Analysis of the Impact of Legal Constraints on Ground-water Resource Development in Idaho

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Prepared in Cooperation with the Idaho Water Resources Research Institute

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CHAPTER I
INTRODUCTION

Purpose and Scope of the Study

The appropriation doctrine of water law is the basis for groundwater administration in a number of western states. The broad statements presented in individual state statutes are the guidelines for control of the development and location of new wells and the continued operation of existing wells. These guidelines have generally been satisfactory for the period of time when the groundwater resource was being developed. However, many states are now facing conditions of well interference, declining water levels and basin overdraft which require administrative management decisions. The broad guidelines must be interpreted and quantified for resource administration. This report presents an analysis of groundwater management alternatives possible under the broad guidelines of the appropriation doctrine as expressed in the legal code for Idaho.

Legislative phrases such as "full economic development . . . reasonable groundwater pumping levels . . . (and) reasonably anticipated average rate of future natural recharge" are the basis for groundwater administration in Idaho. Each of these phrases is subject to a wide range of interpretation. Pumping levels that are reasonable for whom? What is a reasonably anticipated average rate of future natural recharge for a specific basin? Additional questions arise in the application of these regulatory concepts to a particular basin. Is administration limited to hydrologic units or may separate management subunits be created? What is the pattern of closure of junior users to protect a senior? How many levels of decision are required to provide a quantitative management plan for a basin? Many alternative management schemes are possible for resource administration under the guidelines presented in the Idaho Code. This report provides an analysis of possible administrative actions and their respective impacts on a selected water resource system.

The project was designed as a multidiscipline effort involving hydrology, engineering, economics and law. The general plan of study included: 1) an evaluation of the physical, economic and legal factors relevant to the management of groundwater resources, 2) construction of a mathematical model of the water resource system in an arid basin in southern Idaho, 3) evaluation of the economics of groundwater utilization within the basin, 4) evaluation of the legal alternatives to resource management under the existing legal framework, and 5) quantification of the management alternatives and application of the alternatives to the mathematical model. Chapter I is an introduction to the report. Chapter II, entitled "Idaho Groundwater Law", includes a legal analysis of management alternatives for groundwater under the Idaho Code. Chapter III, "An Economic Analysis of the Effects of a Declining Groundwater Level in the Raft River Basin", includes an economic analysis of groundwater utilization in the selected study basin. "Alternatives for Groundwater Management in Idaho" is presented in Chapter IV. A combined summary and conclusions and discussion is presented in Chapter V. Detailed conclusions are presented at the end of Chapters III and IV.

Statement of the Problem

Groundwater is one of the most important natural resources present in the western United States. Problems of management of the resource have proven to be almost as large and complex as the resource itself. These problems have resulted primarily from man's development of the resource.

Groundwater is part of the hydrologic cycle, the world's water distribution system. Recharge is from precipitation; discharge is mostly to lakes, streams, oceans and the atmosphere. Although groundwater moves under the same general physical laws as surface water, it possesses some characteristics that make management of the resource very unique. Water is generally considered to be a renewable resource. Groundwater, however, possesses some of the characteristics of a non-renewable mineral resource. The occurrence of groundwater is tied very closely with the geologic environment in which it is found. Water movement is slow, generally measured in terms of feet per year. The resource has both the characteristics of a pipeline and a storage system.

The development of groundwater is generally accomplished by the construction and operation of wells. From an operator's point of view, a well is a diversion point similar to a headgate on a stream. From a groundwater point of view, it is a vertical line sink with the discharge dependent largely on the hydraulic characteristics of the aquifer system.

Management of the groundwater resource must include consideration of a number of factors. Physical factors include the hydrogeologic environment, the location and characteristics of man-made discharge points and the relation of the resource to other phases of the hydrologic cycle. Management of the resource is bounded by the existing legal framework. Management guidelines presented in the state code must be followed along with any administrative regulations. The field of economics is necessary to provide a measure of the value of legal and physical certainty of an individual right and the cost of administrative decisions. Groundwater is a common pool resource with all the associated problems of economic externalities. Management decisions must also consider the social costs of alternate administrative plans. In short, groundwater management should be the trend toward optimum utilization of the resource within the physical, legal, economic and social constraints.

The appropriation doctrine is a water resource development plan presented as a series of general concepts. The individual water user has some degree of certainty to the continuation of his use of water under this doctrine. The measure of his certainty is the date of his first use of the water or his priority. Ownership of the resource, however, is held by the state; the individual user can only obtain a right to the use of the water. Administration of the resource is placed with the individual state. The state legal code usually contains a limited description of the prior appropriation doctrine with a few general statements intended as guides for management of the resource. Use of the resource is regulated based upon court cases and upon administrative interpretation of the law. A wide range of management plans is possible under such legal guidelines.

Many of the western states that apply the doctrine of prior appropriation are now becoming concerned with detailed management of the groundwater resource. This study is designed to provide a reference for groundwater administration under the doctrine of prior appropriation by the detailed examination of legal constraints presented in the legal code for the state of Idaho.

Model of a Hydrologic System

The Raft River basin in southern Idaho was chosen as a study area for the analysis of the impact of legal constraints on groundwater development. It is the largest of the five areas in Idaho presently declared as critical groundwater areas and the only one that may be considered as a hydrologic unit. A mathematical model of the water resource system in the basin was constructed as an aid in the evaluation of the legal controls for management. An existing finite difference program, developed by Pinder (1970) provided the basis for simulation. This program was modified to fit the objectives of the study and the particular characteristics of the Raft River Basin. The completed model allowed non-steady state analysis of the water resource system with individual well control. Details of model construction and verification are presented by Goldman (1974).

Description of the Study Basin

The Raft River basin includes a drainage basin of approximately 1,510 square miles located in southern Idaho and northern Utah (Walker et al, 1970)(Figure 1). The area is composed of rugged mountains rising above aggraded alluvial valleys. The climate ranges from humid and subhumid in the higher mountains, to semiarid on the floor of the main Raft River valley. Precipitation ranges from less than 10 inches on the valley floor to more

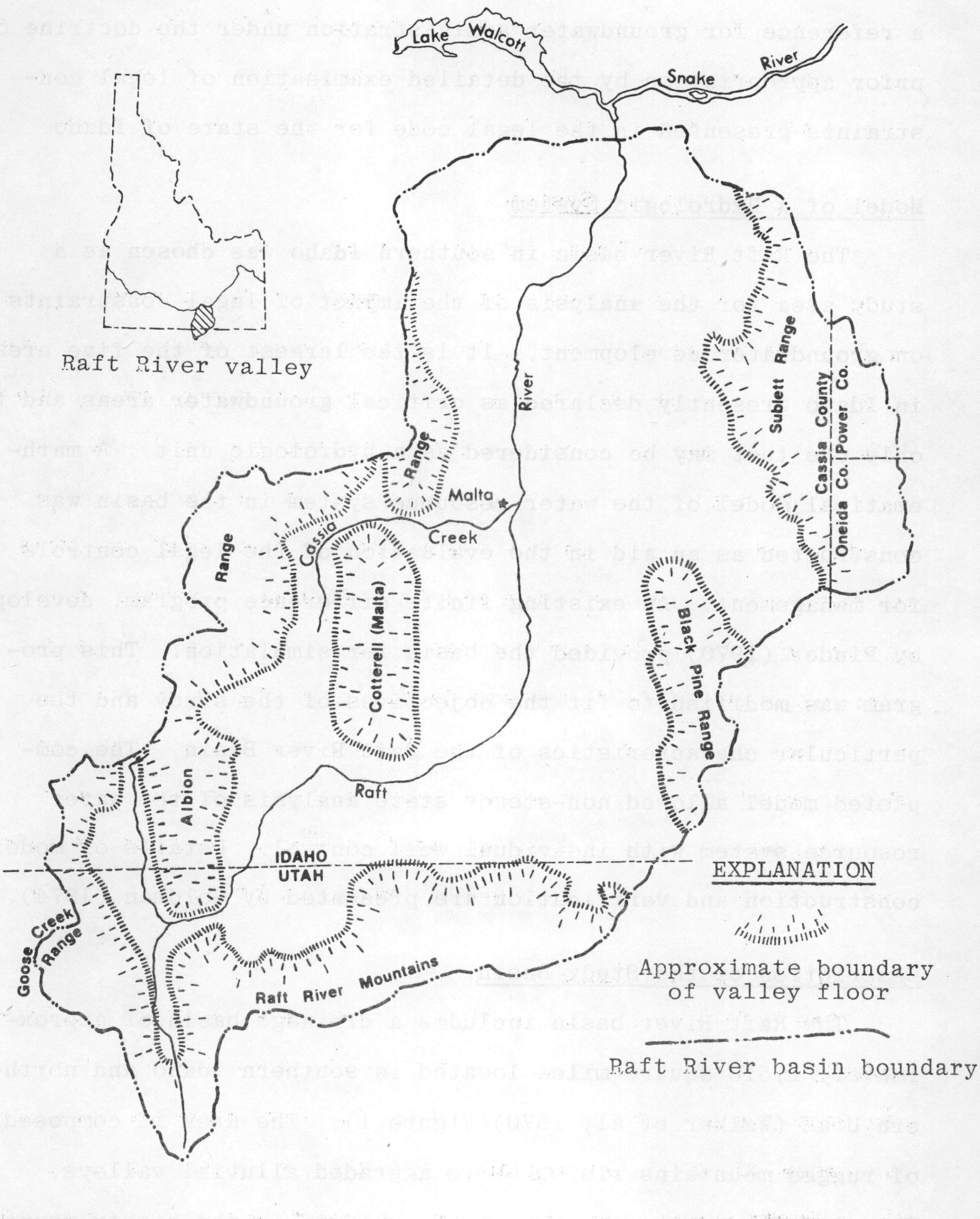

Figure 1

Location Map for the Raft River Basin

than 30 inches near the summits of several ranges. The streams in the basin are tributary to the Raft River which in turn flows north into the Snake River. The lower reaches of the streams are dry in the late summer during most years because of surface water diversion and groundwater pumpage.

The primary aquifers in the basin consist of gravel and sand of the Salt Lake Formation and the Raft Formation and recent alluvium. Basalt of the Snake River Group is also important as an aquifer in the northern part of the basin. The main body of groundwater in the basin occurs under unconfined or water table conditions (Walker et al, 1970, p. 58). Perched groundwater occurs beneath parts of the lowlands; artesian aquifers have been penetrated in several local areas. The depth to water varies from near land surface in the center of the main valley to greater than 400 feet. The known depth of the aquifer system is greater than 700 feet in most parts of the valley and greater than 1,400 feet in the area of greatest pumping.

An estimated 290 irrigation wells were in operation in the basin in 1963 with an increase to 330 in 1966 (Figure 2). The mean discharge from these wells is about 1,300 gallons per minute. The total pumpage in the area increased from approximately 14,000 acre feet in 1950 to an estimated 235,000 acre feet in 1966. About 84,000 acres of land are presently irrigated in the basin. Much of the additional 340,000 acres that lie in the lowlands area could be irrigated if water were available. Walker et al (1970) calculated the total water yield of the basin to be approximately 140,000 acre feet per year. An estimated 9 million acre

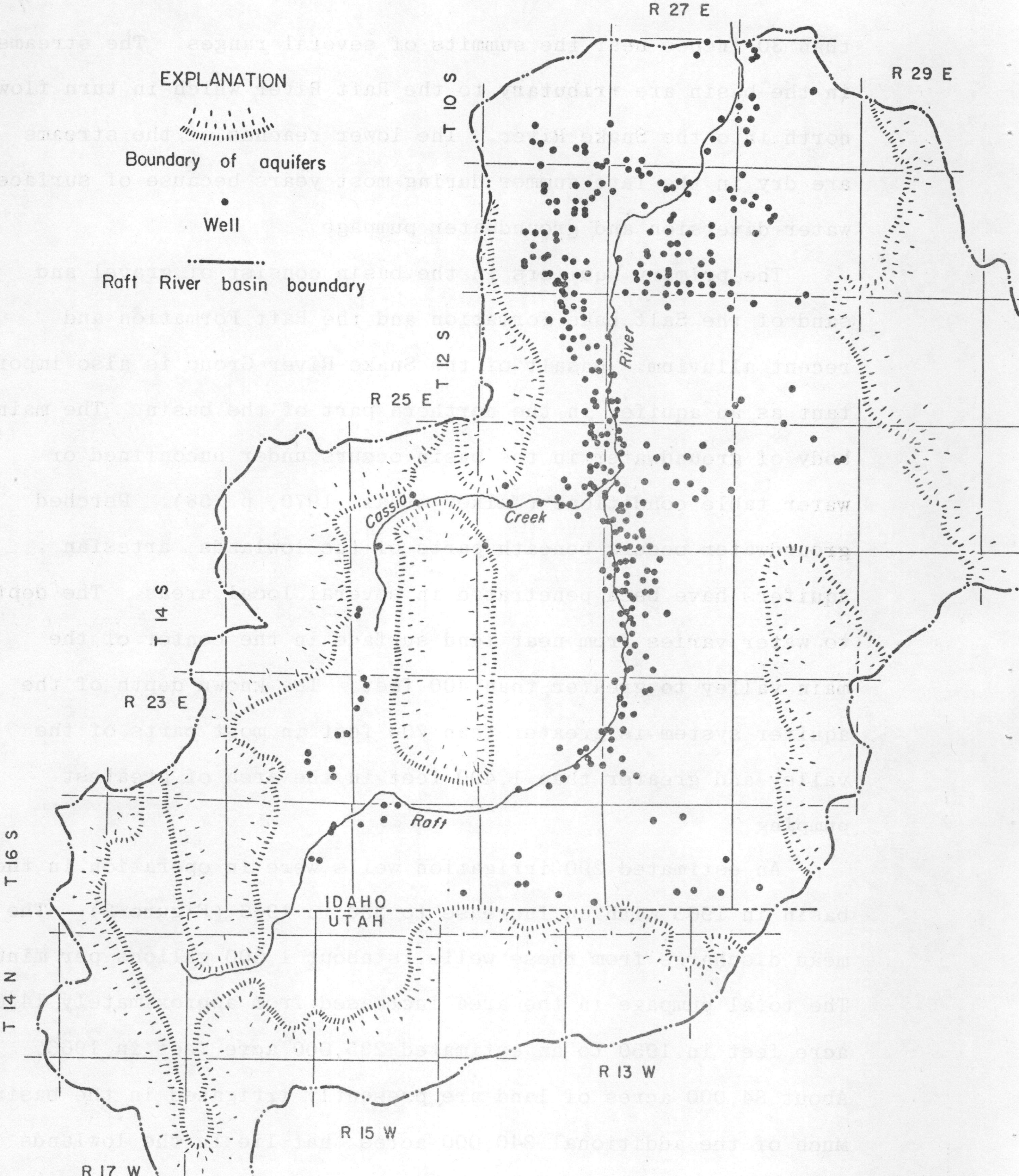

Figure 2

Location of Wells in the Raft River Basin, Idaho and Utah feet of water is in storage in the top 200 feet of the saturated aquifer in the main valley.

The entire Raft River basin was declared a critical groundwater area and closed to future applications to appropriate groundwater in July 1963 because of declining water levels. Aside from changes in the critical designation for several small areas not directly related to the primary problem, the basin has remained closed for groundwater development.

Publications

Results of project investigation are presented in one Ph.D. dissertation, two master's theses, one professional report and two journal articles. Details on the construction of the mathematical model of the water resource system have been presented by Goldman (1974) in a masters thesis in Hydrology. Schatz (1974) has presented the economics portion of the project in a thesis in agricultural economics. The evaluation of groundwater management was reported by Ralston (1974) in a Ph.D. dissertation in Civil Engineering. Grant (1974) has prepared a report on the legal aspects of groundwater management within the state of Idaho. Ralston (1972, 1973) also published several papers on the administration of groundwater as a renewable and nonrenewable resource. These papers were presented at professional meetings. In addition, investigators Ralston, Grant and Schatz, plus Dr. Edgar Michalson and Mr. R. Keith Higginson presented a two-hour panel discussion of groundwater management in Idaho at the 1974 Rocky Mountain Groundwater Conference. Dr. Michalson was an advisor on the economics portion of the study. Mr. Higginson is Director of the

Idaho Department of Water Resources, the water administrative agency in the state.

CHAPTER II
IDAHO GROUNDWATER LAW

The discussion below focuses upon two issues: 1) How are rights to use groundwater acquired? 2) What legal constraints limit the exercise of groundwater rights?

Lay readers of the following analysis should be cautioned not to attempt to solve individual problems on the basis of the principles discussed herein. Since slight changes in fact situations may require a material variance in the legal result, the advice of an attorney should be sought regarding particular fact situations.

Acquisition of Groundwater Rights

Idaho has had a comprehensive Groundwater Act since 1951. That Act as currently amended is the major source of modern groundwater law in the state.[1*] The Act declares that rights to groundwater "may be acquired only by appropriation,"[2] and this applies to "all water under the ground whatever may be the geological structure in which it is standing or moving."[3] Thus, the Act makes no distinction between categories of groundwater. All groundwater is subject to the appropriation doctrine, according to which a water right is acquired by diverting water and applying it to beneficial use.[4]

The Idaho Department of Water Resources[5] supervises the acquisition of groundwater rights by administering a permit system under which a person intending to appropriate water

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*Footnotes for this chapter are presented at the end of the chapter.

applies for a permit prior to commencing work on his diversion and distribution facilities.[6] Idaho's permit system, which applies both to groundwater and surface water appropriations, predates the Groundwater Act and traces all the way back to 1903[7]. Not surprisingly, the permit system has changed in detail over the years. The current statute authorizes the Department to deny a permit application, or grant it for a lesser quantity of water than requested, under the following conditions:

> "where [the] proposed use is such that it will reduce the quantity of water under existing water rights, or that the water supply itself if insufficient for the purpose for which it is sought to be appropriated, or where it appears to the satisfaction of the department that such application is not made in good faith, is made for delay or speculative purposes, or that the applicant has not sufficient financial resources with which to complete the work involved therein . . ."[8]

If the holder of a permit shows the Department that he has diverted water and applied it to beneficial use in accordance with his permit, he is entitled to a license from the Department which is prima facie evidence of a water right.[9]

In addition to the general permit statutes applicable to both surface streams and ground water, there are special provisions in the Groundwater Act governing water permits. The Act introduces the concept of the critical groundwater areas. A critical groundwater area is:

> "any ground water basin, or designated part thereof, not having sufficient ground water to provide a reasonably safe supply for irrigation of cultivated lands, or other uses in the basin at the then current rates of withdrawal, or rates of withdrawal projected by consideration of valid and outstanding applications and permits, as may be determined and designated, from time to time, by the state reclamation engineer [Director of the Department of Water Resources]."[10]

If an application is filed for a permit to appropriate water within a groundwater area which has been designated as critical and if the Director of the Department of Water Resources has reason to believe that there is insufficient water available subject to appropriation at the location of the proposed well, he may forthwith deny the application.[11]

Prior to 1963, the permit procedure was not mandatory for groundwater. An appropriation of groundwater could be established simply by diverting water from the ground and applying it to beneficial use, without first obtaining a permit.[12] An appropriation established in this manner is as valid as one established pursuant to a permit, although the permit procedure traditionally has offered two advantages. First, a right acquired without a permit dates from the time water was first applied to beneficial use, while one acquired pursuant to a permit relates back to and dates from the time of application for the permit.[13] Second, a permit holder who proceeds to obtain a license from the Department has prima facie evidence of priority date and quantity of water appropriated.[14] Recently, the legislature has added a third advantage, at least for groundwater areas incorporated into water districts. A statute was enacted providing that a nonpermit right which has never been recognized in an adjudication shall be treated, for the purpose of distributing water during time of scarcity, as inferior to any adjudicated permit or licensed right within the water district.[15]

In 1963 the Groundwater Act was amended to make the permit procedure mandatory for groundwater appropriations,[16] and five years later the mandatory system was sustained against consitutional challenge by the Idaho Supreme Court.[17] Since 1963, one diverting water and applying it to beneficial use without a permit acquires no right under the mandatory permit system.[18] Several classes of wells are exempted from the requirement of a permit, however. These are 1) wells for domestic purposes,[19] 2) wells for drainage purposes,[20] and 3) wells of owners of irrigation works which wells are "for the sole purpose of recovering groundwater resulting from irrigation under such irrigation works for further use on or drainage of lands to which the established water rights of the parties constructing the wells are appurtenant . . . ."[21]

<u>Legal Constraints on Exercise of Groundwater Rights</u>

<u>Introduction</u>

Section 237a(g) of the Idaho Groundwater Act empowers the Director of the Department of Water Resources to supervise and control the exercise of groundwater rights. It goes on to provide:

> "[I]n the exercise of his power he may by summary order, prohibit or limit the withdrawal of water from any well during any period that he determines that water to fill any water right in said well is not there available ... Water in a well shall not be deemed available to fill water right therein if withdrawal therefrom of the amount called for by such right would affect, contrary to the declared policy of this act, the present or future use of any prior surface or ground water right or result in the withdrawing of the ground water supply at a rate beyond the reasonably anticipated average rate of future natural recharge."

This statute is the most basic source of authority in the Act for controlling the adverse effects which the operation of a well can have. It lists two grounds for shutting down an existing well, partly or completely, within the framework of the appropriation doctrine. The first is when a junior well affects a senior right contrary to the declared policy of the Act. The second is when withdrawals from an aquifer exceed the reasonably anticipated average natural recharge.

The initial part of the above quotation from section 237a(g) states that the Director of the Department of Water Resources "may" shut down a well if there is not water available to fill any water right in the well, i.e., when either of the two grounds mentioned exists. A later provision of section 237a(g), not quoted above, says that the Director "shall, upon determining that there is not sufficient water in a well to fill a particular ground water right therein by order, limit, or prohibit further withdrawals of water under such right as herinabove provided..." (Emphasis added.) The Idaho court recently held, in Baker v. Ore-Idaho Food, Inc.[22] that well closure is mandatory when the second of the two grounds stated in the statute is present, i.e., when withdrawals from an aquifer exceed the reasonably anticipated average natural recharge. There seems to be no basis for taking a different approach under the statute regarding the first of the two grounds. Thus, the work "may" near the beginning of the last quotation from section 42-237a(g) should be read as "shall."[23]

The Average Natural Recharge Clause

As noted above, one clause of section 237a(g) empowers the Director of the Department of Water Resources to close a well when its operation would "result in the withdrawing the ground-water supply at a rate beyond the reasonably anticipated average rate of future natural recharge." In the Ore-Ida Foods case, the Idaho court held that this clause forbids the mining of an aquifer. The court defined "mining" as "perennially withdrawing groundwater at rates beyond the recharge rate."[24] The court's definition of "mining" was taken from a widely cited article on groundwater mining[25] and is in accord with standard usage of the term to refer to permanent depletion of stored groundwater by withdrawals in excess of long term mean annual water supply to the basin.[26]

The component parts of the average natural recharge clause of section 42-237a(g) bear close scrutiny. The clause prohibits "the withdrawing the groundwater supply at a rate beyond the reasonably anticipated average rate of future natural recharge." The statute does not define the word "withdrawing". If total discharge from an aquifer, including both 1) natural discharge by evaporation, transpiration, and seepage into streams, lakes or adjacent groundwater systems, and 2) artificial discharge through wells, exceeds total recharge, then water in storage is depleted and groundwater levels will drop. Since perennial overdraft of this nature would seem to violate the anti-mining holding of the Ore-Ida Foods case, the word "withdrawing" in the statute should be construed to include both natural and artificial discharge. This is so even though in ordinary language we might not speak of natural discharge from an aquifer as constituting the withdrawal of water. If the word "withdrawing" in the statute were interpreted as referring only to artificial discharge through wells and such withdrawals were allowed in a volume equal to total recharge, it is almost inevitable that total discharge from the aquifer i.e., the sum of artificial discharge and natural discharge, would exceed total recharge and there would be a perennial overdraft. In other words, there would be mining. It is puzzling, therefore, that the decision in the Ore-Ida Foods case affirmed a trial court order which seems to allow artificial withdrawals alone to equal total recharge. This does not square with the court's statement in the same case that "(w)e now hold that Idaho's Groundwater Act forbids 'mining' of an aquifer."

