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WATER RESOURCES

Mr. Irving K. Fox

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Water Resources

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CONTENTS

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WATER RESOURCES

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CAPTAIN CASTELAZO: Of all of the natural resources that are available in the United States, I think the most important is our water resource. Without water we'd be awfully dry. Although the United States as a whole is endowed with plenty of water there are many problems in different localities, due, primarily, to distribution, not enough rain in the Nevada area; too much rain, let's say, in some of the other areas such as the Olympic Peninsula. If the economy of the United States is to grow, we must have good quality and an ample supply of water.

We have with us this morning to discuss this problem of water resources, Mr. Irving K. Fox, the Vice President of Resources for the Future. It is my pleasure to introduce Mr. Fox who will discuss the subject of water resources.

MR. FOX: Thank you, gentlemen. It's a pleasure for me to be back here again. This is my third trip, I believe, over here, and it has always been a very pleasant occasion for me.

I have entitle my talk today, "The Water Situation in the United States; Prospects, Problems, and Issues." There has been much discussion of the water problem in the United States. Some of the views that are quite widely held are just plain wrong. Some are partly right. My objective is to portray as accurately as I can, the water situation in the United States, as a background for understanding the nature and significance of some of the planning problems and policy issues confronting us. My presentation will be subdivided into three parts: The supply and demand outlook;

in other words, what is the water situation. The second part is the nature of water problems confronting the United States, some of which grow out of the water supply demand prospect, but some do not. And then thirdly, some of the policy questions. I want you to understand that the story I can tell in about 45 minutes will be incomplete. Probably there isn't any one person who could tell the full story; I certainly cannot, and probably a whole array of people couldn't tell it in a very long time. Thus, I'll give you but a few highlights on this subject.

Now, there has been much talk about a water shortage in the United States. Many of us have visions of wells, lakes and rivers being pumped dry because of the tremendous requirements of a growing population and industry. This is not an accurate reflection of future water prospects. Many factors have contributed to the spread of this view. An important one has been the lack of a valid and consistent framework for comparing supply and use, let alone implementing some more complex concepts such as the economic concept of supply and demand. We still do not have a good framework - as good a framework, at least, as I feel we should have. But in recent years great strides have been made.

Because of this rather poor framework we have statements like this being made by responsible government individuals. This one I picked up from a speech by a prominent federal official a couple of years ago. He said this: "It is estimated that the total average fresh water supply that is usable in the U. S. is about 515 billion gallons per day. We are now using about 290 billion gallons a day for all purposes, or about 55% of the total water available. By 1980 it is estimated that we will be using about 600 billion gallons per day. It doesn't take much of a mathema-

tician to figure out that we'll be short about 85 billion gallons of water unless totally new sources of supply can be developed."

Well, this is the kind of misinformation that I think grows out of the lack of a suitable framework for discussing water supply and demand outlook. I did mention that we have made some strides. One very good study was made by a student in this program here a few years ago, namely Douglas Woodward. Later we had the report of the Senate Select Committee, and for those of you who are interested in looking into this matter more fully I would refer you to Committee Print No. 32 of the Senate Select Committee. I will try to reflect these advances in my presentation, together with some more recent work that we have done at Resources for the Future.

I want to begin by outlining what seems to me like the needed framework or the desirable framework for comparing water supply and demand. (1) First, we need an appropriate measure of water supply. This is difficult because water is constantly in motion, for the most part. There are some isolated ground-water aquifers acerophers, you might say, that are not in motion, but even the water underground is constantly moving for the most part. We have peak flows in rivers that will be 10, 20, 40 times the, say, average flow, or especially the low flow. The low flow in the Potomac will be around seven or eight hundred cubic feet per second. It will rise as high as 200,000 cubic feet per second. It averages about 11,000 cubic feet per second.

What we have arrived at as the measure of supply is the dependable flow, a measure of the dependable flow in a given area expressed in millions of gallons per day, or cubic feet per second. I'll refer to these terms later in the presentation.

The second element of a suitable framework for analyzing supply and demand, is data indicating the cost of providing increments of supply so that we can develop a supply schedule. You can produce, of course, an unlimited supply of water for any portion of the United States provided you are willing to pay enough. However, what we're really concerned with here is a supply curve, or a supply schedule that will show how much it will cost to provide additional increments of supply.

The third element of an appropriate framework for comparing supply and demand, is an appropriate measure of use. And this is very difficult in the water resources field because it is quite unlike, say, minerals, or land, or forest products inasmuch as different uses have quite different consequences. A steam power plant may use very large quantities of water, but only, say, evaporate a very small fraction; take in, maybe millions of gallons per day, but release millions of gallons per day back into the streams. In an Eastern city maybe 90% of the water will be returned to the streams after it is used in a city system. In a Western city much larger quantities will be evaporated because of the heavy use of water for lawn-watering purposes. We use water to preserve water fowl in some areas. We use water for navigation. It is a means for recreation or a base for recreation. We use it for the disposing of waste. And all of these involve quite different concepts of use.

