# Staff Papers Series

Staff Paper P78-12

August 1978

# POLICIES AND PROCEDURES USED FOR GRANTING IRRIGATION PERMITS IN SELECTED UPPER MIDWESTERN STATES

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## Introduction

Western states, where water always has been recognized to be in short supply, have a long history of water allocation policies and well developed bodies of water law. The Midwest, by contrast, has been viewed as water rich. Water shortages have been viewed as temporary aberrations which soon would pass. East of the 100th meridian, water was implicitly treated as a free good, or at least, not a limiting factor in economic development and agricultural pursuits. Irrigation was limited largely to specialty crops and to small local areas.

Because water was not generally a limiting factor in agricultural production, there was no anticipated irrigation development, and because water development was generally accepted as a private matter, there was no need to develop comprehensive water laws. However, with recent increasing demands, water is coming to be recognized as scarce in the economic sense that there are limited supplies for given uses. As use of water for one purpose may preclude other uses, choices must be made. When use of water for irrigation increases, there must be a mechanism to facilitate choice

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+ This paper was prepared under a project entitled An Analysis of Criteria for State Issuance of Irrigation Permits with Limited Information, funded by the Northwest Area Foundation. This paper is a slight modification of a paper presented at the American Society of Civil Engineer's Specialty Conference on Irrigation and Drainage at Blacksburg, Virginia in July 1978 and will be forthcoming in the proceedings of that conference.

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if irrigation interferes with other uses. The Upper Midwest has little history of such institutional mechanisms. The dilemma is that to allow use of groundwater for irrigation is to grant a significant capital asset. Yet, the future implications of that use are uncertain. Decisions must be made with incomplete information. It is to the institutional means of making irrigation decisions that this paper is addressed. Emphasis will be on groundwater, as the major share of supplemental irrigation in the upper midwestern states use groundwater supplies.

Recent interest in irrigation in the upper midwest is due in part to the hot droughty weather of the mid-1970's. In addition to climatic factors, the increased world demand for U.S. food and feed grains, in the early 1970's, and rising commodity prices also had significant effects. The direct effect was the creation of a national agricultural policy aimed at bringing all available farm lands into their full productive potential. The resultant economic pressures coupled with a decline in cattle prices and numbers served to bring many new, marginal acres of former hay and pasture lands into row-crop production. High and rising production costs made it imperative for the individual farmer to maintain high yields on all soils. Thus, a combination of concurrent events have stimulated much interest in irrigation in the last few years in areas previously dependent on natural rainfall. Irrigation in these areas tends to be of a supplemental nature.

The increased demands for irrigation water have prompted some mid-western states to require potential irrigators to apply for a permit to irrigate. In some states application for irrigation permits in the mid 1970's have increased to five or six times their usual rate in previous years. This rapid increase has raised serious questions, on the part of

interest groups and legislative bodies, about the feasibility of widespread irrigation in the upper midwest. Few of these questions can be adequately answered due to a lack of factual knowledge about water. The efficiency and equity of a regulatory system is limited until it is known how much water is available, how it is used, and what effect such use has on supply. While this information is being systematically gathered and collected by the upper midwestern states, all of these states have had to make decisions about irrigation policy for which they have been unprepared.

## Alternative Institutions for Allocating Irrigation Groundwater and How They Evolved

With accelerating demand for groundwater, many users are becoming increasingly concerned with the status of their water rights. Traditionally, water rights laws have evolved from the precedents set by state courts in individual cases adjudicating the rights of rival parties. The body of laws which has developed from this process took two different shapes which are referred to as the "riparian doctrine" and the "appropriation doctrine". While these doctrines are easy to understand in abstract, they are characterized by a lack of precision in defining the extent of the water rights recognized under them.

This lack of certainty about water rights has led many states to attempt to legislate particular statutory rights. Such legislation usually resulted in the creation of an administrative body to define and enforce these statutory rights. The type of administrative agency that evolves will have a significant bearing on whether successful groundwater management results. Credibility and consistency are particularly important in groundwater allocation because the resource cannot be seen or measured by the potential user, who consequently, must rely on the judgement of the agency in charge of water permits.

Many states have chosen a single executive agency for the administering of an irrigation permit system. However, the policy making body within each agency can vary widely in terms of a) the scope of their regulatory power, b) the method by which they are chosen, and c) extent of each member's knowledge of irrigation, hydrology, and related fields.

Besides being able to approve or reject applications for irrigation permits, these agencies are usually vested with other regulatory powers which may include:

1) the right to specify the information each applicant must provide when seeking a permit,

2) the right to establish withdrawal rates and amounts,

3) the right to require periodic reporting on amounts of water withdrawn,

4) the right to establish well construction and pumping equipment standards,

5) the right to require water measuring devices to monitor maximum rate of flow and total amount withdrawn,

6) the right to suspend or modify a permit,

7) the right to inspect equipment,

8) the right to license well drillers, and

9) the right to determine priority of appropriation among users.

For selection of members of an irrigation permit system, several methods are used. In some states, the staff members that are directly responsible for issuing permits are hired according to their expertise in irrigation technology and supporting fields. In contrast, some states provide that the irrigation rights commission be chosen directly by the electorate. A modification of this procedure allows the governor to appoint the members from a list of possible candidates preferred by the electorate. Finally, the governor may appoint the water commission members without the advisement of the states' voters.

Under the last three methods it is quite possible for the permit issuing agent to consist of some individuals who have little knowledge of irrigation and related fields. Thus, these citizens commissions are dependent on state and federal agencies involved in water management to obtain the information they need to make decisions.

Some states in the upper midwest have not yet felt the necessity of initiating a permit system to allocate groundwater for irrigation. These states are characteristically water rich and have not yet experienced sufficient problems with competing demands for water use to warrant the establishment of a permit system. With the supply of water being relatively inelastic, while demand is increasing, even these states will probably find themselves eventually developing legislation to handle water allocation problems.

In general, a permit system serves several important purposes. First, it establishes that water rights are in the realm of state regulation and provides for an administrative mechanism to handle water rights problems. Secondly, water rights will be defined not by the courts but by an agency which can develop considerable expertise in handling water allocation problems by gathering pertinent and factual information. Efficient and equitable allocation of groundwater to irrigators can better be promoted by an administrative body which collects and studies data on water availability and how it is affected by various users.

## Summary of the Administrative Agencies in the Upper Midwestern States

In this section of the paper we present a brief description of the administrative bodies that have developed in each of the upper midwestern states to deal with the allocation of groundwater for agricultural irrigation. Flow charts of the permit issuing process for six of the states which were surveyed are in Appendix A.

North Dakota

The administrative agency responsible for groundwater management policy in North Dakota is the State Water Commission which includes the Governor, the Commissioner of Agriculture, and five other members appointed by the Governor chosen from the qualified electors of the state. The State Engineer serves as the Chief Executive Officer of the Commission. The Commission is empowered to "investigate, plan, regulate, undertake, construct, establish, maintain, control, operate, and supervise all works, dams, projects, public and private, which in its judgement may be necessary or advisable."[1/]

In particular, the State Engineer is responsible for making decisions in regards to the allocation of groundwater for irrigation. He is appointed by the State Water Commission according to his qualifications which require that he be experienced in hydraulic and irrigation engineering. The State Engineer is required to make hydrographic investigations of each water supply in the state with a particular emphasis on determining the availability of water for irrigation. All irrigators are required to have a permit and must supply information prescribed by the State Engineer. In general, the applicant must provide information on amount of water requested, rate of withdrawal, point of diversion, source of supply, depth to the bottom and top of the aquifer, type of irrigation system, estimate of time needed to complete the project, and any additional information the State Engineer may request which may include additional test holes and water level data.

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1/ Section 61-02-14 of North Dakota Water Laws (1977).

When the State Engineer is satisfied that an application has been properly completed, a hearing is held so that other interested parties may give testimony on the merits of the proposed project. After the hearing, the State Engineer determines whether or not enough water is available so that the proposed use will not harm prior appropriations. The facts discovered in the hearing, and groundwater availability, determine whether or not the permit will be issued. If a permit is granted, the approved application becomes a Conditional Water Permit. Upon completion of the project, the State Engineer, or his designate, inspects the equipment and issues a Perfected Water Permit. This permit has no expiration date but does limit the amount of water which can be withdrawn annually.

