completion

If the research program of UWRL is to continue to enjoy steady and balanced growth, its physical facilities must be expanded and improved. In the seven years since the laboratory has been occupied, the research program has increased more than tenfold. This dynamic program growth has been accompanied by essentially static levels of input for capital equipment and facilities, making it increasingly difficult to operate effectively. Further delay in completing the last phase of laboratory building construction will seriously affect the laboratory capability to conduct the water research program and to compete for certain kinds of water research funds.

The laboratory building was originally designed and constructed with roughed-in utility and structural connections to facilitate the addition of permanent office and laboratory space along the north wall within the open-bay area of the building. Because the "shell" already exists, this addition can be accomplished expeditiously and can provide two floors of much needed space at minimum cost. An additional 2050 sq. ft. of office space and 7470 sq. ft. of special laboratory space can be provided for an estimated cost (1972) of $536,900. This figure includes construction costs, heating, air conditioning, office furnishings, laboratory benches and equipment, and apparatus. The proposed floor plans for the completion phase are shown in the accompanying drawing.

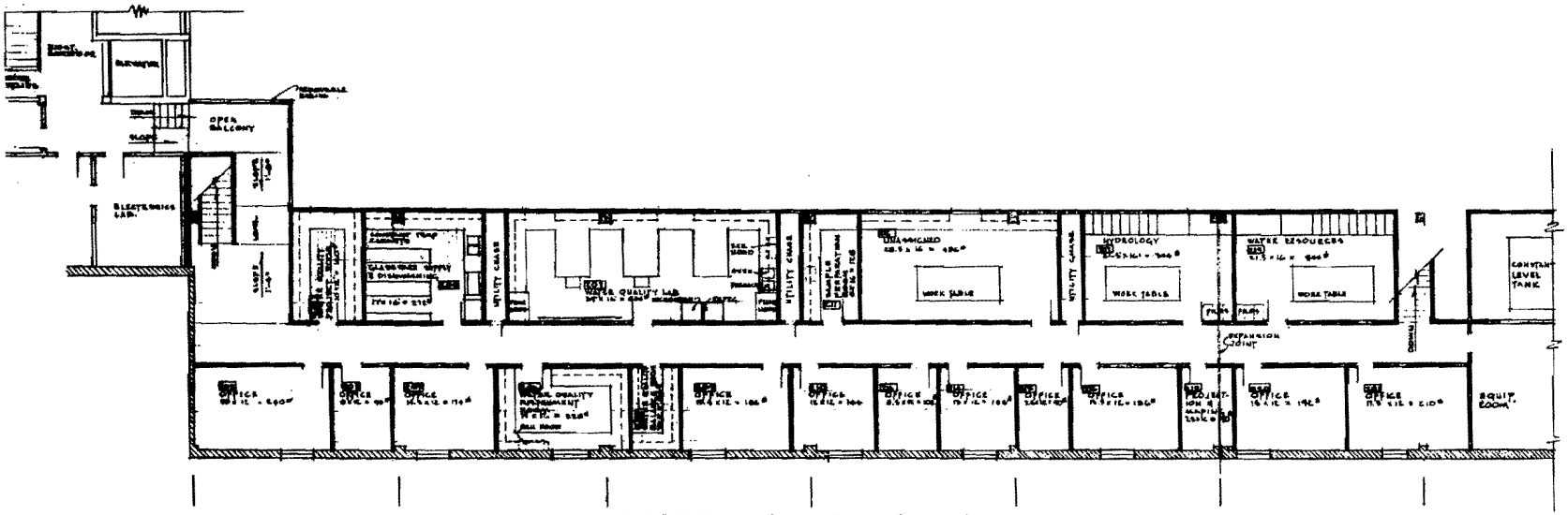
URGENT BUILDING NEEDS

UTAH WATER RESEARCH LABORATORY

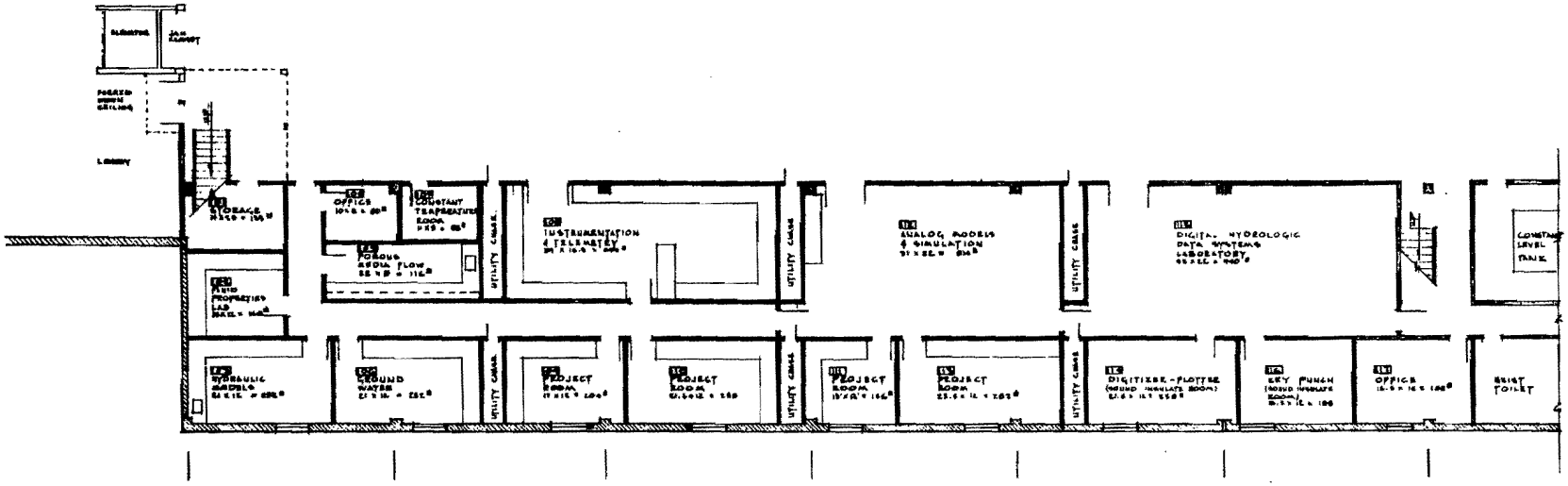


UTAH STATE UNIVERSITY

LOGAN, UTAH



SECOND FLOOR PLAN



FIRST FLOOR PLAN

PROPOSED OFFICES & LABS
UTAH WATER RESEARCH LABORATORY
UTAH STATE UNIVERSITY

KENNETH W. JONES A.I.A. ARCHITECT

A few specific problems associated with the existing, inadequate facilities at the laboratory are outlined below.

1. Water quality research space is critically inadequate.

While the water quality program is growing rapidly and research opportunities are good, the present laboratory facilities are overtaxed and severely lacking in many respects. Pending completion of permanent laboratories, needs have been met by providing temporary space in the large open-bay portion of the laboratory. This space has an open ceiling and is enclosed only with temporary wood partitions. Problems of heating, lighting, and circulation make it necessary to maintain this open exposure. However, since the space cannot be isolated from the