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THE CASE FOR NATIONAL ENVIRONMENTAL
LABORATORIES



A REPORT

PREPARED FOR THE USE OF THE

COMMITTEE ON PUBLIC WORKS
UNITED STATES SENATE

BY THE

AD HOC NEL CONCEPT COMMITTEE
OAK RIDGE NATIONAL LABORATORY

AT THE REQUEST OF

HON. HOWARD H. BAKER

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JANUARY 1970

Printed for the use of the Committee on Public Works

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(II)

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LETTER OF TRANSMITTAL

FEBRUARY 13, 1970.

Hon. JENNINGS RANDOLPH,
Chairman, Committee on Public Works,
U.S. Senate.

DEAR MR. CHAIRMAN: On February 6, 1970, we introduced S. 3410, the National Environmental Laboratory Act of 1970. The legislation was referred to the Committee on Public Works.

The proposal grew out of the report of an ad hoc committee set up at our request at the Oak Ridge National Laboratory. A copy of the report and of the bill are enclosed. We respectfully request that you authorize the printing of the report and the bill (S. 3410) for the use of the Committee on Public Works.

Sincerely,

HOWARD H. BAKER, Jr.,
U.S. Senator.
EDMUND S. MUSKIE,
U.S. Senator.

(III)

THE AD HOC NEL CONCEPT COMMITTEE

Oak Ridge National Laboratory—December 1969

Position at Laboratory

D. J. Rose—Ph. D., 1950, MIT—Engineering physics.	Long-range planning.
H. I. Adler—Ph. D., 1956, Cornell—Bacteriology.	Director of Biology division.
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J. L. Liverman—Ph. D., 1952, California Institute of Technology—Biochemistry.	Assistant director of ORNL.
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(Continued on p. vi)

THE AD HOC NEL CONCEPT COMMITTEE

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J. B. Storer—M.D., 1947, University of Chicago—Medicine.	Head of Pathology and Immunology Research Program of Biology Division.
M. S. Wechsler—Ph. D., 1953, Columbia University—Physics.	Head of Radiation Metallurgy Section Solid State Division.
A. M. Weinberg—Ph. D., 1939, University of Chicago—Physics.	Director of ORNL.
R. P. Wichner—Ph. D., 1965, University of Tennessee—Engineering Science.	Staff member for special projects—Reactor Division.
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THE CASE FOR NATIONAL ENVIRONMENTAL LABORATORIES

I. INTRODUCTION

Few will dispute that we must live with grace, with dignity, with style, and with social justice. But the words mean different things to different people; and what shall we do to realize these ambitions? It is trite to say that burgeoning population, new applications of technology, and exploitation of resources have brought us not only to a present opulence and often better health, but also to a host of uninvited environmental consequences: pollution, fewer resources, sometimes poor health when we expected better, and so on. It is not so trite and more constructive to note the explosively growing awareness of these difficulties—their importance, their ubiquitousness, and most importantly the possibility of their solution within the broad framework of our society.

In briefest abstract, we develop the thesis of organizing certain institutions more meaningfully to match science and technology to the national environmental and technological assessment problems that we face. The organizations envisaged—National Environmental Laboratories—would have interacting components from many physical and social sciences. By their structure and method of working, they would be able to cut across the fabric of environmental problems, in directions not hitherto possible.

We reject any Luddite philosophy, accepting a more optimistic one. As a recent Academy of Science Panel¹ puts it, we have a new chance, where “our visions and capacities have so broadened and deepened that we can now, for the first time in human history, realistically aspire to have it both ways: to maximize our gains while minimizing our losses * * *.”

To reach a workable scheme for implementing such extravagant hopes, we find necessary a very broad view of our affairs; no lesser one seems to fit. The environment is that of people as well as of the wilderness; we will find business in the city as well as in the country—doing urban studies as well as natural resource management. Solving present environmental problems is a retrospective task related to past mistakes, and difficult enough as all can see. But difficult in a different way and inseparably joined is the prospective task of arranging our future in ways least likely to cause uninvited trouble. We have thus two outlooks, as the two faces of Janus, one showing foresight, the other retrospective correction.²

¹ “Technology: Processes of Assessment and Choice,” Report of the NAS Panel on Technology Assessment to the Committee on Science and Astronautics, U.S. House of Representatives (July 1969). Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

² If the title truly must describe the function, we should be proposing the establishment of National Environmental and Technological Assessment Laboratories; but we eschew the *gaucherie*.

The object is to develop specific proposals for action; but the development best starts by our looking at the problems to be solved at several depths. Throughout this work we quote liberally from the NAS Panel report, already referenced. Many other documents not always specifically mentioned later also guided us: Two volumes of hearings³ before Senator Muskie's Subcommittee on Intergovernmental Relations, the Committee on Government Operations, U.S. Senate; the report prepared by Representative Daddario's Subcommittee, Utilization of Federal Laboratories;⁴ the report on Technology Assessment⁵ by the National Academy of Engineering. These all make excellent reading.

Even starting the discussion makes hazards, especially hazards of intention. This will become evident (for instance) to some of our social science colleagues when we choose examples to illustrate concepts. Examples will be too narrowly technological, too incomplete; the suspicion arises that perhaps we mean in the end to run the gamut only from A to B. There exists no such intent; our own expertise is finite, and to have overstepped it would have been to court other dangers. This narrowness—which would have its counterparts in essays written by other groups—reminds us of the fable of seven blind men describing an elephant by feel: to one it is a tree trunk, to another a palm leaf, et cetera. In the concluding remarks of section VII we pick up one topic again.

³ Hearings on S. Res. 68, Mar. 15, 16, 20, Apr. 5, 6, 11 (1967); and on S. Res. 78, Mar. 4, 5, 6, Apr. 24, May 7 (1969); “* * * to establish a Select Senate Committee on Technology and the Human Environment.” Superintendent of Documents, U.S. Government Printing Office.

⁴ Report of the Subcommittee on Science, Research and Development of the Committee on Science and Astronautics, U.S. House of Representatives, 90th Congress (1968), U.S. Government Printing Office.

⁵ A Study of Technology Assessment, Report of the Committee on Public Engineering Policy, NAE, to the Committee on Science and Astronautics, U.S. House of Representatives (July 1969). Superintendent of Documents, U.S. Government Printing Office.

II. MANY PROBLEMS, SEEMINGLY

Hardly any thoughtful person can walk 5 miles from wherever he is right now without seeing how badly we have managed our environmental affairs. Gruesome lists abound. DDT and other chemical residues have disturbed nature in uncounted ways, and we are increasingly apprehensive about the extent. Clear vistas are replaced by miserable urban and suburban atmospheres. Not only Lake Erie, but also many other lakes and rivers face ruin. Too often the position is adopted that unassessed consequences will be manageable, or they will not be serious enough to warrant deliberate interference to restore environmental quality. So higher power automobiles come into natural use for escaping faster from smog-poisoned cities, with no one feeling personally guilty. Taller stacks disperse sulfur oxide pollutants farther from fossile fuel powerplants—such stacks in England cause acid rain in Stockholm.

We need no extensive list of troubles—plenty of accounts exist, familiar to perceptive readers. An excellent one is put out by the American Chemical Society.⁶ There some 75 recommendations for action including, for example, new methods of aqueous waste disposal, epidemiological studies of effects of air pollution, new means of public transport, et cetera, make a good basis for organizing needed activity. There are many lists, and we take their existence as known; but how do we organize for the activity?

Cleaning the environment has become an important and fashionable business; Government agencies compete for the responsibility. By reasoning processes that are extensions of this account up to now, agencies such as NAPCA and FWPCA have been established. About 60 executive agencies and 20 congressional committees in the Federal Government alone—and many more elsewhere—are connected in some way with these environmental problems. That is a flattering measure of concern, and one might think that by the process—or an extension of it with more funds—our condition will be substantially improved. Surely that will be so in specific cases.

These agencies and defined tasks are necessary and beneficial and should continue, though perhaps in somewhat modified form. But we contend that even though special agencies do competent (and sometimes outstanding) work, yet the fragmentation of present approaches makes the effort inadequate, because no one considers the whole problem. The danger exists of our falsely comforting ourselves while an undetected layer of problems becomes even more intractable.

Several points can be made in support of this. First is simple effectiveness: Consider the following:⁷

Federal water pollution control efforts are not succeeding, according to a report sent to Congress last week by the General Accounting Office. Although the

⁶ "Cleaning our Environment: The Chemical Basis for Action," report by Subcommittee on Environmental Improvement, Committee on Chemistry and Public Affairs, American Chemical Society (1969). Library of Congress Catalog Card 74-96123.

⁷ *Chemical and Engineering News*, 10 Nov. 1969.

Federal Water Pollution Control Administration spent \$1.2 billion during fiscal years 1957 through 1969 on waste treatment projects costing a total of \$5.4 billion, pollution levels have continued to climb as a result of industrial pollution and poor planning in the choice of projects. On one of eight rivers chosen for detailed study, four cities spent \$2.1 million for secondary treatment facilities which removed 20,000 pollution units. (One pollution unit represents the average oxygen-demanding wastes produced daily by one individual.) However, two pulp and paper mills on the river continued to discharge between 500,000 and 2 million units.

Possibly the funds allotted to that particular task were insufficient. However, we believe that difficulties such as this stem not from some single correctable insufficiency or inadequacy, but from a too small and too limiting assessment of the problem.

The difficulties can be expressed in more scholarly terms. First, while various retrospective corrections may be indicated, no adequate mechanism exists to detect problems in a systematic way at early stages of development or deployment. Indeed, what is an "early stage"? Timely consideration must be given to potentially injurious effects, often upon sectors of society and the environment quite remote from the initiating places. For by the time deleterious consequences have become obvious enough to generate public concern, we may find that the commitments of various groups to technological paths and institutional arrangements will have made correction very costly.

A second difficulty with the present approach relates a little to the previous topic, but stands by itself: self-interest. Even clear vision of future efforts does not alone suffice if the warnings of potential injury fall on senses dulled by selective interest in exploitation of the technology. This is no accusation of common venality, as the NAS panel remarks:

With few exceptions, the central question asked of a technology is what it would do (or is doing) to the economic or institutional interests of those who are deciding whether or how to exploit it.

That is, even with the establishment of penalties, cleaning procedures, and the like, the assessment is too narrow; optimizing each sector of the general economy separately is not equivalent to optimizing the whole system, as we shall discuss more fully later. The NAS panel has more to say about this:

As they consider the possibility of exploiting or opposing a technological opportunity or development, individuals, corporations, and public institutions attempt to project the gains and losses to themselves of alternative courses of action, and seek a course designed to maximize the gains while minimizing the losses. The difficulty is that self-interested analyses of this sort may ignore important implications of particular choices for sectors of society other than those represented in the initial decision.