In areas which have undergone a significant amount of development and where additional appropriations of water cannot be supported by conventional analyses, the Pinder-Trescott predictive model is used to determine sustained yield and withdrawal limits.[2/] The State Engineer also has the power to revoke or revise any irrigation permit. Because of the lack of data on groundwater availability in some areas, the State Engineer has had to hold up action on some permit requests for 2-3 years.

In determining priority among irrigators, North Dakota uses the appropriations doctrine which establishes priority according to the date that the State Engineer receives the properly completed application.

While the State Water Commission can be classified as a citizens commission, the recognized policy maker on groundwater allocation is the State Engineer and his office. Therefore North Dakota's administrative mechanism may be defined as a single executive agency.

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2/ In Techniques of Water Resources Investigations of the U.S. Geological Survey. Chapter C1. "Finite-Difference Model for Aquifer Simulation in Two Dimensions with Results of Numerical Experiments," by P.C. Trescott, G.F. Pinder, and S.P. Larson.

South Dakota

South Dakota's administrative body having responsibility for groundwater allocation is the Water Rights Commission (WRC) which is a branch of the Department of Natural Resources (DNR). The Commission consists of eight members all of whom are appointed by the Governor and approved by the Legislature. In a public hearing, a quorum of the WRC determines whether or not a permit should be granted by basing their decision on recommendations made by the staff of the WRC which consists of engineers, geologists, and hydrologists; and on the testimony of other interested parties who may object to or favor the issuance of the permit. Three criteria are used to determine who shall be permitted to irrigate: a) water availability, b) project feasibility, and c) public interest.

Each potential irrigator must provide information on the amount of water required, point of diversion, total acres to be irrigated and their legal description, estimate of time needed to complete construction, and well specifications. The applicant must also provide the driller's log from test drilling. Approval of the State Conservation Commission is needed to verify that the water quality is suitable for irrigation. When all required information is received by the DNR, the hearing, which is advertised in a local newspaper, is held to complete the fact finding process.

Once an irrigator receives a "water right", he is allowed a certain development period and then a period before which the water must be put to "beneficial use". After this period, the WRC investigates the project. Upon investigation, the water right holder receives a "Water License" which is issued according to the amount of water which has been put to beneficial use which may not exceed the amount approved by the permit.

To control the withdrawal of groundwater, South Dakota has an "Anti-mining law" which states that "the quantity of water withdrawn annually from a ground water source, shall not exceed the quantity of the average estimated annual recharge of water to such ground water."[3/] The DNR uses, as their primary hydrological information, the data obtained from 850 observation wells that they monitor throughout the state. Secondary data includes the work of the U.S. Geological Survey and the State Geological Survey.

The WRC is empowered to suspend a permit or license for up to one year if the terms of either are violated. The WRC also reserves the right to restrict water withdrawals during periods of water shortage. If water withdrawals from an aquifer are approaching the limit of average annual recharge; or are causing chronic interference among wells; or are resulting in excessive aquifer water surface drawdown, the WRC may establish the area as a groundwater control area. This results in additional regulations being imposed on water withdrawals by large capacity wells.

Of all of the upper midwestern states, the WRC of South Dakota is the best example of a citizens commission. This body is especially recognized for its independence from the influence of the state agencies which are directly involved in irrigation and related studies. For example, in the face of strenuous objections of other interested parties, the WRC may grant an irrigation permit even though such action is contrary to the recommendations of the staff engineers, geologists and hydrologists. Whether this results in a more equitable and efficient allocation of groundwater is difficult to judge.

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3/ In SDCL 46-1-2 of the Water Laws of the State of South Dakota, 1972.

Iowa

The government agency in charge of groundwater irrigation policy in Iowa is the Natural Resources Council (NRC). The NRC consists of nine voting members who are appointed by the governor and approved by the state senate. The tenth non-voting member is the Executive Director of the Department of Environmental Quality. The NRC chooses a Director, a Water Commissioner, and one or more Deputy Water Commissioners.

The Water Commissioner serves in a quasi-judical capacity in the processing of all applications for appropriations permits. He conducts hearings on any permit application as required by state law and the rules of the NRC. In practice, the Water Commissioner usually empowers his Deputy Commissioners to serve as hearing officers to determine whether or not a permit should be granted. All parties involved have the right to appeal the hearing officer's decision to the NRC within thirty days of the determination. If appealed, the hearing process is repeated, allowing for the addition of information not available at the first hearing, with the NRC determining the outcome. A permit can only be granted if it can be shown that the proposed diversion will not result in any material damage to the public interest, or to the interest of property owners with prior or superior rights.

Any person who wishes to use groundwater for irrigation in excess of 5,000 gallons per day is required to obtain a permit for that use. Because of the recent controversy over groundwater irrigation, applicants are now required to supply specific data about proposed irrigation projects. This information includes the location of the diversion, the number of acres to be irrigated and their legal description, the annual amount of water requested, and the maximum withdrawal rate for a specified period

of use. Applicants are also required to provide geological data from a well log of a test hole or existing well on or near the property to be irrigated. In some cases, pumping tests are required prior to the filing of a determination.

In most instances, a public hearing, as mentioned above, is held on each application. These hearings are intended as a mechanism for the gathering of information. The hearing officer uses the information and other relevant technical information in forming a determination. Until a year ago, permits were granted for a ten year period. Now a new irrigation permit is only in effect for one year pending an adoption of a comprehensive state water plan by the Natural Resources Council. Each permit, for groundwater use, requires that records of actual water usage and of water levels be kept and submitted to the council.

New legislation, in response to an increase in interest in irrigation during the recent drought, has now provided that the public hearing requirement may be waived for irrigation from a source which is an alluvial aquifer of a river bordering the state if due notice to grant the permit does not result in any objections. Such "special permit" areas are typified by an irrigation history which indicates that there is little likelihood that new irrigation projects will cause serious groundwater conflicts. Irrigation withdrawals from the Dakota sandstone aquifer are now prohibited and a similar ban is pending for the Jordan sandstone aquifer. Legislation has also been proposed which would reduce the maximum amount of water which may be authorized for irrigation.

Thus groundwater allocation policies in Iowa are determined by the NRC, while the permit system is the responsibility of the Water Commissioner or his designates. The NRC is another example of a citizens commission

which is affiliated with the state water planning agency but is also empowered to act independent of state influence when hearing an appeal of a permit determination.

Nebraska

In Nebraska groundwater allocation is determined by a combination of state and local efforts. For the state as a whole, the influence of the State Department of Water Resources (DWR) is limited to policies concerning well registration, spacing requirements between wells (a minimum of 600 feet between irrigation wells and a minimum of 1,000 feet between municipal and/or industrial wells), aquifer contamination from fertilizers and pesticides and, the transfer of groundwater to neighboring states. On the local level, the Natural Resources Districts (NRD's), whose membership is chosen by the local electorate, are responsible for the formulation and implementation of groundwater management policies.

There are 24 such Natural Resources Districts within the state. Each has employed a staff experienced in resource management. The NRD staff members direct much of their attention to groundwater management problems. Each NRD has adopted and now enforces rules and regulations to control excessive waste water runoff from fields irrigated by groundwater. Many NRD's also make periodic measurements of groundwater levels.

A NRD may initiate a hearing, held by the DWR, to designate a Ground Water Control Area if sufficient information is available to show that "there is an inadequate groundwater supply to meet present or reasonably foreseeable needs for beneficial use of such water supply."[4/] The Director of the DWR makes the final determination of whether an area will

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4/ In Section 46-658 of the Nebraska Groundwater Management Act of 1975.

be designated a Control Area. In determining the adequacy of the groundwater supply, the Director, through the public hearing process, reviews the testimony of the Conservation and Survey Division of the University of Nebraska, the Nebraska Natural Resources Commission, and that of other interested parties. This information, as well as the results of any investigations the Director has conducted, assist him in making his determination. Some of the Director's considerations may include but are not limited to the following: a) conflicts between users which exist or are anticipated, b) economic hardships which exist or are anticipated due to current or future groundwater shortage, or c) other conditions that indicate the inadequacy of the groundwater supply or that require the area designated as a Control Area for protection of public welfare.