Does it necessarily follow that every permanent depletion of stored groundwater should run afoul of the no mining policy of the Ore-Ida Foods case? When the extraction of groundwater by wells is commenced, total discharge may for a time exceed total recharge. Then later the resulting decline in water level may either increase recharge or, more likely, decrease natural discharge to the point that total discharge and total recharge come into balance and produce a new stable, but lower, water level. (This process will be described more fully by the quotation in the next paragraph.) It is possible, then, for a period of storage depletion to be followed by an equilibrium condition between total discharge and total recharge even though artificial discharge does not decrease.[27] If an overdraft situation is anticipated to be only temporary for this reason, arguably it would not constitute mining in the sense denounced in the Ore-Ida Foods case, i.e., perennial overdraft, even though the temporary condition is expected to continue for several years or longer. In the Ore-Ida Foods case there was no evidence that the overdraft would correct itself through an increase in recharge or a decrease in natural discharge; closure of some wells was the only way to stop annual overdrafts. Thus, the court did not necessarily have in mind during its discussion the kind of disequilibrium just hypothesized.

Even if such a temporary overdraft, with permanent but carefully limited depletion of storage, it is not necessarily prohibited by the Ore-Ida Foods case, there is need to consider whether it is prohibited by the underlying statutory language i.e. the average natural recharge clause of section 237a(g) The clause itself does not further define the proscription against withdrawals in excess of recharge, but an earlier part of the same statute declares a policy "to conserve . . . groundwater resources." Arguably, it would be permissible to allow the limited permanent depletion of storage now being discussed when the stated policy of conserving groundwater resources is juxtaposed with these facts:

> "When pumping from wells is started, it must be accompanied by a drop in water level . . . The drop increases the opportunity for recharge from influent streams. It reduces the area of seep lands and uneconomic losses through consumptive use and evaporation. It provides opportunity for penetration of rain falling on the valley floors, which under normal conditions did not happen because the groundwater levels were too high. It also increases the opportunity for underflow into the reservoir by increasing the gradient.
>
> Extractions by pumping from wells at this state of groundwater development functions as a conservation measure by converting uneconomical losses to beneficial uses."28

Further indication that the legislature contemplated the possibility of reaching a new equilibrium after a period of storage depletion can be found by reference in the average recharge clause to "the reasonably anticipated average rate of future natural recharge". Past recharge rates are not necessarily determinative under this language. Arguably, at least it would be permissible to look to expected future recharge at a new, lower water level where the net average natural recharge would be greater than at the present level.

If the foregoing analysis is accepted, then neither the average natural recharge clause of section 42-237a(g) nor the Idaho court's interpretation of it in the Ore-Ida Foods case would preclude all permanent depletion of water stored in an aquifer. Permanent depletion of storage could occur in the special kind of situation described above.

The next topic is the significance of the word "average" in the average natural recharge clause. Precipitation is a major factor in determining recharge. All other things being equal, recharge into a basin which is not already filled to capacity is likely to be greater in a wet year than in a dry year. The average natural recharge clause seems to contemplate computing the rate of recharge over a sufficiently long period that series of wet and dry years tend to average out. This would allow temporary depletion of storage during a dry year or series of dry years. The advantage of such a policy has been described as follows:

> "(Such) lowering of the water table . . . creates a capacity for storing and carrying over the water that originates in wet periods for use during dry periods.
>
> In that respect a groundwater reservoir is not unlike a surface reservoir. A reservoir that is maintained full or nearly full at all times is not being used to greatest advantage. Falling water tables during dry periods should not necessarily be viewed with alarm, because water placed in storage

during wet periods is being drawn upon and storage capacity is being created for the wet periods that follow."[29]

The author of the above excerpt goes on to add that falling or even static water tables during wet periods are a "serious problem." It is this problem to which the average natural recharge clause of section 42-237a(g) seems to be directed, rather than the cyclical fluctuation from dry to wet years.

There is another aspect of the average natural recharge clause which requires close examination. The clause prohibits withdrawals in excess of average natural recharge. In some states the sustained yield capacity of certain groundwater basins has been increased through artificial recharge, i.e., by techniques such as injection wells, water spreading, and recharge pits.[30] The option of artificial recharge seems to be foreclosed by the language of the Idaho statute.

The exact scope of the statutory limitation to natural recharge is not clear, however, most groundwater diversions, when used on the surface, are not fully consumed. Some of the unconsumed water may return to the aquifer. As much as half of the water pumped for irrigation may return to the aquifer.[31] Assume that recharge to an aquifer from precipitation and stream inflow averages 100,000 a.f. (acre feet) per year and that irrigation withdrawals average 100,000 a.f. per year, with fifty percent return flow to the aquifer. Is the "natural" recharge 100,000 a.f. per year or 150,000 a.f. per year? To state the same question differently, is the 50,000 a.f. of return flow "natural" recharge? The Idaho court did not have to face this question in the Ore-Ida Foods case because the water source there was a confined aquifer which did not receive return flow recharge from the area of water use. While the no-mining policy of section 42-237a(g) would not be violated by treating return flow to an aquifer as natural recharge when computing the amount of water that may be withdrawn from it under the statute, this does not necessarily prove that return flow should be treated as natural recharge. The statute prohibits not only mining, but also the avoidance of mining through artificial recharge.

The answer to the question of how to treat return flow under the statute must, of course, lie in legislative intent. The extent to which a natural/artificial recharge dichotomy has a settled meaning in the field of hydrology is likely to be highly significant, however, A leading groundwater hydrology text defines artificial recharge as "augmenting the natural infiltration of precipitation or surface water into underground formations by some method of construction, spreading of water, or by artificially changing natural conditions".[32] Another defines it as "the practice of increasing, by artificial means, the amount of water than enters a groundwater aquifer".[33] Insofar as the word "artificial" appears in the definitions, they are circular and not particularly helpful. Since the irrigation water was artificially withdrawn from the aquifer in the first place, it might be argued that return flow from the irrigation must be treated as artificial recharge. On the other hand, the return flow is an unintended by-product of irrigation due to the natural force of gravity. One text classified the practice of increasing infiltration into the ground in irrigated areas by irrigating with excess water during dormant, winter or non-irrigation seasons as artificial recharge.[34] Could the difference between natural and artificial recharge implicit in the Idaho statute turn upon a distinction between return flow which is unintended and that which is deliberate and motivates the entire process? Although such a distinction may fall short of being a self evident truth and may generate classification difficulties in practice, support for the distinction may be found in a recent groundwater study prepared for the National Water Commission.[35] The study lists four sources of groundwater recharge, namely, 1) precipitation, 2) stream flow, 3) return flow to groundwater, and 4) artificial recharge. The study distinguishes the "intentional and purposeful use of aquifers to store water" from "recharge which is essentially unintentional and which is incidental to some other process". It states that "artificial groundwater storage normally is, and always should be used to describe only" the former situation.

There is some basis, then, in the language of hydrology for a distinction between intended and unintended return flow even though such a distinction has its arbitrary aspects. (Perhaps the true source of arbitrariness is the legislative decision to exclude artificial recharge in computing permissible withdrawals from an aquifer.) The advantage of making such a distinction is that it would enable greater utilization of groundwater under the Idaho statutory framework than would the classification of all return flow as artificial recharge. Furthermore, it would be in harmony witha legislatively announced policy, in the first section of the Idaho Groundwater Act, to promote the "full economic development of underground water resources."[36]

The Adverse Effect Clause

The possible adverse consequences to others from the operation of a well previously may be divided into five classes: 1) interference with other wells, 2) interference with surface water rights, 3) compaction and land subsidence, 4) water quality impairment, and 5) depletion of storage to the detriment of future generations. The average natural recharge clause of section 42-237a(g) prohibits the occurrence of any of these consequences to the extent that they are produced by groundwater mining--and mining may produce any or all of them. The first four types of consequences can occur, however, even without mining in the usual sense of the term, i.e., without permanent depletion of storage due to perennial overdrafts. The question for discussion here is the extent to which the adverse effect clause of section 42-237a(g) regulates such consequences.

It will be well to begin by repeating the precise language of the adverse effect clause:

> "Water in a well shall not be deemed available to fill a water right therein if withdrawal therefrom of the amount called for by such right would affect contrary to the declared policy of this act, the present or future use of any prior surface or groundwater right . . ."

Since the clause forbids only those adverse effects which are "contrary to the declared policy of this act," identification of the declared policy of the Groundwater Act is essential. Section 42-237a(g) refers in an offhand fashion to "the policy of this state to conserve its groundwater resources". Section 42-226 includes the following statement of policy:

> "It is hereby declared that the traditional policy of the state of Idaho, requiring the water resources of this state to be devoted to beneficial use in reasonable amounts through appropriation is affirmed with respect to the groundwater resources of this state as said term is hereinafter defined*: *and while the doctrine of 'first in time is first in right' is recognized, a reasonable exercise of this right shall not block full economic development of groundwater resources, but early appropriators of underground water shall be protected in the maintenance of reasonable groundwater pumping levels as may be established by the . . . [Director of the Department of Water Resources] as herein provided*". (The asterisk and italics are part of the statute.)

In addition to the formal declaration of policy at the beginning of the section, the italicized language implicitly declares a policy of promoting "full economic development of groundwater resources". The touchstone for interpreting this language is legislative intent, but the task is made difficult by the absence of any record of legislative history of the Groundwater Act. The Colorado legislature has enacted a similarly worded statute,[37] but there is nothing illuminating in the Colorado legislative history or judicial decisions.

One possible approach in seeking insight into the meaning of the "full economic development" language of section 42-226 of the Idaho Groundwater Act is to examine what was being said about the earlier law which the Act replaced. Apparently it was generally believed that Idaho pre-Ground Act cases protected a senior well owner's historic means of diversion, i.e., pumping level or artesian pressure, without regard to its reasonableness. Thus, the following criticism of Idaho groundwater law appeared in the Journal of the American Water Works Association in 1938:

> "One feature of the doctrine of appropriation in certain cases deserves notice. Thus, in two Idaho cases (Bower v. Moorman, 27 Idaho 162,147 Pac.

> 496, 1915; Noh v. Stoner, et al., 26 Pac. 2d 1112, 1933) where prior appropriatiors claimed harmful effects from wells of later nearby appropriators, the court awarded damages. There is no indication in the decisions that the defendants set up as their justification, that by the laws of nature it would generally be impossible for any subsequent user of groundwater to pump from the same water bearing formation without affecting to some degree the water level and yield of every well previously installed in the area. Carried to an ultimate conclusion, these decisions might mean that in many areas the first appropriator could require damages from all later appropriators, until the last one would have to pay tribute to all. If the doctrine of appropriation is to accomplish the desired end of making full use of the groundwater resources of the state, it must be recognized that some lowering of the water table or of the artesian pressure is a reasonable result of a reasonable method of diversion (pumping) of the water and should not constitute a basis for damages."[38]

Immediately prior to adoption of the Groundwater Act, there was some uncertainty in the legal profession about the extent to which a senior well appropriator's means of diversion should be protected under the priority principle of the appropriation doctrine.[39] When the Groundwater Act was adopted in 1951, section 42-226 merely affirmed that the appropriation doctrine governed groundwater development. Two years later the legislature added the following phrase to it:

> *"and while the doctrine of 'first in time is first in right' is recognized, a reasonable exercise of this right shall not block full economic development of underground water resources, but early appropriators of underground water shall be protected in the maintenance of reasonable groundwater pumping levels as may be established by the . . . [Director of the Department of Water Resources] as herein provided."*

This amendment is consistent with and likely was motivated by the sentiment expressed in the above quoted excerpt from the Journal of the American Water Works Association.

The full economic development concept of section 42-226 has not been the subject of judicial comment except for dictum in Baker v. Ore-Ida Foods, Inc. That case contains the following statement:

> "Idaho's Groundwater Act seeks to promote 'full economic development' of our groundwater resources . . . . (The Groundwater Act is consistent with the constitutionally enunciated policy of promoting optimum development of water resources in the public interest.) Idaho Const. Art. 15,S7. Full economic development of Idaho's groundwater resources can and will benefit all of our citizens. Trelease, F.J., Policies for Water Law: Property Rights, Economic Forces and Public Regulation, 5 Nat. Resources Journal 1 (1965): Hutchins, W.A., Groundwater Legislation, 30 Rocky Mountain L. Rev. 416 (1958)."[40]

The court's citation of the Trelease and Hutchins articles calls for examination of them to see what they say about the concept of full economic development of groundwater resources. Although neither of the articles discusses the exact phrasing of the Idaho statute, the Trelease article refers to the "maximization principle" in economics, under which the goal is to obtain the largest possible net social returns from the use of a resource. Trelease concludes that the maximization principle does not require compulsive development of water: "What is to be maximized is welfare from water use, not water use itself".[41] He reports that economists have not yet devised any magic test for determining when maximization has been achieved:

> "Some have attempted to take a given resource, a river with known potentialities of use, and discover that use or combination of uses producing the greatest economic product from a given expenditure of goods and services. In a more complicated fashion others have tried to determine by linear programming the point at which the optimum ratio between expenditures and benefits is reached, out of all possible combinations of 'inputs and outputs'. Some economists try to eliminate the dollar as a measuring device, since market values fluctuate, and since the value to society of the product of a water resource project may not be accurately reflected by money. By using the technique of 'indifference curves', they measure the relative welfare position of each combination of uses against other combinations and reach a

ranking or desirability of alternatives rather than a comparison based on the common denominator of the dollar."[42]

The phrase "full economic development" in section 42-226 could mean any of these things. A recent groundwater study prepared for the National Water Commission says that the goal of economic efficiency in resource allocation is achieved by:

"that combination of resources which produces the maximum net benefits (i.e., total benefits less costs) to the owners, users and beneficiaries of the resource over time. Applied to groundwater and related resources this means that the total resource - water, storage capacity, transmission and treatment capability of the underground structures - should be used to achieve maximum net benefits."[43]

This would seem to be a justifiable interpretation of the phrase "full economic development".

The policy of full economic development which is stated in section 42-226 is not to be pursued at all costs. It is qualified by the following language of the same section:

"but early appropriators of underground water shall be protected in the maintenance of reasonable groundwater pumping levels as may be established by the . . . [Director of the Department of Water Resources] as herein provided."

Thus, it is necessary to explore the concept of reasonable pumping levels.

The only other reference to the concept in the Groundwater Act appears in section 42-237a(g), sandwiched between a delegation of power to the Director to close any well for which he determines water "is not available" and the statement that water shall not be deemed available if operation of the well would "affect, contrary to the declared policy of this act, the present or future use of any prior surface or groundwater right or result in the withdrawing the groundwater supply at a rate beyond the reasonably anticipated average rate of future natural recharge."

The specific language is this:

> "To assist the . . . [Director of the Department of Water Resources] in the administration and enforcement of this act, and in making determinations upon which said orders shall be based, he may establish a groundwater pumping level or levels in an area or areas having a common ground water supply as determined by him as hereinafter provided."

Since section 42-237a(g) empowers the Director to issue well closure orders either to prevent injury to a senior appropriator contrary to the declared policy of the act or to prevent mining, it might seem at first blush that, under the statutory language quoted immediately above, the Director might set a reasonable pumping level in a particular area and then, if existing pumping levels are above that, allow mining down to the reasonable level before issuing closure orders. Baker v. Ore-Ida Foods Inc., expressly rejects this interpretation, however. Thus, it is only in closing a well for creating an adverse effect contrary to the policy of the Act that the concept of reasonable pumping levels comes into play.

In dicta the Idaho court made these additional observations in the Ore-Ida Food case about reasonable pumping levels:

> 1. "Priority rights in ground water are and will be protected insofar as they comply with reasonable pumping levels. Put otherwise, although a senior may have a prior right to ground water, if his means of appropriation demands an unreasonable pumping level his historic means of appropriation will not be protected."[44]
>
> 2. "Because of the need for highly technical expertise to accurately measure complex ground water data the legislature has delegated to the I.D.W.A. [now the Department of Water Resources] the function of ascertaining reasonable pumping levels . . . Implicit in this delegation is the recognition that reasonable pumping levels can be modified to conform to changing circumstances."[45]

In addition, the Court quoted the following statement by a commentator about the reasonable pumping level concept in the

Groundwater Act:

> "If 'reasonable pumping levels' were interpreted by the court as requiring each appropriator to alter his means of diversion a little each year, or a little with each subsequent appropriator until full development was achieved, the statute would accomplish its purpose. (Emphasis supplied) Comment, Who Pays When the Well Runs Dry, 37 U. Colo. L. Rev. 402, 413 (1965)."[46]

The references to reasonable pumping levels in the Act and the discussion in the Ore-Ida Foods case still leave a lot of questions unanswered and difficulties unresolved. Among them are the following.

First, does the statutory reference to protecting "reasonable pumping levels" imply that a means of diversion consisting wholly of artesian pressure (i.e., no pumping) is not entitled to protection?

Second, in determining the actual pumping level of an existing well, where are the beginning and ending points of the measurement? Should the beginning point be affected by whether a well is located on a hill or in a valley? How far downward should the measurement be continued -- to the water table, all the way down to the bottom of the cone of depression, or to some intermediate point? It might be argued that the measurement should include the drawdown caused by operation of a pump since section 42-226 refers to reasonable "pumping levels", not reasonable static water levels. Such an interpretation would generate complexity, however, since the drawdown of a well is in part a function of its efficiency, and taking drawdown into account would require a decision about permissible well efficiency. Also, localized differences in transmissivity within an aquifer can produce significant variations in drawdown. To what extent should that be taken into account?

Third, in furtherance of the policy of full economic development of groundwater stated in section 42-226, it would seem that economic, as well as physical factors should be taken into account in developing reasonable pumping level regulations. In doing so, to what extent should or can it be recognized that the land overlying a groundwater basin may encompass areas of varying climates, soil types, and crop yields? The only statutory guidance on this question is a clause in section 42-237a(g), which empowers the Director of the Department of Water Resources to:

> "establish a ground water pumping level or levels in an area or areas having a common ground water supply as determined by him as hereinafter provided."

If the work "area" refers to overlying land and the words "common ground water supply" refer to an aquifer, then the phrase "areas having a common ground water supply" would seem to imply that the land overlying an aquifer can be divided into various areas according to such factors as topography, climate, and soil type. Furthermore, the word "levels" seems to suggest that different pumping levels may be established for different areas.

The foregoing analysis depends upon defining the word "areas" in the above quoted clause of section 42-237a(g) as referring to land overlying an aquifer. This is not implausible in view of the following additional language in the same section:

> "[The Director] shall also have the power to determine what areas of the state have a common ground water supply and whenever it is determined that any area has a ground water supply which affects the flow of water in any stream or streams in an organized water district, to incorporate such area in said water district; and whenever it is determined that the ground water in an area having a common ground water supply does not affect the flow of water in any stream

> in an organized water district, to incorporate such area in a separate water district . . ."

The words "area" and "areas" here seem to refer to surface land area.

If the land overlying an aquifer may be subdivided into various areas according to economic factors such as topography, climate, and soil type, may other economic factors be considered also -- for example, the fact that a particular farmer may have just invested a lot of capital into a pumping plant, and if a reasonable pumping level is set lower than the physical capacity of his plant, he will suffer a significant economic loss? If the justification for considering economic factors is the policy of full economic development or a general concern with efficient resource allocation, the answer to this question should depend upon whether or not protection of the farmer's investment will help to promote full economic development or efficient resource allocation. At first blush, protecting an existing investment in a pumping plant may seem to run counter to a policy of full economic development. After all, section 42-226 provides that "while the doctrine of 'first in time is first in right' is recognized, a reasonable exercise of this right shall not block full economic development of underground water resources." A contrary argument can be made, however. Without investment in pumping plants by farmers and other water users, there will never be full economic development of Idaho's groundwater resources. If a farmer does not have a reasonable expectation that his investment in a pumping plant will yield a fair return, he will not make the investment. He can hardly have such an expectation if his existing investment in a pumping plant is totally irrelevant to the setting of reasonable pumping levels.

One of the historic policies underlying the appropriation doctrine has been the promotion of investment needed for water resource development by giving security of use.[47] Since section 42-226 does affirm the appropriation doctrine for groundwater -- albeit modified by a policy against protecting historic means of diversion without regard to reasonableness in the event that prior Idaho case law had interpreted the appropriation doctrine as affording such protection -- concern about protecting existing investment in pumping plants and related capital outlays should not be totally irrelevant to setting reasonable pumping levels. Probably, it should be a relevant but not controlling factor.

Fourth, consideration of economic factors inevitably raises social issues as well. For example, there is evidence that due to economies of scale a large farm may be able economically to pump from a significantly greater depth than a small farm.[48] If pumping levels are set by reference to what is reasonable for large farms, small ones may be driven out of existence. Does the legislative delegation of power to regulate pumping levels really include a power to regulate farm size? If so, does the policy of full economic development compel a preference for larger farms if they are more efficient production units? Even among farms of the same size, the kind of crop produced will affect the reasonableness of a particular pumping level. Should the production of potatoes be favored over the production of some other crop? A reasonable pumping level for a small domestic user might be less than for an irrigator. What should be done about the small domestic user?

Fifth, it is likely that the reasonable pumping level statute was aimed at well interference disputes.[49] As noted earlier, the operation of a well may have other adverse effects even in the absence of a general condition of groundwater mining. There may be interference with surface water rights, compaction and land subsidence, or water quality impairment. To what extent may, or must, these potential adverse effects be taken into consideration in the setting of reasonable pumping levels? Section 42-237a(g) empowers the Director of the Department of Water Resources to prohibit groundwater withdrawals which "would affect, contrary to the declared policy of this act, the present or future use of any prior surface or ground water right." Section 42-231 directs him "to do all things reasonably necessary or appropriate to protect the people of the state from depletion of ground water resources contrary to the public policy expressed in this act." The full economic development policy of section 42-226 would seem to authorize an accounting for all costs -- including not only costs in terms of interference with senior surface water rights expressly mentioned in section 42-237a(g) but also compaction and land subsidence costs -- in seeking to achieve an optimum allocation of the groundwater resource through the tool of reasonable pumping levels.[50]

As the foregoing discussion indicates, the Groundwater Act does not give very clear or specific guidance for the resolution of a number of questions or difficulties that must be faced in the development of reasonable pumping level regulations. The questions posed above are hardly more than the tip of the iceberg, and the analysis of the questions is more in the nature of arguments-that-can-be-made rather than hard and fast conclusions. Perhaps of major significance is the language in section 42-231 which empowers the Director "to do all things reasonably necessary or appropriate to protect the people of the state from depletion of ground water resources contrary to the public policy expressed in this act." (Emphasis added.)[51] It might be argued that this constitutes an implied delegation of authority to resolve these questions and difficulties which are not very well covered explicitly in the Groundwater Act in any way that would make sense in view of hydrologic, economic, and social considerations. In other words, the argument would be that the Director can consider factors and make distinctions, which are reasonably necessary to accomplish the public policy expressed in the Act. Some support for this implied powers approach may be found in the Ore-Ida Foods case, where the court did not hesitate to find an implicit delegation of authority to the Director to modify reasonable pumping levels from time to time to conform to changed circumstances.[52] The court did not explain its rationale for this conclusion but the justification would seem to be that it is reasonably necessary for the Director to have the power of modification.

