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HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND WATER RESOURCES

OF THE

COMMITTEE ON
INTERIOR AND INSULAR AFFAIRS

UNITED STATES SENATE

NINETY-FOURTH CONGRESS

FIRST SESSION

ON

S. 1301

A BILL TO PROMOTE A MORE COMPREHENSIVE NATIONAL
PROGRAM OF WATER RESOURCES RESEARCH AND TECH-
NOLOGY DEVELOPMENT TO REORGANIZE CERTAIN FUNC-
TIONS IN THE DEPARTMENT OF THE INTERIOR, AND FOR
OTHER PURPOSES

JULY 11, 1975



Printed for the use of the
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MEMORANDUM

TO : THE PRESIDENT
FROM : THE SECRETARY OF THE INTERIOR
SUBJECT: PROPOSED REVISIONS TO THE NATIONAL ANTIMONY ACT

The Department of the Interior has the honor to acknowledge the receipt of your letter of the 10th inst. regarding the proposed revisions to the National Antimony Act. The Department is currently reviewing the proposed changes and will submit a report to you by the 15th inst. The proposed revisions are intended to clarify the language of the Act and to provide for more effective enforcement of the provisions relating to the export of antimony. The Department believes that these changes are necessary to ensure the integrity of the Act and to protect the interests of the United States in the antimony trade.

The proposed revisions are as follows: 1. The definition of "antimony" is expanded to include certain alloys and compounds. 2. The maximum quantity of antimony that may be exported without a license is reduced from 10,000 pounds to 5,000 pounds. 3. The penalty for violation of the Act is increased from \$10,000 to \$20,000. 4. The Act is amended to provide for the seizure of antimony in transit.

WATER RESOURCES RESEARCH AND TECHNOLOGY DEVELOPMENT ACT

FRIDAY, JULY 11, 1975

U.S. SENATE,
SUBCOMMITTEE ON ENERGY RESEARCH AND WATER RESOURCES,
OF THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D.C.

The subcommittee met at 10 a.m., in room 3110, Dirksen Office Building, Hon. Paul J. Fannin, presiding.
Present: Senators Fannin and Haskell.
Also present: Ben Yamagata, counsel.

OPENING STATEMENT OF HON. PAUL J. FANNIN, A U.S. SENATOR FROM THE STATE OF ARIZONA

Senator FANNIN. The hearing will come to order. This morning we will consider S. 1301, to promote a more comprehensive national program of water resources research and technology development to reorganize certain functions in the Department of the Interior.

This is a hearing of the Subcommittee on Energy Research and Water Resources. The Subcommittee on Energy Research and Water Resources has convened this hearing to receive testimony on S. 1301, a bill introduced at the request of the administration to combine into a new office of Water Research and Technology those functions authorized by the Saline Water Conversion Act of 1971 and the Water Resources Research Act of 1964.

We are in the throes of an energy crisis with some very fundamental differences dividing Members of Congress and, also, the executive branch over possible solutions. Part of that division must be attributed to the fact that we are reacting to a crisis.

Water is much like energy. It is a fundamental resource, one vital to society. Our capability to provide water, like energy, will be limited by the sophistication of our management. But, while we have the data-gathering systems, the trained personnel to advise policymakers and, until recently, the commitment towards technological advancement in water resources, our water managers have reduced Federal support for training institutions, for research programs, for planning.

If this continues, the "stepup" we have on water resources research and management will be lost and instead of acting to avert a water crisis, we'll be reacting to a crisis.

So, I'm sure I express the sentiment of the subcommittee in its support of water resources research and training and technology development.

The real questions are, how do we achieve the optimum mix between public and private efforts and how should public efforts best be directed? Perhaps this legislation will provide part of the answer.

At this point in the record, I will insert the text of S. 1301 and the relevant Department reports.

[The material referred to above follows:]

94TH CONGRESS
1ST SESSION

S. 1301

IN THE SENATE OF THE UNITED STATES

MARCH 21 (legislative day, MARCH 12), 1975

Mr. CHURCH (for Mr. JACKSON) (for himself and Mr. FANNIN) (by request) introduced the following bill; which was read twice and referred to the Committee on Interior and Insular Affairs

A BILL

To promote a more comprehensive national program of water resources research and technology development to reorganize certain functions in the Department of the Interior, and for other purposes.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*

3 SHORT TITLE

4 SECTION 1. This Act may be cited as the "Water Re-
5 sources Research and Technology Development Act of
6 1975".

II

1 AMENDMENT OF WATER RESOURCES RESEARCH ACT OF
2 1964

3 SEC. 2. The Water Resources Research Act of 1964,
4 as amended, is further amended to read as follows:

5 (a) In title I delete the word "September" in section
6 102 and insert "December" and in the first sentence of the
7 second paragraph of section 104, delete the word "July"
8 and insert "October.".

9 (b) Substitute the following title II:

10 "TITLE II—WATER RESOURCES RESEARCH
11 AND TECHNOLOGY
12 "DEVELOPMENT PROGRAMS

13 "SEC. 200. (a) The Secretary of the Interior is au-
14 thorized to make grants and finance contracts and match-
15 ing or other arrangements with qualified educational
16 institutions, private foundations, or other institutions, with
17 private firms, with local, State, and Federal agencies and
18 individuals to undertake research into water resources prob-
19 lems of national interest which he may deem to be desirable
20 and are not otherwise being studied.

21 "(b) The Secretary is further authorized to conduct a
22 water resources technology development program which pur-
23 sues research results through the development of effective
24 structural or nonstructural techniques, methods, procedures,
25 and equipment, and through testing, evaluation, and demon-

1 stration, to a point where such results can be adopted for
2 practical application to problems of national interest.

3 “(c) Water resources research and technology develop-
4 ment programs carried out in accordance with this title may
5 include, without being limited to: saline water conversion;
6 irrigation and other water use efficiencies; water and related
7 land use planning, operations, management, and legal sys-
8 tems; protection and enhancement of the water-based en-
9 vironmental institutional arrangements; saline water con-
10 version technologies for water reclamation and use; salinity
11 management; and economic, social, and environmental im-
12 pact assessment. Due consideration shall be given to priority
13 problems identified by water and related land resources plan-
14 ning, data acquisition, and like studies conducted by other
15 agencies and organizations. The Secretary shall cooperate
16 fully with the Administrator of the Environmental Protec-
17 tion Agency to insure that water resources research and
18 development work performed under the Act makes the fullest
19 possible contribution to the improvement of water resources
20 processes and techniques and to avoid in the performance of
21 this Act the duplication of the experience, expertise, and
22 data regarding water resource technologies which have been
23 acquired.

24 “SEC. 201. To carry out the water resources research

1 and technology development programs authorized by this
2 title, the Secretary may:

3 “(a) Foster and participate in conferences relating to
4 water resources research and technology development, and
5 other water-related topics, and provide information, advice,
6 and assistance to local, State, Federal, and other agencies and
7 organizations in the solution of water and water-related
8 problems.

9 “(b) Engage, by competitive contract or otherwise,
10 chemists, physicists, engineers, and such other personnel as
11 may be deemed necessary, and any educational institution,
12 scientific organization or individual, Government agency, or
13 private firm deemed suitable to do any part of the research,
14 technology development, or other work authorized by this
15 Act, and, correlate and coordinate the research and tech-
16 nology development work of such educational institutions,
17 scientific organizations, and private firms.

18 “(c) Develop and implement technology transfer
19 methodologies as required to assure that the results of re-
20 search and development undertaken pursuant to this Act can
21 be adopted for practical application by others, including but
22 not limited to the reduction of scientific and technical reports
23 into suitable and understandable formats, and conduct assess-
24 ments of the impacts of other technology on water resources.

25 “(d) Maintain an awareness through on-site inspection

1 of promising projects and facilities, and cooperate and par-
2 ticipate, when the purposes of this Act will be served thereby.

3 “(e) Accept financial and other assistance from any
4 local, State, Federal, and other agency in connection with
5 studies or surveys relating to water problems and facilities,
6 and enter into contracts with regard to such assistance.

7 “(f) Establish and operate facilities as necessary to
8 carry on the research and technology development programs
9 to effectuate the purpose of this Act.

10 “(g) Acquire processes, technical data, inventions,
11 patent applications, patents, licenses, land, and interest in
12 land (including water rights), research and technology
13 development equipment and facilities, and other property or
14 rights by purchase, license, lease, or donation.

15 “SEC. 202. There are authorized to be appropriated such
16 sums, to remain available until expended, as may be specified
17 in annual appropriation Acts to carry out the provisions of
18 this title.”.

19 (e) Amend title III as follows:

20 (i) In section 300 delete the last sentence and insert:
21 “To accomplish this the Secretary shall, in addition to such
22 other actions as may be required, make generally available
23 abstracts and other summary type information concerning
24 water related research accomplishments by all Federal agen-
25 cies and by non-Federal agencies, private institutions, and

1 individuals, to the extent such information can be obtained,
2 and completed reports on research projects funded under
3 provisions of this Act, including any direct publication of
4 research information undertaken by the Institutes.”.

5 (ii) In section 301, following the word “research”
6 wherever it appears, insert the words “and technology
7 development”.

8 (iii) Delete section 303 and insert in lieu:

9 “SEC. 3. The Saline Water Conversion Act of 1971
10 (Public Law 92-60) is hereby repealed.”

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

MAR 10 1975

Dear Mr. President:

Dear Mr. Speaker:

There is enclosed a draft bill "To promote a more adequate national program of water resources research and technology development, to reorganize certain functions in the Department of the Interior, and for other purposes." It constitutes an amendment to the Water Resources Research Act of 1964, P.L. 88-379, as amended by P.L. 89-404 and P.L. 92-175.

We recommend that the proposed bill be enacted.

The bill combines into a new Office of Water Research and Technology those functions authorized by the Saline Water Conversion Act of 1971, P.L. 92-60, and the Water Resources Research Act of 1964, P.L. 88-379, as amended. It also provides for an expanded technology development program which encompasses desalting technology development activities authorized by the Saline Water Conversion Act of 1971 but, additionally, provides authorization to pursue, through technology development program actions, the results of other water-related research authorized by the Act to the stage where such findings and determinations can be used for practical application in resolving or mitigating the Nation's water and water-related problems.

The draft bill extends certain authorities under the Water Resources Research Act which would otherwise expire at the end of fiscal year 1976. That Act authorizes the appropriation of funds with which the Secretary of the Interior can by means of grants, matching grants, contracts or other arrangements with qualified educational institutions, private firms and individuals, and with local State and Federal government agencies, undertake research into aspects of water problems related to the mission of the Department of the Interior which may be deemed desirable and are not otherwise being studied. This authorization started at \$5,000,000 in fiscal year 1967 and gradually increased to a maximum of \$10,000,000 for each fiscal years 1972 through 1976.

The bill does not change the "Assistance to State for Institutes" or the "Matching Grants for Institutes" water resources research, training, and technical information dissemination program currently authorized by Title I of P.L. 88-379, as amended. Institutes, together with their cooperating universities, will continue to be a major source for producing the basic problem-oriented research results that are an absolute requirement for sound and cost-effective technology development. The draft bill authorizes appropriation of such funds as may be specified by the Congress in annual appropriation acts to carry out the provisions of Title II, in contrast to the specified limitations of the present Act.

Similarly, the Saline Water Conversion Act of 1971 authorizing annual appropriations for the initiation of new desalting program work extends only through fiscal year 1977. The draft bill would extend this program in modified form. Inasmuch as the functions authorized by the Saline Water Conversion Act are incorporated as part of the research and development activities authorized under the proposed amended Title II of the Water Resources Research Act of 1964, the draft bill repeals the Saline Water Conversion Act of 1971, P.L. 92-60, as amended.

The draft bill as forwarded is lacking patent provisions which will be provided in the near future.

New legislation is desirable to continue the water resources research and the technology development programs previously administered by the Office of Water Resources Research and the Office of Saline Water. Excellent progress has been made during the last decade in research directed toward a better understanding of the many complex biological, physical and sociological elements which comprise our water resource systems. There is, however, less certainty of the effectiveness with which these excellent and innovative research results have been interpreted and converted into practical applications. Recognition of this technology development and technology transfer deficiency prompted the National Water Commission, in its 1973 Report, to recommend that the Federal government establish an Office of Water Technology.

To meet this need of converting water resources research results into viable action programs without sacrificing the emphasis on research, the Secretary of the Interior established an Office of

Water Research and Technology this past July. This action combined the functions then assigned to the Office of Water Resources Research and the Office of Saline Water; and established added responsibility for assuring the systematic and orderly application of research and research results to our most critical water problems.

The bill contains a provision that the Department of the Interior will cooperate fully with the Environmental Protection Agency to avoid duplication of efforts and it was the stated view of the Department of the Interior representatives, during negotiations formulating the bill, that the Department had no intention to encroach upon matters already being undertaken by EPA or to duplicate their efforts. It was understood that the Department of the Interior would coordinate its efforts with EPA to the extent necessary.

The proposed bill provides a comprehensive framework for carrying out this coordinated water resource research and technological development effort.

The Office of Management and Budget has advised that the presentation of this proposed legislation would be consistent with the Administration's objectives.

Sincerely yours,

Jack Horton

~~Assistant~~

Secretary of the Interior

Honorable Carl Albert
Speaker of the House of
Representatives
Washington, D. C. 20515

Enclosure

Identical letter to:

Honorable Nelson Rockefeller
President of the Senate
Washington, D.C. 20515

A B I L L

To promote a more comprehensive national program of water resources research and technology development to reorganize certain functions in the Department of the Interior, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That

SHORT TITLE

SEC. 1. This Act may be cited as the "Water Resources Research and Technology Development Act of 1975."

AMENDMENT OF WATER RESOURCES RESEARCH ACT OF 1964

SEC. 2. The "Water Resources Research Act of 1964", as amended, is further amended to read as follows:

(a) In Title I delete the word "September" in section 102 and insert "December" and in the first sentence of the second paragraph of section 104, delete the word "July" and insert "October."

(b) Substitute the following title II:

TITLE II—WATER RESOURCES RESEARCH AND TECHNOLOGY

DEVELOPMENT PROGRAMS

SEC. 200. (a) The Secretary of the Interior is authorized to make grants and finance contracts and matching or other arrangements with qualified educational institutions, private foundations, or other institutions, with private firms, with local, State and Federal agencies

and individuals to undertake research into water resources problems of national interest which he may deem to be desirable and are not otherwise being studied.

(b) The Secretary is further authorized to conduct a water resources technology development program which pursues research results through the development of effective structural or non-structural techniques, methods, procedures and equipment, and through testing, evaluation and demonstration, to a point where such results can be adopted for practical application to problems of national interest.

(c) Water resources research and technology development programs carried out in accordance with this Title may include, without being limited to: saline water conversion; irrigation and other water use efficiencies; water and related land use planning, operations, management and legal systems; protection and enhancement of the water-based environmental institutional arrangements; saline water conversion technologies for water reclamation and use; salinity management; and economic, social and environmental impact assessment. Due consideration shall be given to priority problems identified by water and related land resources planning, data acquisition, and like studies conducted by other agencies and organizations.

The Secretary shall cooperate fully with the Administrator of the Environmental Protection Agency to insure that water resources research and development work performed under the Act makes the fullest possible contribution to the improvement of water resources processes and techniques and to avoid in the performance of this Act the duplication of the experience, expertise, and data regarding water resource technologies which have been acquired.

SEC. 201. To carry out the water resources research and technology development programs authorized by this title, the Secretary may:

(a) Foster and participate in conferences relating to water resources research and technology development, and other water-related topics, and provide information, advice, and assistance to local, State, federal and other agencies and organizations in the solution of water and water-related problems.

(b) Engage, by competitive contract or otherwise, chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization or individual, Government agency, or private firm deemed suitable to do any part of the research, technology development, or other work authorized by this Act, and, correlate and coordinate the research and technology development work of such educational institutions, scientific organizations, and private firms.

(c) Develop and implement technology transfer methodologies as required to assure that the results of research and development undertaken pursuant to this Act can be adopted for practical application by others, including but not limited to the reduction of scientific and technical reports into suitable and understandable formats, and conduct assessments of the impacts of other technology on water resources.

(d) Maintain an awareness through on-site inspection of promising projects and facilities, and cooperate and participate, when the purposes of this Act will be served thereby.

(e) Accept financial and other assistance from any local, State, Federal, and other agency in connection with studies or surveys relating to water problems and facilities, and enter into contracts with regard to such assistance.

(f) Establish and operate facilities as necessary to carry on the research and technology development programs to effectuate the purpose of this Act.

(g) Acquire processes, technical data, inventions, patent applications, patents, licenses, land and interest in land (including water rights), research and technology development equipment and facilities, and other property or rights by purchase, license, lease, or donation.

SEC. 202. There are authorized to be appropriated such sums, to remain available until expended, as may be specified in annual

appropriation acts to carry out the provisions of this title.

(c) Amend Title III as follows:

(i) In section 300 delete the last sentence and insert: "To accomplish this the Secretary shall, in addition to such other actions as may be required, make generally available abstracts and other summary type information concerning water related research accomplishments by all Federal agencies and by non-Federal agencies, private institutions, and individuals, to the extent such information can be obtained, and completed reports on research projects funded under provisions of this Act, including any direct publication of research information undertaken by the Institutes."

(ii) In section 301, following the word "research" wherever it appears, insert the words "and technology development".

(iii) Delete section 303 and insert in lieu:

Sec. 3. The Saline Water Conversion Act of 1971 (P.L. 92-60) is hereby repealed.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

JUN 25 1975

Dear Mr. President:

We have previously forwarded to you a proposed bill, "To promote a more comprehensive national program of water resources research and technology development to reorganize certain functions in the Department of the Interior, and for other purposes." Through the courtesy of Interior Committee members, the proposed bill has been formally introduced as S. 1301.

At the time of the submission of the proposed bill, the Department and the Administration had not been able to finally establish a position with respect to patent policy for the proposed water research and development program. It was important for other reasons, however, to submit the bill when we did. Since that time, the Department and the Administration have reached a position on patent articles that should apply to the proposed legislation.

We are therefore submitting to you at this time an augmented version of the proposed bill, which has been revised to include patent articles.

The augmented bill is in all other respects identical to S. 1301, with one minor change. On page three of S. 1301, at lines eight and nine, the present wording reads, "protection and enhancement of the water-based environmental institutional arrangements". We feel this language should be changed to read, "protection and enhancement of the water-based environment; institutional arrangements". The attached, augmented version of the proposed bill reflects this change.

We request that the attached bill be introduced as a substitute for S. 1301, or that S. 1301 be amended to include the additions herein enclosed. We have previously consulted with the Interior Committee staff concerning the proposed amended bill, and we advised them of the forthcoming patent articles at the time of submitting the original bill.

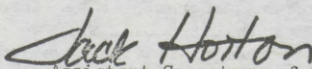
The patent articles are similar to those recently adopted in legislation relative to the newly created Energy Research and Development Administration.

The articles allow sufficient flexibility so that patent clauses in OWRT funded R&D contracts can be readily adapted to individual contracting situations. The policy generally requires the Government to take title to inventions resulting from the R&D. Flexibility is retained by permitting limited exceptions to the Government's acquisition of title in "exceptional circumstances," and provides safeguards by requiring contractors to license others if they do not bring inventions into commercial use.

The patent policy is designed to stimulate private incentive in undertaking water research projects, and to attract qualified applicants for projects, so as to maximize quality and efficiency and minimize costs and delays in performance of research contracts.

The Office of Management and Budget has advised that there is no objection to the presentation of this report and the enclosed augmented bill from the standpoint of the Administration's program.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Jack Horton". The signature is fluid and cursive, with the first name "Jack" and last name "Horton" clearly distinguishable.

Assistant Secretary of the Interior

Honorable Nelson Rockefeller
President of the Senate
Washington, D.C. 20510

Enclosures

A B I L L

To promote a more comprehensive national program of water resources research and technology development to reorganize certain functions in the Department of the Interior, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That

SHORT TITLE

SEC. 1. This Act may be cited as the "Water Resources Research and Technology Development Act of 1975."

AMENDMENT OF WATER RESOURCES RESEARCH ACT OF 1964

SEC. 2. The "Water Resources Research Act of 1964", as amended, is further amended to read as follows:

(a) In Title I delete the word "September" in section 102 and insert "December" and in the first sentence of the second paragraph of section 104, delete the word "July" and insert "October."

(b) Substitute the following title II:

TITLE II—WATER RESOURCES RESEARCH AND TECHNOLOGY

DEVELOPMENT PROGRAMS

SEC. 200. (a) The Secretary of the Interior is authorized to make grants and finance contracts and matching or other arrangements with qualified educational institutions, private foundations, or other institutions, with private firms, with local, State and Federal agencies

and individuals to undertake research into water resources problems of national interest which he may deem to be desirable and are not otherwise being studied.

(b) The Secretary is further authorized to conduct a water resources technology development program which pursues research results through the development of effective structural or non-structural techniques, methods, procedures and equipment, and through testing, evaluation and demonstration, to a point where such results can be adopted for practical application to problems of national interest.

(c) Water resources research and technology development programs carried out in accordance with this Title may include, without being limited to: saline water conversion; irrigation and other water use efficiencies; water and related land use planning, operations, management and legal systems; protection and enhancement of the water-based environment; institutional arrangements; saline water conversion technologies for water reclamation and use; salinity management; and economic, social and environmental impact assessment. Due consideration shall be given to priority problems identified by water and related land resources planning, data acquisition, and like studies conducted by other agencies and organizations.

The Secretary shall cooperate fully with the Administrator of the Environmental Protection Agency to insure that water resources research and development work performed under the Act makes the fullest possible contribution to the improvement of water resources processes and techniques and to avoid in the performance of this Act the duplication of the experience, expertise, and data regarding water resource technologies which have been acquired.

SEC. 201. To carry out the water resources research and technology development programs authorized by this title, the Secretary may:

(a) Foster and participate in conferences relating to water resources research and technology development, and other water-related topics, and provide information, advice, and assistance to local, State, federal and other agencies and organizations in the solution of water and water-related problems.

(b) Engage, by competitive contract or otherwise, chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization or individual, Government agency, or private firm deemed suitable to do any part of the research, technology development, or other work authorized by this Act, and, correlate and coordinate the research and technology development work of such educational institutions, scientific organizations, and private firms.

(c) Develop and implement technology transfer methodologies as required to assure that the results of research and development undertaken pursuant to this Act can be adopted for practical application by others, including but not limited to the reduction of scientific and technical reports into suitable and understandable formats, and conduct assessments of the impacts of other technology on water resources.

(d) Maintain an awareness through on-site inspection of promising projects and facilities, and cooperate and participate, when the purposes of this Act will be served thereby.

(e) Accept financial and other assistance from any local, State, Federal, and other agency in connection with studies or surveys relating to water problems and facilities, and enter into contracts with regard to such assistance.

(f) Establish and operate facilities as necessary to carry on the research and technology development programs to effectuate the purpose of this Act.

(g) Acquire processes, technical data, inventions, patent applications, patents, licenses, land and interest in land (including water rights), research and technology development equipment and facilities, and other property or rights by purchase, license, lease, or donation.

SEC. 202. There are authorized to be appropriated such sums, to remain available until expended, as may be specified in annual appropriation acts to carry out the provisions of this title.

(c) Amend Title III as follows:

(i) In section 300 delete the last sentence and insert: "To accomplish this the Secretary shall, in addition to such other actions as may be required, make generally available abstracts and other summary type information concerning water related research accomplishments by all Federal agencies and by non-Federal agencies, private institutions, and individuals, to the extent such information can be obtained, and completed reports on research projects funded under provisions of this Act, including any direct publication of research information undertaken by the Institutes."

(ii) In section 301, following the word "research" wherever it appears, insert the words "and technology development".

(iii) Delete section 303 and insert in lieu:

Sec. 303 (a) Whenever any invention is made or conceived in the course of or under any contract pursuant to this Act and the Secretary determines that--

(1) the person who made the invention was employed or assigned to

perform research, development, or demonstration work and the invention is related to the work he was employed or assigned to perform, or that it was within the scope of his employment duties, whether or not it was made during working hours, or with a contribution by the Government of the use of Government facilities, equipment, materials, allocated funds, information proprietary to the Government, or services of Government employees during working hours; or

(2) the person who made the invention was not employed or assigned to perform research, development, or demonstration work, but the invention is nevertheless related to the contract or to the work or duties he was employed or assigned to perform, and was made during working hours, or with a contribution from the Government of the sort referred to in clause (1).

title to such invention shall vest in the United States, and if patents on such invention are issued they shall be issued to the United States, unless in particular circumstances the Secretary waives all or any part of the rights of the United States to such invention in conformity with the provisions of this section.

(b) Each contract entered into by the Secretary with any person shall contain effective provisions under which such person shall furnish

promptly to the Secretary a written report containing full and complete technical information concerning any invention, discovery, improvement, or innovation which may be made in the course of or under such contract.

(c) Under such regulations in conformity with the provisions of this section as the Secretary shall prescribe, the Secretary may waive all or any part of the rights of the United States under this section with respect to any invention or class of inventions made or which may be made by any person or class of persons in the course of or under any contract if the Secretary determines that the interests of the United States and the general public will best be served by such waiver. The Secretary shall maintain a publicly available, periodically updated record of waiver determinations. In making such determinations, the Secretary shall have the following objectives:

(1) Making the benefits of the water research and development program widely available to the public in the shortest practicable time.

(2) Promoting the commercial utilization of such inventions.

(3) Encouraging participation by private persons in the water research and development program.

(4) Fostering competition and preventing undue market concentration or the creation or maintenance of other situations inconsistent with the antitrust laws.

(d) In determining whether a waiver to the contractor at the time of contracting will best serve the interests of the United States and the general public, the Secretary shall specifically include as considerations--

(1) the extent to which the participation of the contractor will expedite the attainment of the purposes of the program;

(2) the extent to which a waiver of all or any part of such rights in any or all fields of technology is needed to secure the participation of the particular contractor;

(3) the extent to which the contractor's commercial position may expedite utilization of the research, development, and demonstration program results;

(4) the extent to which the Government has contributed to the field of technology to be funded under the contract;

(5) the purpose and nature of the contract, including the intended use of the results developed thereunder;

(6) the extent to which the contractor has made or will make substantial investment of financial resources or technology developed at the contractor's private expense which will directly benefit the work to be performed under the contract;

(7) the extent to which the field of technology to be funded under the contract has been developed at the contractor's private expense;

(8) the extent to which the Government intends to further develop to the point of commercial utilization the results of the contract effort;

(9) the extent to which the contract objectives are concerned with the public health, public safety, or public welfare;

(10) the likely effect of the waiver on competition and market concentration; and

(11) in the case of a nonprofit educational institution, the extent to which such institution has a technology transfer capability and program, approved by the Secretary as being consistent with the applicable policies of this section.

(e) In determining whether a waiver to the contractor or inventor of rights to an identified invention will best serve the interests of the United States and the general public, the Secretary shall specifically include as considerations paragraphs (4) through (11) of subsection (d) as applied to the invention and--

(1) the extent to which such waiver is a reasonable and necessary incentive to call forth private risk capital for the development and commercialization of the invention; and

(2) the extent to which the plans, intentions, and ability of the contractor or inventor will obtain expeditious commercialization of such invention.

(f) Whenever title to an invention is vested in the United States, there may be reserved to the contractor or inventor--

(1) a revocable or irrevocable nonexclusive, paid-up license for the practice of the invention throughout the world; and

(2) the rights to such invention in any foreign country where the United States has elected not to secure patent rights and the contractor elects to do so, subject to the rights set forth in paragraphs (2), (3), (6), and (7) of subsection (h): Provided, That when specifically requested by the Secretary and three years after issuance of such a patent, the contractor shall submit the report specified in subsection (h) (1) of this section.

(g) (1) Subject to paragraph (2) of this subsection, the Secretary shall determine and promulgate regulations specifying the terms and conditions upon which licenses may be granted in any invention to which title is vested in the United States.

(2) Pursuant to paragraph (1) of this subsection, the Secretary may grant exclusive or partially exclusive licenses in any invention only if, after notice and opportunity for hearing, it is determined that--

(A) the interests of the United States and the general public will best be served by the proposed license, in view of the applicant's intentions, plans, and ability to bring the invention to the point of practical or commercial applications;

(B) the desired practical or commercial applications have not been achieved, or are not likely expeditiously to be achieved, under any nonexclusive license which has been granted, or which may be granted, on the invention;

(C) exclusive or partially exclusive licensing is a reasonable and necessary incentive to call forth risk capital and expenses to bring the invention to the point of practical or commercial applications; and

(D) the proposed terms and scope of exclusivity are not substantially greater than necessary to provide the incentive for bringing the invention to the point of practical or commercial applications and to permit the licensee to recoup its costs and a reasonable profit thereon:

Provided, That, the Secretary shall not grant such exclusive or partially exclusive license if he determines that the grant of such license will

tend substantially to lessen competition or result in undue concentration in any section of the country in any line of commerce to which the technology to be licensed relates. The Secretary shall maintain a publicly available, periodically updated record of determinations to grant such licenses.

(h) Each waiver of rights or grant of an exclusive or partially exclusive license shall contain such terms and conditions as the Secretary may determine to be appropriate for the protection of the interests of the United States and the general public, including provisions for the following:

(1) Periodic written reports at reasonable intervals, and when specifically requested by the Secretary, (a) A written report shall be submitted to the Secretary within nine (9) months after the submission of the final report concerning the conception or actual reduction to practice, or both, as may be applicable, of every invention made pertaining to the work called for in the contract which was conceived or first actually reduced to practice within the period of three (3) months prior, during, or three (3) months subsequent to the term of the contract, which invention would be a Subject Invention if made under the contract, but which the Contractor believes was made outside the performance of work required under this contract. The Secretary may require additional information to be furnished in confidence by the Contractor. At the request of the Secretary made during or subsequent to the term of the contract, including any extensions for additional research and development

work, the Contractor shall furnish information concerning any other invention which appears to the Secretary to reasonably have the possibility of being a Subject Invention; (b) All information supplied by the Contractor hereunder shall be of such nature and character as to enable the Secretary reasonably to ascertain whether or not the invention concerned is a Subject Invention. Failure to furnish such information called for herein shall, in any subsequent proceduring, place on the Contractor the burden of going forward with the evidence to establish that such invention is not a Subject Invention. If such evidence is not then presented the invention shall be deemed to be a Subject Invention. After receipt of information furnished pursuant hereto, the Secretary shall not unduly delay rendering his opinion on the matter. The Contractor may furnish the information required under this paragraph as Contractor Confidential information, which shall be identified as such.

(2) At least an irrevocable, nonexclusive, paid-up license to make, use, and sell the invention throughout the world by or on behalf of the United States (including any Government agency) including the power to issue sublicenses for use in behalf of the Government and/ or in furtherance of the foreign policies of the Government and States and domestic municipal governments, unless the Secretary determines that it would not be in the public interest to acquire the license for the States and domestic municipal governments. When the foreign rights in and to an invention are not assigned to the Government but the Government may, at its option or on request,

acquire such rights and determines not to cause an application to be filed in any particular foreign country or otherwise to seek protection of the invention, or fails to take such action, (a) within six months of the filing of an application for United States patent on the invention, or (b) within six months of declassification of an invention previously under a security classification, or (c) within six months after disclosure of an invention to the Government pursuant to contract, whichever is later, such determination or such failure to act shall constitute a decision by the Government to leave such rights to the inventor, subject to the extent practicable, to a nonexclusive, irrevocable, royalty-free license to the Government in any patent which may issue thereon in any foreign country, including the power to issue sublicenses for use in behalf of the Government and/ or in furtherance of the foreign policies of the Government.

(3) The right in the United States to sublicense any foreign government pursuant to any existing or future treaty or agreement if the Secretary determines it would be in the national interest.

(4) The reservation in the United States of the rights to the invention in any country in which the contractor does not file an application for patent within such time as the Secretary shall determine.

(5) The right in the Secretary to require the granting of a nonexclusive, exclusive, or partially exclusive license to a responsible applicant or applicants, upon terms reasonable under the circumstances,

(A) to the extent that the invention is required for public use by governmental regulations, or (B) as may be necessary to fulfill health, safety, or water needs, or (C) for such other purposes as may be stipulated in the applicable agreement or by Agency regulation.

(6) The right in the Secretary to terminate such waiver or license in whole or in part unless the recipient of the waiver or license demonstrates to the satisfaction of the Secretary that he has taken effective steps, or with a reasonable time thereafter is expected to take such steps, necessary to accomplish substantial utilization of the invention.