What we have finally arrived at through our various studies - and I think the concept is generally accepted now - is that the measure of use is the flow required to provide the services demanded, expressed in millions of gallons per day or cubic feet per second, and this is so we can compare it with supply. In discussing use we have arrived at a classification into three broad categories: The withdrawal uses;

these include irrigation, municipal and industrial water supply, and steam power. Here in this instance the water is taken from the water course, used, goes through certain processes, and is returned to the stream or the waterway. The measure in a given region, a given river basin, is the total withdrawal for the largest user in the water supply system, plus depletion from all other users, all of this expressed as a flow. Let me explain this just briefly. In the Potomac River Basin how much water do we need? What is the demand? The demand is governed by how much water Cumberland, and the upstream areas in the Potomac Basin actually use up or deplete - evapotransporate, you might say, to the atmosphere - plus the total supply withdrawn by the largest user, namely Washington D. C. This is the nature of withdrawal use in comparing it with the available supply.

(2) The second category of use is what we call the "on-site uses." These are conservation practices on land, the maintenance of wet land areas for, say hunting and fishing and water fowl, and measures of this kind. Here the measure of use is the evapotransporation to the atmosphere, again expressed as a flow in terms of millions of gallons per day or cubic feet per second.

(3) Finally we come to what we refer to as the flow uses; navigation, hydroelectric power, waste disposal and recreation. Here the measure is the minimum flow required to provide the service such as the navigation service or the hydroelectric power output planned. In the case of waste disposal it's the level of flow required to carry the wastes away and maintain whatever quality may be your standard. And incidentally, for purposes of our projection we have used the requirements for waste disposal as the measure of the total flow requirement rather than adding up, of

course, navigation, recreation and other uses.

Put it this way, then, the measure of use is the flow required by the largest flow use, namely waste disposal, plus evapotransporation from on-site uses, plus depletion from the withdrawal uses. And these are the way we have gone about preparing our projection. I have mentioned here so far, three elements of our supply-demand picture. First, an appropriate measure of supply. Secondly, the data indicating costs of providing increments of supply. Thirdly, a measure of use which we have just discussed. And now I come to the fourth factor which we would like to have but which we do not, namely, data indicating the amount of flow that would be demanded at different price levels so as to establish a demand curve. In other words, we would like to be able to do with water as for other commodities, which is, arrive at a more or less conventional set of supply-demand curves so we could see how much water would be demanded at given prices. And at the point where these crossed we would know how much water would actually be used.

We can't do this because we do not have demand schedules. The fifth factor that we need, of course, is an appropriate geographic area for comparing supply with demand. There is no national market for water because transporting water is too high in cost compared with the value of water. Thus we must be concerned with a relatively small region. Now, what we have done in our analyses, is divide the United States into three broad areas. First is the East, or the line running approximately where this white line is drawn here on the map. The West, including all of this portion except the Pacific Northwest which is this area up here. Those are the three regions for which I will later be giving you data.

Now, before we proceed with these figures - which we're going to be putting on the screen in a moment - I'd just like to remind you that what we're going to be concerned with here is the supply for each of these three regions, expressed as a dependable flow, and the demand which will include the depletions from withdrawal uses plus the depletion from on-site uses plus the flow requirements for the largest flow uses. And the flow requirement that has governed out level of use here is waste disposal. RFF has made new estimates of depletion from withdrawal uses, and these, by the way, you might say are confidential yet; they'll be released in a new publication along about next spring, and we would prefer not to have them quoted.

We are using, for the purposes of this presentation, the other estimate for the on-site uses and for the flow uses, the estimates of the Senate Select Committee on National Water Resources. These accrued; we're not very well satisfied with them, but they're the best we have. I would also like to mention that the estimates that have been made are based on numerous assumptions. For the year 2,000, for example, we're looking forward to a population of about 300 million. We look to a quadrupling of those national products from 1960 to 2,000. We are expecting a moderate rate of technological advance; we're not anticipating, you might say, a major breakthrough here; and for the waste disposal demand we're expecting that we're trying to keep our rivers clean enough so that there will be four parts per million of oxygen. Could I have the slide, please.

I think that you can see these figures. These figures, of course, are in billions of gallons per day, so we wouldn't have so many digits on here. You have 790.4

billion gallons per day dependable flow for the East. This is the amount that we should provide all the time if we had sufficient storage either underground or in surface reservoirs, to just even out the flow through the year. In the West you can see how modest it is compared with the East, 154.1 billion gallons. And in the Pacific Northwest which is a relatively small region of the country compared with, say, the West, you 136.3 billion gallons per day.

Now, let's look at the depletion which I've put on here from withdrawal uses. Here are the 1960 figures and you can compare them with the figures that we have for the various regions. Here in the East for irrigation, municipal and industrial water supply purposes you have a quite small figure compared with the total supply. And you have this going up to about 37.4 which is still relatively modest. I think you'll be interested in noting that of this depletion 40% of it will be for irrigation purposes. I've got figures that we could give you for the various types of use, but you can see that these for municipal and industrial uses are relatively small.