The words speak of the charges often inadvertently but sometimes advertently put upon the public sector—the external diseconomies. This term from economics appears often and importantly enough to warrant brief explanation by example. Suppose our factory produces much dust, but no regulations exist to prevent our releasing it. What shall we do? By installing filters, we incur a charge but no compensating reward. In fact, the product price may have to be raised, to our disadvantage, and perhaps the business fails because of altruism. Conversely, by blowing the dust into the air we save money; but there are costs to the community that may easily exceed the cost of installing filters—poor health, dirty surroundings, and so on. These real costs

were not figured into classical economics, being external to the system (the factory operation); they are the external diseconomies.⁸

These phrases speak of the need for process control and better regulatory laws. But here we reach, as does the NAS panel, for something beyond the problem of dealing with those who bedew their neighbors with garbage (however defined). What is missing is an organization of our future technology so that the alternates are presented clearly enough, early enough, and well-developed enough to make much more visible the consequences of action. This is the important matter of preserving future options, for which an adequate method does not now exist. Retrospective taxes and penalties have their places; but what is the tax or penalty for an unwisely chosen technological system? A 500,000 ton tanker may represent a danger uncompensated by all its beneficial economies.

Other difficulties have been brought up, some related to those already mentioned. The concern that present mechanisms are preoccupied with highly visible present problems (hence go from crisis to crisis without reaching deeper) is an alternate statement to that of the previous paragraph.

A crucial difficulty of all but the most recent approaches and of present working organizations remains to be stated; many preceding items point toward it. Environmental or technological assessment problems are borne and flourish very ecumenically, but the true nature and extent are masked through artificial categorization, parceling out to agencies with separately defined tasks, and a process of mental molding to fit prefabricated compartments. Subdivision is of course necessary at intermediate levels, to identify and deal with particular social, economic, and other tasks; that is not calamitous. What is missing and necessary is a means for reintegrating these fragmented efforts at the working level, plus a focus of advisory functions at many levels, all of which will match the scope of the work to the true extent of what needs to be dealt with. The point is that there is no way to organize a set of laboratories so that problems remain in one place and solutions can be identified as coming from one place, for very long. In a little while, the matrix of abilities and problems changes, because the new problems were by their nature unforeseen in the structuring for the old ones. Our aim is to take a quite different cut at the matrix.

⁸ An excellent account is contained in the article "Conservation Law I: Seeking a Breakthrough in the Courts," *Science*, vol. 166, Dec. 19, 1969, pp. 1487-1491. See esp. *The Tennessee Copper Smelting* case, p. 1490.

III. THE PROBLEMS REVISITED

In looking for a more adequate restatement of what environmental maintenance implies, and of how to go about it, we turn first to the Senate Congressional Record⁹ and to the Senator Muskie subcommittee hearings of reference 2. A deep awareness of the required scope, present inadequacies, and practical possibilities are contained in discussions leading up to and connected with the National Environmental Policy Act of 1969, P.L. 91-190 and related measures S. 7 and H.R. 4198 of the 91st Congress. More than that, Representative Daddario's proposal of a technology assessment board partly describes the prospective face of our Janus.

Much philosophy has been written about all this. For instance, in the Senate record⁹ we find:

If it is ethical for man to value his chances for survival, to hope for a decent life for his descendants, to respect the value that other men place upon their lives, and to want to obtain the best that life has to offer without prejudicing equal opportunities for others, then the cornerstone is the maintenance of an environment in which human life is not only possible, but may be lived with the fullest possible measures of personal freedom, health, and esthetic satisfaction that can be found. No government is able to guarantee that these values can be realized, but government is able to assist greatly in the maintenance of an environment where such values are at least realizable.

In the end, philosophy and social purpose, not science, and not even strict logic (though we think we are logical) set the purpose here. Then again, as at the start of this discussion, how shall the preservation of this spaceship earth be effected?

We envisage the establishment of (or conversion of certain existing organizations to) National Environmental Laboratories, whose missions can be broadly defined as:

(1) The development, collection, and storage of information concerning activities that affect man's environment and the dissemination of such information to all individuals, groups, organizations, and institutions that seek it; and

(2) Developing and presenting to policy makers at all levels—without recommendation—ordered sets of alternatives whose relative costs and benefits are clearly defined.

These phrases take on more meaning as we develop the theme; as Einstein replied when asked how the theory of relativity was defined, the development of the work is the extended definition. Regarding both missions, we envision very large information-handling and cooperative activities associated with NEL's. Regarding the second mission, we take a position contra those who suggest that scientists must present in clinical sterility only the data from which the decisions can be deduced or inferred by policymakers. If the "sterile data concept" had worked, we wouldn't be facing many of the environmental problems we have today.

⁹ Senate Congressional Record, Oct. 8, 1969, pp. 12106-12159, approximately.

Neither of those objectives nor any activities of NEL's would include legislative or executive action to preserve the environment, nor would they include any regulatory or enforcement activity. The NEL roles will be large enough as it is; decisionmaking or enforcing roles would be quite contrary to our governmental arrangements, and probably to the Constitution. To put the matter sharply, we believe that people are reasonable and will take steps to preserve our environment when workable attractive methods are presented. But that is a decision for society as a whole, and if it wishes truly to destroy the environment, it can and will do so. What is inexcusable from our present operational point of view is to act in ignorance or stupidity, and that is basically what we are concerned about.

As implied in section II, we propose some working principles. Again, this whole account contains extended definitions, but the two most important principles can be stated explicitly:

(1) Reintegration at both the working and advisory levels of all the disparate parts of these problems—problems that start their life integrated, but tend to become fragmented and redefined in terms of the parts appearing in each sector of society. It is this reintegration (and the methods to achieve it) that permits the new approaches—the cuts in new directions across the fabric.

(2) Maximizing the mobility of relevant information and of ideas. Detailed actions derive from these considerations: In-depth analysis of environmental problems, information accumulation, applicable basic research, evaluation, technological development, systems analysis and assessment; studies of biological, ecological, and sociological effects; communication of all kinds; and cooperation with many other public and private agencies; more besides.

Beyond this, success depends upon recognition of more factors that are sometimes emphasized, sometimes not. We state several here to make clear our opinions:

(1) Most important environmental problems are not properly definable in terms of single specific tasks or even as a sum of such separate tasks. This basic point influences our whole approach. It can be put in pseudo- (and also more rigorous) mathematical terms; we do so because of the importance to our thesis. When our relations with each other and with the environment were so weak that the environment appeared as an infinite resource, those relations were generally describable by a linear coupling; at that stage, each effect—a dirty stream, for instance—could be described more or less separately, and separate cures could meaningfully be prepared. The optimum solution consisted of optimizing each separate part. On the other hand, when our activities grow enough that the environment appears finite in comparison, the interactions are no longer describable by linear relations at all. The interactions are both coupled and nonlinear, a situation that generates conditions and solutions of quite different character. Very importantly, optimizing the whole system is by no means approachable by any process of optimizing each segment individually, which has tended to be the ancient pattern. As a simple example, optimizing any one sector by itself (pulp and paper manufacture) exacerbates other difficulties (water pollution); here is the origin of external diseconomies, which do not appear in simple linearly programable systems.

Failing to recognize and approach the problems at the larger scale is mismatching the effort to the problem. The connectivity is often mentioned; as Senator Allott¹⁰ says:

In our studies of this matter, I believe we determined that there are some 20 or 21 agencies of the Government which are directly involved with problems which affect the environment. For example, it is impossible to think about future environments without thinking about the Department of Housing and Urban Development of our Government. It is impossible to think of them without thinking of HEW, because the environment does not involve only water and air; as suggested by the distinguished Senator from Maine, it involves noise—and we are all becoming acutely conscious of this factor. More and more as time goes on—environmental questions will also involve land distribution, land planning for the future, what kind of future cities we will plan, and what we will do about the ghettos—for the ghettos are a part of the environmental picture, and, as a responsibility of HUD, are also a part of this question.

We could go on endlessly, bringing in the various departments and agencies of Government which, sooner or later, if not now, will be actively engaged in problems and fields which do involve the environment.

(2) Not only are the tasks not definable in terms of separate simple objectives, they are mission oriented and usually cannot be defined at all in terms of separated scientific disciplines. This sometimes impedes both problem recognition and a will to commitment by those in specific disciplines who are able to offer imaginative solutions. The fact that any effective solution or abatement procedure changes the environmental problem that was being studied bespeaks a degree of coupling found scientifically uncomfortable.

(3) The tasks of technological abatement (of present problems) or technological assessment (of future ones) have large technological components, which might sound like a tautology, and has been said above anyway; but there is a missed point yet to be emphasized. We believe that these environmental tasks, both retrospective and prospective, must proceed in the atmosphere of large working laboratories and not in think tanks. It is all too easy to lose sight of alternates, to assume that solutions exist where they do not, or to miss exploitable developments. In section VI we show some examples where all the skills need to be coupled.

Much needs to be said about how properly to present alternates and information upon which legislative, executive, or regulatory decisions can be made. There is often a discouraging gap between technological and decisionmaking levels. Arrangements must exist to transfer information at all levels, to make known at the right time what has been done, what is possible, and what is to be expected because of some action—often what is to be expected somewhere quite remote from the point of application. To put a related point colloquially but importantly, there should also be a number that a Congressman can call; and to any reasonable question he should expect an answer.

(4) The nets of assessment and technological exploration must be cast wide enough to encompass as many future paths as possible. The actual course of development cannot accurately be predicted, and in any case the best one could not be found without exploration. The retrospective vision of Janus is sharp; but in the forward direction breadth must replace acuity. As the NAS panel says:

¹⁰ Senate Congressional Record, October 8, 1969, pp. 12106-12159, approx.

In the final analysis, it may be more important to foresee the full range of possibilities than to predict the most probable direction of development. The understanding of possibilities at an early stage enlarges the range of choice in the phase of innovation in which choice is still relatively easy and cheap. It also facilitates redesign of measures to evaluate effects, and thus to discern such effects before they precipitate an environmental or social crisis.

Of course, there are difficulties in the way of reaching the hoped for state of affairs. One is cost in the broadest sense, on which much has been written. Corollary objectives are to increase the available meaningful options, not decrease them, and to decrease total costs, not increase them. Costs can be monetary, esthetic or human, as can the benefits. The evaluation of each alternative must, therefore, address itself to the effect on (a) the economy (private, public, and personal), (b) society (institutional, governmental, and personal), and (c) the environment (atmospheric, aquatic, esthetic, and so forth). There will be real costs and limitations to some, but the objectives of technological abatement and assessment activities should be achievable as much as possible through individually attractive incentives. Again from the NAS:

The root of the matter is that no enterprise, private or public, can afford indefinitely to assume costs that its competitors will not likewise assume. The only solution lies in the direction of a mutual assumption of costs—either by contractual agreement, domestic or international, or by submission to externally imposed constraints that directly or indirectly compel all to assume costs that none could afford to assume alone.