(7) The right in the Secretary commencing three years after the grant of a license and four years after a waiver is effective as to an invention, to require the granting of a nonexclusive or partially exclusive license to a responsible applicant or applicants, upon terms reasonable under the circumstances, and in appropriate circumstances to terminate the waiver or license in whole or in part, following a hearing upon notice thereof to the public, upon a petition by an interested person justifying such hearing--

(A) if the Secretary determines, upon review of such material as he deems relevant, and after the recipient of the waiver or license, or other interested person, has had the opportunity to provide such relevant and material information as the Secretary may require, that such waiver or license has tended substantially to lessen competition or to result in undue concentration in any section of the country in any line of commerce to which the technology relates;
or

(B) unless the recipient of the waiver or license demonstrates to the satisfaction of the Secretary at such hearing that he has taken effective steps, or within a reasonable time thereafter is expected to take such steps, necessary to accomplish substantial utilization of the invention.

(i) The Secretary shall provide an annual periodic notice to the public in the Federal Register, or other appropriate publication, of the right to have a hearing as provided by subsection (h)(7) of this section, and of the availability of the records of determinations provided in this section.

(j) The Secretary shall, in granting waivers or licenses, consider the small business status of the applicant.

(k) The Secretary is authorized to take all suitable and necessary steps to protect any invention or discovery to which the United States holds title, and to require that contractors or persons who acquire rights to inventions under this section protect such inventions.

(1) (1) Nothing in this Act shall be deemed to convey to any individual, corporation, or other business organization immunity from civil or criminal liability, or to create defenses to actions, under the antitrust laws.

(2) As used in this section, the term "antitrust law" means--

(a) the Act entitled "An Act to protect trade and commerce against unlawful restraints and monopolies," approved July 2, 1950 (15 U.S.C. 1 et Seq.), as amended;

(b) the Act entitled "An Act to supplement existing laws against unlawful restraints and monopolies, and for other purposes," approved October 15, 1914 (15 U.S.C. 12 et Seq.) as amended;

(c) the Federal Trade Commission Act (15 U.S.C. 41 et Seq.), as amended;

(d) Sections 73 and 74 of the Act entitled "An Act to reduce taxation, to provide revenue for the Government and for other purposes," approved August 27, 1894 (15 U.S.C. 8 and 9), as amended; and

(e) the Act of June 19, 1936, chapter 592 (15 U.S.C. 13, 13a, 13b, and 21a).

(m) As used in this section--

(1) the term "person" means any individual, partnership, corporation, association, institution, or other entity;

(2) the term "contract" means any contract, grant, agreement, understanding, or other arrangement, which includes research, development, or demonstration work, and includes any assignment, substitution of parties, or subcontract executed or entered into thereunder;

(3) the term "made", when used in relation to any invention means the conception or first actual reduction to practice of such invention;

(4) the term "invention" means inventions or discoveries, whether patented or unpatented; and

(5) the term "contractor" means any person having a contract with or on behalf of the Secretary.

Sec. 3. The Saline Water Conversion Act of 1971 (P.L. 92-60) is hereby repealed.

Senator FANNIN. I'm pleased to welcome our witnesses and on behalf of Senator Church, who is unable to be here this morning, I want to express the subcommittee's appreciation for your testimony.

The first witness this morning is Hon. Jack Horton, Assistant Secretary, Land and Water Resources, Department of the Interior, who will be accompanied by Dr. William S. Butcher, Director, Office of Water Research and Technology, Department of the Interior.

Gentlemen, we are very pleased to welcome you here this morning. Mr. Secretary, if you will, proceed as you so desire.

**STATEMENT OF HON. JACK O. HORTON, ASSISTANT SECRETARY,
LAND AND WATER RESOURCES, U.S. DEPARTMENT OF THE
INTERIOR, ACCOMPANIED BY DR. WILLIAM S. BUTCHER, DIRECTOR,
OFFICE OF WATER RESEARCH AND TECHNOLOGY, DEPARTMENT OF THE INTERIOR**

Mr. HORTON. Mr. Chairman, thank you very much for your introduction and for your welcome. On my immediate left, I have Dr. William S. Butcher, who is the new Director of the Office of Water Research and Technology, and on my immediate right, the Associate Director, Mr. J. W. O'Meara.

It is an honor and a privilege for the three of us, along with two members of our Solicitor's Office who are immediately behind us. These are Mr. Moody Tidwell, associate solicitor in the Department of the Interior, Division of General Law; and Mr. Don Fraser, assistant solicitor for the Division of Patent Law.

The five of us are pleased to appear before the committee on the activities of the newly formed OWRT—Office of Water Research and Technology. In July 1974, the Office of Water Research and Technology was established, in part, to provide a broader-based organization for implementing technology development programs to better assure that the findings of original and innovative research are interpreted and developed in the State where they can be used for practical application in resolving or mitigating water and water-related problems. Previously, there had been no agency with a responsibility for converting water resources research results into viable action programs even though there was, and is, important development work being done on an hoc basis. It was in recognition of this deficiency that led to the recommendation of the National Water Commission that an Office of Water Technology be established.

The objectives of the Office of Water Research and Technology are to develop new understandings and knowledge needed to solve or mitigate high priority water resource problems and to assist in dissemination of research results. To achieve these objectives, OWRT will carry out coordinated research, development, scientific information dissemination, and technology transfer programs. The Office of Water Research and Technology will utilize by means of grants and contracts the outstanding scientific and technical competence that is available in educational institutions, private firms, foundations, and other organizations.

Merger of the two programs resulted in the need for legislative changes which have been incorporated in the proposed legislation

that has been submitted for consideration by the Congress, and has been introduced in the Senate as S. 1301. The legislation as submitted by the administration did not include a patent article, as the development of a revised patent article was under way at the time of submission and needed to be coordinated with other agencies. The proposed patent article has recently been submitted to the Congress for consideration along with the proposed legislation. The proposed legislation will provide the Department with sufficient flexibility to help bridge existing and future gaps in our research program, such as initiation of new technology development that may be needed to assure that the results of completed water resources research may be applied by others to solve water or water-related problems.

Mr. Chairman, our testimony this morning is divided from this point on into four parts: assistance to States for institutes and matching grants. The second category, additional water resources research. The third category, technology development, and the fourth category is water resources scientific information center.

We would be pleased to cover in detail the formal statement which has six remaining features which would take approximately 12 to 13 minutes, or we can abbreviate these as you might direct.

Senator FANNIN. Mr. Secretary, since we do have the information in your statement, if you would just digest it it would probably be helpful.

Mr. HORTON. Fine, sir. Then we will condense the formal statement since it will be in the record.

Senator FANNIN. The complete statement and any supporting data will be made a part of the record.

Mr. HORTON. Under "Assistance to States for Institutes and Matching Grants, Water Resources Research Institutes."

The largest segment of the program is the State Water Resources Research Institute activities. Particular emphasis is being given to water problems of a regional nature and to integrated water resource needs. Based on past experience with this part of the program, it is anticipated that the States will contribute well over 50 percent of the total cost of these research proposals. Two new water resources research institutes were established in 1974. The new institutes are the District of Columbia and the Virgin Islands. Guam, which was also authorized by the 1971 amendments to the Water Resources Research Act, has established an institute.

There are now 54 water resources research institutes eligible to receive funds under the annual allotment and matching grant program. The Water Resources Research Act provides an authorization of \$250,000 per institute for the allotment program and an authorization of \$5 million for the matching grant program.

I would point out that these are both under title I of the former OWRR. The President's fiscal year 1976 budget provides an allotment of \$110,000 per institute and \$40,000 for the three new institutes and \$3 million for the matching grant program.

Senator FANNIN. Mr. Secretary, if you want to just cover the complete statement—it is a rather short statement.

Mr. HORTON. I think, Mr. Chairman, if you have the time it would provide greater continuity. Fine. Good.

In order to improve coordination of the research efforts among the institutes and to avoid possible duplication in research and development projects, the institutes have been organized into eight regional associations based on commonality of water problems. These are New England, Middle Atlantic, South Atlantic, Great Lakes-Ohio-Upper Mississippi, Missouri River, Southern Plains, Colorado Great Basin, and Pacific Northwest. These regional organizations provide a firm scientific foundation for assessing and addressing regional needs.

Internally, the Office of Water Research and Technology has matched their organization with the regional structure by assigning program development and management for each region to an OWRT staff scientist. Our scientists have been given primary responsibility to develop the best possible research program within available funding levels. The staff scientist works with the institute in identifying and verifying the most important problems of his region and priority research needs associated with them as well as with OWRT staff members of the various divisions.

(b) Identifying regional research needs: During the past year increased effort has been devoted to the improvement of procedures for identifying critical water problems and the research needs associated with those problems, and research is currently being directed toward the solution of these problems. For example, in the New England region the major problem areas are water quality, like management strategy, wetlands and estuaries, and land use planning and related water resources. In the Middle Atlantic region the major problem areas are water quality, flood plain risk management, municipal and industrial water supply, estuarial resources management. The Colorado Great Basin region has identified major problem areas as salinity and related water quality factors, water supplies for developing new energy sources, allocation of scarce water among competing users, water conservation through irrigation and other water use efficiencies, and land-water management for improved quality and quantity.

The procedures used to identify regional research needs are being refined with the full cooperation and participation of the State research institutes and their collaborators. The objective of the effort is to identify more explicitly than was heretofore possible the critical water research needs of the several States and hydrologic regions of the Nation.

Steps are being taken to integrate the OWRT procedures with the Water Resources Council ongoing national assessment of critical water problems so that the necessary research may be focused on national and regional problems identified by this study. The OWRT research program will be coordinated with the Committee on Water Resources Research of the Federal Council for Science and Technology.

II. ADDITIONAL WATER RESOURCES RESEARCH

Under this program the OWRT will utilize the specialized research and development competence available through private firms, individuals, consultants, universities and Government agencies, to seek answers to the specific problems faced at the Federal level.

This program consists of R. & D. effort toward: Improving water resource planning management, identifying Indian water problems,

promotion of water use efficiency, protection of the environment, solving energy related water problems, technology assessment and research transfer, and saline water conversion research. All of these efforts bear upon priority needs related to the mission of the Department of the Interior.

III. TECHNOLOGY DEVELOPMENT

(a) Technology assessment and research transfer: As a first step toward achieving the broader functioning envisioned for the new Office of Water Research and Technology, a new program of technology assessment and research transfer has been initiated.

There is an urgent need to evaluate, in a systematic way, the technology that has been developed and is available for use in resolving water-related problems, as well as to develop processes and practices to assure prompt application of research results. Not all research results need to pass through the development process to be applicable and to help solve water problems. However, the significance of research in the many water resource-related disciplines needs to be coordinated and interpreted with respect to its impact on major water-related problems. This is particularly important for avoiding costly mistakes; for suggesting new approaches for solving problems; as well as for assuring maximum payoff from research efforts, investments, and results. This function is coordinated closely with the activities of the Federal Council for Science and Technology.

(b) Saline water conversion research and development: The saline water conversion program over the past 22 years has made significant contributions to the development of technology for the conversion of saline and other chemically contaminated water to potable use. The technology developed is in application in many areas of the world and is to a large degree commercially available. Distillation plants are being constructed and operated in the Middle East and other distillation plants are operating around the world. Total land-based distillation plants, installed or under construction, with a capacity of 25,000 gallons per day or more worldwide equals 447 million gallons per day. Research results from this program have been documented in technical publications totaling more than a thousand. Future saline water conversion programs will be directed toward developing technology for the solution of specific problems and will concentrate in those areas that appear to be most promising.

The saline water research programs planned are directed toward the further advancement of seawater membranes and freezing processes. The level of effort planned for the research of seawater membranes is commensurate with past years. There is no plan to eliminate or further reduce this effort at this time. The saline water conversion research can play an important part in contributing to the overall solution of water or water-related problems. What has been done in this area through the consolidation of the two offices is to bring together resources research and to prevent overlap and duplication. Consideration must be given to the future use of saline water conversion technology in connection with the National Drinking Water Standards Act of 1974, and this technology needs further refinement and improvement to make it more energy conscious, as existing technology is a large consumer of energy. An objective of this program is through

research to advance the technology to the point where, if results are favorable, other organizations will demonstrate and adapt the technology for particular water needs. Provided with a good technology and a viable marketplace, industry has demonstrated in the past their capability for moving new technology into use rapidly.

During fiscal year 1976, the saline water conversion program will carry out research and development in support of the Colorado River Basin salinity control project. This research and development work will be closely coordinated with the Bureau of Reclamation which is the project leader for the construction of the 100-million-gallon-per-day desalting plant to be located at Yuma, Ariz., to desalt the waters of the Wellton-Mohawk Canal.

Mr. Chairman, I am happy to say that research leading toward the Yuma desalination plant has permitted a significant improvement in the efficiency of this plant. We had expected approximately 75 percent efficiency in the recovery of water and it appears it will be closer to 80 or 85 percent.

The seawater membrane development work previously mentioned will be conducted at our Wrightsville Beach test facility located at Wrightsville Beach, N.C. During fiscal year 1975 significant progress was made in advancing seawater membrane processes for economical desalting of seawater. Results from the test program indicate that the membrane process—reverse osmosis—could be economically superior to the distillation process. Furthermore, unlike distillation, a reverse osmosis plantsite is not dependent upon location of a source of steam, and its brine discharge will have less environmental impact because of the lack of thermal or metallic pollution. Further cost reduction could be gained by improving methods for pretreating raw seawater to remove suspended solid and marine organisms. With soaring energy costs, the lower energy required for membrane processes provides a major incentive for continued development of seawater membrane processes. Rapid development of the membrane processes for seawater desalting can provide U.S. companies with a technological and economic edge over others in competing for foreign desalting markets.

During the past year OWRT has made a major effort to publish and make available to the public technical reports on a wide range of projects related to the development of distillation processes. All documented technical information on projects which went to a significant stage of completion is now available through the National Technical Information Service—NTIS.

The vertical tube evaporator/multistage flash—VTE/MSF—module at Orange County, Calif., is now in a startup phase of operation. We will be evaluating its performance over the next 6 to 9 months.

Progress has been made on the development of freeze desalting processes. The full capacity of the 75,000-gallon-per-day pilot plant being tested at Wrightsville Beach, N.C., has been demonstrated for short periods and problem areas have been defined. The efficiency of individual components as well as the total system reliability are expected to be attained during the early part of fiscal year 1976. When these test results are obtained, further evaluation will be necessary before additional work can be justified in the freezing process area.

IV. WATER RESOURCES SCIENTIFIC INFORMATION CENTER

The center is a focal point for water resources information and is responsible for collection, storage, retrieval, and dissemination of scientific information services to the water resources community. The bank of scientific information now amounts to a total of 83,000 items. The center has an improved fast computer retrieval system recently installed to facilitate the use of the vast collection of information on water research and water research-related problems. By agreement between OWRT and the Energy Research and Development Agency all of the information collected by this Center in the form of abstracts and subject index terms was installed as a data base at Oak Ridge, Tenn. This data base has become 1 of the 17 bases which are part of the computer information network called Recon—remote console—system. By means of TV-type terminals installed at various locations throughout the United States, the information contained in this system can be and is being retrieved by researchers as immediate answers on any scientific subject.

Other data bases available to the users of the system now include nuclear science abstracts, energy data base, toxic materials data base, energy R. & D. projects, heated effluent bibliography, and solar energy. Four terminals were installed to begin the establishment of a network of the WRSIC/Recon system. These are located at Cornell University, University of Wisconsin, North Carolina State University, and University of Arizona. The cost of operating these terminals is partially absorbed by the State institutes.

The Office of Water Research and Technology has been recently assigned the function of coordinating the Department of Interior's water resources research. During the development of the Department's fiscal year 1977 budget estimates, OWRT played a key role in coordinating the Department's water resources research programs. This new process will help to insure that there is no undesirable overlap of research efforts within the Department and, more importantly, that water resources research programs directed toward solving these problems be given highest priority. Water resources research coordination will be accomplished through such organizations as the Committee on Water Resources Research, the 54 State institutes, and bureaus and offices within the Department of Interior.

Mr. Chairman, I believe that we have in the OWRT the beginnings of an organization that will result in a responsive, viable water resources research program that will greatly assist the Department and others in the solving of water and water-related problems for this Nation. The Office is in its infancy and must be allowed to grow and demonstrate itself. I am sure there will be need for further improvements in the future to adjust to a changing environment.

This concludes my statement. The Director of OWRT, Dr. Butcher; Mr. O'Meara; and I will be happy to answer any questions the committee may have.

I would say, in conclusion, that we totally agree with your introductory observations. Our whole commitment here is to avoid, not react to, a water crisis in the same proportions that we have today in the energy crisis.

[The prepared statement of Mr. Horton follows:]

STATEMENT OF HON. JACK O. HORTON, ASSISTANT SECRETARY, LAND AND WATER RESOURCES, U.S. DEPARTMENT OF THE INTERIOR

Mr. Chairman, it is an honor and a privilege to appear before you and other members of this Committee to brief this Committee on the activities of the newly formed Office of Water Research and Technology.

In July, 1974, the Office of Water Research and Technology was established, in part, to provide a broader based organization for implementing technology development programs to better assure that the findings of original and innovative research are interpreted and developed to the state where they can be used for practical application in resolving or mitigating water and water-related problems. Previously there had been no agency with a responsibility for converting water resources research results into viable action programs even though there was and is important development work being done on an *ad hoc* basis. It was in recognition of this deficiency that led to the recommendation of the National Water Commission that an Office of Water Technology be established.

The objectives of the Office of Water Research and Technology are to develop new understandings and knowledge needed to solve or mitigate high priority water resource problems and to assist in dissemination of research results. To achieve these objectives, OWRT will carry out coordinated research, development, scientific information dissemination, and technology transfer programs. The Office of Water Research and Technology will utilize by means of grants and contracts the outstanding scientific and technical competence that is available in educational institutions, private firms, foundations and other organizations.

Merger of the two programs resulted in the need for legislative changes which have been incorporated in the proposed legislation that has been submitted for consideration by the Congress, and has been introduced in the Senate as S. 1301. The legislation as submitted by the Administration did not include a Patent Article, as the development of a revised Patent Article was under way at the time of submission and needed to be coordinated with other agencies. The proposed Patent Article has recently been submitted to the Congress for consideration along with the proposed legislation. The proposed legislation will provide the Department with sufficient flexibility to help bridge existing and future gaps in our research program, such as initiation of new technology development that may be needed to assure that the results of completed water resources research may be applied by others to solve water or water-related problems.

MAJOR PROGRAM ACTIVITIES

The program activities of the Office of Water Research and Technology currently consist of the following:

- I. Assistance to States for Institutes and Matching Grants.
- II. Additional Water Resources Research.
- III. Technology Development.
- IV. Scientific Information Center.

Both the Assistance to States for Institutes and the Matching Grants to State Institutes are administered through the Water Resources Research Institutes.

I. ASSISTANCE TO STATES FOR INSTITUTES AND MATCHING GRANTS

a. Water Resources Research Institutes

The largest segment of the program is the State Water Resources Research Institute activities. Particular emphasis is being given to water problems of a regional nature and to integrated water resource needs. Based on past experience with this part of the program, it is anticipated that the states will contribute well over 50% of the total cost of these research proposals. Two new Water Resources Research Institutes were established in 1974. The new Institutes are the District of Columbia and the Virgin Islands. Guam, which was also authorized by the 1971 amendments to the Water Resources Research Act, has established an Institute.

There are now fifty-four Water Resources Research Institutes eligible to receive funds under the annual allotment and matching grant program. The Water Resources Research Act provides an authorization of \$250,000 per Institute for

the allotment program and an authorization of \$5,000,000 for the matching grant program. The President's FY 1976 budget provides an allotment of \$110,000 per Institute and \$40,000 for the three new Institutes and \$3,000,000 for the matching grant program.

In order to improve coordination of the research efforts among the Institutes and to avoid possible duplication of the research and development projects, the Institutes have been organized into eight regional associations based on commonality of water problems. These are New England, Middle Atlantic, South Atlantic, Great Lakes-Ohio-Upper Mississippi, Missouri River, Southern Plains, Colorado Great Basin, and Pacific Northwest. These regional organizations provide a firm scientific foundation for assessing and addressing regional needs.

Internally, the Office of Water Research and Technology has matched their organization with the regional structure by assigning program development and management for each region to an OWRT staff scientist. Our scientists have been given primary responsibility to develop the best possible research program within available funding levels. The staff scientist works with the Institute in identifying and verifying the most important problems of his region and priority research needs associated with them as well as with OWRT staff members of the various divisions.

b. Identifying Regional Research Needs

During the past year increased effort has been devoted to the improvement of procedures for identifying critical water problems and the research needs associated with those problems, and research is currently being directed toward the solution of these problems. For example, in the New England Region the major problem areas are water quality, lake management strategy, wetlands and estuaries, and land use planning and related water resources. In the Middle Atlantic Region the major problem areas are water quality, flood plain risk management, municipal and industrial water supply, estuarial resources management. The Colorado Great Basin Region has identified major problem areas as salinity and related water quality factors, water supplies for developing new energy sources, allocation of scarce water among competing users, water conservation through irrigation and other water use efficiencies, and land-water management for improved quality and quantity.

The procedures used to identify regional research needs are being refined with the full cooperation and participation of the State Research Institutes and their collaborators. The objective of the effort is to identify more explicitly than was heretofore possible the critical water research needs of the several states and hydrologic regions of the nation. Steps are being taken to integrate the OWRT procedures with the Water Resources Council ongoing national assessment of critical water problems so that the necessary research may be focused on national and regional problems identified by this study. The OWRT research program will be coordinated with the Committee on Water Resources Research of the Federal Council for Science and Technology.

II. ADDITIONAL WATER RESOURCES RESEARCH

Under this program the OWRT will utilize the specialized research and development competence available through private firms, individuals, consultants, universities and government agencies, to seek answers to the specific problems faced at the Federal level.

This program consists of R & D effort toward: improving water resource planning management, identifying Indian water problems, promotion of water use efficiency, protection of the environment, solving energy related water problems, technology assessment and research transfer, and saline water conversion research. All of these efforts bear upon priority needs related to the mission of the Department of the Interior.

III. TECHNOLOGY DEVELOPMENT

a. Technology Assessment and Research Transfer

As a first step toward achieving the broader functioning envisioned for the new Office of Water Research and Technology, a new program of technology assessment and research transfer has been initiated.

There is an urgent need to evaluate, in a systematic way, the technology that has been developed and is available for use in resolving water-related problems,

as well as to develop processes and practices to assure prompt application of research results. Not all research results need to pass through the development process to be applicable and to help solve water problems. However, the significance of research in the many water resource related disciplines needs to be coordinated and interpreted with respect to its impact on major water-related problems. This is particularly important for avoiding costly mistakes, for suggesting new approaches for solving problems, as well as for assuring maximum pay-off from research efforts, investments, and results. This function is coordinated closely with the activities of the Federal Council for Science and Technology.

b. Saline Water Conversion Research and Development

The saline water conversion program over the past 22 years has made significant contributions to the development of technology for the conversion of saline and other chemically contaminated water to potable use. The technology developed is in application in many areas of the world and is to a large degree commercially available. Distillation plants are being constructed and operated in the Middle East and other distillation plants are operating around the world. Total land-based distillation plants, installed or under construction, with a capacity of 25,000 gallons/per/day or more worldwide equals 447 million gallons/per/day. Research results from this program have been documented in technical publications totaling more than a thousand. Future saline water conversion programs will be directed towards developing technology for the solution of specific problems and will concentrate in those areas that appear to be most promising.

The saline water research programs planned are directed towards the further advancement of sea water membranes and freezing processes. The level of effort planned for the research of sea water membranes is commensurate with past years. There is no plan to eliminate or further reduce this effort at this time. The saline water conversion research can play an important part in contributing to the overall solution of water or water related problems. What has been done in this area through the consolidation of the two Offices is to bring together basic water studies applicable to saline water conversion as well as to water resources research and to prevent overlap and duplication. Consideration must be given to the future use of saline water conversion technology in connection with the National Drinking Water Standards Act of 1974, and this technology needs further refinement and improvement to make it more energy conscious, as existing technology is a large consumer of energy. An objective of this program is through research to advance the technology to the point where, if results are favorable, other organizations will demonstrate and adapt the technology for particular water needs. Provided with a good technology and a viable market place, industry has demonstrated in the past their capability for moving new technology into use rapidly.

During fiscal year 1976, the saline water conversion program will carry out research and development in support of the Colorado River Basin Salinity Control Project. This research and development work will be closely coordinated with the Bureau of Reclamation which is the project leader for the construction of the 100 million gallon/per/day desalting plant to be located at Yuma, Arizona, to desalt the waters of the Wellton-Mohawk Canal.

Mr. Chairman, I am happy to say that research leading toward the Yuma Desalting Plant has permitted a significant improvement in the efficiency of this plant. We had expected approximately 75 percent efficiency in the recovery of water and it appears it will be closer to 80 or 85 percent.

The sea water membrane development work previously mentioned will be conducted at our Wrightsville Beach Test Facility located at Wrightsville Beach, North Carolina. During fiscal year 1975 significant progress was made in advancing sea water membrane processes for economical desalting of sea water. Results from the test program indicate that the membrane process (reverse osmosis) could be economically superior to the distillation process. Furthermore, unlike distillation, a reverse osmosis plant site is not dependent upon location of a source of steam, and its brine discharge will have less environmental impact because of the lack of thermal or metallic pollution. Further economics could be gained by improving methods for pretreating raw sea water to remove suspended solid and marine organisms. With soaring energy costs, the lower energy required for membrane processes provides a major incentive for continued development of sea water membrane processes. Rapid development of the membrane

processes for sea water desalting can provide U.S. companies with a technological and economic edge over others in competing for foreign desalting markets.

During the past year OWRT has made a major effort to publish and make available to the public technical reports on a wide range of projects related to the development of distillation processes. All documented technical information on projects which went to a significant stage of completion is now available through the National Technical Information Service (NTIS).

The Vertical Tube Evaporator/MultiStage Flash (VTE/MSF), Module at Orange County California, is now in a start-up phase of operation. We will be evaluating its performance over the next six to nine months.

Progress has been made on the development of freeze desalting processes. The full capacity of the 75,000 gallon/per/day pilot plant being tested at Wrightsville Beach, North Carolina, has been demonstrated for short periods and problem areas have been defined. The efficiency of individual components as well as the total system reliability are expected to be attained during the early part of fiscal year 1976. When these test results are obtained, further evaluation will be necessary before additional work can be justified in the freezing process area.

IV. WATER RESOURCES SCIENTIFIC INFORMATION CENTER

The Center is a focal point for water resources information and is responsible for collection, storage, retrieval, and dissemination of scientific information services to the water resources community. The bank of scientific information now amounts to a total of 83,000 items. The Center has an improved fast computer retrieval system recently installed to facilitate the use of the vast collection of information on water research and water research related problems. By agreement between OWRT and the Energy Research and Development Agency all of the information collected by this Center in the form of abstracts and subject index terms was installed as a data base at Oak Ridge, Tennessee. This data base has become one of the 17 bases which are part of the computer information network called RECON (Remote Console) System. By means of TV-type terminals installed at various locations throughout the United States, the information contained in this system can be and is being retrieved by researchers as immediate answers on any scientific subject. Other data bases available to the users of the system now include: Nuclear Science Abstracts, Energy Data Base, Toxic Materials Data Base, Energy R&D Projects, Heated Effluent Bibliography, and Solar Energy. Four terminals were installed to begin the establishment of a network of the WRSIC/RECON System. These are located at Cornell University, University of Wisconsin, North Carolina State University, and University of Arizona. The cost of operating these terminals is partially absorbed by the State Institutes.

The Office of Water Research and Technology has been recently assigned the function of coordinating the Department of Interior's water resources research. During the development of the Department's fiscal year 1977 budget estimates, OWRT played a key role in coordinating the Department's water resources research programs. This new process will help to ensure that there is no undesirable overlap of research efforts within the Department and, more importantly, that water resources research programs directed towards solving these problems be given highest priority. Water resources research coordination will be accomplished through such organizations as the Committee on Water Resources Research, the 54 State Institutes, and bureaus and offices within the Department of Interior.

Mr. Chairman, I believe that we have in the OWRT the beginnings of an organization that will result in a responsive, viable water resources research program that will greatly assist the Department and others in the solving of water and water related problems for this nation. The Office is in its infancy and must be allowed to grow and demonstrate itself. I am sure there will be need for further improvements in the future to adjust to a changing environment. This concludes my statement. The Director of OWRT, Dr. Butcher, Mr. Meera and I will be happy to answer any questions the Committee may have.

Senator FANNIN. Mr. Secretary, thank you for your statement. We have, I think, great opportunities in this field. The work being done is tremendously important, not only to this Nation but to other countries of the world.

I note in your statement you refer to work you are doing with some of the other nations. It is vital that we go forward with this program, and I will have some questions regarding some of the other technologies that may be utilized.

Before I do so, I do have some questions that have been supplied by some of the other members of the committee that direct themselves to some of the concern about what has been happening.

The first one, the Office of Saline Water and Water Resources Research were consolidated and you have presented legislation to reflect that consolidation. This committee and other committees in the Congress were not notified of your plans to consolidate these two Offices. Would you explain to the committee why this action was taken without prior notification to the Congress?

Mr. HORTON. Mr. Chairman, the consultation that we achieved with the Congress was not perfect although I do have in front of me here the listings of both the meetings and telephone calls and discussions which I had with various members of the committee.

I remember talking and meeting with you individually and then briefing other minority Members of Congress. I have in my log a request by telephone to meet with Senator Church. I was unable to achieve that meeting. Nonetheless, I did have a long discussion with Mr. Dan Dreyfus, the professional staff member of the committee.

It was by his personal suggestion that we started to draft the legislation we have now submitted to Congress. On the House side, in addition to discussions with the subcommittee chairman, Mr. Johnson, I had a personal meeting with him and also with Mr. Craig Hosmer and with the professional staff member there, Mr. Jim Casey.

I think, nonetheless, it would have been desirable for us to have held a total briefing for both committees.

Senator FANNIN. Mr. Secretary, I certainly know that you made every attempt as far as the minority is concerned, and I am sure the majority members of the committee, to explain to them just what was being done.

You did. As far as I was concerned I know you were in my office and we discussed this matter quite thoroughly. But there seems to be a breakdown in communications that did necessitate this question for clarification and I appreciate your answer.

In the development of your estimates for funds for fiscal year 1976, did the Office of Management and Budget cut your request, and, if so, how much?

Mr. HORTON. I don't think they cut it very much. I don't know the answer—

Senator FANNIN. Perhaps that can be supplied for the record.

[Subsequent to the hearing the Department supplied the following:]

OMB ALLOWANCES FISCAL YEAR 1976

The Department asked for \$21.8 million for the OWRT programs. The Office of Management and Budget denied an amount of \$3,473,000, leaving a residue request that had their approval of \$18.3 million which is before the Appropriation Committees at this time.

Senator FANNIN. What future role do you see for this new Office, Mr. Secretary?

Mr. HORTON. I tend to be personally very excited, and also professionally for the Department. What the Office essentially does is provide a firm bridge between basic research and applied technology research and the high priority needs of the Department.

Before we had a very fragmentary effort. As we looked at basic research here at the institute level and under title II as we looked at the emerging high priority needs of the Department on water efficiency, water for energy, and irrigation for agriculture.

This Office will provide the bridge between the needs of this country for water research and the research actually happening. Particularly as we look at the energy crisis and the obviously vital part that water will play in that.

A great deal of research in OWRT is directing itself toward energy related water problems.

Senator FANNIN. I certainly agree that the future role of this Office is very important to our energy problems as well as the solution to many of the water problems of the country.

If we can at reasonable cost do what is contemplated, what is projected, as far as making water available for both crops and utilization for other purposes, it will be of tremendous benefit to this Nation. And as I stated, this research is being carried on, especially when the tremendous project is underway in Yuma, Ariz., the magnitude of which is many, many times over anything that has ever been attempted.

And I think it will be justified because of the tremendous need that exist for proving that it can be done in a large volume manner. I am very thrilled over what is being done in that regard. And I also will have some questions regarding what other investigation can be carried on that might assist in utilizing other methods at Yuma in conjunction, also using your membrane system, your reverse osmosis, I think, is what is contemplated now.

In fact the project is going forward on that basis. Is that right, Doctor?

Dr. BUTCHER. It is clear there will be membrane processes. At the present time we are investigating two membrane processes. One is reverse osmosis, and one is electrodialysis. Perhaps a mix will be used.

Senator FANNIN. While we are talking about that maybe I can bring up one of my questions. As you know we are very interested in what can be done with solar energy in that regard.