If you come on down the on-site uses figures are here; 30.3 billion gallons per day for 1980; 48.0 for 2,000. And look at these figures compared with the rest. In other words, with present technology if we are to dilute the wastes that we now anticipate we'll have with a quadrupling of industrial output and a doubling of population, roughly, we'll have to have this much of a sustained flow - 251.5 - 342.3. And this adds up to fairly large figures here. And yet, they're not bad compared with the total supply that we could provide if we were willing to construct sufficient storage.

When we get into the West we have a somewhat different picture. Here you

have the figure 154.1; looking at the year 2,000, 91.7 of it being depleted largely through irrigation - 90% of it. On-site uses appear fairly large according to the estimates of the Senate Select Committee. And the waste dilution flows are fairly substantial. So, you end up here with figures for 1980 and 2,000 that are in excess of the available supply. In the Pacific Northwest you have quite generous flows compared with the demands that have been projected here, and you find that even with the year 2,000 we still have quite adequate supplies. So much for the figures. I'd like to have them left there for the moment because we might refer back to them. But, I'd like to make just a few comments on them.

In the East the situation doesn't appear serious if the data are accepted at face value. However, I want to make some comments a little later about the waste dilution flow. In the West I would say that the data actually understate the problem because the sub-humid portions of the region, particularly Texas and Northern California, provide a fairly substantial proportion of the total supply. Therefore, some portions of the region, particularly the Rocky Mountain States, areas like Arizona have a much more serious situation. Arizona is a classic example. It is now withdrawing 3 million acre feet per year; more than is available, you might say, on a sustained yield basis, to the state. If they win the current suit before the Supreme Court, with California, they will get another million two hundred thousand acre feet, but they'll still be more than a million and a half acre feet in the hole. In other words, they'll still be depleting their reserves of ground water at a rate of over a million and a half acre feet per year.

With regard to the Pacific Northwest, although the total supply is quite adequate

here, the fact is that there are portions of that region in the eastern part of the basin where you have aridity and can have supply stringencies. Now, I think that these estimates as I mentioned earlier for the on-site uses and flow uses deserve a word of comment. We have not done enough work yet, I believe, to come up with very firm estimates for these categories of uses, or for these. In particular, with regard to the waste dilution flow, one can question whether the assumption of four parts per million of oxygen is an appropriate one. Some streams possibly we're going to permit to be dirty, to carry away wastes. We do this to a degree already; probably we'll continue to do it. We could store wastes for periods of time and release them during flood flows. This possibility has not been taken into account. You couldn't do this with all wastes, but you could do it with some.

We have not anticipated major changes in technology and there is evidence that there will be changes and they will occur quite rapidly. At best these estimates of waste dilution flows are suggestive of the, you might say, the significance of the waste disposal problem confronting us in the United States. So much for the estimates, and I don't think that we'll need the chart anymore.

Now I would like to describe rather briefly some of the problems pointed up by the water supply situation, and also some other problems that may not arise directly out of the data that I have shown to you. (1) First of all I think it is abundantly clear to even the most casual observer that we will have a stringent supply situation in much of the West. And here we're looking for possible solutions. One possibility, and one that has been being used rather widely, is the diversion of supplies from surplus areas. This is what California is doing under its California Water Plan.

It is moving water from the northern part of the state into the southern part which is more arid.

We can conceivably increase the water supply. We may do this by, first, rain-making, or desalinization. I won't say too much about this because I think you're going to have some more authoritative discussion of this later. But, rain-making is a very inexact science. Desalinization costs are running about, roughly, a dollar per thousand gallons of sea water. An irrigation farmer can afford to pay, roughly, one to five cents per thousand gallons; maybe eight cents in some cases. Cities can afford to pay as much as 25¢ or 30¢, maybe. We're not quite in shooting range yet for these, and it's hard to say just what new technology will bring. It appears that we'll have to have a major technological breakthrough before these other sources become available.

One possibility in the West and which, no doubt, will be receiving attention, will be reducing depletions per unit of product. Here we will no doubt be looking to new ways of using supplies more efficiently. And in the West probably the greatest opportunities for doing this will occur in the field of irrigation because irrigation counts for such a large proportion of the loss.

And another possibility and one I feel that it will be essential for the West to resort to, is adjusting use to supply by transferring, you might say, the use of water from the less valued uses to the higher valued uses, namely, from agricultural purposes to industrial and irrigation purposes. This would be a great advantage or permit a very high level of economic activity, compared with agriculture. Let me give you an example. A transfer to municipal and industrial use of 10% of projected

depletions for 2,000 in the West for irrigation; you transferred 10% of the water used for irrigation; it would support about double the projected 2,000 level of depletions for municipal and industrial activity. And I think this sort of adjustment will no doubt have to be made in the West and this is one of the major problems that will be confronting us in the years ahead. That is, unless we do have a major technological breakthrough in such fields as desalinization.