Currently there exist two Ground Water Control Areas accounting for less than one fifth of the total area of Nebraska. Another area consisting of parts of five counties will likely be designated in the fall of 1978. Thus, many Natural Resource Districts have no Control Areas within their boundaries.

Once a Control Area has been established, any person desiring to construct a well in the Control Area must apply for a permit from the Director of the DWR. If the NRD has formulated rules and regulations pertaining to groundwater allocation, the Director must consider these in deciding whether to issue the permit. Since the concept and creation of Ground Water Control Areas is new to Nebraska, only one Natural Resource District has actually established regulations for their Control Areas. Such rules and regulations must be approved by the Director. In districts which have not yet formulated such policies the Director is still empowered to issue or deny permits.

Permits for all new, large capacity wells expire within one year and are conditional on any rules and regulations formulated by the district board. Such conditions may include spacing requirements, limits on the amount of groundwater which may be withdrawn, or may involve rotation of use between users. The district board may even establish a moratorium on all drilling within a Control Area.

As in most other states, an applicant for a well permit in Nebraska must supply information on the location of the proposed well; total acreage to be irrigated and its legal description; the diameter, depth and capacity of the well and pump; and a log of any test hole drilled for exploration purposes.

In summary, Nebraska's groundwater allocation policies for agricultural irrigation are mainly the product of two agencies. On the state level, the Department of Water Resources is the institutional mechanism and is best typified as a single executive agency. Its Director, who is responsible for the formulation of groundwater policies, is appointed by the Governor and is required to hold a professional engineer's license and have at least five years experience in irrigation technology and related fields. On the local level, the decision making body is the Natural Resource District Board. Board members are elected locally and are not required to have experience in water resource management.

Minnesota

The Division of Waters, under the Department of Natural Resources (DNR) is responsible for determining groundwater allocation policies in the state of Minnesota. Anyone who wishes to appropriate any waters of the state, by an amount of 10,000 gallons per day or more or in excess

of one million gallons a year, must obtain a permit from the Division of Waters. The applicant has the burden of proving that the proposed irrigation project is reasonable, practical, and will adequately protect public safety and promote public welfare.

The amount of information an applicant must provide depends on whether the proposed irrigation project lies in a Class A or Class B area. Class A applications are for wells located in areas where the Division of Waters has adequate groundwater availability data. Thus an applicant in a Class A area only needs to provide information on means of appropriation, rate of withdrawal, estimated annual use, schedule of appropriations, life expectancy of the project, method of monitoring withdrawals, and flow or circulation diagrams. The applicant in the Class A area must also submit a test hole log to prove that the proposed well will be placed in the studied aquifer, which is usually surficial, as opposed to the deeper buried aquifer from which little water availability data has been collected.

Class B areas are all other areas in the state and are characterized by a lack of adequate groundwater data. An applicant in a Class B area must supply all of the information specified above, as well as a separate list of all domestic wells within a 1½ mile radius of the proposed irrigation well. Certain specifications for the domestic wells must also be included. Class B applicants also submit the results of an aquifer test which is supervised by a DNR representative. During the pumping test, at least one observation well shall be monitored other than the pumping well. Proof that the quality of the water to be used for irrigation will not harm the crops or soil to be irrigated must also be

supplied. Thus, through the permit application process, the DNR is able to gather hydrological data for areas in which groundwater information is inadequate.

If the Division of Waters determines that proposed soil and water conservation measures are adequate according to the recommendations of soil and water conservation districts; and that an adequate water supply is available such that the proposed irrigation well will not deplete the aquifer, then a permit for irrigation from a groundwater source will be issued. The irrigator is responsible for neighboring domestic wells and, if the irrigators pumping causes a domestic well to go dry, water must be provided for those affected. For example, the irrigator may provide for the additional drop pipe so that the temporary drawdowns during irrigation will no longer affect the domestic well.

The permit may be cancelled at any time if the Division of Waters deems this necessary to protect the public interest. The granting of the permit also limits the amount of withdrawal in terms of acre feet and millions of gallons a year. This amount varies among permits and is dependent on crop and soil characteristics. The period of time during which the farmer may irrigate is also specified and depends on the crop to be irrigated. The Division of Waters also specifies the time within which all authorized construction must be completed, or within which actual use of the water must be made.

Permit decisions made by the Department of Natural Resources with its Divison of Waters is an example of a decision by a single executive agency. The Director and the employees of the Division of Waters are selected for their experience and knowledge in the field of water resource management.

The regulatory power of the agency is over all waters designated as state waters, and includes both surface and underground sources. Only domestic use for households of less than 25 persons and appropriations of less than 10,000 gallons a day (or which do not exceed one million gallons per year) are exempt from agency regulation and the permit requirement.

Wisconsin

In Wisconsin, the agency responsible for formulating policy for groundwater allocation for agricultural irrigation is the Private Water Supply Section (PWSS) of the Department of Natural Resources (DNR). Under the high capacity well law, enacted in 1956, a person wishing to construct a well or pump, with a pumping capacity either singly or combined with all wells on his property of 70 gallons per minute or more, must apply to the PWSS for approval.

In applying for approval the applicant must provide information on current and anticipated well use on normal and on maximum days of use, the expected duration for both rates of use, the location of the proposed well and all existing wells on the applicants' property, the proposed metering device, and the proposed method to determine water levels.

The PWSS uses the information provided by the applicant and the data collected from their own investigation in determining whether or not to approve the project. In particular, the DNR must determine the effect of the proposed irrigation well on nearby public utility wells. This is done through theoretical computations using the known characteristics of the aquifer if such information is available. When possible, such computations are made using U.S. Geological Survey data. However, in many cases, such data is not available and the DNR must rely on information

about the geologic formations in the area, thickness of the geologic sections, and specific data on the capacities of wells in the area.

If it is found that the proposed project will reduce the supply of water available to the nearest public utility well or wells, the PWSS may deny the approval or limit the pumpage allowed by specifying modifications in construction and operation. If multiple aquifers exist, water must be obtained from an aquifer different from that which supplies the public utility well. Any approval given is conditional on the operator's monthly reporting of well water levels and pumpage. This information is computerized and will provide a basis for the collection of water availability data throughout the state. In all cases the DNR reserves the right to request curtailment of pumping if actual pumping has resulted in a reduction in well water levels in public utility wells which is greater than that anticipated as based on the theoretical computations.

Since late 1973 the DNR has also sought to determine the effects of proposed high capacity wells on nearby private wells, even though the high capacity well law does not protect private well owners. However, a recent decision by the state Supreme Court in the State vs. Michels Pipeline Construction, Inc., 63 Wis. 2d. 278(1973), does appear to give recourse by civil action for damages.[5/] Thus, the DNR will inform a receipient of a high capacity well approval that the granting of this approval will not negate the protection to which these private well owners are entitled under Wisconsin Case Law, if there is evidence that such interference to private wells can be expected.

The Department of Natural Resources, with its Private Water Supply Section, is an example of a single executive agency. The Director of the PWSS is hired according to his experience and knowledge in hydrology.

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5/ This case involved a dewatering project temporarily affecting private wells. As a result of this decision in 1973 the basic groundwater law in Wisconsin was changed from the common law of Absolute Ownership to one of a modified American Doctrine of Reasonable Use.

Illinois

The Water Resources Division of the Department of Transportation is an agency in charge of formulating water management policy in specified areas within Illinois. There is currently no statewide permit system in existence for agricultural irrigation from a groundwater source. All water wells are subject to certain licensing and information requirements, none of which deal with water allocation. A permit will be required for diversion of waters from flood plain aquifers in the specified areas. The concern here though is for the management of prescribed surface water levels and those directly affected by any irrigation withdrawal from the bordering flood plain. Thus, Illinois has no general legislation which enables state influence on groundwater allocation. Any conflict in groundwater use is settled by the state courts which favor the "riparian doctrine" of reasonable use.

Illinois does have adequate groundwater data which is collected by the State Water Survey which conducts pumping tests and operates observation wells throughout the state.

The Department of Transportation, Water Resource Division in Illinois is an example of a single administrative agency. The department head, designated as the Secretary, is appointed by the governor and approved by the state senate. The division director is appointed by the Secretary for his qualifications and experience in water resource management.