Perhaps the most serious difficulty with the implied powers approach lies in the rule that an attempted legislative delegation of rule making power to a state agency is invalid unless the delegation is limited by legislatively prescribed standards to guide the agency, directing and channeling its discretion.[53] In upholding a delegation of rule making power to the State Tax Commission, the Supreme Court of Idaho phrased the limitation this way:

> "It is an accepted rule of judicial decision that the legislative function has been complied with, where the terms of the statute are sufficiently definite and certain to declare the legislative purpose and the subject matter meant to be covered by the act; and that the legislature may constitutionally leave to administrative agencies the selection of the means and the time and place of the execution of the legislative purpose, and to that end may prescribe suitable rules and regulations."[54]

The central difficulty in applying the legislative standards requirement is to determine how tight the standards must be.[55] For example, it was noted earlier that the power to set pumping levels may entail a power to determine (and require a decision upon) minimum farm size.[56] Is this delegation of power adequately circumscribed by the statutory reference to the policy of full economic development of the state's groundwater resources? It probably would be unwise to try to predict how the Idaho court would answer this question in view of the following two observations by Frank Cooper in his authoritative treatise on state administrative law:

1. "[W]hile the doctrine [of legislatively prescribed standards] has proved a useful tool and has provided a means of imposing workable controls on administrative discretion, nevertheless it cannot be relied upon as a basis for predicting judicial decision."[57]

2. "The courts soon came to recognize that the test must necessarily vary with the nature of the power conferred. It is quite all right to insist, with exactly measurable precision, that a liquor control commission may not license a dramshop within 500 feet of a church or school; but when the question is how many customers a contract motor carrier may serve, a greater measure of

> discretion must be accorded the agency, to permit it to fulfill the purpose for which it was created.
>
> "It has been recognized that loose and imprecise standards - referable to such elusive concepts as 'adequacy' of a service, or 'appropriateness' of a bargaining unit, or other criteria, not susceptible of proof or disproof by objective tests - are valid whenever it is impracticable to lay down more precise controls. This concession has meant that the legislature may delegate such measure of discretionary power as the court considers wise and proper in the circumstances of a particular case. Thus, determinations of the validity of the delegation are governed not by jurisprudential analysis of the sufficiency or precision of the standard selected by the legislature, but rather by ad hoc assessment of variable and imponderable desiderato."[58]

After disclaiming the existence of any "logical basis" for determining how far the nature of a situation permits or prohibits the legislative fashioning of specific standard, Cooper seeks to identify practical considerations which have seemed to motivate judicial decisions on delegation questions.[59] He concludes that courts have been unwilling to sustain vague standards where the arbitrary exercise of an agency's discretionary powers could have calamitous effects on substantial rights of property. This consideration seems to cut against the validity of the Groundwater Act delegation of power to develop pumping level regulations, at least insofar as there is a risk that some small farmers may be driven out of business by the regulations. On the other hand, he notes that broad delegations tend to be sustained when judicial review is readily available to correct abuses (as it is under section 42-237e of the Groundwater Act), when there is an obvious need for agency expertise, and when there is a genuine and substantial need for administrative regulation. All these factors seem to cut in favor of the validity of the delegation in the Groundwater Act. It is impossible, however, to say with certainty how a court would weigh the competing considerations.

The statutes of a number of other western states which apply the appropriation doctrine to groundwater either refer to protecting senior appropriators in the maintenance of reasonable pumping levels or contain equivalent language.[60] There is little on the face of these statutes which would aid in construing the Idaho Groundwater Act, however.

Some Problems of Administration

Selection of Wells for Closure

In Baker v. Ore-Ida Foods, Inc.[61] a groundwater basin was being depleted in violation of the prohibition against mining in section 42-237a(g). To correct the situation, the court simply applied the appropriation doctrine principle that priority in time gives priority in right and ordered wells closed in inverse order of priority until the overdraft was stopped. Would the same solution fit if junior wells had been interfering with the pumping level of a senior well owner but there was no general mining of the aquifer? Section 42-237a(g) provides:

> "[E]arly appropriators of underground water shall be protected in the maintenance of reasonable ground water pumping levels as may be established by the . . . [Director of the Department of Water Resources] as herein provided."

The Director has not yet issued pumping level regulations, but let us suppose that such regulations have been issued and a senior well owner's rights under those regulations are being violated. Which wells will be shut down--all those in the aquifer with priority dates junior to his or only some of them; and if only some are to be closed, which ones?

At the outset, it should be observed that application of the appropriation doctrine principle that priority in time gives priority in right to groundwater allocation presents difficulties not encountered in the application of that principle to surface water allocation. Groundwater moves much slower than surface water, typically at rates ranging from five feet per day to five feet per year.[62] If a junior appropriator who is interfering with the flow of a senior's well is shut down, it may be years before the senior's flow is restored.[63] Also, because groundwater is not readily observable and most groundwater does not flow in confined channels, there may be greater difficulty in predicting the effect of shutting down a junior. To take a specific example, assume there are 30 pumpers in a basin and number 26's pumping level protection is violated. Number 27 is close to number 26, and closing his well would restore number 26's pumping level in a relatively short time. Number 28 is farther away from number 26. Closure of his well would, by itself, restore number 26's pumping level, but would take several years for this to happen. Number 29 is still farther away and closing his well might help number 26, but there is considerable uncertainty about that. Number 30 is situated so that it is inconceivable closing his well would have any noticeable effect upon number 26's well or the wells of numbers 27, 28, and 29. Which well or wells should be shut down.

Generally, a junior appropriator who wishes to divert water has the burden of proving, by clear and convincing evidence, that his diversion will not injure any senior appropriator. Most of the Idaho cases applying this principle have been surface water cases,[64] but the court has applied it in the groundwater context as well,[65] although perhaps not consistently. Even if number 30 has the burden of proof of not interference, he should be allowed to continue to operate his well. A possible solution as to number 27, 28 and 29 would be to shut down 27 and 28 but to allow 29 to continue to operate. Closure of number 27 would restore number 26's reasonable pumping level as promptly as possible. Closure of number 28 would, after several years, enable number 27 to resume operation of his well. For that reason, number 27 should be able to insist upon closure of number 28 at the same time his well is closed.[66] Under the rule that puts the burden of proof upon the junior to show that his diversion of water will not harm any senior, it would appear at first blush that number 29 should also be closed. If that were done, however, it would not necessarily enable number 28 to resume pumping after some length of time. The reason is that absent strong evidence number 26's pumping level would be protected, allowing number 28 to resume operation may later interfere with number 26's pumping level and then number 26 could insist on closure of number 27 to get the situation corrected promptly. Thus, number 27 ought to be able to insist that number 28 remain closed absent clear and convincing evidence that number 26 would not be harmed by number 28's operation. If number 28 must remain closed and that, in itself, will protect number 26, there would seem to be no point in also closing number 29. Arguably, number 29 could be allowed to continue to operate, even under the rule that puts the burden of proof of no injury on him, upon the ground that if number 28 must remain closed it then becomes clear that number 29's operation won't injure numbers 26, or 27 (it is assumed), or 28.

Turning away from the above hypothetical, let us assume a situation in which closure of a junior would restore a senior's protected pumping level but, due to the slow movement of groundwater, this will not occur for about 40 years. Should the time lag make the priority principle of the appropriation doctrine inoperative? In favor of an affirmative answer is the fact that by the time the senior's reasonable pumping level is restored, he may well have gone broke and lost the investment in facilities which is protected by the reasonable pumping level concept. This would not necessarily happen, however, especially if the junior is held liable in damages to the senior for increased pumping costs until the reasonable level is restored. Although not squarely in point, a recent Colorado decision is worth noting in connection with the time lag problem. In Hall v. Kuiper,[67] the Colorado Court affirmed the denial of applications to drill two wells into a groundwater source that was hydrologically connected with the Cache LaPoudre River some 13 miles away. Operation of the proposed wells would not have materially affected other wells or surface rights in the area, but the permits were denied because operation of the wells would have reduced the amount of groundwater flowing into the Cache LaPoudre River. Since the groundwater was moving toward the Cache LaPoudre at a rate of only 3/10 of a mile per year, it is evident that there would have been a considerable time lag between commencement of operation of the wells and any impairment of appropriations from the Cache LaPoudre.

FOOTNOTES

1. The current Groundwater Act consists of Idaho Code Ann. §§42-226 to -231, 42-233a, 42-237 to -239.

2. Idaho Code Ann. § 42-229 (Supp. 1973).

3. Idaho Code Ann. § 42-230(a) (Supp. 1973).

4. E.g., Silkey v. Tiegs, 51 Idaho 344, 5 P.2d 1049 (1931). Intent to make an appropriation is also necessary, e.g., State ex rel. Reynolds v. Miranda, 493 P.2d 409 (N.M. 1972), but that is so seldom lacking that it usually is not even listed as an element of an appropriation.

5. The agency used to be called the Department of Water Administration, and before it was called the Department of Reclamation. Most of the statutes in the Idaho Code referring to the Department of Reclamation have never been amended on an individual basis to reflect the changes in name of the agency. Idaho Code Ann. § 42-1801a instead provides: "Wherever the words Department of Reclamation or Department of Water Administration appear in the Idaho Code they shall mean the Department of Water Resources, and wherever the words State Reclamation Engineer or Deputy State Reclamation Engineer appear in the Idaho Code they shall mean the Director of the Department of Water Resources or the Deputy Director of the Department of Water Resources, respectively."

6. Idaho Code Ann. §§ 42-202, -229 (Supp. 1971). An application for a permit must contain certain information about the proposed project and be accompanied by a plan and map of the failities and payment of a fee which varies with the size of the appropriation. Idaho Code Ann. §§ 42-202, -221 (Supp. 1973). The Department then publishes notice and, if anyone files a protest against approval of the application, a hearing is held. Idaho Code Ann. § 42-203 (Supp. 1973.)

7. H.B. No. 146, §1 [1903] Idaho Sess. Laws 223.

8. Idaho Code Ann. § 42-203 (Supp. 1973). See also section 42-233a regarding denial of permits for wells in areas designated as critical groundwater areas.

9. Idaho Code Ann. §§ 42-219, -220 (Supp. 1973).

10. Idaho Code Ann. § 42-233a (Supp. 1973).

11. Id.

12. Silkey v. Tiegs, 51 Idaho 344, 5 P.2d 1049 (1931).

13. Silkey v. Tiegs, note 20 _supra_ says that a priority under the permit procedure "dates from the date of the permit." 51 Idaho at 353, 5 P.2d at 1053. This appears to be loose language in view of prior analogous surface water cases which say that a permit procedure appropriation dates from the time of filing an application for a permit. Reno v. Richards, 32 Idaho 1, 10-11, 178 P. 81, 84 (1918). Crane Falls Power and Irrigation Co. v. Snake River Irrigation Co., 24 Idaho 63, 81-82, 133 P. 655, 661 (1913).

14. Idaho Code Ann. § 42-220 (1948).

15. H.B. No. 121, § 2 (1973) Idaho Sess. Laws 537.

16. Ch. 216, § 1, (1963) Idaho Sess. Laws 623.

17. State _ex rel._ Tappan v. Smith, 92 Idaho 451, 444 P.2d 412 (1968).

18. See State _ex rel._ Tappan v. Smith, 92 Idaho 451, 444 P.2d 412 (1968).

19. Idaho Code Ann. § 42-227 (Supp. 1973). Section 42-230(d) defines "domestic purposes" as follows: "Water for household use or livestock and water used for all purposes including irrigation up to one-half (½) acre of land in connection with said household where total use is not in excess of thirteen thousand (13,000) gallons per day. For the purpose of the exception in, section 42-227, Idaho Code, 'domestic purpose' shall not include water for multiple ownership subdivisions, mobile home parks, commercial or business establishments."

20. Idaho Code Ann. § 42-228 (Supp. 1973).

21. _Id._

22. 513 P.2d 627 (Idaho 1973).

23. See also Baker v. Ore-Ida Foods, Inc., 513 P.2d 627, 637 (Idaho 1973).

24. 513 P.2d at 629.

25. Bagley, Water Rights Law and Public Policies Relating to Groundwater "Mining" in the Southwestern States, 4 J. Law and Economics 144, 145 (1961).

26. C. Todd, Groundwater Hydrology 201 (1959); Walton, Groundwater Resource Evaluation 608 (1970).

27. It is even possible that total recharge could come to exceed total discharge by this process even though there is no reduction in the operation of wells.

28. Muckel, Pumping Groundwater so as to Avoid Overdraft, U.S.D.A. the Yearbook of Agriculture - 1955 (House Doc. No. 32, 84th Congress, 1st Session) 294, 295. See also D. Todd, Groundwater Hydrology 212-213 (1959); W. Walton, Groundwater Resource Evaluation 607 (1970).

29. Ibid.

30. See W. Walton, Groundwater Resource Evaluation 364-68 (1970).

31. C. Corker, Groundwater Law, Management and Administration, National Water Commission Legal Study No. 6 at 58 (1971).

32. D. Todd, Groundwater Hydrology 251 (1959).

33. W. Walton, Groundwater Resource Evaluation 364 (1970).

34. D. Todd, Groundwater Hydrology 256 (1959).

35. J. Crosby, A Layman's Guide to Groundwater Hydrology in C. Corker, Groundwater Law, Management and Administration, National Water Commission Legal Study No. 6, at 56-60 (1971).

36. Idaho Code Ann. § 42-226 (Supp. 1973).

37. Colo. Rev. Stat. Ann. § 148-18-1 (Supp. 1965).

38. Thompson and Fiedler, Some Problems Relating to Legal Control of Groundwaters, 30 J. of American Water Works Assn. 1049, 1075 (1938). See also W. Hutchins, Selected Problems in the Law of Water Rights in the West 179 (1942).

39. See 22 Idaho State Bar Proceedings 52 (1948); 23 Idaho State Bar Proceedings 19 (1949).

40. 513 P.2d 627, 636 (Idaho 1973).

41. Trelease, Policies for Water Law: Property Rights, Economic Forces and Public Regulation, 5 Nat. Res. J. 1, 4 (1965).

42. Id. at 4

43. C. Corker, Groundwater Law, Management and Administration, National Water Commission Legal Study No. 6 at 129 (1971).

44. 613 P.2d at 636.

45. Id.

46. Id. at 635.

47. C. Meyers, A Historical and Functional Analysis of the Appropriation System, Legal Study No. 1, at 6 (1971).

48. See Cheline, An Economic Approach to the Agricultural Use of Groundwater in the Oakley Fan Area of Cassia County, Idaho, (unpublished master's thesis, University of Idaho 1968); see also Von Bernuth, Factors Affecting Irrigation Pumping Costs (unpublished master's thesis, University of Idaho 1969.

49. See text accompanying notes 38-39, supra.

50. See the quotation, supra, indicated by footnote 43.

51. In Hart v. Stewart, 519 P.2d 1171 (Idaho 1974). The court held that the Department is authorized to issue rules of practice or procedure before the Director or a local groundwater board constituted under section 42-237d of the Groundwater Act by section 42-406, which empowers the Directors "to make such rules and regulations as may be necessary . . . to the proper administration . . . of this chapter." The result seems sound but the implied delegation theory would have been a more appropriate rationale since section 42-406, upon which the court relied for its rationale, appears in a chapter of the Idaho Code which deals exclusively with appropriations for use outside the state.

52. 513 P.2d 627, 636 (Idaho 1973). The implied powers approach would be entirely consistent with the following attitude expressed in Keller v. Magic Water Co., 92 Idaho 276, 282-83, 441 P.2d 725, 731-32 (1968), a surface water case:

> "It is seldom that a court will interfere with the discretionary action of the state engineer (Now the Director of the Department of Water Resources) upon matters involving the administration of the water laws of the state . . . As stated by Mr. Justice Holmes, the state engineer is the 'expert on the spot', Mayer v. Peabody, 212 U.S. 78, 85 S. Ct. 235, 237, 53 L. Ed. 410, 416 (1909), and we are constrained to realize the converse, that 'judges are not super engineers' . . . The legislature intended to place upon the shoulders of the state engineer the primary responsibility for a proper distribution of the waters of the state, and we must extend to his determinations and judgment, weight on appeal."

53. For modern Idaho cases on the delegation of rule making authority to state agencies, see Abbot v. State Tax Commission, 88 Idaho 200, 398 P.2d 221 (1965); State v. Heitz, 72 Idaho 107, 238 P.2d 439 (1951); State ex rel. Taylor v. Taylor, 58 Idaho 656, 78 P.2d 125 (1938). See also 1 Cooper, State Administrative Law 54-61 (1965) for discussion of cases from other states.

54. Abbot v. State Tax Commission, 88 Idaho 200, 205, 398 P. 2d 221, 223 (1965).

55. 1 F. Cooper, State Administrative Law 61 (1965).

56. See text accompanying note 47, supra.

57. 1 F. Cooper, State Administrative Law 55, (1965).

58. Id. at 61-62.

59. I F. Cooper, State Administrative Law 71-91 (1965).

60. Alaska Sta. §46.15.050 (1966); Colo. Rev. Stat. Ann. 148-18-1, 148-18-10(b), 148-18-6(4), (5) (Supp. 1965); Kan. Gen. Stat. Ann. §82a-711a (1969); Nev. Rev. Stat. § 534,110(4) (1967); Wash. Rev. Code Ann. §90.44.070 (1961).

61. 513 P.2d 627 (Idaho 1973).

62. J. Crosby, A Layman's Guide to Groundwater Hydrology in C. Corker, Groundwater Law, Management and Administration, National Water Commission Legal Study No. 6 at 42 (1971); C. Meyers and A. Tarlock Water Resource Management 562 (1971).

63. Ellis, Water Rights: What They Are and How They Are Created, 13 Rocky Mtn. Min. L. Inst. 451, 470 (1967).

64. E.g. Jackson v. Cowan, 33 Idaho 525, 196 P. 216 (1921); Josslyn v. Daly, 15 Idaho 137, 96 P. 568 (1908); Moe v. Harger, 10 Idaho 302, 77 P. 645 (1904).

65. Silkey v. Tiegs, 54 Idaho 126, 28 P. 2d 1037 (1934); see Martiny v. Wells, 91 Idaho 215, 419 P.2d 470 (1966); but see Hart v. Stewart, 519 P.2d 1171 (Idaho 1974).

66. See Jones v. Vanausdeln, 28 Idaho 743, 156 P. 615 (1961); Bower v. Moorman, 27 Idaho 162, 147 P. 496 (1951), see also Hart v. Stewart, 519 P.2d 1171 (Idaho 1974).

67. See Martiny v. Wells, 91 Idaho 215, 419 P.2d 470 (1966).

CHAPTER III
AN ECONOMIC ANALYSIS OF THE EFFECTS OF A DECLINING GROUNDWATER LEVEL IN THE RAFT RIVER BASIN

The economic portion of the study provides an interpretation of the economic effects of various rates of groundwater level decline in the Raft River Basin in southern Idaho. Crop farms in the study area were examined to determine how the returns to operator labor and management would be affected by a declining water level. The MPS-360 Linear Programming technique was used for the examination of farm plans.

Farm Analysis

Dissimilar crop possibilities within the study area necessitated the division of the basin into northern and southern portions for the purposes of the study. Early fall frosts and a shorter growing season limit field crops in the southern part of the Raft River Basin to alfalfa hay, pasture, silage corn, and various grain crops. The northern portion has these possibilities plus the additional high value cash crops of potatoes and sugar beets. Two farm sizes were selected for study in each portion of the basin: 640 and 960 acre field crop farms in the northern section of the basin and 320 and 640 acre field crop farms in the southern portion of the study area.

The crop constraints (bounds) of the linear programming model involved in the programming of each farm plan were set at three different levels to give three possible crop combinations for each farm plan. The choice of the crop mix had an important impact on farm income. Annual returns to operator labor and management were estimated for a 20 year period to determine the present value of the stream of returns from a farm operation.

Costs of Water Level Decline

Groundwater decline is a serious problem in the study area. Water level declines of 100 feet have been noted in portions of the basin since 1952. The rates of decline examined in this study were 1, 2, 3, 4, 5, and 10 feet of water level decline per year.

The power cost for pumping an acre foot of water from a well increases with increased depth to water. The increased power cost is, however, only a portion of the overall cost of the water level decline. Without proper planning, the pumping equipment and wells become obsolete in a shorter than normal period of time. This obsolescence increases the depreciation and replacement costs for wells and pumping equipment. Representative wells for the basin were evaluated and costs were calculated for the improvements and changes necessary to maintain well yields at the current levels for 20 years. The 20 year accumulated present value net return to the 640 acre farm plan in the southern portion of the study area decreased from $182,420 when no decline occurred to $153,248 when 5 feet of yearly decline occurred. Ten feet of yearly decline decreased the return to $121,076. However, this return level for the most profitable crop mix was still greater than the return from the production of the next most profitable crop mix with no decline, $91,111.

Results of the economic analysis indicated that farms in the northern section of the study area should be able to make the necessary well and pumping equipment changes with only slight reductions in their returns. When the acreage of land on a farm is restricted, i.e., adequate irrigation water is not available to irrigate all the crop land on a farm, the ability of a farm operator to make the necessary changes is reduced. This is also the case when low value cash crops are grown on a farm.

Returns to operator labor and management for farms in the southern portion of the study area limit the ability to make improvements and changes in wells and pumping equipment as water level decline occurs. Examination of the 20 year effects of 10 feet of decline per year resulted in a net loss for a 640 acre farm plan producing feed barley and alfalfa hay.

Opportunity Cost of Not Pumping the Groundwater

The opportunity cost or value foregone by not pumping the groundwater in the Raft River Basin is best expressed by the accumulated present value net returns of the farm plans. Without the irrigation water pumped from the aquifer, agricultural use for land in the basin would be limited to desert grazing range. A limited amount of land in the study area is wholly irrigated with surface water from the Raft River and Cassia Creek. An improved Bureau of Land Management grazing area in the eastern portion of the valley containing approximately 5,000 acres produced only 5,404 A.U.M.'s (animal unit months) of grazing in 1971 (interview with a representative of the Burley BLM office). The value of one A.U.M. of grazing per acre ($.80 for federal lands for 1972) is minimal when compared to the potential returns from irrigation of the land. The opportunity cost of not irrigating would be nearly identical to the present value net return to a farm plan.

Relative Importance of Groundwater Decline

The location and size of the farm, the management capabilities of the operator, crops produced and characteristics of wells affect returns from the farm operation in addition to the water costs. It is desirable to discuss the importance of water level decline and depth to groundwater in relation to other variables affecting farm plan returns.

The location of the farm, in either the northern or southern portion of the study area, has an important impact on farm income. The dissimilar crop possibilities for the two areas is of major importance to farm income. The size of the farm and the management capabilities of the farm operator also affect farm income. As farm size increases, efficiencies of equipment and labor usage tend to increase. These increased efficiencies when accompanied by a high level of management capability can affect returns significantly. The crop mix also has a major impact on return levels for the farm plans. The three crop combinations examined for each farm plan in the southern portion of the Raft River Basin can be produced with the same equipment inventory and amount of irrigation water. The 640 acre field crop plan has 20 year accumulated present value net return possibilities of $182,420 (390 ac. Malting Barley, 250 ac. Alfalfa Hay), $91,111 (100 ac. Malting Barley, 290 ac. Feed Barley, 250 ac. Alfalfa Hay), and $59,625 (390 ac. Feed Barley, 250 ac. Alfalfa Hay). This range of return possibilities, which is typical for all farm plans in the study area, shows the importance of the crop mix selected for a farm plan.

The characteristics of wells on a farm and depth to water, although important factors influencing farm returns, are not as important as crops produced, farm size, management capabilities, and farm location. Farms located some distance from the river typically have deeper wells and greater depths to water. Power costs per unit of water pumped increase as the depth to water increases. Investment costs and depreciation expenses also increase for deep wells and associated pumping equipment. These changes in costs are relatively minor. For example, the 20 year accumulated present value net returns for the 320 acre farm plan in the southern portion of the study area is decreased by only $21,000, $134,495 to $113,432 when deep wells provide irrigation water rather than shallow wells. Similar relationships exist for other farm plans examined in this study.