The second major problem that I would refer to is what I would call stream pollution versus recreation and the amenities. Now, measured in narrow dollar terms economic efficiency would dictate, I would gather, loading the streams with wastes. Fill them up so that you had about one part per million, of oxygen. There are quite efficient waste disposal systems. This would be cheaper than trying to treat the wastes. This is impracticable in the United States because of our interests in recreation and our interests, you might say, in the aesthetics of our streams and waterways. I think we will probably invest more in pollution abatement in the years ahead than in any other aspect of water development.

We have serious deficiencies in waste disposal technology. The plant nutrients that are released into streams in normal sewage treatment processes fertilize the streams, increase the growth of algae, algae is distasteful in water for municipal purposes; when the algae die it takes oxygen out of the stream, and as a consequence, even though you have a high degree of sewage treatment you will still be required to have a fairly large amount of dilution flow as suggested by the estimates that I showed on the screen just a few moments ago.

Yet, stream flow regulation is not always desirable or practicable. And I think

we have a good example of the situation here in the Potomac River Basin where the Corps of Engineers is now proposing a program which would provide a large amount of storage for waste dilution; roughly half of the storage in the Potomac River plant, as far as I can make out, would be for waste dilution. Yet, I think all of you know the controversy that surrounds the construction of the dams that has been contemplated by the Corps of Engineers. I think we will confront this problem more and more as our population expands and industry grows, especially in the more settled areas of the Eastern United States.

(3) A third problem that I would mention is the flood problem. This problem is not reflected in the supply-demand estimate. It has been quite interesting to note that over the years, with a fairly heavy investment in flood control in the United States, average annual damages measured in constant dollars appear to be rising. In other words, we began in 1936 with a fairly substantial flood control effort, a large amount of damages have been prevented, but average annual damages today are greater than they were when we started, measured in constant dollars, because of the increased occupation of flood plain areas. Here control is not always practicable and we've begun to learn that other techniques will be necessary if we're adequately going to meet the flood menace.

(4) The third problem that I would mention - and it's a fairly complex problem - I want to take a couple of minutes here to elaborate it - this I would call the change in the orientation of water resources planning that has occurred with increased population growth, especially urban population growth and industrialization. We traditionally think of water development as involving navigation, power, irrigation

and flood control. These purposes continue to be important. Navigation has increased rapidly since World War II. Through the advent of pump storage, the use of hydroelectric power for peaking purposes, hydro continues to be a valuable source of energy, although it is not a very large portion of our total energy supply. Irrigation is increasing in use, particularly in the Eastern part of the United States. Flood management - flood control - continues to be a serious problem.

Yet, I would say that in spite of these it is not obvious in any single instance, which of these developments should or should not be undertaken. We have many alternatives in energy, food production, transportation, etc. These all have to be carefully appraised. It also not obvious, as we once thought it was, that river basin development was an automatic stimulus to economic development with a region. We're concerned here with a problem of what you might call marginal analysis; appraising investments in water development in comparison with other alternative investments facing our society.

Added to this we face a problem of relating water development rather closely to urban development problems. Waste disposal has become of serious importance and is related to the location of factories and recreation areas. Water development is closely allied with location of transportation facilities. It is allied to the location of recreational areas. It is related to the use of flood plains, particularly in urban areas. Thus, we face a much more complex planning problem than we visualized a few years ago. Thus, I would summarize our water problem in this way.

The cost increases in prospect because of supply stringencies, are not serious enough to inhibit economic development. We can even meet the water problem in

the West without inhibiting economic development if we have the imagination to do so. And this will not require technological advance to accomplish it. Secondly, although water development for traditional uses - agriculture, municipal and industrial power, and navigation, will merit considerable investment, our most difficult problems will stem from the need to integrate land use with water use, particularly in developed areas. Waste disposal may conflict with recreation. Proposed reservoirs will conflict with other land uses. Use of flood plain land must be coordinated with overall land use problems. And this, I think, is our most difficult and complex problem.

Water development will not be looked upon as a special stimulus to economic development. But since the capital investments will be large and some actions are irreversible, it behooves us to plan wisely. We must plan wisely if water development is to contribute to economic growth and if the amenities are to be preserved in a society with double the population and four times the economic activity.

Now, in the last few minutes here I would like to summarize about three major policy problems. You could break these down into hundreds, or I could cite some more. But I'd like to suggest only three. I think one big question in the policy field relates to the adequacy of Western water law. There has been a great deal of discussion in recent years on Eastern water law. I think we have some serious problems there. But I think maybe the most serious question arises with reference to Western water law. Western Water Law is irrigation water law, traditionally. And yet, as we look ahead - as we see the picture today - the major adjustments must be made in the use of water in the West, and there must be a transfer in use from

irrigation to municipal and industrial uses.

The question we face here is this; does the existing water law in the West contribute to inefficient use of limited water supplies in an area which faces serious shortages? I think there is evidence in literature that this is happening at the present time. I think this could result in considerable hardship to communities in the West such as we had, let's say, in the Owens Valley at one time. Or, it could mean the provision through the development of supply and other ways of quite costly water supply for some of our communities in the West, when the transferred use would be the more economic alternative. So, this is one policy question that I would like to draw to your attention.