Indiana

Water policy in the state of Indiana is currently the realm of the Department of Natural Resources (DNR). Like Illinois, Indiana does not have any laws or policies governing groundwater diversion for irrigation,

even though permits are required for irrigators who wish to divert surface waters from a stream or lake which is considered to be navigable under either state or federal law. There are only eleven such permits in force within the state.

Indiana, like other states, has become increasingly aware of competing demands upon its water resources. In 1977, the Governors's Water Resources Study Commission was created to develop an integrated system of policy, law, programs and institutions to provide a framework by which the DNR can meet public and private water needs in a more timely and equitable fashion. Policies on agricultural irrigation will form an important part of this study. The DNR is best classified as a single executive agency.

## Analysis of Institutional Mechanisms

### Criteria

There are three broad sets of criteria which one might use to compare institutional arrangements for allocating irrigation water. These include economic efficiency, equity, and administrative considerations.

Economic Efficiency -- Economic efficiency refers to maximizing over time the present value of increased product from water use. Specifically, this involves estimating the increased net product from irrigation, attaching values to it, and discounting these benefits back to the project. While conceptually this is straight forward, the process is somewhat difficult in practice because of possible uncertainty of water yield, future technologies, prices of inputs and products, and selection of the appropriate discount rate.

Economic efficiency, historically, has been a major objective in water planning. In recent years, other objectives such as regional development and environmental quality have received more consideration. In a broader context, efficiency can be thought of as attainment of some optimal combination of broad objectives such as national income, environmental quality, and regional development. Appropriate institutional mechanisms will take into account efficiency of water use in attaining these broad objectives.

In the process of attaining a higher level of economic efficiency, there may be external effects. For example, gains in production may be at the expense of the water supply of someone else. It is important that these external effects be included as part of the economic efficiency calculations.

Equity -- Equity considerations of irrigation decisions involve "justice" or "fairness" to individuals or economic units affected by irrigation decisions. For example, irrigation may interfere with municipal water supplies, with neighboring domestic wells, or with other irrigators. Such externalities should not necessarily be avoided, as the increased welfare from irrigation may override the negative effects to damaged parties. Justice demands that the damaged parties be compensated, however.

In the decison making process for irrigation, there should at least be means of ascertaining the external effects. Ideally, it would be desirable to know who the damaged parties are, and the extent of possible damages which might be expected.

Another aspect of equity, broader in scope, involves equity between uses, such as environmental quality. This aspect is difficult to consider as environmental damage may be spread among many individuals, and there may be no spokesmen for this purpose. An "ideal" mechanism would take into account these other potential effects.

Administrative Considerations -- This broad class of criteria would include various administrative considerations. Of particular importance is an agency's ability to facilitate the permit application process. Ideally, there should be time to gather, assimilate, and assess the necessary information on efficiency and equity. As information can never be total and complete, a compromise must be drawn between assessing the permit, and rendering a decision to the applicant.

Along these same lines, there should be provisions in the process for "facilitating learning" by the permit granting institutions. This would include provisions in the procedure for increasing the information base to the agency, and for assimilating information and applying it to present and future decisions.

An ideal system would be oriented toward avoiding crisis. That is, a forward looking system would attempt to prevent serious problems from arising and to avoid situations where decisions would be made in the heat of controversy. Decisions made by rational, established processes, incorporating the maximum amount of reliable information, are far more likely to lead to efficient use than are decisions made through costly and lengthy court procedures.

Comparison with Criteria

Economic Efficiency -- The states which have groundwater irrigation permit systems seem to have several common features, even though there are many differences. Appendix 2 summarizes some of the more important institutional features in the six permit granting states. To assure economic efficiency in water appropriations, several policies, institutions, and attitudes have evolved in some of the upper midwestern states. One such policy, particularly for those states subscribing to the "appropriations doctrine", provides for the revocation of a water permit if the water allocated is not put to beneficial use. For example, in North Dakota, the State Engineer may declare that a water right or permit be forfeited if an appropriator fails to apply water to the beneficial use cited in his permit for three successive years, unless such failure is the result of unavailability of water, a justifiable inability to complete the project, or other good and sufficient cause. Thus, in states such as North Dakota, the speculative aspect of obtaining a permit to appropriate water is essentially eliminated.

While the economics and feasibility of irrigation will generally have to be determined by the farm operators in question, some states have policies to aid the farmer in making his decision. In Minnesota,

farmers wishing to irrigate in areas with inadequate groundwater data, are required to submit the results of a pumping test supervised by a DNR representative. During the pumping test, the water level is monitored in a nearby observation well. The purpose of the test is to assure the farmer and the DNR that the required water is available before further capital expenditures are incurred. In this way unfeasible irrigation projects can be avoided.

Also, since "on farm" irrigation works are such large capital investments, most states have attempted to provide the farmer with some reassurance that he will be able to appropriate waters in the amount and over the time period needed to amortize the project. Even though the conditions of a permit may be revised, most state agencies will only intervene when conflicts among users or aquifer depletions are evident. In Nebraska, special groundwater control areas may be established to protect the dwindling resource. In contrast, Iowa has instituted a special permit system to simplify groundwater allocation in areas along rivers bordering the state which are historically water rich. It appears that most of the upper midwestern states try to be as pragmatic as possible in administering groundwater policies and will foster the autonomy of the individual farmer when the situation allows.

An example of a practice which does not favor economic efficiency is South Dakota's "Anti-mining law" which states that the quantity of groundwater withdrawn annually must not exceed the quantity of average annual recharge of water to such groundwater source. It is not at all clear that abiding by "safe yield" is a socially or economically desirable policy. The values gained through the mining of groundwater may exceed the benefits of maintaining a sustained yield. An optimal solution

is obtained when pumping in the future is pushed to the point where marginal benefits equal unit pumping costs plus the value foregone due to stock drawdown. So, in cases where recharge occurs mining may be supported for many years before the optimal pumping rate falls to the rate of recharge.[6/]

Another policy which results in a less that desirable allocation of groundwater is that which protects other users by eliminating any project which may lead to conflicts among users. Minnesota is one of the states which provides for a mechanism to compensate those injured by a new irrigation project. Irrigators may withdraw water according to permit limitations so long as they can assure their neighbors of an adequate water supply. A typical solution is to provide additional drop pipe for any neighboring wells which are affected adversely by irrigation withdrawals.

Another source of inefficiency in state groundwater policy would be the absence of provisions to facilitate the transfer of groundwater allocations to more desirable and efficient uses. Many states establish priority among different types of users but these ordering systems may be too inadequate or archaic in view of current demands on groundwater. Iowa's recently initiated policy to eliminate withdrawals from the Dakota sandstone aquifer is an attempt to assure the citizens of the state of an uncontaminated supply of drinking water for the future. While this policy is a good example of a future oriented attitude to avoid crises it may also result in inflexibility in changing allocation patterns if other important uses become dependent on the same groundwater source.

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6/ An interesting example of such a situation is the subject of Ronald G. Cummings' water management study Interbasis Water Transfers: A Case Study in Mexico. 1974.

Equity -- The greatest similarities among the permit granting states seem to be with respect to policies concerning equity. Almost all of the states provide that even the initial determination on the permits be based on the information presented in a public hearing. Typically, such a public hearing provides for an information-gathering process in which all interested parties have a voice. Hydrologists and geologists make recommendations and other parties, particularly those that perceive that they may be adversely affected by the proposed project, also give testimony. There does exist pronounced differences in who actually conducts the hearing. In South Dakota, the permit decision is made by the Water Rights Commission which consists of eight lay-persons appointed by the governor. North Dakota, on the other hand, provides that the State Engineer determine the merits of permit issuance.

Similarly, most of the states provide for an appeal process so that parties who object to the initial determination can contest the outcome. In some states, such as Wisconsin, an appeal is aired through the office of State Hearing Examiners, a subsection of the DNR. Other states, such as Iowa, provide for an appeal process through the State court system.

Most of the permit issuing states also attempt to provide some mechanism to protect other users from the effects of nearby high capacity wells. In particular, several states have established priority among water users when the water supply is insufficient to supply all applicants. For example, North Dakota directs the State Engineer to adhere to the following order of priority - 1) domestic use; 2) municipal use; 3) livestock use; 4) irrigation use; 5) industrial use; and 6) fish, wildlife, and other outdoor recreational uses. In Minnesota, a high capacity well owner is responsible for neighboring

domestic wells and, if his pumping causes a domestic well to go dry, he must provide his neighbor with water.