By what recipes do we minimize costs and maximize benefits? What value is to be put on a pleasant view or the preservation of a future choice? We discuss the existence of helpful guidelines later, noting here only that the working teams must contain substantially larger contingents from the social sciences than has hitherto been the case in large technically oriented laboratories. The social and natural sciences must be stretched to where they join. Recent evolutionary trends in other technical institutions—for example, at the Massachusetts Institute of Technology¹¹—bear this out.

These matters touch on public and individual conscience and will. As the Muskie Subcommittee on Intergovernmental Relations and other congressional hearings on these topics brought out many times, there must be acceptance of a community responsibility and the development of public understanding of the nature of the problems we face. If the words seem self-evident, there is still needed recognition of their importance.

We are hopeful and in a hurry; so are others. In summing up 2 years of hearings Senator Muskie says:

* * * I should like to say that I see a common theme running through all the testimonies that both the benefits and hazards of technology are escalating at such a pace that a central forum is necessary to assess technological impact on man and his environment.

And Senator Jackson says:

If we are to make intelligent decisions which are not based on the emotion of conservation's cause célèbre of the moment or on the error of simply perpetuating past practices, there is a very real need to develop a national capacity for constructive criticism of present policies and the development of new institutions and alternatives in the management of the environmental resources of land, air, water, and living space.

¹¹ Massachusetts Institute of Technology, Report of the President, for the year ending June 30, 1969, p. 1

IV. THE GENERAL NATURE OF NATIONAL ENVIRONMENTAL LABORATORIES

For developing these thoughts an imperfect but useful analogy occurs to us. In the best-managed industrial corporations, the research department plays an essential role. Its interactions with the rest of the company are delicately arranged. The laboratory has independence, much local option, concern for the future, mandate to explore areas of company interest that do not fall in the time scale of present profitability for the operating divisions. It picks up from the operating divisions problems that were unforeseen consequences of earlier decisions. In developing and presenting alternate solutions to the corporate management, it considers costs and benefits from an overall viewpoint; some operating parts may lose something. Yet in all these activities, it makes no final decisions, establishes no corporate policy, regulates no company operations. It lives in harmonious relation with operating divisions which may do their own research. No fears of elitism or technocratic management arise.

We propose that National Environmental Laboratories are analogous instrumentalities for the country as a whole; the tasks implied but not spelled out either in any of the bills S. 1075, S. 7, or H.R. 4148, or in the NAS panel report call for such organizations, perhaps partly by the conversion or partial conversion of some present public facilities. Large, sensitive, dedicated groups with considerable local discretionary power are required and will be successful at the national level.

We now describe more specifically our concept.

A. Number, size, and startup.—Many problems of NEL's are truly national, sometimes international, and cannot be subdivided. Nevertheless, many have flavor more of one region than another, and in addition our view is of the NEL's in close contact with all parts of the environment. By this, we mean even to such details as an immunologist practicing his daily art at 8,000 feet altitude, from which may come significant inputs about how aerosols affect respiration. A very successful partial precedent exists. One feature of our agricultural program that led to U.S. preeminence—a virtual revolution in agricultural methods and productivity—was its contact everywhere at the working level. Local agents solved local problems; and so the system progressed to groups with national functions. We too have something of that extensiveness in mind. Having several NEL's—perhaps four or five—will assist these purposes, while yet keeping strength in *all* environmental areas at each place. As a corollary to this, the NEL's would be in much closer communication with each other than any existing national laboratories are now accustomed.

Both these sensing functions and the size of the tasks to be done bespeak large laboratories, at least including their extensions. We do not have in mind exact numbers, but estimate that several thousand persons at or connected with each place will be necessary, making the

total NEL structure large (Bell Telephone Laboratories is the largest single R. & D. organization of this type, with about 15,000 employees total at several locations).

These estimates appear to differ from the recommendations both appearing in the NAS panel report on technological assessment, and suggested by bill S. 1075. However, the functions are similar; the chief difference is one of opinion of how much and what kind of skills are needed to do the job. Also, we imagine a number of activities partly inside NEL's that are presently being done elsewhere. (See some examples in section VI.)

As large as they are proposed, NEL's would still be small compared with the total R. & D. that is environmentally related—particularly with our view of what is the environment. Experience with smaller tasks suggests that the information gathering, processing, and evaluation function alone will occupy the time of several hundred people, and those tasks must be done inhouse if the right information connections are to appear.

We see the necessity for NEL's to take up at their own option many tasks which do not fall within the purview of existing research facilities. This will be particularly so in exploring new systems, examples to be given later. The discussion recalls another about whether the National Science Foundation with some 10 percent of the Nation's science to support could act as a "balance wheel." According to many it could not, without a larger piece of the action. Should we not then be even gloomier about a similar role played by NEL's vis-a-vis a much larger activity? We think not, because (a) with internal discretionary use of funds NEL's can have a large and prompt leverage; (b) their ability to communicate—not only in R. & D. activities, but also with all sectors of the Nation—gives them more visibility; subsection B-5 of section V develops these points.

NEL's must be large enough to protect themselves. We suggest a more-or-less equilibrium sized establishment; there seems to us (fortunately) no necessity for NEL's to start full grown, as Minerva from the head of Jove. It is the totality of tasks and other things that makes for large size as much as the size of many of the environmental tasks themselves. Thus, we can imagine smooth and mostly internal adjustments whereby environmental functions are grafted onto existing organizations. By way of example, the Argonne National Laboratory is now (December 1969) establishing an Environmental Center to focus on a number of its related activities; the Oak Ridge National Laboratory has for some time been directing about 10 percent of its effort (i.e., about \$10 million per year) to environmental problems of many kinds, as integral parts of its program. More of this later.

B. Where in the Government structure?—Given the size and general mission, we can make a case about where NEL's should be placed in the Federal Government structure. We come to much the same view as has the Congress, in proposing the Office of Environmental Quality and the Environmental Council. Differences exist, consonant with our estimates of larger size and role; but the intent being similar, we judge the differences easy to overcome. According to the NAS panel the system should:

* * * be conceived in the most flexible terms, with the possibility of restructuring its agenda and modifying its procedures, its assumptions, and even its location within government, as it learns from experience * * *

There must be a close relationship of the new organization to the President and the executive branch; and to Congress, both to it as a whole in an advisory capacity and to one or more congressional committees, preferably joint committees. A continuing substantive interaction of the NEL's with these bodies (and with many other sectors) is a fundamental condition for keeping issues lively and for a constant flow of ideas and information in all directions.

Our choice is for an independent commission (or authority); here is a summary discussion about a number of possibilities:

(1) *An extension of the President's Office, say through an enlarged OST.*—This is the form suggested in the NAS report, but there are objections for what we have in mind. First, such a large structure is not likely to sit comfortably in the role of a staff-advising function. The total 1970 budget for the Office of the President is \$34 million; this includes \$12 million for the largest organization (Bureau of the Budget) and \$2 million for the Office of Science and Technology. Second, the loyalty of such organizations is simple and undivided: political allegiance to the President. Third, Presidential allegiance seems to result in an emphasis of the advisory role and an avoidance of public controversy. In contrast, the Joint Economic Committee investigates military expenditures and the Interstate Commerce Commission regulates tobacco advertising. The Budget Bureau and OST tend not to engage in public disputation, but NEL's might need to do so.

(2) *A Congressional Bureaucracy.*—This mirrors similar objections relevant to a Presidential organization. (The total budget for the legislative bureaucracy is \$344 million for 1970; included here are the General Accounting Office, Government Printing Office, Library of Congress, et cetera. The more discretionary part is relatively small.)

(3) *An Intra-Departmental Agency or Bureau.*—Wholly inadequate. Simply, note the difficulties of the Food and Drug Administration, FWPCA, National Park Service, et cetera, with respect to funding, Civil Service requirements, and evaluation controversies.

(4) *An Inter-Departmental Committee.*—A relevant example here is the Federal Water Resources Council. Formal membership here consists of the Secretaries of the Interior, Army, Agriculture, HEW, and the Chairman of the FPC. In practice, it is dominated by two construction agencies, the Army Corps of Engineers, and the Bureau of Reclamation. One evidence of this dominance is funding: appropriations for participation in interagency studies by individual employees of the National Park Service, Fish and Wildlife Service, et cetera, is *through* the regional offices of the Corps and the Bureau. This is obviously a substantial way for an agency to influence evaluation.

(5) *An Executive Department of the Environment/Science/Natural Resources.*—We see three objections. First, this means directly competing with other Federal departments, and putting the NEL function in parallel with activities of other departments; we have in mind something more-or-less at right angles to them. Second, Departments must be responsive to "the President's program" if there are to be effective programs. Third, Departments are meant for executive action, and NEL's are not.

(6) *University Research Centers.*—Universities will play important roles in an NEL's activities, but their centers tend to exhibit the usual characteristics of little money and small-problem, single discipline,

dissertation type studies. This is partly related to the role of these centers as dispensers of money to individual professors. Of course, this doesn't mean incompetence—it means more than that the organizational form is inappropriate. The few larger centers run by universities (*e.g.*, the Los Alamos Scientific Laboratory, or the MIT Lincoln Laboratory) are either so remote that the question of their connection is not even an academic matter, to twist a phrase; or else the relevance of such a large enterprise to the educational program comes sharply in question.

(7) *Foundation or Research Corporation*.—Resources for the Future is at least as relevant here as the RAND Corp. This would be second choice. The positive reasons are those given below for the independent agency or commission. The logic for placing this form second is that an independent government organization is more likely to receive the necessary large-scale public funding.

(8) *An Independent Agency or Commission*.—This is the first choice; in our view it is the logical extension to larger scale of the NAS panel and congressional views. A body like this has the opportunity to interact at many levels with all branches of the Government, and with other sectors. It can connect well with the Congress, yet also be sufficiently close to a sympathetic administration, as AEC experience has shown. It can handle large projects, and provide the necessary internal environment wherein honest work of more-than-ordinary public value will flourish. Individual initiative, competence, and scientific and social responsibility are needed everywhere, but particularly in NELs. We have no doubt that these qualities can be achieved, and will make specific suggestions later. Very importantly, the Commission or agency provides for independent funding—independent of those whose interests will be affected by any outcome of an NEL's activity.