I notice that, Mr. Secretary, you referred to some work with Israel. Has that been involved with solar energy?

Mr. HORTON. The work in Israel, Mr. Chairman, is not involved with solar energy. Let's state that question in two parts. I am hopeful that Secretary Hathaway has reported to you the proposal that former OSW made through the Department to the Energy Research and Development Agency on the application of solar energy to the Yuma plant.

If that has not reached you yet, I will see that it is hand carried. It is the proposal ERDA is looking at now.

Senator FANNIN. It was my pleasure to talk to Secretary Hathaway and discuss the possibility of incorporating this into your determina-

tions as to a combination or what could be done. I am sure that you realize better than most anyone the tremendous potential that we have with solar energy, and the opportunity of perhaps making a test that would be of worldwide significance.

I feel when we are considering all these projects we must take into consideration what has already been done. I know that Israel has been quite prominent in the utilization of solar energy.

Over the years we have had projects. One of the first ones was down in Chile that operated for quite some years. We know that the techniques work. How efficient are they? Doctor, isn't that the determination now as to a comparison of efficiencies and what would be involved in the final end product?

Dr. BUTCHER. Any of these technologies work. ERDA, as I understand, is investigating this and we will coordinate closely to make sure that any results they might have or expect to have can be related to the Yuma problem.

Senator FANNIN. It is my hope we can coordinate our efforts with the Department of the Interior, Mr. O'Meara's department and its activity with ERDA and other agencies that might be involved. I think in doing so we can come up with some conclusions and determinations that will be long lasting.

You referred to the University of Arizona and they are carrying forward. Dr. Mynell is now working on a report that will be made to your Department, Mr. Secretary, in regards to what the recommendation would be for this research, I know there are others that you referred to, North Carolina's project is being carried forward. These are tremendously important to decide what can be done and the cost factors involved.

We are just getting underway with some large programs for solar installation and I just hope that this would be the one place in which we could make a determination as to what would be best in that regard.

There are some other questions that were submitted. For the 2 consecutive years following the reorganization of the Office of Saline Water and Water Resources Research, the Congress authorized a desalting program considerably larger in scope and funding than that proposed by the administration.

Did you, at any time, ask for a supplemental appropriation under those authorizations either for the saline water conversion program or water resources research?

Mr. HORTON. Mr. Chairman, we did not ask for supplemental requests.

Senator FANNIN. You did not see the need for it, or was it from the standpoint of legality—

Mr. HORTON. Mr. Chairman, what we wanted to do was consolidate the two offices to give it a good firm administrative base, new structure, to demonstrate the capability of the Office and then move ahead. We thought we should not ask for the funds first and try to reorganize at the same time.

Senator FANNIN. The Saline Water Conversion Act authorized and directed the Secretary of the Interior to undertake an aggressive program for the development and demonstration of practicable means to convert saline and other chemically contaminated water to a quality suitable for beneficial uses.

In light of the rather meager funding requests for saline water research by the administration, is it your opinion that this program as directed by the Congress is being vigorously carried out?

Dr. BUTCHER. We believe in the past the saline water conversion program has had many achievements. These achievements found their place in the commercial market and that was the objective of the program. We are looking at the further opportunities in that area. The further opportunities we have judged to be of sufficient priority to include in future programs are the treatment of sea water through membrane processes and possibly through a freezing process.

We are pursuing these consistent with other priority needs for water research and quality.

Senator FANNIN. We talked about the crisis programs, and I don't like the idea of crisis programs. We would want programs carefully worked out and ones that when they have been completed the results are justifiable in comparison to the costs involved.

I do feel, though, that now when we are up against the situation where we have made commitments as to what we will do, especially the national treaty, then I do feel that we perhaps will need to move more rapidly than what was contemplated a short time ago.

Dr. BUTCHER. Mr. Chairman, you will recall that the Congress did make a supplemental appropriation to the Office of Water Research and Technology for supportive work for the Yuma desalting plant. We are pursuing that vigorously. We have committed a large part of that money. We are working with the Bureau of Reclamation who has also expended funds on their part of the program.

I assure you we are working hard to make sure that the needs are met.

Mr. HORTON. Mr. Chairman, the Yuma effort is an arrangement between OWRT, responsible for the basic membrane research, and the Bureau of Reclamation, which will actually construct it.

If you look at the Bureau's funds for that, we believe it would be upwards of \$100 million for that plant. In that one area we are not being skimpy in our budget request.

Senator FANNIN. I realize we have a total budget there of \$135 million. That does not include the canal—\$20 some million or \$30 some million, but the magnitude of it is vast in comparison with anything that has ever been done before.

Just to complete some of these questions, then I do have some further questions on my own.

It is my understanding that it is the opinion of the Department that distillation technology, developed pursuant to the Saline Water Conversion Act, has reached the state of the art whereby private industry is in a position to take over the role of research and development.

Is that a correct statement as to the Department's opinion?

Dr. BUTCHER. We believe it is now commercial and extra work would not be productive for us to undertake. There are other problems, but not for us.

Senator FANNIN. When we are talking about solar research, then we are getting into another field of activity and something that has been done over the years whether or not the type of a program we are discussing now could be measured by what has been done in the past is questionable, is it not?

In other words, there have been rather limited developments of distillation by solar energy.

Dr. BUTCHER. Sir, our Office is not now addressing directly distillation by solar energy.

Senator FANNIN. We have the project at Puerto Penasco I think it was a cooperative program between the University of Sonora, the University of Arizona, and the Department of Interior. They practically abandoned it. It was not unsuccessful, but it was not of a sufficient size to make it a profitable venture.

Mr. O'MEARA. We conducted a rather extensive program on solar distillation, but we have not conducted any work in that area for 6 or 7 years now. The current work that we are interested in solely is to use solar as an energy source in support of the Yuma plant.

Senator FANNIN. The University of Arizona is considering both as far as their research is concerned. Dr. Mynell was in my office a couple of weeks ago and stated that he was approaching it from the angle of producing the power and also from the standpoint of the distillation process.

I think you are familiar with some of the projects that they are testing now. The one that would not apply to Yuma—I don't know of any place in Yuma that would be appropriate for the particular installation that is contemplated for the open pit mine at Presby, Arizona.

I think you are familiar with that where they are going to have mirrors in the mine reflecting back up to an absorber-reflector on top and similar to the project there that in some of the countries such as France. France has several units in place now, some generating 1,000 kilowatts of electricity. But they have them on high temperature utilization, 4,000-degree temperatures being generated.

But the work is being done by the University of Arizona and that particular program is also connected with the work being done with parabolic units of some size that would, they hope, generate 10 megawatts of electricity.

I think you are figuring 40 megawatts of electricity at the Yuma plant, is that right?

Mr. O'MEARA. It is approximately 36 megawatts.

Senator FANNIN. So four of those units would be sufficient for that?

Mr. O'MEARA. OWRT gave a contract to a firm called Arthur D. Little, and they conducted a feasibility study for us on the potential use of solar energy as an energy source for the Yuma plant. Their approach is somewhat different than has been studied by others in that they propose to use a flat plate collector rather than mirrors. It will operate at much lower temperatures but the cost would be very competitive with any other solar development for energy that is underway.

Our interest in that would be for direct pumping energy from solar, or electrical generation from solar. We did the feasibility study, but any demonstration would have to be funded by ERDA. We sent our proposal to them for their consideration.

Senator FANNIN. I understand the procedures you would follow, but Mr. Secretary you would be interested in any type of a presentation that would be made whereby distillation could be with solar energy without going through the processes now considering where they would generate 36 megawatts of electricity.

I think the greatest factor involved is that we have a commitment now, and that commitment must be fulfilled or we would be in difficulties with Mexico. If this could be done, these tests could be made without delaying your forward progress, would you not be interested in seeing just what is feasible?

Mr. HORTON. We have a very open mind. I think we have to balance off our international commitments timewise along with our enthusiastic review of any solar proposal that would come onstream.

Senator FANNIN. I understand that. In any conversation I have had with people who are going to make proposals have been along that line. They cannot be talking about something 10 years in the future, or even 2 to 3 years in the future. They must talk about months rather than years, and I think the program properly financed, determinations could be made in months.

Just to continue the questions that have been given by some of the members, how many U.S. firms are presently manufacturing equipment for saline water distillation?

Mr. O'MEARA. To give you a complete list, I would like to furnish it for the record. There are a number of companies.

[Subsequent to the hearing the Department supplied the following:]

List of U.S. Manufacturers and Vendors of Distillation Equipment

Aqua-Chem, Inc., 240 W. Capital Drive, Milwaukee, Wis. 53201.	Resources Conservation Co., P.O. Box 936, Renton, Wash. 98055.
Hydro-Dyne, 225 Wetmore Avenue SE., (P.O. Box 443), Massillon, Ohio 44646.	Riley Beaird, Inc., P.O. Box 1115, Shreveport, La. 71130.
Mechanical Equipment Co., Inc., 861 Carondelet Street, New Orleans, La. 70131.	Rosenblad Corporation, P.O. Box 2325, Princeton, N.J. 08540.

Senator FANNIN. With what U.S. distillation equipment manufacturers have you discussed this opinion?

Have you had any discussions as far as what can be done with regard to the desalting plant—some of these questions are repetitious. The opinion referred to was, private industry is capable of doing this work, that's what I was referring to in my question.

Have you discussed that with some of the private industries?

Mr. O'MEARA. Are you saying our position is that private industry is ready to take over further research?

Senator FANNIN. In other words that they are at the point now that they are developing the equipment and they have successfully operating equipment.

As I understand, when I asked the question, it is my understanding that it is the opinion of the Department that distillation technology, developed pursuant to the Saline Water Conversion Act, has reached the state of the art where private industry is in a position to take over the role of research and development. You said, yes. And then the further question was what U.S. distillation manufacturer have you discussed this opinion with?

Dr. BUTCHER. Sir, there are distillation firms actively in business—

Mr. HORTON. For example, Fluor Corp. Have you discussed it with them?

Dr. BUTCHER. Not in those terms.

Senator FANNIN. That is one of the firms building this equipment. Is there a consensus within the industry that the manufacturers are in a position to assume the financial burden associated with research and development of distillation technology?

Mr. HORTON. Mr. Chairman, we have indicated in our statement that the construction of distillation plants that have a capacity of 25,000 gallons a day or more, there is something on the order of 447 million gallons a day now being produced. That would be substantially by private enterprise in the distillation process.

Dr. BUTCHER. May I add to that, sir? Our involvement with the distillation technology is not complete. We are not requesting further funds, but we have underway at Fountain Valley, Calif., the culmination of distillation technology. We plan to transfer the technology developed there to all firms who want to come to us, and it will be their responsibility to move on it.

We believe we will have a very developed technology available to them.

Senator FANNIN. As I explained, these are questions some of the other members had. I will try to not have repetitive questions and see if we can't take less of your time on this.

Do you have any plans to expand the Fountain Valley module to a full-size prototype desalting plant?

Dr. BUTCHER. No, sir. That is a test plant, and our plans are for transmitting the results to the industry and that was the end of our commitment.

Senator FANNIN. When the Department announced its partnership agreement with the Orange County Water District, it was stated that if the operation of the module met anticipated performance it was the intent of the Department to expand it to a prototype.

If you do not expand, as originally planned, what effect will this have on the investment of the Orange County Water District and their water development program?

Dr. BUTCHER. Sir, this is a question that might best be answered by the Orange County Water District.

Senator FANNIN. Fine. We will wait on that.

The administration's position regarding the funding for the State institutes, as I understand it, was at the \$200,000 level per year. The legislation authorizes \$250,000 per institute per year. You consistently ask for funds in the neighborhood of \$100,000 per year per institute, which appears to be inconsistent with the administration's policy and inconsistent with the intent of Congress. Would you please explain this?

Mr. HORTON. That is a matter of budgetary balance, Mr. Chairman. As you appreciate, there were levels in the administration last year that cut it down way below \$100,000 and that has been increased. That request will be made to the OMB, and the final decision was made in the light of overall departmental administrative budgetary objectives.

We believe that the figure of \$110,000 is adequate for institutes. We are also convinced that they would like a lot more than that.

Senator FANNIN. I understand. Many agencies in the Federal Government are involved in water or water related research and development. Would you explain to the committee how your programs are coordinated with these other agencies?

Part of that has been done, but just for this record.

Dr. BUTCHER. Coordination is accomplished through an arm of the Federal Council for Science and Technology, the Committee on Water Resources Research.

Last year, lead agency responsibility for that committee was assigned to the Office of Water Research and Technology. The chairman of that committee has a very active coordination effort with all agencies on water resources research.

Senator FANNIN. One last question. In the proposed bill submitted to the Congress by the administration, I see that the patent article has been greatly expanded. Would you please explain to the committee why you felt expansion of the patent article was necessary and what advantages this expanded patent article would have over previous patent articles?

Mr. HORTON. Mr. Chairman, we have Mr. Moody Tidwell here who can give a very expansive answer. There were two basic considerations engaged.

First was what we deemed to be a highly desirable objective in attracting bids from companies who otherwise would not bid on a particular research project in a way that we could protect their patent rights.

The second, of course, was the language drawn up we understand by Mr. Dan Dreyfus for the ERDA legislation and we have adopted the patent language of the ERDA bill to this particular OWRT legislation.

Moody Tidwell is here. Moody, if you would, why don't you just expand on that.

Senator FANNIN. Could you just be very brief?

Mr. TIDWELL. That was complete, Mr. Chairman. The OSW and OWRR did not have problems in contracting with companies in the past under the patent policy of the Department of Interior. It was forced upon them by interpretations of those two acts that existed. We have tried to expand the policy to give some discretion to OWRT as was given to the Administrator in ERDA.

Basically we take title to inventions. But we do have discretion in certain instances to leave the title with the contractor or to exclusively license the rights to those inventions.

Senator FANNIN. Thank you very much, Mr. Secretary and gentlemen. Thank you for your testimony and fine responses. If there are further questions, they will be submitted to you in writing. I appreciate very much your being here this morning.

Mr. HORTON. Mr. Chairman, I had the pleasure of having lunch a little over a month ago with Governor Castro from the State of Arizona. He was then making a public proposal that the new National Solar Institute be located appropriately in Arizona and he did so under three arguments.

The first was that Arizona had a high population density and could well use the energy. The second one, obviously Arizona had lots of solar energy to use. And third, there were more professors in Arizona that knew about solar energy than anywhere else.

I said to the contrary, that the Solar Institute should be located in Wyoming because it had limited sunshine and no professors at all that knew anything about solar energy, but he disagreed with me.

Senator FANNIN. Thank you, Mr. Secretary. Of course, we will accept your advice that it should be located in Arizona.

The next witnesses will be Dr. A. Ray Chamberlain, Chairman, National Association of State Universities and Land Grant Colleges; Dr. David Howells, chairman, National Association of Water Center Directors, North Carolina State University; Dr. William R. Walker, Chairman, Executive Board, Universities Council on Water Resources.

STATEMENT OF DR. A. RAY CHAMBERLAIN, CHAIRMAN, NATIONAL ASSOCIATION OF STATE UNIVERSITIES AND LAND GRANT COLLEGES; DR. DAVID HOWELLS, CHAIRMAN, COUNCIL OF REPRESENTATIVES, NATIONAL ASSOCIATION OF WATER INSTITUTE DIRECTORS; AND DR. WILLIAM R. WALKER, CHAIRMAN, EXECUTIVE BOARD, UNIVERSITIES COUNCIL ON WATER RESOURCES

Dr. CHAMBERLAIN. To identify the three people, on my right is Bill Walker, director of Water Resources and Research Center at Virginia Polytechnic Institute. On my left is Dr. David Howells, chairman of the National Association of Water Center Directors, North Carolina State University.

I am Ray Chamberlain, president, Colorado State University and today speaking as chairman of the National Association of State Universities and Land Grant Colleges.

We have prepared—I have prepared a statement on behalf of our association with which your permission, we would simply like to have made part of the record. And I will verbally add some comments.

Senator FANNIN. Your complete statement will be made a part of the record and you may proceed as you think best to present your testimony.

Dr. CHAMBERLAIN. Mr. Chairman, I would like to make five main points on behalf of the association. The first is the association supports the enactment of Senate bill 1301 with some modest amendments that we would like to suggest.

The second thought, we propose three small changes in the bill for you to consider. First, on page 3, line 5, of the bill we would like to suggest that you insert the words "water for energy" in the listing of subject matter as appropriate to activities conducted under the bill.

I suggest among other things it would be appropriate since the subcommittee itself is named Energy Research and Water Resources. It would be highly appropriate for the bill to encompass the interrelationships between water and energy.

The second proposed suggestion for a change of language occurs on line 16 of page 3 where we would suggest specific reference to EPA be deleted and language substituted. We have presented a proposal for that in the written statement that would extend the cooperation and coordination to all Federal agencies rather than solely EPA.

The third proposal links to page 5, line 7, where we suggest the insertion of the word demonstration between the words operate and facilities. The reason for this suggestion is that it would better delineate the appropriateness of activities in testing and demonstration without the indication of a creation of new in-house Government research laboratories.

A fourth area where we do not yet know whether we would have suggestions to propose to you has to do with the patent provision that was just discussed. We have just received a copy of this. As the Assistant Secretary indicated, it has just been prepared.

We would like to submit at a later time our reaction to that particular item. Our third point for presentation to you has to do with consideration of the value of the program as a State and Federal partnership in water research and development. For the record, we believe that it is important that it be acknowledged that this Federal input into most States has served as seed money in such a way that it has induced many, many of our States to upgrade their commitment to water research and development in such a way as in many cases to lead the States to over match with Federal input.

This in itself seems to be a substantial fulfillment of the original content of the legislation, and it should be supported through continued legislation. It has drawn the States into a high order of commitment to what jointly is considered to be, through Federal and State, a meaningful effort.

We think in the same context that one of the byproducts of this particular legislation, that is its predecessor legislation during the last 10 years or so has been an improvement in the local decisionmaking by virtue of the enhanced interaction between State agencies, Federal agencies, and the intellectual resources available from our campuses and some of our private companies.

We do have one point of concern which links to a question you posed to the preceding people who were testifying, specifically in regard to the authorization in 1971 for increasing support to the Institutes under section 100 to the level of \$250,000 per year to the State. The administration has not seen fit to propose, including fiscal year 1976, more than \$110,000 or less than half of the authorization the Congress has put on the record.

Since the legislation was initiated more than 10 years ago, and the proposed expenditures now only run at \$110,000 a year we fail to see how such administrative indications are supportive of the high priority which this committee has indicated one should put in the area of water research, particularly now that we have such strong interaction between energy development and water.

It would seem appropriate that a higher portion of the authorization be sustained through an administrated budget. We would like to convey to you another output of the program to date. Over the 10 years that the program has been underway more than 2,500 academic courses have been developed around the campuses that are involved in the program. These courses, by and large, impact on all the students of the campuses. I think one can say that a spinoff effect of the program has been a tremendous enhancement in the level of general literacy among the college age population as to the fundamental role of water in our society.

A very explicit side effect of the legislation has been that something over 1,800 students a year are actively involved in the research programs sustained by title I. This constitutes the flow of human capital. It is absolutely fundamental to our ability as a Nation to cope with the water needs and changing water requirements of our society.

It also provides a technical skill with which to be of assistance to our friends around the world. One has to have this flow of human capital in order to perform as a Nation.

Our fourth point, we would like to suggest that S. 1301 authorization be for 5-year intervals. This would provide a means for periodic review. At the same time it would provide a mechanism for periodically considering any major new needs and programmatic areas that have emerged by virtue of research in the preceding period. It would provide a means for upgrading the authorization in a manner to cope with the impact of inflation in our general fiscal structure.

The fifth point we want to present has to do with stating that the program has demonstrated the universities and colleges ability to help States, regions and the nation as a whole to deal with current perceptions of water problems. We believe that we demonstrated clearly under this legislation the university's ability to not solely devote its efforts to high-brow intellectual long-range esoteric activities.

We feel we truly demonstrate a capacity to help our States and our regions, and secondarily, our Nation on current and explicit major problems.

Thanks to that the communications systems that have been developed between the universities and colleges, between these universities and State agencies and Federal agencies have truly led to better coordination for our entire social structure, and an improved cost effectiveness for all water research and development activities in the country.

Granted we still have a ways to go, and one of our priorities is trying to encourage an enhancement in the technology transfer sector. We believe title II has been very, very effective to date and should be extended in that it has permitted a way to bring to bear the private sector as well as other sectors of the public arena above and beyond those encompassed under title I in a way that has been a benefit to the entire water research and technology program of the country.

With these five major points, Mr. Chairman, we would like to simply extend our willingness to respond to questions, and further, if there are written questions that may occur to you at a later date we would be pleased to receive these and submit responses to you at your convenience.

In our written statement we have indicated the specific representation of our association that is involved in the Water Resources Committee that I am representing today.

In addition, I would say for the record that I speak on behalf of this group that encompasses more than 100 of the major public universities and colleges in America including the University of Arizona that you have mentioned several times this morning and Arizona State University. Such institutes as the University of Colorado that Senator Haskell knows well, and all of us will do our best to be responsive to any questions you may wish to put to us.

[The prepared statement of Dr. Chamberlain follows:]

STATEMENT

of the

Chairman of the Water Resources Committee

National Association of State Universities and Land-Grant Colleges

on

S. 1301

To promote a more comprehensive national program
of water resources research and technology development

before the

ENERGY RESEARCH AND WATER RESOURCES SUBCOMMITTEE

of the

Senate Committee on Interior and Insular Affairs

July 11, 1975

This statement by A. R. Chamberlain, President, Colorado State University, and Chairman of the Water Resources Committee of NASULGC calls for enactment of this Bill which will strengthen and extend the Water Resources Research Act of 1964 (P.L. 88-379 amended); expand the authority of the Department of Interior to promulgate technological development in water resources in order to accelerate the transfer of technology from research to application; and repeal the Saline Water Conversion Act of 1971 (P.L. 92-60).

I am A. R. Chamberlain, President of Colorado State University, Fort Collins, Colorado. As Chairman of the Water Resources Committee of the National Association of State Universities and Land Grant Colleges (NASULGC), I speak for the 118 institutions of higher education across this nation which constitute the membership of the association. Member institutions grant approximately 1/3 of all baccalaureate degrees and nearly 2/3 of all doctoral degrees in the United States.

The Water Resources Committee of NASULGC is composed of distinguished university scientists and administrators expert in water resources. Their names are included as attachment A to this statement.

Thank you for the opportunity to present the NASULGC views in support of S.1301 and to recommend that it be enacted with minor changes set forth herein. At the same time, we wish to commend the subcommittee for its stated concern for the health and direction of federal water resources programs, including research and technology development. We believe water resources are of high priority among citizen concerns, and we concur in the belief of the subcommittee that they are vital concerns to the future of this country.

The Association has repeatedly affirmed by resolution its support of the Water Resources Research Act over the past 10 years. We are impressed by the quality of research produced and by the multiplier effect of the program in stimulating state funds for water research. We are gratified by the support of public officials in the states, and by the interest of citizen organizations. We believe the Act of 1964 as modified has evolved into a cornerstone in the structure of the federal water resources program. We and others have repeatedly documented in Congressional hearings over the past 10 years the results of the program, showing without doubt its value to the states and the nation.

It has been, therefore, puzzling to us why the Executive Branch has failed to take maximum advantage of the program. Although the Congress in 1971 amended the Act to increase state authorizations in Section 100 from \$100,000 to \$250,000, the executive budget recommendations have consistently remained near \$100,000 -- \$110,000 during the past two years, to be specific.

Now, more directly to the subject of this hearing--S.1301. The Association recommends its enactment. It provides for a vital element in the emerging federal water program which places an increasing amount of the planning and decision responsibility in the states and, in so doing, places greater burdens on the states for scientific and technological capabilities. The state water research institutes furnish necessary parts of that capability.

The bill is in harmony with the National Water Commission's call for an office charged with the mission of research and development of new technologies in water resources and related fields.^{1/} Title II will expand the responsibility of the Secretary of Interior to see that necessary technology is developed to complement OWRT research and insure its usefulness. A more complete and effective program of technology transfer will result.

Although S.1301 repeals PL92-60, the Saline Water Conversion Act of 1971, it provides for any desalting technology development yet unfinished or for new priorities that may arise in that problem area.

We suggest three changes of wording in the Bill:

1. Section 200(c), page 3, line 5--insert the words "water for energy" after the colon and before the words "saline water conversion" to emphasize water-energy problems which we believe are high priority and should be included in the series.
2. Section 200(c), page 3, line 16--strike the words "Administrator of the Environmental Protection Agency" and substitute the words "chief administrative officer of all federal agencies engaged in water research and development." Although we recognize the importance of coordination with EPA, the same can be said for other federal agencies.
3. Section 201(f), page 5, line 7--insert between the words "operate" and "facilities" an appropriate word, such as "pilot" or "demonstration," to indicate that the facilities are those needed in testing or demonstrating new technology, not for in-house research.

Observers of the federal water program note that although the level of federal water development has doubled during the past few years, it has not kept pace with inflation. Many are tempted to view this fact as evidence that there is a declining national concern for water resource development and management, or that all the problems have been solved. It should be remembered, however, that federal assistance to states for water resources has increased by 16 times in the same period, indicating that the federal program is merely changing to one of providing support to state and local government. Water development projects are still needed and will, we believe, become more urgent, not less. But more will be done by states, less by the federal government.

^{1/}National Water Commission, Water Policies for the Future, final report to the President and to the Congress, June 1973, p. 537.

State and local governments today are experiencing unprecedented pressure to assume decision-making and management responsibilities covering the full range of complex water problems. Federal grant-in-aid programs, revenue sharing and the new federalism have placed greater technical and scientific demands on local and state governments.

With this changing pattern in the federal water program has come a realization that scientific and technical capabilities will be as important to state and local governments in the decades ahead as it has been to the federal government in the decades just ended. If we are to progress in this mode, the capacity of state and local governments to utilize scientific and technical information in meeting immediate concerns of society must become a reality. We believe that S.1301 will provide, through the state water research institutes, much of that state-level capacity.

Urban water management, for example, is clearly a problem for the immediate future. Such management includes, for many urban areas, development of new domestic and industrial water supplies. For all regions, it includes waste-water management and reuse of water to the greatest possible extent. Urban flood-plain management, including development of flood protection works, is also a priority need. And the new urban majority is interested in water-based recreation, aesthetics, wild and scenic rivers, and the like. All of these problems must be solved at the state and local levels and their solutions must be implemented by state and local governments.

I must warn you that the universities are falling behind in the production of new knowledge relative to emerging state and local water resource problems. Explosive issues raised in the 1960s are still with us; problem solutions are still being sought on:

1. Quality of urban life.
2. Water and air pollution control.
3. Preservation of environmental quality.
4. Energy resource development.
5. Land use regulation.
6. Food supply.

These are vital issues, each of which has water as a key and limiting element.

The development of energy resources in the Rocky Mountain region is an example with which I am familiar.

The region is a remarkable depository of energy resources. Eight hundred billion tons of coal lie within the region, 100 billion tons of it readily accessible to surface mining. Oil shale contains an estimated 1.8 trillion barrels of oil--600 billion barrels in accessible high-grade deposits. Enough natural gas to double the known reserves of the United States (300 trillion cubic feet) is contained within geologic formations, too tight for economic yield but potentially available through new technology. A large portion of the nation's uranium is contained within this region and geothermal resources are known but not fully inventoried.

Power generation by coal requires about 15 acre-feet of water per megawatt. With 30,000 megawatts generation expected by 1990 in the Colorado River Basin alone, the water demand will be 450,000 acre-feet per year. Coal gasification at the mine site would introduce additional water demands.

Oil shale production at one million barrels per day will require 120,000 acre-feet per year. To that must be added 4,000 acre-feet per year which will be required to sustain vegetation on reclaimed land and shale residue.

Water demands totaling 574,000 acre-feet exceed the 340,000 acre-feet of uncommitted water in the Colorado River. Thus, the competition for water will be severe. Unless research can point the way to reduced water demands, and unless the technology for it can be developed, there will be substantial amounts of water transferred from present uses to energy production with associated social and economic disruption.

The water research institutes in this region are being called upon now for research under PL88-379 which will answer questions being raised by this emerging problem. The technology development that will be needed is a gap that would be filled by S.1301.

The nation's universities are experiencing new demands upon their scientific and technical capabilities for state and local problem-solving, accounted for in part by the increasing complexity of those problems. There is ample evidence that public perception of the proper role of public universities now includes public services in areas beyond education and training. As long ago as 1963, the Committee on Natural Resources of the National Research Council of the National Academy of Science observed, "The faculties of universities should be called upon to serve as advisors and assistants to local and state agencies having responsibilities for resource development, planning and management." This is now occurring, and the state water research institutes are a major outlet for university response. These institutes have the advantage of extending statewide and using the best qualified faculty within the state.

Several thousand young men and women have been prepared for professional careers in water resources in the 10 years of the PL88-379 program. Many more will be needed. Although only a so-called spinoff benefit, this human resource is perhaps, in dollars, worth the entire public investment in PL88-379 to date. The rising capacity for science and technology in state government is based on this pool of trained people. Unlike some other fields, the water resources field has never had an oversupply of trained professionals or technicians, and there is no prospect for even meeting the demands in the decade ahead.

The federal program of water resources research under Title I and Title II of the Act has been both productive and cost effective. We shall not attempt to document in this statement the research productivity of the program, leaving that to OWRT and others. We call attention to the several congressional hearings on amendments and appropriations during the past few years in which the research accomplishments have been amply documented. At the same time, those hearings have disclosed a serious weakness in the transfer of research results into the hands of users in a form suitable for immediate application. It is this deficiency which will be remedied by S.1301.

With regard to cost effectiveness, it is seldom possible to measure in dollars the output effectiveness of research. I need not elaborate for this committee why this is so. However, in another frame of reference, the multiplier effect of federal dollars invested in this program is a very obvious measure of effectiveness. Most of the state institutes report that nonfederal funds expended in support of Title I projects exceed federal funds by 10 to 60 per cent. For example, in my own state, each federal dollar generated \$1.40 of nonfederal support last year. Any federal program that can do this is certainly cost effective.

Still another very important benefit of the OWRT program related to effectiveness is its ability to assess priority research needs. Although this has been demonstrated reasonably well by the Section 100 grants, where state problems are selected by the institutes for investigation, the payoff has come during the past two years with the systematic problem analysis now being used. Grants and contracts under Section 101 and Title II are far more certain now to meet an immediate and high priority need.

The state institutes have joined in workshops with state and federal agencies and other potential research users to thoroughly examine the major problems, such as flood-plain management or salinity control in the Colorado River. This has been done within individual states as well, as among regional groups of states, and has resulted in improved identification of priority research tasks. We believe this is a vital function which must be provided in any problem-solving water research program if wasteful investment in research questions that are of no immediate concern is to be avoided.

Let me use a specific case from my region, the Colorado River Basin. The Colorado River-Great Basin, Consortium of Water Institutes and Centers (CWIC), of the seven basin states organized themselves for the purpose of analyzing major basin problems involving water. For example, they planned and conducted a series of one-day workshops on the problem of controlling the salinity level in the Colorado River. Workshop participants included representatives of all state and federal agencies involved in or interested in solving that problem. The first workshop in July 1973 was productive enough that the Pacific Southwest Interagency Committee collaborated in sponsoring subsequent meetings on this and other problems.

Out of the systematic analysis in these workshops has come a framework for research which identifies all--or at least most--of the gaps in current information or processes which will need to be filled before any one of several alternative problem solutions can be fully implemented. Attachment B is a typical array of sub-problems and alternative solutions identified in the series of problem-analysis workshops.

With priority research tasks thus identified in agreement with potential users of the results, CWIC initiated several projects with PSIAC* as an active collaborator and advisory body. One such project, initiated 18 months ago to examine the economics of salinity control measures, will produce much-needed and timely information for decisions which must be made in the near future by both federal and state governments. The USBR** is an active participant in the project, furnishing a coprincipal investigator and performing some of the work. The Metropolitan Water District of Southern California is also an active collaborator in the study. This research team contains seven of the top authorities in the basin, including agronomists from California, Utah and Colorado. Attachment C shows the organization of the project and team members.

* PSIAC--Pacific Southwest Inter-Agency Committee

**USBR--U.S. Bureau of Reclamation

In selecting team members for this project, CWIC called upon leading scientists in not only institute universities but also in other universities of the region. This is facilitated by formal memorandum of agreement linking, in most cases, the state institute to the other research universities of the state. Attachment D shows the CWIC network of universities which includes the 19 major institutions in the seven states. This is an impressive scientific resource for water research.

