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Guidelines of the Council on Environmental Quality for the Preparation of Environmental Impact Statements

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Definitions and the seven principles of ecology are listed. NEPA expresses or implies all seven. Section 101 is quoted in illustration. CEQ Guidelines implement Sec. 102(2)(C). The reasons for initial delays in implementation are reviewed; these are now largely resolved. The policy involves action through integrating engineering, economics and ecology. Alternative actions must be considered, and short-term effects weighed against the long-term goals. Twelve modes of approach are advocated.

This conference is naturally of vital concern to those of us on the Council on Environmental Quality, because it is with us that the responsibility resides for working with agencies to improve the process of environmental impact analysis. Therefore, I am glad to be here to share some thoughts with you about how to implement the CEQ Guidelines. I have demonstrated in my professional work as an ecologist for a decade and a half that the principles and processes evolving from this science hold a significant key to the demands placed on us by the National Environmental Policy Act of 1969.

Before proceeding further, I believe it would be helpful for us to define a few basic terms of reference, about which I find people frequently are not clear.

Environment is generally the sum total of what surrounds man. More specifically, as used in ecology, it is the composite of physical and chemical features of the life support system—climate, geology, water, etc.

Ecology is the science that examines the interrelationships that operate among the components of the life support system. It is a fairly old and composite science, integrating elements of the physical, geological, chemical, biological, engineering, social and other sciences.

Ecosystem is any discrete unit of the landscape; it is composed of environment factors, biological organisms, and the processes—inputs, outputs, sinks, feedback loops—that operate among the components.

Environmentalist (conservationist) is any person who has an interest in the concern for the health and longevity of earth's ecosystems. Their backgrounds are as diverse as man himself.

Principles of Ecology

To focus the data base of the science of ecology as practiced in the 1970's on NEPA

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and the CEQ Guidelines requirements I would like to give what are considered the seven basic principles of ecology.

Interrelationships

First, and of primary importance: *everything on earth affects everything else, directly or indirectly.* Nothing operates in isolation. The best example of this principle in operation is that fact that DDT and radionuclides have been found in the tissues of all organisms tested to date, even in flightless Antarctic penguins that must obtain these substances from outside the Antarctic Continent, since neither have been introduced to that continent. Therefore they travel to penguins through a series of food chains.

Ecosystems and Niches

The earth is covered with a vast array of ecosystems, large and small. They also interact with each other.

Within these systems, each type of organism has a role to play—a "niche." To man, these roles of other organisms are sometimes detrimental, negligible, or obscure, but research demonstrates that they are nevertheless significant in the total functioning of their systems.

A prime example is a cypress swamp bordering the Savannah River between the Atomic Energy Commission plant and the river, which was considered negligible in usefulness to man until recently. Research of the material flow pattern in that swamp showed that, under the specific conditions prevailing (long undisturbed system with water pH 7), kaolinite of the soil was absorbing all the ^{123}Cs being released by the plant. Therefore, cesium did not reach the river, unless the pH balance was changed by adding small quantities of nearby well water, which released cesium from the kaolinite into the river.

Material Cycling and Energy Flow

Chemical substances in ecosystems cycle through and among systems at varying rates. For this reason they are available for reuse in geologic or shorter time. Conversely, energy follows a one-way downhill path, sometimes circuitous. But energy is always dissipated eventually as heat.

Limiting Factors

Within all ecosystems, specific features of the environment interact with the genetically controlled nature of the organisms to restrict or limit the functioning of these organisms. The operation of these interactions defines the operating parameters of that system and the organisms within it. Frequently a constellation of physical and chemical factors interact with a group of species to describe the limiting factors of the system.

Carrying Capacity

The composite interactions of environment factors and organisms comprise a dynamic optimum operating budget that the ecologists call the ecosystem's carrying capacity. This principle also operates in engineering systems, where transmission systems are designed to carry a given electrical load and in computers, which are designed to carry a given information load. Engineers are familiar with what happens to these latter systems if these loads are exceeded: they cease to function properly or productively. So it is with ecosystems, but because they are living they have a bit more dynamic resilience. They may not indicate that the carrying capacity is exceeded until the actual point is well past in time, numbers, and balance.

