ANOTHER RIO GRANDE FOR NEW MEXICO?

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Like other southwestern states, New Mexico needs more water. According to the Water Resources Research Institute, the Upper Rio Grande and Pecos basins have smaller water supplies, in relation to projected demand, than any other basin in the United States.[1]

Besides needing water, New Mexico shares in the Nation's need for increased supplies of electric power, preferably electric power that can be generated without payment of a high price in terms of environmental damage. Governor King's recent executive order establishing the Governor's Energy Task Force makes an important point: "For the first time the energy crisis is not only recognized but deemed real at the state, regional, and national levels."[2]

The purpose of this report is to suggest a way in which New Mexico's needs for water and power might be satisfied, at least in large part, through imaginative use of resources already located within the State. One of these resources is a vast underground reservoir of saline water. Another is an impressive array of scientific, engineering, political, environmental, and economic talent in universities, industry, and government installations. In view of these resources, it is time to consider the possibility of producing the equivalent of another Rio Grande for the State, together with large quantities of clean electric power.

Obviously, the present report cannot attempt to prove the feasibility of the immense project it describes. All it can hope to demonstrate is that a full-scale feasibility study should be conducted as soon as possible.

The project concept to be described here is based on desalting, ultimately by means of geothermal or nuclear energy, the several hundred million acre-feet of saline ground water in the Tularosa Valley.[3] The resulting recreational-industrial-agricultural complex would ultimately encompass on the order of one million acres. It would provide one million acre-feet of fresh water per year, 2000 megawatts of electric power, valuable magnesium

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and other minerals separated from the saline water at a rate of several million tons per year, and many associated recreational and social benefits. The name by which we have referred to this enterprise during our preliminary conceptual studies is the Tularosa-Rio Grande (TRG) Project.

The cost of the TRG Project would be one to two billion dollars. This is admittedly a huge price tag, but it should be looked at in perspective, and with some realization of the value of one million acre-feet of fresh water annually. In The Value of Water in Alternative Uses, published by the University of New Mexico in 1962, figures are given indicating that "the contribution of the Rio Grande basin to gross national product would be about $50 for each acre-foot of water used in agriculture. It would be between $200 and $300 for each acre-foot used as fish and wildlife habitat. It would be between $3,000 and $4,000 for each acre-foot used in industry."[4] Value for such uses will only increase in future years.

Given the fact that a very large new supply of water and power would bring great benefits to the State (the scale and variety of expected benefits are described in a later part of this report), what procedure should be followed to get the Project underway? First, there would have to be a period of further study. Once confirmation of a feasible plan had been established, there would be a period of step-by-step construction. Considerable thought has been given by the authors, both to the areas in which study is needed and to the steps of construction.

The feasibility study, which is expected to occupy two or three years, will be devoted to several areas:

1. Political and legal

   The TRG Project presents a unique combination of political and legal questions. A large fraction of the land involved in the plan forms part of the White Sands Missile Range. Other lands to which access might be desirable before completion of the project are under control of such agencies as the Bureau of Land Management and the Bureau of Indian Affairs. Many formidable problems of land acquisition, multiple use of government land, and mineral and water rights, need further investigation.

   Inherent in the TRG plan, however, are certain great advantages in areas of politics and law. One such advantage arises from the fact that the entire complex will be located within New Mexico. Interstate boundaries and interstate or international water compacts are of no limiting concern. Inter-basin water transfers form no part of the plan, except for the entirely optional possibility that some desalted water from the Tularosa basin might be piped across the mountains to the Rio Grande (hence the name, Tularosa-Rio Grande Project). Certainly no inter-basin transfers will be necessary to the feasibility of the project.

2. Sociological

A project such as this would offer newly created living space and a useful way of life to many people. In doing so, however, it might create less favorable consequences for other New Mexico citizens. The meaning of the TRG Project for the average New Mexican is not easy to predict. Social consequences of the Project must be a matter of serious concern and intensive study, because the overall quality of life is, of course, more important than any combination of economic benefits. Certainly the creation of new wealth by the TRG Project would result in new opportunities for many New Mexicans. What must be guarded against, obviously, is the possibility that new opportunities for some will bring some unsuspected disadvantages to others. Those of us who have looked at this possibility have seen nothing to fear. We wish to stress, however, that potential social results of the Project must be a primary concern of the feasibility study.