Groundwater decline and depth to groundwater do affect farm returns, but in relatively minor amounts when compared to the importance of farm location, farm size, management capability, and crop mix produced. Administration of the groundwater resource based on depth to water or rate of groundwater decline alone ignores several more important factors affecting a farm's return.

Summary

An economic analysis of farm plans in the Raft River Basin was performed to 1) estimate the value of water pumped from the aquifer system, 2) examine the effects of a declining groundwater level on returns to farms, and 3) estimate the opportunity cost of not pumping the groundwater. An examination of agricultural activities in the basin showed dissimilar crop opportunities in the northern and southern portions of the area. Therefore, the basin was divided into two areas for consideration in this analysis.

Data pertaining to costs of production, returns for crops, agricultural practices and cropping patterns in the study area were gathered in 1972 to provide the information base for this study. Activity budgets for producing crops were formulated from this data. A linear programming analysis using the information from the budgets was then applied to estimate the returns to operator labor and management from representative farm plans examined in the two divisions of the study area. This analysis was then extended to examine the effects of 6 rates of decline on the returns to operator labor and management. The added costs which a farm would experience in changing its irrigation wells and pumping equipment to maintain its irrigation water supply were estimated to determine the impact from various rates of water level decline on the 20 year accumulated present value of net returns for each farm plan.

As the rate of groundwater decline increased, the returns and annuity values decreased as expected, but not by the amounts that had been anticipated. The rate of water level decline on a farm had less impact on the returns than did the alternative crop mixes for the farm plans. Farms in the northern portion of the Raft River Basin should be able to operate with up to five feet of yearly decline and experience only slightly lower returns. Farms in the southern portion of the study area which produce the lower value crop mix of feed barley and alfalfa hay have low returns even without decline. Groundwater decline in the southern portion of the Raft River Basin is far more serious a problem than decline in the northern portion. Income levels for farms in the southern portion are at or below subsistence levels without a decline in the groundwater level. Returns in the northern portion of the study area are at a considerably higher level.

The value of irrigation water is the value of the return to operator labor and management for the crops produced in a farm plan. If the water was not pumped for use at this time, the loss would be nearly equal to this value. The alternative to irrigated agriculture for the lands currently irrigated with groundwater is desert grazing.

Groundwater decline affects farm returns, but by relatively minor amounts when compared to other factors. In the Raft River Basin the major factors affecting the returns to farms are the location of the farm (northern or southern portion of the basin) and crop mix produced. Characteristics of the wells on a farm, depth to water, and farm size and management capabilities also affect returns, but to a lesser degree.

Administration of the groundwater resource should consider all factors affecting farm returns. The effect of groundwater decline is only one measure of the economic position of a farm enterprise.

Conclusions

This analysis has shown the effects of a declining groundwater level on the returns to various farm plans. The rate of decline that can be tolerated on a farm varies for different farms and different cropping patterns. The returns to farm operations in the Raft River Basin are influenced more by farm location and crop mix produced than groundwater decline and depth to water.

The value of a water right is the certainty it provides the holder. When applied to groundwater, the certainty concerns the level of the water and the rate of decline, if any, which can be expected. If the rate of yearly decline can be anticipated, wells and pumping equipment can be designed to minimize costs as decline occurs. The added costs incurred from groundwater decline are influenced more by the time period over which the decline occurs than the depth to water.

CHAPTER IV
ALTERNATIVES FOR GROUNDWATER MANAGEMENT IN IDAHO

Application of the Appropriation Doctrine to Groundwater in Idaho

The appropriation doctrine was designed for the allocation of a perpetual but fluctuating flow of water among competing users. The system is reasonably applicable to surface water and serves as the basis for water rights in a number of western states. In some of these states, including Idaho, the doctrine has been applied to groundwater.

The important aspects of the Idaho Code with respect to groundwater are as follows:

> Section 42-226. "It is hereby declared that the traditional policy of the state of Idaho, requiring the water resources of this state to be devoted to beneficial use in reasonable amounts through appropriation, is affirmed with respect to the groundwater resources of this state as said term is hereinafter defined; and, while the doctrine of 'first in time is first in right' is recognized, a reasonable exercise of this right shall not block full economic development of underground water resources, but early appropriators of underground water shall be protected in the maintenance of reasonable groundwater pumping levels as may be established by the Director of the Department of Water Administration as herein provided. All groundwater in this state are declared to be the property of the state, whose duty it shall be to supervise their appropriation and allotment to those diverting the same for beneficial use. All rights to the use of groundwater in this state, however, acquired before the effective date of this act are hereby in all respects validated and confirmed."

> Section 42-233a. "'Critical groundwater area' is defined as any groundwater basin, or designated part thereof, not having sufficient groundwater to provide a reasonably safe supply for irrigation of cultivated lands, or other uses in the basin at the then current rates of withdrawal, or rates of withdrawal projected by consideration of valid and outstanding applications and permits, as may be determined and designated, from time to time, by the Director of the Department of Water Administration.

Upon the designation of a 'critical groundwater area' it shall be the duty of the Director of the Department of Water Administration to conduct a public hearing in the area concerned to apprise the public of such designation and the reasons therefore. Notice of the hearing shall be published in two (2) consecutive weekly issues of a newspaper of general circulation in the area immediately prior to the date set for hearing.

In the event an area has been designated as a 'critical groundwater area' and the Director of the Department of Water Administration desires to remove such designation or modify the boundaries thereof, he shall likewise conduct a public hearing following similar publication of notice prior to taking such action.

In the event the application for permit is made with respect to an area that has not been designated as critical groundwater area the Director of the Department of Water Administration shall forthwith issue a permit in accordance with the provisions of section 42-203 and section 42-204 provided said application otherwise meets the requirements of such sections.

In the event the application for permit is made in an area which has been designated as a critical groundwater area, if the Director of the Department of Water Administration from the investigation made by him on said application as herein provided, or from the investigation made by him in determining the area to be critical, or from other information that has come officially to his attention, has reason to believe that there is insufficient water available subject to appropriation at the location of the proposed well described in the application, the Director of the Department of Water Administration may forthwith deny said application; provided, however, that if groundwater at such location is available in a lesser amount than that applied for the Director of the Department of Water Administration may issue a permit for the use of such water to the extent that such water is available for such appropriation."

Section 42-237a-g. g. "To supervise and control the exercise and administration of all rights hereafter acquired to the use of groundwaters and in the exercise of this power he may by summary order, prohibit or limit the withdrawal of water from any well during any period that he determines that water to fill any water right in said well is not there available. To assist the Director of the Department

> of Water Administration in the administration and enforcement of this act, and in making determinations upon which said orders shall be based, he may establish a groundwater pumping level or levels in an area or areas having a common groundwater supply as determined by him as hereinafter provided. Water in a well shall not be deemed available to fill a water right therein if withdrawal therefrom of the amount called for by such right would affect, contrary to the declared policy of this act, the present or future use of any prior surface or groundwater right or result in the withdrawing the groundwater supply at a rate beyond the reasonably anticipated average rate of future natural recharge..."

The statutes call for the "full economic development" of the resource with the restriction that "reasonable ground water pumping levels" be maintained. The total development is limited to the "reasonably anticipated average rate of future natural recharge". Recognition is given that excessive declines in water levels may occur and some protection is noted for the means of diversion. It is difficult to determine if the statement concerning full economic development refers to the use of the resource beyond the flow component. No guidelines are given for the use of stock groundwater except as an elevator to help maintain reasonable pumping levels.

Groundwater administration in Idaho has been limited to the designation of five critical groundwater areas. This designation closes the area to the future applications to appropriate groundwater but does not affect any of the existing pumpers or those holding valid outstanding permits.

Groundwater Management Under the Idaho Code

Two levels of resource management are allowed under the Idaho statutes. It is possible for the director of the Department of Water Administration to deny a permit for a new user in a groundwater basin on the basis that unappropriated groundwater is not available. The Director may indicate that unappropriated groundwater is not available in an area by the declaration that the area is a critical groundwater area. This designation serves as a notice to new users that applications for permits will either be denied or approved in reduced quantities. The recent decision in the case of Tappen v. Smith indicates that the director of the Department of Water Administration does have sufficient power to create critical groundwater areas and to prevent new uses of groundwater on the basis that unappropriated groundwater is not available. Because of this case, it is assumed for this study that the director of the Department of Water Administration has sufficient power to close areas to future appropriation.

Two main restrictions are presented in the Idaho Code that could result in closure of wells with valid water rights. These are noted as the recharge limitation and the pumping lift limitation. The recharge limitation is the limit on development to the "reasonably anticipated average rate of future natural recharge". The pumping lift limitation is the protection that the individual user has in the maintenance of "reasonable groundwater pumping levels".

Groundwater Administration Under the Pumping Lift Restriction

An outline of groundwater administration under the criteria of reasonable groundwater pumping levels is presented in Figure 3. A number of decisions must be made in order to arrive at a management plan. The first level of decision involves the

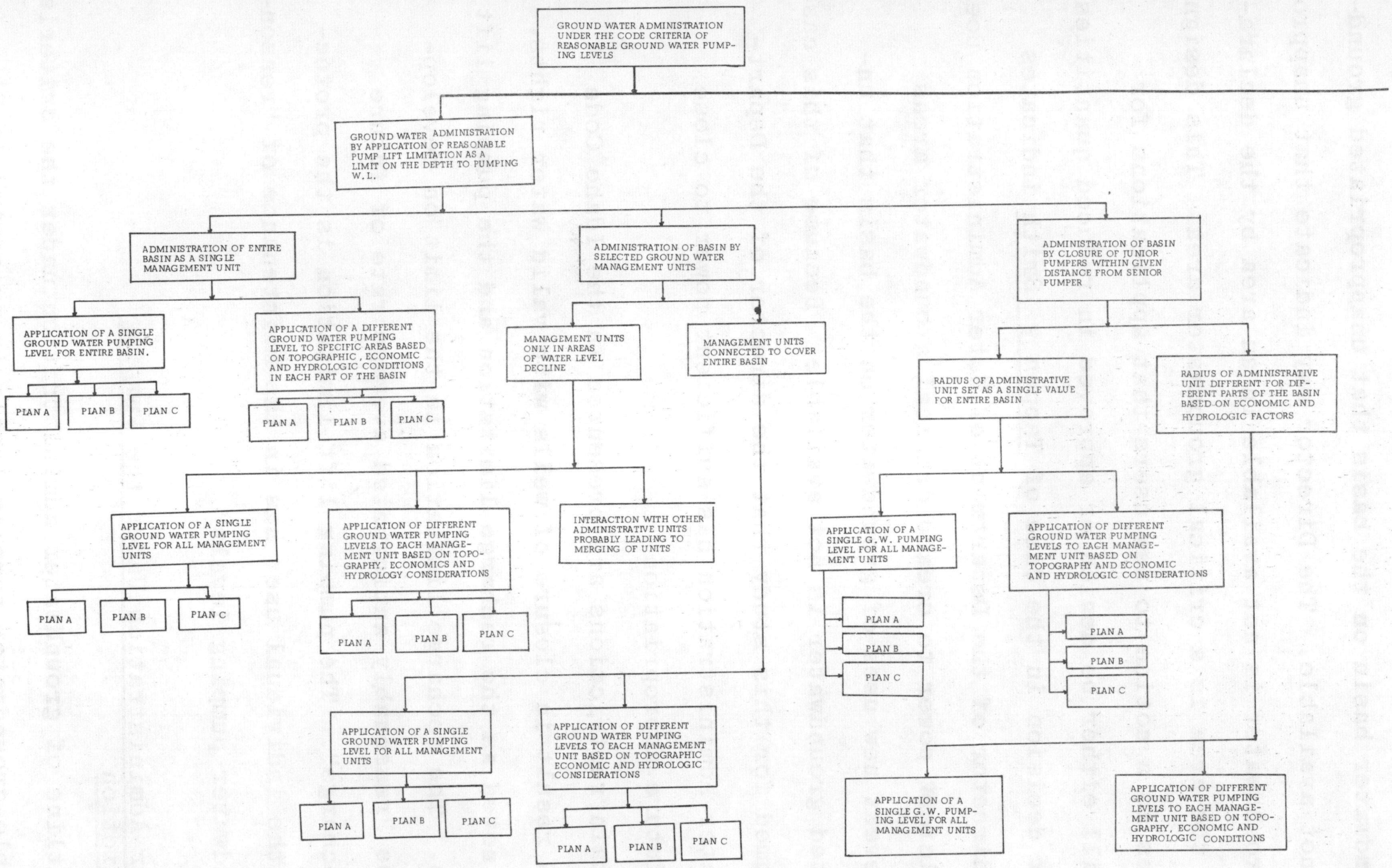


Figure 3

Alternatives for Groundwater Management Under the Concept of Reasonable Groundwater Pumping Levels

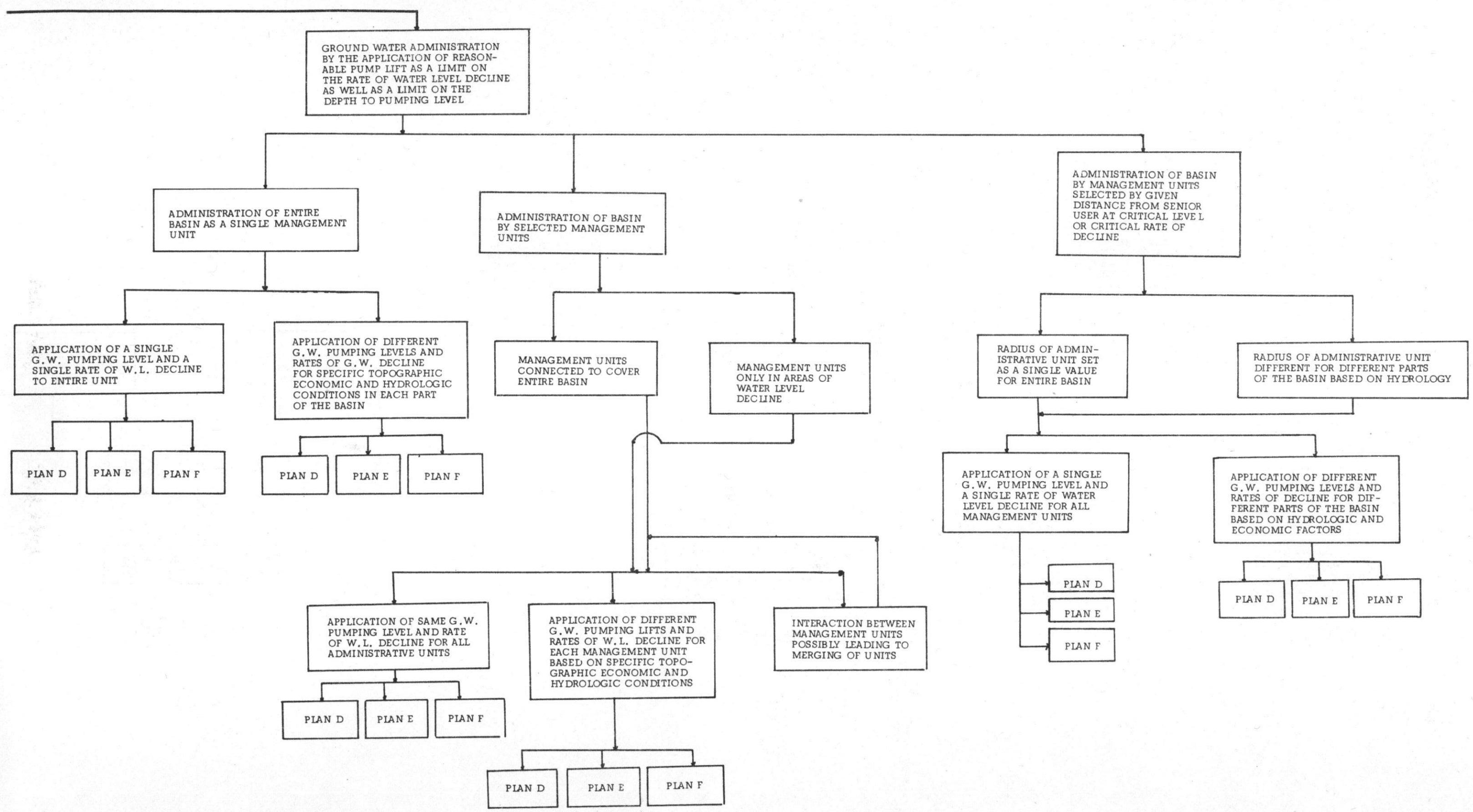
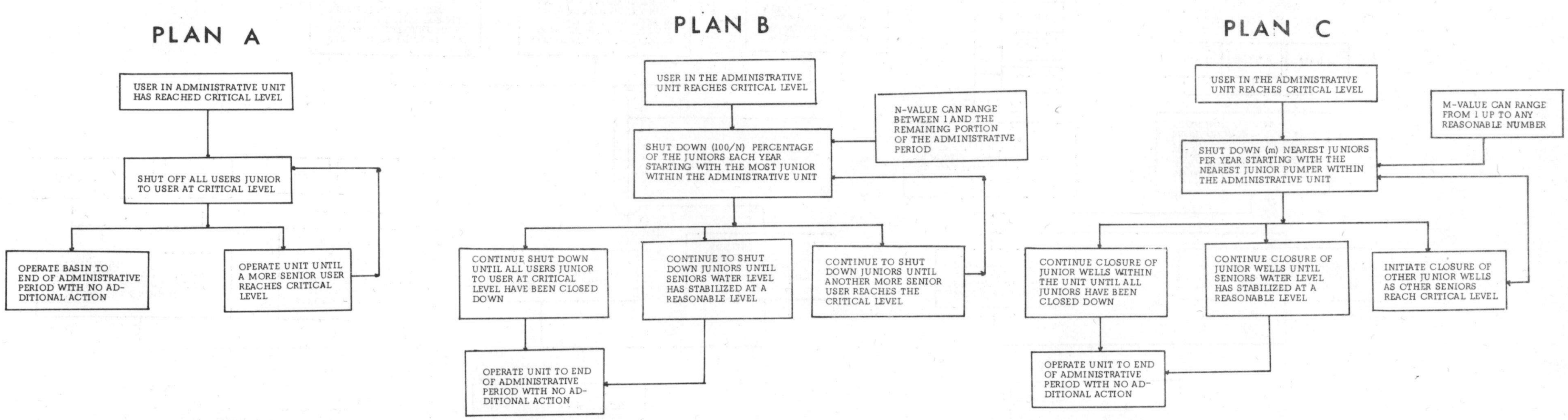


Figure 3 (continued)



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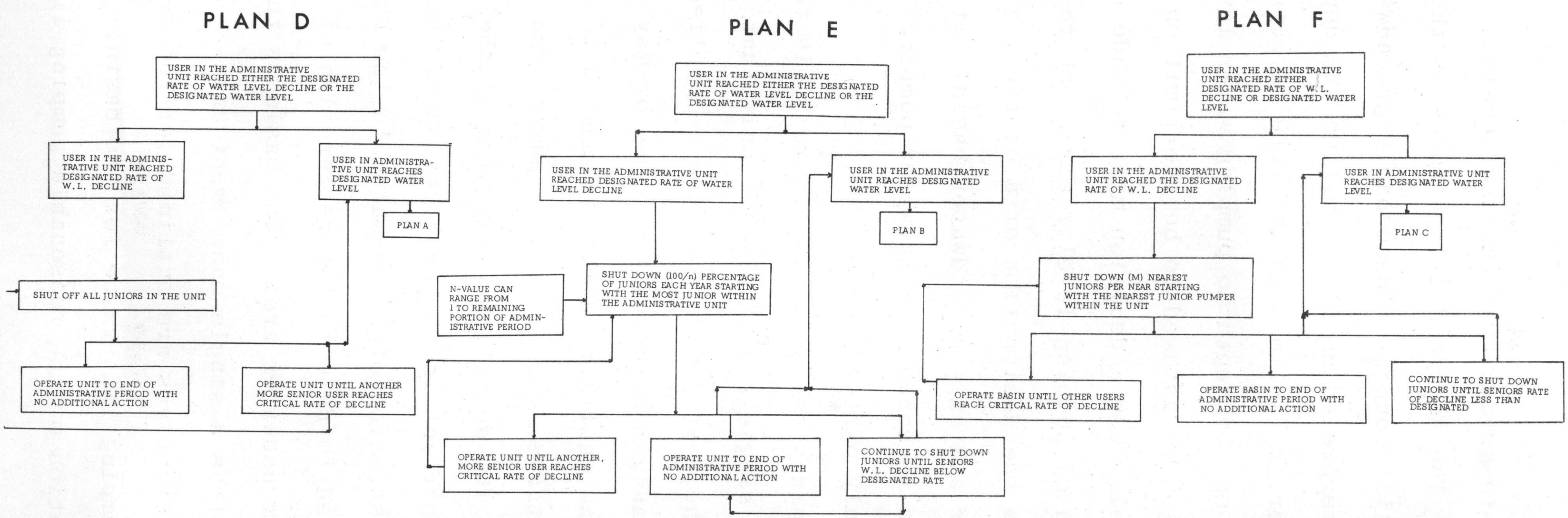

Figure 3 (continued)

selection of reasonable groundwater pumping levels as the primary administrative tool. The second decision concerns the definition of the pumping lift concept. Reasonable groundwater pumping levels can be interpreted as 1) a limit on the depth to pumping water level or, 2) a limit on the rate of water level decline plus a limit on the depth to pumping water level. If the pumping lift limitation is assumed to be the limit on the depth to pumping water level, then a decision must be made on the method of application of pumping level restriction to the basin. The Idaho Code allows the designation of a critical groundwater area as part or all of a groundwater basin. It is thus possible to apply the reasonable groundwater pumping lift restriction to all or only part of the basin.

The first alternative, noted in Figure 3, is to apply the restriction to a single administrative unit that includes the entire basin. The restriction may also be applied to selected groundwater management units which may or may not include the entire basin. The restriction may be applied to units defined by a given distance from the senior pumper who has reached the critical level. The selection of the size of the administrative unit is very important in the application of the pumping lift restriction. Administration of groundwater in the Raft River Basin has been limited to date to the declaration of the entire basin as a critical groundwater area. The basin is thus being treated at the moment as a single management unit.

Two primary alternatives are outlined for the selection of the reasonable pumping lift value for the basin. The first and simplest application of the reasonable pumping lift concept is the application of a single groundwater pumping level for the entire basin. Based on the assumptions noted by Young and Ralston (1971), the pumping level would be designed for a typical irrigator for the entire basin without reference to growing season and crop variations within the basin and differences in topographic features. The second major alternative in the application of reasonable pumping lifts to a single unit covering the entire basin is the application of different groundwater pumping levels in each part of the basin based upon specific topographic, economic and hydrologic conditions. Under this plan, a reasonable groundwater pumping level would better fit the conditions in each part of the basin. It would be difficult, however, to interface the groundwater pumping lift management scheme when conflicting users have different reasonable pumping lift values.

Once the reasonable pumping lift value is selected for the basin or for parts of the basin, considerable question exists on the application of that value to users within the basin. Three basic plans of application of the reasonable pumping lift value within the administrative unit are presented in Figure 3. These plans are repeated throughout the various alternatives noted on the diagram. Each of these plans is initiated when any user in the administrative unit has reached the designated critical level. Under plan A, the administrative official would shut off all users junior to that user that has reached the critical level. Thus, if the user at the critical level were the most senior user in the basin, all of the other users in the basin would be shut off. However, if he were the second most junior user, only the most junior user would be shut off. Two basic courses of action are possible following this closure of juniors. The basin may be operated to the end of the administrative base period with no additional administrative action. However, if another user within the administrative unit reaches the designated critical level, all users junior to him would be shut off with administration following this general plan to the end of the administrative base period.