Ecosystem Development

Over geologic time, ecosystems pass stages of development from especially simple systems on biologically naked surfaces of rock, sand, or water through progressively more complex systems until stable permanent highly complex system is reached. Processes exist for healing various naturally occurring ecosystem disruptions, such as fire, landslide, insect infestations. These processes also can heal perturbations introduced by man, espe-

cially when the perturbations are introduced in a manner that complements or is integrated with existing processes. But if processes are introduced that are diametric to existing ecosystem processes, they can be as toxic to ecosystem operation as cyanide to the human system.

Specialization, Diversity, Stability

These ecosystem development processes result in increased numbers of species inhabiting a system. This absorbs the existing ecological roles (niches). Competition for air, water, food, space, brings increase in specialization, creating added niches. This increase augments diversity. As in economic and social systems, diversity creates stability by dampening the influence of any perturbation in the system. Therefore the simpler the system, the more responsive to perturbation; the more diverse the system, the less responsive to perturbation. One can see this in experiences with ice storms in the Southeast in the winter of 1973. Natural forests sustained breakage proportional to their inclusion of those trees that had brittle wood. Plantations of long-leaf pine sustained far more breakage because of their homogeneity for brittle trees, coupled with long needles that held considerable ice.

The National Environmental Policy Act

What does all this have to do with NEPA? The National Environmental Policy Act was spawned and nurtured in part by ecologists and related scientists whose knowledge of the operation of these principles in the world's life support systems led them to recognize accelerating trends of ecosystem deterioration. This recognition caused them to voice their concerns and supportive facts to appropriate Congressional committees.

It is highly significant to me that four of the above seven ecological principles are clearly stated in Title 1 of NEPA, where the policy and how to implement it are stated. The other three are implied there. Let us examine Title 1, Section 101, for it is the cornerstone of the CEQ 102(2)(C) Guidelines:

> The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (P.L. 91–190, Section 101(a))

To implement this policy, the Congress establishes it as

> . . . the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may: (1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations; (2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings; (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesireable and unintended consequences; (4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice; (5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and (6) enhance the quality of renewable resources and approach the maximum attainable recycling of de-

pletable resources. (P.L. 91–190, Section 101(b)).

The CEQ Guidelines for Measuring Agency Implementation of the National Environmental Policy Act

The renowned NEPA Section 102(2)(C) provides a mandatory avenue for Federal agencies to measure the degree to which they have succeeded in implementing the NEPA Title I on "proposals for legislation and other major actions that can significantly affect the quality of the human environment." This calibration is in the form of Environmental Impact Statements. Delays in projects in a wide variety of stages of accomplishment were experienced especially in mid-1971 to late-1972 for five major reasons.

(1) It took time for agencies to determine how to apply NEPA to their actions, even with the CEQ Guidelines and other assistance in EIS preparation.

(2) NEPA did not provide a "grandfather clause"; therefore it applied (and still does) to all Federal actions in all stages of planning, design, development, and operation.

(3) NEPA did not provide additional money and manpower to agencies for the achievement of its mandate.

(4) Many agencies tended to treat NEPA as not applicable to their specific activities, so resisted CEQ and other efforts encouraging and requesting compliance.

(5) Lack of action by agencies led to numerous famous class action suits brought by concerned citizens across the Nation, which consumed time, money, manpower, and human energies.

Now, after almost five years of working with NEPA, significant progress has been realized in reducing delays on all these points, due to the better, more skilled operation and application of the NEPA EIS process. Many agencies have come to realize numerous advantages from application of the EIS process to their planning and decision-making procedures. They are more willingly and understandingly developing their own methods for environmental impact analysis. A majority of projects in existence pre-NEPA have been carried through the EIS process. This provides a clean slate for agencies applying the EIS process to projects conceived post-NEPA. In these, the EIS process can be integrated with the economic and engineering plans from the very outset. Also, agencies have been able to reorganize and to fund the additional time and manpower. The sizeable court record of the past four years leaves no doubt as to the applicability of NEPA to activities of all agencies.

As with any complex reordering of societal priorities and activities in a nation, the processes attendant to it appear somewhat chaotic and disruptive during the reordering. But the end result is an orderly and sizeable progress toward a long-desired societal goal. So it is and will be with NEPA.

With this initial period of confusion largely behind us and with a new set of EIS Guidelines for this all-important evaluation of changes anticipated in ecosystem functions from specific Federal actions, this is an opportune time to pause and question: "What is the most productive meaningful way to accomplish this national environmental policy?