3. Economic

An intensive study must be made, first to arrive at reliable estimates of the cost of project development, and second to determine the most favorable methods of financing and organizing the Project. The cost of the feasibility investigation itself will be several hundred thousand dollars. If its results are favorable, they are expected to attract private investment. The feasibility study would almost certainly have to be financed in substantial part by government agencies.

The total economic impact of the Project on the region would have to be studied, along with the potential value of mineral and other by-products, agricultural products, associated industry, appreciation of land values, and power and water sales. Economic resource management techniques would have to be developed to identify the various management alternatives.

4. Environmental

The TRG Project, like all large development plans, could have harmful effects on the environment. Unlike some other plans, however, it could have extremely beneficial effects on the environment. Both possibilities will require attention from those who perform the feasibility study.

Ways of minimizing possible deleterious effects have already been studied, in a preliminary sense. For instance, some thought has been given to the possibility of using underground transmission lines for the large quantity of electrical power to be generated. If one were limited to present technology, this would not be feasible, but it is hoped that the underground superconducting transmission lines now being developed at the Los Alamos Scientific Laboratory will be ready in time for use by the TRG Project. The matter of effluents and other environmental effects from energy sources used in pumping and desalting appears controllable but must, of course, receive more intensive study.

Possible beneficial effects of the TRG Project on the environment are exceedingly interesting. A certain fraction of the fresh water produced could well be devoted to improvement of wildlife habitat in the area. Irrigated parkland, freshwater lakes, and lakes of slightly saline water might all be created, making the Tularosa Valley a truly important nesting and resting area for waterfowl and also providing extensive water-based recreation areas.

5. Technical

Because of the step-by-step approach now envisioned, with a relatively small pilot plant to be followed by gradual scaling up, certain technological options can be left open for several years, even after construction begins. Certain aspects of desalting and of mineral recovery technology, seen more clearly as a result of experience obtained in the step-one pilot plant, will serve during later steps in ways that cannot now be predicted in detail. The feasibility study will, however, evaluate all currently available technology applicable to the TRG concept, including desalting, coupling of power and water plants, and geologic and hydrologic conditions of the Tularosa Basin.

After feasibility has been confirmed, including financing and organizational arrangements, a four-step plan (summarized in Fig. 1) would go into effect. Step one would consist of building and operating a pilot plant. The pilot plant would produce about one million gallons per day of desalted water. Its fuel would be natural gas. Its main purpose would be to define the desalting process best suited to the Tularosa application, given the particular minerals present in the water and their relative levels of concentration. The pilot plant would also serve as a laboratory for materials development and for mineral extraction studies and as an experimental facility for solving problems of scale formation and corrosion. Capital and expense costs of construction and operation of the pilot plant have not yet been calculated, but the three years scheduled for its construction are probably ample.

Step two, which would begin a year after the beginning of step one, would consist of building and operating a plant that would produce a significantly useful amount of new water, about ten million gallons per day. This is equal to 10,000 acre-feet per year, about twice the water requirement of the town of Los Alamos, New Mexico. The energy source for the ten million gpd plant would probably be natural gas, but an important part of step two would be to investigate the alternative of geothermal energy as exploited by the dry hole, water injection technique described later in this report. Other important purposes of step two would be (1) further exploration of the mineral by-product potential of the TRG Project, (2) experimental research on use of water in large-scale greenhouses, and (3) definition of the most practical component unit, or module, for much larger dual-purpose plants. Step two would be continued for at least four years.