remainder of the laboratory work area, fumes from welding, combustion engines, etc. act as toxicants in biological experiments and interfere with some of the sophisticated analyses. Dust and particulate matter enter easily and quickly covers everything. Temporary laboratory benches are difficult to clean and are not designed for laboratory analysis. Glassware and other equipment cannot be effectively stored because there are no dustfree cabinets. Washing facilities are primitive. Electrical power, natural gas, lighting, temperature control, and water supply are barely adequate for most work and inadequate for some projects. These problems make analysis more time-consuming and less efficient, shorten the life of the instrumentation, and generally create a very poor impression in site visits by sponsoring agencies.

The temporary water quality laboratory space is located some distance from the water quality labs provided originally in the office wing of the building. This situation splits the facilities and leads to some duplication of glassware and other commonly used items.

Increasing research and graduate student thesis projects added to the sponsored projects have strained the facilities to the limit. Because of the congestion, students and technicians are disrupting each other's work. At present there are more than eighteen students and staff members working on a variety of projects in this temporary space. As an example of the special needs which cannot be adequately met by the present facilities, there are projects in hand and others in the proposal stage that require an atmosphere-controlled, environmental-controlled, laboratory space. Such space has been planned in the completion phase. Needs are being temporarily met by rather unsatisfactory plastic enclosures with primitive controls.

2. A temporary sewer system poses a contamination hazard.

Because of the location of the temporary water quality laboratory in the west end of the building at a considerable distance away from any existing sewer lines, it was necessary to provide a makeshift sewer line connection to this laboratory area. A sump pump and overhead line were provided. This temporary system constitutes a hazard should an overload occur or should pumps or pipes fail. Chemical reagents, carcinogenic materials, and other highly toxic agents must be disposed of through this system to the Logan City sewer. Failures would cause these discharges to be diverted into the Logan River.