Primary in the eyes of the Council is thinking environment, just as we think economics and engineering. This takes form in an early start on developing environmental data and integrating it from the outset of project conception, through exploration, planning, design, development, operation, and phaseout. NEPA did not create another "permit-filing syndrome." It requested everyone in the country to "stop, look, listen, and redirect" his actions so that man's actions could harmonize with his ecosystem, as a skilled hand slips adroitly, gently, smoothly into a glove, with little or no disruption of either the hand or the glove.

How can we do this? The device was invented by an eminent engineer with whom I once had the privilege of working. It is called the "3E's tripod." One leg stands for engineering, one for economics, and one for

ecology. With a tripod, all legs must be present, functioning, and used to make the "sighting operation" operable and valid.

A functional plan or project cannot emerge in any walk of life if one integral component of it remains undeveloped or inoperative throughout the period of its applicability. And yet some agencies continue to insist that they cannot apply the NEPA EIS process until their planning, design, and budgeting are complete. "It would be wasted effort," they say, "to undertake the EIS process until just previous to sending legislation to the Hill, after OMB has cleared it."

Let's analyze this statement in view of the science of ecology, the 3E's tripod, and just good common sense.

First, to gather data on ecosystems so as to evaluate alternative means of accomplishing projects and sites for them objectively requires a minimum of one year. Three are better, so that the range of variation can be better estimated. Ten years from now, hopefully this will not be so true, but our present data base is geographically spotty, as well as fragmented in comprehensive knowledge of ecosystem processes, distribution, and variability.

Leaving EIS preparation to the last means little time (usually weeks) remains to accomplish this long-term complex process. It is patently impossible to do this, just as producing viable babies in six weeks is impossible. The gestation period is essential. Fortunately, this one will be shortened as more ecological data are gathered and more environmental impact analyses accomplished.

Second, telescoping the EIS process provides no opportunity for developing a sense of the "carrying capacity" of ecosystems and regions for any facility.

Third, the limiting factors operating within a system are not always obvious; sometimes the major ones only operate for a few days per decade. This is true, for example, of the Gulf of Mexico upslope snowstorms that limit deciduous trees from the natural ecosystems of the high plains. At infrequent intervals, these storms deposit heavy snow and ice along the last base of the Rocky Mountains during early fall, when deciduous trees usually still have their leaves. The snow is trapped by the leaves and branches until an intolerable load is released by massive breaking of the branches. One could live in the high plains for years without observing this phenomenon, thus missing a prime feature controlling the nature and operation of the system. The longer the observation period, the greater chance for accuracy of prediction.

Fourth, application of the prime principle "that everything affects everything else" prompts preparation of generic, programmatic, and regional statements. These too cannot be done in vest-pocket time.

A correlary to this, learned by professional ecologists early in their careers, is that the human computer needs several field checks and reruns to assure that a high degree of validity has been accomplished from available data. Projects must be examined from all possible angles in the context of the ecosystems where they might be placed. This is impossible with a once-through, rapid preparation. Each feedback loop must be retraced, each input questioned, etc. Then all possible imaginable changes in their functioning of the system postulated and analyzed for probabilities. Different disciplines must raise different questions, analyze the same data from different standpoints.

After that, the trends suggested by the analyses must be viewed from all imaginable standpoints. By so doing we frequently discover new and unexpected ways of integrating man's activities with those of the whole ecosystem, so as to harmonize man with nature.

Fifth, small ecosystem perturbations heal in short times, relative to the time involved to produce the original ecosystem. Large perturbations can take systems back to primary development (base surfaces) then require centuries or even millenia to reheal.

Real estate developers have a penchant for clearing the site, carving a basement platform, building, then willing on to the home-

owners the impossible chore of relandscaping the sites, when usually landscaping already was well done at the outset. Homeowners must telescope ecologic time to restore a bearable environment. Yet all this could have been avoided.

Sixth, knowledge and understanding of the whole system enables us to recognize those conditions necessary to maintain species diversity. This diversity is one major indicator of ecosystem vitality; as it declines so does ecosystem health, often in subtle ways, unseen at first. No "quicky" EIS process can come close to predicting these interactions in a manner adequate to alleviate subtle change to them that can culminate in ecosystem deterioration.