Plan B also would be initiated when a user in the administrative unit reaches the designated critical level. Under this plan the administrative officer for the state would shut down (100/n percentage) of the juniors each year starting with the most junior within the administrative unit. This would continue for (n) years with (n) being any number between 1 and the remaining number of years in the administrative period. Administration would follow this guideline until either 1) all users junior to the user at the critical level had been shut down or 2) the senior's water level had been stabilized at the designated reasonable level. In either of these cases, administrative action would be terminated for the remainder of the administrative period. However, if another user reaches the critical level, administration action would include shutting off (100/n percentage) of the users junior to that user each year.

Plan C would be initiated when any user in the administrative unit reaches the critical level. Under this plan, (m) nearest juniors would be shut down per year starting with the nearest junior user within the administrative unit. The (m) value can range from 1 up to any reasonable number. The users to be shut down would be the nearest junior users so that all users, junior to the pumper at the critical level, would be grouped irrespective of priority. Administration under plan C would continue until either 1) all users junior to that user at the critical level have been closed down, or 2) sufficient juniors have been closed down to stabilize the senior's water level at the designated reasonable level. Administration would then continue without further action to the end of the administrative period. However, if another user reaches the critical level within the administrative unit, administration would include the closure of (m) juniors per year near that senior user.

Plan A provides for the closure of a probable large number of users without examination of the positive benefit for the senior who has reached the critical level. This plan would be advisable only if the administrative unit were selected as a very small area. Plan B provides an important modification of Plan A in that only a portion of the juniors would be shut down each year with this closure to continue until either all juniors are closed down or the senior has been protected as to his reasonable pumping level. However, this plan still ignores the importance of the location of each particular user. In a large administrative unit, a user at great distance may be shut down with no immediate benefit to the senior. This plan would also provide reasonable administrative action in small administrative units. Plan C would perhaps provide greatest protection because those users closest to him would be shut down first. Conversely, all users junior to the user at the critical level would be assumed to have equal priority thus eliminating some of the value of the water right. Location would be an important factor in the certainty of water use.

The administrative unit may be selected as other than the entire basin. Administration of the groundwater resource in a basin may be performed in selected groundwater management units or in groundwater management units based on a given distance from a senior pumper who has reached the designated critical level (Figure 3). The selected administrative units may connect to cover the entire basin or may be located only in areas of immediate water level decline. Selection and application of reasonable pumping lift value or values would follow the same course of action as described for management of the basin as a single unit. However, the complicating factor of interaction between selected administrative units would have to be considered. Closure of juniors under this application of the reasonable pumping lift concept would follow plan A, plan B, or plan C described previously.

The size of the administrative unit could be based on a given distance from a senior pumper who has reached the designated reasonable pumping lift. The radius of the administrative unit could be set either as a single value for the entire basin or modified for different parts of the basin based on hydrologic and economic factors. The application of selected reasonable pumping lift value or values would follow the format described previously with final application of the critical value under plan A, B, or C as described above.

Reasonable pumping lift has been discussed previously as a control on the depth to pumping level. It is also possible to interpret reasonable pumping level as a combination of control on the rate of water level decline and control on the depth to pumping water level. As is shown in Figure 3, this interpretation provides a different set of alternatives for closure of junior users.

Plan D is initiated when a user in the administrative unit reaches either the designated rate of water level decline or the designated pumping water level. If a user in the administrative unit reaches the designated rate of water level decline, all users junior to him in the unit are shut off. This plan is directly parallel to Plan A. Upon this action the unit would either be operated until the end of the administrative period with no additional action, operated until another, more senior user reaches the critical rate of decline or operated until a user reaches the designated reasonable pumping lift. In the second case, all users junior to the second person reaching the critical rate of decline would be shut off. When a user reaches the designated reasonable pumping lift value, plan D then reverts directly to plan A.

Plan E is very similar to Plan B. In this case when the user reaches the designated rate of water level decline (100/n) percentage of the junior users would be shut off each year starting with the most junior within the administrative unit. This operation would continue until 1) another more senior user reaches the critical rate of decline, 2) the first senior has had his water level decline reduced below the designated rate of water level decline, or 3) a user in the area reaches the designated reasonable pumping lift value. Under the latter possibility, plan E would then revert to plan B.

Under plan F, when a user in the administrative unit reaches the designated rate of water level decline, (m) nearest juniors would be shut down each year starting with the nearest junior pumper within the unit. The basin would then be operated until either 1) other users reach the critical rate of decline, 2) the seniors rate of water level decline is reduced until it is less than the designated rate of decline, or 3) a user in the administrative unit reaches the designated reasonable pumping lift value. In the latter case, plan F would revert to plan C described previously.

The outline of decisions under administration of reasonable pumping lift as a limit on the rate of water level decline as well as a limit on the depth of pumping water level is similar to that discussed previously with the exception that the final plans of application of the reasonable pumping lift concept are plans D, E, and F, rather than A, B, and C.

Five basic levels of decision are described on Figure 3. First, the administrator must choose the particular management tool to apply to the basin. In this case, the choice is reasonable pumping lift. Secondly, the administrator must choose a definition of reasonable pumping lift. The definition may either be a limit on the depth to pumping water level or a limit on the rate of water level decline plus a limit on the depth to pumping water level. Third, the administrator must choose the size of management unit and the length of management period. Fourth, he must select the pumping lift value or values and the rate of decline value or values to be applied in the management units. Fifth, he must select a method of application of the designated pump lift and rate of decline values to users in the administrative units.

<u>Groundwater Administration Under the Recharge Limitations</u>

The Idaho Code limits development in a groundwater basin to the "reasonably anticipated average rate of future natural recharge". The decision diagram for this administrative alternative is presented in Figure 4. One of the primary problems with administration of the resource under this criteria is the definition of the recharge limitation. Four alternative definitions are presented in Figure 4. First, the recharge limitation may be defined as the total water available for man's use in the basin (water yield). Second, the recharge limitation may be defined as the total recharge to the groundwater system. Third, it may be defined as equal to the total recoverable discharge from the groundwater system. Fourth, the recharge limitation may be defined as a time dependent function of the hydrologic, economic and well location conditions in the basin. The size of administrative units must be selected under any of these alternative definitions. A single administrative unit may cover the entire basin, or the basin may be administered through selected groundwater management units.

The application of a single recharge value to an administrative unit covering an entire basin would follow plan G

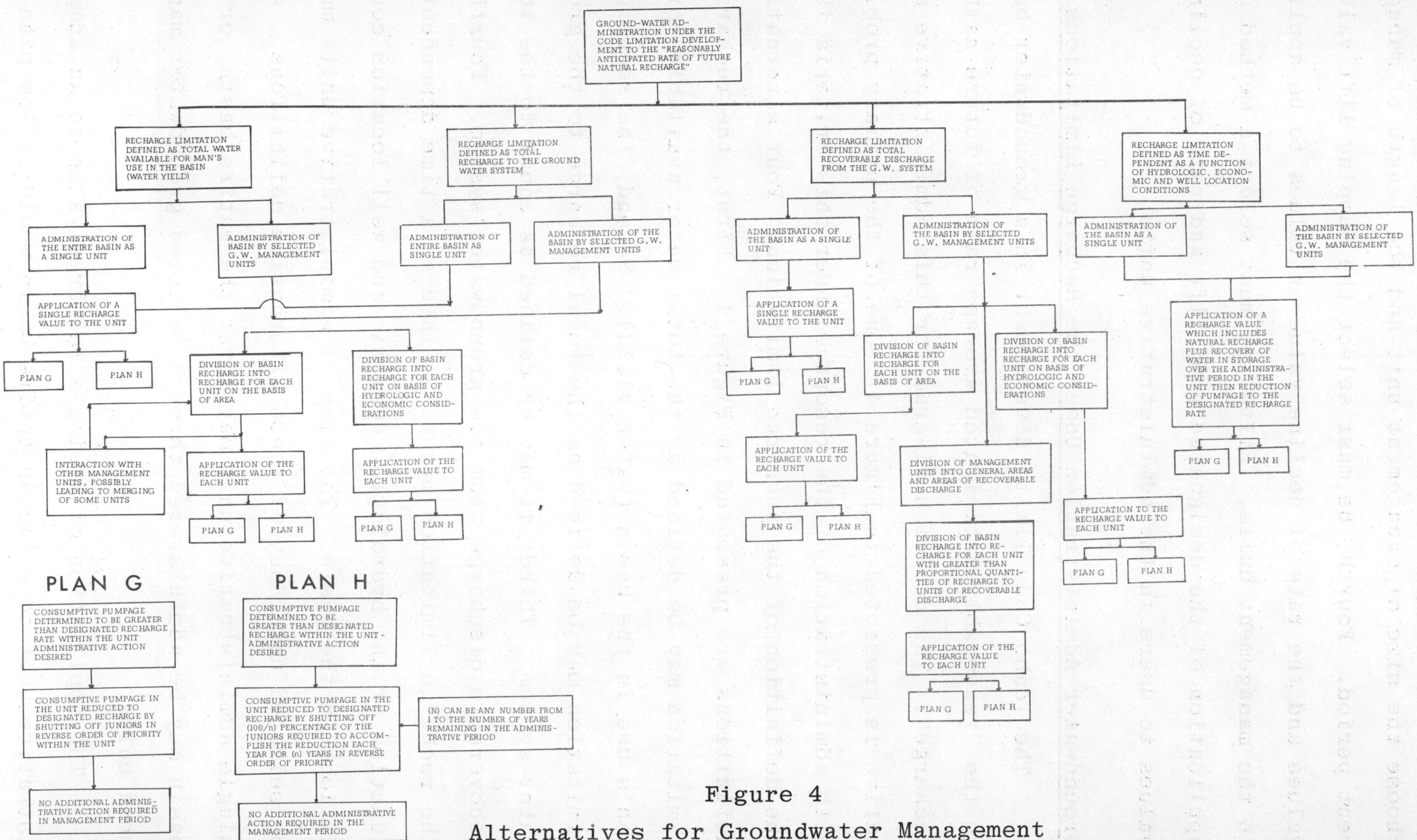

Figure 4

Alternatives for Groundwater Management
Under the Concept of Reasonably Anticipated
Average Rate of Future Natural Recharge

or plan H, as shown on Figure 4. Under plan G, the consumptive pumpage in the unit would be reduced to the designated recharge value by shutting off juniors in reverse order of priority within the unit. It is envisioned that the well closure would occur all at once. Under plan H the consumptive pumpage in the unit would be reduced to the designated recharge by shutting off (100/n) percentages of the juniors required to accomplish the reduction each year for (n) years in reverse order of priority. This alternative plan would spread the impact of the closure over a number of years.

A decision must be made on the division of the basinwide recharge value into recharge values for each specific unit if administration of the basin under the recharge limitation is to be performed in selected groundwater management units. As is shown in Figure 4, this division may be based on either the size of each administrative unit with respect to the total area in the basin or on the basis of hydrologic and economic considerations. In either case, the application of the selected recharge value to the users in each unit would follow either plan G or plan H described previously.

Administration of the resource under the recharge limitation defined as the total recharge to the groundwater system would follow the same pattern as described for the definition of the recharge limit as water yield. The only difference would be in the total magnitude of the defined natural recharge value.

Resource administration with the definition of recharge being recoverable discharge from the groundwater system would follow that described above with one exception. The division of the basinwide recharge into recharge for each groundwater management unit would be varied on the basis of recoverable discharge within each management unit. For example, management units near discharge points might be allowed greater unit recharge than other units of the same size within the basin.

Administration of the recharge limitation with a definition of recharge being time dependent as a function of hydrologic, economic and well location conditions could vary widely from administration under other definitions of the constraint. The application of a recharge value which included both natural recharge and recovery of water in storage over the administrative period would allow a greater immediate development of the resource. In this case, the length of the administrative period would be very important as the development would revert back to the designated natural recharge to the area at the end of the assigned administrative period. Closure of juniors within the unit would follow either plan G or plan H described previously.

Five levels of decisions are apparent in the application of the recharge restriction for basin management. First, the administrator would select the recharge limit as the management tool. Secondly, the administrator would define the recharge limit. Third, he would select the size of the administrative unit or units and select the length of the management period. Fourth, he would select the reasonable recharge value or values for each unit. Fifth, he would select the method of application of the recharge limits to users within each administrative unit.

Steps in Groundwater Administration

The first indication of a groundwater problem is often excessive water level decline. Some decline of water levels must necessarily result from man's development of the resource. The water level decline must thus be interpreted as a water resource management problem. Under Idaho statutes, the probable, but not necessary, next step is the declaration of a critical groundwater area. This declaration prohibits new applications for permit to appropriate groundwater in the area. The next logical, and very necessary step is an adjudication of the groundwater rights. Under this process, each user has his recorded or non-recorded water right established with respect to priority, quantity of water and location of water use. The product of an adjudication is a priority list noting valid water rights and giving the priority date, the quantity of water and the lands irrigated. Pumpage must be discontinued for those wells without valid water rights. The water level decline may continue or the decline may be slowed or stopped as a result of this adjudication action. No further administrative action is required if the water levels stabilize.

If the water level decline continues, the next step is an evaluation of the physical aspects of the problem and a selection and application of a management tool. Four general classifications of physical problems may be outlined: 1) local water level decline with total basin pumpage believed less than basin recharge, 2) general water level decline with total basin pumpage believed less than basin recharge, 3) local water level decline with total basin pumpage believed to be greater than basin recharge, and 4) general water level decline with total basin pumpage believed to be greater than basin recharge. The selection of the management tool is based on the type of physical problem. The administrative decisions noted on Figures 3 and 4 would then follow.

Analysis of Management Alternatives for Groundwater in Idaho

Management of groundwater under the appropriation doctrine must first include an adjudication of water rights. A mock adjudication of groundwater rights in the study basin was performed because an actual adjudication had not been conducted. The second step in groundwater management is the development of administrative procedures based on the physical aspects of the basin and the alternatives outlined in the legal code. Alternatives for groundwater management in Idaho are presented earlier. The third step in groundwater management is the application of the management procedures to the basin under consideration. In this study, management alternatives are applied to the mathematical model of the water resource system in the Raft River Basin. The analysis of alternatives for groundwater management in Idaho is based on operation of the model under given sets of constraints.

Application of Management Alternatives to the Model of the Study Area

Management alternatives are evaluated using the model of the water resource system in the Raft River Basin by the control of pumpage from individual wells. Each well is identified by location and water right priority. Specific management plans include the operation or closure of wells based on priority and/or location.

A Basis Run was designed to provide the standard for comparison of the impact of various management alternatives on the water resource system. The model was operated for this run for the period 1971-1990, with only those wells with valid water rights operating. Punched output was obtained of the water level elevation at all nodes at the end of the pumping season each year. In addition, water level data were punched at the start and end of the pumping season for all nodes where pumping wells are located. These data were utilized for hydrograph plots. Groundwater outflow from the basin was also calculated at the start and end of the pumping season for each year.

Basis Run

The Basis Run represents administration of the groundwater resources in the basin after the water rights adjudication without any closure of wells with valid rights. Considerable water level change occurs in the basin during the period of 1971-1990. Areas of major decline coincide with concentrations of wells. The rate of decline is shown on Figures 5 and 6 for well locations. The rate of decline is approximately constant for most at Nodes 4536 and 5437. The groundwater outflow, as calculated by the model, steadily decreases with time as the impact of pumpage reaches the northern end of the basin.

Analysis of Reasonable Groundwater Pumping Levels as a Tool for Resource Management

A number of administrative alternatives for management of groundwater under the guidelines of reasonable pumping levels

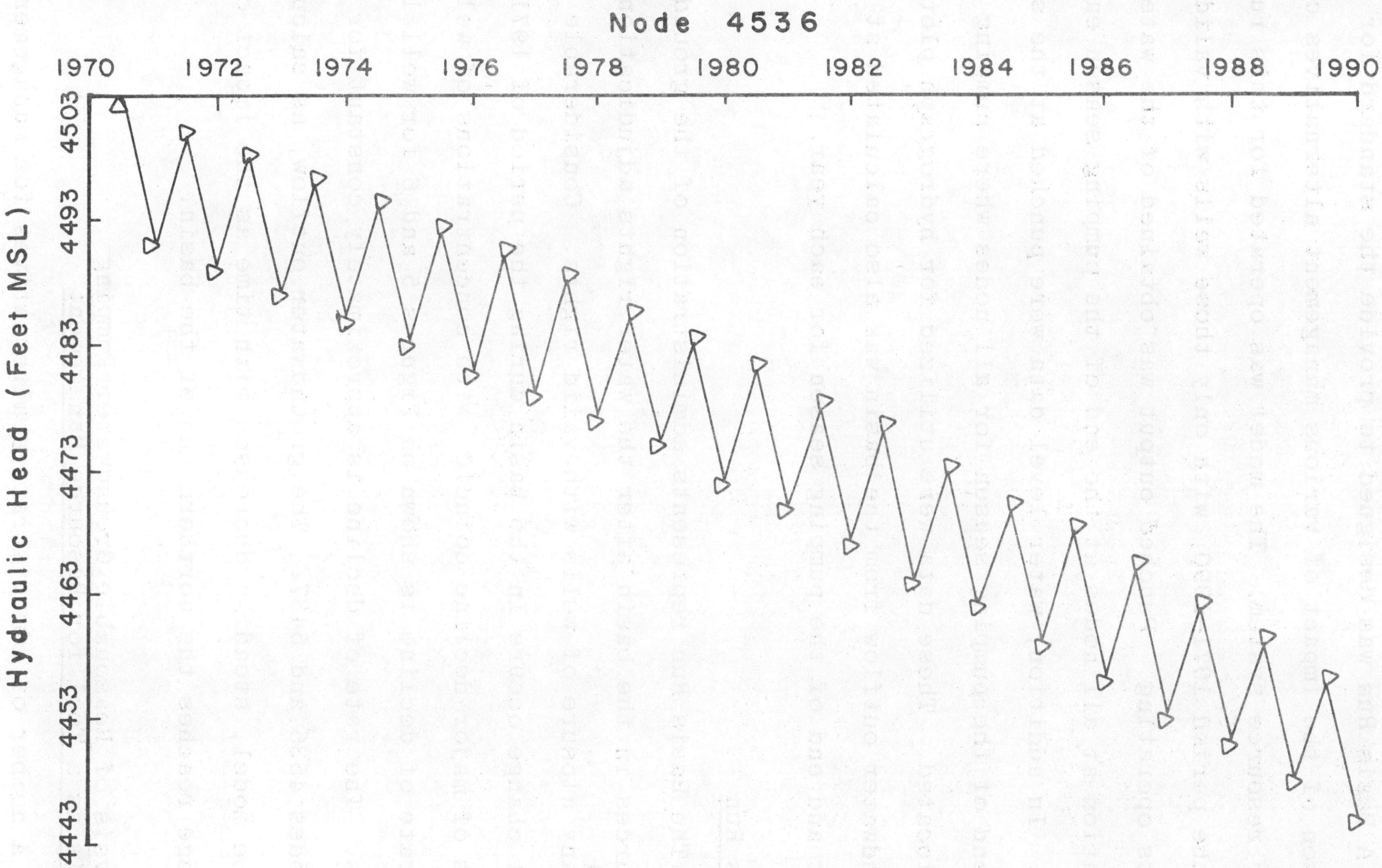

Figure 5
Hydrograph of the Well at Node 4536, Basis Run

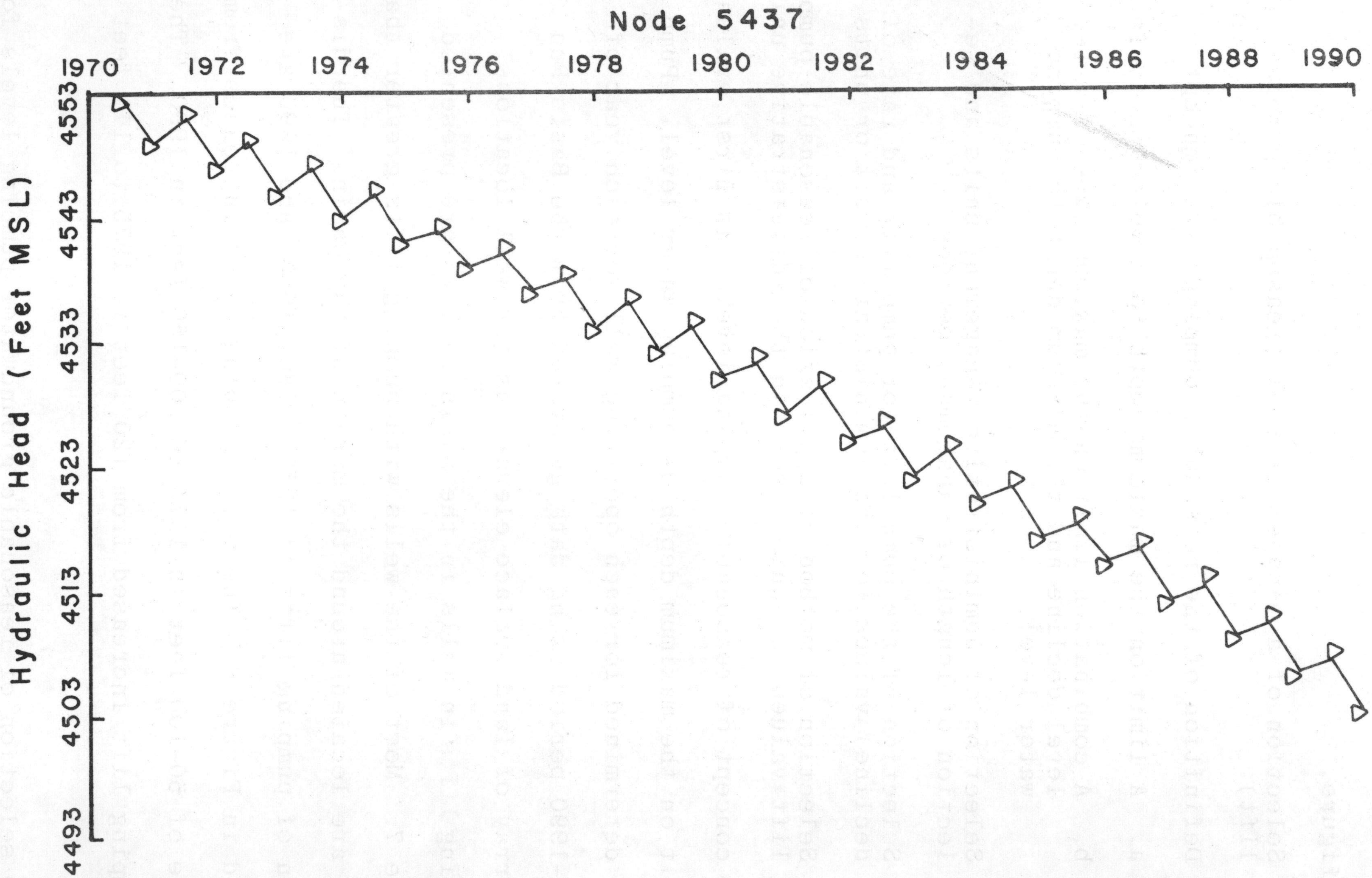

Figure 6

Hydrograph of the Well at Node 5437, Basis Run are presented in Figure 3. Five levels of decision are noted on that figure.

1. Selection of a management tool (reasonable pumping lift).

2. Definition of the reasonable pumping lift concept.

   a. A limit on the maximum depth to pumping water level

   b. A combination limit on the maximum rate of water level decline and the maximum depth to pumping water level.

3. Selection of administrative management units and selection of length of management periods.

4. Selection of the pump lift (or pump lift and rate of decline) values for the administrative unit or units.

5. Selection of method of application of reasonable pump lift values to junior users in the administrative units.

The concept of reasonable pumping levels was first evaluated as a limit on the maximum depth of pumping water level. Pump lift was determined for each operating well for each year of the 1970-1990 period using data generated from the Basis Run and an array of land surface elevations for well locations. The pumping lifts in wells in the basin in 1975 are presented in Figure 7. Most of the wells with pumping lifts greater than 250 feet are located around the margin of the basin. The distribution of pumping lifts in 1975, 1980, 1985, and 1990 are presented in Figure 8. The modal pumping level increases from the range of 50-100 feet in 1975 to 100-150 feet in 1990. The mean pumping lift increased from 120 feet in 1975 to 144 feet in 1990.