3. More staff office space is needed.

Permanent offices within the laboratory building are fully occupied and have been for some time. In fact, two small laboratories and two project work rooms have had to be partitioned for office space. Some permanent staff and graduate research assistants are located in temporary offices provided by wood partitions in the open-bay area of the building. These rooms are rather poorly lighted, noisy, dusty, and inconvenient from the standpoint of coordinating activities with other offices. Large open areas without suitable partitions and cabinets constitute poor utilization of space, and inadequate provisions for heating and air conditioning make these areas costly to operate and maintain.

Temporary office and laboratory space provided in the annex building (the old residence) is even more remote from the normal flow of activities in the laboratory than the temporary offices in the open bay. Consequently, a greater loss of time and effort results from coordinating activities. The annex is in an advanced state of deterioration, and as a result is also costly to maintain. Furnishings are makeshift and inadequate.

4. Instruments and equipment are difficult to maintain in the temporary space.

The open, environmentally uncontrolled, temporary space provided for the hybrid computer and simulation equipment is not conducive to its most efficient operation and maintenance. Dust and heat are both adverse elements to contend with. A makeshift window air conditioning unit has been installed to reduce the temperature in the area.

The atomic absorption equipment in the basement of the annex requires an isolated atmosphere for silver analysis. Although the basement provides the required isolation, the deteriorated condition of the plumbing and the annex in general makes this location much less than ideal. The expensive equipment located there is also in jeopardy from possible flood damage. Sand bags and temporary levees along the river next to the annex have been required at times to limit flooding of the basement.

5. Centralization is needed for Weather Modification Program.

The new 3-year contract on weather modification calls for development of an operational control center. Such a center must receive and process information from weather facsimile, weather teletype, computer teletype, radar and rawinsonde, and hydroclimatic radio telemetry. These data are fed into programs and models and the results used in real time operational decisions. This operation is presently scattered in several different locations including the annex. Until the final phase of construction is completed, it will be impossible to centralize this program.

Parking Lot

With the research program still growing and the parking lot already full much of the time, expanded parking facilities are urgently needed now and will be needed even more urgently when the building is completed. The open irrigation canal traversing the UWRL property makes full utilization of the property difficult. Putting the canal in a pipe will make the necessary parking area available.

Auxiliary Water Wells

During the low river flow season there are times when additional flow has been needed to carry on the hydraulics work of the laboratory. Furthermore, some experiments require large flows of clean water. This can best be supplied from a deep well. The permit for the first of three wells has been approved. Deadline for completing the well was June 30, 1971, but a 3-year extension has been granted by the State Engineer. It is imperative that the well be completed by the 1974 deadline.

Laboratory Equipment

The following items are basic to a water research laboratory and are normally built or wired into the structure so as to be a permanent part of the building:

Tilting Flumes - Plans are already prepared for a high velocity tilting flume and a variable infiltration sediment recirculating flume. These unique flumes are necessary to make possible certain kinds of research. Already the laboratory has lost several possible research grants due to lack of long tilting flume facilities. Outside money for flume construction has not been available. Research contracts and grants cannot provide such major equipment and facilities. State funds must provide the basic facilities which are needed to take on the wide variety of needed hydraulic research.

Digital Data Acquisition System - This modern data recording and processing system will greatly expedite experimentation and evaluation

of results. It will open doors to many kinds of additional research in fluid mechanics, hydraulics, hydrology, and water quality.

Flow Meters and Measuring Equipment - These devices are basic to the efficient operation of a hydraulics laboratory. Their purchase and installation has long been deferred and should now be implemented.

PROBLEMS, NEEDS, AND CHALLENGES

Financing Imbalance

The lagging level of state line item appropriation leads to several concerns such as:

1. diminished responsiveness in support of state mission agency needs;
2. growing backlog of critical equipment needs;
3. insufficient funds for matching;
4. dwindling ability to "cushion" unexpected cuts in federal funding;
5. elimination of "growth" or "working" capital;
6. inadequate backup for "breakage";
7. less stimulation and support for interdepartmental collaboration; and
8. inadequate basic program support.

Teaching Interface

Teaching opportunities are not expanding in proportion to UWRL research. Consequently, joint teaching-research appointments are becoming more limited and/or the proportion of teaching time is being lessened for UWRL staff. While this does not have a detrimental effect on research productivity, most senior researchers with terminal degrees desire some classroom teaching. The lack of teaching opportunity has two principal drawbacks: (1) it becomes more difficult to attract truly

outstanding researchers who prefer some teaching and (2) academic programs suffer because curriculum cannot be expanded and enriched even though the capability is at hand to bring this about.