We are convinced that the ability of state institutes to join together in problem-solving research and to do it with the active participation of the research user is a great strength of the OWRT program. The network of institutes creates a field-level organization based in state research universities with coordination and fiscal support from OWRT. This system should be a powerful element in the future federal water resources program. For that reason, we believe that OWRT should be assigned to a broader federal responsibility in its water research and technology development coordination, to include all federal water research and development.

Referring again to the content of S.1301: While we favor the permanent program provided by the Bill, we acknowledge that periodic reviews are desirable for any federal program. Annual review would be more frequent than necessary because research and technology development generally are not one-year processes; three to five years is the typical range of project duration. We therefore suggest that a five-year review period would be reasonable and effective.

Concerning levels of funding authorization, the Association believes that current levels of authorization in the OWRT program should be adjusted to compensate for inflation, but otherwise provide a reasonable level of support for the OWRT continuation part of the Bill. We emphasize that this represents a stable base for a continuing, modest program of water research but that it would not be adequate to meet the demands for "big ticket" research or development efforts which can be expected to arise periodically. High urgency crisis problems could not be handled reasonably at these levels of funding but should be dealt with as they occur.

I regret that we do not have as yet a recommendation on funding for the technology development part of the Bill which includes continuation of OSW work and the addition of technology development for other water problems. We request the privilege of submitting recommendations on this question by letter at a later date.

On behalf of the National Association of State Universities and Land-Grant Colleges and my own institution, Colorado State University, I urge this Committee to recommend enactment of S.1301, endorsing the concepts of the Water Resources Research Act of 1964 as amended, and adding to it a much needed program of water resource technology development and technology transfer. This will assure the Nation that the results of research will be extended to practical application and used in solving the Nation's water problems.

ATTACHMENT A.

June 12, 1975

Members, NASULGC Water Resources Committee

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ATTACHMENT B.

CWC REGIONAL RESEARCH ANALYSIS
REGIONAL PROBLEM: SALINITY CONTROL IN THE COLORADO RIVER

ALTERNATIVE SOLUTION	SUB - PROBLEM	ALTERNATIVE SOLUTION	SUB - PROBLEM	ALTERNATIVE SOLUTION	SUB - PROBLEM
I. REDUCE SALT INPUT	A. CONTROL NATURAL DIFFUSE SOURCES	1. COLLECT AND DESALT	a. IDENTIFY SOURCE AREA	(1) GEOLOGIC MAPPING	
				(2) MONITOR AND SAMPLE RIVER	
				(3) REMOTE SENSING SURVEY	
			b. COLLECTION METHOD		
			c. DESALTING METHOD	(1) ION EXCHANGE	(a) VOLUME (b) RATE (c) ECONOMICS (d) POWER REQUIREMENT
				(2) ELECTRODIALYSIS	(a) SEE I-A-1 -c-(1) (b) " (c) " (d) "
			a. RESIDUE DISPOSAL		
			e. LEGAL ISSUES		
			2. COLLECT AND EVAPORATE		
			a. IDENTIFY SOURCE AREA	(1) SEE I-A-1-a (2) " (3) "	
			b. COLLECTION METHOD		
			c. EVAPORATION METHOD	(1) POND	(a) OPTIMUM DIMENSION (b) RATE (c) ECONOMICS
				(2) POND + SPRAY	(a) SEE I-A-2-c-(1) (b) " (c) "
				(3) FLASH DISTILLATION	(a) RATE (b) POWER (c) ECONOMICS
				(4) SOLAR DISTILLATION	(a) COLLECTOR (b) RATE (c) ECONOMICS
			d. RESIDUE DISPOSAL		
			e. LEGAL ISSUES		

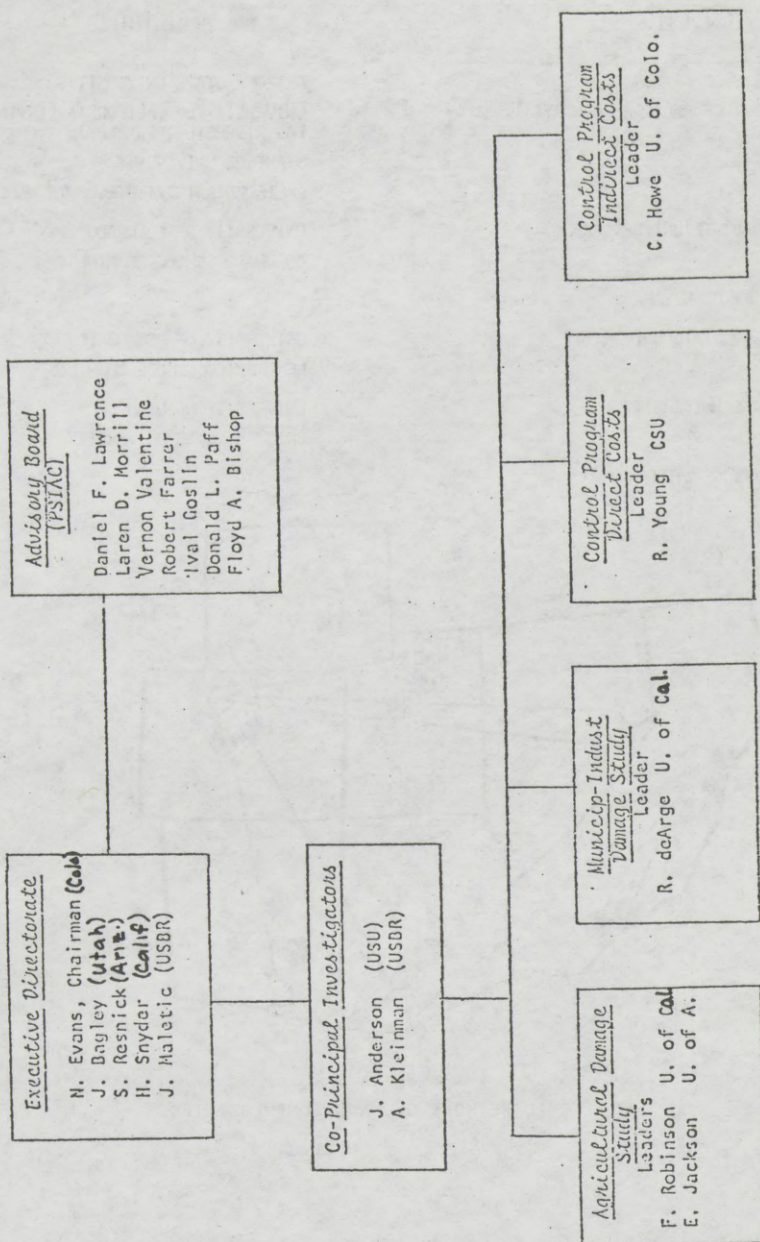
ALTERNATIVE SOLUTION	SUB-PROBLEM	ALTERNATIVE SOLUTION	SUB-PROBLEM	ALTERNATIVE SOLUTION	SUB-PROBLEM
		3. COLLECT AND SPECIAL USE	a. IDENTIFY SOURCE AREA b. COLLECTION METHOD c. SPECIAL USES d. LEGAL ISSUES	(1) SEE I-A-I-a (2) " (3) " (1) FISH FARM (2) SALT TOLERANT CROPPING (3) COOLING (4) INDUSTRIAL PROCESS (5) GEOTHERMAL INJECTION	(a) AREA REQUIRED (b) WATER BALANCE (c) OPERATING CRITERIA (d) MARKET / PROCESSING (e) ECONOMICS
		4. CONTROL WATERSHED SOURCES	a. VEGETATION REPLACEMENT b. FOREST MANAGEMENT c. STRUCTURAL MEASURES d. WATER HARVEST e. REDUCE SEDIMENT PRODUCTION		
		5. PHREATOPHYTE CONTROL	a. CONTROL SPREAD b. VEGETATION REPLACEMENT c. ANTI-TRANSPIRANT		

ALTERNATIVE SOLUTION	SUB-PROBLEM	ALTERNATIVE SOLUTION	SUB-PROBLEM	ALTERNATIVE SOLUTION	SUB-PROBLEM
	B. CONTROL POINT SOURCES	1. DESALT.	a. METHOD OF DESALTING	(1) ION EXCHANGE	(a) DESIGN CRITERIA (b) RATE (c) ECONOMICS
				(2) ELECTRODIALYSIS	(a) SEE I-B-1-a-(1) (b) " (c) "
			b. RESIDUE DISPOSAL		
			c. LEGAL ISSUES		
		2. DIVERT/EVAP.	a. EVAP. METHOD	(1) SEE I-A-2-c (2) " (3) " (4) "	
			b. RESIDUE DISPOSAL		
			c. LEGAL ISSUES		
		3. DIVERT/SPECIAL USE	a. SEE I-A-3-c		
			b. SEE I-A-3-d		
		4. PLUG WELLS	a. PHYSICAL FEASIBILITY b. LEGAL ISSUES		
		5. DEEP INJECTION	a. PHYSICAL FEASIBILITY b. LEGAL ISSUES		
	C. CONTROL IRRIGATION SOURCES	1. REDUCE SOLUTION PICKUP IN RETURN FLOW	a. REDUCE VOLUME OF RETURN FLOW	(1) REDUCE OVER-IRRIGATION (2) REDUCE CANAL SEEPAGE LOSS (3) INTERCEPT	(a) SCHEDULING (b) LAND PREPARATION (c) WATER CONTROL (a) LINE CANALS (b) SUBSTITUTE PIPE LINE (a) DRAIN PIPE
			b. DIVERT RETURN FLOW	(1) STRUCTURAL MODIFICATION	(a) BURIED DIKES

ALTERNATIVE SOLUTION	SUB-PROBLEM	ALTERNATIVE SOLUTION	SUB - PROBLEM	ALTERNATIVE SOLUTION	SUB-PROBLEM
		2. REDUCE E.T. RESIDUE IN RETURN FLOW	a. STORE RESIDUE IN SOIL	(1) FORM SLOWLY SOLUBLE PRECIPITATE (2) ACCUMULATE IN ROOT ZONE (3) ACCUMULATE BELOW ROOT ZONE	(a) USE BICARBONATE TO PRECIPITATE LIME/GYPSUM (a) DRIP IRRIGATION (a) CONTROL AMOUNT OF WATER APPLIED (b) CONTROL WATER TABLE (c) LIMIT LEACHING
			b. REDUCE LEACHING FRACTION	(1) SCHEDULE (2) PRECISION DRAINAGE (3) SOIL PHYSICAL-CHEMICAL REACTIONS (4) UNIFORM APPLICATION	(a) LAND PREPARATION (b) SPRINKLER (c) DRIP IRRIGATION (d) AUTOMATION (e) CONTROL
		3. DILUTE E.T. RESIDUE IN RETURN FLOW	a. MINIMIZE E.T.	(1) CONTROL PHREATOPHYTES (2) CROPPING (3) CULTURAL MANAGEMENT	(a) ERADICATION METHOD/COST (b) ENVIRONMENTAL CONSTRAINTS (c) ANTI-TRANSPIRANTS (a) VARIETY SELECTION (b) CROP SELECTION (a) MULCHING (b) EVAPO. BARRIER (c) SURFACTANT
		4. MINIMIZE SALT IN SURFACE RUNOFF	(a) CONTROL SURFACE WASTE	(1) LAND PREPARATION (2) WATER CONTROL (3) AUTOMATION	

ALTERNATIVE SOLUTION	SUB-PROBLEM	ALTERNATIVE SOLUTION	SUB-PROBLEM	ALTERNATIVE SOLUTION	SUB-PROBLEM
II. INCREASE WATER SUPPLY FOR DILUTION	A. INCREASE WATERSHED RUNOFF	1. REDUCE E.T.	a. CONTROL PHREATOPHYTES	(1) ERADICATE	(a) WILDLIFE IMPACT (b) RECREATION IMPACT (c) METHODS/COSTS EFFECTIVENESS
				(2) ANTI-TRANSPIRANTS	(a) MATERIALS/COSTS/EFFECTIVENESS (b) ECOLOGICAL EFFECT
			b. VEGETATIVE SUBSTITUTION	(1) ERADICATE AND RESEED	(a) METHODS/COSTS EFFECTIVENESS (b) SUITABLE SPECIES (c) ECOLOGICAL IMPACT
				(2) HARVEST OR CULTURAL MANAGEMENT	(a) SEE II-A-1-b-(1) (b) " (c) "
			c. VEGETATIVE MANAGEMENT	(1) MECHANICAL HARVEST	(a) METHODS/COSTS EFFECTIVENESS (b) ECOLOGICAL EFFECTS (c) MARKETS
				(2) LIVESTOCK HARVEST	(a) SEE II-A-1-c-(1) (b) " (c) "
				(3) WILDLIFE HARVEST	(a) SEE II-A-1-c-(1) (b) " (c) "
		2. REDUCE INFILTRATION	a. SURFACE PAVING		
	B. INCREASE PRECIPITATION	1. CLOUD SEEDING	a. SUITABLE SITE		
			b. METHODS/COSTS/EFFECTIVENESS		
	C. INTERBASIN TRANSFER	1. IMPORT	c. ECOLOGICAL IMPACT		
			d. LEGAL ISSUES		
			a. SOURCE	(1) COLUMBIA BASIN (2) CANADA	
			b. POSSIBLE DESTINATION		
			c. CONVEYANCE		
		2. INTERBASIN EXCHANGE	a. SEE II-c-1		
			b. "		
			c. "		
			d. "		

ALTERNATIVE SOLUTION	SUB-PROBLEM	ALTERNATIVE SOLUTION	SUB-PROBLEM	ALTERNATIVE SOLUTION	SUB-PROBLEM
III. REMOVE SALT AT DESTINATION	D. REDUCE CONSUMPTIVE USES	1. SEE II-A-1 2. ELIMINATE SOME DIVERSIONS 3. REDUCE EVAPORATION LOSSES			
	E. REDUCE EXPORTS				
	F. DESALT SEA WATER & IN-BASIN EXCHANGE				
IV. MINIMIZE IMPACT OF SALINITY ON AGRICULTURE	A. SELECTIVE DELIVERY (RIVER MANAGEMENT)	1. SPLIT STREAM OPERATION 2. SLUG FLOW OPERATION	a. ISOLATE RECEIVING AREA		
	B. PARTIAL DESALTING	1. SEE I-A-1-c 2. "			
	C. IRRIGATION WITH SALINE WATER	1. CONTROL MOISTURE STRESS 2. TOLERANT VARIETIES 3. CONTROL SALT DISTRIBUTION IN SOIL	a. CONTROL IRRIGATION TIMING a. WATER TABLE CONTROL b. CONTROL SOIL WATER MOVEMENT	(1) WATER CONTROL (2) AUTOMATION (3) EQUIPMENT (1) PRECISION DRAINAGE (1) SEE I-c-2	(a) YIELD RESPONSE FUNCTIONS
V. MINIMIZE IMPACT OF SALINITY ON R/I	A. SEE IV-A				
	B. SEE IV-B				
	C. ALTERNATE PARTIAL SUPPLY				



MANAGEMENT ORGANIZATION
CWIC PROJECTION ECONOMICS OF SALINITY CONTROL

ATTACHMENT D.

○ CWIC● AFFILIATED

UNIVERSITY OF ARIZONA
UNIVERSITY OF CALIFORNIA (DAVIS)

ARIZONA STATE UNIVERSITY
UNIVERSITY OF CALIFORNIA (IRVINE,
LA, RIVERSIDE, BERKELEY)
STANFORD UNIVERSITY
CALIFORNIA INSTITUTE OF TECHNOLOGY

COLORADO STATE UNIVERSITY

UNIVERSITY OF COLORADO
COLORADO SCHOOL OF MINES

UNIVERSITY OF NEVADA

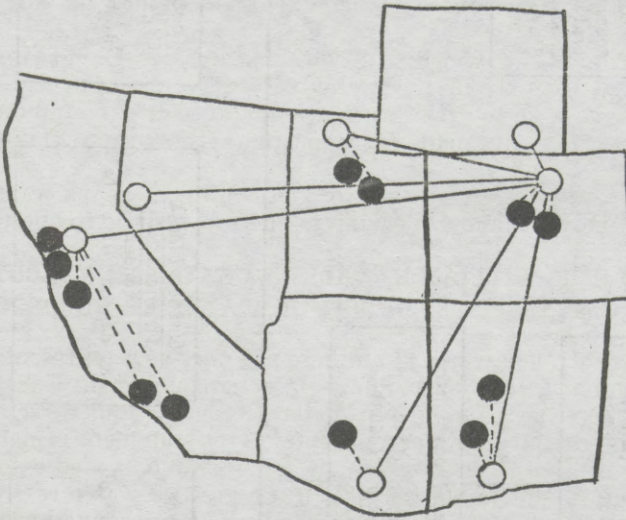
NEW MEXICO STATE UNIVERSITY

UNIVERSITY OF NEW MEXICO
NEW MEXICO SCHOOL OF MINES

UTAH STATE UNIVERSITY

UNIVERSITY OF UTAH
BRIGHAM YOUNG UNIVERSITY

UNIVERSITY OF WYOMING



THE CWIC NETWORK OF MAJOR UNIVERSITIES

Senator FANNIN. Thank you, Dr. Chamberlain. Senator Haskell.

Senator HASKELL. Thank you, Mr. Chairman. I would just like to welcome Dr. Chamberlain. I am sorry I was not here at the beginning, and unfortunately I will have to go to another hearing but that's the name of the game.

We all know, and Senator Fannin knows as well as any one of us, both of our States, Colorado and Arizona, are a little on the shy side of water. I know that Colorado State University has done excellent work in all aspects of water. Particularly, I think, on desalination which is a real problem in Western Colorado.

I don't have any questions of Dr. CHAMBERLAIN. I just wanted to welcome you.

Dr. CHAMBERLAIN. We appreciate the opportunity to appear before the committee, and we appreciate your continued interest in both energy and water and the quality of life and our environment.

Senator HASKELL. Thank you, Mr. Chairman.

Senator FANNIN. Dr. Chamberlain, you have certainly made a fine presentation. As I stated, your complete statement will be made a part of the record.

You have covered quite a variety of subjects. Do I understand that this is the only statement you have this morning, or do your associates—

Dr. CHAMBERLAIN. I have with me two associates, Dr. David Howells and Dr. Bill Walker from the water resources research center at VPI. They might wish to give information, add to or expound on any of the remarks that I have made representing their own special interest areas.

Senator FANNIN. Before we get to questioning, perhaps we could hear from Dr. Howells and Dr. Walker. Then we will go to questions.

STATEMENT OF DR. WILLIAM R. WALKER, CHAIRMAN, EXECUTIVE BOARD, UNIVERSITIES COUNCIL ON WATER RESOURCES

Dr. WALKER. Mr. Chairman, I am here not only as a representative from the Commonwealth of Virginia, but as chairman of the Executive Board of Universities Council on Water Resources and director of Virginia Water Resources Research Center. This statement is made on behalf of UCOWR, an association of 80 universities dedicated to research, training, and public service in the area of water resources. Your two universities in Arizona are members of our council as such.

I would like to emphasize a couple of points that Dr. Chamberlain has made. The funding level to which this legislation addresses itself is very important in my particular State. We have outlined a 5-year program in water which amounts to about \$5.7 million. It is this funding level that is provided by the Federal Government that acts as a catalyst by which we are able to capture a lot of the public and private moneys that would allow us to go forward to carry out the research needs as viewed by our water resource managers in the States.

It is very important that this funding level be raised to the authorized level as authorized by Congress in 1971.

We are also very concerned that the information which is now currently available get out to our water users. So additional funds are very important to us in terms of getting the information from the researchers in a form that the users can have them.

I think that anything else that I may say would only be repetitious of Dr. Chamberlain. We do support the two modifications that he has suggested, the amendments to the proposed bill, S. 1301. And I think that this would conclude my statement.

Senator FANNIN. Thank you very much indeed.

[The prepared statement of Dr. Walker follows:]

STATEMENT

of the

Chairman of Executive Board

Universities Council on Water Resources

on

S. 1301

To promote a more comprehensive national program of
water resources research and technology development

before the

ENERGY RESEARCH AND WATER RESOURCES SUBCOMMITTEE

of the

Senate Committee on Interior and Insular Affairs

July 11, 1975

This statement by William R. Walker, Chairman of Executive Board of Universities Council on Water Resources and Director of Virginia Water Resources Research Center recommends enactment of S. 1301 which is designed to strengthen and extend the Water Resources Research Act of 1964 as Amended (P. L. 88-373); expand the authority of the Department of Interior to promulgate technological development in water resources; accelerate the transfer of technology from research to application; and repeal the Saline Water Conversion Act of 1971 (P. L. 92-60).

I am William R. Walker, Chairman of the Executive Board of the Universities Council on Water Resources (UCOWR) and Director of the Virginia Water Resources Research Center. This statement is made on behalf of UCOWR an association of 80 universities dedicated to research, training, and public service in the area of water resources.

The Council appreciates the opportunity to speak in support of S. 1301 and to recommend its enactment. We think that it is most appropriate that the subcommittee in considering this new legislation review the accomplishments of this program and to assess its future needs as part of its total concern for all Federal water resource programs.

UCOWR favors accountability and periodic review for all programs authorized by Congress, especially the one to which S. 1301 is addressed. The original legislation contemplated a Federal-state partnership designed to provide a mechanism whereby (1) state and regional water related problems could be specifically addressed (2) the information generated by the research could be effectively transmitted to users, and (3) there would be sufficiently trained personnel to implement the resulting decisions and programs. The partnership concept contemplates that each partner will fully discharge its obligations and responsibilities. In 1971 Congress recognized that water related problems had become more severe and complex, that there was greater urgency to move the knowledge already known into the hand of users at a faster rate, and that inflation had severely decreased the purchasing power of the research dollar. It therefore increased the authorization of Section 100 from \$100,000 to \$250,000 annually. The Executive Branch of this Federal partnership has not implemented this authorization and thereby weakened the partnership.

It is important that the program have continuity so the states can plan with confidence that the partnership will endure. In my state of Virginia we have developed a five year research plan in consultation with local, county, and state officials, industrial managers, planning district personnel, researchers, and others. It is contemplated that \$5.7 million will be needed during this period to develop the informational needs in eight major areas -- water supply, waste treatment, resource management, inventory and monitoring, flood damage prevention, non-point sources of pollution, outdoor recreation and marine environment. The availability of the authorized funds under Section 100 on a sustained basis allows such planning to go forward with confidence and provides the catalyst for attracting state and private funds necessary to meet the five year goals.

The training by this program is important in helping to meet both state and Federal manpower needs in the area of water. Legislation such as Water Pollution Control Amendments of 1972 and The Drinking Water Act of 1974 required increasing numbers of trained personnel in both the private and public sector. There needs to be periodic assessment of these manpower needs but the training program cannot remain effective if it is always clouded with uncertainty. Continuity is required for definite periods.

On behalf of the Universities Council on Water Resources I would recommend passage of S. 1301 by this Committee. It will help insure that much of the informational needs to effectively manage our water resources will be available.

STATEMENT OF DR. DAVID H. HOWELLS, CHAIRMAN, COUNCIL OF
REPRESENTATIVES, NATIONAL ASSOCIATION OF WATER INSTI-
TUTE DIRECTORS

Dr. HOWELLS. Mr. Chairman, I have a very brief statement. If it could be made a matter of the record, I would just elaborate on a couple of points that Dr. Chamberlain has already made.

First of all, the water institute directors fully endorse all the points in Dr. Chamberlain's statement on behalf of the National Association of State Universities and Land-Grant Colleges.

The first thing I would like to underscore that he has already addressed is our feeling that we would welcome periodic review by the Congress. We would welcome oversight hearings periodically. We would welcome a chance to come to you and tell you what we have been doing.

We would suggest something other than open-ended authorizations, and we would endorse the 5-year periodic reauthorization that has already been mentioned.

I would like to reemphasize what both Dr. Chamberlain and Dr. Walker have said with respect to the inconsistency between authorization and appropriation. The original position of the administration in 1971 when Congress enacted the amendments to the Water Resources Act was that \$200,000 was required. Yet subsequently we have come in each year with either \$100,000 or less than \$100,000 and now slightly over \$100,000. This is of critical importance to the water institutes. This is recognized as a cooperative State-Federal program. Our States have responded. In a State like North Carolina, for example, the State now contributes two-and-a-half times as much as this annual allotment.

It is increasingly difficult for us to justify that in terms of the cooperative nature of the program because the question is asked is this really all the Federal Government is going to do on its side of the fence; \$110,000 now is worth roughly in terms of purchasing power about \$50,000 in 1974.

I do not understand the administration's position that \$110,000 is adequate. I would like as a last point to underscore the importance of the institutes insofar as bringing the resources of the universities, both private and public, in the States they serve to assisting the State water resources planning and management agencies. This has been the strongest point for this program in that it has made it possible for the universities to work closely with the water agencies to encourage faculty involvement in water problems, to bring the water agency technical staff into closer liaison with these university people and to greatly strengthen the overall process.

I think if this program were to lapse this whole university support that I am emphasizing would largely fall to the wayside. Beyond that I would certainly respond to questions.

[The prepared statement of Dr. Howells follows:]

PREPARED STATEMENT OF DAVID H. HOWELLS, CHAIRMAN, COUNCIL OF REPRESENTATIVES NATIONAL ASSOCIATION OF WATER INSTITUTE DIRECTORS, JULY 11, 1975, AT HEARINGS ON S. 1301 BEFORE THE SUBCOMMITTEE ON ENERGY RESEARCH AND WATER RESOURCES OF THE SENATE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS.

I am David H. Howells, Chairman, Council of Representatives, National Association of Water Institute Directors, (NAWID), and Director, Water Resources Research Institute of The University of North Carolina, located on the campus of North Carolina State University at Raleigh. This statement is made on behalf of the 52 state water resources research institute directors.

The proposed changes in Title I of S. 1301 are necessary adjustments to the new fiscal year schedule. No other changes to this Title appear to be necessary at this time.

Questions have been raised as to the intent of Congress in par.(f) Sec. 201, Title II of the proposed amendments:

"Establish and operate facilities as necessary to carry on the research and technology development programs to effectuate the purpose of this Act."

Would this authorize an in-house research capability for the kinds of research now conducted by universities and other institutions under Title I and II, or is it intended to be limited to research associated with saline water-type technology development programs?

The existing Title I and amendments to Title II proposed in S. 1301 provide open-ended authorizations. It is our view that the program should be subject to periodic review and that 5-year authorizations would provide sufficiently frequent opportunities for this purpose. More frequent authorizations would require proportionally more time for preparation with consequent loss of attention to the operating programs. So we would recommend 5-year authorizations in lieu of the open-ended authorization.

Another matter of associated concern is the continued problem with appropriations. In 1971, the Department of Interior witness endorsed an increase in authorized annual allotments from \$100,000 to \$200,000. The Congress eventually approved \$250,000. Until this year, when it asked for \$110,000, the Administration has never requested more than the original \$100,000 authorization. Indeed, it proposed a decrease to \$89,000 for FY 1975. The inconsistency between authorization and appropriation requests has given us all kinds of difficulty. Periodic oversight hearings would provide the opportunity to demonstrate how well this small amount of money has been used. But without some appreciable increase in the Administration's appropriation request to match the authorization it supported, we may not be able to survive long enough to appear before you in oversight hearings.

Thank you for the opportunity to present these viewpoints on S. 1301.

Senator FANNIN. Thank you very much, Dr. Howell. I certainly agree we need better communications and the oversight hearings, if held, would be very valuable.

We are all concerned about the spending level. The amount of funds involved are minute compared with the tremendous importance of the project and the resulting benefits that can accrue.

I would just like to ask the three of you what levels of funding are needed for effective title I and II programs? And just give me the reason for that.

Dr. CHAMBERLAIN. Our perception is that first priorities can get up closer to the existing authorization levels. You may recall the Secretary indicated that in regard to the matching programs the administrations' budget proposal is \$3 million against an authorization of \$5 million. And in regard to the institutes an authorization of \$250,000 against a budget request of \$110,000.

Our priorities at this point are just to get up reasonably close to existing authorizations. Particularly so in regard to the title I sector where the Federal Government gets substantially more than \$2 of activity at the State level for every \$1 of Federal investment.

Dr. Howells has indicated $2\frac{1}{2}$ to 1 in his State. In my State it runs about $1\frac{1}{2}$ to 1. But across the country that one has a very high payoff in terms of input of Federal funds.

Senator FANNIN. How much local and regional guidance goes into the matching grant program?

Dr. CHAMBERLAIN. There is a substantial advisory system involved. I would ask Dr. Howells to speak specifically to that issue.

Dr. HOWELLS. If you would forgive me for using our own State as an example, I think it is fairly typical and it is difficult to answer your question in general terms concerning 54 institutes.

In our case this process starts with continuing discussions, involvement jointly in special meetings working together elbow to elbow trying to better understand the problem in the first place. Then to get some agreement on what is really researchable and how to research it.

Once we develop a research proposal the first thing we do is send it back to the user agency before we consider acting on it. The first thing we read to our review committee are the responses from those agencies, what do they think about this proposal, how important does it appear to them. They will have suggestions. If we decide on funding a project, the first thing we will do before moving ahead would be to get back to the agency to build into that proposal those things they think they want in there.

Then we have a similar process of technology transfer during the course of the project. Once it is underway we have initial meetings, we appoint liaison people to user agencies. These people work with the—user agencies—a procedure that doesn't exist with the traditional classic research grant from Washington.

Senator FANNIN. What method of research transfer technology should be provided for OWRT, and is current structure designed to accommodate the mission involved?

Dr. CHAMBERLAIN. My own perception is that the basic organizational structure of OWRT is suitable to accomplish the missions articulated. It may take some further time for full innovation of the full activities being merged by this creation of OWRT.

We are confident in the present leadership that is there and believe that the objectives can be accomplished within the structure.

Senator FANNIN. You are not recommending any changes then that you feel would be beneficial?

Dr. CHAMBERLAIN. No, sir, not at this time.

Senator FANNIN. What would be accomplished if the allotment was increased to \$250,000? Could the additional funds be used effectively and beneficially?

Dr. CHAMBERLAIN. In order to really make that explicit, to help illustrate by example what can happen, I would ask our manager from Virginia to use his own State as an example of what typically would happen throughout the system. This would make it more concrete.

Dr. WALKER. As I indicated previously we went through a very elaborate process of trying to identify what our major water problems were in Virginia, from users, from industry, from managers, from planners and so forth. Then we recirculated these things among these people and said, "OK, now we have identified these kinds of problems. What are your needs? What are your priorities?"

From this we developed our 5-year program that has a price tag on it of about \$5.7 million. If we approached funding at the \$200 million, I believe then we are in a position to get the kind of support we need from our State legislatures and other research organizations to really attack this problem.

As long as our funding level remain at the 100,000 level we will have much difficulty getting the additional funds. It is a catalytic sort of thing that allows us to take that money and to bring in the additional money which we need to have to attack these many problems which we have.

Senator FANNIN. Thank you very much. Dr. Chamberlain, you certainly covered very well the problems of water in the Rocky Mountain States, and I appreciate very much having the information regarding the amount of water needed for the power generation and for the energy programs that we have in those areas.

When you speak of oil shale production at 1 million barrels per day will require 120,000 acre-feet per year. To that must be added 4,000 acre-feet per year which will be required to sustain vegetation on reclaimed land and shale residue.

Is that 120,000 acre-feet, is there a return flow or are you talking about utilizing 120,000 acre-feet?

Dr. CHAMBERLAIN. My understanding is there is some return flow but of questionable quality. Those figures have to be considered as pretty crude estimates at this stage.

Senator FANNIN. If you add up the amount of water that could be utilized just in your area, it would be an appreciable amount as compared to the amount of water now being made available in the same area for other purposes. Isn't that true?

Dr. CHAMBERLAIN. It is a very, very serious problem. I think it is not an exaggeration to indicate that the potential transfer problem is for development of not just oil shale but coal gasification and so on in the Rocky Mountains area leads to the potentiality of extreme stress in figuring out which shall be of highest priority, the use of water for agriculture or the use of water for making availability of energy.

These transfer problems will require a great deal of public policy analysis as well as research to back up that policy analysis.

Senator FANNIN. The figure is given by the statement that you have furnished us and also the figures given to us this morning brings out the magnitude of the problem that we have in the West.

Of course, this is true, whether it be Virginia or North Carolina. Of course, North Carolina seems to be blessed with a good deal of water resources, but this morning when testimony was being received from the Department of Interior people the statement was made about the research work being done at one of your universities.

Are you familiar with desalination? Are you familiar with what is being done?