In choosing between a National Environmental Commission and a National Environmental Administration, we opt for the former. Very simply, it is more likely to have public defenders in and out of Congress, and more likely to acquire the needed scientific breadth.

As with the Council of Environmental Quality plan (and consistent with current legislation), we suggest that several commissioners be nominated by the President and approved by Congress. That is as the AEC, but from here on we envisage a different arrangement in detail. The commissioners should act as a board of directors; there is a modest staff in Washington to fulfill the many informational functions, and to provide proper connection with Congress, the executive branch, and so forth. But responsibility for actual management of the research and development, which is required for effective environmental plans and alternates to emerge, would reside more with the Directors of the Commission's own laboratories. This responsibility includes the one of sub- and joint-contracting with others as necessary to form cooperative groups.

With this arrangement fits naturally our earlier stated rubric about each NEL (and the NELs acting together) having large discretionary power in arranging its program, within the limit of appropriated funds. On a more general note, too rigid control never works well for such tasks anyway: if the qualities of the controlees was such that the control was needed, the wrong people were put on the job and nothing much will be created; if the putative controlees

have the qualities most needed in an NEL, they are the best ones to assume important programmatic roles. In effect, choosing the team establishes de facto the trust.

These last remarks touch upon the problem of obtaining the most capable persons for an NEL, which should have more than its pro rata share: persons with much amiable ferocity, as we shall see in the next section. In our own opinion, the programs of an NEL will be themselves inducement, but more is needed. Thus arise such touchy questions as whether NEL's should be under civil service, run as contract laboratories, or something else (as TVA, for example). Our choice from personal experience would be for noncivil service laboratories, because (1) they can compete better for the best people; (2) there is less de facto tenure and less bureaucracy; (3) we envisage exchanges between NEL's, universities, and industry, and a number of other activities (described later) that would be hard to imagine taking place in a civil service arrangement. Certainly there should be no sinecures in NEL's, nor automatic longevity, nor too-fixed arrangements. In this philosophy and method is needed some of Harry Truman's aphorism "if you can't stand the heat, keep out of the kitchen."

We discuss some internal arrangements of an NEL in the next section.

V. FUNCTIONS AND CONTENT OF NEL'S

Having essayed an analogy at the start of section IV, we try another.

In a university, traditional departments of history, chemistry, law, and so forth, divide the organization into parallel paths; faculty find their careers in them, and students study the particular curricula. In this model, there is no formal mechanism for discovering connections between departments. To rectify the deficiency and stimulate desirable synergistic effects, interdepartmental centers (or laboratories, or whatever) have been established, and their number is growing rapidly. For the most part, these centers have been very successful, having found rich profits in the act of connecting one field with another: electrical engineering to physics, to create much of modern electronics; modern computers to meteorology, to make possible accurate realtime weather prediction; nuclear physics to geology and archeology to fix dates. The key concept here is establishment of cross-linkages, so that the system is woven together in useful ways. University departments do not die this way, but tend to live more fully.

This sort of grid system exists to some extent now in the Federal administration. Departments have missions, and a number of agencies—the Bureau of the Budget, the Office of Science and Technology, and some others—act in an orthogonal and synergistic way. In this sense NEL's are meant to act: orthogonal to NAPCA, to NCAR, to FWPCA, to many others, making possible continually new and interdisciplinary cuts at national problems. This cross-linking idea appears sometimes explicitly, sometimes not, in what follows; but it is always present.

A. The population makeup of an NEL.—Different NEL's would tend to specialize on different sorts of tasks—perhaps one on how best to move people, goods, and services; another on maintaining qualities of the physical environment and its effect on health; a third on housing and urban problems. But all would have some common expertise.

We illustrate the need for such a makeup by considering just one problem with which we are familiar and that has some current notoriety: central station power for the future. We all surely agree that the problem can't be resolved without evaluating possibilities for nuclear and fossil fuel devices. Thus conventional power engineers, nuclear reactor engineers, also heat transfer specialists and such categories are needed. The problem also can't be resolved without consideration of how the waste heat (in the most modern plants still a larger amount of energy than all the electricity generated) is to be disposed of. Hence comes a requirement for experts on water and air resource. This might seem to make a tidy package, but the problem size hasn't yet appeared. Perhaps the reader imagines us about to turn eyes on the indirect and direct costs of strip mining for coal, or on radioactive effluents from nuclear fuel reprocessing plants, or on the necessity for knowing about future long-distance power transmission

costs (which help determine whether to put the power plants near or far). And so we do, and perhaps the reader thinks those extensions are enough.

Not so; reflect upon what follows. Power economists in England point out that the average United Kingdom use of all central station plants is about 50 percent (because of reserve capacity for peak loads, some old units saved for emergencies, et cetera). But in London the average use is about 33 percent, caused by high workday demand and low demand at all other times. Old powerplant sites in London are small. An economic study made on this basis would show that the future requirement is for small low capital cost (per unit of power) plants. Fuel cost would be secondarily important.

Maybe this is the correct solution, but maybe it is totally wrong. Land is cheap for a powerplant compared to the plant cost itself, even in London. What about the alternate scheme of one or a few very large plants with low fuel and operating cost? Off-peak power could be made very cheap—perhaps free to some classes of users and attractively cheap to others. That kind of power policy could be used to stimulate an entirely different approach to the inner city problem of London. And where was included a host of purely sociological problems—for example, the very real one that some communities just will not permit the powerplant to be built inside their boundaries, irrespective of all arguments?

Then what is the policy to be? We face the future with less certainty than before; we need demographers and other social scientists, economists working on larger issues than economics of central power systems alone. And what about this; the need for intelligent forecasts of whether the combinations of pollution by automobile engines and cheap electric power are likely to lead to acceptable electric transport systems; thus our problem connects with many others.

One example surely suffices. By induction, we see the need in NEL's for—

(1) Natural scientists—ecologists, physicists, biologists, chemists, geologists, and so forth.

(2) Engineers—civil, mechanical, electrical, chemical, nuclear, and so forth.

(3) Mathematical scientists—statisticians, applied mathematicians, computer scientists, and so forth.

(4) Social scientists—economists, demographers, political scientists, psychologists, urban planners, lawyers, and so forth.

(5) Specialists and generalists in communication and transfer of knowledge.

In the penultimate category above, there is a special need for developing methods of quantifying esthetic values insofar as possible—whether to do or not to do some technical thing depends in part on factors describable technically and in part on factors that many persons feel but cannot yet quantify. Success so far at quantifying economics and demography leads us to expect that more can be done. Even the putting of things in order of preference would help the resolution of many problems.

In the last (fifth) category above, we recognize that this entire activity requires for its success that people grasp what is happening, and what are the options. Very often it is not factual invention, but

awareness and concern in the right places at the right time that are needed. For large environmental problems that concern all, there are no inappropriate places or times for presenting thoughtful appraisals.

No such grouping for purposes we have in mind now exists in the United States. For the most part, exact and social scientists and engineers to whom the proposition has been put are much attracted by these broader possibilities; this is particularly so for more active and capable persons.

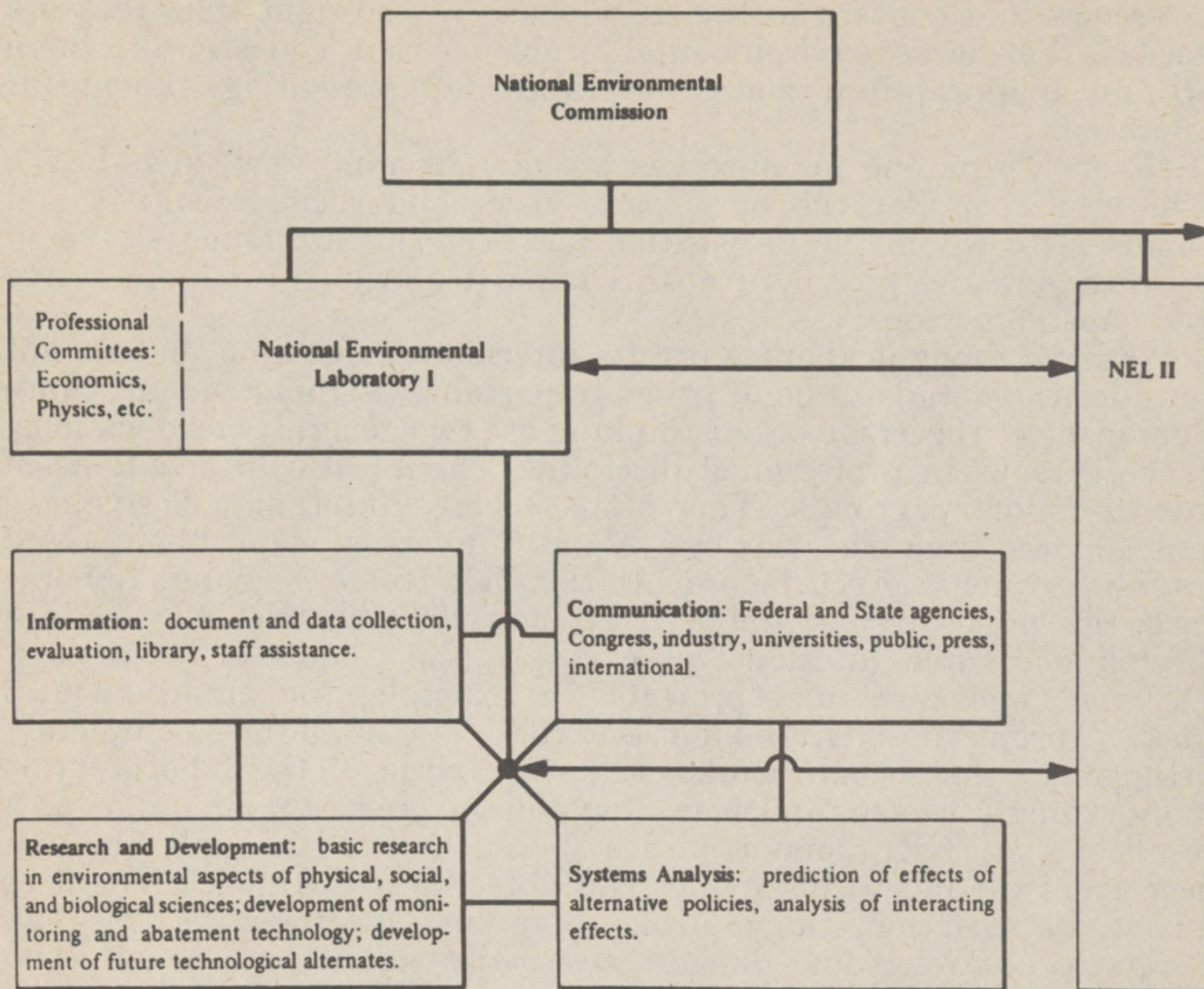
We have thought about a precise internal organization, but do not consider the details to be of prime importance at this moment. More significant at this stage of our thinking are two general considerations:

(1) Persons in professional disciplines should also be members of interdisciplinary groups. This is to achieve internal cohesiveness, and follows from the analogy about university departments and interdepartments given before. At the Oak Ridge National Laboratory, this philosophy is practiced extensively; a chemist may be in a discipline-oriented division (for example, the Chemical Technology Division) and also in a project (for example, the environmental quality project); even though the roles are often not completely orthogonal, the scheme works well; the fabric of the laboratory is more strongly woven, and many have discovered new directions as a result. In an NEL, opportunities for such activities will abound, because of the mix of disciplines and objectives: the nuclear engineer mixed up with long-range urban planning, for instance. We can recognize but overcome dangers classically stated¹² about all this; those who immerse themselves wholly in narrow channels should seek careers elsewhere.