The selection of reasonable groundwater pumping levels for a basin must be based on economic, social, physical, and political considerations. Young and Ralston (1971) present the only

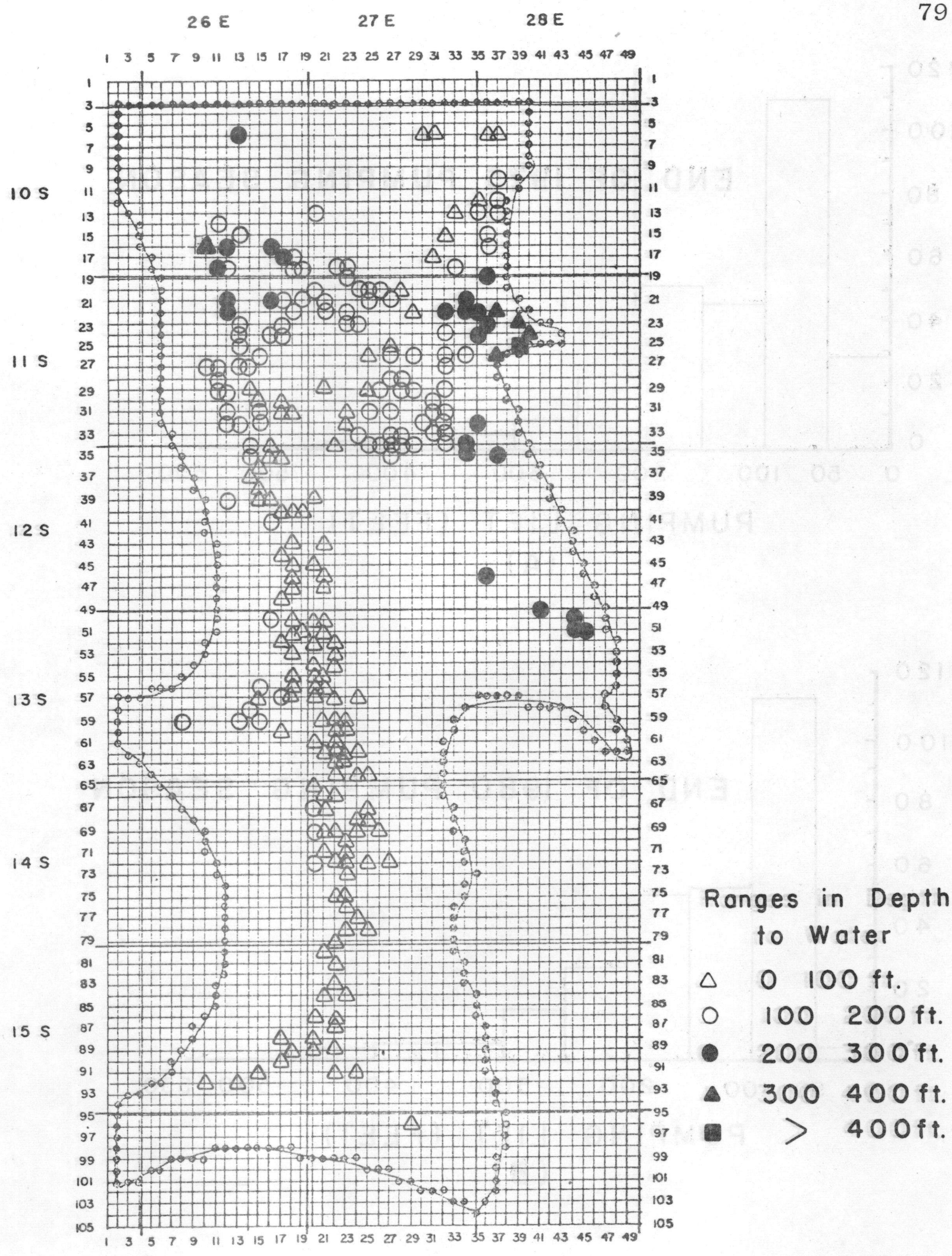

Figure 7

Depth to Pumping Water Level in Wells
at the End of the Pumping Season of 1975, Basis Run

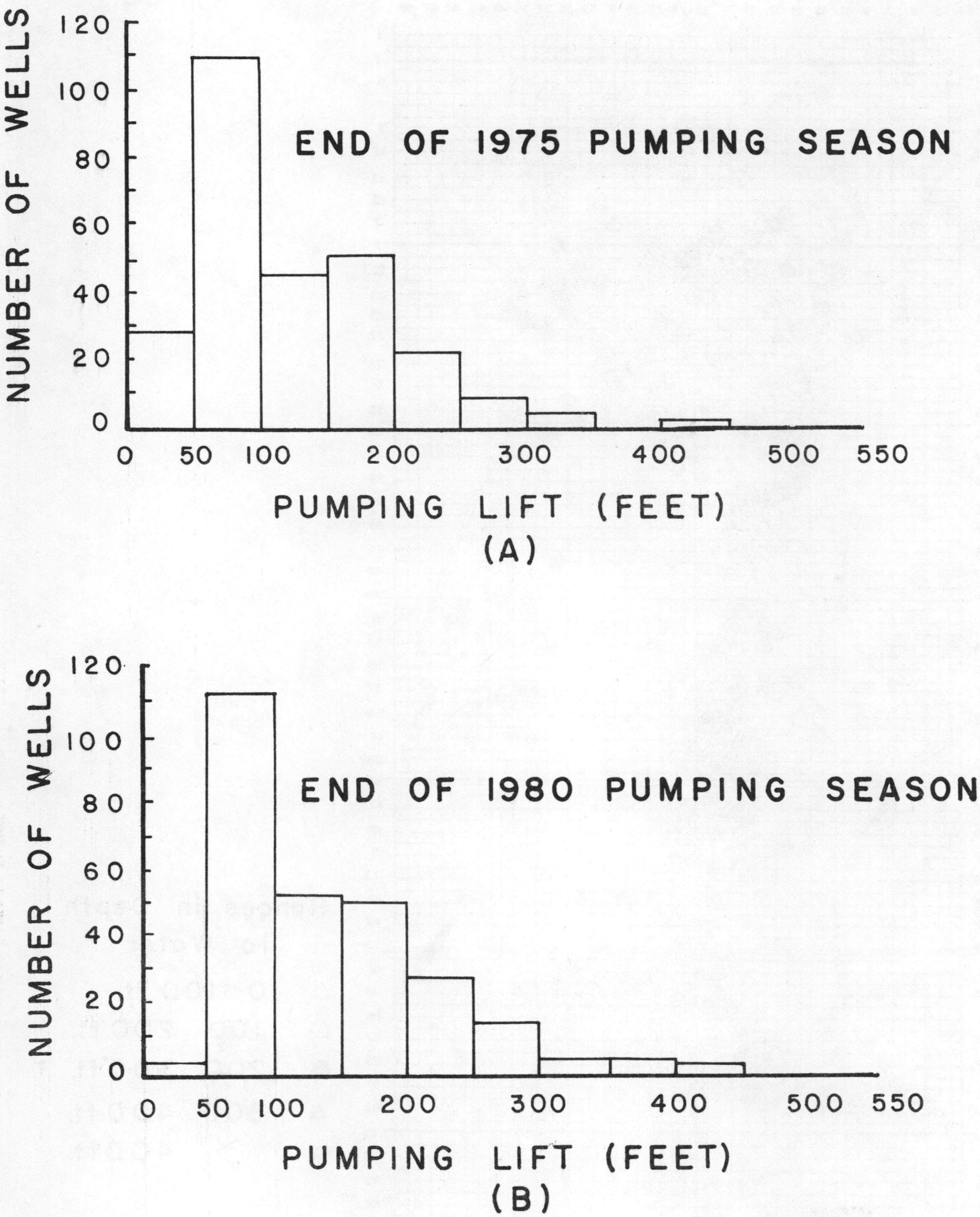

Figure 8

Distribution of Pumping Lift in the Study Basin
at End of Pumping Season of
(A) 1975, (B) 1980, (C) 1985 and (D) 1990

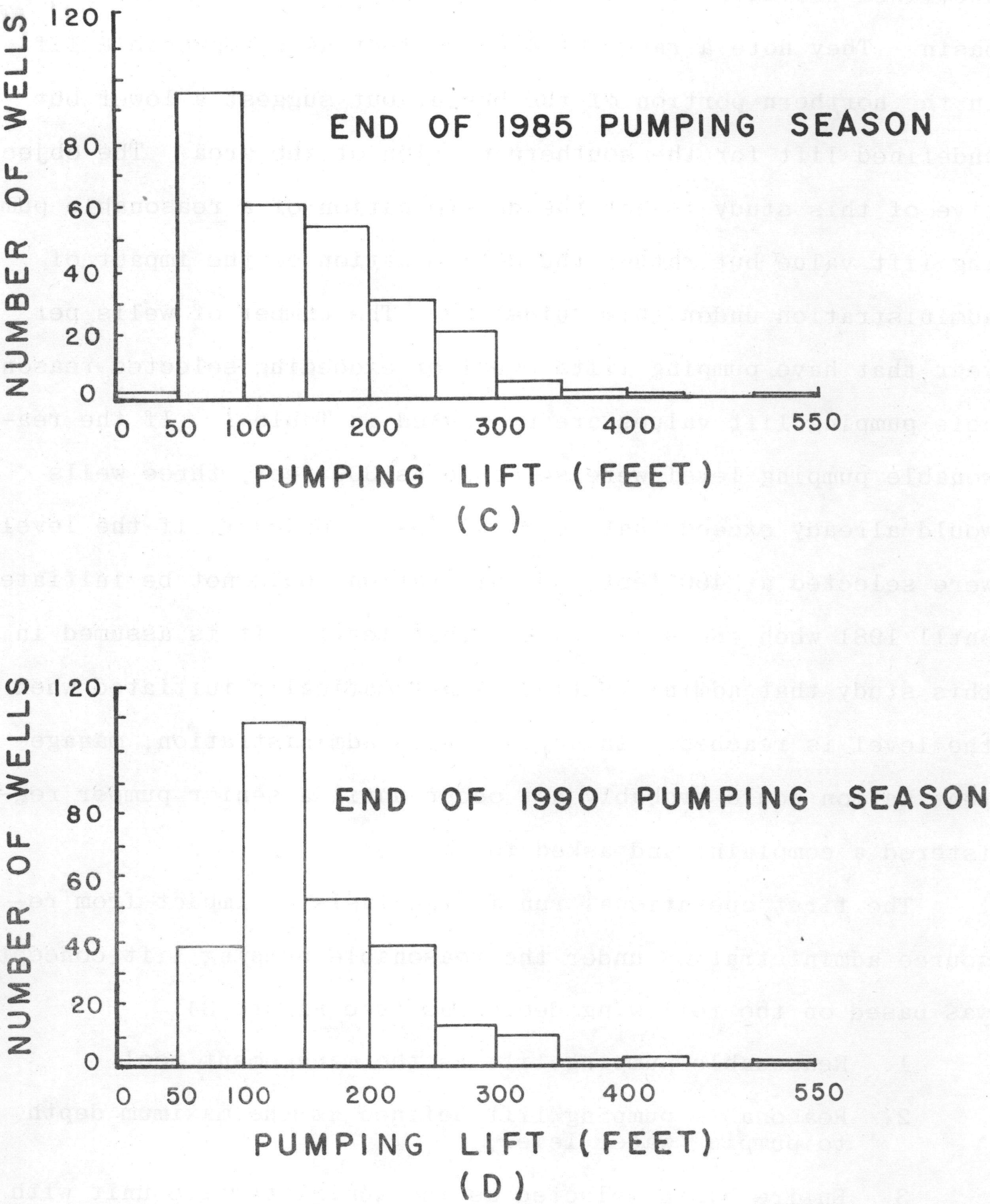

Figure 8 (continued)

published estimates of reasonable pumping levels for the study basin. They note a range of 450-550 feet as a reasonable lift in the northern portion of the basin, but suggest a lower but undefined lift for the southern portion of the area. The objective of this study is not the determination of a reasonable pumping lift value but rather the determination of the impact of administration under this guideline. The number of wells per year that have pumping lifts equal or exceeding selected reasonable pumping lift values are presented in Table 1. If the reasonable pumping level were selected as 300 feet, three wells would already exceed that level in 1971. However, if the level were selected at 450 feet, administration would not be initiated until 1981 when one well reaches that level. It is assumed in this study that administration is automatically initiated when the level is reached. In actual basin administration, management action would probably not occur until a senior pumper registered a complaint and asked for action.

The first operational run for analysis of impact from resource administration under the reasonable pumping lift concept was based on the following decisions (see Figure 3).

1. Reasonable pumping lift as the management tool.
2. Reasonable pumping lift defined as the maximum depth to pumping water level.
3. Entire basin selected as the administrative unit with administrative action continuing through 1990.
4. Reasonable pumping lift of 450 feet selected for administration.
5. Closure of junior users under plan A.

No administrative action would be required under this plan until 1981 when a single well reached the designated reasonable

Table 1: Number of Wells Per Year Equal or Exceeding Selected Reasonable Pumping Lift Values in Study Basin

	Pumping Lift Value				
Year	300 Feet	350 Feet	400 Feet	450 Feet	500 Feet
1971	3				
1972	3	1			
1973	4	1			
1974	4	1	1		
1975	5	1	1		
1976	5	1	1		
1977	5	1	1		
1978	5	3	1		
1979	5	3	1		
1980	5	3	1		
1981	5	3	1	1	
1982	8	3	1	1	
1983	8	3	1	1	
1984	8	3	1	1	1
1985	8	3	1	1	1
1986	10	4	3	1	1
1987	12	4	3	1	1
1988	13	4	3	1	1
1989	15	4	3	1	1
1990	17	4	3	1	1

pumping lift. Resource administration would then be based on the priority and location of the control user at the critical level. The critical depth of 450 feet was reached by a well at node 2539 with a priority of 272. Under plan A, all users junior to the user at node 2539 would discontinue pumpage for the remainder of the administrative period. In this case, sixty users were shut off with a combined discharge of 97.8 cubic feet per second. The location of these juniors is shown on Figure 9. The impact of this closure is shown on Figure 10 as water level changes from the Basis Run by 1990. Most of the water level change occurred

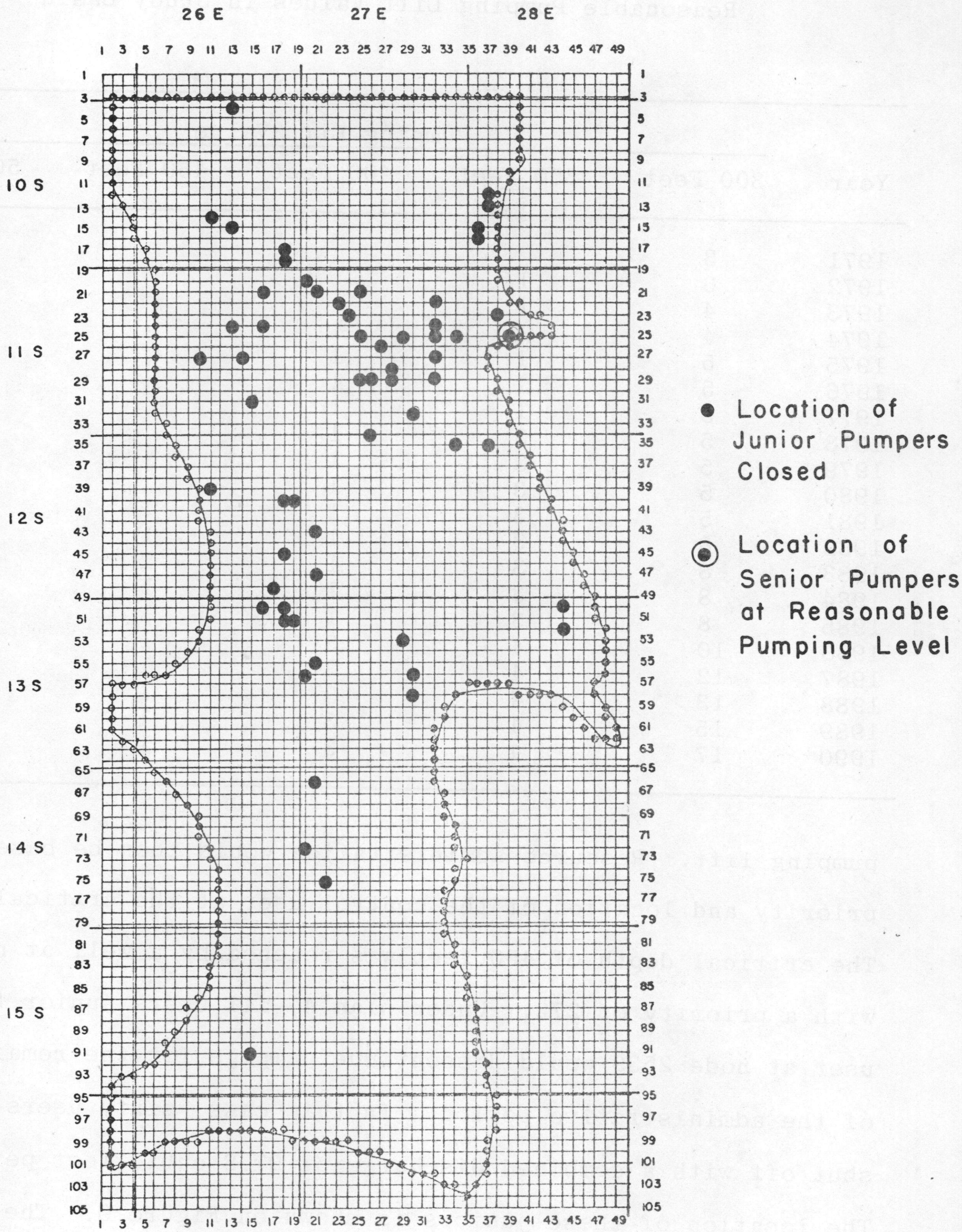

Figure 9
Location of Junior Pumpers Not Allowed to Operate
Under Plan A With Control Senior at Node 2439

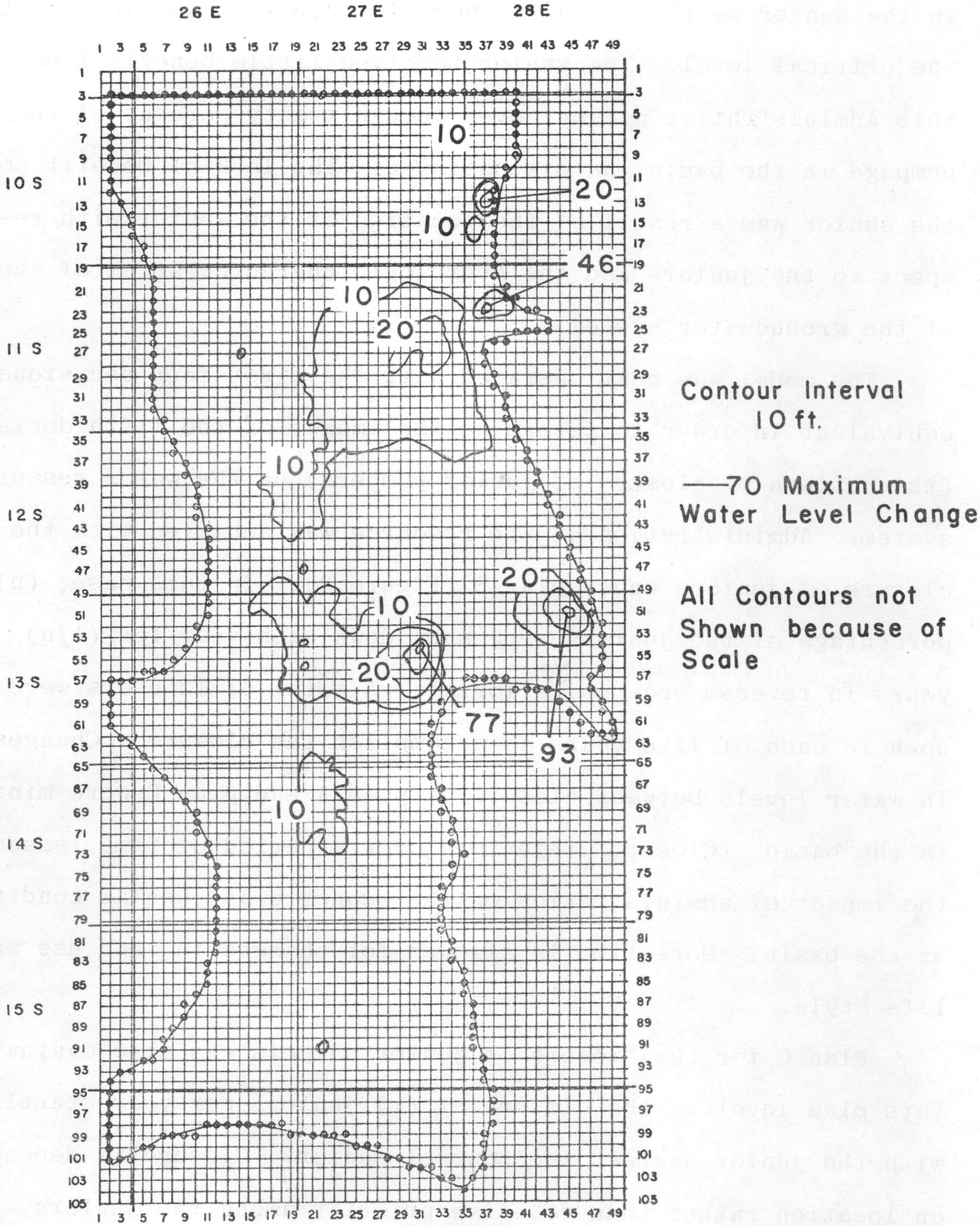

Figure 10
Water Level Rises by 1990 Because of Closure of Juniors
Under Plan A With the Control Well at Node 2539
as Compared to the Basis Run

in the center of the basin at some distance from the senior at the critical level. The senior received little benefit from this administrative action, even though twenty percent of the pumpage in the basin was discontinued. The lack of benefit to the senior was a result of the location of the senior with respect to the juniors and the hydrologic characteristics of the of the groundwater system.

The model was next operated with the first four decisions equivalent in order to determine the impact of the fifth decision (the pattern of closure of junior pumpers) on the water resource system. Administration of the resource was achieved with the closure of juniors under plan B (Figure 3). In this case, (n) percentage of the juniors were shut down each year for (1/n) years in reverse order of priority. A total of 12 users were shut down in each of five years to accomplish the closure. Changes in water levels between closure by plan A and plan B were minimal in the basin. Closure of juniors over a period of time lessens the impact of administration on the economic and social condition of the basin. More time is allowed for changes in land use and life style.

Plan C for the closure of junior pumpers was also evaluated. This plan involves the closure of (m) juniors per year starting with the junior nearest the control senior. Closure is dependent on location rather than relative priority among the juniors. This alternative was analyzed by closing five juniors per year for three consecutive years. Water level changes are more localized in the area of the senior pumper. However, the senior received little benefit from the closure. The economic and social impact of administration in the basin is more limited under plan C than plans A or B.

The impact of administration of the basin with different reasonable pumping lift values was also evaluated. A reasonable pumping lift of 350 feet was selected for examination. The 350 foot pumping level is first reached by the well at node 2539 in the pumping season of 1972 (see Table 1). Administrative action would be initiated by the closure of wells for the pumping season of 1973 under either plans A, B, or C. The only difference between this action and the one described earlier, is the length of the administrative period. Water level changes would be similar to those presented previously.

The well at node 2539 is not representative of the majority of the wells in the basin. It is located on the extreme eastern margin of the basin in a relatively thin section of the aquifer. The pumping lift is at least 50 feet greater than any other well in the study area. This well was temporarily removed from the analysis to determine the impact of administration based upon a different control senior.