I suppose the second and very significant policy problem is this one; how adequate are our planning and development institutions? We have four major federal agencies concerned with water development in the United States - the Bureau of Reclamation, the Corps of Engineers, the Soil Conservation Service and the Public Health Service. Our state governments, for the most part, have done relatively little in the water resources field. Exceptions are California and one or two others that I could mention. The big metropolitan regions haven't really given this problem very much attention. At the federal level we have been trying to deal with this, you might say, coordination problem through inter-agency committees and inter-agency commissions. Some of these have been state-federal commissions or committees in regions like, say, Texas or the Southeast.

We have recently had an innovation on the East Coast with the establishment of the Delaware Compact Commission, of which the federal government is a member.

This past week I visited the Northeastern Illinois Planning Commission and here we found for the first time, at least in my experience, a metropolitan region planning a water development program for a 3,500 square mile area. These traditional agencies have been concerned with particular purposes, purposes that were important in years gone by. Can these institutions achieve the kind of consideration that urban development needs and the situation in general calls for? What adjustments in administrative arrangement are needed? If you come to Chicago early in December, I'll speak to this point. I'm going to make a talk out there on this subject.

The third major policy question - and I think it's a rather fundamental one - is this; can we optimize? Can we get the most out of our water under a basic policy whereby water services will be highly subsidized by the federal government? And I think this is much more than a question of what is fair or equitable in terms of the distribution of the benefits and the costs. I think the question is, for example in the West, can we provide the additional supplies for the West or make the adjustments that I referred to earlier, under a policy whereby we may supply large quantities of water, you might say, in an uneconomic fashion because it is subsidized by the federal government through diversion projects or desalinization. I think, under our political system, it is quite difficult to resort to the most economic institutions when there is so much motivation for federal investment.

I think the same question could be raised with regard to flood control and navigation. I think one can argue with regard to these purposes; irrigation, flood control and navigation, the die was cast several years ago and is not subject to change. And here I think the most important opportunity lies in the field of waste disposal.

Can we develop a system whereby the people who dispose of wastes in rivers are charged on the basis of the quantity and quality of waste they contribute to streams? It's quite interesting to us at Resources of the Future that in the Ruhr region of Western Germany this is what is done. And this region which has eight million people - 40% of the population of West Germany - has each season, half the lowest flow the Potomac has ever experienced, and preserves the Ruhr River so it can be used for swimming and fishing. And I think that this type of approach, whereby users are charged for the quantity and quality of their effluent is an important factor in this result, although there are some other ones there too.

Well, we face, then, these three important policy questions that I've mentioned. I think that they deserve a great deal of study and attention, and they will, of course, be difficult to change. And in this I'm reminded of a little statement by Metterlink, in which he said, "At every cross-way on the road that leads to the future, each progress the spirit as opposed by a thousand men appointed to guard the task. Let us have no fear lest the fairest towers of former days be insufficiently defended."

Thank you.

QUESTION: Mr. Fox, assume that a cotton farmer down in El Paso, Texas, has been taking water from the Rio Grande River for a long time. How would you propose that that land be converted to industrial or municipal use? Would the federal government buy his land?

MR. FOX: Well, I happen to have lived out in that part of the country myself, and what El Paso has done is that El Paso itself has gone out and bought up the

land from the irrigation farmer and paid him what they thought it was worth; you know - just bought it in the market; then made the land idle - just set it aside and took the water to use for city purposes. And a certain amount of this has been done in the West. But there are some difficult problems here in making this sort of a transfer. Some years back the City of Denver acquired a fairly substantial amount of farmland hoping to get the water supply. It went through a certain amount of court litigation and when they got through they had 12% as much water as they thought they had bought. Since then, Denver, for example, has developed a fairly extensive supply instead of buying out land. Did I answer your question, sir?

QUESTION: Mr. Fox, is our available usable water supply being affected to any measurable degree by radioactive fallout from the world-wide nuclear tests?

MR. FOX: I'm probably not a very good person to respond to that question, sir, but to my knowledge this has not been a serious problem. And you shouldn't take my answer as a final one by any means. There have been some radioactive waste problems in particular areas, especially, I think, in the Rocky Mountain area where uranium was being mined and certain by-products of the milling operation got into the streams and caused a radioactivity problem. But I haven't seen any reports on the bomb-testing as causing any water supply problem.

QUESTION: In discussing pollution you made no mention of a potential health hazard in a polluted stream. Is there any?

MR. FOX: Well, there certainly is a health hazard. And this is a fairly difficult problem to, you might say, portray as accurately as one would wish. There are toxic wastes that evidently are not subject to treatment through ordinary treat-

ment processes that get into streams, and there are many of these, and many of the wastes that do get into streams - or could get into streams - are such that we really don't know what their effects are on public health. In addition, it is found that certain viruses get through these treatment facilities and appear in water supplies. I don't think we really know how significant the health hazard is in many parts of the country where we have complex wastes getting into the water supply sources.