Administrative Considerations -- Administrative considerations are also important criteria in evaluating the effectiveness of each states' permit granting institutions. One such consideration would be the means by which the state water agency may expedite the permit issuing process. There must be time to gather, assimilate, and assess the necesary information on efficiency and equity. As information can never be total and complete, a compromise must be drawn between assessing the permit, and rendering a decision to the applicant. Some states, such as South Dakota, have an extensive state groundwater monitoring system which consists of 850 observation wells. In other states, such as Minnesota, the primary hydrological data source is the work of the U.S. Geological Survey (USGS). Applicants from these Class A areas provide minimal information compared with that which must be provided by applicants in Class B areas for which little USGS data exists. Thus, Minnesota is one of several states which requires the applicant to provide hydrological data which can be added to the states' information base. This provides that some of the cost of hydrological data collection be borne by the recipient and benefactor of the groundwater resource. Many states also require annual reporting of water appropriations which further facilitates the fact finding process needed to determine the effects of such use on the water supply. This information is an aid in specifying the conditions of a permit which includes the determination of withdrawal limits.

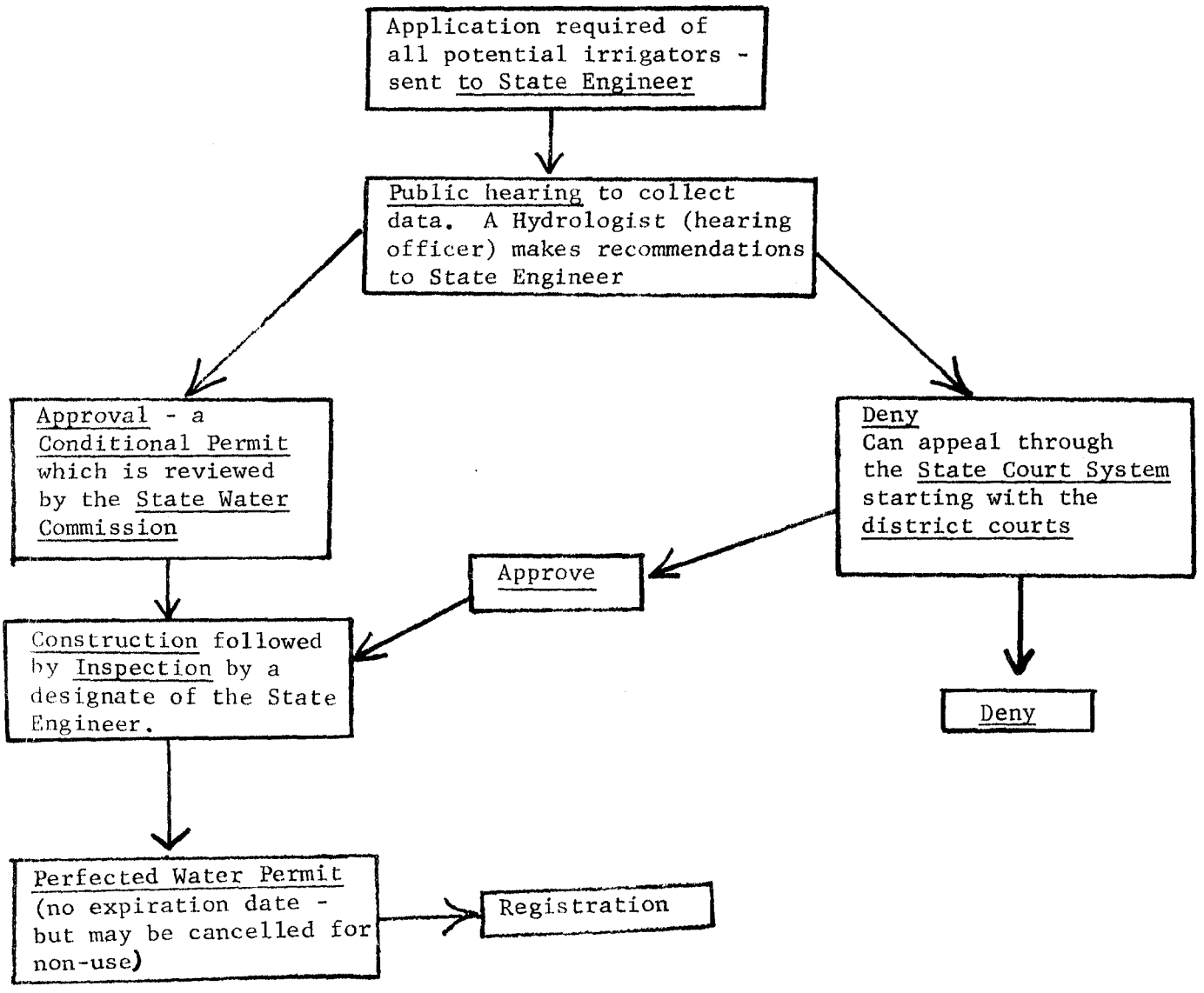
All of the permit granting states surveyed have some guidelines for dealing with, avoiding, and easing the effects of a water shortage crisis. All of the permit issuing agencies reserve the right to revise or revoke any water appropriations permit. Some states, such as Nebraska, have

guidelines for designating special groundwater control areas. Such control areas are governed by locally elected lay-persons in the form of a Natural Resources District Board. This board is responsible for formulating rules and regulations to ensure the conservation of groundwater within the control area. Such local resource stewardship may be preferred to absolute state control when the problems of conflicting uses confront irrigators and other users.

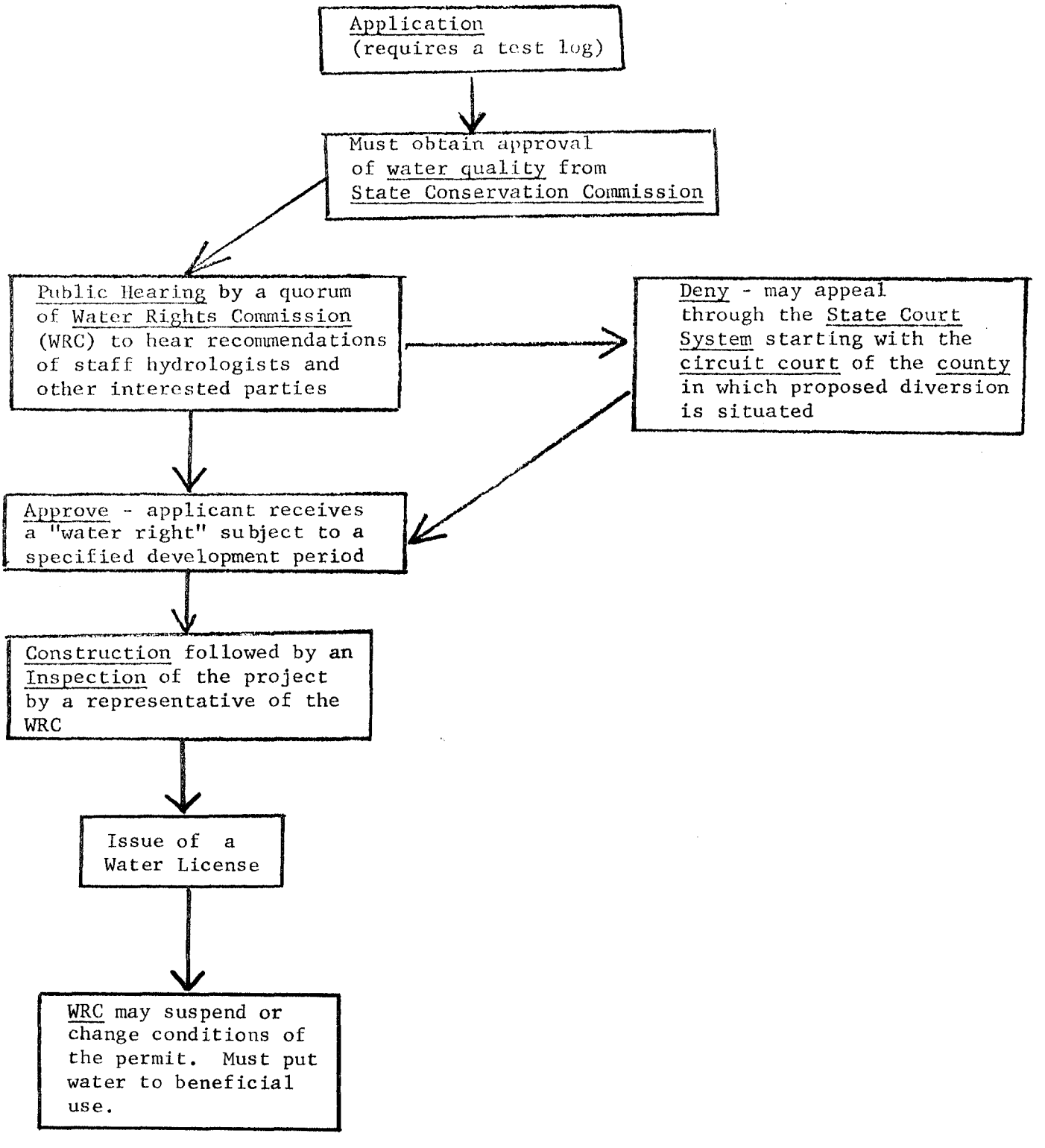
Thus, many of the upper midwestern states have attempted to meet the challenge of providing for equitable and efficient use of groundwater. All of the water resources management institutions have felt the pressures of the ever increasing demand for water supplies. Several state water officials have commented that they hope the next few years are rainy - so that they have the time they need to formulate sensible groundwater allocation policies without having to frustrate farmers by withholding permits in areas where they have too little information on water availability.