(2) The organization should be kept quite flexible internally, echoing previous remarks about the external setup.

B. Method of Working.—We find it convenient to describe five broad categories of functions: programmatic perception, information gathering and processing, systems analysis, technological research and development, and communication. The schematic diagram on page 20 serves as a basis for discussion, but the parts are more connected than any diagram permits. The reasons why it is not possible to separate such activities as information gathering, information processing, modeling and technical abatement functions are straightforward. In fields as this, the data are not reducible to simple laws as (for example) in physics. At the same time, we are not looking for single solutions attainable by linear programming technique, but grid solutions (if you will) that have many parts, and feed back to many other parts of the problem input. Thus, insight comes by manipulating large amounts of information, searching for correlations, making computer models of what is thought to be happening, et cetera. These models accept large amounts of input data (e.g., pollution sources); predict observables (e.g., air quality at various places and times); seek out responses (e.g., of lichens or other monitor organisms); and when sufficient beneficial coupling of this sort is had with the real world, there comes understanding. The functions cannot really

¹² Matthew 6: 24: "No servant can be slave to two masters; for either he will hate the first and love the second, or he will be devoted to the first and think nothing of the second. You cannot serve God and money."



Proposed Functional Structure of National Environmental Laboratories.

be separated. By the same token, abatement technology must be developed in the presence of these interactions; how else can the cure be assessed?

1. Programmatic Perception.—Who sets the goals? In the end, the Congress and the executive branch establish the most basic goals: even here we have in mind that NEL's can perform a ubiquitous advisory function. But we mean the question here to refer more to the goals at the next step of particularity: what methods, what alternates, what costs? We suggest that perception of these still major tasks be done jointly by the NEL's, their Washington administration, and the main Government branches. The internal NEL contribution to this activity should come by way of informal discussion and formal committees: committees containing systematic ecologists, economists, chemists, power engineers, and so forth. The system has worked well for universities and for all branches of the Government for a long time. There must be large inputs to and from the public and other sectors, and ample opportunity for all to be heard. We see little need for or value in privacy or bureaucratic classification.

No ordering of priorities will satisfy everyone; there will be for a long time more problems needing attention than there is attention to give. All we can hope for is the most informed judgment on which questions are needier (or riper) for solution than others, because of either scientific, technological, or social changes—usually a combination of these.

The "perception" activity then combines both senses of the term priority: (a) importance in a sense of fundamental or urgent practical need (Weinberg's internal and external criteria of choice), and (b) time phasing of operational steps (for a combination of scientific, logistic, and organizational reasons). Judging both kinds of priority, of course, depends on maintaining updated sources of information, with particular emphasis on continuing scientific assessment of whether or not data are good (or sufficient), whether the problem has to be changed, whether the earlier tentative evaluations of the problem (which of necessity had to be partly intuitive) were being confirmed or not, and so forth.

If enough workable alternates are to be prepared that the actual course of future events is likely to be covered to some extent, then many must be started and carried a little way at little expense for each. Most will be dropped early, fewer at intermediate stages, and even fewer carried to serious developmental stages. Even so, that number is expected to exceed substantially the number generally adopted. The whole process is not cheap: Only cheap compared to the cost of no good alternates; this continual perceptive evaluation is an obligation of all the capable persons involved.

Incidentally, the activity is a good example of opportunity for interdisciplinary cross-linking within an NEL, and for connection with other organizations—especially those whose prime responsibility is in relatively narrow areas of the environment, and whose activities include regulation.

2. Information Gathering and Processing.—This is the scientific sensing part of the NEL. It must be able to measure things, as we have said: Pollution of air, water, land; such things as transport of nutrients into and out of forests, to find in advance about what it really would mean to apply lots of fertilizers in silviculture; examples abound. We see chemists, meteorologists, and other basic disciplines involved—not just in monitoring, but in predicting, testing predictions, and so forth.

The largest information gathering function of an NEL is not its own measurement program, however; it is the collection and processing of information gathered elsewhere. An NEL could aspire to do only some of the measuring. It would arrange to have interactive access to all sorts of activities proceeding elsewhere, and would stimulate a much-needed coordination. This requires quite new methods of obtaining, storing, correlating, recognizing, and retrieving information. There is thus both a measuring (and diagnostic) function, and a broader information handling function.

Expanded information processing is one of the new and essential features of an NEL. At present, for example, the Oak Ridge National Laboratory administers about half the AEC's information centers (on nuclear safety, atomic collisional processes, etc.) and about 15 percent of the total number with which the Federal Government has a working connection. Yet all that is as nothing compared with what is to come. Being at the crossroads of information flow is essential to an NEL.

To show only part of what is required, consider the example of a previous section: central station power for the future. Where are the data related to nuclear reactor safety? At ORNL's nuclear safety information center, at the moment, but they must be accessible to an NEL, and not just upon slow application. They must be accessible in some usable form to an NEL urban system modeler (for instance)

as an extension of his own intelligence and memory. Similarly available must be demographic predictions (some obtainable now from the Census Bureau) and useful data on many other things.

Extend this requirement to cover many fields (atmospheric condition, water quality in many places, etc.) to cover the need for servicing other NEL groups, for servicing outside groups, and for performing inhouse evaluation of data, and some measure of the task appears.

We visualize processing of information to be organized in a number of NEL's, and in a number of centers inside them. Each would be small enough so that its coverage can be comprehended by a few specialists (who are themselves working experts in the fields), and numerous enough for a systematic overlook of the environment. These centers will be connected in a network capable of drawing on as many as necessary to fill a request for service. Probably, nontechnical clients would be serviced by a single group, able to extract the necessary data from appropriate centers, and to present it in a form usable by the requester.

These activities pose great demands on our information processing and computerized library sciences—arts with which research groups are now engaged. Nevertheless, we believe the required methods can be developed; NEL's would play central roles in the development.

Related closely to this and the work of other NEL groups is the task of developing information necessary for various environmental quality standards, which we see as one of the prime functions. In a later section, we suggest the preparation of environmental indices (How is the quality of water here, or there?). Not much can be done without baseline studies of what is natural, and what is unnatural. To judge, for example, whether CO₂ from fossil fuels is accumulating in the atmosphere, one must have an estimate of the content in earlier times. Obtaining such baselines is not as simple as it may seem, with all that man has already done to the surroundings.

These activities are recommended in the NAS panel report. They say—

As a comprehensive information-management system, the center should be designed to support systematic inquiry into past and present assessment activities and findings, with emphasis upon identifying gaps in the resulting body of data and evaluation. The center would issue bibliographies, abstracts, project lists, and state-of-the-art summaries on its own initiative. It would also operate an inquiry service to answer appropriate questions directed to it by any government official or private individual group * * *

with which we agree, but opine that the task is larger than they thought.

Some of the R. & D. effort of an NEL and of the Nation are related to activities discussed in this section. Information gaps will appear; some data are so hard to obtain (e.g., idiosyncracies in human reactions to pesticides in ways not extrapolatable from animal experiments) that the underlying phenomena must be understood (e.g., biochemical mechanisms). This calls for fundamental research in fields related to the NEL activities.

3. *Systems Analysis*.—The activity relates both to the forward- and backward-looking faces of our Janus, and we intend it to be a principal mechanism by which disparate problems are reintegrated at the working level.

Most functions so far discussed have counterparts, albeit frequently inadequate, in the present matrix of efforts around the coun-

try. While we believe there is much more to be done along the lines outlined above, a main contribution the NEL can make is in an area where, so far as the environment is concerned, there has been only little and sporadic effort hitherto. This is an integrated view, by the methods sometimes referred to as systems analysis, of present and future problems, and of the alternatives for their solution. People responsible for this approach will strongly influence the selection of problems by the other groups in the laboratory, and should be closely associated with the laboratory management. They should be much more effective working in an NEL complex than in an isolated think tank, because of their close association with people knowledgeable about the details of what is going on in the environment and of what can be done about it.

Systems analysis will stress paper and computer studies, in contrast to process and hardware development. All seemingly feasible routes to a specified objective (as well as variations of the objective itself) will be examined. For example, abatement of sulfur dioxide pollution by removal from coal versus removal from stack gases versus long-distance power transmission versus substitution of nuclear fuel for coal, et cetera, would be measured against one another. Secondary impacts, and impacts further down the line, of the various alternatives would be considered.

This group will also be charged with attempting to anticipate future threats to the environment from new processes, products, and population trends. As well as possible, relative costs would be assigned; alternate paths of R. & D. would be suggested for adoption inside or outside the NEL. Hopefully, many difficulties can be avoided by early program modification, a topic discussed earlier.

In these works, there appears again the need to include as scrupulously as possible all the relevant inputs. This is no such simple matter as including all the atmospheric data (for some relevant problem). As the NAS panel says—

When a new and less costly building technique would disrupt the construction industry, one can rely on the opposition of those building interests that would be disadvantaged, but not on organized advocacy by residents of the ghetto who might benefit from cheaper housing.

In all such situations, a thorough consideration of the relative merits of alternate technologies is required, bringing in the diverse abilities of an NEL.

We make a few more remarks before leaving the topic. Not only are different technologies or technological fixes likely to appear, but also different methods of using present ones. These might include, for example, different ways of allocating radiofrequencies; or different ways of integrating the present parts of our transportation system.

These works of assessment can proceed quite well partly inside and partly outside the NEL. A good example comes to mind, not usually recognized as such. It is the multiple choice assessment that we discussed earlier and that is going on now about what central station power systems we will have in the future: fission breeders of what type, or fusion breeders of what type, possibly mixed with advanced fossil fuel burners. The whole activity covers reactor physics, plasma physics, materials sciences, economics; and also such things as alternate land uses, subjectively decided limitations on quality degradation, aspects of city planning. A chief difficulty with this particular

assessment is its hitherto uncoordinated nature, which speaks forte for focusing it, as in an NEL.