SCHEDULE OF FOUR-STEP PLAN

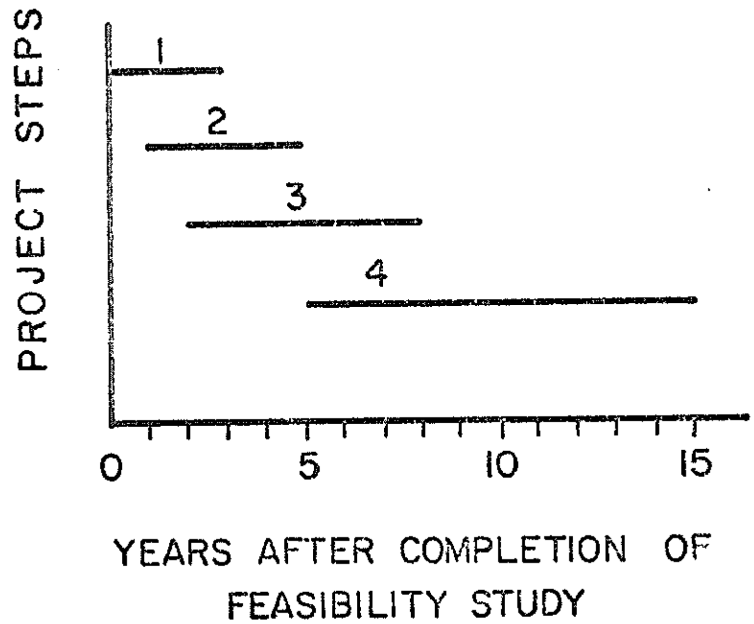


Figure 1

Meanwhile, a year after the beginning of step two, step three would begin. It would consist of the planning, design, construction, and operation of a plant producing about 100 million gallons of desalted water per day, about equal in quantity to the water introduced into the Rio Grande Valley by the San Juan-Chama Diversion. The step three plant would probably also produce marketable quantities of electric power and minerals. Its objective would be the definition of desalting systems for a plant about ten times as big. Its energy source might be fossil fuel, though its fuel requirement would be large enough to make nuclear energy almost obligatory. Because of new concepts under development at Los Alamos, geothermal energy is another possibility (as discussed on a later page.) The 100 million gpd plant would be completed about eight years after the beginning of step one.

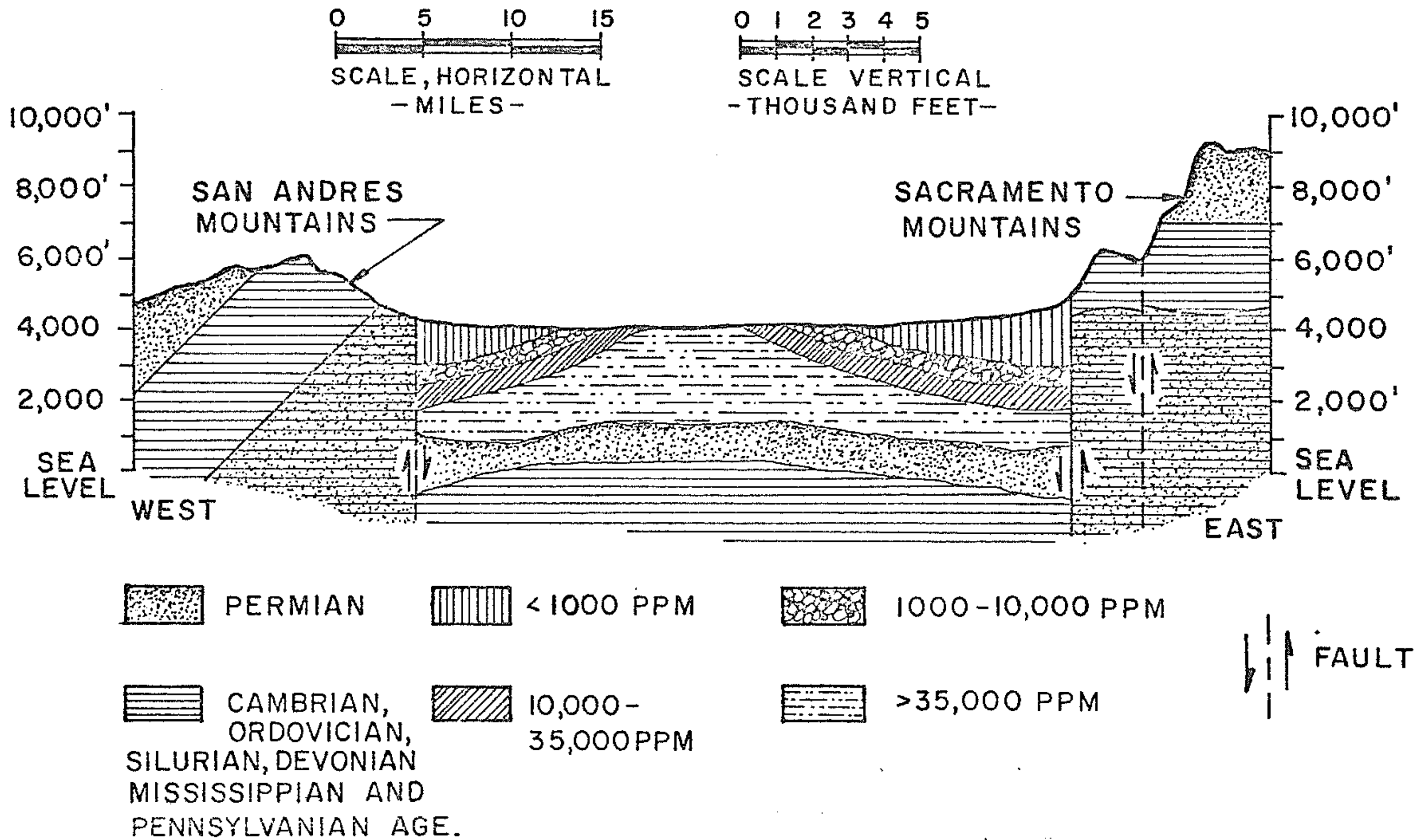
Step four, to occupy the final ten years of the fifteen-year plan, would begin three years after the beginning of step three. It would consist of the construction and operation of a plant using nuclear or geothermal energy to pump and desalt one billion gallons of water per day, and to generate 2000 megawatts of electric power.