Dr. HOWELLS. We have worked with faculty interested in desalination from the standpoint of helping them get to sources of money. We have not been authorized in the past under previous legislation to use our funds for that purpose, so we have not been directly involved in that research effort.

May I make the comment, sir, with respect to the abundance of water resources in North Carolina, we have our problems, too, sir. We have just gone through a severe drought and I guess our corn crop is largely lost. In terms of annual averages we have good water supplies, but we have extreme variations with respect to time.

Senator FANNIN. Mother Nature has not been very complimentary, but I was referring to the sea membrane development work previously mentioned at the Wrightsville Beach test facility located in North Carolina. Are you familiar with that?

Dr. HOWELLS. We are generally familiar with it. We have problems, particularly on our coast. And we had a conference in which they participated dealing with coastal problems. A part of this, the end result was to familiarize people on the coast of Carolina with the desalination program.

Senator FANNIN. Gentlemen, we very much appreciate your testimony. Your complete statements will be made a part of the record. If there are any further questions, we may write to you for further details. But you have been very cooperative and we appreciate your testimony.

Dr. CHAMBERLAIN. Mr. Chairman all three of us thank you for the opportunity to appear before the committee.

Senator FANNIN. Thank you. The next witness will be Neil Cline, president-elect, National Water Supply Improvement Association.

Mr. Cline, we welcome you here this morning.

We have your statement, Mr. Cline, and you may proceed as you desire.

STATEMENT OF NEIL M. CLINE, PRESIDENT-ELECT, NATIONAL WATER SUPPLY IMPROVEMENT ASSOCIATION

Mr. CLINE. Mr. Chairman, my name is Neil Cline. I appear before you today representing both the Orange County Water District of California, of which I am secretary manager, and the National Water Supply Improvement Association of which I am president-elect and secretary-treasurer.

I thank you on behalf of all of the members of NWSIA for the opportunity to present to you our views on the importance of Federal support of water research and technology, particularly in the fields of desalination and water supply improvement.

One of the principal reasons that the United States has evolved into the greatest country in the world is our ability to furnish an adequate water supply to our citizens for municipal, industrial, and agricultural uses. As we pushed our frontiers westward, new methods of water supply were developed, and through the combined efforts of local and Federal agencies the United States has consistently managed to provide the essential water requirements of our people. As our communities have become more concentrated and complex, so too have our methods of water supply and disposal become more technical and complicated.

Thankfully, the U.S. Government has kept pace with the ever-changing requirements of our community by developing programs that responded to the challenge. The U.S. Bureau of Reclamation and the U.S. Army Corps of Engineers have constructed a dazzling array of water and power facilities that make possible the existing economy of our Western States.

In 1953, recognizing that our fresh water supply was not limitless, the Government implemented a saline water conversion program to develop a technological base so that at the time in our Nation's future it would be necessary to demineralize seawater, brackish water, or wastewater, we would be prepared.

This ambitious program has been responsible for advancing desalination processes to a point where there now exists a variety of potential alternatives to water suppliers faced with water quality problems. However, it now appears that this essential activity is being abandoned or diminished to point where it is no longer effective, just at the time when in our view it should be broadened and emphasized.

There is much work to be accomplished before the local agency or industry can confidently consider salinity removal programs. The significant breakthroughs that have been accomplished by the Federal effort in the locations or at pilot plant scale must be expanded to demonstrate reliability and performance at municipal requirement capacities.

I would like to cite the Orange County Water District experience as an example of the possible tragedy imposed by the discontinued Federal desalting efforts.

The Orange County Water District started up its Water Factory 21 on June 5, 1975, when product water from the Office Water Research and Technology 3 mgd. VTE/MSF ocean water desalter was first mixed with reclaimed wastewater from the treatment plant that we provide and the mix was injected into the groundwater reservoir that serves our 1,500,000 customers.

The Water Factory 21 VTE/MSF unit is a research facility designed to show how seawater conversion may be used to fill a niche in a very complex water environment. Our district which has the water quality problems to contend with no matter whether the Federal Government remains constant in its purpose to demonstrate seawater desalination, has spent millions of dollars on Water Factory 21.

As planned, the program was to include a 15 mgd wastewater reclamation plant and a desalting plant to produce a high quality min-

eral-free blending supply to be mixed with the polished wastewater. The wastewater plant was 55 percent funded by the U.S. Environmental Protection Agency, 25 percent by the State of California, and the balance from our district.

The plant is completed and operational at a cost of \$15 million. Imagine our consternation during the last several years when the Department of the Interior inexplicably has progressively reduced desalination in its research programs. The deemphasis has extended even to the point of proposing to terminate the testing of the 3 mgd VTE/MSF plant short of completion of the demonstration and research program that was originally set for it.

Our district is alarmed, chagrined, and deeply disappointed by the withdrawal of our Federal partner in what we undertook as a cooperative venture. In part, we participated in this program because of the persuasion of the Federal desalting experts who were so anxious and enthusiastic a scant 4 years ago to have a new method of seawater conversion tried in a substantial, real-life demonstration project.

Our district and NWSIA do not believe that the Government has carried desalination research to the point at which industry or the local agency can be relied upon to complete the job.

The Orange County Water District has invested more than it really can afford in this undertaking. With our energy costs spiraling, we must seek a less-energy-intensive solution to our demineralization problem than the VTE/MSF has so far demonstrated that it can provide. From every point of view, therefore, the carrying out of the testing program on the VTE/MSF technology by the OWRT is essential if this phase of the program is not to become a monumental white elephant on the hands of the Federal Government and a constant problem source to the Orange County Water District.

We are pleased to note that the cooperative program to build a large desalting plant in Israel is now underway. We concur that these kinds of projects are essential to furthering our country's goal to provide and share our technical achievements with our international friends; however, we lament that \$20 million has been appropriated for this overseas program and virtually none to perfect a more advanced technique that is being developed by the Office of Water Research and Technology in California.

In order to provide a fallback program, when OSW disappeared and OWRT asked the Congress for no funds for testing the VTE/MSF 3-mgd—million gallons per day—plant beyond a startup period, the Orange County Water District has advertised for bids on a 1-mgd demineralizer to reduce the TDS in a part of the stream from our tertiary waste water plant. Treated sewage, in our original plan, was to supply half of the 30,000 acre-feet of water a year we need for an underground barrier to prevent seawater intrusion into our basin and for ground-water replenishment. The other half of the required water, we hoped, would come from a 15-mgd seawater desalter into which the 3-mgd demonstration plant could be expanded if it were proved to be as successful as the OSW forecast it would be.

Abandonment of the tests of the 3-mgd plant while they are inconclusive will force us to demineralize a part of our wastewater stream, for the treated wastewater will not meet injection quality standards without mixing high-quality water with it.

Our efforts to get bids on a 1-mgd demineralizer also have presented new evidence that American industry is not ready to take over desalting research. We are working with some of the leading U.S. manufacturers, including the du Pont Co., Dow Chemical, Universal Oil Products Co., and Ionics, Inc. We originally required that the manufacturers guarantee their product.

This did not seem unreasonable since we are dealing with our community's water supply. Each of these companies, despite the research done to date, notified us that it is unwilling to guarantee its product performance because of so many uncertainties and unknowns in wastewater desalination. We have had to modify our requests of the manufacturers and to redouble our efforts in support of the additional needed research.

Please do not accept bland, general statements that the research is all completed. We who are at the point where the use must be made of these new water sciences are not finding this to be true.

NWSIA recently completed under a contract with the Interior Department an updating of the inventory of the world's desalting plants. A total of 1,036 plants with capabilities of producing more than 25,000 gpd were found to be operating in the world. Of these, 346 were in the United States. Plants in Europe and those in the Arabian Peninsula and Iran produce as much or more fresh water than do ours.

Desalination is on the verge of a quantum jump in expansion of installed capacities. We in the United States are proceeding with the Colorado River desalting plan, but the oil-rich countries of the Middle East are planning investments of \$8 billion or more in the new desalters. The Bureau of Reclamation, by way of comparison, has spent \$6 billion since its inception in 1902. So far, the American desalting industry has not fared at all well in international competition for this new business.

Obviously, more research is needed to prepare our industry to meet the European and Japanese competition with technologies and tested equipment. This year, we have less than 20 desalination experts in the OWRT. With this level of research management and the level of financing that goes with this totally inadequate staff, the United States has resigned its leadership in desalting technology. The world markets have already been taken over by others.

We see, therefore, that the deemphasis on desalination research has not served the domestic water supply industry well. I give you the Orange County Water District experience in proof. The deemphasis also is not serving American industry well in the world competition for business, but is opening the way for other competitors just when the market is most demanding.

Mr. Chairman, I have talked only about desalting programs and only about some aspects of that research. The Orange County Water District and the National Water Supply Improvement Association are not so narrowly oriented as to be oblivious to the needs of additional water-oriented research. We are in support of continuation of and expansion of such additional research to extend our Nation's water supply through technological methods. We feel, however, we may be in the best position to lay before your committee the needs for desalination research and demonstration. That is why I have confined my presentation to these requirements.

Thank you.

Senator FANNIN. Thank you very much, Mr. Cline. I am concerned about your feeling, and I can say that you are wrong. We do not believe that the Government has carried desalination research to the point at which industry or the local agency can be relied upon to complete the job.

Is that—that the concerns involved in this activity, and there are some very large manufacturers that are manufacturing equipment—is it the difficulty of making the equipment that is involved or why do you feel they will not go forward with their development?

Mr. CLINE. They will furnish material, but they will not guarantee the product. It is just rather early in the development of this equipment. This has not been a long-range experience. While their engineers might be optimistic, their attorneys aren't.

We had to soften our guarantee, and we will accept what happens. I mentioned a 1 million-gallon-a-day plant. We actually will require a 5 million-gallon-a-day plant, but we are unwilling to build a 5 until we know how the 1 works, and the industry cannot guarantee us that the 1 million-gallon-a-day plant will work. So we are in effect conducting research and development with local taxpayers funds in Orange County.

Senator FANNIN. You mentioned the experimental plant in Fountain Valley. A plant that as I understood cost about \$5 million. Was this substantial contribution from the Orange County Water District? I am a little confused over some of the figures you were using. I don't know whether or not I am mixing oranges with apples here.

On page 3, you are talking about one plant here, waste-water plant 55 percent funded by the U.S. Environmental Protection Agency. There is no connection between these separate facilities?

Mr. CLINE. Yes; they are connected. We claim waste water in one facility and desalinize water in the other, and blend the two waters.

Senator FANNIN. The one project referred to, the \$5 million project, is that included in the \$15 million or is it separate?

Mr. CLINE. It is separate. The water factory which combines the two technologies will cost about \$23 million, of which \$15 million is waste-water reclamation and the balance is for desalting. We will blend the two waters with the two water products.

Without the desalter, the waste-water reclamation plant—

Senator FANNIN. I understand. Secretary Horton indicated that the Fountain Valley model will not move to a full-scale prototype desalting plant. What effect will that have on the future investment of the District?

Mr. CLINE. If the desalter is not expanded, the water district will have to develop some other method of desalting water. Otherwise we will have spent—

Senator FANNIN. Your complete program?

Mr. CLINE. We will have to completely redirect the program. When this program was undertaken, there was no guarantee that the Federal Government would expand the desalting plant. But it was our understanding there would be adequate testing to determine the feasibility, whether or not the plant should be expanded.

It appears to us, with the emphasis on desalination programs, it does not appear that we will get an adequate test of the existing program, let alone expansion of the program.

Senator FANNIN. That's what I was trying to determine. What effect this would have on the future work you will be doing. Of course, your answer is that you feel a great deal will be sacrificed if that is not completed, if you don't go forward?

Mr. CLINE. Yes, sir.

Senator FANNIN. What are the most important issues to be addressed relative to saline water conversion? What do you feel are the most important issues?

Mr. CLINE. Speaking on behalf of the National Water Supply Improvement Association, we feel there should be an intensive expanded development program to analyze technological means to treat brackish water, industrial waste, and emphasis on osmosis, electrode dialysis, and freezing process that has not been fully developed.

We are on the threshold of progress when it appears that the program is being sadly deemphasized.

Senator FANNIN. What level of funding would be needed to resolve them in a timely fashion, do you think?

Mr. CLINE. That is a difficult question for me to answer.

Senator FANNIN. What do you think is between research and development.

Mr. CLINE. It is the gap between research and development. We suggest it is coming along quite well. We are prepared to see the Office of Technology and Research emphasize development.

Senator FANNIN. Has there been any work to your knowledge in the field of using solar energy in this activity in your California area?

Mr. CLINE. I understand OSW did some work in the past, but at the present time we are so underfunded and understaffed—

Senator FANNIN. I was wondering if in your area of California, has there been any work?

Mr. CLINE. No, there has not.

Senator FANNIN. Thank you very much, Mr. Cline. We appreciate your testimony. Your full statement will be made a part of the record. It has been very helpful, and we certainly commend you for the work you are doing and wish you well.

I hope that we can do a great deal more. I know you will be watching what is being done in my home State as far as that plant is concerned, and we certainly are supportive of programs that will help to solve this very serious problem we face in the years ahead. They have been brought out this morning, the interrelationship with energy and every phase of economic activity.

We have a very serious problem at hand, and I think there will be a great deal of effort and coordination of effort to accomplish these objectives, and we appreciate your help.

Mr. CLINE. Thank you, Senator. I would like to invite you to California to see our beautiful plant there and at that time to share with you a glass of reclaimed waste water.

Senator FANNIN. Thank you, Mr. Cline.

The subcommittee will now adjourn.

[Whereupon, at 11:45 a.m., the subcommittee adjourned.]

[Subsequent to the hearing, the following letter was submitted for the record.]



STATE OF NEW MEXICO

STATE ENGINEER OFFICE

SANTA FE

S. E. REYNOLDS
STATE ENGINEER

July 18, 1975

Bataan Memorial Building
STATE CAPITOL
SANTA FE, NEW MEXICO 87501

The Honorable Frank Church, Chairman
Subcommittee on Energy Research and
Water Resources
Senate Committee on Interior and
Insular Affairs
United States Senate
Washington, D. C. 20510

Dear Mr. Chairman:

I am advised that your committee recently held a hearing on S. 1301, a bill to promote a more comprehensive national program of water resources research and technology development, to reorganize certain functions in the Department of the Interior and for other purposes, and that the record of the hearing remains open. I respectfully request that this letter be made a part of the record.

I believe it is essential that the Secretary of the Interior have the water resources research and technology development authority that would be given by Title II of the bill. There have been recently indications that the Federal government intends to abandon or severely curtail its activities in saline water conversion research. I believe it is generally recognized that the Office of Saline Water under the authority given it by the Congress made extremely important contributions to the technology of saline water conversion, particularly in the development of the membrane processes. Nonetheless, I believe there remains a great opportunity to reduce costs and improve feedwater recovery efficiency by further membrane research and technology development.

New Mexico is most vitally interested, of course, in the advancement that can be made by continuation and possible expansion of activities at the Roswell Test Facility of the Department of the Interior. In 1963 the State of New Mexico contributed \$100,000 to the construction of a saline water conversion plant utilizing the vapor compression process at the Roswell site. The City of Roswell donated the land for the demonstration plant site and the facilities needed to dispose of brine effluent from the plant. In recent years the test facility has been converted

to a brackish water test center with facilities for research in membrane processes including a high pressure pump loop for testing pumps of the nature used in reverse osmosis process desalting plants. The State of New Mexico, the City of Roswell, and the other communities of the state continue to be actively interested in the operation of the Roswell facility of the Department.

There are several western water resources problems that could be solved, or at least mitigated, by the results of continued Federal research in membrane technology. In the course of consultations on the formulation of legislation to authorize the construction of a conversion plant to treat the return flows from the Wellton-Mohawk Irrigation Project for delivery to Mexico (P.L. 93-320) representatives of the executive department advised representatives of the Colorado River Basin states that then current reverse osmosis membrane technology would allow the recovery of only about 70 per cent of the plant feedwater, leaving 30 per cent of the feedwater to be disposed of as unusable brine effluent, but that ongoing research gave reason to hope that the recovery efficiency could be increased to 90 per cent. With a recovery efficiency of 70 per cent it would be necessary to dispose of about 40,000 acre feet of brine effluent from the plant authorized, thus reducing the amount of water available for use in the Colorado River Basin in the United States by that amount. Furthermore, it appears that several of the units authorized for study by Title II of P.L. 93-320 could usefully employ membrane conversion processes. Research and technology development that would reduce costs and improve the recovery efficiency of the membrane processes would be of great benefit to the states of the Colorado River Basin and to the United States.

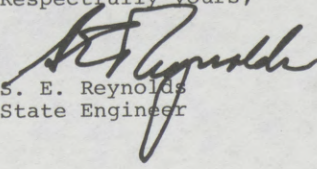
At this time it seems certain that recent enactment of the "Save Drinking Water Act" (P.L. 93-523) and the regulations to be promulgated thereunder will profoundly increase the need for membrane conversion processes of low cost and high recovery efficiency in New Mexico and probably the rest of the States in the West. The impact of this legislation will probably be felt most by our small communities if research and technology development do not yield small capacity units having low capital and operation maintenance costs and high recovery efficiencies.

Some have suggested that in consideration of the state-of-the-art of saline water conversion it is time for the Federal government to abandon its research and technology development and rely on private industry for future research and development in this field. I submit that this suggestion is not well taken in consideration of the immediate problems on the Colorado River and

the imminent problems to be faced under the Safe Drinking Water Act. My view in this matter is based in part on the savings that can be realized by the public entities involved from the patent policy under the Federal research program and the importance to the western states of research directed toward improvement of recovery efficiency. The general market for saline water conversion facilities may not give private industry sufficient incentive to improve recovery efficiency.

I urge your committee's early and favorable consideration of S. 1301, particularly the provisions thereof relating to water resources research and technology.

Respectfully yours,



S. E. Reynolds
State Engineer

SER:b

THE
OFFICE OF THE
SECRETARY OF THE
NAVY
WASHINGTON, D. C.
JANUARY 10, 1900

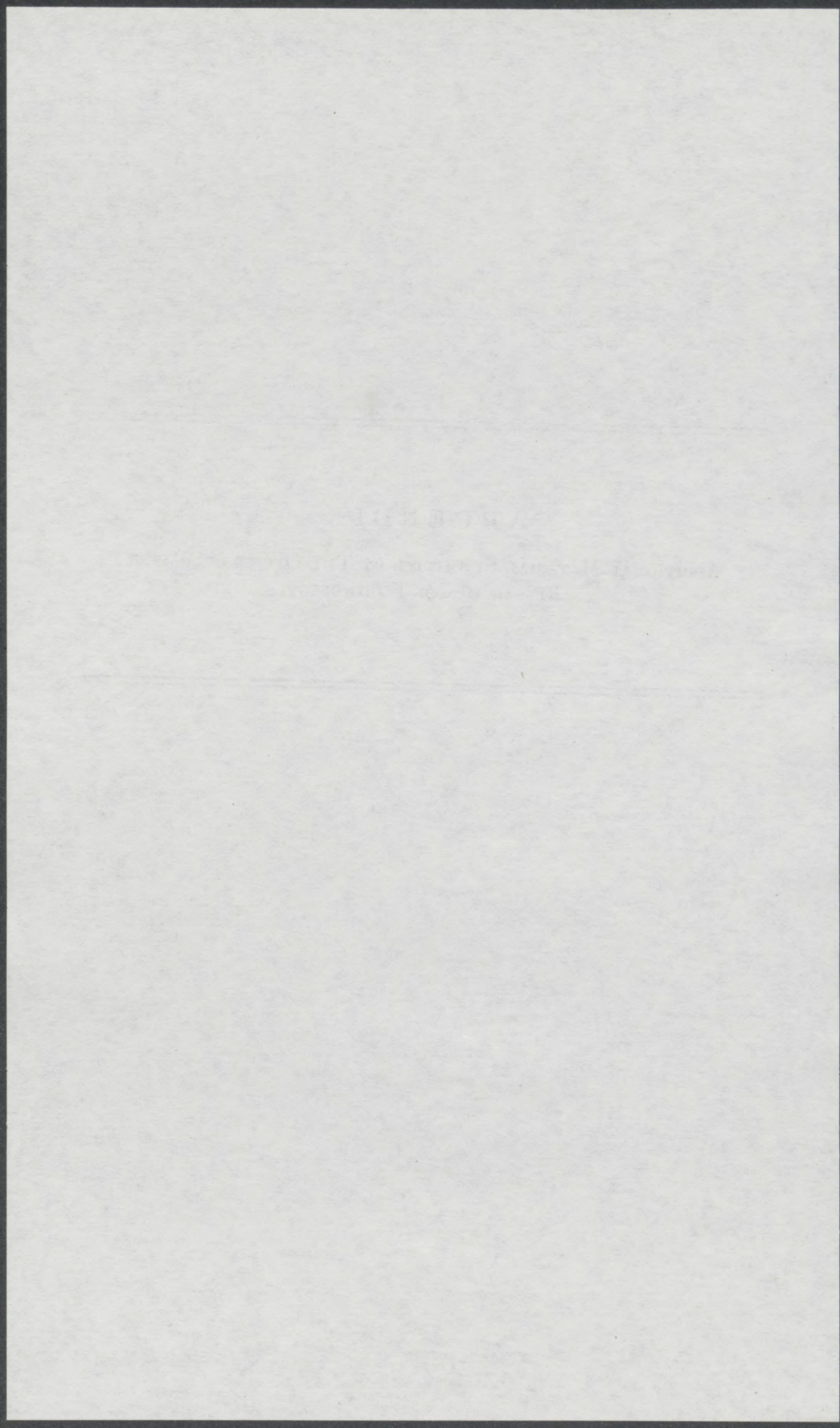
TO THE
HONORABLE
MEMBERS OF THE
NAVY
DEPARTMENT
WASHINGTON, D. C.

SIR:

Very
Respectfully,
Yours,
J. D. [Signature]

APPENDIX

ADDITIONAL MATERIAL SUBMITTED BY THE OFFICE OF WATER
RESEARCH AND TECHNOLOGY



3/75

Office of Water Research and Technology

Research Accomplishments

(Under Provisions of P.L. 88-379, as Amended)

Briefly described below is the result of one research project from each State. Where appropriate, reference is given to the application of the research findings or the adoption of the research results by water resource action agencies. These projects are not necessarily the most outstanding examples as data on the application or adoption of research findings made freely available and in the public domain are not always readily available. Many, if not most research findings reach the user through the media of technical, scientific, trade, and professional journals or through the training process, including short courses, workshops, and seminars for professional workers in water resources. In such instances the application of research results is difficult to trace.

This summary list of research descriptions and applications is similar to a list submitted for the hearing record last year, but different research projects have been cited.

ALABAMA---The phased concept of once-through cooling of power plant effluents was investigated by the Alabama Institute to develop a form of once-through cooling which is environmentally acceptable. A cost comparison of the phased-cooling system with the cost of wet cooling towers and cooling ponds indicated that phased cooling is less expensive than wet cooling towers but more expensive than cooling ponds. However, each of the other systems evaporated more water than the phased-cooling system. A number of power companies have expressed an interest in this research as have the Electric Power Research Institute (EPRI) and the National Science Foundation. Funds have been made available by EPRI to construct and test a model system.

ALASKA---Research has indicated that the most dynamic and perhaps the most important soil water behavior occurs in the winter when a significant amount of water is lost to the atmosphere. A thorough knowledge of soil water interaction in frozen soils is crucial for successful engineering and construction of roads and pipelines in Alaska. A research project conducted at the University of Alaska indicates that during the winter months atmospheric conditions cause a significant amount of soil water evaporation with a significant amount of heat being lost from the soil as a consequence of the moisture migration. These findings can be utilized to schedule construction activities and design equipment to cope with seasonal variability in the properties of the Alaskan land surface.

ARIZONA--The current rate of increase in demand for electrical energy, both nationally and regionally, not only is placing a stress on energy resources, but also is imposing an additional draft on water resources. The degree to which water use and reuse criteria can be incorporated into efficient power-plant siting and operation is an important aspect of regional water management. In this project ten locations in Arizona where nuclear power plants might be located and where significant quantities of municipal wastewater are produced were examined. A comparative evaluation between ground water and wastewater showed a significant reduction in cost of cooling where wastewater was used; estimated savings in water production cost ranged from \$101,000/year at Flagstaff to \$246,000/year at Tucson, for a 500 MW(e) conventional light-water reactor facility. Contracts for such use have been negotiated between the City of Phoenix and the Arizona Nuclear Power Project.

ARKANSAS--As a result of research performed by the Arkansas Center which led to an improved design of septic tank systems, both local and State regulatory agencies are reevaluating their design standards for septic tank installations. In addition, both the Corps of Engineers and Farmers Home Administration are reviewing the results of this Arkansas research study with a view of utilizing the results in their programs.

CALIFORNIA--A ground-water quality model developed in a project by the California Department of Water Resources provides a useful planning tool for assessing the effects of alternative water supply and disposal plans on the general concentration of dissolved solids in productive aquifers. This model is being applied in the Santa Clara-Calleguas area in testing of future alternative water management plans of interest to Ventura County water planners.

COLORADO--As a result of research in Colorado, it has been estimated that water losses from the snowpack in alpine regions may be as high as 60 percent of the snow-season precipitation, and 45 percent in the forests and forest clearings. A technique for blasting ridgeline snow accumulations into natural accumulation areas below the ridge was applied successfully to increase water yields at the rate of 240 acre-feet of water per mile of ridgeline treated.

CONNECTICUT--In a study of much interest and importance to the shellfish industry, the Connecticut Institute of Water Resources and Marine Research Laboratory investigated the influence of heated effluents from a fossil fueled power plant upon the growth and development of oysters. It was demonstrated conclusively that the heated water from a power plant on the north shore of Long Island Sound accelerated the growth of the oysters and extended the normal growing season, thus resulting in increased efficiency of shellfish production.

DELAWARE--The objective of a Delaware project was to examine the feasibility of short-term wastewater effluent regulation to maintain water quality in the Delaware Estuary following local increases in biochemical oxygen demand. The optimal policy of effluent regulation was determined using the calculus of variations and a simplified model of the Delaware River near Philadelphia. Comparison of the results of the optimal effluent policy with a policy of no regulation reveals that the differences between the two are not sufficiently large to justify the expense and effort of short-term regulation. From the start, this research was coordinated with the staff of the Delaware River Basin Commission. The conclusions have immediate application to the management policies of this regulatory agency.

DISTRICT OF COLUMBIA--At Howard University, Washington, D.C., a mathematical model, based on kinematic wave theory, has been developed to evaluate the effects of urbanization on peak flows for small areas, and takes into account the spatial variations of slope, roughness, slope-length, rain-excess intensity and duration. The model has been applied to hypothetical cases of land-surface alterations to determine the best pattern of alteration. The results of this study will be of value in establishing efficient drainage system design for metropolitan areas undergoing changes in land use patterns.

FLORIDA--Results of research by the Florida Institute on irrigating citrus with treated wastewater from citrus processing plants were put into practical use before the research was completed. The study, completed in January 1974, showed that it was feasible to irrigate citrus with this treated wastewater and provided guidelines for the quantity and quality of wastewater to be used. Last year, Coca Cola Company's Minute Maid Division started to irrigate a 27-acre mature citrus grove near Leesburg, Florida. Apparently finding the technique useful, the Company expanded the operation this year, installing a wastewater irrigation system in a 200-acre grove.

GEORGIA--Mercury pollution in rivers has become widespread nationally and it is of particular importance in parts of Georgia. Research at the University of Georgia on the biological transformation of toxic mercury compounds to nontoxic forms discovered that laboratory containers were adsorbing significant amounts of mercury compounds. The phenomenon was first noted on glass but further investigations of various materials showed rubber to be a much more effective adsorbent. It is possible that such items of waste rubber as old tires could be effective in removing toxic mercury compounds from industrial waste discharges or from rivers with high concentrations of mercury.

HAWAII--A research project conducted by the Hawaiian Institute analyzed irrigation water requirements for various crops grown in the Hawaiian Islands. The results of the analysis suggest that if the findings were applied to a large irrigation system on the Island of Hawaii an almost three-fold increase in crop production would be possible. These results offer considerable potentiality for increasing sugar productions in Hawaii to help meet burgeoning world demand.

IDAHO--Research underway in Idaho seeks to evaluate the quantity of sediment removed from cultivated fields and to develop design parameters for ponds and sediment retention basins on farms. Predictive regression equations were developed from field data. Owing to the practical applied nature of this study, the Potato Processors of Idaho have added substantially to the support of the work. Results will be a report and manual which can be used by farmers and agricultural engineers to retain sediment on site, thus reducing the water pollution potential of irrigated agriculture.

ILLINOIS--Research on an Illinois project on the development of a dimensionless unit stream power equation for the prediction of total sediment concentration in natural rivers will be very valuable to engineers and planners concerned with sediment transport, erosion processes, and the design of water supply and recreational lakes. Unit stream power, the time rate of potential energy expenditure per unit weight of water, was shown to be the dominant factor in the determination of total sediment concentration. Additionally, two other equations were developed and verified that provide simple and direct criteria for incipient motion of sediment particles.

INDIANA--Research on an Indiana project of biochemical and physiological studies to determine the safety of 2,4D formulations to fish and the aquatic food chain organisms has resulted in the development of a herbicide formulation which is effective in controlling the weeds and brush but does not affect animal tissues. This result was determined by means of a sophisticated laboratory assay technique involving the location of receptor sites for the herbicide molecule on membrane tissue.

IOWA--Ongoing research at the University of Iowa has resulted in the development of methods that define the impacts that large scale thermal discharges from power plants have on ice-covered streams. The work included the development of a linearized model of the rate of surface heat exchange, with generalized relations for the coefficients established in terms of meteorological variables. Results of this research are being used by the Commonwealth Edison Company as part of its study of the impacts of the Quad-Cities Nuclear Power Plant on the Mississippi River and by the Mid-Continent Area Power Pools to determine the thermal regime of the Mississippi and Missouri Rivers.

KANSAS--A computer program designed by investigators at Kansas University would simulate the discharge of hot water to streams and the simultaneous dispersion of organic wastes; and predict the quality of water downstream from the discharge point. The study also proposes a design procedure to determine the number of aerators that need to be installed in order to maintain the oxygen content of the stream above that required for normal aquatic life. Water quality control agencies at the state and local level should be able to use the results of this research in setting design standards for power generating plants so as to minimize thermal pollution.

KENTUCKY--A Kentucky study investigated the response of saturated sands to cyclic shear at earthquake amplitudes. The National Center for Earthquake Research, the Bureau of Reclamation, and private consulting firms have expressed interest in the research findings. The results of the program should provide the analyzing engineer with detailed quantitative information on the stiffness and energy dissipative characteristics of saturated sand soils.

LOUISIANA--The Louisiana Institute researched feasible safeguards to preserve fresh water bayous and lakes in the coastal areas as important future sources of domestic and industrial water. This was extremely timely as the area is faced with an influx of people and industries associated with oil and gas developments. This research will contribute significantly to officials planning for orderly development of the area.

MAINE--The Land and Water Resources Center at the University of Maine conducted several public service projects relevant to Maine lakes during the past year. These included an effort to train voluntary lake water quality monitors and establish a voluntary water quality monitoring network. Representatives from two state agencies, five universities, and a large private group (The Congress of Lake Associations) were actively involved in this effort, providing an outstanding example of the Center's efforts to play a coordinative role among other Maine agencies, institutions and individuals interested in water resources. The Center also gave much attention to the lack of public awareness with regard to Maine's water resources. To this end, publication of a widely distributed newsletter has been reestablished.

MARYLAND--The results of several Maryland research projects have provided the basis for direct recommendations by Cooperative Extension Specialist Herbert Brodie for pollution abatement measures on approximately 300 farms and in 20 plants processing vegetables, poultry, red meat, and seafood. Additional educational material was distributed to about 2,000 farmers. These results were based on several completed projects; current research on the ability of different grasses to assimilate waste effluents from a poultry processing plant; and research pertaining to chlorination and aeration techniques for treating effluents where discharge to streams cannot be avoided.

MASSACHUSETTS--Until recent years both coastal and freshwater wetlands have been regarded traditionally as waste areas. Their natural values have been largely unrecognized, and more than a third of the Nation's original wetland acreage has been obliterated through drainage and filling. During the last 10 years several States in the Northeast have realized the value of wetlands and have enacted legislation to control their alteration. Recognizing the need for criteria for evaluating wetlands, a research team organized at the University of Massachusetts has conducted studies of various aspects of wetlands preservation and use. One of the most valuable products from these studies is the wetlands inventory publication entitled "Classification of Freshwater Wetlands in the Glaciated Northeast." This inventory is an invaluable guide to those responsible for the planning, management, and development of the wetlands resource.