Seventh, straightforward materials and resource commitment and potential recycling can be relatively easily calculated. More complex are the cumulative commitments of resources and progressive "domino effects" triggered by approaching each project as though it were the first and last to enter the systems under consideration. The off-site impacts of more power, more housing, more roads, more sewers, more people, more industry are rarely analyzed with more than an inventory approach. What of changes in social structure, changes in distances to be travelled, community costs for schools, sewers, roads, police, personnel, changes in land commitment, etc.?

What of energy efficiency? Are we perhaps using more total energy in the project than it may produce overall, when all energy used to accomplish and maintain the project is considered? We now rarely stop to think this through and balance the equation candidly.

Why Is Consideration of Alternatives Necessary?

There are several references in the above development that lead to a realization that, unless all possible ways of accomplishing something, including doing nothing, are carefully evaluated from the ecosystem standpoint, we have no means of looking at the total budgetary equation—monetary costs and benefits, social costs and benefits, ecological costs and benefits, personal costs and benefits, national security costs and benefits, recreational costs and benefits, and aesthetic costs and benefits. We may be overlooking a far more attractive means of accomplishing the end by using tunnel vision.

Short-Range Commitment of Resources versus Long-Range Values of Resources

Two examples serve to illustrate the wisdom of this NEPA factor in EIS preparation.

Commitment of the upper part of a coastal redwood watershed to clear-cutting of trees was made about 10 years ago. In the short-range, this commitment netted dollars of profit for the company, salaries for employees, wood for fences and homes—all good things. The long-range commitment of resources converted a viable, diverse forest that held soil in place and tempered effects of winter storms on the landscape into a barren hillside that rapidly and progressively eroded with each rain. This displaced soil was redeposited downstream over the roots of giant redwoods growing on the floodplain. This deposit is smothering these roots slowly so that forest in Humboldt State Park is gradually dying.

An alternative that would have distributed resource commitment differently but would have had numerous of the same human benefits would have been to selectively remove mature trees throughout the forest by helicopter or some other means. By this means the rest of the forest could have been retained viable and functioning in its role as "watershed manager."

Prime agricultural cropland in south and central California and elsewhere in the nation is being committed to housing developments, shopping centers, highways, and industrial facilities. Thousands of square miles of prime soil are covered each year in our nation. Rocky areas where soil is poor are seldom used for building, yet millions of

people in the world are undernourished most of their lives.

The end result of this lack of adequate environmental impact analysis is not yet clear to us here. We cannot wait for a food crisis to bring us awareness of the multidimensional reticulum that is being unravelled by thoughtless commitment of this resource.

Summary

Seek to think, feel, smell ecology just as you think, feel, smell, engineering.

Start ecological-environmental research even before projects are conceived.

Approach environmental matters from the holistic viewpoint, for the region, the program, or the flowsheet of a process.

Use the 3E's as a unit—engineering; ecology, and economics, supporting each other.

Establish base lines of ecosystem information, including human components of schools, community features, roads, attitudes, etc.

Seek new and better ways of five-dimensional analysis of effects of projects on ecosystem processes (the other two are time and evolution).

Develop a repertoire of potential alternatives; seek to augment this with time. Increase your data base about these alternatives with time.

Involve the public in your thinking, planning, deliberations. They are a vital, helpful, constructive ecosystem component if so viewed and amalgamated into your work.

Document your data sources so others can satisfy themselves of where the information came from.

Take nothing for granted. That which seems so self-evidently harmless to you must be so proven, with patience, to the uninitiated, as many who read your statements are.

Arrange to monitor projects when in operation so as to check your accuracy of prediction and to augment your data base, increasing your ability to predict accurately in the future.

Keep uppermost in thought and action, it is the substance of NEPA—the basic "ecological conscience," the "land ethic" of what action is optimal for maintaining viable diverse ecosystems on this planet. That is really important, not whether you have section 2A on the right page. The EIS process is not a lab manual exercise, but a fight for the survival of the fittest—the fittest now having human reason to consciously recognize his place in history and the ecosystem; reason with which to mold his own destiny in harmony with the ecosystems of the world.

The challenge is great; EIS preparation is crucial. The benefits of excellence in accurate analyses and candid acceptance of the conclusions are capable of multiplying and ramifying down through the millenia—for man, if you will but join the battle.