Is the TRG Project feasible? Preliminary studies have found evidence that it may prove not only feasible but highly successful.

The Tularosa Basin is a structural trough covering an area of 6500 square miles. It is bounded on the west by the Organ and San Andres Mountains, on the east by the Hueco and Sacramento Mountains, on the north by a broad, high topographic divide, and on the south by a divide separating it from the Hueco Bolson in Texas. The basin floor is relatively flat.

According to a recent study,[5] the trough is filled with alluvial material, a large part of which is saturated with saline water to depths as great as 6000 feet. Hydrologically, the area forms a closed basin with no significant outflow of water. This has resulted in a vast underground reservoir, virtually untapped, estimated conservatively at several hundred million acre-feet. Less than 0.2 percent of the saturated deposits contain fresh water. The groundwater ranges from fresh water on the edges of the basin to concentrations greater than 100,000 parts per million at the center. An east-west cross section of the basin, taken in the vicinity of White Sands National Monument, illustrates this range in salinity (Fig. 2).

Chemical analyses of four wells have been used in the TRG preliminary study on potential mineral recovery. These analyses and the comparable data for seawater are given in Table 1.



EAST-WEST CROSS-SECTION, SHOWING SALINE WATER DISTRIBUTION IN ALLUVIAL FILL

Figure 2

TABLE I (ref. 6)

Chemical Analyses of Sea Water and of Wells in the Tularosa Basin

	Sea Water Mg/1	Well 1 Mg/1	Well 2 Mg/1	Well 3 Mg/1	Well 4 Mg/1
Calcium	400	965	1,660	1,260	250
Magnesium	1,272	3,360	792	62	282
Sodium	10,561	7,938	26,910	10,560	247
Potassium	380	4,617	15,490	7,040	577
Sulfate	2,560	9,280	1,060	1,450	1,210
Chloride		24,000	66,800	28,500	3,390
Bicarbonate		208	112	71	36
Total Dissolved Solids		50,300	112,000	48,900	7,000

Many alternative principles of demineralization exist, several of which have been thoroughly proven in practice during past years. At the moment, the likeliest candidate for use in the Tularosa Basin would seem to be one of the distillation processes, at least for the largest TRG plants, but several alternatives will be considered. What appears to be certain is that the important energy savings inherent in the dual-purpose idea, as illustrated in Table 2, will be taken advantage of to the fullest extent possible.