MICHIGAN--A research study on the ecology and use of three important streams in Michigan identified and quantified conflicts between the various groups of recreational users of the stream. As a result of the study it became recognized that one of the streams was suffering greatly through over exploitation and over use by recreational groups. In recognition of these conflicts and over exploitation, the Michigan Department of Natural Resources instigated widesweeping changes to protect the river and its future. These regulations are now being challenged in the courts, and the results of the study will be available for consideration of the courts, in reaching their conclusions.

MINNESOTA--Research on Lake Minnetonka, demonstrated that phosphorus is the nutrient that limits algal growth during the summer, when very dense populations of nitrogen-fixing blue green algae develop. A model of the photosynthetic system of the phyto-plankton was developed. Computations based on a materials balance indicated that the mean annual phosphorus content of the Lake's largest basin should decrease from an existing 13 metric tons to a desirable 4 metric tons within 3 years if the phosphorus influx was reduced by stopping the influx of sewage. Based on the result of the research, a comprehensive lake watershed management plan was prepared. Sewage effluents from two villages contributing about 80 percent of the annual phosphorus influx into the largest basin of the lake were diverted from the lake during the winter of 1971-72. The effect of stopping the flow of sewage into the lakes was monitored to measure the effectiveness of the management plan. The data for 1972 and 1973 suggest that Lake Minnetonka may in fact be responding according to the predictions. Thus, the results of the research have assisted people living near the lake and governmental agencies in Minnesota.

MISSISSIPPI--Although Mississippi is fortunate in receiving relatively abundant rainfall, there are occasional periods when drought conditions occur. Since tree and agricultural production are important in the State's economy, a drought can have serious consequences. Research at the Mississippi Water Resources Research Institute determined the frequency, distribution, and severity of droughts for 10 geographic districts of the State. The results will be used in planning fire protection and control of insects and tree diseases in forests, and in the planning of cultural practices for tree seed orchards. In a general way the findings should be useful also as a tool to evaluate the effect of drought on streamflow and water supplies.

MISSOURI--Research conducted by the University of Missouri on the preparation and oxidation properties of Ferrate Ion (FeO_4^{-2}) has resulted in the development of an economical method of water purification that can remove iron, colloidal material and bacteria from water. The compound is easy to prepare and with some water supplies has certain advantages over chlorine treatments. The method is now being tested in regular water treatment plants.

MONTANA--Research conducted at Montana State University has led to the development of microwave moisture sensing equipment that provides for rapid, on-site measurement of the moisture content of forest litter just before and even during prescribed forest burns. When the equipment is perfected it could be a valuable tool in forest and watershed management.

NEBRASKA--Investigators at the University of Nebraska are developing models of urban storm-water quality which will provide a base for better understanding of the constituents of urban runoff. A hydrograph simulation model was developed to generate flow hydrographs comparable to observed runoff data. Data were also obtained on concentrations of nitrogen, phosphorus, pesticides, and bacteria in runoff. Project findings should aid planners and engineers in the treatment and management of urban storm-water flows. The Nebraska Natural Resources Commission has participated and is using the results in its "Comprehensive Plan for Water Quality Management in the Salt Creek Basin."

NEVADA--In two projects, "Selected Physical Parameters Relating to Management Alternatives for Recharge and Flood Control on Alluvial Fans" and "Influence of Near-Surface Caliche Distribution in Infiltration Characteristics, Las Vegas, Nevada," the physical constraints to water management alternatives concerning ground-water recharge and flood control in the Las Vegas Valley have been examined. The role played by caliche on the process of natural ground-water recharge and its relationship to the frequent and often damaging floods experienced in this area has been investigated. Results have shown that on large areas of the valley's alluvial aprons precipitation is precluded from infiltrating by the caliche and thus runs off rapidly to create high flood peaks. Methods of enhancing ground-water recharge and simultaneously relieving the flood problem were examined as well as methods for additional artificial recharge and flood control measures.

NEW HAMPSHIRE--One of the most valued features of water supply reservoirs and lakes, whether natural or man made, is the potential for recreation uses. The popularity of water based recreation and the demand for such facilities forces all levels of authority from the local water officials to the Federal government to develop the recreation potentials of these water bodies to their ultimate, while maintaining the quality of water essential for their intended consumptive uses. In an initial study completed and reported on this year, the Water Resource Research Center at the University of New Hampshire attempted to determine the tolerance of one of the State lakes for recreational development and usage. One phase of the study involved locating sources of pollution and contamination by a systematic method of water analysis. As these sources were located, the information was given to the respective town health officers who in turn continued the investigation to eliminate the sources of pollution.

NEW JERSEY--In 1969, a research project conducted at the New Jersey Water Resources Institute revealed that in three New Jersey river basins the pollution from sources other than the known and recorded point sources was over two-thirds of the total load in the rivers. This finding has led to a national effort to identify the sources, volume, frequency and character of non-point sources of pollution and to investigate the implications of these findings in relation to efforts to control pollution in the Nation's water resources. The results of this research project gave impetus to the EPA, in 1973, to direct research emphasis toward finding ways and means to control the non-point sources of water pollution.

NEW MEXICO--Historically, the water-short arid and semiarid areas of the Southwest are almost devoid of manufacturing industries. A study was made of water requirements of major water-using industries and their technological ability to adapt to the economic and environmental conditions in the Southwest. The results showed that several types of industry could be introduced into the Southwest but highlighted petroleum refining and coal gasification because of the current energy crisis. The results of this research are being used by New Mexico State officials to formulate plans for the development of the State's resources.

NEW YORK--Can flood damage be turned to a community's advantage? The New York Water Resources and Marine Sciences Center states this provocative question more specifically: can you manage flood-damage compensation so that you have a more viable community after a flood than before? Economic evaluation methods have been developed to do just that as a part of "Project Agnes - Redesigning Flood Management with Emphasis on New York's Agriculture and Tropical Storm Agnes: Impacts, Programs, Reconstruction and Lessons." They are applicable to the planning needed after any disaster.

NORTH CAROLINA--The ecology of the coastal wetlands of the Atlantic Coast is endangered by urban, industrial, and agricultural expansion. Research on the future status of North Carolina wetlands has documented extensive changes of public and private holdings of these wetlands. This information will be put to use by the North Carolina Department of Natural and Economic Resources in the formulation of land management policies.

NORTH DAKOTA--Results of studies conducted by North Dakota State University that show the basic relationships between land and water use and water quality in the area are being used to develop a multiple purpose water and related land resource development plan for the Southeast Cass Water Management District. Other studies are providing the economic, attitudinal and environmental analyses needed by the State Water Commission in its planning for water development to meet agricultural, municipal and industrial needs with emphasis on coal development in Southwestern North Dakota.

OHIO--An Ohio study examined microorganisms capable of degrading refractory hydrocarbons in Ohio waters. This project isolated and identified organisms that are capable of degrading hydrocarbons in natural waters. The study is continuing and it is hoped that the results will provide a basis for the biological detoxification of natural waters polluted by oils.

OKLAHOMA--An Oklahoma project examined the toxins present in oil refinery effluents and developed laboratory processes for removing them. They found that partial evaporation treatment can remove toxic compounds from refinery wastewaters which are not degraded by conventional biological waste treatment. This is a very significant finding during our current energy crisis when we are seeking to expand our oil refinery industry as well as some allied petrochemical industries. It is conceivable that partial evaporation, in conjunction with other treatment methods could achieve the 1985 goal of "no discharge of any pollutants" without the necessity of complete recycle-reuse of all wastewaters.

OREGON--At Oregon State University scientists are developing environmentally related strategies for management of estuaries. One planning approach under study places a high value on environmental variety, including a wide range of undeveloped ecosystems. Cluster communities with intervening open spaces are called for within systems selected for development. An outline of a proposed classification plan for various development levels in Oregon's estuaries, has been prepared for the Oregon Coastal Conservation and Development Commission, and collaborative efforts are continuing with that agency.

PENNSYLVANIA--Soil may be to acid mine water what bicarbonate of soda is to an upset stomach, based on the findings of a study recently completed by Institute scientists. Just as bicarbonate of soda relieves acid indigestion, scientists in the Department of Agronomy have discovered that many soil types act as highly effective buffers in neutralizing water contaminated by acid mine seepage. The soils tested displayed a rapid initial reaction when mixed with acid mine water followed by a slower but continuing reaction. Soils containing calcium carbonate proved most effective in producing an alkaline water devoid of heavy metal concentration. Even acidic soils demonstrated an ability to improve the pH level of acid water by removing up to 75 percent of the acid. The use of soil or land discharge as a means of recycling acid polluted mine drainage may provide an economical solution for some cases of acid mine drainage pollution.

PUERTO RICO--The quality of the coastal environment in Puerto Rico is being threatened by the discharge of liquid wastes in rivers and bays. Results of research at the University of Puerto Rico on levels of pollution in selected bays and estuaries was used by Ramon Guzman & Associates, environmental engineering consultants, in their presentation before the Oversight Subcommittee of the Public Works Committee of the U.S. House of Representatives concerning possible changes to the Water Pollution Control Act of 1972, particularly as they relate to needs and conditions in Puerto Rico.

RHODE ISLAND--Recently publicized links between some types of malignancies and the carcinogens believed to result from the chlorination of certain waste waters make the use of ozone, in combination with or as an alternative to chlorination, for water treatment purposes of much interest at present. Several aspects of water treatment with ozone are being investigated by various organizations. In one of these studies, recently reported by the Rhode Island Water Resources Center, the viricidal effects of ozone were evaluated, and the contact times required to inactivate specific strains of virus were determined.

SOUTH CAROLINA--Discoloration of water is a serious problem to control because there is no existing color measurement method that can be easily applied to all types of colored waste. The South Carolina Institute has developed a filter photometer for measuring color concentration in water that will satisfactorily evaluate color concentrations in samples free of turbidity. Interest in adopting the system has been indicated by pollution control agencies in North and South Carolina as well as by the Southeast Region of EPA.

SOUTH DAKOTA--A study of South Dakota State University shows that the number of wetlands, in particular the amount of shoreline, is crucial in duck production. Thus, when a mitigation plan is made for an exchange of original duck producing marshlands for man-made bodies of water, the size of the wetlands in the plan does not in itself necessarily indicate a replacement of wetland losses in terms of duck production. Information from this study is now being used by a task force evaluating the effects of the Oahe Irrigation Project on waterfowl, and will be available for development planners throughout the North Central Prairie Region.

TENNESSEE--Research on the removal of viruses from water and wastewater at the Tennessee Institute has revealed that aluminum sulfate and ferric chloride are the most effective coagulants for the removal of viruses. Also, these coagulants reduce turbidity by over 90 percent. Organic coagulants were much less effective for virus removal. Requests for the results of this work have been received from agencies and individuals in many parts of the world.

TEXAS--Irrigation is the greatest single use of water in Texas and much of this is coming from steadily diminishing ground-water resources. A research effort directed to conserving water and increasing the efficiency of water use found that significant water saving could be achieved by trickle irrigation applying water sparingly and frequently. These results have been useful to water planners, consulting irrigation engineers, irrigation farmers, and State and Federal agencies concerned with food and fiber production.

UTAH--The nationwide energy crisis has greatly intensified water management problems in Utah. The Utah Water Resources Center is giving high priority to water problems related to energy. One project will begin to assess the "possible impacts on agricultural land use, income, and employment resulting from water transfers to facilitate Utah's oil shale development." Another project will study the "water quantity and quality requirements for development of various energy resources" and relate these to availability and suitability of potential sources of supply. The results of these projects will be of great value to Utah State officials in the development of their energy resources.

VERMONT--The impact of oil contamination on biologic life and the aesthetic quality of water bodies is of immediate and increasing concern, because of the irreparable damage and untold costs resulting from oil spills, chronic fouling of the water, etc. While the spectacular oil spills have, perhaps, received the most publicity, the less spectacular, continuous, low level contamination of waters by petroleum and petroleum products are potentially just as damaging. In preliminary experiments conducted recently by the Vermont Water Resources Research Center, the toxic effects of specific petroleum hydrocarbons on *Aedes* pupae and other aquatic insects were studied. Some changes in metabolic rates and marked differences in surfacing and feeding behavior were observed. The importance of these effects on such insects as the mosquito lies in the fact that they constitute a significant link in the food chain of fish. In addition to the results of these preliminary studies the Vermont report contains a good "State of the Art" discussion and bibliography.

VIRGINIA--Research at the Virginia Institute has resulted in the development of a new, relatively uncomplicated process for extracting water from sewage sludge. The process involves bubbling butane through the sludge which freezes the contained water; and then siphoning off the meltwater after the solids settle out of the mixture. The liquid is almost totally free of pollutants, thus simplifying the disposal process. Several industrial firms and government agencies are evaluating the process for possible adoption in the waste treatment field.

WASHINGTON--A project entitled "An Investigation of the Cause and Effect of Eutrophication in Long Lake, Washington," was completed on June 30, 1973. It was funded for a second year by the State Department of Ecology. The principal investigator has provided substantial amounts of information on the eutrophication of Long Lake which is located a few miles downstream from the city of Spokane. Data from the study has been very useful in testimony presented before the Environmental Protection Agency, Department of Ecology, and the city of Spokane on the need for more advanced waste treatment to prevent further degradation of the Long Lake system. The project will continue into fiscal year 1975 with increased funding from the Department of Ecology. Throughout the period of research, contact has been maintained with all of the agencies mentioned above. This project is another example in which OWRT provided initial funding for research which, because of its direct benefit to a State agency, received continued support from that agency.

WEST VIRGINIA--Research in West Virginia has produced statistical models to describe streamflow in relation to various physical parameters, and to define the frequency of precipitation occurrence in the State. Theoretical and empirical models were selected for evaluating the seasonal probabilities of 1-month, 3-day, and 1-day intense precipitation and their relation to flash floods in small upstream watersheds. The results were applied to a study of the conditions preceding the 1972 disastrous flood on Buffalo Creek, Logan County, West Virginia. Contrary to conclusions reached by competent persons using traditional methodology, the study indicated that precipitation events preceding the flood were in an extremely unusual sequence.

WISCONSIN--A Wisconsin study evaluated the impact of freezing and thawing soil conditions on nutrient movement. The results of this study will provide valuable inputs for the development of management strategies for handling farm yard manure in the northern portion of the country, where freezing conditions make the handling of farm yard manure more difficult. These strategies will be used to determine the optimum procedures for agricultural production with minimal detrimental effects on surface and groundwater qualities.

WYOMING--Research at the University of Wyoming has resulted in the development of a hydrologic model of the North Platte River. The model not only simulates the existing state of the river but also lends itself to modification to show the impact of changes in physical, legal, institutional, or economic conditions that effect the river. Similar research is now being undertaken in the Powder River Basin to show the social, economic and environmental impacts that can be expected as coal-related energy development proceeds in the region.

QUESTIONS FOR HEARING ON

OFFICE OF WATER RESEARCH AND TECHNOLOGY

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1. What have been the major achievements of the Title II program? Has it been effective in impacting on priority national research needs? Why should it be continued?

A. The Title II program has been in existence eight years. In that period 366 research projects have been funded dealing with a wide variety of resource problems. Major achievements have been made in the four problem areas as follows:

Hydrologic Systems Analysis - With the development of high speed computers in the last two decades, new methodologies and powerful new tools became available for application to problems in the water resources field. These new tools allow for the utilization and manipulation of masses of data on a scale never before realized in the water resources field. The Title II program has allowed the funding of research in the development and application of new mathematical models in such diverse fields as the management of groundwater aquifers, rainfall-runoff relationships in rural, urban and transitional watersheds, regional management of water quality and supply, management of multiple-purpose reservoirs, management of lakes and estuaries, optimal use of irrigation water, expansion of water distribution systems, and design of efficient drainage systems to minimize storm water damage. The use of this new mathematical technology is having a profound effect on water resources planning and management strategy. The water resource planner and manager is now being provided the tools to enable him to explore a variety of alternatives for accomplishing a given goal or set of goals and to test the consequences of alternate courses of action before deciding the "best" course of action to attain the specified goals.

Water Resources Management - The emphasis on that part of the Title II program described above is primarily concerned with the problems of engineering feasibility, efficiency of water resource developments, and the physical aspects of such developments. Good engineering plans and analysis can determine whether a development is possible. However, it is often the social-political-legal-economic constraints which decides whether a development will be undertaken at all.

This has led OWRT to place heavy emphasis on research which examines our existing water planning and management institutions and the authorities and constraints under which they function to determine their ability to adapt to the new sets of conditions imposed upon them. Where limitations are found, research hopes to provide more workable alternatives and increase the range of management opportunities.

Research has been supported which has been concerned with analysis of water rights and doctrines especially as they affect the process of decision making, user attitudes and water management practices and policies. Also, research has been conducted on the problems associated with multiple jurisdictions and conflicting objectives in metropolitan and regional water resources and planning management. The results of this research has led to improved mechanisms for water resources planning, implementation of plans, and improved management effectiveness.

Urban and Metropolitan Region Water Problems - Since 1920, land occupancy in the U.S. has shifted from a primarily rural dispersion to a heavily concentrated urbanization of somewhere between a twentieth and a tenth of the Nation's land area. It has been estimated that the amount of urbanized land will double in the next 30 years. Relatively little is known about the effects of large urban environments on the hydrologic system. Even less information is available for use in understanding the political, economic, and social aspects of water use, conservation, development and management as they are affected by the metropolitan complex. Deliberate and systematic study of metropolitan water problems is necessary if future crises resulting from inadequate management of water resources are to be averted. OWRT Title II funds have been awarded for research on metropolitan water resources planning and management policies, metropolitan water supply and distribution systems, urban hydrology, storm drainage, flood plain management, metropolitan water quality, waste disposal, and a variety of other studies dealing with urban water pricing policies, urban waterfront restoration, urban water recreation, and so forth.

The reports generated by OWRT urban water research programs have become major national and international reference sources and are monitored overseas where they are regarded as indices of U.S. progress in urban water development.

Environmental Research - The objective of the OWRT environmental research program is to generate knowledge that will allow us to anticipate and predict the ecological consequences of our water resource developments, to estimate the costs of our proposed actions, and to determine the price we will pay for the courses of action we choose to pursue. We seek a better understanding of ecological processes so that we can devise approaches in water resource development activities to minimize potential adverse ecological consequences.

OWRT Title II funds have been used to support research concerned with the hydrodynamics of the dispersion of pollutants in rivers, lakes, and estuaries; stream eutrophication mechanisms; simulation techniques of the eutrophication process; the effects of urban development on the biological processes in estuaries; the effects of thermal discharges on estuarine primary productivity and; numerous other related studies. The results of these studies have been useful to State and Federal regulatory agencies, to water resource development agencies, and to local, State and Federal legislative bodies concerned with water resource problems.

B. The response of the Nation's research community to the Title II program as evidenced by the number of proposals submitted to OWRT, the broad spectrum of problems that have been investigated, and the high quality of the research produced:

1. Confirms that highly qualified scientists, engineers and research organizations representing a wide diversity of technical and social

disciplines are desirous of and qualified to undertake research on priority national research needs with Title II support;

2. Demonstrates that Title II research can be oriented toward finding solutions for important water resource problems;
3. Allows many water problems to be investigated simultaneously so that the degree to which the problems interface, relate and affect each other may be determined; and
4. Shows that Title II research-performing organizations, and the individual scientists and engineers associated with them as principal investigators, co-investigators and consultants significantly enhance the technical strength and diversity of the Department of the Interior's research capability.

C. The Title II program makes it possible to utilize the talents of participants which are particularly well suited to the study of special types of water-related problems and which may not ordinarily be available through the Title I program. For example: (a) Activities dealing with some of the non-physical aspects of water resources such as management, organization, and institutional administration of water resources could be carried out effectively through participation by private and public organizations that are eminently qualified to carry on research by virtue of experience accumulated through association with those who administer water supplies, construct and improve water facilities and operate and test equipment employed in water programs; (b) Competencies developed in industry such as the use of systems engineering and systems analysis and computer hardware and software could be utilized in the application of those techniques to water resources planning; (c) research dealing with the practical application of laboratory findings can best be accomplished by industrial concerns already possessing the skilled staffs and know-how required for development work; and (d) Title II provides a mechanism for the support of research on those water problems which do not fall within the field of activity of mission-oriented agencies.

Title II Achievements

The results achieved from a number of research projects supported under Title II are briefly described below. These projects are not necessarily the most outstanding examples of Title II accomplishment since users of research results made freely available and in the public domain are under no obligation to report on the use or application of the results of such research. Consequently, many significant applications of research results go unrecorded.

-- The Idaho Water Resources Board made use of the results of a project entitled "Evaluation of the Regional Multipurpose Economic Benefits Resulting from Water Related Land Resource Development", to prepare their Interim State Water Plan. The results are also the basis for the studies the board is making on other water development projects, as well as the Pacific Northwest River Basin's Columbia River Basin Plan.

-- Under a Title II grant, the University of Delaware while studying the Christina River Basin published a public information brochure which was well received by the land and water planners, the media and the public. An initial supply of the brochure was immediately exhausted. Basic recommendations contained in the brochure are being followed by the New Castel County government and by some municipalities. A revision of septic tank standards and controls for runoff retention and groundwater recharge through stormwater seepage in subdivisions are being developed by the county. Ordinances that were adopted include flood plain zoning and a surface and groundwater drainage code.

-- Results of a series of three projects funded by OWRR at Rensselaer Polytechnic Institute dealing with diatom populations in Lake George have received wide acclaim.. For instance the U.S. Bureau of Sport Fisheries and Wildlife office in South Dakota wrote "This report... one of the most comprehensive studies in the field. The quantitative analysis of all data is excellent." and "...data is excellent baseline data to man made changes...."

-- A report by the Metropolitan Washington Council of Governments (COG) on a study, "Analysis of the Joint Interactions of Water Supply, Public Policy, and Land Development Patterns in an Expanding Metropolitan Area," sponsored by OWRR, indicates much demand by local units of government for the information being developed. Included among the agencies requesting such information from COG are the Prince William County's Planning Office, the Northern Virginia Planning District Commission, Fairfax County's Department of Public Works, and the Maryland-National Capital Planning Commission. Also, information derived from the study was used by COG in a training institute for the staff of local agencies concerned with regional planning activities and techniques.

-- An OWRR Title II project at Cornell involving a large number of U.S. and Canadian universities developed a "Proposal for Improving the Management of the Great Lakes." The House Subcommittee on Inter-American Affairs requested a special 2-1/2 hour briefing on the results. We have a highly commendatory letter from the Chairman (Fascell of Florida).

-- An OWRR-supported project involving hydrologic, biological, and socio-economic studies, is exploring ways in which development in areas surrounding a bay (Rookery Bay, Florida, for example) may be accomplished without degrading the environment. Preliminary research efforts caused modifications on a Rookery Bay area development plan so as to retain certain natural environmental values.

-- The benefit-cost analysis applied to Federal water resource project planning and evaluation has been an area of considerable contention and controversy. A research study by INTASA, Inc., of California developed a conceptual framework for multi-objective water resource plan formulation and evaluation. This framework was an outgrowth of the study and analysis of a completed Corps of Engineers reservoir and two completed Bureau of Reclamation reservoirs. The analysis was keyed to identifying and measuring the impacts stemming from the construction and management of these reservoirs. It will provide planners with insights into broader examination of benefits, costs and alternatives.

-- Auburn University in Alabama reports highly significant interim findings from a research project entitled, "The Impact of Water Pollution Abatement in Alabama on Consumer Prices and the Balance of Competition." The researchers have thus far completed their investigation of the textile industry and are currently analyzing the steel and paper industries. Their in-depth study of the textile industry reveals that pollution abatement under current standards would cause an increase of 0.01 to 2.40 percent in the unit cost of textile products. Indications are that this added expense could be borne entirely by textile manufacturers, there would be no shifts in competition, no jobs would be lost, and consumers would not have to pay higher prices. Fundamental economic analysis such as this is vital in providing the basis for policies and decisions related to the Nation's quest for clean water.

-- An Illinois-based project by a consulting engineering firm and entitled, "Investigation of On-Site Stormwater Storage Concepts and Techniques for Pollution and Flood Control" is an in-depth investigation of onsite detention storage of urban stormwater runoff as opposed to directed flows to conventional stormwater drainage systems. Such storage systems appear to offer practical and economical means for reducing the adverse effects of stormwater flow at reasonable costs. Because of this, a great deal of interest has been evidenced in this study, and excellent cooperation has developed with the American Public Works Association (APWA). This has included supplying information on existing applications of on-site storage techniques. Furthermore, the APWA Research Foundation has agreed to print the first report as an APWA Special Report to insure wide distribution to many of its 12,000 members who are, in fact, the ones who will use the results.

-- A report, "An Economic Analysis of Erosion and Sediment Control Methods for Watersheds Undergoing Urbanization," by Dow Chemical Company is receiving wide interest. Multiple copies have been requested by a sediment legislative task force in North Carolina, by the Federal Highway Administration, and by the Geological Survey. Additionally, numerous requests for individual copies have been received from planning commissions, soil conservation districts and other groups concerned with the sediment problems. Methods were devised in the Dow study to calculate effectiveness of control systems and to determine the resulting economic impact on larger streams. Present practice employs sediment basins, diversion berms, level spreaders, grade stabilization structures, sodded ditches, and seeding and straw mulch tacked with asphalt or disked. The practice was estimated to control 91 percent of the potential erosion and to cost \$1,125 per acre, on the average. Large sediment basins can boost system performance to 96 percent at slightly lower cost. Sediment forebays preceding multipurpose impoundments provide the highest achievable control, but are more expensive per ton of sediment trapped. However, improved land values and recreational values help justify their costs.

-- Research being conducted at the Massachusetts Institute of Technology (MIT) dealing with the forecasting and control of urban runoff has produced results that are being applied in coping with increased flooding and sediment transport problems in Fairfax County, Virginia. The engineering consultants retained by the County to develop and implement a multi-million dollar flood control program are putting to use techniques developed by MIT that will forecast the future hydrologic effects of continued urbanization in Fairfax County. More specifically, the computer models provided by the subject research will enable the County to assess fairly the upstream developers for downstream hydrologic impacts.

-- The National Association of Counties (NACO), Washington, D. C., studied the data and methodological needs of local officials for optimum water-resources planning and management. The end product was a relatively simple, readable, and effective manual intended for the use of local officials. This manual was widely disseminated; 21,000 copies to members of NACO, 3,000 distributed at NACO's Annual County Convention, and 5,000 to other interested individuals and organizations. It should be of substantial assistance in attuning local officials to viable approaches for solving water resources problems.

-- Substantial reductions in costs are possible by development of regional water quality management systems on the Wisconsin River. This conclusion, by a team of University of Wisconsin investigators, has been favorably reviewed by the State Natural Resources Board which has adopted a resolution recommending study programs to determine what regional management agencies might be used and the legislation needed.

-- Numerical models developed at the University of Texas, and which are applicable to the analysis of dispersion in shallow, well mixed estuaries, are being used in the United States and abroad. Verification of astronomical tides and physical exchanges in Corpus Christi Bay, measurement of salinity responses in San Antonio and Matagordo Bays, and the studies of channel alignment and sediment movement in the estuary of the Orinoco River in Venezuela are examples of application.

-- Two methods for evaluating wild rivers have been developed and demonstrated as a result of a Title II project. In the "Benefits foregone-subjective decision method," the nonmonetary, intangible benefits of the wild conditions are presumed to be equal to the foregone monetary benefits of full development. For the second method - "Nonmonetary expression of benefits" - intangible benefits are estimated as percentages of the monetary benefits accruing to each purpose of development including recreation, navigation, flood control, power generation, and others. Both methods were demonstrated on the Skagit River basin in Washington. Each procedure indicated that a developed arm of the river should be developed even more fully, whereas a currently undeveloped arm should be preserved in its present wild state. By these methods development projects as well as preservation objectives can be evaluated and environmental impact studies can be incorporated in socio-economic evaluations.

-- In Florida an extensive study was made of the water rate structures, policies, and accounting methods of over 200 municipally-owned water utilities and of the economic literature on the pricing of public utility services. Results of these two classes of studies were integrated in a project report and a handbook with suggested guidelines for the pricing of municipal water services. Numerous requests for these reports have been received from water executives. Results have also been published in the Journal of American Water Works Association and the Public Utilities Fortnightly.

-- Using input data from several municipal water supply systems, another study developed a mathematical model of these systems. The results are so promising that a demonstration test case is underway to evaluate the model in controlling a part of the Philadelphia water distribution system.

-- A research project supported jointly by OWRR and the Texas Water Development Board resulted in a report on techniques for management of regional water resource systems. It is a guide for applying stochastic optimization and simulation techniques to water resources planning. The optimization models and usage procedures are finding wide application. They are being used by the Corps of Engineers and, to a certain extent, the Bureau of Reclamation for study of the proposed Texas Water System and by the State Board in cooperation with the State Water Rights Commission to support adjudication negotiations in the Cypress Creek basin in northeast Texas. Slightly modified versions of these models are being applied by a firm of consulting engineers to the Vistula River in Warsaw, Poland.

2. Recognizing the changes resulting from the merger of OWRR and OSW, what redirection, if any, should be taken in the Title II program? What level of funding would be required?

A. The Title II program should be amended to include a development program for water resources research results and saline water conversion technology. These changes have been proposed in legislative amendments to the Water Resources Research Act, submitted to the Congress. The changes proposed would allow the Office of Water Research and Technology to begin a technology development program in the water resources area and continue the saline water technology development programs.

B. We are requesting a \$6.5 million program for FY '76.

3. What are the major factors limiting the effectiveness of OWRT in accomplishing its objectives? What are the options for change? How could they be implemented?

A. The Office of Water Research and Technology was established to provide a broader-based organization for implementing technology development programs to better assure that the findings of original and innovative research are interpreted and developed to the state where they can be used for practical application in resolving or mitigating water and water-related problems. Previously there had been no agency with the responsibility for converting water resources research results into viable action programs, even though there was and is important development work being done on an ad hoc basis. It was in recognition of this deficiency that led to the recommendation of the National Water Commission that an Office of Water Technology be established. We are proceeding toward the accomplishment of our stated objective and with enactment of our proposed legislation can continue towards these objectives. As research needs are identified and related to water problems, additional changes may be required. If further legislative changes are necessary in the future, these would be transmitted to the Congress.

4. How does OWRT coordinate its research program with that of other agencies and organizations? How are the programs of Title I Institutes coordinated? Could OWRT assume broader responsibility for coordinating Federal water research programs?

A. OWRT coordinates its research programs through the Committee on Water Resources Research. The Department has been assigned lead responsibility by the Committee to coordinate Federal water resources research programs.

B. The Title I programs are coordinated with the 54 State Water Resources Research Institutes. To improve coordination of research efforts among them, they have been organized into 8 regional associations based on commonality of water problems: New England, Middle Atlantic, South Atlantic-Gulf, Great Lakes-Ohio-Upper Mississippi, Missouri River, Southern Plains, Colorado Great Basin, and Pacific Northwest. A ninth region would be the Islands and Alaska. These programs in turn are coordinated with the Committee on Water Resources Research. Additionally, water resources research programs conducted by the Department of Interior are coordinated by OWRT. The regional organizations provide us a firm foundation for assessing and addressing regional needs. First, they provide a means of focussing our attention on specific sets of critical problems involving water and water related resources in the regions. Second, they provide an excellent mechanism for coordinating research and research planning between Institutes. Third, it has proved to be a major stimulus to good coordination with state and local agencies and Federal field offices, particularly for the identification of the most important regional water problems. Fourth, the regional associations are helpful in defining research approaches which are feasible in terms of available manpower and relevance to the major problems of the region. Fifth, because of their close association with state and local agencies, the adoption of research results by user agencies has been greatly facilitated.

C. Federal water research is a very broad area and coordination of all programs in this area would require legislative changes. OWRT would provide the best mechanism for coordination of all water research programs, as OWRT is not mission-oriented. Given the legislative mandate and the proper resources OWRT could be an effective means for coordinating Federal water research programs.

5. Why shouldn't the research and development mission of OWRT be reassigned to the major water agencies?

A. The water resources research program was established as a unit independent of any one of the subordinate bureaus or agencies dealing with a limited field of water problems and at a level in the Department where it could assist all of the Department of Interior agencies in enlisting the interest and assistance of state water research centers and the other centers of competence available to the Department under Title II of the bill. Such an independent agency is necessary to assure that the water resources research program will not be so preoccupied with the limited programs of one agency that it will not be responsive to the needs within the states but will stand ready to approve state research projects on local problems regardless of lesser importance of the Department's own interest. The mission organizations are concerned with a wide variety of water problems. Their programs are directed towards specific aspects of water resources. An independent organization such as OWRT can provide a much more objective research and development program covering the many aspects of water resources.