4. *Research and Development.*—Secretary of Interior Hickel was recently quoted as saying that water pollution in this country could be eliminated by the expenditure of \$15 billion over the next 5 years. Although such an expenditure is urgently needed to clean up aquatic faults, much more will be needed to achieve the desired harmony between man and his surroundings, both urban and rural. Even worse, only part of the knowledge required is in hand; therefore, the NEL must be concerned with research to develop new insights that are to be used to ameliorate the problems and design a better civilization.

Although a great deal of research is carried out in the United States on individual environmental problems, no single laboratory brings all aspects together. The central feature of a National Environmental Laboratory would be the uniting of people who are working in each of the environmental problem areas. The synergistic interactions induced thereby will produce more effective solutions to total environmental problems than are obtained in the absence of such an arrangement. It is important that these selected efforts be done in the vicinity of the other NEL activities, so that the desired synergism comes about.*

In the beginning especially, a large part of the NEL budget for research and development would be appropriated as a line item by Congress; in the spending much discretionary power should reside with the NEL director, as we said before. Other R. & D. funds would be obtained from existing Federal agencies having specific missions, and quite possibly from private sources, also.

Some criteria of suitability for internal R. & D. programs are: (a) The problem lacks integration—that is, no existing agency or organization has complete responsibility, (b) the NEL possesses appropriate facilities and expertise, (c) the problem is national and necessary, according to some agreed-upon judgment scheme, and/or (d) the problem contains important elements of diseconomy (thus tending to preclude its solution elsewhere, even if its importance is publicly advertised).

Some examples of suitable activity are given in section VI. To generalize again, a shopping list of activities could look like the Nation's shopping list. Our interest is that an NEL should know the Nation's shopping list relevant to environmental problems, and buy important items itself from time to time as necessary. An example not only of the benefit but also of the requirement for a synergistic laboratory comes from ORNL's present work: In connection with one project, a scheme (originally conceived in the U.S.S.R.) was developed for fracturing rock with high pressure water jets. This may have great effect on a number of other areas, because here may be a scheme for boring neat holes in almost any kind of rock quickly, cheaply, and safely. Given a novel method of excavation, entirely new possibilities are opened for urban and suburban transportation systems, as well as solutions to even more problems—underground utility corridors for instance.

* The Argonne Universities Association recently thought of establishing a socio-technological research organization ("Universities, National Laboratories and Man's Environment," report CONF-69075, Clearinghouse for Federal Scientific and Technical Information, NBS, U.S. Department of Commerce, Springfield, Va.) in the vicinity of the Argonne National Laboratory, but not a part of it and also not containing any genuine hardware divisions itself. In our opinion that would be a mistake, tending to divide environmental problems and possibilities, where reintegration really is required.

In the social science area, two areas of ignorance relating to environmental problems are immediately obvious and urgently require multidisciplinary research. One was noted earlier: the importance of nonmonetary values to technical questions. This means not only aesthetic questions (the type referred to in discussing power generation), but also the perception of various types of pollution health hazards. Very basic research is needed here. A second obvious social science environmental research need is decision-making in business and government relating to environmental quality. How does a utility management view sulfur dioxide emission? How does it respond to government regulation? What do managements do internally in response to conservationists' public criticisms? Clearly an understanding of relevant decisionmaking is essential to predicting the effects of alternative policies. Such research areas have the potential for substantial contribution by industrial and government personnel.

The required R. & D. is sometimes small, sometimes large; recall the fission-breeder fusion-breeder fossil fuel power system research going on now, mentioned earlier. Not all is at an NEL, of course. Here the concept must be recognized of developing systems to a stage of assessability, whereupon some may be dropped. This winnowing, even on the scale here proposed, is well understood in both public and private industrial sectors. In the late 1940's, the Bell system had to solve the problem of providing transmission channels having what was then immense bandwidth. As part of their systems research, the research department of Bell Telephone Laboratories developed components and built the first microwave relay link from New York to Boston, prepared to tear it down again if the scheme failed vis-a-vis others under development. So far must exploratory activities sometimes be carried.

5. *Communication*.—Maximizing the mobility of ideas is a guiding principle behind our plans: we apply it now to what could be called national and international relations.

We have in mind many informing and being-informed tasks related sometimes to the more mechanistic information-transfer tasks discussed in function (2) above; but usually we refer to something broader—a conversation at many levels and between many sectors about conditions, assessment, options, R. & D., and so forth. Thus we find, for example, schemes to introduce new programs into activity (1), and run a more integrated establishment.

A continual public dialog is required for many purposes—to make people aware of developing technologies and their effects, to provide for independent criticism and countervailing pressures, which latter can be a powerful balance on the activities of an NEL. To quote again the NAS panel:

Whatever structure is chosen, it should provide well-defined channels through which citizens' groups, private associations, or surrogate representatives can make their views known and, if insistent, be granted a hearing, though mechanisms should also be provided to filter out for summary treatment truly frivolous or irresponsible claims.

Mechanisms to stimulate these interchanges are:

(a) An annual report, as both suggested by the NAS panel and required by bill S. 1075.

(b) No security classification or privileged documents.

(c) Open hearings where any activity can be questioned.

(d) Public lectures.

(e) Substantial personnel interchange programs between NEL's internally, between NEL's and industry, universities, and other organizations, of which more anon.

(f) An aggressive policy of transferring technology to the public sector, through public communication, attitudes that encourage spinoff, and so forth, in addition to the traditional professional methods.

(g) A function (or section) concerned with advising the Congress and the executive branch of major possibilities and developments, and of responding constructively to requests.

(h) An active international program of exchanging information and personnel.

A recent example shows the depth at which this communication can be lacking. In Burlington, Vt., the AEC, the State of Vermont, and conservation groups confronted each other about the merits of installing a nuclear power station nearby. Our concern here is not with judging the merits, but identifying the elements of confrontation. In our opinion, at least some parts of the debate should have gone like this:

(a) The State wants stricter radioactive emission standards, because of general and specific considerations related to minimizing dangers not fully assessable, and perhaps other reasons.

(b) The AEC agrees with such sentiments, but points out a number of constraints:

(1) The reactor and general public would not be safer—probably less safe—because lower radioactive emission requires (for example) thicker fuel cladding, which brings other hazards, and so forth.

(2) Because of (1), the Federal recommendations to reactor manufacturers are as they are, and it is doubtful if manufacturers could meet much stricter radiation standards at present without falling afoul of these other important reactor problems.

(c) The State can then insist on lower radioactive emission if it wants, but may wait a long while until a reactor acceptable both to them and the reactor safety groups is developed.

(d) The alternates are:

(1) Buying power from outside.

(2) Putting up fossil fuel plants, but Vermont must realize that atmospheric pollution hazards exist which might seem less only because they have become so familiar; besides, increasingly strict emission standards are being set for that, too.

(3) No more power, a course that Vermonters might wish to adopt, considering Vermont's jewel-like qualities.

Unfortunately, many of the basic questions and options available to the participants seemed not to be fully understood by all parties. Some of this difficulty might have been avoided had the full consequences of each alternative been more fully developed, discussed, and understood.

What was missing? The developing nuclear power options *versus* other options should have been discussed years earlier at every appropriate level, instead of being handled as an afterthought.

Besides usual techniques for information transfer, we propose active cooperation and interchanges between working groups in a number of sectors:

(a) *Universities*: To oversimplify, the most basic and essential product of universities is people; of national laboratories, it is science, technology, and methods applicable to problems of national importance; the two organizations need each other for these complementary tasks. Thus, an increased flow of graduate students and faculty between universities and national laboratories serves two good purposes. First, it keeps the laboratory intellectually renewed and minimizes the danger of its becoming too fixed in population or outlook (these are very real dangers because national laboratories, unlike universities or industrial research laboratories, do not have natural places to which staff can "graduate"—the country as a whole or operating divisions of the corporation, respectively). Second, it keeps the university connected with long-range national problems in ways that cannot be simulated at any university in isolation from such a laboratory.

(b) *Industries*: There is much more enlightenment in corporate offices than some in universities or national laboratories will admit. We think that cooperative programs between an NEL and industries will produce benefits to both. Mutually satisfactory licensing and other financial arrangements should not be hard to find. Variations on the theme apply to industries likely to be regulated, or producing pollution control or sensing equipment. Experience teaches us that sub-contracts related to these cooperative tasks should be managed by the NEL that actually leads the activity, and not by a remote administration. We do not deem these cooperative measures in conflict with the principle that private industry be encouraged to find its own technical solutions whenever possible—not compelled to follow dicta.

(c) *Local, State, and Federal Agencies*: Cooperation with these bodies is already implicitly discussed in much of what has gone before. In addition, we point out that cooperative demonstration projects are valuable, especially to groups too divided to develop their own work (there are some 23,000 water utilities in the United States, most of them small).

(d) *International*: Assessments are not importable and exportable without second thoughts, because what is good here is not necessarily good there. But much of what an NEL does will be negotiable coin of the international realm; many actual or putative environmental problems are worldwide, and any promising approaches deserve propagation. We doubt that an NEL should act in more than an advisory capacity to any international regulatory body, for reasons already given.

VI. EXAMPLES OF ACTIVITIES

We intend not to reproduce here the Nation's shopping list of environmental and assessment imperatives, but rather to show some tasks that in our opinion are peculiarly suited to NEL's. Each contains considerable external diseconomies—a feature to be weighed when choosing what is best to work on. Note that diseconomies can be in time scale; the activity may be in the long-term national interest, but not yet justifiable industrially.

A. Environmental indices.—There is a public need to know how the environment is being maintained, in the simplest meaningful ways. Thus, environmental indices should be developed applicable to air, water, land, etc. Since such indices must be revised, the index bears a year designation. The index quantifies the state of local affairs in a way which can be intercompared with the previous local state, or the state elsewhere, and so forth. For example, the index can show a certain harbor has the lowest (worst) index in the United States, or that a measured improvement has occurred as a result of enforcement of new regulations regarding waste disposal along rivers that empty into it.

Parenthetically, consider the results of actually setting up an NEL in the absence of indices. A large amount of money is appropriated. A multiplicity of programs begins—but it is hard to see if anything is happening, partly because of the nature of slow changes. Even a successful program might then be jeopardized. With widely understood and respected indices, however, the problems and approaches come directly into focus, and merit can be measured in real terms.