TABLE II (ref. 7)

Energy Requirement--Combination Plant

	Energy Required--Btu	Total Energy Requirement--Btu
Separate Plants		
Electricity-- 1 kwh	10,377	24,237
Water--147 lb	13,860	
Combination Plant		
Electricity--kwh	17,273	17,273
Water--147 lb		
Difference		6,964

Nuclear energy is generally thought of as the heat source necessary for production of power and desalted water in a large multi-purpose plant. By the time the TRG Project achieves full size, however, there may be an alternative energy source for medium to large-scale power generation and desalting--the geothermal energy stored in the rocks of the earth's crust. One serious limitation on geothermal energy in the past has been the fact that the heat stored in underground rocks was impossible to extract at a high enough rate for practical purposes unless the underground structure included plentiful water. This meant that geothermal energy was nearly useless except in geyser or hot spring areas.

Los Alamos scientists have now proposed a way of extracting energy from solid rock, in the absence of naturally occurring water. Their method makes use of hydrofracturing, a technique first developed for use in oil fields, as a means to establish the initial heat transfer surface in the rock. The first step in developing a geothermal power plant using energy from dry rock would be the drilling of a well into the hot volume. The second step would be hydrofracture--a process in which the pressure of water, pumped down the well from the surface, is used to crack the rock and create a vertical heat-exchange surface, several square kilometers in area. The next step is the drilling of a second hole, this time into the upper part of the heat-exchange volume. After that, water injected into the well is heated by the rocks and circulated to the surface,where its energy can be extracted by conventional means before the water is circulated downward again. Thereafter cracks progress further into the rock mass due to thermally induced strains produced in the hot rock by presence of relatively cool water injected from the surface. As the cracks progress, more hot surface area can exchange heat to the water destined to return to the surface, and so on.

Therefore, if progress continues as expected at Los Alamos, geothermal energy may prove extremely important to the TRG Project. It is known that the Tularosa Basin has at least one area in which underground temperatures are unusually high.[8]

The financial feasibility of the TRG Project was the subject of a preliminary study using rough estimates of cost based on 1968 prices. A cost estimate on the order of one billion dollars was arrived at by adding the costs of the water collection and distribution systems and the land to an extrapolation of AEC-sponsored cost estimates for large nuclear agro-industrial complexes.[9]