6. What are the leading research issues? What percentage of funding is going into these areas? What is the expected payoff?

A. Listed below are our leading research areas addressed pursuant to Title I and II of the Water Resources Research Act:

Improving Water Resources System Planning and Management Processes

Approximately 25% of our research funds are allocated to this area. Considerable emphasis is on developing methodologies for multi-objective planning, evaluating socio-economic aspects of water resources projects, and analysis of institutional or organizational problems inherent in water resources planning and management.

Water Quality

Approximately 25% of our research funds are allocated to this research area. Our studies range over a wide spectrum such as: pollutional effects of cattle feed lots or some specific industry, costs of pollution abatement, or spray irrigation of sewage effluents.

Conserving Ecological Values in Water Resources Planning

Approximately 10% of our research funds are allocated for this research area. It includes such things as ecologic impacts of new or expanded industries or residences in estuarial areas, the effects of pollution on aquatic life, or the evaluation of recreational and cultural benefits of estuarine use in an urban setting.

Metropolitan Area Water Systems

About 10% of our research funds are allocated for this research area. It includes such things as improved methods for operating urban water supply or sewage treatment systems; evaluation of urban waterfront developments, and pricing systems for urban water supply systems.

Hydrologic Cycle

Also about 10% of our research funds are allocated for this research area. It includes such things as groundwater studies, correlation of rainfall and stormwater runoff, and development of flood hydrograph - flood damage relationships.

B. The expected payoff of our research is in its successful application to real world problems. This holds true even in our basic research which might lay the groundwork for subsequent applied research. In any research program there is an element of risk, as the unknown is probed. However, we feel we have had a rather high percentage of research successes. Some of these are listed under question 1, above.

7. What research does OWRT have in progress on: the quality of irrigation return flows; non-point source pollution; irrigation water use efficiency; energy-water relationships; improving water resources planning and management; environmental impact of water resources development; and saline water conversion?

A. Quality of Irrigation Return Flows

10 projects are currently being supported at a funding level of \$473,752 (List of projects attached).

B. Non-Point Source Pollution

26 projects are currently being supported at a funding level of \$576,874 (List of projects attached).

C. Irrigation Water Use Efficiency

23 projects are currently being supported at a funding level of \$920,587 (List of projects attached).

D. Energy-Water Relationships

69 projects are currently being supported at a funding level of \$2,546,058 (List of projects attached).

E. Improving Water Resources Planning and Management

224 projects are currently being supported at a funding level of approximately \$5,000,000. Detailed listing of projects not included due to large volume. Listing will be supplied upon request.

F. Environmental Impact of Water Resources Development

113 projects are currently being supported at a funding level of approximately \$3,200,000. Detailed listing of projects not included due to large volume. Listing will be supplied upon request.

G. Saline Water Conversion

33 research projects are currently being supported at a funding level of approximately \$4,805,717 (List of projects attached).

A. QUALITY OF IRRIGATION RETURN FLOWS

A-057-ARIZ, Institutional Arrangements for Reducing Conflict over Water Quality in International Rivers - Wagner -----	\$ 4,000
A-052-CAL, Adaptation to Increasing Salinity of the Colorado River - Robinson -----	26,000
B-121-COLO, Evaluation of the Storage Mechanisms of Diffuse Sources of Salinity in the Upper Colorado River Basin - Schumm -----	28,766
B-170-CAL, Economic Analysis of Optimal Investment Scheduling for Salinity Control in the Colorado River - Erlenkotter -----	50,000
A-017-COLO, Transport of Salts in Irrigation Return Flow - McWhorter -----	31,000
B-115-COLO, The Role of Water Reuse in Meeting Regional Water Requirements - Hendricks -----	50,000
C-6301 (COLO), Salt Balance Management in the Lower San Luis Rey River Basin - Labadie -----	62,946
C-5046 (NEB), Preserving the Environmentally Compatible Practices for Intensive Irrigation Development - Olson -----	85,000
C-1630 (NMEX), Soil and Water Management for Salinity Control, Phase II - Wierenga -----	46,223
C-2165 (NMEX), Soil and Water Management for Salinity Control, Phase III - Wierenga -----	89,817

 \$473,752

B. NON-POINT SOURCE POLLUTION

A-021-ARK,	Movement of Pesticides in the Soil-Water-Fertilizer System to Plants - Scott -----	\$ 30,000
A-025-ARK,	Trace Elements Composition of Stream Sediments - An Integrating Factor for Water Quality - McDonald -----	13,205
A-023-COLO,	Toxic Heavy Metals in Ground Water of a Portion of the Front Range Mineral Belt - Edwards ----	6,000
A-029-CONN,	Quantity and Movement of Nitrates in Soil Water in Two Connecticut Soils Treated with High and Low Levels of Inorganic Nitrogen Fertilizer - Griffin -----	13,962
A-019-DEL,	Identification and Determination of Trace Amounts of Organic and Inorganic Contaminants in the Delaware River and Bay - Seidel -----	19,550
B-023-FLA,	Pollution in Runoff from Nonpoint Sources - Campbell -----	32,625
A-044-HI,	Quality and Quantity of Non-Point Pollution Sources - Dugan -----	20,394
B-066-IND,	Nitrogen and Metal Contamination of Natural Waters from Sewage Sludge Disposal on Land - Sommers -----	30,000
A-050-IOWA,	Movement of Pesticides and Nutrients with Water and Sediment as Affected by Tillage Practices - Johnson -----	11,392
A-055-IOWA,	Nitrate Movement and Denitrification Defined Relative to Bromide Tracer in the Drained Land - Baker -----	9,744
B-050-IOWA,	Effect of Tillage Systems on Runoff Losses of Pesticides: A Simulated Rainfall Study - Baker -----	10,055
A-058-KY,	Influences of Nitrogen Fertilization on Quality and Quantity of Streamflow from a Forested Watershed - White -----	11,602
A-066-MASS,	Definition of Procedures for Study of River Pollution by Non-Point Urban Sources - Coler ---	3,250

B. NON-POINT SOURCE POLLUTION (CONT'D.)

B-099-MO,	Losses of Fertilizers and Pesticides in Runoff and Sediment - Smith -----	\$ 34,537
A-024-NEB,	Mobility and Deactivation of Herbicides in Soil-Water Systems - Lavy -----	19,950
A-036-NEB,	Water Quality Study of Non-Point Source Agricultural Runoff - Andersen -----	16,000
B-059-NJ,	Delaware Estuary Urban Runoff and Unrecorded Polltion - Whipple -----	35,000
B-052-NC,	Nutrients and Eutrophication in a North Carolina Estuary, Phase III - Copeland -----	37,919
B-029-NDAK,	Water Quality and Land Use in the Sheyenne River Basin: An Interdisciplinary Analysis - Phase I - Nelson -----	25,000
B-030-NDAK,	Water Quality and Land Use in the Sheyenne River Basin: An Interdisciplinary Analysis - Phase II - Nelson -----	104,676
A-052-RI,	Movement of Trace Metals with Percolating Water - Wang -----	18,138
A-031-TENN,	Effects of Agricultural Practices and Land Disposal of Solid Waste on Quality of Water From Small Watersheds - Shelton -----	14,745
A-053-VA,	A Case Study of Non-Point Source Pollution in Virginia - Harms -----	4,420
A-058-VA,	Effects of Agricultural Land Use on the Chemical Quality of Runoff and Groundwater - Shanholtz -----	23,500
A-067-WASH,	Investigation to Determine Extent and Nature of Non-Point Source Enrichment and Hydrology of Several Recreational Lakes of Eastern WASH - Funk -----	10,000
B-059-WASH,	Economics of Water Quality Control Through Man- agement of Irrigation Return Flows - Whittlesey-	21,210
		\$576,874

C. IRRIGATION WATER USE EFFICIENCY

A-025-LA,	Irrigation Scheduling and Application in Humid Climates - Busch -----	\$ 16,788
A-034-ARIZ,	Use of Amendments to Reduce Water Requirement For Stand Establishment of Small-Seeded Crops - Dennis -----	16,900
A-050-ARIZ,	Extended Use of Treated Municipal, Wastewater by the Buckeye Irrigation Company: A Documen- tation of Effects - Day -----	8,800
B-035-ARIZ,	Modeling Soil Water Movement for Trickle Irrigation - Warrick -----	14,380
A-050-CAL,	Economic Efficiency of Water Used to Produce Calories and Proteins in California - Rada ----	21,000
B-014-FLA,	Disposition of Water from Fruit Crops and Approaches to Increase Water Use Efficiency - Bartholic -----	45,000
B-075-IND,	Effects of Spray Irrigation of Municipal Waste- water on Phosphorus Transformations in Soil - Sommers -----	34,741
A-050-KAN,	Predicting Evapotranspiration from Agricultural Watersheds Under Dry Conditions - Zovne -----	6,260
A-060-KAN,	Maximizing Stomatal Control and Root System to Optimize Water-Use Efficiency in Soybeans - Teare -----	6,518
B-029-MICH,	Trickle Irrigation in Michigan Fruit Plantings - Kenworthy -----	30,730
B-024-NEB,	Improved Irrigation and Fertility Management for Irrigation Systems - Fischback -----	65,750
B-028-NEB,	A Regional Model for Predicting Great Plains Evapotranspiration - Rosenberg -----	51,925
A-040-OKLA,	Improvement of Water Application of Self- Propelled Sprinkler Irrigation Systems - Barefoot -----	18,400
B-029-OKLA,	Evapotranspiration Reduction by Field Geometry Effects for Water Resource Enhancement - Stone -----	35,000

C. IRRIGATION WATER USE EFFICIENCY (CONT'D.)

A-039-SDAK, Increasing Water Utilization Efficiency of a Pasture Grass by Increasing Aftermath Through Plant Selection - Phase II - Ross -----	\$ 8,000
A-043-SDAK, Efficient Utilization of Irrigation Water and Equipment - DeBoer -----	8,800
A-024-TEX, Optimization of Water Use Efficiency Through Trickle Irrigation and the Stress Day Index - Hiler -----	21,370
B-080-TEX, Increasing Water Use Efficiency Through Improved Orifice Design and Operational Procedures for Subirrigation Systems - Runkles -----	22,200
B-167-TEX, Increased Water Use Efficiency Through Trickle Irrigation - Hiler -----	19,000
B-121-UTAH, Optimizing Crop Production Through Control of Water and Oxygen Levels in the Soil - Riley ---	30,000
C-5189 (UTAH), Water Production Functions and Predicted Irrigation Programs as Required for Water Resource Planning and Increased Water Use Efficiency - Hagan -----	160,521
C-6273 (TEX), Quantity and Quality Considerations for Water Use Efficiency in Irrigation - Goodin -----	86,904
C-6030 (CAL), Antitranspirants to Increase Water Supply and Water Use Efficiency by Reducing Transpiration from Phreatophytes, Crops, and Other Vegetation - Hagan -----	141,000
	\$920,587

D. ENERGY-WATER RELATIONSHIPS

A-054-ARIZ,	Geothermal Water Resources In Arizona: Feasibility Study - Norton -----	\$ 7,700
A-024-COLO,	Economic Activity and Water Use in Oil Shale Development Areas of Colorado - Gray -----	4,000
A-056-CONN,	Unconventional Nuclear Power Plant Siting Options and Water Quality Impacts - Stern -----	6,250
A-048-GA,	Heat Dissipation Under Conditions of Turbulent Open Channel Flow - Mayer -----	10,500
A-049-GA,	Breaking of Dilute Oil-In-Water Emulsions by the Electrical Process - Orr -----	9,500
A-054-GA,	Water-Energy Considerations in Land Use Planning - Asmus -----	8,100
A-035-IDA,	Effects of River Fluctuations Resulting from Hydroelectric Peaking on Selected Aquatic Invertebrates - Gordon -----	38,946
B-071-ILL,	Laboratory Study of Thermal Discharge in Rivers and Estuaries - Holley -----	34,393
B-083-ILL,	Control of Mixing at Heated Water Outlets - Maxwell -----	29,786
B-088-ILL,	Mechanics of Heated Surface Discharges to Rivers - Holley -----	36,055
B-092-ILL,	The Importance of Energy-Related Water Demands in Developing Regional Water Resources: An Optimization Approach - Brill -----	47,960
B-041-IOWA,	Computational, Laboratory, and Field Study of the Effects of Large Thermal Discharges on Ice- Covered Rivers - Phase II - Macagno -----	33,862
A-062-KAN,	Protochemical Generation of Hydrogen from Water - Lambert -----	8,147
A-066-KAN,	Thermal Plumes in the Kansas River - Sheng Yu --	5,700
B-023-KAN,	Disposal of Heated Water Through Ground Water Systems - Willhite -----	25,167

D. ENERGY-WATER RELATIONSHIPS (CONT'D.)

B-032-KAN,	A Study of Physical and Biological Effects of Thermal Discharges at La Cygne Lake - O'Brien --	\$ 77,244
B-037-KAN,	Modeling and Optimization of Transient Cooling Water Discharge from Power Generating Plants - Phase II - Hwang -----	17,002
B-097-MINN,	Thermal Pollution and Second Trophic Level Fauna in Lake Superior - Swain -----	41,362
B-039-MO,	The Effect of Water Temperature on Ecological Processes in a Reservoir Receiving Heated Water - Witt -----	52,066
B-110-MO,	Cleaning Coal with Coal: Coal Humic Acids for Removal of Iron, Heavy Metals, and Organic Pollutants Associated with the Use of Coal as Fuel - Manahan -----	2,658
A-042-MONT,	Study of Possible Effects of Strip Coal Mining on the Hydrological Regimen in Eastern Montana - Van Voast -----	30,460
A-077-MONT,	Study of Hydrological Characteristics of Coal-Mine Spoils, Southeastern Montana - Van Voast --	9,810
A-056-NEV,	Evaluation of Geothermal Activity in Truckee Meadows, Washoe County, Nevada - Bateman -----	9,755
A-051-NMEX,	Use of Brackish Water for Coal Gasification - Wilson -----	4,810
B-045-NY,	Energy Demand and Water Resource Management: The Economic Aspects - Kalter -----	23,400
A-060-NC,	Use of Waste Heat for Soil Warming in the Southeast - Skaggs -----	15,617
A-041-OHIO,	The Effects of Coal Gasification on Water Quality and Quantity - Whitlatch -----	9,928
A-057-OKLA,	The Impact of Increased Energy Cost on Water Use and Agricultural Output in Northwestern Oklahoma - Eidman -----	5,800
B-039-ORE,	Animal Waste Conversion Systems Based on the Use of Thermal Discharges With By-Product Recovery and Recycling - Boersma -----	30,000

D. ENERGY-WATER RELATIONSHIPS (CONT'D.)

B-043-PA,	Heat Dissipation from Shaded, Thermally Polluted Rivers - DeWalle -----	\$ 22,163
B-069-PA,	Revegetation of Coal Mining Spoils With Munici- pal Wastewaters - Phase III - Sopper -----	25,000
A-046-PR,	Effects of Heated Discharges from Power Plants Upon Coastal and Estuarine Animals in Puerto Rico - Gonzalez -----	12,578
B-049-SC,	Siting Power Plants on Estuaries Considering Interaction of Thermal Pollution With Other Wastes - Dysart -----	26,200
B-053-SC,	Thermal Loading Effects on Primary Productivity of Lacustrine Phytoplankton, Periphyton and Benthic Macrophytes - Dillon -----	19,962
A-037-TENN,	Thermal Effects on Biodegradation - Hollis -----	10,701
B-091-TEX,	The Relationship of Electric Power Station Thermal Circulation to Biological Productivity of Reservoirs - Lind -----	22,709
B-135-TEX,	The Relationship of Electric Power Station Thermal Circulation to Biological Productivity - Phase II: Possible Control of Thermal Pollution by Biologi- cal Systems - Lind -----	14,743
A-027-UTAH,	Impacts on Agricultural Land Use, Income, and Employment, resulting from Water Transfers to Facilitate Oil Shale Development - Roberts -----	12,080
A-028-UTAH,	Water as a Factor in Energy Resource Develop- ment - Bishop -----	13,179
B-054-VA,	Penetration and Mixing of Heated Jets Injected Into Rivers, Lakes, and Bays, with Application to the Thermal Pollution Problem - Schetz -----	37,460
B-057-WASH,	Models for Assessing the Economic Value of Hydro- power for Peaking Purposes and the Pricing of Peaking Alternatives - Hanson -----	55,397

D. ENERGY-WATER RELATIONSHIPS (CONT'D.)

A-024-WVA,	Effects of Concentrations and Ratios of Cations in Acid Mine Water on Phytoplankton Ecology and Water Quality - DeCosta -----	\$ 8,121
A-028-WVA,	An Evaluation of a Process of Dewatering Neutralized Acid-Mine-Drainage Sludge by Use of a Dual-Functional Filter - Henry -----	7,480
B-089-WIS,	Thermal Plumes: Field Measurements for Input to Mathematical Models - Green -----	36,666
B-092-WIS,	Integration of Biological With Thermal Criteria for Power Plant Design and Water Resource Use - Magnuson -----	49,997
A-019-WYO,	Hydrology of Madison Formation and Its Potential Use for Water Supply for Energy Development - Huntton -----	16,000
C-3033 (CAL),	Numerical Modelling of Thermal Loading in Bodies of Water - Street -----	74,950
C-5205 (CAL),	Management of Groundwater Basins to Inject, Store and Recover Useful Heat - Meyer -----	76,242
C-4134 (DC),	User Evaluated Impact of Thermal Pollution on Estuary - Williams -----	35,150
C-5083 (FLA),	Calibration of a Thermal Enrichment Model for Shallow Barricaded, Estuaries - Carder -----	70,000
C-3140 (IOWA),	Mixing and Transfer of Heat in Open Channel Flow - Sayre -----	99,400
C-4071 (IOWA),	Optimization of Water Consumption and Cost of Cooling Towers for Power Plants by Use of Combination Dry-Wet Towers - Patel -----	68,230
C-1401 (MD),	Effects of Thermal Loading and Water Quality on Estuarine Primary Production - Fleamar -----	4,421
C-3027 (MASS),	Combined Effect of Thermal and Organic Pollution on Oxygen Sag Curve - Keshavan -----	33,326
C-4067 (MASS),	Combined Effect of Thermal and Organic Pollution on Oxygen Sag Curve - Phase II - Keshavan --	51,339
C-4343 (MINN),	Environmental Impact of a Nuclear Plant on Mississippi River Biota in an Ecological Recovery Zone - Dieterman -----	84,149

D. ENERGY-WATER RELATIONSHIPS (CONT'D.)

C-5258 (MONT), Water Use and Coal Development in Eastern Montana: Water Availability, Water Demands, and Economic Impacts - Stroup -----	\$ 69,236
C-5049 (ORE), Power Shortage Contingency Program for the Pacific Northwest: Legislative, Regulatory, and Institutional Aspects - Jourolmon -----	50,000
C-4016 (VA), Ecological Impact of Thermal Loading on a Piedmont River: An Ecosystem Approach - Dahlberg -----	83,508
C-6011 (IOWA), Optimum Combination of Cooling Alternatives for Water and Fuel Economics of Electric Power Plants - Patel -----	111,551
C-6038 (NY), Numerical Modeling of Heated Discharges and Measurements of Their Mixing Coefficients - Kennedy -----	87,567
C-6052 (LA), Energy Related Activities and Assessment of Their Water Resource Management Alternatives in the Lake Boeuf-Lake Des Allemands Region of South Louisiana, Phase II of Water Resources Research in Bayou Lafourche Delta - Whitehurst -----	83,382
C-6076 (COLO), Energy Development Strategies in the Upper Colorado River Basin - Walker -----	81,994
C-6265 (CAL), Management of Groundwater Basins to Inject, Store and Recover Useful Heat - Phase II - Meyer -----	71,129
C-6268 (TEX), Water Resource System Management for Increased Power Production - Beard -----	105,752
C-6300 (WYO), Meeting Demands for Public Services Created by Water and Energy Resources Development: Financing Problems in Impacted Wyoming Communities - Griffin -----	8,792
C-6303 (MONT), Study of the Social Impact of the Allocation of Large Portions of Water from the Yellowstone River Drainage to Coal Related Industrial Development - Williams -----	27,475

D. ENERGY-WATER RELATIONSHIPS (CONT'D.)

C-6307 (NDAK), Profiling Trace Elements in Resources and Processes Involving Water, Coal and Air - Tallman -----	\$ 63,200
C-6531 (PA), Development of Guidelines for the Preparation of Environmental Reports for Fossil Fueled Steam Electric Generating Stations - Baird -----	78,850

\$2,546,058

Contract No. & No.	Contract Date	Name of Contractor	Amount of Contract	Anticipated Completion Date	Description
MEMBRANE RESEARCH PROGRAM					
: 3250	1/22/74	DeBell and Richardson, Inc.	\$ 73,974	1/22/75	Development of porous polyvinyl chloride tubules for use in the fabrication of composite RO membranes.
: 3165	10/19/72	Gulf South Research Inst.	176,080	4/18/75	Development of NS-100 coated porous polysulfone hollow fibers for use in seawater desalination.
: 3222	12/27/73	Universal Oil Products	65,000	5/31/75	Research and development of an advanced reverse osmosis module for spacecraft wastewater recycling at 165° F.
: 2725	10/9/70	Chemical Systems	525,993	7/31/75	Preparation of RO membranes by a dry process.
: 3298	11/20/74	North Star Research Inst.	155,457	11/20/75	Development of novel desalination membranes vice in-situ polymerization reaction.
: 3297	12/1/74	MIT	32,595	11/30/75	Hydrodynamic research of desalination membrane systems.
: 3295	10/31/74	OXY Metal Industries	122,384	11/30/75	Evaluation of ultrafiltration systems as a pretreatment process for seawater desalination via RO membrane processes.
: 3303	2/12/75	Universal Oil Products	261,239	12/31/75	Development of spiral wound membrane systems for single stage sea water desalination.
: 3307	2/28/75	Chemical Systems Inc.	150,000	2/28/76	Development of dry-RO membranes of cellulose triacetate for the single pass demineralization of sea and brackish waters.
: 2911	9/3/71	Florida State University	69,910	6/30/76	Influence of water structure on RO membrane desalination.
: 3302	2/20/75	University of California	99,876	10/31/76	Study of mass and current transfer in RO membrane processes.
: 3301	3/4/75	Research Triangle Inst.	76,811	11/30/76	Investigation of plasma polymerization processes for use in the preparation of RO membranes.
: 3241	11/28/73	University of Pittsburgh	46,552	11/30/76	To develop a mechanism for salt rejection in reverse osmosis to serve as a guide in the selection of improved materials for use in the fabrication of RO membranes.
: 3300	4/1/75	Bend Research	91,200	10/1/76	To elucidate the mechanism of active layer formation in asymmetric membranes.
: 3304	2/15/75	Envirogenics, Inc.	110,272	2/15/76	Development of improved performance sulfonated polysulfone membranes for use in seawater desalination.

To investigate the differences in fouling mechanisms occurring with use of cationic (NS-100) and anionic (NS-200) desalination RO membranes.

Research on piezodialysis (A pressure driven electrical membrane process).

3292 11/20/74 North Star Research \$ 73,518 12/31/75

3248 11/29/73 Ionics, Inc. 167,805 7/31/75

SUB-TOTAL \$2,298,666

FREEZING PROCESSES RESEARCH PROGRAM

Crystallization processes for desalination.

Secondary Nucleation of ice crystals in a suspension of crystals in turbulent-cylindrical flow.

Modification for the freezing process.

Models of secondary nucleation attributable to crystallizer-crystallizer collisions.

3124 8/21/72 Syracuse University \$159,000 6/30/75

2573 1/12/70 Clarkson College of Technology 78,529 6/30/75

3072 9/20/72 Cornell University 165,141 9/1/75

3268 4/9/74 MIT 63,999 4/15/76

SUB-TOTAL \$ 466,669

MATERIALS RESEARCH PROGRAM

Material test center operation.

3111 6/30/72 Dow Chemical \$ 819,350 7/31/75

SUB-TOTAL \$ 819,350

BASIC RESEARCH PROGRAM

Investigation of relations of water structure to liquid solution properties.

Thermodynamic studies of salt solutions and geothermal brines at elevated temperatures.

Investigation of water and solute transport in uniformly sized microporous membranes.

A nuclear magnetic relaxation investigation of the interaction of water with RO desalination membranes.

2520 9/23/69 University of Pittsburgh \$ 149,454 3/31/75

2918 6/13/72 Westinghouse Electric Corp. 77,305 4/30/75

3167 11/21/72 University of Pennsylvania 78,954 6/30/75

3267 2/4/74 University of Connecticut 17,200 8/31/75

(C) 3236	2/11/74	Rochester Inst. of Tech.	\$175,500	10/31/75	Characterization of physical properties of water.
(A) 1291	5/20/68	Atomic Energy Commission	348,950	10/31/75	Electrochemical studies of electrode reactions of metallic membranes developed for use as desalination barriers.
(G) 1308	5/25/67	Yale University	171,169	12/31/75	Research on short-range interionic and ion-solvent interactive
		SUB-TOTAL	\$1,018,532		
WATER QUALITY RESEARCH PROGRAM					
(C) 3150	9/28/72	New York University	\$ 60,000	3/31/75	To study the foam separation removal of trace metals from polluted waters.
(C) 3151	10/21/72	University of Missouri	68,303	9/30/75	The development of novel techniques for the determination of organic contaminants in water.
(G) 3299	3/25/75	Polytechnic Institute of N.Y.	37,247	4/30/76	Investigation of the removal of trace toxic heavy metal ions from wastewater.
(C) 3242	4/3/74	Permutit Corp.	36,930	5/30/75	To investigate different pretreatment processes for use in the prevention of RO membrane fouling.
		SUB-TOTAL	\$202,500		
		Number of Active Projects: 33			
		Total \$ Obligations: \$4,805,717			

8. What coordinating mechanism has been established between OWRT and research and development arms of EPA? Are their programs complementary? If so, how is this arranged?

A. An arrangement has been in effect for several years, between EPA and OWRT, whereby, selected proposals are sent to EPA for their views and recommendations. The proposals sent to EPA are those considered to be in EPA's area of expertise, and further, they must be rated highly enough by the OWRT staff to be considered for funding under the matching grant (Section 101) of Title I and under the Title II program.

Additionally, we have recently initiated the practice of supplying packets of executive summaries of all proposals under the matching grant and the Title II programs to EPA and to other selected water resources agencies in the Federal government. The EPA response to these summaries has been very good.

Another informal arrangement has been established with the National Environmental Research Center at Cincinnati, whereby we exchange our Notices of Research Proposals (NRP) and EPA in return, furnishes us their plans for in-house research on water use and reuse of the upcoming fiscal year.

B. On the whole, our program is complementary, and we avoid duplication with the EPA program to the maximum extent possible.

9. What type of technology development program is planned? What are its key elements? How will it be implemented? What payoff is expected?

A. The technology development program planned for FY '76 includes work on sea water membranes and freezing. Development work in connection with the Yuma Desalting Plant will be carried out in FY '76 applying brackish water membrane technology.

B. The transfer of research and development results to practical application is the key element of this program. It is our plan to move technology to others for practical use as rapidly as possible. Saline water conversion will play a very important role in the development of water resources technology as well as general water technology.

C. The technology development program will be implemented through contractors under contract to the Office of Water Research and Technology. The program will be problem-oriented and closely coordinated with other agencies including the 54 State Institutes.

D. The technology developed by this program will assist in the solution of problems associated with water resources planning and management, salinity control, treatment of impaired water for reuse, water-related problems in connection with the development of energy resources, urban and metropolitan regional water problems, and environmental research.

10. What should be the role of OWRT in identifying regional problems and promoting and funding the related research? Cite examples of accomplishment in this area.

A. At this time the role that OWRT is performing in identifying regional water resources research problems is proving to be effective. The responsibility assigned to the Department by the Committee on Water Resources Research as lead agency in the coordination of water resources research, the 54 Institutes and related regional organizations provides a mechanism to identify and coordinate regional water resources research programs.

B. We have just completed the development of a system to facilitate and improve coordination of all of Interior's water resources research with the Committee on Water Resources Research and the 54 Institutes and related regions. The procedure used for coordinating and identifying water resources research and water resources problems of the 54 Institutes has been adapted for use by the Department of Interior in coordinating its water resources research programs. Resources required for water resources research are being identified and priorities established. Funds are directed towards water resources research problems identified as critical. OWRT and the Committee on Water Resources Research will support water resources research determined to be needed within available resources.

11. How well has OWRT performed in identifying regional problems and promoting and funding the related research? Cite examples of accomplishments in this area.

A. During the past year additional effort has been devoted to the improvement of procedures for identifying critical water problems and the research needs associated with those problems. Improved procedures which may be useful for establishing priorities for research attention are being tested and methods for determining the optimum allocation of research funds with which to conduct the research in accordance with those priorities are under development. These innovations are being developed with the full cooperation and participation of State institutes and their collaborators. The objective of this program is to identify more explicitly than heretofore possible the critical water research needs of the several States and hydrologic regions of the Nation. Accordingly, its successful application will significantly increase the cost-effectiveness of the OWRT research and development program. The approach, which involves the identification of water problems on a regional basis and the analysis of feasible alternative problem solutions should improve coordination of research at the regional, State, and national levels, and will serve to minimize undesirable duplication of research effort. Moreover, steps are being taken to integrate the OWRT system with the Water Resources Council's assessment of critical water problems so that necessary research may be focused on those problems.

B. Using the analyses of problem and research needs, we design our program on the basis of the two major OWRT research program responsibilities. The first is to develop and support research programs directed toward resolving the problems of the States and regions (Title I). The second is to develop and conduct research programs directed toward the priority needs related to the mission of the Department of the Interior.

C. Identification of critical water resource problems and the research needed is a continuing process wherein evaluations must be made regularly based on new information, changing conditions and like factors. Major water resource problems in each region of the Nation warranting prompt research attention at this time, have been identified and are described in the OWRT budget justifications document. Those major problem areas have been and will continue to be analyzed to determine the specific research that can contribute to problem solving in a cost-effective way. It is expected that a large percentage of the research proposals to be submitted to OWRT for 1976 consideration will be the result of this problem analysis and, hence, relevant to the most urgent water problems of the Nation.

12. What has the Title I program accomplished? Has it been cost-effective? Give specific examples of beneficial results.

Briefly described below is the result of one research project from each State. Where appropriate, reference is given to the application of the research findings or the adoption of the research results by water resource action agencies. These projects are not necessarily the most outstanding examples as data on the application or adoption of research findings made freely available and in the public domain are not always readily available. Many, if not most research findings reach the user through the media of technical, scientific, trade, and professional journals or through the training process, including short courses, workshops, and seminars for professional workers in water resources. In such instances the application of research results is difficult to trace.

ALABAMA--The phased concept of once-through cooling of power plant effluents was investigated by the Alabama Institute to develop a form of once-through cooling which is environmentally acceptable. A cost comparison of the phased-cooling system with the cost of wet cooling towers and cooling ponds indicated that phased cooling is less expensive than wet cooling towers but more expensive than cooling ponds. However, each of the other systems evaporated more water than the phased-cooling system. A number of power companies have expressed an interest in this research as have the Electric Power Research Institute (EPRI) and the National Science Foundation. Funds have been made available by EPRI to construct and test a model system.

ALASKA--Research has indicated that the most dynamic and perhaps the most important soil water behavior occurs in the winter when a significant amount of water is lost to the atmosphere. A thorough knowledge of soil water interaction in frozen soils is crucial for successful engineering and construction of roads and pipelines in Alaska. A research project conducted at the University of Alaska indicates that during the winter months atmospheric conditions cause a significant amount of soil water evaporation with a significant amount of heat being lost from the soil as a consequence of the moisture migration. These findings can be utilized to schedule construction activities and design equipment to cope with seasonal variability in the properties of the Alaskan land surface.

ARIZONA--The current rate of increase in demand for electrical energy, both nationally and regionally, not only is placing a stress on energy resources, but also is imposing an additional draft on water resources. The degree to which water use and reuse criteria can be incorporated into efficient power-plant siting and operation is an important aspect of regional water management. In this project ten locations in Arizona where nuclear power plants might be located and where significant quantities of municipal wastewater are produced were examined. A comparative evaluation between ground water and wastewater showed a significant reduction in cost of cooling where wastewater was used; estimated savings in water production cost ranged from \$101,000/year at Flagstaff to \$246,000/year at Tucson, for a 500 MW(e) conventional light-water reactor facility. Contracts for such use have been negotiated between the City of Phoenix and the Arizona Nuclear Power Project.