Now, it's not as serious a problem as it one time was. I would illustrate it in this way. Chanute, Kansas, some years back, ran out of water; the supply got way down. And, as some of you may know, they finally put a little dam down below the sewage treatment plant and ran the water back up into the water intake. After it had been treated thoroughly it was re-treated in the water supply system and put back through the city system. They re-circulated the supply right there at Chanute, Kansas, for some weeks. Now, the state became aware of this and checked on matters rather carefully, and the state could not find, according to the journal articles that I read, any evidence of a public health hazard or water-borne diseases resulting from this practice.

The water was not very pleasant, so I'm told. When you took a glass of water out of the faucet you had a head on it like a glass of beer because certain hard detergents are not processed in this way. But at least the immediate results of the adverse type were not evident. On the other hand, I think you could consider the pollution abatement problem in two categories. Certainly there is the public health problem, and we're going to have to devise ways and means of protecting our water supply from these toxic wastes and wastes that you can't know enough about to know

whether they're toxic or not.

In addition we have the large burden of organic wastes and here we're concerned as much as anything, with the fish and wild life that are protected, the use of the streams for recreation areas; and things of this nature. And to do this will require a fairly substantial investment. Probably, if we were only concerned with the toxic waste problem we could develop ways and means of keeping them out, etc., and meet our problem at a much lower cost than when we try to do both - beat the toxic problem and this other problem that I've referred to.

By the way, it may be of interest to you to hear a little verse that Coleridge wrote about the Rhine and the City of Cologne. He ended up that verse like this: "Ye nymphs that reign o'er sewers and sinks the River Rhine, it is well-known, doth wash your City of Cologne. But tell me, nymphs, what power divine shall henceforth wash the River Rhine?"

QUESTION: Sir, what are some of the problems we face in this area insofar as our neighbors are concerned - Canada and Mexico?

MR. FOX: I could give another lecture on that subject. It's a good one. I'll mention Canada first. As you realize, starting with Columbia in the West and going across to the St. Johns in the East we share a large proportion of our water resources with Canada. In the Columbia River Basin the Columbia River rises in Canada and flows down into the United States. We have developed a fairly substantial proportion of the potential hydroelectric power in the United States, downstream from the Canadian border, the first dam being Grand Coulee.

Now, we could very greatly benefit our own power output, or, our power output

would be benefitted if there was more regulation upstream in Canada, because much of the water flows over the tops of the ten dams that we have built on the main stem within the United States. If we had storage there we could produce a substantial amount of power. For example, one dam in Canada at a relatively modest investment would increase the power output in the United States by the equivalent of the output of Grand Coulee. So, we have an interest in what is done up there. Recently a treaty was negotiated and ratified by the U. S. Senate to provide for, you might say, joint development of the Columbia and the sharing of the benefits between the two countries.

I will not try to go into the difficulties here, but the treaty has been bogged down in Canada for a variety of, let us say, political considerations. It's quite complicated. Well, this is one sort of problem. If we move over to the Great Lakes, I'm sure many of you have heard about the diversion problem. We are diverting water at Chicago into the Illinois. There is talk about other diversions. All of us, of course, on both sides of the border are interested in the maintenance of the water quality in the Great Lakes, the fisheries, the use of the navigation facilities on the St. Lawrence; and we can have, through the way we use this water supply jointly, a great affect upon both countries.

When you move to the St. Johns you have the reverse of the situation on the Columbia. Here you have the possibility of storage in the United States that would benefit hydroelectric power output in Canada. This is being talked about and where we'll go on that one, I do not know. These are quite thoroughly involved, so I won't say too much more about them.

When you go on to the Canadian border, one of the problems that has received some attention in the Press recently, is the quality of the Colorado River water that goes to Mexico. We have been putting in salty or brackish water into the river and this has adversely affected the situation in the use of the water in Mexico and they have complained. There are some steps being taken there to alleviate the situation, but we must recognize that as we increase the use of the water of the Colorado for irrigation purposes the salinity content increases because of the leaching of the soil. And I think that this sort of problem will no doubt confront us in that area in the future.

We can have a somewhat similar problem on the Rio Grande as it comes down from Colorado and New Mexico, and on downstream. We have, of course, an international joint commission that is proceeding with the development of certain dams on the border area of the Rio Grande.

Well, so much for that. I could say a lot more about it, but this may be all I should in the time we have available.

QUESTION: What is your recommended solution for the problem of the Potomac?

MR. FOX: Well, the Potomac is one of my favorite subjects, sir, but I do not have a solution and one that I recommend for the Potomac. I have some rather strong views about how we should approach this situation, because I think we face a quite complicated problem in the Potomac partly because of its, you might say, physical characteristics, and partly because of the kinds of demands that we make upon the river. It is used rather widely, you might say, for recreation purposes at the present time. We are threatened with a growing pollution problem both in

the river proper and in the estuary.

Now, what the Corps of Engineers' proposal envisages is a series of reservoirs, I would say a traditional approach to the water problem of the Potomac River Basin, in which you would store considerable water upstream. And these are orders of magnitude. I haven't seen the report yet; I don't think it's available. But this is about the way the storage is allocated. About 40% of it is for flood control. About 10% of the storage is for municipal and industrial water. And approximately half of it is for the dilution of wastes.