The next wells to reach the designated reasonable pumping lift of 350 feet are located at nodes 2339 and 2440 in the pumping season of 1978. The priorities of the wells at nodes 2339 and 2440 are 270 and 271 respectively. They are located within one mile of the well at node 2539 with a priority of 272. The only difference between administration based on these wells and administration based on well 2539, is the closure of the well at node 2539. The water level changes resulting from administration based on the wells at nodes 2339 and 2440 would be very similar to that described previously. If these wells are also removed from the analysis, administration would be based on the well at node 2237. This well reaches the critical level in the pumping season of 1986. The location and priority (262) of this control senior would result in a similar physical impact from administration as that described above.

Administrative action based upon the following decisions provide a single general impact upon the basin.

Decisions:

1. Reasonable pumping lift as the management tool.
2. Reasonable pumping lift defined as the maximum depth to pumping water level.
3. Entire basin selected as the administrative unit with administration continuing from the time of administrative action through 1990.
4. Reasonable pumping lift selected as any value equal to or greater than 350 feet including or excluding the three users with the greatest lift.
5. Closure of juniors under plan A, B, or C.

Administration of groundwater is controlled by a group of wells along the eastern margin of the basin. These wells have consecutive priorities which may indicate ownership by a single individual. Users junior to these wells are located throughout the basin. Closure of the juniors results in general water level rise in the basin, but provides little improvement of the senior's pumping level. The depth to water in these wells is greater than other wells in the basin because of their location near the margin of the valley and the lower aquifer transmissibility. Given the decisions noted above, administration of the basin appears ineffective. Little protection is given to the senior user at the expense of closure of a large group of juniors.

The administrative action outlined above might benefit the senior user if the length of the administrative period is extended significantly. The analysis was limited to the period of 1970-1990 because of monetary limitations on the operation of the model. The length of the administrative period required to provide the senior with a measureable benefit could not be estimated from the available information.

The next series of operational runs was conducted with the following decisions:

Decisions:

1. Reasonable pumping lift as the management tool.
2. Reasonable pumping lift defined as the maximum depth to pumping water level.
3. Basin divided into two administrative units with the division line at node row I=37 with administration continuing from the time of administrative action through 1990.
4. Reasonable pumping lift of 450 feet selected for administration in the northern portion of the basin and a lift of 300 feet selected for administration in the southern portion of the basin.
5. Closure of junior users under plan A.

The division of the basin into two units has been suggested by Schatz (1974) on the basis of his analysis of economic return from irrigation by groundwater. He noted that the northern portion of the basin has the potential for row crop agriculture while the southern portion of the basin is limited to lower return grain and pasture operations. The division of the basin at node row 37 follows Schatz's economic division of the basin. Young and Ralston (1971) noted different reasonable pumping lift values for the northern and southern portions of the basin. Their division line is similar to that suggested by Schatz. A reasonable pumping lift of 300 feet was suggested by Schatz (personal communication 1974) for the southern portion of the basin on the basis of lower net returns from farm operation. The 450 foot reasonable pump lift value is that suggested by Young and Ralston (1971) as a minimum for the northern part of the basin.

The division of the basin into two administrative units limits closure of juniors to users within each unit. A senior user at the critical level in the northern portion of the basin may not force closure of a junior user in the southern portion of the basin.

Administrative action was initiated in the northern portion of the basin when the user at node 2539 reached the designated reasonable pumping lift of 450 feet in the pumping season of 1981. The first user to reach the designated level of 300 feet in the southern portion of the basin was at node 4941 in the pumping season of 1982. The water right for this well has a priority of 172. Under plan A, all users junior to priority 272 in the northern portion of the basin were closed in 1982, while all users junior to priority 172 in the southern portion of the basin were closed in 1983. Thirty-eight wells in the northern portion of the basin with a combined discharge of 58 cubic feet per second were not allowed to pump. An additional 61 wells totaling 103 cubic feet per second of discharge were not allowed to operate in the southern administrative unit. The location of the wells are shown on Figure 11. The results of the administrative action is presented in Figure 12 as water level change from the Basis Run by 1990. Extensive water level change may be

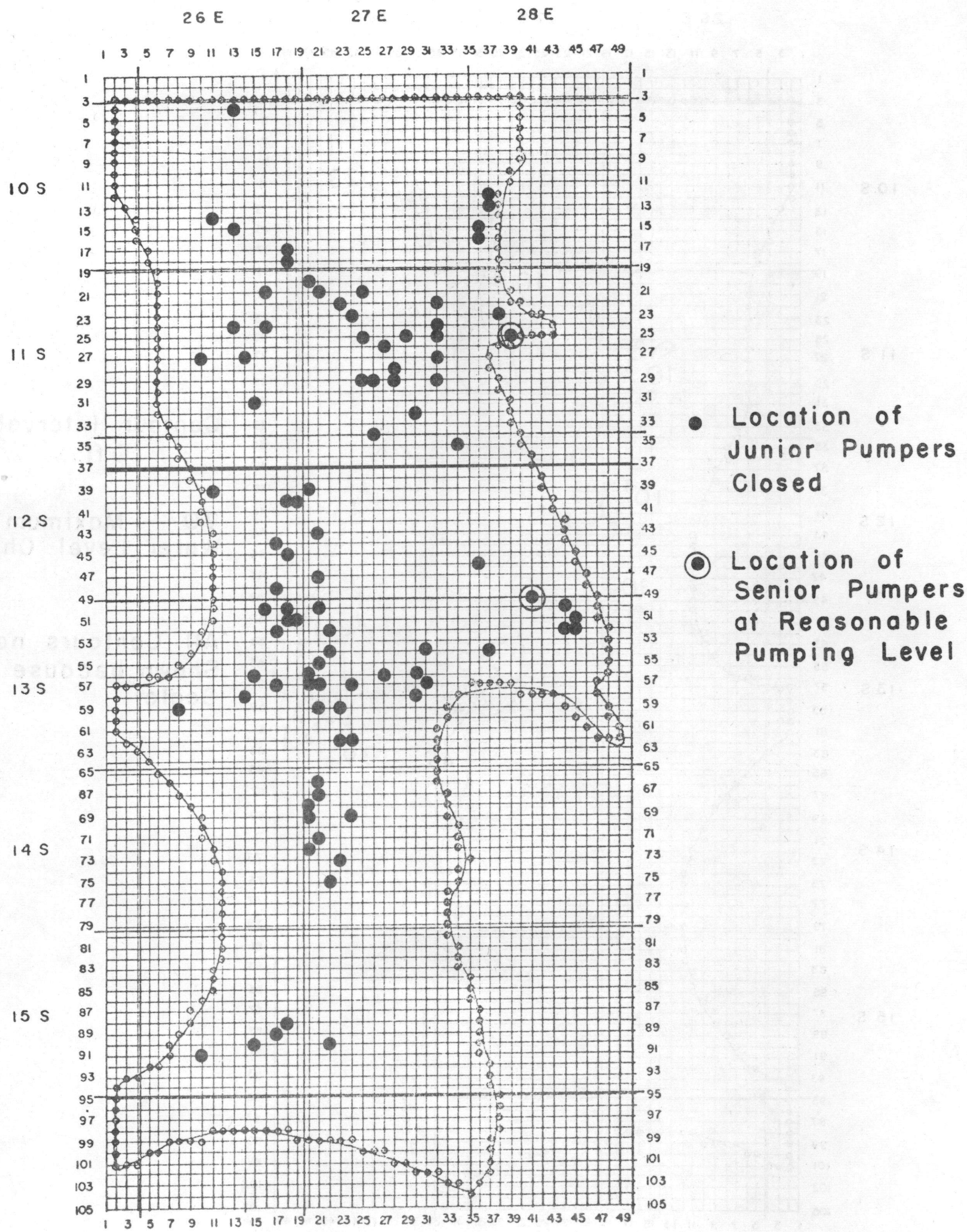

Figure 11

Locations of Junior Pumpers Not Allowed to Operate Under Plan A with Basin Divided at I=37 and Control Seniors at Nodes 2539 and 4941

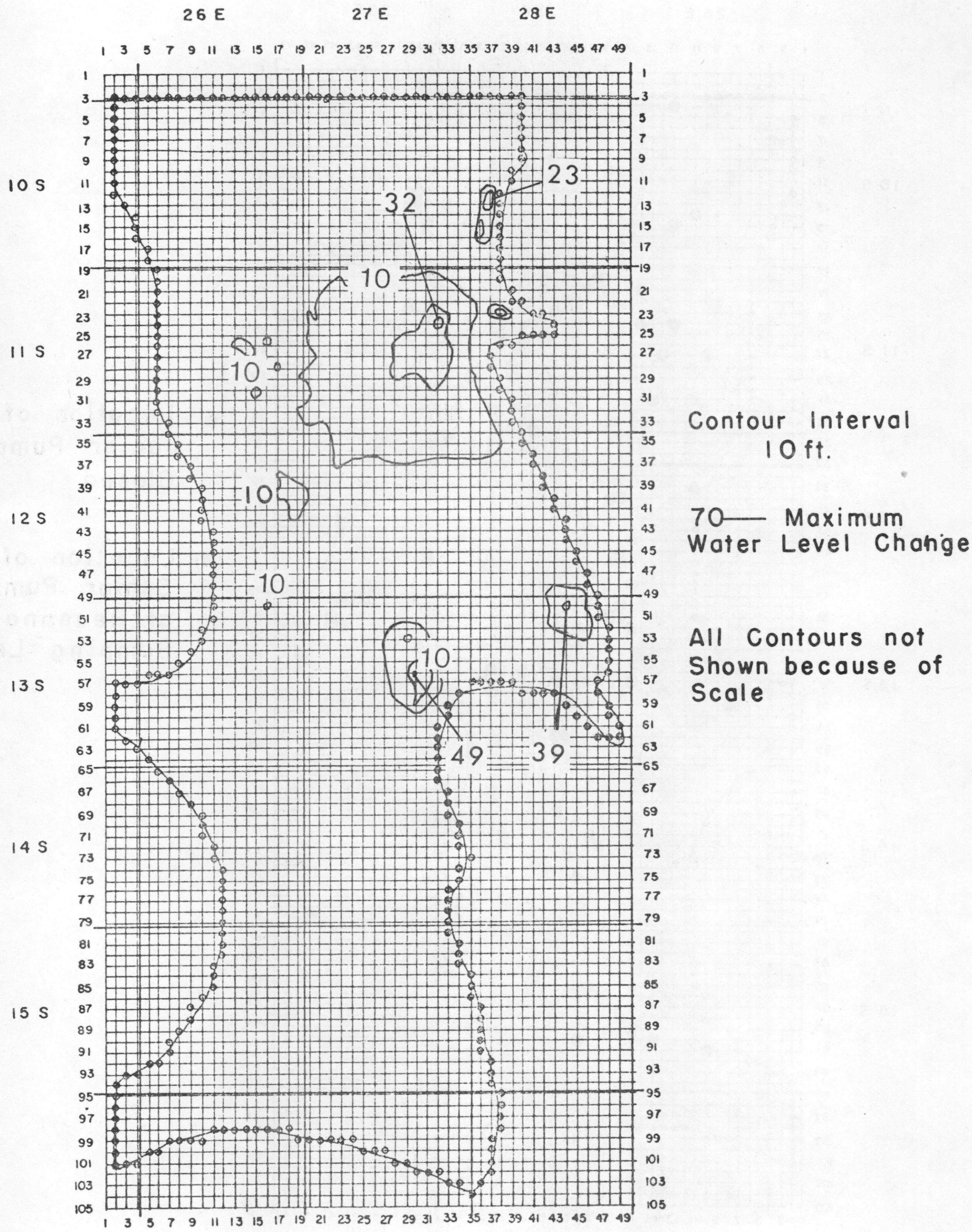

Figure 12
Water Level Rises by 1990 Because of Closure of Juniors
Under Plan A with Basin Divided at I=37
with Control Wells at Nodes 2539 and 4941
as Compared to the Basis Run

seen in the center of the basin. Little rise of water levels occurs near the northern control well. Some rise in water level is shown at node 4941, as a result of closure of wells to the southeast. The decreased rate of water level decline in well 4941 is shown in Figure 13.

Closure of juniors under plans B and C were evaluated in the next operational runs. Water level changes by 1990 from closure of juniors under plan B were very similar to those for plan A. The water level changes by 1990 from the Basis Run by closure of juniors under plan C is presented in Figure 14. The location of the wells is shown on Figure 15. Rises in water level are more localized to the areas of the control wells. The hydrographs from the well at node 4941 from the closure of juniors under plans B and C are similar to that for Plan A. The senior in the southern unit is provided with the same benefit within the administrative period by the closure of 12 wells closest to him as by the closure of all 61 users junior to him in the administrative unit.

The division of the basin into two administrative units does not increase the protection given to the senior at the cri-ical level but does increase the protection for the juniors from closure based on the water level conditions of a well in the other end of the basin. The division allows for administration of the water resource in the basin on more than one reasonable pumping lift. The degree of protection given the senior by ad-ministrative action is still more dependent on his location with-in the basin and with respect to other users than on the relative priority of his water right. Closure of 58 users in the northern

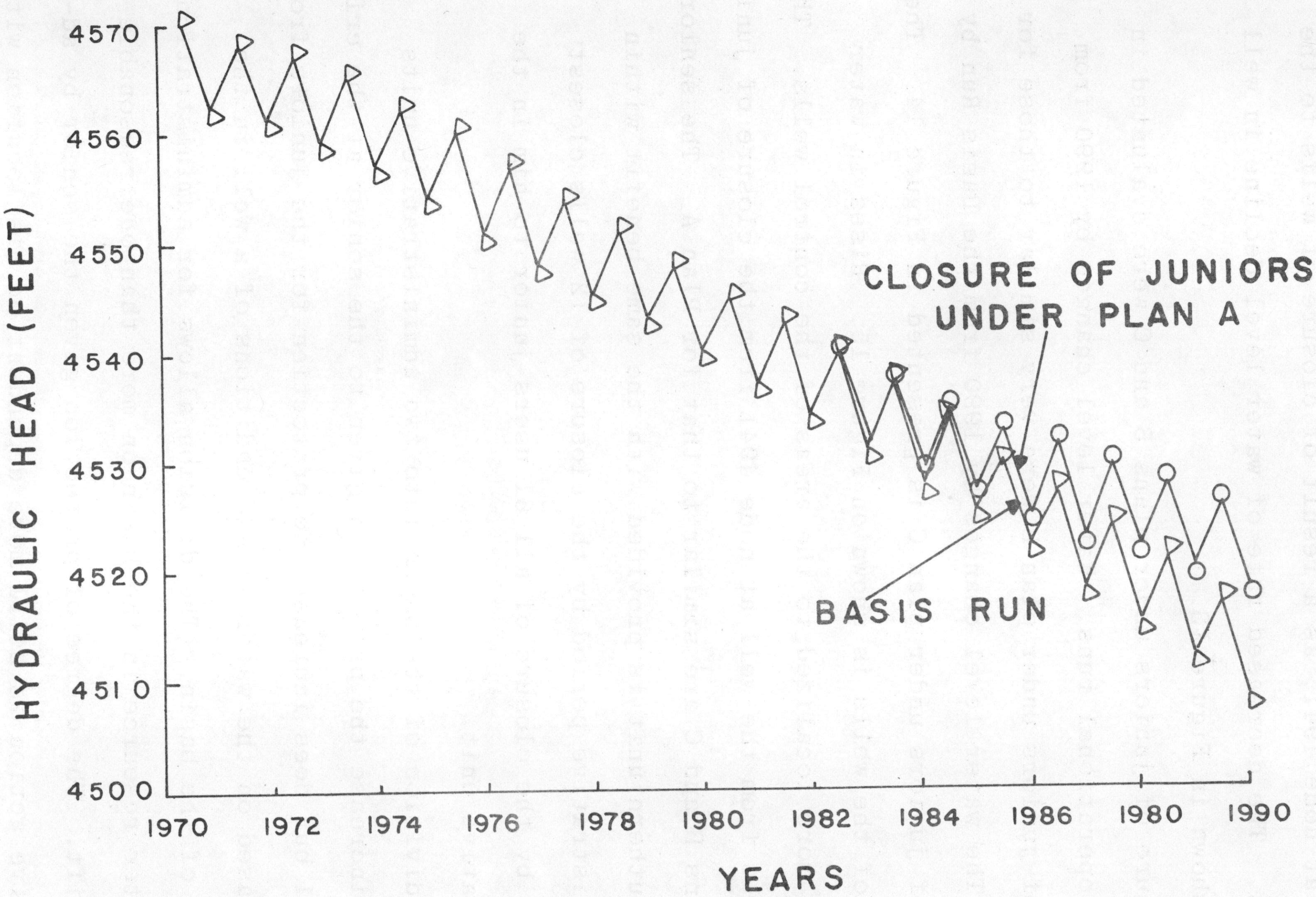

Figure 13

Hydrograph of Well at Node 4941 From Basis Run and From Operational Run with Closure of Juniors Under Plan A with Basin Divided at I=37

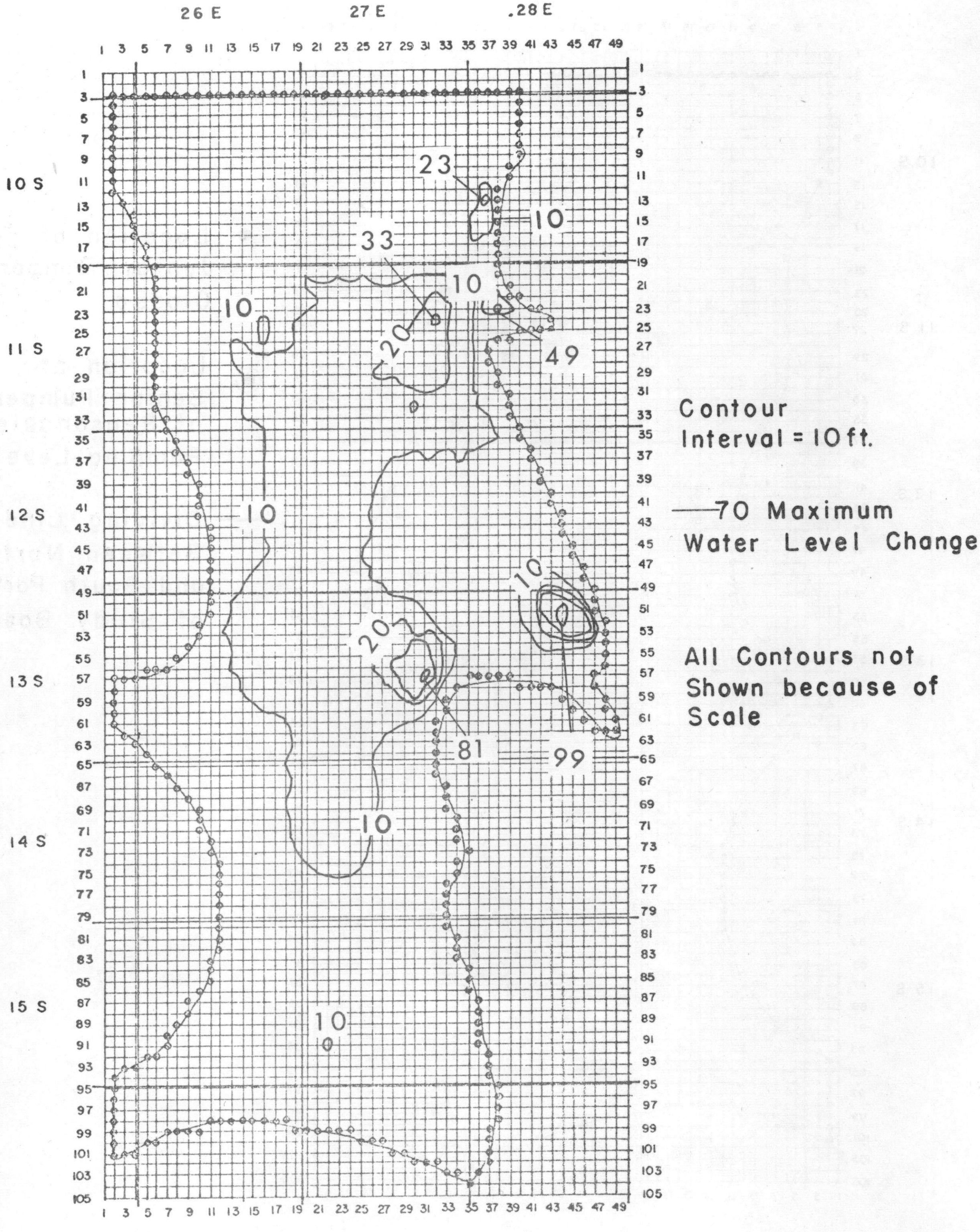

Figure 14

Water Level Rises by 1990 Because of Closure of Juniors Under Plan C with Basin Divided at I=37 with Control Wells at Nodes 2539 and 4941 as Compared to the Basis Run

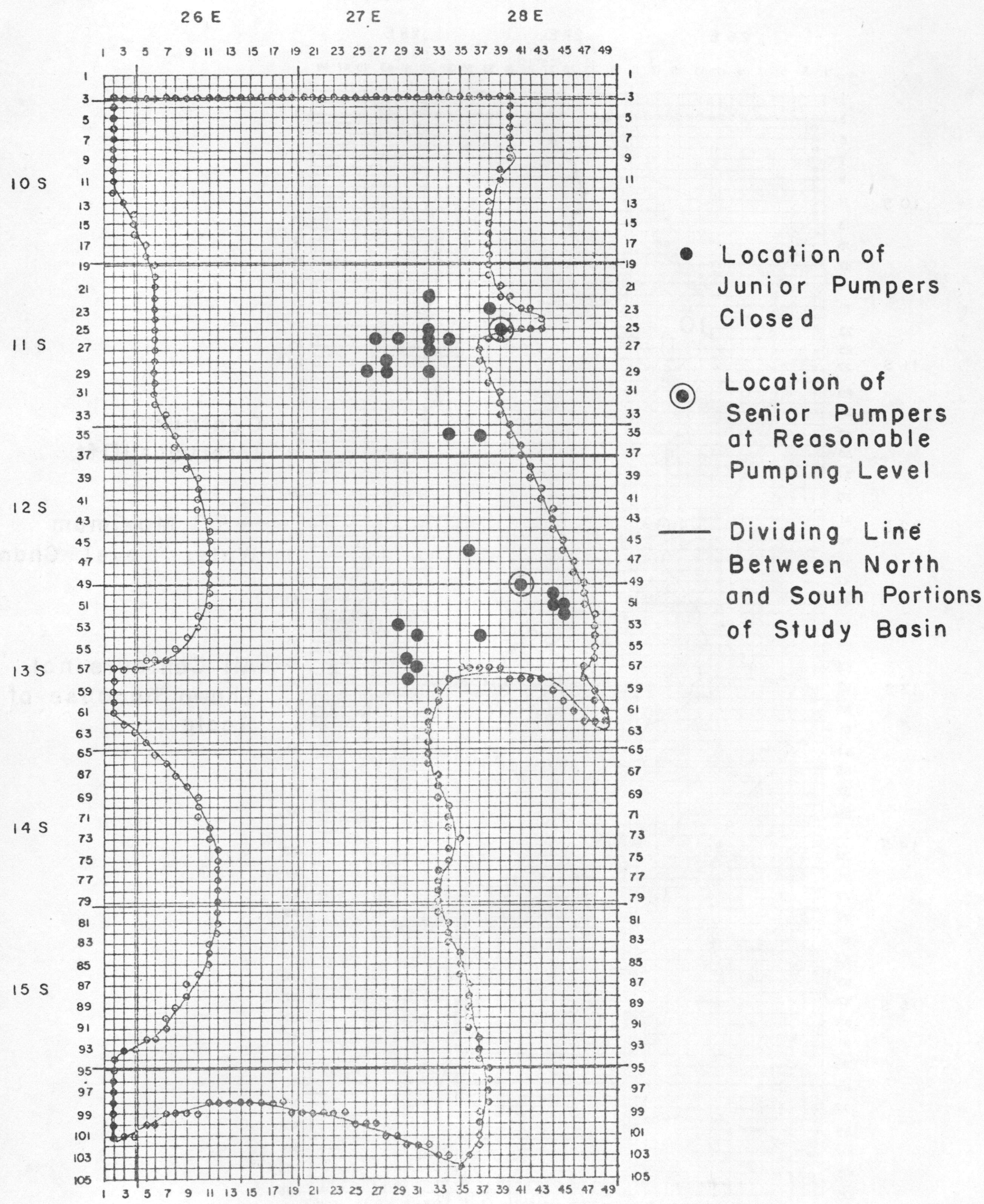

Figure 15

Locations of Junior Pumpers Not Allowed to Operate Under Plan C with Basin Divided at I=37 and Control Seniors at Nodes 2539 and 4941 portion of the basin did not benefit the senior because none of the juniors were located near him. However, closure of 12 juniors in the southern portion of the basin benefited the senior because they were located near him.