ARKANSAS--As a result of research performed by the Arkansas Center which led to an improved design of septic tank systems, both local and State regulatory agencies are reevaluating their design standards for septic tank installations. In addition, both the Corps of Engineers and Farmers Home Administration are reviewing the results of this Arkansas research study with a view of utilizing the results in their programs.

CALIFORNIA--A ground-water quality model developed in a project by the California Department of Water Resources provides a useful planning tool for assessing the effects of alternative water supply and disposal plans on the general concentration of dissolved solids in productive aquifers. This model is being applied in the Santa Clara-Calleguas area in testing of future alternative water management plans of interest to Ventura County water planners.

COLORADO--As a result of research in Colorado, it has been estimated that water losses from the snowpack in alpine regions may be as high as 60 percent of the snow-season precipitation, and 45 percent in the forests and forest clearings. A technique for blasting ridgeline snow accumulations into natural accumulation areas below the ridge was applied successfully to increase water yields at the rate of 240 acre-feet of water per mile of ridgeline treated.

CONNECTICUT--In a study of much interest and importance to the shellfish industry, the Connecticut Institute of Water Resources and Marine Research Laboratory investigated the influence of heated effluents from a fossil fueled power plant upon the growth and development of oysters. It was demonstrated conclusively that the heated water from a power plant on the north shore of Long Island Sound accelerated the growth of the oysters and extended the normal growing season, thus resulting in increased efficiency of shellfish production.

DELAWARE--The objective of a Delaware project was to examine the feasibility of short-term wastewater effluent regulation to maintain water quality in the Delaware Estuary following local increases in biochemical oxygen demand. The optimal policy of effluent regulation was determined using the calculus of variations and a simplified model of the Delaware River near Philadelphia. Comparison of the results of the optimal effluent policy with a policy of no regulation reveals that the differences between the two are not sufficiently large to justify the expense and effort of short-term regulation. From the start, this research was coordinated with the staff of the Delaware River Basin Commission. The conclusions have immediate application to the management policies of this regulatory agency.

DISTRICT OF COLUMBIA--At Howard University, Washington, D.C., a mathematical model, based on kinematic wave theory, has been developed to evaluate the effects of urbanization on peak flows for small areas, and takes into account the spatial variations of slope, roughness, slope-length, rain-excess intensity and duration. The model has been applied to hypothetical cases of land-surface alterations to determine the best pattern of alteration. The results of this study will be of value in establishing efficient drainage system design for metropolitan areas undergoing changes in land use patterns.

FLORIDA--Results of research by the Florida Institute on irrigating citrus with treated wastewater from citrus processing plants were put into practical use before the research was completed. The study, completed in January 1971, showed that it was feasible to irrigate citrus with this treated wastewater and provided guidelines for the quantity and quality of wastewater to be used. Last year, Coca Cola Company's Minute Maid Division started to irrigate a 27-acre mature citrus grove near Leesburg, Florida. Apparently finding the technique useful, the Company expanded the operation this year, installing a wastewater irrigation system in a 200-acre grove.

GEORGIA--Mercury pollution in rivers has become widespread nationally and it is of particular importance in parts of Georgia. Research at the University of Georgia on the biological transformation of toxic mercury compounds to nontoxic forms discovered that laboratory containers were adsorbing significant amounts of mercury compounds. The phenomenon was first noted on glass but further investigations of various materials showed rubber to be a much more effective adsorbent. It is possible that such items of waste rubber as old tires could be effective in removing toxic mercury compounds from industrial waste discharges or from rivers with high concentrations of mercury.

HAWAII--A research project conducted by the Hawaiian Institute analyzed irrigation water requirements for various crops grown in the Hawaiian Islands. The results of the analysis suggest that if the findings were applied to a large irrigation system on the Island of Hawaii an almost three-fold increase in crop production would be possible. These results offer considerable potentiality for increasing sugar productions in Hawaii to help meet burgeoning world demand.

IDAHO--Research underway in Idaho seeks to evaluate the quantity of sediment removed from cultivated fields and to develop design parameters for ponds and sediment retention basins on farms. Predictive regression equations were developed from field data. Owing to the practical applied nature of this study, the Potato Processors of Idaho have added substantially to the support of the work. Results will be a report and manual which can be used by farmers and agricultural engineers to retain sediment on site, thus reducing the water pollution potential of irrigated agriculture.

ILLINOIS--Research on an Illinois project on the development of a dimensionless unit stream power equation for the prediction of total sediment concentration in natural rivers will be very valuable to engineers and planners concerned with sediment transport, erosion processes, and the design of water supply and recreational lakes. Unit stream power, the time rate of potential energy expenditure per unit weight of water, was shown to be the dominant factor in the determination of total sediment concentration. Additionally, two other equations were developed and verified that provide simple and direct criteria for incipient motion of sediment particles.

INDIANA--Research on an Indiana project of biochemical and physiological studies to determine the safety of 2,4D formulations to fish and the aquatic food chain organisms has resulted in the development of a herbicide formulation which is effective in controlling the weeds and brush but does not affect animal tissues. This result was determined by means of a sophisticated laboratory assay technique involving the location of receptor sites for the herbicide molecule on membrane tissue.

IOWA--Ongoing research at the University of Iowa has resulted in the development of methods that define the impacts that large scale thermal discharges from power plants have on ice-covered streams. The work included the development of a linearized model of the rate of surface heat exchange, with generalized relations for the coefficients established in terms of meteorological variables. Results of this research are being used by the Commonwealth Edison Company as part of its study of the impacts of the Quad-Cities Nuclear Power Plant on the Mississippi River and by the Mid-Continent Area Power Pools to determine the thermal regime of the Mississippi and Missouri Rivers.

KANSAS--A computer program designed by investigators at Kansas University would simulate the discharge of hot water to streams and the simultaneous dispersion of organic wastes; and predict the quality of water downstream from the discharge point. The study also proposes a design procedure to determine the number of aerators that need to be installed in order to maintain the oxygen content of the stream above that required for normal aquatic life. Water quality control agencies at the state and local level should be able to use the results of this research in setting design standards for power generating plants so as to minimize thermal pollution.

KENTUCKY--A Kentucky study investigated the response of saturated sands to cyclic shear at earthquake amplitudes. The National Center for Earthquake Research, the Bureau of Reclamation, and private consulting firms have expressed interest in the research findings. The results of the program should provide the analyzing engineer with detailed quantitative information on the stiffness and energy dissipative characteristics of saturated sand soils.

LOUISIANA--The Louisiana Institute researched feasible safeguards to preserve fresh water bayous and lakes in the coastal areas as important future sources of domestic and industrial water. This was extremely timely as the area is faced with an influx of people and industries associated with oil and gas developments. This research will contribute significantly to officials planning for orderly development of the area.

MAINE--The Land and Water Resources Center at the University of Maine conducted several public service projects relevant to Maine lakes during the past year. These included an effort to train voluntary lake water quality monitors and establish a voluntary water quality monitoring network. Representatives from two state agencies, five universities, and a large private group (The Congress of Lake Associations) were actively involved in this effort, providing an outstanding example of the Center's efforts to play a coordinative role among other Maine agencies, institutions and individuals interested in water resources. The Center also gave much attention to the lack of public awareness with regard to Maine's water resources. To this end, publication of a widely distributed newsletter has been reestablished.

MARYLAND--The results of several Maryland research projects have provided the basis for direct recommendations by Cooperative Extension Specialist Herbert Brodie for pollution abatement measures on approximately 300 farms and in 20 plants processing vegetables, poultry, red meat, and seafood. Additional educational material was distributed to about 2,000 farmers. These results were based on several completed projects; current research on the ability of different grasses to assimilate waste effluents from a poultry processing plant; and research pertaining to chlorination and aeration techniques for treating effluents where discharge to streams cannot be avoided.

MASSACHUSETTS--Until recent years both coastal and freshwater wetlands have been regarded traditionally as waste areas. Their natural values have been largely unrecognized, and more than a third of the Nation's original wetland acreage has been obliterated through drainage and filling. During the last 10 years several States in the Northeast have realized the value of wetlands and have enacted legislation to control their alteration. Recognizing the need for criteria for evaluating wetlands, a research team organized at the University of Massachusetts has conducted studies of various aspects of wetlands preservation and use. One of the most valuable products from these studies is the wetlands inventory publication entitled "Classification of Freshwater Wetlands in the Glaciated Northeast." This inventory is an invaluable guide to those responsible for the planning, management, and development of the wetlands resource.

MICHIGAN--A research study on the ecology and use of three important streams in Michigan identified and quantified conflicts between the various groups of recreational users of the stream. As a result of the study it became recognized that one of the streams was suffering greatly through over exploitation and over use by recreational groups. In recognition of these conflicts and over exploitation, the Michigan Department of Natural Resources instigated widesweeping changes to protect the river and its future. These regulations are now being challenged in the courts, and the results of the study will be available for consideration of the courts, in reaching their conclusions.

MINNESOTA--Research on Lake Minnetonka, demonstrated that phosphorus is the nutrient that limits algal growth during the summer, when very dense populations of nitrogen-fixing blue green algae develop. A model of the photosynthetic system of the phyto-plankton was developed. Computations based on a materials balance indicated that the mean annual phosphorus content of the Lake's largest basin should decrease from an existing 13 metric tons to a desirable 4 metric tons within 3 years if the phosphorus influx was reduced by stopping the influx of sewage. Based on the result of the research, a comprehensive lake watershed management plan was prepared. Sewage effluents from two villages contributing about 80 percent of the annual phosphorus influx into the largest basin of the lake were diverted from the lake during the winter of 1971-72. The effect of stopping the flow of sewage into the lakes was monitored to measure the effectiveness of the management plan. The data for 1972 and 1973 suggest that Lake Minnetonka may in fact be responding according to the predictions. Thus, the results of the research have assisted people living near the lake and governmental agencies in Minnesota.

MISSISSIPPI--Although Mississippi is fortunate in receiving relatively abundant rainfall, there are occasional periods when drought conditions occur. Since tree and agricultural production are important in the State's economy, a drought can have serious consequences. Research at the Mississippi Water Resources Research Institute determined the frequency, distribution, and severity of droughts for 10 geographic districts of the State. The results will be used in planning fire protection and control of insects and tree diseases in forests, and in the planning of cultural practices for tree seed orchards. In a general way the findings should be useful also as a tool to evaluate the effect of drought on streamflow and water supplies.

MISSOURI--Research conducted by the University of Missouri on the preparation and oxidation properties of Ferrate Ion (FeO_4^{-2}) has resulted in the development of an economical method of water purification that can remove iron, colloidal material and bacteria from water. The compound is easy to prepare and with some water supplies has certain advantages over chlorine treatments. The method is now being tested in regular water treatment plants.

MONTANA--Research conducted at Montana State University has led to the development of microwave moisture sensing equipment that provides for rapid, on-site measurement of the moisture content of forest litter just before and even during prescribed forest burns. When the equipment is perfected it could be a valuable tool in forest and watershed management.

NEBRASKA--Investigators at the University of Nebraska are developing models of urban storm-water quality which will provide a base for better understanding of the constituents of urban runoff. A hydrograph simulation model was developed to generate flow hydrographs comparable to observed runoff data. Data were also obtained on concentrations of nitrogen, phosphorus, pesticides, and bacteria in runoff. Project findings should aid planners and engineers in the treatment and management of urban storm-water flows. The Nebraska Natural Resources Commission has participated and is using the results in its "Comprehensive Plan for Water Quality Management in the Salt Creek Basin."

NEVADA--In two projects, "Selected Physical Parameters Relating to Management Alternatives for Recharge and Flood Control on Alluvial Fans" and "Influence of Near-Surface Caliche Distribution in Infiltration Characteristics, Las Vegas, Nevada," the physical constraints to water management alternatives concerning ground-water recharge and flood control in the Las Vegas Valley have been examined. The role played by caliche on the process of natural ground-water recharge and its relationship to the frequent and often damaging floods experienced in this area has been investigated. Results have shown that on large areas of the valley's alluvial aprons precipitation is precluded from infiltrating by the caliche and thus runs off rapidly to create high flood peaks. Methods of enhancing ground-water recharge and simultaneously relieving the flood problem were examined as well as methods for additional artificial recharge and flood control measures.

NEW HAMPSHIRE--One of the most valued features of water supply reservoirs and lakes, whether natural or man made, is the potential for recreation uses. The popularity of water based recreation and the demand for such facilities forces all levels of authority from the local water officials to the Federal government to develop the recreation potentials of these water bodies to their ultimate, while maintaining the quality of water essential for their intended consumptive uses. In an initial study completed and reported on this year, the Water Resource Research Center at the University of New Hampshire attempted to determine the tolerance of one of the State lakes for recreational development and usage. One phase of the study involved locating sources of pollution and contamination by a systematic method of water analysis. As these sources were located, the information was given to the respective town health officers who in turn continued the investigation to eliminate the sources of pollution.

NEW JERSEY--In 1969, a research project conducted at the New Jersey Water Resources Institute revealed that in three New Jersey river basins the pollution from sources other than the known and recorded point sources was over two-thirds of the total load in the rivers. This finding has led to a national effort to identify the sources, volume, frequency and character of non-point sources of pollution and to investigate the implications of these findings in relation to efforts to control pollution in the Nation's water resources. The results of this research project gave impetus to the EPA, in 1973, to direct research emphasis toward finding ways and means to control the non-point sources of water pollution.

NEW MEXICO--Historically, the water-short arid and semiarid areas of the Southwest are almost devoid of manufacturing industries. A study was made of water requirements of major water-using industries and their technological ability to adapt to the economic and environmental conditions in the Southwest. The results showed that several types of industry could be introduced into the Southwest but highlighted petroleum refining and coal gasification because of the current energy crisis. The results of this research are being used by New Mexico State officials to formulate plans for the development of the State's resources.

NEW YORK--Can flood damage be turned to a community's advantage? The New York Water Resources and Marine Sciences Center states this provocative question more specifically: can you manage flood-damage compensation so that you have a more viable community after a flood than before? Economic evaluation methods have been developed to do just that as a part of "Project Agnes - Redesigning Flood Management with Emphasis on New York's Agriculture and Tropical Storm Agnes: Impacts, Programs, Reconstruction and Lessons." They are applicable to the planning needed after any disaster.

NORTH CAROLINA--The ecology of the coastal wetlands of the Atlantic Coast is endangered by urban, industrial, and agricultural expansion. Research on the future status of North Carolina wetlands has documented extensive changes of public and private holdings of these wetlands. This information will be put to use by the North Carolina Department of Natural and Economic Resources in the formulation of land management policies.

NORTH DAKOTA--Results of studies conducted by North Dakota State University that show the basic relationships between land and water use and water quality in the area are being used to develop a multiple purpose water and related land resource development plan for the Southeast Cass Water Management District. Other studies are providing the economic, attitudinal and environmental analyses needed by the State Water Commission in its planning for water development to meet agricultural, municipal and industrial needs with emphasis on coal development in Southwestern North Dakota.

OHIO--An Ohio study examined microorganisms capable of degrading refractory hydrocarbons in Ohio waters. This project isolated and identified organisms that are capable of degrading hydrocarbons in natural waters. The study is continuing and it is hoped that the results will provide a basis for the biological detoxification of natural waters polluted by oils.

OKLAHOMA--An Oklahoma project examined the toxins present in oil refinery effluents and developed laboratory processes for removing them. They found that partial evaporation treatment can remove toxic compounds from refinery wastewaters which are not degraded by conventional biological waste treatment. This is a very significant finding during our current energy crisis when we are seeking to expand our oil refinery industry as well as some allied petrochemical industries. It is conceivable that partial evaporation, in conjunction with other treatment methods could achieve the 1985 goal of "no discharge of any pollutants" without the necessity of complete recycle-reuse of all wastewaters.

OREGON--At Oregon State University scientists are developing environmentally related strategies for management of estuaries. One planning approach under study places a high value on environmental variety, including a wide range of undeveloped ecosystems. Cluster communities with intervening open spaces are called for within systems selected for development. An outline of a proposed classification plan for various development levels in Oregon's estuaries, has been prepared for the Oregon Coastal Conservation and Development Commission, and collaborative efforts are continuing with that agency.

PENNSYLVANIA--Soil may be to acid mine water what bicarbonate of soda is to an upset stomach, based on the findings of a study recently completed by Institute scientists. Just as bicarbonate of soda relieves acid indigestion, scientists in the Department of Agronomy have discovered that many soil types act as highly effective buffers in neutralizing water contaminated by acid mine seepage. The soils tested displayed a rapid initial reaction when mixed with acid mine water followed by a slower but continuing reaction. Soils containing calcium carbonate proved most effective in producing an alkaline water devoid of heavy metal concentration. Even acidic soils demonstrated an ability to improve the pH level of acid water by removing up to 75 percent of the acid. The use of soil or land discharge as a means of recycling acid polluted mine drainage may provide an economical solution for some cases of acid mine drainage pollution.

PUERTO RICO--The quality of the coastal environment in Puerto Rico is being threatened by the discharge of liquid wastes in rivers and bays. Results of research at the University of Puerto Rico on levels of pollution in selected bays and estuaries was used by Ramon Guzman & Associates, environmental engineering consultants, in their presentation before the Oversight Subcommittee of the Public Works Committee of the U.S. House of Representatives concerning possible changes to the Water Pollution Control Act of 1972, particularly as they relate to needs and conditions in Puerto Rico.

RHODE ISLAND--Recently publicized links between some types of malignancies and the carcinogens believed to result from the chlorination of certain waste waters make the use of ozone, in combination with or as an alternative to chlorination, for water treatment purposes of much interest at present. Several aspects of water treatment with ozone are being investigated by various organizations. In one of these studies, recently reported by the Rhode Island Water Resources Center, the viricidal effects of ozone were evaluated, and the contact times required to inactivate specific strains of virus were determined.

SOUTH CAROLINA--Discoloration of water is a serious problem to control because there is no existing color measurement method that can be easily applied to all types of colored waste. The South Carolina Institute has developed a filter photometer for measuring color concentration in water that will satisfactorily evaluate color concentrations in samples free of turbidity. Interest in adopting the system has been indicated by pollution control agencies in North and South Carolina as well as by the Southeast Region of EPA.

SOUTH DAKOTA--A study of South Dakota State University shows that the number of wetlands, in particular the amount of shoreline, is crucial in duck production. Thus, when a mitigation plan is made for an exchange of original duck producing marshlands for man-made bodies of water, the size of the wetlands in the plan does not in itself necessarily indicate a replacement of wetland losses in terms of duck production. Information from this study is now being used by a task force evaluating the effects of the Oahe Irrigation Project on waterfowl, and will be available for development planners throughout the North Central Prairie Region.

TENNESSEE--Research on the removal of viruses from water and wastewater at the Tennessee Institute has revealed that aluminum sulfate and ferric chloride are the most effective coagulants for the removal of viruses. Also, these coagulants reduce turbidity by over 90 percent. Organic coagulants were much less effective for virus removal. Requests for the results of this work have been received from agencies and individuals in many parts of the world.

TEXAS--Irrigation is the greatest single use of water in Texas and much of this is coming from steadily diminishing ground-water resources. A research effort directed to conserving water and increasing the efficiency of water use found that significant water saving could be achieved by trickle irrigation applying water sparingly and frequently. These results have been useful to water planners, consulting irrigation engineers, irrigation farmers, and State and Federal agencies concerned with food and fiber production.

UTAH--The nationwide energy crisis has greatly intensified water management problems in Utah. The Utah Water Resources Center is giving high priority to water problems related to energy. One project will begin to assess the "possible impacts on agricultural land use, income, and employment resulting from water transfers to facilitate Utah's oil shale development." Another project will study the "water quantity and quality requirements for development of various energy resources" and relate these to availability and suitability of potential sources of supply. The results of these projects will be of great value to Utah State officials in the development of their energy resources.

VERMONT--The impact of oil contamination on biologic life and the aesthetic quality of water bodies is of immediate and increasing concern, because of the irreparable damage and untold costs resulting from oil spills, chronic fouling of the water, etc. While the spectacular oil spills have, perhaps, received the most publicity, the less spectacular, continuous, low level contamination of waters by petroleum and petroleum products are potentially just as damaging. In preliminary experiments conducted recently by the Vermont Water Resources Research Center, the toxic effects of specific petroleum hydrocarbons on *Aedes* pupae and other aquatic insects were studied. Some changes in metabolic rates and marked differences in surfacing and feeding behavior were observed. The importance of these effects on such insects as the mosquito lies in the fact that they constitute a significant link in the food chain of fish. In addition to the results of these preliminary studies the Vermont report contains a good "State of the Art" discussion and bibliography.

VIRGINIA--Research at the Virginia Institute has resulted in the development of a new, relatively uncomplicated process for extracting water from sewage sludge. The process involves bubbling butane through the sludge which freezes the contained water, and then siphoning off the meltwater after the solids settle out of the mixture. The liquid is almost totally free of pollutants, thus simplifying the disposal process. Several industrial firms and government agencies are evaluating the process for possible adoption in the waste treatment field.

WASHINGTON--A project entitled "An Investigation of the Cause and Effect of Eutrophication in Long Lake, Washington," was completed on June 30, 1973. It was funded for a second year by the State Department of Ecology. The principal investigator has provided substantial amounts of information on the eutrophication of Long Lake which is located a few miles downstream from the city of Spokane. Data from the study has been very useful in testimony presented before the Environmental Protection Agency, Department of Ecology, and the city of Spokane on the need for more advanced waste treatment to prevent further degradation of the Long Lake system. The project will continue into fiscal year 1975 with increased funding from the Department of Ecology. Throughout the period of research, contact has been maintained with all of the agencies mentioned above. This project is another example in which OWRT provided initial funding for research which, because of its direct benefit to a State agency, received continued support from that agency.

WEST VIRGINIA--Research in West Virginia has produced statistical models to describe streamflow in relation to various physical parameters, and to define the frequency of precipitation occurrence in the State. Theoretical and empirical models were selected for evaluating the seasonal probabilities of 1-month, 3-day, and 1-day intense precipitation and their relation to flash floods in small upstream watersheds. The results were applied to a study of the conditions preceding the 1972 disastrous flood on Buffalo Creek, Logan County, West Virginia. Contrary to conclusions reached by competent persons using traditional methodology, the study indicated that precipitation events preceding the flood were in an extremely unusual sequence.

WISCONSIN--A Wisconsin study evaluated the impact of freezing and thawing soil conditions on nutrient movement. The results of this study will provide valuable inputs for the development of management strategies for handling farm yard manure in the northern portion of the country, where freezing conditions make the handling of farm yard manure more difficult. These strategies will be used to determine the optimum procedures for agricultural production with minimal detrimental effects on surface and groundwater qualities.

WYOMING--Research at the University of Wyoming has resulted in the development of a hydrologic model of the North Platte River. The model not only simulates the existing state of the river but also lends itself to modification to show the impact of changes in physical, legal, institutional, or economic conditions that effect the river. Similar research is now being undertaken in the Powder River Basin to show the social, economic and environmental impacts that can be expected as coal-related energy development proceeds in the region.

13. At the time the Saline Water Conversion Act of 1971 was passed, the Congress believed this program was vital to the Nation's responsibility for conserving water resources. The initial budget was \$27,025,000. Since the merger of OSW and OWRR, the budget is not entirely separable, but for FY '76 it would likely not exceed about \$3 million. How can the significant deemphasis of this program be explained? Is it justified? What funding level should be provided for this area of research and development? Why? What emphasis is planned for saline water programs in the future?

A. The saline water conversion program over the past 22 years has made significant contributions to the development of technology for the conversion of saline and other chemically contaminated water for beneficial use. The technology developed is in application in many areas of the world and it is to a large degree commercially available. For example, distillation plants are being constructed and are in operation in the Middle East. Other distillation plants are being constructed or are in operation throughout the world. Total land-based distillation plants installed or under construction with a capacity of 25,000 gallons/per/day or more worldwide equals 447 million gallons/per/day. With the completion of our development work on the Vertical Tube Evaporator/MultiStage Flash Experimental Module at Fountain Valley, California, no further work appears justified for Federal support. Additional work in distillation technology would yield a small increment of improvement at costs not commensurate with improvements. When the brackish water membrane research and development work in connection with the Yuma Desalting Plant is completed, this technology will have moved into large-scale operating plants. With the completion of the research and development work in connection with this plant, we will have reached another plateau in the brackish water membrane program. At this time saline water conversion programs will concentrate on the development of technology or application of water problems and to technology that will continue to result in the greatest payoffs. Major emphasis will be directed towards the development of sea water membranes.

B. We have requested for FY '76 \$.8 million to continue the development work on sea water membranes. In addition, we have requested \$1.4 million for research on sea water membranes, freezing and new processes. The total level of effort in this area for FY '76 amounts to \$2.2 million. This level of funding was developed in relation to the possible utilization of saline water conversion technology to the solution of water resources problems. The saline water program is an important part of the total research and development program planned by OWRT. The saline water conversion programs will be directed towards the solving of problems as will the other OWRT programs. We do not anticipate conducting research and development

activity for improving processes unless these processes show promise for application to specific water problems and are economical and will not have an unfavorable impact on the environment.

14. What implication does the saline water research and development program have for waste water treatment, energy development, and marketing of saline water conversion hardware in the Middle East and other areas of the world? Is the level of effort sufficient in these areas?

A. Technology developed by the saline water program has application in the treatment of some waste waters and in the solution of some water-related energy problems. Distillation, membrane technology, and freezing are used to upgrade waste water to help solve water pollution abatement problems. We have been working with the Environmental Protection Agency on an agreement to transfer saline water conversion technology to their organization for use if deemed feasible for specific situations. If the situation warrants, the Environmental Protection Agency would then pick up the development phase and demonstrate the technology. The Energy Research and Development Agency is also looking at saline water conversion technology in connection with water related problems in the development of our Nation's energy resources. It appears that there may be situations where our research and development results may be used effectively. Saline water conversion technology has been and is being used in the Middle East and other areas of the world to help solve water supply or water quality problems. The technology developed by this Office has been and will be transferred to U.S. industry and others for use in various parts of the world. We have established an Office of Assistant Director, Technology Transfer. His primary function will be to expeditiously transfer technology for further development and application.

15. Since materials research is vital to hardware development for saline water conversion processes, why was the Materials Test Station in Freeport, Texas, closed?

A. Materials research was discontinued as this activity mainly supported the development of distillation technology. The materials research and development work carried on at the Freeport Test Station played an important role in the development of distillation technology. With the coming of age of distillation technology and the apparent market for this technology, it was no longer justifiable for the Government to support materials testing. Materials manufacturers in a competitive environment will have the incentive to achieve additional materials improvements if justified.

16. What was the rationale for dropping most of the research effort in brackish water conversion and distillation processes?

A. As previously mentioned, the distillation technology has come of age and is in the market place. Further research and development on this technology would cost more than anticipated payoffs. The brackish water research and development currently taking place in connection with the Yuma Desalting Plant will move this technology into large-scale application. It is our objective to focus on technology that appears the most promising and that has application in the solving of water problems. We do not plan to conduct further development into technologies that are commercially available and that are in use throughout the world. U.S. industry has demonstrated their high level of capability in developing advancing technology if a viable market exists. A large amount of technology has been developed and transferred to the private sector during the past 22 years of the saline water conversion program. The saline water conversion programs proposed were developed to concentrate resources on finding the best solution to water resource problems. Technology developed will then be transferred for demonstration and application to water resources problems.

17. How effective has OWRT been in the area of information dissemination? What is the future role to be played in this area? What is its importance? What percentage of funds will be used for this purpose?

A. Since 1967 when the Water Resources Scientific Information Center (WRSIC) was officially established by the OWRT (then OWRR), the coverage, announcement and user services dealing with information on water resources research have been expanded until at the present time there is a data base of some 85,000 items and a series of services which include a twice monthly announcement journal which carries about 550 abstracts per issue, and a network of computer terminals by means of which the data base can be searched and pertinent information located in minutes. Added to this is the publication of (1) an annual catalog of on-going research which is compiled in cooperation with the Smithsonian Science Information Exchange (SSIE), (2) a series of bibliographies, and (3) state-of-the-art studies and literature reviews.

B. The effectiveness of this expansion can be judged by the growing number of requests for the information from the Center and user response to the material provided. In the last two years more and more requesters have been motivated--presumably by satisfaction with the WRSIC responses--to acknowledge the utility of the information received. In one instance during the past year, a \$140,000 saving was brought to our attention that resulted from a search of the WRSIC data base and yielded references which showed that the research to be undertaken had already been done and the results could be used. Recently an increasing number of inquiries from foreign countries have indicated interest in the Center itself as well as the research which is being carried on in the water resources field. To enhance the system further, plans have been made to have a panel of experts in the fields of water resources research and information determine its present adequacy and effectiveness and to provide guidance for any improvements which may be desirable. This should result in WRSIC having an expanded role in water resources information dissemination.

C. The importance of dissemination of information about research which is in process or has been done lies in the fact that duplication of any effort is costly, particularly present-day research. Knowledge of scientific and technological progress can be applied directly by those who have to deal with related problems or it can provide base points to scientists for further developments without having to waste resources to repeat earlier studies.

D. The funds requested for this program for FY 1976 amount to \$980,000 or 5½% of the total budget request of \$18,327,000.

18. How effective has the OWRT program been in training scientists? How valuable is this aspect of the program? What fraction of the manpower needs for water resources professionals and technicians is being met by the program?

A. A primary purpose of the Water Resources Research Act of 1964 is the training of scientists in the fields of water and of resources which affect water. Hence the OWRT program of funded research has major beneficial impacts upon educational programs in water resources, even though no funds are made directly available for educational activities. And over 100 universities throughout the Nation, through their participation in OWRT sponsored research, contribute to the effectiveness of the program in various ways, including the training of students involved in the research. A significant percent of these students are ultimately hired by the universities to teach, to do additional research or to fill other responsible positions.

B. In an effort to evaluate the effectiveness of the training aspects of the OWRT program, each of the participating state Water Resources Research Institutes or Centers has attempted to keep records regarding employment of students involved in OWRT sponsored research projects following their graduation.

C. As can be seen in the attached Table I, approximately 50% of the students involved in OWRT sponsored research in FY 74 were employed in water related positions following graduation, 46% returned to school, and about 4% went into military service. Of those who accepted employment about 39% went into private industry, 37% were employed by State and Federal agencies, and 24% were employed by colleges and universities.

D. During the ten year period in which the OWRT program has been in operation, the State Water Resources Research Institute Universities and associated schools have reported the development of 2453 new water-related courses. Many of these are taught by the 10 to 12 percent of the graduates who participated in water resources research and who were subsequently employed by the universities. Over the ten year period since the program began, 1763 new positions have been filled for this purpose. Others employed by the universities have gone into various jobs different from teaching such as administration of research activities.

E. The professional disciplines involved in water related research cover a broad spectrum ranging from Law to Engineering and include such specialized fields as economics, statistics, anthropology, ecology, botany, and soil science, to name only a few. (See Table II). Of the approximately 1800 students who receive financial support and training on Title I projects

each year, roughly half of these are classified as engineers, biologists, or economists with the number in engineering about equal to the other two combined. The total number of graduates in these disciplines who are employed in water related occupations would be difficult to determine. Consequently, the determination of the proportion of the total that have been trained under the OWRT sponsored research program becomes a prohibitive task.

TABLE I
STATUS OF GRADUATES AS REPORTED AT THE END OF SELECTED SCHOOL
YEARS, 1965-66 to 1973-74 ^{1/}

Status	1965-66	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
Occupations of Graduates Whose Whereabouts Were Known ^{1/}									
Water-related positions	49.3	50.3	49.0	47.4	50.6	55.3	54.4	65.5	49.7
Returned to School	33.2	30.0	26.7	29.0	23.9	34.3	37.3	30.4	46.0
Military Service	17.5	19.7	24.3	23.6	25.5	10.4	8.3	4.1	4.3
Types of Water-Related Agencies in Which Graduates Were Employed:									
Private Industry, etc.	33.7	31.0	32.2	29.5	34.0	32.8	29.6	28.7	38.8
Federal	28.9	29.4	26.5	25.9	24.9	22.1	20.9	18.1	17.7
State	20.8	21.0	20.2	20.0	20.2	19.7	22.7	21.1	19.3
College and University	16.6	18.6	21.1	24.6	20.9	25.4	26.8	32.1	24.2

^{1/} Excluded from this table are those graduating whose status was not known or who were unemployed or working in other fields at the close of the year following graduation.