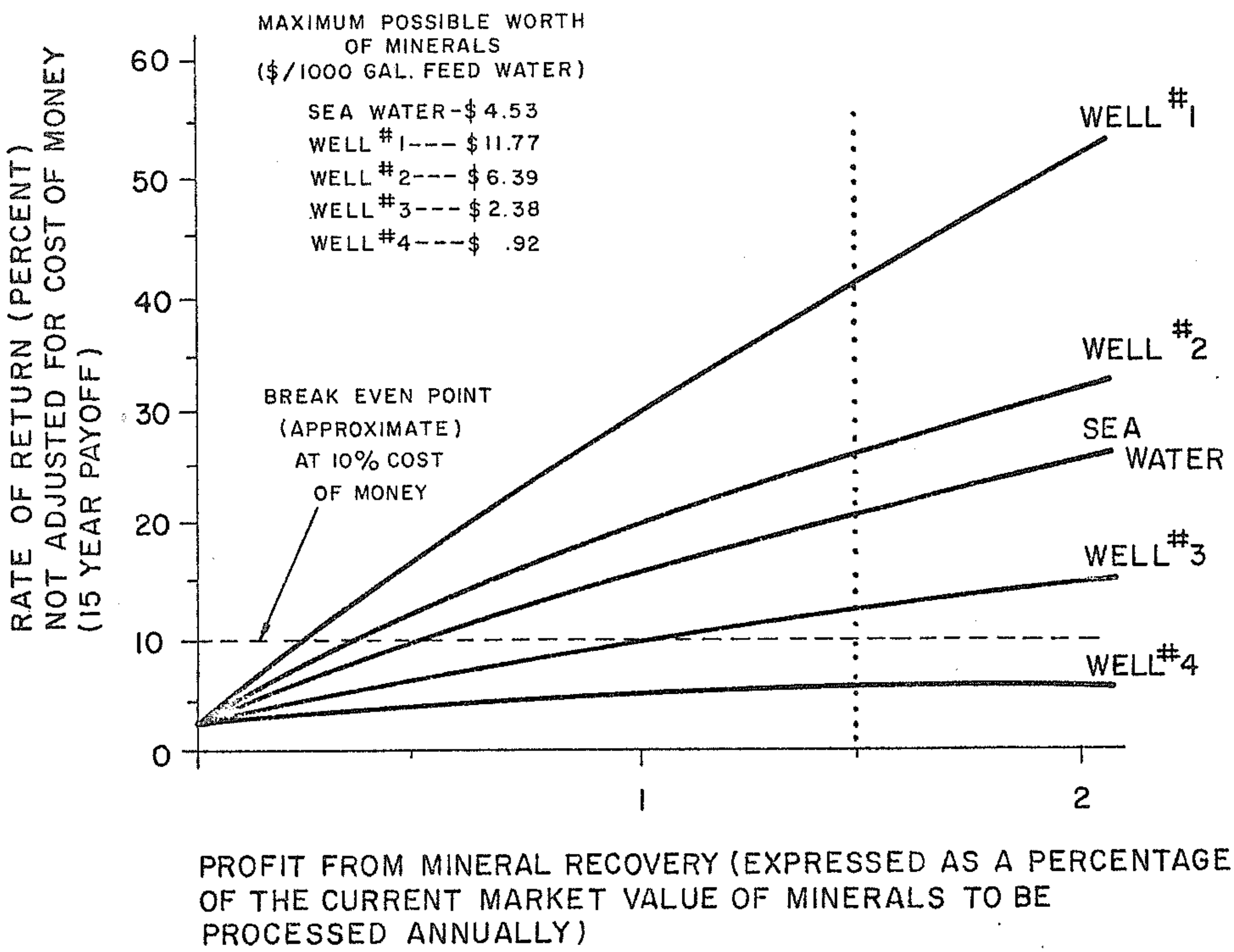
Central to the preliminary financial study was the possibility of selling large quantities of minerals in addition to power and water. Reference 9 lists, as a first order of approximation, the mineral value of brine as 10% of the market price of the contained minerals. In this study, the concentrations shown in Table I were used.

Consideration was given to the elasticity of demand for the minerals. Since large quantities are involved, depression of the market price is a definite possibility. In the case of magnesium, for example, the price of aluminum--already produced in much larger quantities--was taken as a floor under the price of magnesium. The methods of reference 9 were then used to calculate mineral worth of the brine, with the result that the brine was found to be worth 6% of the current market price of the contained minerals.

Results shown in Figure 3 indicate that the TRG Project would be economically viable if the profit from mineral recovery were to equal or exceed only 1.5% of the value, at 1970 prices, of the minerals processed. Since reference 9 indicates a profit percentage four times this minimum requirement, the preliminary results seem to justify hopes of economic success.

In summary, this report describes a project that would provide one million acre-feet of new water annually and 2000 megawatts of new power. Evidence of feasibility already exists in the results of preliminary investigations by the authors, but they urge that a complete feasibility study be undertaken as soon as possible.

POTENTIAL RATE OF RETURN ON CAPITAL
– TRG PROJECT –



Curves based on the measured mineral concentration in four Tularosa Basin wells are shown with a comparison curve based on the average mineral concentration in sea water. The graph shows, for example, that even if only 1.5% of the 1968 market price of recovered minerals could be realized as profit, the annual net rate of return on investment over a 15-year amortization period, with money cost at 10%, would range from break-even for well #3 to about 30% for well #1. Of course a higher mineral recovery profit yield would produce a correspondingly higher return on investment. The graph is based on 5 mills/kwh and $15/acre-foot as the prices of power and water to be sold by the project, and on 50% recovery of minerals.

Figure 3

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