An index may be a simple number (scalar), carefully defined to be suitable for a particular objective, where one objective or another prevails strongly in the intended resource use. For example, toxicity and concentrations of bacteria, viruses or radioactive isotopes may get over-riding emphasis where drinking water standards are crucial for health; but people will still be concerned with clarity, taste and odor. As the function changes (with respect to agriculture, industry, fishing, recreation and aesthetics), other measures of organic or inorganic content, heat and oxygen enter in different degrees. Unfortunately a multifactorial average or a simple sum may be misleading.

Where one overall number or simple derived average is clearly insufficient for the public interest, a more descriptive "profile" may have to be developed. But even here, it appears possible to coalesce many individual qualities into a few descriptive numbers. Like the Dow-Jones indices of railroads, industrials and average stocks, each is backed by technical and fundamental appraisals; and these are available for detailed study by those intending to make substantial environmental investments.

B. Estimating the direct hazards to man resulting from the introduction of chemical and physical agents into the environment.—An important responsibility of an NEL would be to develop biological assays that

will allow us to make a reasonable estimate of how hazardous a given insecticide, herbicide, food additive, and so forth, is for man and others. At present there is an incomplete arsenal of suitable tests, and they are somewhat haphazardly applied. One of the most striking weaknesses of current tests is that they are primarily geared to measuring immediate effects on the organism exposed to the agent, but make inadequate estimates of genetic effects that will be revealed only in later generations. It is important to develop a series of such tests that can be applied rapidly and routinely to agents that are being considered for widespread introduction into the biosphere. Since it is obviously not practical to do the experiments directly on man, our best approach is to run tests over a wide range of species and, when possible, human cells grown in culture. An NEL having scientists capable of handling a wide variety of living systems is a logical place (but not the only place) at which to carry out the development of these tests to detect immediate and delayed genetic effects of chemical and physical agents. If DDT had been run through such a battery of tests at the time it was being considered for introduction and use (or even in the 1950's), we might have been in a better position to make logical restrictions of its use for specific purposes.

A program of this sort relates well to establishing environmental indices, part A above.

C. Lead pollution from auto exhausts.—Topics can be large or small. This one is small enough and simple enough for all its main parts to be set down here; but (significantly) we have not seen it so laid out. Leaded gasoline leaves deposits inside automotive engines which cause increased emission of unburned fuel; that exacerbates the smog problem. Also, large amounts of fine particulate lead compounds in the environment is an unassessed hazard.

Lead-free premium fuel can be made at an additional cost of 2 or 3 cents per gallon. Switching formulas gradually would not particularly bother either the large petroleum refiners or the automobile manufacturers. If that were the whole story, we might well decide to switch not even bothering to assess in detail any more the leaded gasoline hazard: the fix is cheap. But there is more to the story. The additional aromatic hydrocarbons put into lead-free gasoline tend to exacerbate the smog problem and appear to be more hazardous to health than the other constituents. Thus, we define several interacting aspects:

- (a) The hazards of continuing lead pollution.
- (b) The hazards of aromatic hydrocarbons to gasoline handlers, and at low levels to the public.
- (c) The penalty (if any) of having engines use lower octane fuel.
- (d) The probability of entirely new engines becoming available, using different fuel.
- (e) Automotive emission control, including the possibility of requiring catalytic systems, and taking into account the fact that such control can be more effective in clean (lead-free) exhausts.
- (f) The need to conserve lead, whose ore reserves are rapidly diminishing.

The problem is not yet resolved, but very importantly it can be defined in terms of real tasks.

D. Power generation, transmission, and use.—We worked on this topic in earlier sections—fission power, fossil fuel power, fusion power—what kind? Will central station capacity really quadruple

(a million megawatts) in the next 20 years, as hitherto reliable sources predict? Where can they be put? Cheap electric power provides so much material affluence, yet by its ascendancy is becoming an important contributor to both the visible and invisible degradation of urban and rural environments.

The existing approach to the solving of this jigsaw puzzle has been to hand a few pieces to each of several agencies with highly intensive skills. The need for intensive skills in problem solving is unquestioned; but the picture cannot be reassembled by specialized skills alone.

Besides the subtopics of technical assessment (fission, fossil, et cetera), as seen from inside the plant, and demographic effects discussed in earlier sections, major subtopics are—

- (a) Effect of plant size and hence power cost on electric use, and the inverse;
- (b) Siting, and
- (c) Industrial development policy.

All of these interact. Enough flavor comes through if we list some parts of the siting subtopic:

(1) Direct costs of site, plant, delivered fuel, and power transmission.

(2) Internal costs of nonelectric products.

(a) SO_2 , NO_x removal, possible sale of byproducts (fossil plants).

(b) Ash or used fuel disposal.

(c) Radiation protection (nuclear plants).

(d) Heat dissipation (all but hydro plants).

(e) Possible beneficial uses for cities, enclosed agriculture, and so forth.

(f) Direct rejection costs to streams, ponds, wet cooling towers, dry towers, off-shore water.

(3) Off-plant considerations, good and bad.

(a) Compatibility with regional plans—for example, recreation use of buffer land, use of impounded water for navigation, effect on fish, social factors affecting urban development.

(b) Total cost of thermal, radiological, chemical pollution, with various degrees of effluent control.

(c) Total cost of mining (fossil and nuclear plants).

(d) Relative effects of surface, subsurface, and so forth, siting.

(e) Aesthetic costs (for example, scenery enhancement or degradation, historic factors).

(f) Preservation or nonpreservation of future options.

E. Integrated waste management systems.—Of all the kinds of waste, we choose in this brief entry to focus on sewage. The consequences of a policy that “dilution is the solution to pollution” becomes very expensive as soon as general abatement is required; the offending material must be recaptured from a great bulk of carrier. Usually, the less that waste diffuses into the environment, the easier can it be managed. What constitutes dilution must be delicately judged: garbage grinders in kitchen sinks dilute waste, which is partly reconcentrated at the sewage treatment plant. Thereby arise a complicated set of economies

(personal and of garbage collection services) and uneconomies (more difficult sewage treatment) as well as outright diseconomies.

The pace of process development has recently quickened, after long neglect. The return to society as a whole per dollar invested promises to be high—even small fractional savings on the tens of billions of dollars expected to be spent in the next decade are worth a lot of effort.

Directions preferred by the NEL would tend to be toward those processes which promise to help in a variety of problems. New techniques of general applicability and more general applications of older techniques tend to be neglected in the present allocation of support; a disproportionate fraction of resources goes into trying out particular hardware on the market. A few examples of areas suitable for NEL attention might be the new membrane processes, more imaginative use of older ion-exchange techniques, evaporation to dryness, or a combination of these schemes appropriate to the dilution stage in the treatment. Economic byproducts have occasionally been recovered from contemporary plants; much more can be done: potable water and useful material can be end products.

Development of new processes should continue to earliest stage of realistic evaluation. For schemes that look very promising, an NEL can perform a real service and reduce some substantial diseconomies by operating demonstration plants, for communities that could not themselves afford development costs.

F. Atmospheric Effects.—Substantial programs at ESSA, NCAR and elsewhere are now telling us much about how the atmosphere works in detail. These are important details: how the ozone layer at the top of the atmosphere acts to protect all things below from excessive solar ultraviolet radiation; how carbon dioxide contributes to a world-wide greenhouse effect; how small contributions of aerosols and particulates can alter earth's reflectivity and heat balance. These things an NEL—and all of us—should watch carefully, even if it does not directly participate in the programs.

NEL's can play synergistic roles here. For example, if a large fraction of earth's petroleum is burned, as some public policy apparently would have it, how will the carbon dioxide be distributed between air, water and other places? Are the consequences such that a different world policy about combustion ought to be considered? History shows such questions to be empty if no attractive alternates are available. So appear more factors affecting the priorities of technological development.

Another role suitable to an NEL is the interface between urban microclimatology, urban planning, and urban technology development. Urban areas are hot, rough, dry, and dirty compared with the surrounding countryside. They inject a multitude of pollutants into the atmosphere. At times a persistent closed circulation sets up in the air covering an urban area. Steep temperature gradients change the weather pattern, usually adversely. Can these problems be ameliorated sufficiently by pollution control alone? What may be needed also are urban designs with improved air circulation, more rational control of surface reflectivity and heat transfer, and perhaps development of technology that requires less energy to accomplish the same tasks as before—hence reject less heat to the surroundings.

G. Regional Activities.—The following example for ORNL must have counterparts elsewhere. The Southeast Appalachian area has a number of qualities: (1) in its present state, very beautiful; (2) salubrious climate; (3) well-watered; (4) large reserves of high-sulfur coal near the surface, now being strip-mined; (5) much empty space; (6) good potential for recreation; (7) high frequency of poor atmospheric diffusion conditions; (8) thin topsoil and easily eroded shale beneath, especially in the hills; (9) starting to be rapidly developed; (10) much poverty and need for some development. This is an explosive situation, particularly the combination of (4), (7), (8), and (9). Fortunately, the Tennessee Valley Authority has studied some of these problems and is actively concerned with environmental problems. Here is the chance for an NEL to interact with TVA, the Federal agencies, State and local governments, industry, and the public in making the best out of one of our National resources. Proper use involves broad social and economic considerations. Peculiar advantages of such an activity are (1) many input data already exist; (2) the problem is large enough (TVA-land for example) to be a real challenge and serve as an example, yet finite in extent; (3) there is a chance to add economists, demographers, and other social scientists to existing groups, making a smooth transition to a new activity; (4) there is a need now for the work.

Note that many of these activities would proceed partly inside, partly outside an NEL. Any or all could be presently undertaken at least in significant part by some present laboratories, if their missions were so defined. The ones we have described are too narrowly technical fully to describe the NEL concept: but that imbalance was predicted in section I.

These phrases reintroduce the question of how NEL's can be started, and we offer a further thought. Physical and social scientists have contributed their joint skills and feelings to a number of real problems—for example, urban decentralization—at our Laboratory. The experience has been excellent for all; the very act of interacting showed new and valuable directions to move. Therefore, we have come to believe that the interdisciplinary art, science and spirit for which we aspire will indeed flourish in a budding NEL structure. Then in a little while that group itself will tell us important things about our concepts. These are matters of belief, faith in an idea, and social purpose; we have no absolute answers. The concepts need some physical expression and practical working to be made more sure.

(S. 3410 follows:)

91ST CONGRESS
2D SESSION

S. 3410

IN THE SENATE OF THE UNITED STATES

FEBRUARY 6, 1970

Mr. BAKER (for himself and Mr. MUSKIE) introduced the following bill; which
was read twice and referred to the Committee on Public Works

A BILL

To establish a structure that will provide integrated knowledge and understanding of the ecological, social, and technological problems associated with air pollution, water pollution, solid waste disposal, general pollution, and degradation of the environment, and other related problems.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 That this Act may be cited as the "National Environmental
4 Laboratory Act of 1970."