Interdepartment and Interdivision Collaboration

The typical mode for conducting research at UWRL is that individuals of differing specialties are organized to work as an interdisciplinary team on a problem whose solution requires such input. Such teams form and reform in different mixes as projects phase in and out. An individual may be project leader, principal scientist, or a consultant, in constantly changing proportions over time as specific opportunities come and go. Under this mode of operation where financial support is predominantly "soft", there must be flexibility yet consistency in management, a certain mobility in personnel and a sharing or pooling attitude with respect to supporting facilities, equipment, and services. Without this the cushioning of shocks resulting from funding fluctuations is impossible.

In a larger scale, some of the most challenging and important research opportunities of the future will require a willingness and capability to operate somewhat in the pattern described above. This will require increased interaction and interface between campus divisions and their personnel. Thus, organizational structure and operating policies should be in effect which will facilitate and even encourage interdepartmental or interdivisional association and collaboration at the staff level. When whirling gears are brought together, unless their cogs are of a similar dimension and their peripheral speeds equal and in the same direction, there is likely

to be some grinding and grating in the meshing attempt. Similarly, if campus professionals are to divide or transfer their effort, in changing proportions over time and among different campus divisions, then university policies must be consistent between and among research units and academic departments if they are to successfully interface.

This means that policies with regard to personnel appointments, titles, promotions, tenure, salary structure, etc., should assure professional equity regardless of departmental affiliation or functional assignment. The plain fact is, that departmental interaction requires joint appointments and differing personnel policies operating on the same individual creates problems. These problems will tend to discourage cooperation rather than foster it. Achieving this necessary professional equity under the funding realities that prevail would suggest there be overt recognition that (1) teaching and research are co-equal in importance and priority to the university mission, (2) that tenure be conditioned not according to source of funds but only availability, and (3) that in the event funds are not available, personal productivity and importance to the university mission would be paramount factors in determining who is retained.

If USU wants to reach the positions of strength and excellence for which the potentials exist, then operating with a significant proportion of "soft" money must be accepted. If soft money is a part of the standard operating mode, then the attendant risks must be borne by all. Accomplishing this means that financial resources should be regarded as

"pooled". It follows from this that tenure is disassociated from source of funding. This, in turn, requires a published strategy for evacuation if the ship begins to list. So long as all this is stated before people come aboard, they will accept the conditions or seek safer passage elsewhere.

International Programs

UWRL has provided a reservoir of expertise that have been drawn on intermittently to assist with international programs. Presumably, there is a net gain to the university in this process but the tangible gain to UWRL is not always apparent. There are several reasons for this. First, the work abroad has been more of a training or extension activity than research. Involvement seldom results in research contracts. Secondly, responding to foreign calls can be quite disruptive to ongoing work on campus. UWRL projects are conducted under a tight technical, budgetary, and time framework. Our livelihood depends on maintaining a reputation for meeting these committments. It is often difficult to make satisfactory adjustments to foreign leaves which guarantee that the research committments are fully met. Thirdly, foreign assignments normally require some "start-up" or "ready" time locally, and some readjustment or wind-down activity upon return. This is generally not provided for in the foreign activity and becomes an added burden of time and expense that must be borne by research projects.

Obviously, the key to a successful interface with international programs is careful coordination, advance scheduling, and a realistic appraisal of tradeoffs entailed.

Dissemination of Research Results

One of the most important yet difficult problems UWRL faces relates to the implementation and use of research findings. Researchers use some rather sophisticated hard and software (equipment, instruments, mathematical and statistical theory, etc.) in their study of problems. Their reports and recommendations are couched in the language of these tools. At the same time decisionmakers are insisting on practical, down-to-earth, easy to use applications. We need to establish working relationships which bring the user more intimately into the research identification and research approach formulation, and which permit the researcher to follow his brainchild into the implementation phase as an integral part of the user agency staff.

Business Support

A dynamic and continually changing research program requires a management-oriented fiscal accounting and control function. The concern is not so much with whether certain balances were achieved looking back but whether the fiscal situation today suggests management decisions for the future. Fiscal management should be in tandem with technical management and serve not direct it. Over the years, business management has been a significant problem to UWRL. While major improvements have been made recently, it is probably fair to say that the business interface will need continuing attention to assure that it serves the needs of the time.