Appendix A. Flow Charts for Permit Issuing Processes

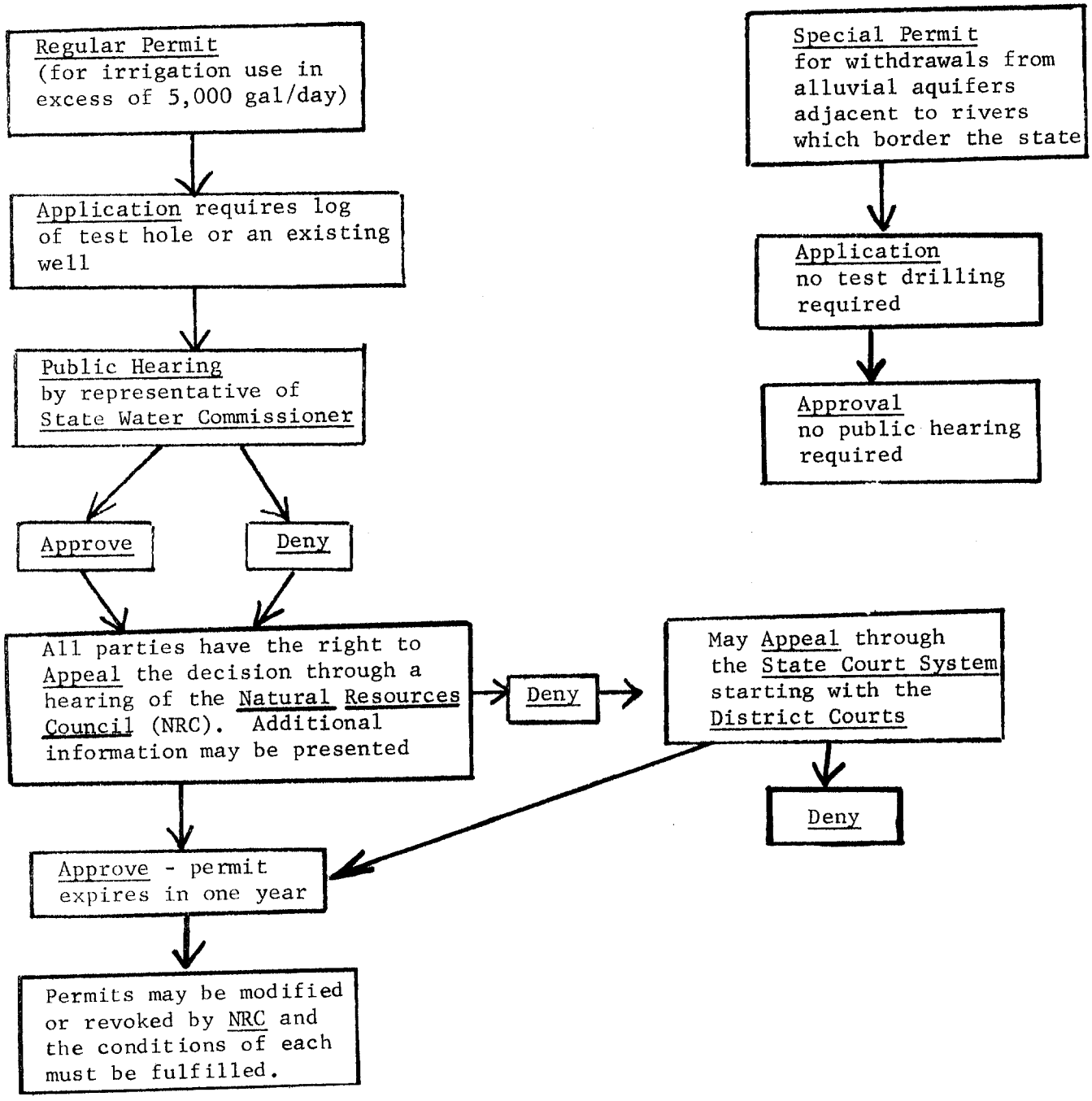
North Dakota



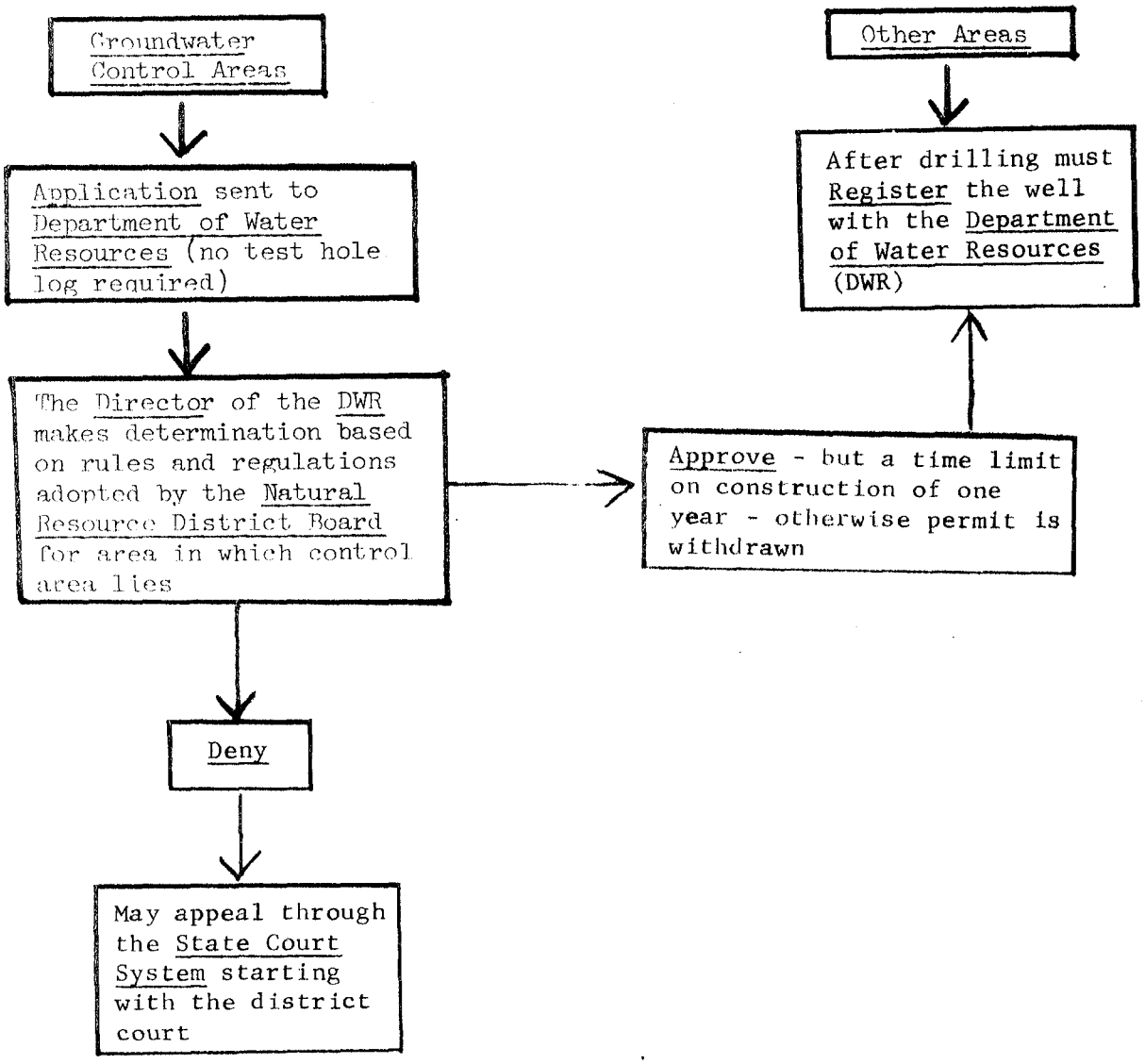
South Dakota



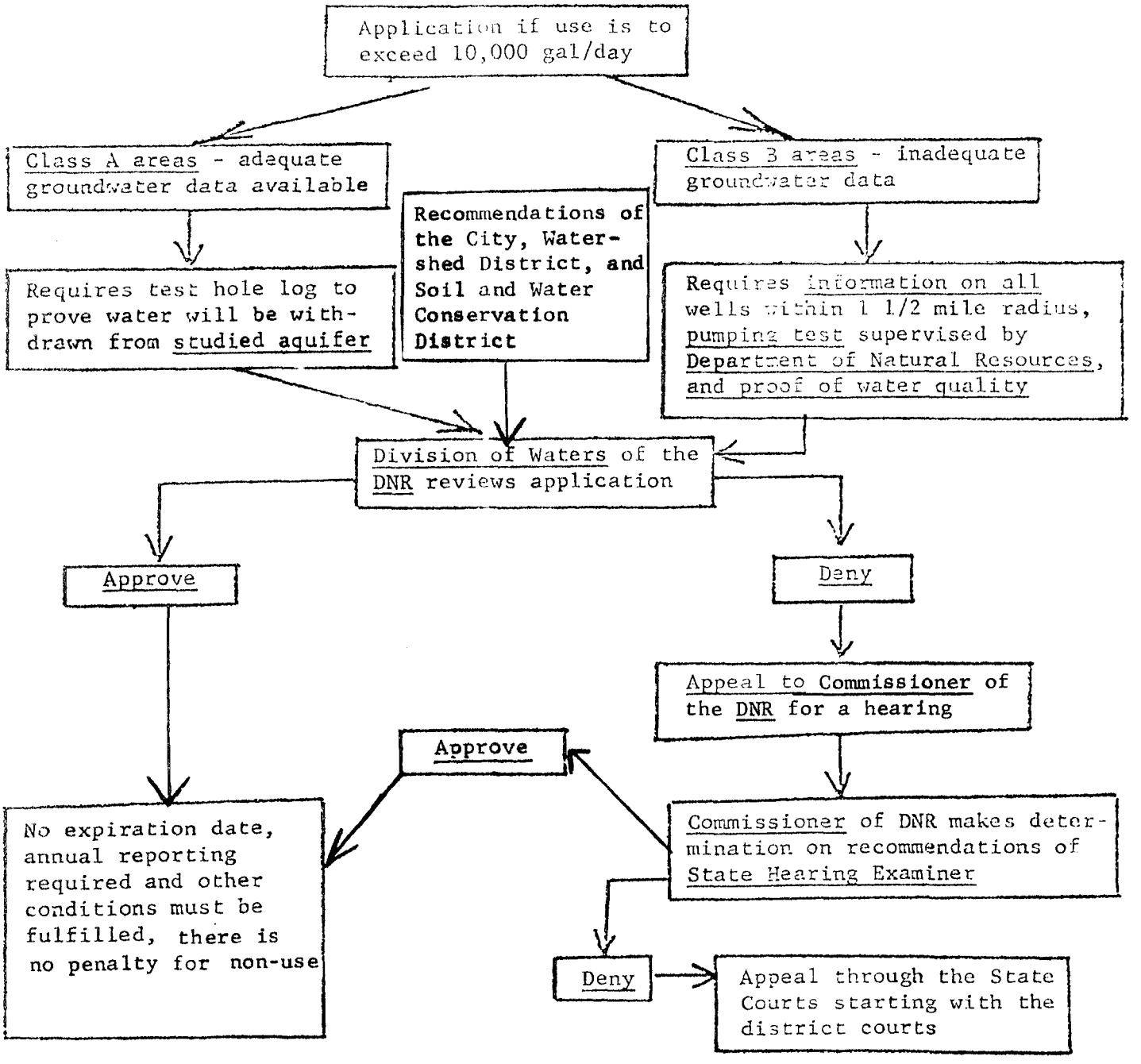
Iowa


Regular Permit
(for irrigation use in excess of 5,000 gal/day)
Application requires log of test hole or an existing well
Public Hearing
by representative of State Water Commissioner
Approve
Deny
All parties have the right to Appeal the decision through a hearing of the Natural Resources Council (NRC). Additional information may be presented
Deny
May Appeal through the State Court System starting with the District Courts
Deny
Approve - permit expires in one year
Permits may be modified or revoked by NRC and the conditions of each must be fulfilled.
Special Permit
for withdrawals from alluvial aquifers adjacent to rivers which border the state
Application
no test drilling required
Approval
no public hearing required