Now, I'm not one who is inclined to believe that we have had presented to us yet the alternative possibilities that I think should be available for consideration through the political process, carefully analyzed and assessed for us to examine. It has been suggested, for example, that some of the wastes from the Washington, D. C. area that contribute to the pollution problem in the estuary could be piped into the deep water of the Chesapeake and disposed of there, or further down the estuary. I don't know whether this is a good alternative or not, but it has not been carefully examined and the cost estimates and the problems presented to us.

I think that there is a full range of alternatives which, incidentally, I have outlined in some greater detail in another talk, that I think should be put out on the table for the public to consider and debate. Anybody who wants to see a copy of that talk, I think I have a few reprints left and I'll be glad to send them to you.

QUESTION: Rachel Carson's new book, which is a best-seller and I wonder if you've had an opportunity to read it, and if you have, how serious are her charges with respect to processing, the use of insecticides, herbicides, etc. on our water

supply.

MR. FOX: I'm acquainted with her book. I haven't read it completely yet, but I have it on my desk at the present time. I've also seen the articles that appeared preceding the arrival of the book, in the New Yorker. I'm not in a good position to judge how serious these charges are because I really don't know enough about the subject. I might tell you that one of the things I was doing last week was helping to get underway a study that I hope will answer your question for you. A year from now, Resources for the Future hopes to have an objective analysis not only of what the situation really is as far as we know it, but to appraise what we don't know and to suggest lines of study that Resources should have used and that others might undertake, to give us the kind of understanding that we ought to have in dealing with this type of problem.

QUESTION: Sir, since most of us will not be able to attend your meeting in December in Chicago, would you care to discuss the adequacy of our planning and development institutions?

MR. FOX: Well, there is relatively little that I can cover on a pretty complicated subject of this type, in a very short time. But I can say just a few things that occur to me, and I could also refer to you some things that I have written on this subject if you would care to look at them. First of all, we have responsibility for planning and development quite thoroughly diffused within the federal government. It's pretty hard for any geographic area where the government is undertaking plans to pin responsibility very clearly on anyone. And I think that for those of you who are in the military establishment understand what sort of difficulties that creates.

This is varied somewhat, over the country.

Secondly, the problems that we have vary a great deal over the United States. And we have tended to try to deal with them through the same kinds of institutions in all regions, and we don't have the same kinds of water problems in all regions. This was driven home to me this past week when I visited the Northeastern Illinois Planning Commission and saw the problems there with, say, the problems that I had dealt with when I worked in the West, or in discussions I've had with people in the Northeastern U. S., in the South, etc. Now, these are two problems.

A third aspect of it is that these problems are regional and local in character, and yet we have not developed strong regional and local organizations to be concerned with water development. Now, these are, maybe, the three major points that I would make at this time with regard to the problem. I'm not about to lay out what I consider to be an appropriate solution to these, but one of the things that I think is essential if we are going to have a solution to the federal problem is some leadership by the Executive Office. And let me say why I would refer to this.

Our water development programs of the ~~federal government~~ have been used, in large measure - have been kind of pushed aside because of more important problems. And they have been used to trade a project for certain support etc. in Congress. And, as a result, at the federal level policy and leadership has come from the Congress rather than the Executive Branch. I don't think there's any doubt about that. And I think that if we're going to develop stronger and more powerful institutions the Executive Office must become interested in doing so.

I'm not being critical here, because I know that there have been some very

important problems pressing upon the Executive Office in other fields. And maybe in view of the other problems confronting the country this ought to be given low priority. But nevertheless, this is what I think it's going to take if we're going to get any improvement in our federal institutions. Now, I think beyond that it will also be necessary for the states and the metropolitan regions to take a hold of this problem in a powerful way, you might say, if they're going to come into the picture. Have I evaded you successfully?

QUESTION: Some 25 years ago there was a compact among several states concerning the Washington and Connecticut River Valleys. To my knowledge thus far this has been a very useful device for doing nothing. Is this a fair statement, and if so, why has nothing been done about it?

MR. FOX: Well, there have been compacts and there have been compacts over the country. Most of the compacts have been concerned with the dividing of water among the states in the West. You agreed on this. And as one of my friends characterized those compacts, they have been a license for litigation in the courts. They haven't been the most successful instruments, I would say. Yet, maybe we are in a better position to protect those.

We've had another type of compact which has been concerned with pollution. For the most part these have been kind of voluntary associations to get together and try to work on quality problems. If I remember the Connecticut compact correctly, it was largely concerned with flood problems. Am I right on that? And here it was again you could agree to reimburse an upstream neighboring state if you put a reservoir up there to provide flood control down stream. These have

been quite loose and have lacked teeth.

There is now one compact that does have teeth and strength, and this is the Delaware Basin Compact. There is sufficient authority there in that compact to actually undertake quite a program of development management in the Delaware River Basin. Whether it will materialize in thi s direction, we do not know. It could become a quite strong agency. We might have a new example of an institution here that is regionally oriented, concerned with water development management problems, and may be quite effective. I think the big question is this; that in view of the fact that they look to Uncle Sam for investment money, whether they really will become, in effect, a lobby for investment by Uncle Sam in water development within their regions rather than a bona fide river development management agency, we'll see. I have hopes that it might become something quite effective.