The reasonable pumping levels criteria was next evaluated as a limit on the rate of water level decline and the maximum depth of pumping water level. The annual water level change in each well in the basin was determined from the punched arrays of data generated from the Basis Run. The water level change in wells from 1982 to 1983 (measurements at the end of the pumping season) is presented in Figure 16 as an example of these annual changes. The distribution of these changes is presented in Figure 17. The mean annual change in water level shown on the figures is 2.8 feet. Only eight wells have a water level drop greater than five feet per year. Only one well has an annual decline greater than 10 feet.

Schatz (1974) evaluated the impact of various rates of water level decline on farm enterprises in the study basin. He studied annual decline rates of 1, 2, 3, 4, 5, and 10 feet and concluded that the lower rates have little economic significance on farm income in the area. Users have sufficient time to depreciate required changes in well depth and pumping equipment to minimize the impact. Schatz did note that a water level decline of ten feet per year or greater has a significant impact on the net return to the user. These rates of decline were found to be significant from an economic viewpoint as measured by the impact on farm income. Butcher and others (1972) concluded that a decline

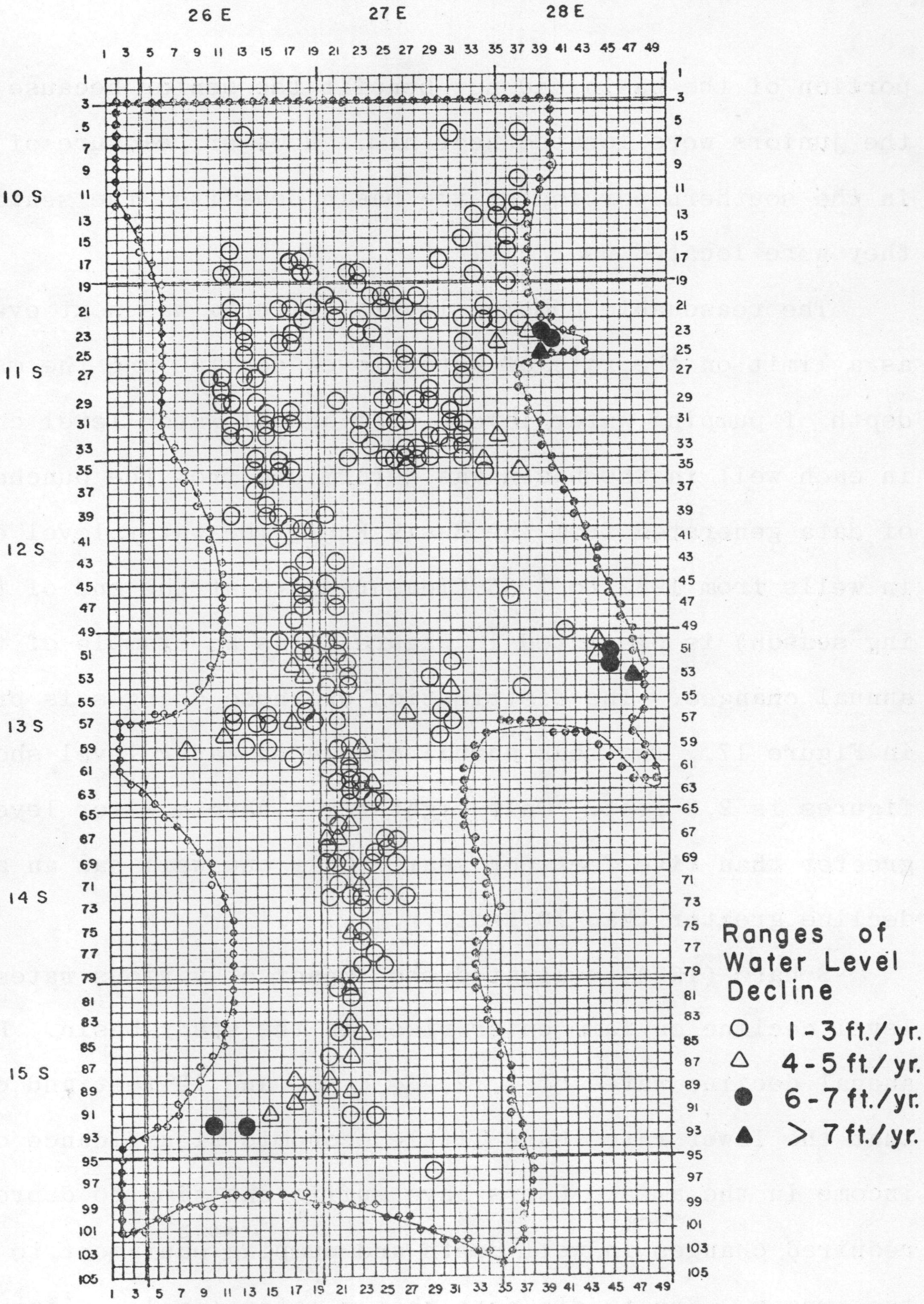

Figure 16
Water Level Decline in Wells
for Period 1982-1983, Basis Run

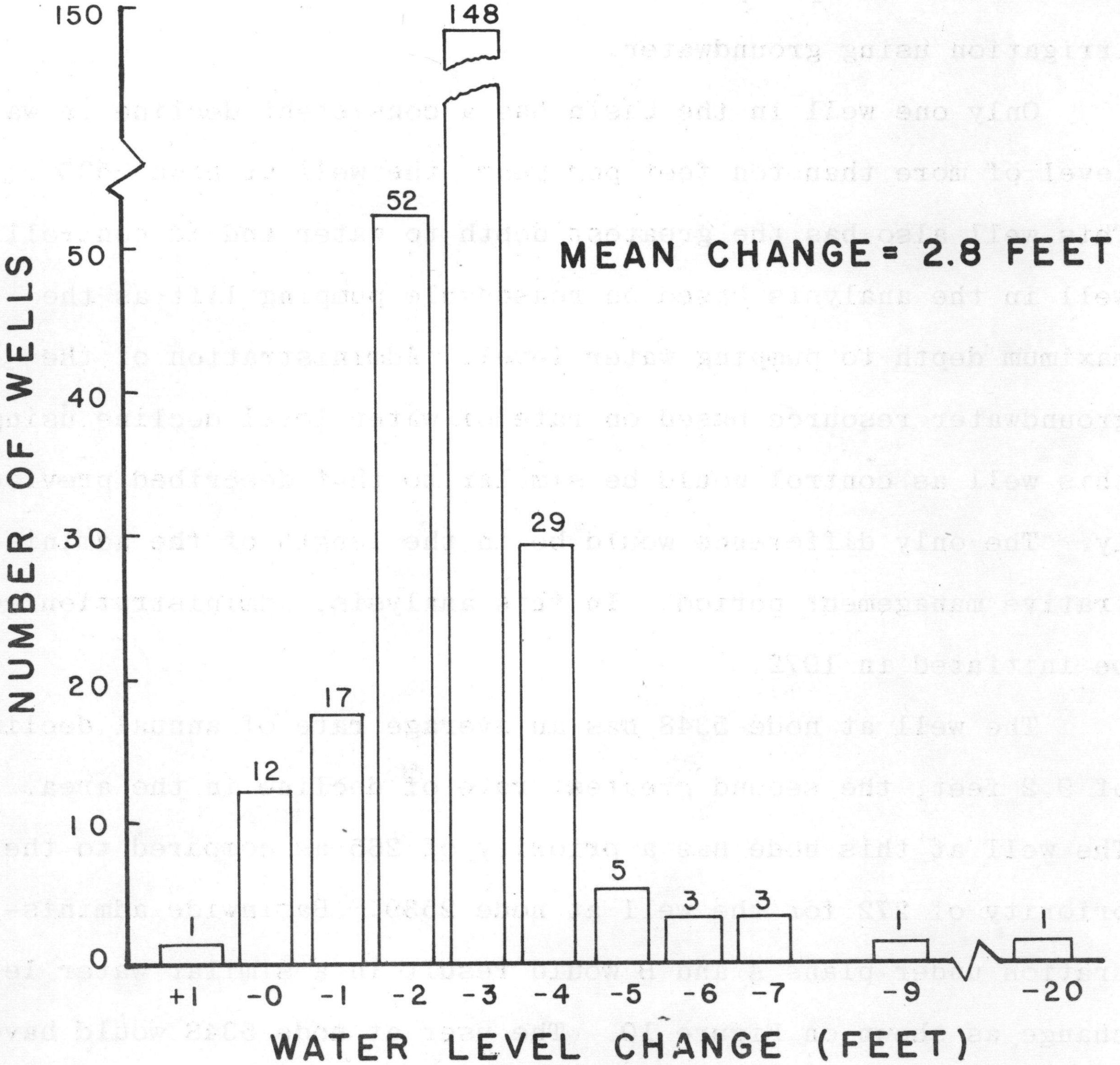

Figure 17

Histogram of Water Level Changes in Wells
from 1982 to 1983, Basis Run

rate of ten feet per year is the maximum limit for continued irrigation using groundwater.

Only one well in the basin has a consistent decline in water level of more than ten feet per year; the well at node 2539. This well also has the greatest depth to water and is controlling well in the analysis based on reasonable pumping lift as the maximum depth to pumping water level. Administration of the groundwater resource based on rate of water level decline using this well as control would be similar to that described previously. The only difference would be in the length of the administrative management period. In this analysis, administration would be initiated in 1972.

The well at node 5348 has an average rate of annual decline of 9.2 feet, the second greatest rate of decline in the area. The well at this node has a priority of 265 as compared to the priority of 272 for the well at node 2539. Basinwide administration under plans A and B would result in a similar water level change as shown on Figure 10. The user at node 5348 would have little relief under this administrative action. The water level decline in his well is primarily the result of his own withdrawal and his location near the edge of the aquifer system. Protection of a reasonable rate of water level decline is a function of the senior's location in the basin and the location and priority of nearby users as well as his own priority.

Analysis of the Recharge Limitation as a Tool for Resource Management

Administrative alternatives for management of groundwater under the guideline of limiting pumpage to the "reasonably anticipated average rate of future natural recharge" are presented in Figure 4. Five levels of decision are noted on that figure:

Decisions:

1. Selection of a management tool (recharge limit).
2. Definition of the recharge limit concept
   a. Recharge limitation defined as the total water available for man's use in the basin (water yield).
   b. Recharge limitation defined as the total recharge to the groundwater system.
   c. Recharge limitation defined as equal to the total recoverable discharge from the groundwater system.
   d. Recharge limit defined as time dependent as a function of the hydrologic, economic and well location conditions in the basin.
3. Selection of administrative management units and selection of the length of management periods.
4. Selection of recharge value or values.
5. Selection of method of application of the recharge restriction to junior users in the administrative units.

Administration of a groundwater resource under this criteria does not depend on a cause-effect type of resource response. Junior users are not shut down to provide immediate relief for seniors but rather to provide some long term certainty of water availability. The mathematical model of the water resource system in the study basin was not suited to long term analysis of impact from administration because of the limited period of calibration and the high cost of operation. The model was used to provide short term information on the impact from administration under the recharge limitation.

The major problem with administration of the resource under the recharge limitation is the definition of the concept and its quantification. The "water yield" of the study basin has been estimated in three separate studies. The yield estimates of the entire Raft River Basin, of which the modeled area is only a part, range from 140,000 acre-feet per year (Walker and others, 1970), to 320,000 acre-feet per year (Mundorff and Sisco, 1963). The third estimate was 183,000 acre-feet (Nace and others, 1960). Some difference occurs between the reports in the definition of the term water yield. If the highest estimate of water yield is adopted for administration, then no management action is warranted. Pumpage during the Basis Run was held at 203,000 acre-feet per year. Selection of the 140,000 acre-feet per year or the 183,000 acre-feet per year values would necessitate closure of a portion of the users in the basin. Ninety-seven users would be shut off with the former recharge value; thirty-four users would not be allowed to pump with the latter recharge estimate.

If the recharge limit is defined as the total recharge to the groundwater system, then a value less than the basin water yield would have to be used. Some water included in the water yield estimate is diverted and consumptively used for surface water irrigation. No estimates are available of the quantity of water annually recharged to the groundwater system. Direct recharge to the groundwater system was held at 74,000 acre-feet per year for the model operation. This figure is believed to be a conservative estimate of the recharge to the system. Pumpage would have to be reduced by about sixty-three percent if this value was selected as the basis for administration under the recharge limitation. Only the most senior 130 users would be allowed to pump in the basin.

The recharge limitation may be defined as equal to the total recoverable discharge from the groundwater system. It is often not possible to eliminate all natural discharge from the basin because of various physical, economic and social constraints. Well development must be limited to the portion of the discharge from the basin that is recoverable to have a long term equilibrium condition. Walker and others (1970) estimated that 29 percent of the natural discharge from the study basin was by consumptive use of riparian vegetation, 12 percent by surface water discharge and 59 percent by groundwater outflow. They noted that development by 1966 had resulted in a 50 percent reduction in the consumptive use of riparian vegetation, an 89 percent reduction in the surface water outflow and four percent reduction in the groundwater outflow. Walker further stated that a "reduction of the groundwater outflow by about half . . . would require lowering the water level several tens of feet in the area immediately north of the present areas of greatest water level decline. The time required to effect the reduction would be very great, and very large additional quantities of groundwater would be removed from storage". (Walker and others, 1970, p.91). If half of the groundwater outflow is considered recoverable, then the recharge value (based upon the 140,000 acre-feet per year water yield estimate) would be 100,000 acre-feet per year. If none of the groundwater outflow is considered recoverable, then the recharge value would be only 60,000 acre-feet per year.

A wide range of equilibrium conditions between recharge, natural discharge and artificial discharge can occur in the basin depending on the extent to which the water level is allowed to decline. The recharge value may be defined as a rate of pumpage which will allow equilibrium conditions to occur. A relatively shallow reasonable pumping lift would prevent major water level decline and limit the recovery of natural discharge. Pumpage would be limited severely under these conditions. The recharge limit under this definition has not been estimated.

The short term impacts of basinwide administration under three defined recharge levels are presented to illustrate the impact of management under this constraint. The water level change map presented in Figure 10 shows the impact of eight years of basin operation with a reduction of pumpage to 166,000 acre-feet per year. The impact of pumpage at a level of 143,000 acre-feet per year is shown on Figure 12 after seven years of administration. An additional run was made to show the impact of the extreme closure down to a pumpage level of 74,000 acre-feet per year after ten years of basin operation (Figure 18). Water level rises are seen from all three figures. Sufficient data are not available to interpret the long term impact from such administration.

The selection of administrative management units and the selection of the administrative management period would be based upon the definition of the recharge limitation. These administrative tools could be used to achieve the equilibrium condition with maximum basin pumpage.

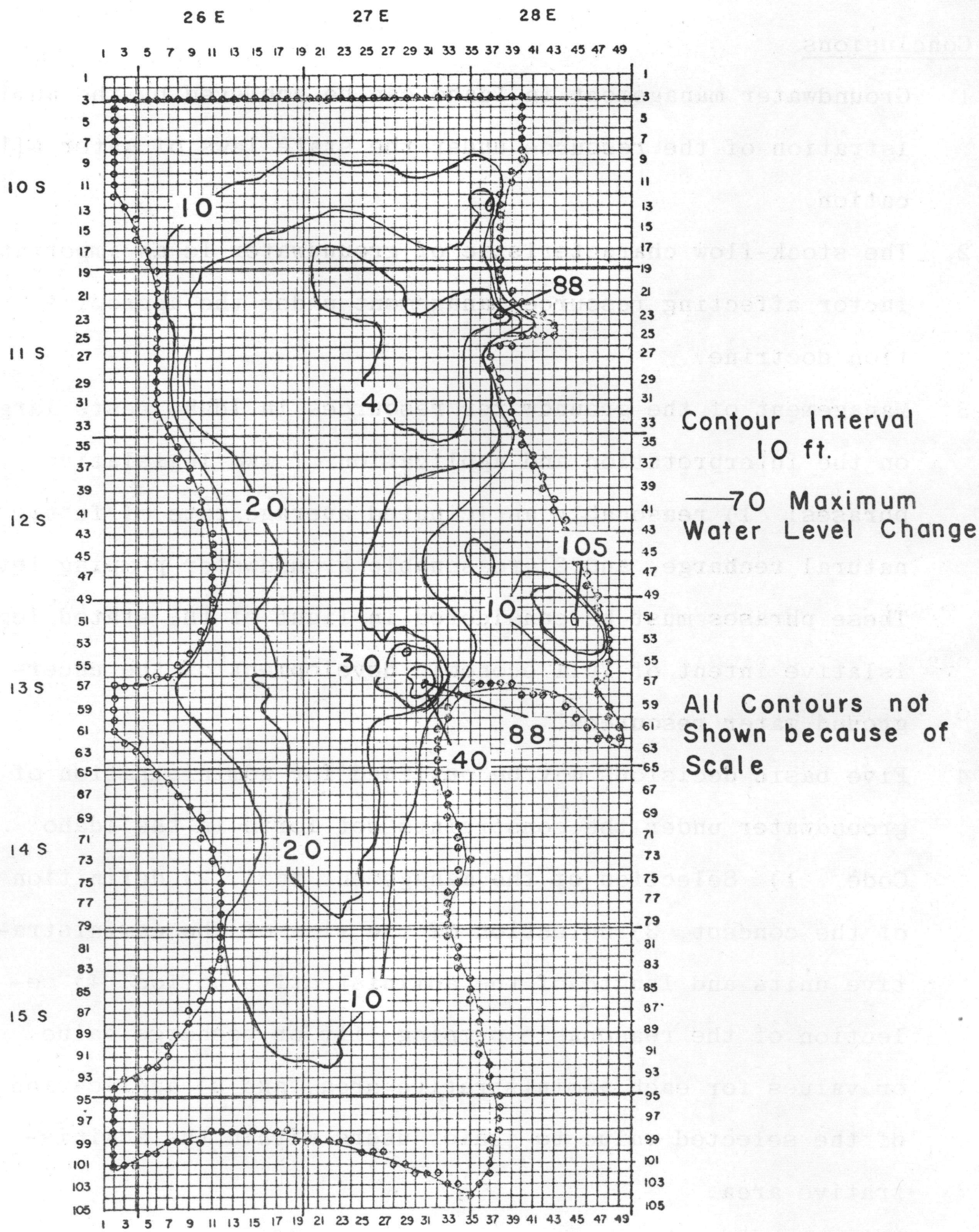

Figure 18

Water Level Changes by 1990 From Closure of Wells
to Limit Pumpage to 74,000 Acre-Feet Per Year,
as Compared to the Basis Run

Conclusions

1. Groundwater management in Idaho can be achieved by the administration of the resource under the state laws of water allocation.
2. The stock-flow characteristic of groundwater is an important factor affecting resource management under the appropriation doctrine.
3. Management of the groundwater resources in Idaho rests largely on the interpretation and application of two legislative phrases: 1) reasonably anticipated average rate of future natural recharge, and 2) reasonable groundwater pumping levels. These phrases must be considered in light of the stated legislative intent of full economic development of the underground water resources.
4. Five basic decisions may be outlined for administration of groundwater under the constraints set forth in the Idaho Code. 1) Selection of the management tool, 2) definition of the concept, 3) selection of the size of the administrative units and length of the administrative period, 4) selection of the reasonable pumping lift or recharge value or values for each administrative area, and 5) application of the selected value to junior users within the administrative area.
5. The reasonable pumping lift concept is based upon a cause-effect relationship. This relationship is dependent on a number of factors. The impact on a senior's well of closure of a junior appropriator's well may be very limited because of the stock characteristics of groundwater.

6. Operation of the mathematical model indicated that the senior users at the designated reasonable pumping levels received little benefit from closure of juniors under any of the management plans.
7. Alternative plans for the closure of junior appropriators under the reasonable pumping lift restriction had little impact on the groundwater levels in the vicinity of the senior user's well. The senior received equal or greater protection with lessened impact on the economy of the area by closure of juniors over extended periods or by closure of only those juniors nearest the senior.
8. Changes in the value of the pumping lift had little effect on the pattern of resource administration in the study plan.
9. Application of the constraint of reasonable groundwater pumping levels was based on senior appropriators who are located along the edge of the basin where the static depth to water is greater and the aquifer is thinner.
10. The division of the basin for resource administration had little impact on the protection given the control seniors.
11. The pattern of administration of the groundwater resource in the study basin was the same for either definition of the reasonable pumping lift constraint.
12. The degree of protection for a senior's means of diversion is only partially measured by his water right priority. It is also dependent on his location both in the basin and with respect to other users and the relative priority of the surrounding users. The user who is surrounded by users with

more senior rights receives little benefit from any plan of resource administration.

13. Administration of the groundwater resource under the recharge restriction is based upon long term impacts and is not dependent on any direct cause-effect relationship.

14. The most important decision in the administration under the recharge restriction is the definition of the concept.

15. Administration of the resource under the recharge restriction must include consideration of the time required for the establishment of hydrologic equilibrium conditions and the relationship between the level of equilibrium and the extent of groundwater mining.

16. Effective groundwater management may occur in Idaho by the development of adequate definitions and techniques of administration under the two major concepts of reasonable groundwater pumping levels and reasonably anticipated average rate of future natural recharge. Administrative plans must be designed for each basin within the general legal guidelines based on the specific hydrologic and geologic conditions and the pattern and extent of resource development. A sufficient range of alternatives is available in the concepts to allow efficient resource management of a wide range of situations.

CHAPTER V
GENERAL CONCLUSIONS

The problem of groundwater management under the legal code of Idaho has been investigated from the viewpoints of hydrology, engineering, economics and law. Conclusions from each of these specific studies have been presented. Several general conclusions may be presented from the combined study.

1. The legal guidelines for groundwater management are subject to a wide range of interpretation which in turn may provide a wide range of possible administrative actions. The present lack of judicial interpretation makes it impossible to assess the feasibility of many of the alternatives. However, it is believed that the range of alternatives available under the Idaho Code will allow efficient groundwater management in a wide range of physical situations.

2. The reasonable pumping lift concept is based upon the assumption of a strong cause-effect relationship in a groundwater flow system. It is also based upon the assumption that the depth to pumping water level is a major factor in the economics of water uilization. Neither of these assumptions is necessarily true. The cause-effect relationship of well interference is dependent on hydrologic factors as well as distance between wells and the location of the wells in the basin. The depth to pumping water level and the rate of water level decline are not the most dominant factors in farm economics. The concept of reasonable pumping levels is valuable for resource management only if adequate definitions and techniques of resource administration are utilized.

3. The recharge limit concept is based upon long-term impacts of resource development. The legal and physical definition of the concept of "reasonably anticipated average rate of future natural recharge" is the greatest problem for resource adminiistration.

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