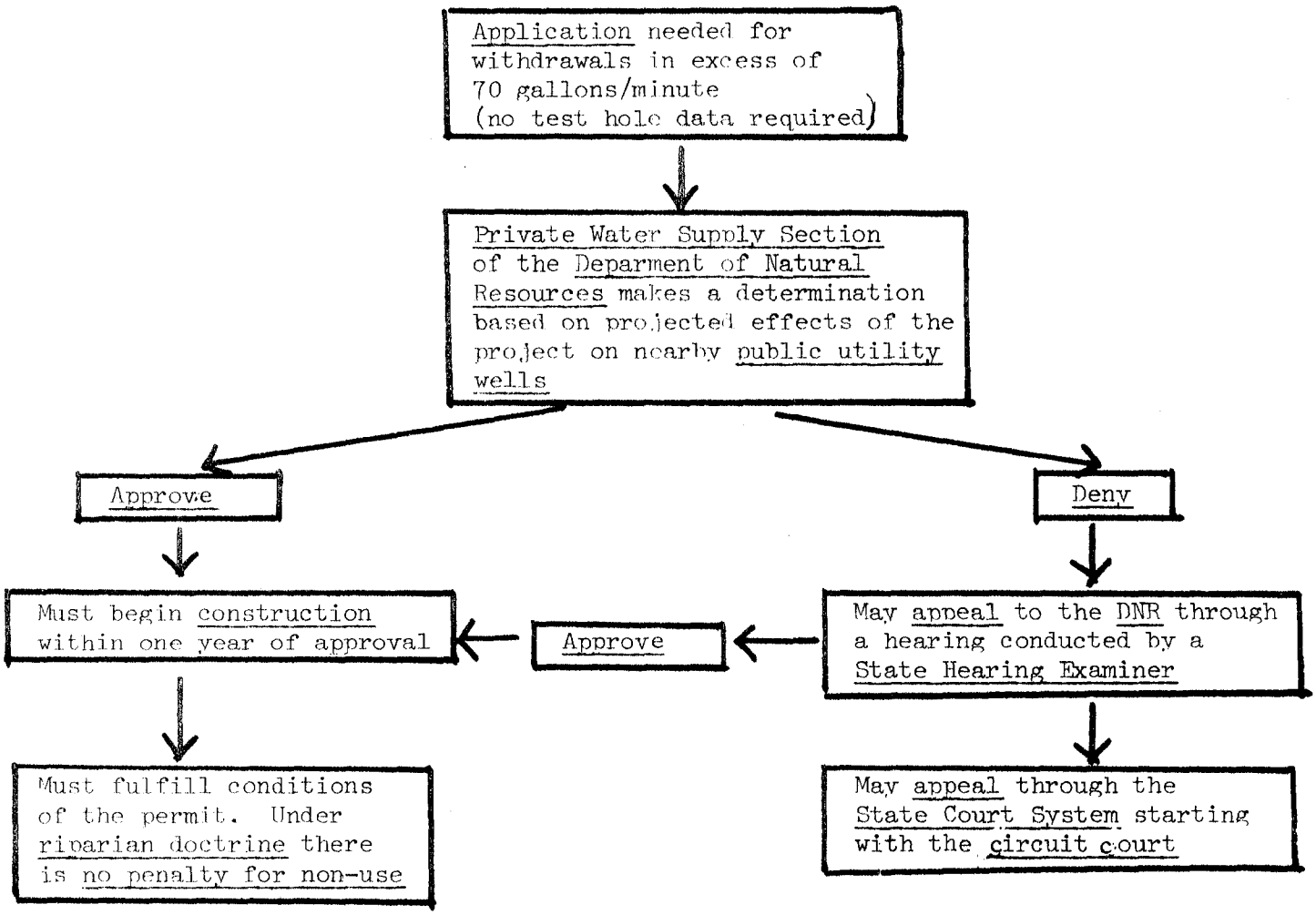
Nebraska


Groundwater Control Areas
Application sent to Department of Water Resources (no test hole log required)
The Director of the DWR makes determination based on rules and regulations adopted by the Natural Resource District Board for area in which control area lies
Deny
May appeal through the State Court System starting with the district court
Approve - but a time limit on construction of one year - otherwise permit is withdrawn
Other Areas
After drilling must Register the well with the Department of Water Resources (DWR)

## Minnesota


Application if use is to exceed 10,000 gal/day
Class A areas - adequate groundwater data available
Class B areas - inadequate groundwater data
Recommendations of the City, Watershed District, and Soil and Water Conservation District
Requires test hole log to prove water will be withdrawn from studied aquifer
Requires information on all wells within 1 1/2 mile radius, pumping test supervised by Department of Natural Resources, and proof of water quality
Division of Waters of the DNR reviews application
Approve
Deny
Appeal to Commissioner of the DNR for a hearing
Approve
No expiration date, annual reporting required and other conditions must be fulfilled, there is no penalty for non-use
Commissioner of DNR makes determination on recommendations of State Hearing Examiner
Deny
Appeal through the State Courts starting with the district courts

Wisconsin


Application needed for withdrawals in excess of 70 gallons/minute (no test hole data required)
Private Water Supply Section of the Deparment of Natural Resources makes a determination based on projected effects of the project on nearby public utility wells
Approve
Deny
Must begin construction within one year of approval
Approve
May appeal to the DNR through a hearing conducted by a State Hearing Examiner
Must fulfill conditions of the permit. Under riparian doctrine there is no penalty for non-use
May appeal through the State Court System starting with the circuit court

Appendix B. Summary of Key Features of Permit Granting Processes.

| | North Dakota | South Dakota | Iowa | Nebraska | Minnesota | Wisconsin |
|---|---|---|---|---|---|---|
| 1. Permit can be cancelled for non-use | Yes | Yes | Yes - a case has yet to come to court, and many water officials believe that the law, as written, would not hold up in court | No | No | No |
| 2. An application requires information from a test hole log | Yes - in areas with inadequate groundwater data | Yes | Yes - except for special permit area where withdrawals are from alluvial aquifers of rivers bordering the state | No - may submit this information if available. 5-10% of the applicants provide this data | Yes | No |
| 3. The applicant must also supply data from an aquifer test | Yes - when needed to determine withdrawal limits | No | Yes, in areas where conflict has occured | No - but the applicant is encouraged to provide the data if it is available | Yes, only in Class B areas which have inadequate groundwater data | No |
| 4. Public hearing procedure is part of the permit determination process | Yes | Yes | Yes - except in special permit areas | No | No | No |
| 5. Appeal process | Yes - starting with state district courts | Yes - starting with state circuit courts | Yes - initial appeal to Natural Resources Council, then to state district courts | Yes - starting with state district courts | Yes - initial appeal to Commissioner of the Department of Natural Resources, then to state district courts | Yes - initial hearing by a State Hearing Examiner, then to the state circuit courts |
| 6. Are there provisions under state law for compensation to an injured party | No - owners of wells which marginally penetrate the aquifer and are consequently affected by irrigation drawdowns usually must bear the cost of additional drop pipe | Yes - each permit contains a "domestic well clause" which requires irrigators to curtail use if irrigation causes a domestic well to go dry, or the irrigator may be able to compensate the domestic well owner in some other manner | No - recourse is only available through civil action in the state district courts | No - no provisions in the state laws or in the rules and regulations adopted by the Natural Resource Districts for control areas. Recourse is available through civil action | Yes - each irrigator is required to compensate any neighboring domestic well owners if their wells go dry due to irrigation drawdowns | No - the Private Water Supply Section does warn irrigators the private domestic well owners can seek recourse by civil action for damages |

Appendix 2 (Continued)

| | North Dakota | South Dakota | Iowa | Nebraska | Minnesota | Wisconsin |
|---|---|---|---|---|---|---|
| 7. Adequacy of Groundwater Data | General data on aquifer characteristics such as recharge and yields are fairly adequate while data assessing impacts of development are inadequate | Groundwater studies are complete for 8 counties; remaining studies will be complete by 1990 | General data on static water levels and the extent and depth of aquifers are adequate for 3/4 of the state. Data on yields, recharge, and effects of development are inadequate | Data on the size and extent of aquifers is fairly adequate. Data on recharge, yields, and effects of development are site specific and are inadequate for making some groundwater decisions | Reliance on USGS studies, Minnesota state studies and data from permit applications. This data may be inadequate for making some groundwater decisions | Reliance on USGS studies where available and on geologic data in other area. This data may be inadequate for making some groundwater decisions |
| 8. Groundwater permit expiration date | None | None | One year on new permits and ten years or older permits. Current dissatisfaction may result in the reinstatement of the ten years expiration date | None | None | None |
| 9. Is periodic reporting of withdrawals required | Yes, annually | Not required, but 80-85% of the irrigators do respond to an optional annual questionnaire. This usually assures that they will not be charged with non-use or over-use | Yes-annual reporting of total withdrawals and static water levels are required at the end of each irrigation season | Yes-the Natural Resource District in which a control area lies requires annual reporting of total amount of water pumped | Yes-annual reports on state well levels and total amount appropriated are required plus a $5 filing fee | Yes-monthly reporting during the season of use requires data on static and pumping water levels and total amount withdrawn. Also static levels for month preceding and following pumping must be reported. |
| 10. Type of agency | Single executive agency and a citizens commission | Single executive agency and a citizens commission | Single executive agency and a citizens commission | Single executive agency at the state level and a citizens commission at the local level | Single executive agency | Single executive agency |
| 11. General form of the state's water laws | Appropriations doctrine | Appropriations doctrine | Appropriations doctrine | Appropriations doctrine | Riparian doctrine of reasonable use | Riparian doctrine reasonable use |

Appendix 2 (Continued)

| | North Dakota | South Dakota | Iowa | Nebraska | Minnesota | Wisconsin |
|---|---|---|---|---|---|---|
| 12. Groundwater permit application fees | $100 | Fees assessed according to number of acres to be irrigated<br>Acres — Fee<br>0 - 60 — $150<br>61 - 120 — $225<br>121 - 180 — $250<br>181 - 240 — $275<br>and an additional $25 for each 60 acres | $25 due initially and upon renewal | $25 | $15 | None |
| 13. Transfer of groundwater rights | Appurtenant to the land - may not transfer the water to another use | Appurtenant to the land, transferred to the purchaser. As of July 1, 1978 municipalities may use excess irrigation water | The permit stays with the land - only a name change is required unless the new owner wants to modify the conditions of the permit | The permit stays with the land - only a name change on the permit is required. An irrigator may sell and transfer his water to other uses and users but may invite litigation from his neighbors | New owner has the permit transferred to his/her name. A groundwater permit is an appurtenance to the land | Once land has changed hands the new owner must apply for a new permit based on his own needs. The old permit is no longer in effect |