5 "SEC. 2. (a) The Congress finds—

6 “(1) that the Nation is presently experiencing a
7 rapid deterioration of environmental quality;

1 “(2) that the environmental resources of the Na-
2 tion are finite;

3 “(3) that the demands of a growing population and
4 an increasing material standard of living will place an ad-
5 ditional burden upon the capacity of the environment;

6 “(4) that the optimum allocation and use of our
7 limited environmental resources will require the maxi-
8 mum use of scientific principles if the Nation is to re-
9 store and enhance the health, diversity, beauty, and
10 capacity of the environment for perpetuity;

11 “(5) that the development of technologies has often
12 created unintended ecological, economic, and social ef-
13 fects which have a profound impact on the environment;

14 “(6) that technologies must be assessed on a timely
15 basis in order to detect and predict the detrimental effects
16 these may have on the ecosystem, which includes man,
17 and that existing technologies must continually be re-
18 appraised to detect latent detrimental effects;

19 “(7) that the amelioration and prevention of en-
20 vironmental problems depend on a thorough understand-
21 ing of the complex interactions among the human, nat-
22 ural, and technological components of the ecosystem,
23 thereby requiring multidisciplinary research and anal-
24 ysis of the total environment;

25 “(8) that while the established departments and

1 mission-oriented agencies make valuable contributions
2 in specialized research and development, they lack au-
3 thority and organization to deal comprehensively with
4 the interconnected problems of the environment; and

5 “(9) that a complete and thorough understanding
6 of the ecosystem cannot be accomplished through frag-
7 mented application of specialized research and develop-
8 ment efforts, but rather requires a unity of effort and
9 emphasis which is focused on the restoration and en-
10 hancement of the total environment.

11 “(b) The Congress declares—

12 “(1) that in the interest of restoring and enhanc-
13 ing environmental quality it is necessary to establish an
14 organization with sufficient professional breadth and
15 scope to provide a unified and systematic approach to
16 its area of concern; such organization to complement
17 those agencies presently dealing with various aspects of
18 the environment; and

19 “(2) that the organization will conduct research,
20 development, and analysis of environmental problems,
21 which will include (A) data collection, information
22 storage and dissemination, data analysis and synthesis,
23 development of methods and devices, education and
24 training, and environmental policy analysis; (B) the
25 formulation, development, testing, and demonstration of

1 alternative solutions to environmental problems for con-
2 sideration by policymakers; and (C) the performance of
3 any other functions necessary to provide for the restora-
4 tion and enhancement of the environment.

5 "SEC. 3. There is established at the seat of government a
6 National Environmental Laboratory and a Board of Trustees
7 of the Laboratory (hereinafter referred to as the 'Laboratory'
8 and the 'Board') whose duty it shall be to maintain and ad-
9 minister the Laboratory and site or sites thereof, and to exe-
10 cute other functions as are vested in the Board by section 4.

11 "SEC. 4. (a) The Board shall be composed of nine mem-
12 bers as follows: (1) the Vice President; (2) the Chairman
13 of the Council on Environmental Quality established by
14 Public Law 91-190; (3) the Director of the Office of Sci-
15 ence and Technology; (4) the Director of the National Sci-
16 ence Foundation; and (5) five members appointed by the
17 President from the public, by and with the advice and con-
18 sent of the Senate. Not more than three of the public mem-
19 bers of the Board may be members of the same political
20 party.

21 "(b) Each Member of the Board specified in clauses 1
22 through 4 of subsection (a) of this section may designate
23 another official to serve on the Board in his stead.

24 "(c) Each member of the Board appointed under clause
25 5 of subsection (a) of this section shall serve for a term

1 of six years from the expiration of his predecessor's term
2 except that (1) any such member appointed to fill a va-
3 cancy occurring prior to the expiration of the term for which
4 his predecessor was appointed shall be appointed for the
5 remainder of such term, and (2) the terms of office of such
6 members first taking office shall begin on April 24, 1970,
7 shall expire, as designated by the President at the time of
8 appointment, one at the end of two years, two at the end
9 of four years, and two at the end of six years. No member
10 of the Board chosen from private life shall be eligible to
11 serve in excess of two terms, except that the member whose
12 term has expired may serve until his successor has qualified.

13 “(d) The President shall designate a Chairman and
14 a Vice Chairman from among the members of the Board
15 chosen from the public.

16 “SEC. 5. In administering the Laboratory, the Board
17 shall have all necessary and proper powers which shall
18 include, but not be limited to, the power to—

19 “(a) establish regional national environmental lab-
20 oratories not to exceed six in number with the geo-
21 graphical distribution of any such regional laboratories
22 determined by environmental criteria, and if the Board
23 determines it is feasible to initiate any regional Na-
24 tional Environmental Laboratory through the transfer

1 of certain research functions and facilities of existing
2 national laboratories of the Atomic Energy Commis-
3 sion or any other Federal agency, the Board shall rec-
4 ommend to the President that such functions and facili-
5 ties be transferred to the Laboratory;

6 “(b) establish broad policy directions for the Lab-
7 oratory as determined from an analysis of the social
8 and environmental priorities established by the Congress,
9 the executive branch, and the private sector;

10 “(c) solicit, accept, and dispose of gifts, bequests,
11 and devices of money, securities, and other property of
12 whatsoever character for the benefit of the Labora-
13 tory, and any such money, securities, or other property
14 shall, upon receipt, be deposited into a special fund ad-
15 ministered by the Board for the purposes of the Labora-
16 tory, and the source, amount, and restrictions of any
17 gift, bequest, or device of money, securities, or other
18 property in excess of \$5,000 fair market value shall be
19 included in the annual report required under section 10;

20 “(d) obtain grants from, and make contracts with,
21 State, Federal, local, and private agencies, organiza-
22 tions, institutions, and individuals;

23 “(e) acquire such site or sites as a location for the
24 Laboratory or regional laboratories;

25 “(f) acquire, hold, maintain, use, operate, and dis-

1 pose of any physical facilities, including equipment, nec-
2 essary for the operation of the Laboratory;

3 “(g) appoint and fix the compensation and duties
4 of a General Manager and such other officers of the
5 Laboratory as may be required. The compensation of the
6 General Manager and other such officers shall be fixed
7 without regard to the provisions of title 5 of the United
8 States Code governing appointments in the competitive
9 service and chapter 51 and subchapter III of chapter
10 53 of such title 5; and

11 “(h) appoint and fix the compensation and duties
12 of a Director, or Directors and such other officers of the
13 Laboratory to administer any regional laboratory, or
14 laboratories, established pursuant to subsection (a) of
15 this section; and such Director or Directors may be ap-
16 pointed and compensated without regard to such pro-
17 visions of title 5.

18 “SEC. 6. Any Director appointed under clause (h) of
19 section 4 shall be responsible for the management and devel-
20 opment of the regional laboratory for which he is appointed
21 and for the research program that such laboratory conducts,
22 subject only to the broad policy directions provided by the
23 Board pursuant to subsection (b) of section 4.

24 “SEC. 7. The Board shall, in connection with acquisi-
25 tion of any site or sites, as provided for in clause (e) of

1 section 4, provide to businesses and residents displaced from
2 any such site or sites relocation assistance, including pay-
3 ments and other benefits, equivalent to that authorized to
4 displaced businesses and residents under the Housing Act
5 of 1949, as amended. In providing such relocation assistance
6 and developing such relocation program the Board shall
7 utilize to the maximum extent the services and facilities of
8 the appropriate Federal and local agencies.

9 "SEC. 8. The Board is authorized to adopt an official
10 seal which shall be judicially noticed and to make such
11 bylaws, rules, and regulations as it deems necessary for the
12 administration of its functions under this Act, including,
13 among other matters, bylaws, rules, and regulations relating
14 to the administration of its trust funds and the organization
15 and procedures of the Board. A majority of the members
16 of the Board shall constitute a quorum for the transaction of
17 business.

18 "SEC. 9. (a) There is hereby authorized to be appro-
19 priated to the Board \$50,000,000 for each of five consecutive
20 fiscal years beginning with the fiscal year ending June 30,
21 1971, to be deposited in a fund (hereinafter referred to as
22 the "Special Trust Fund") for the perpetual maintenance
23 and support of the long-term research activities of the Labora-
24 tory. It shall be the duty of the Board to invest such fund
25 only in interest-bearing obligations of the United States or

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1 in obligations guaranteed as to both principal and interest by
2 the United States. For such purpose such obligations may be
3 acquired (1) on original issue at the issue price, or (2) by
4 purchase of the outstanding obligations at the market price.
5 The purposes for which obligations of the United States may
6 be issued under the Second Liberty Bond Act, as amended,
7 are extended to authorize the issuance at par of public-debt
8 obligation for purchase by the Special Trust Fund. Such ob-
9 ligations issued for purchase by the Special Trust Fund shall
10 have maturities fixed with due regard for the needs of the
11 Special Trust Fund and shall bear interest at a rate equal to
12 the average market yield (computed by the Secretary of the
13 Treasury on the basis of market quotations as of the end of
14 the calendar month next preceding the date of such issue) on
15 all marketable interest-bearing obligations of the United
16 States then forming a part of the public debt which are not
17 due or callable until after the expiration of four years from
18 the end of such calendar month; except that where such aver-
19 age market yield is not a multiple of one-eighth of 1 per
20 centum, the rate of interest of such obligations shall be the
21 multiple of one-eighth of 1 per centum nearest such market
22 yield. The Board may purchase other interest-bearing obli-
23 gations of the United States or obligations guaranteed as to
24 both principal and interest by the United States, on original
25 issue or at the market price only where it determines that the

1 purchase of such other obligations is in the public interest.
2 Any obligations acquired by the Special Trust Fund (except
3 public-debt obligations issued exclusively to the Special Trust
4 Fund) may be sold by the Board at the market price, and
5 such public-debt obligations may be redeemed at par plus ac-
6 crued interest.

7 “(b) In addition to amounts appropriated pursuant to
8 subsection (a) there are authorized to be appropriated such
9 sums as may be necessary to carry out the purposes of this
10 Act: *Provided*, That not to exceed \$200,000,000 may be
11 appropriated for the use of any one regional laboratory estab-
12 lished pursuant to subsection (a) of section 5. Such sums
13 appropriated under authority of this subsection shall remain
14 available until expended.

15 “SEC. 10. The General Manager of the Laboratory shall
16 transmit annually to the President and to Congress a report
17 which shall set forth, but not be limited to, (1) the audit
18 reports required under subsection (a) of section 10 of this
19 Act, (2) bibliographies, with annotations, of research per-
20 formed, and (3) a description of ongoing research programs.”