QUESTION: I am interested in a couple of figures on your chart that show a decrease in the Pacific Northwest and the water required for waste dilution.

MR. FOX: Well, I'll have to look at my figures. I'm sorry, I can't account for these. These were projected for the Senate Select Committee and I really don't know what they were considering. I could mention a couple of possibilities. One of them could be a change in, let's say, the technology of the pulp and paper industry, for example, contemplated here that would make an adjustment. It could be some other regional adjustments or movement of industry contemplated for that period. I'm sorry.

QUESTION: Are there any major projects under consideration for massive transfers of water from one river basin to another?

MR. FOX: Massive transfers of water from one river basin to another. First, I think these are probably in the minor category - things like the Colorado Big Thompson, the Frying Pan, Arkansas, etc. - bringing water out of the Colorado into the East Slope and into the Arkansas and the Missouri Basin. Then, of course, you have the transfers from Northern California to Souther California, and from the Colorado over into Southern California.

Now, there has been consideration given from time to time, to bringing water from the Columbia River Basin down into the Southwest. And this was to be a fairly substantial investment, a very large-scale diversion. This was proposed or studied by the Department of the Interior, Bureau of Reclamation, when Michael Strauss was Commissioner of Reclamation. And this was called, I think, the United Western Project. But when the change of Administration occurred in 1953 this was put aside - shelved - and I haven't heard anything of it lately until I read a little bulletin that Mike Strauss had authored recently, laying it out again.

Now, from time to time there are a number of private suggestions for fairly massive transfers in the West that come up, some by fairly reputable engineering organizations. But I don't think there is any official consideration being given to these large-scale transfers that I know of at the present time.

QUESTION: Mr. Fox, you used the term during your talk "evapotranspiration." And during the break I tried five good dictionaries and the subject to my peers, and there seems to be some question as to what exactly this word might mean. Would you enlighten me?

MR. FOX: Well, as I understand it, I remember hearing this word for the

first time about 15, 18 or 20 years ago, myself, and I was quite concerned with it. But I found that people who work in this water business use it rather regularly, to refer in one word to the evaporation from surface areas, maybe from soil and water areas, and transporation from plants. Many people with whom I've worked, you might say, over the years - I'm not a scientist, so I can't vouch for this term - but it is, I think, fairly commonly used among water people, at least, as referring both to evaporation and transporation from an area.

QUESTION: How serious is the detergent waste problem in our large metropolitan areas, and is anything being done about it that might become laws?

MR. FOX: I think, as many of you know, detergents have plagued the sewage treatment processes, the household detergents and also the detergents used for washing purposes in industrial processes. These are referred to as hard detergents, inasmuch as they're not broken down by processes of normal sewage treatment. They are relatively few parts per million of these detergents that you have foaming. One of the problems that they've had, for example, I think it was abroad, the foam got up in such clouds that it blocked highways. It came in front of cars, caused accidents, and things of that kind. It caused an awful mess around communities blowing through the air etc.

Then, of course, it appeared in the downstream water supply and gave you a head on your glass of water. As far as I know there is no evidence as yet that this is unhealthy, although I think there may be some disagreement on this particular point. Now, this has become more serious, I think, abroad, than it has in this country, but I think it is quite serious in certain local areas in the United States.

There are efforts being made to find soft detergents to replace the hard detergents which will eliminate this sort of problem. The treatment processes have not come along, you might say, so as to deal with it. I do not know of any legislation here to deal with this problem, but there is legislation now in Germany to prevent the use of hard detergents and require people, effective sometime in the future, to use soft detergents or detergents that will be broken down by waste treatment processes.

I just talked to a businessman whose company had recently built a plant in Germany to make hard detergents and they're going to have to change their business in a little while, or go out of business.

QUESTION: Sir, is there an advance being made in the rain-making technology or science to achieve water?

MR. FOX: There are probably people here who know more about this than I do. I have had fairly recent discussions with people on this. I would say that from my discussions with the scientists who are concerned with rain-making they feel they are understanding much better than they did a few years back, the atmospheric physics that bear upon rain-making. They're making scientific advances of this nature, but at least in the recent discussion that I had with people at the University of Arizona, they feel that we've got a long ways to go. They feel that some of the, you might say, beliefs as to how effective, let us say, silver iodide was as a nucleation agent, they just don't feel that it was as effective as they thought it was, and there is a new paper out, I understand, that bears upon this.

I would gather that there is generally the feeling that we're going to have to

spend many, many years before we can at all depend upon this to increase our supply. So, it's even more remote, I would say, than desalinization. Although, if we could do it with the kind of techniques that are being experimented with, it would be a relatively low-cost large addition to available supplies.

CAPTAIN CASTELAZO: Mr. Fox, you seem to have flooded our audience with information and have dried up the questions. We thank you very, very much for your excellent talk.