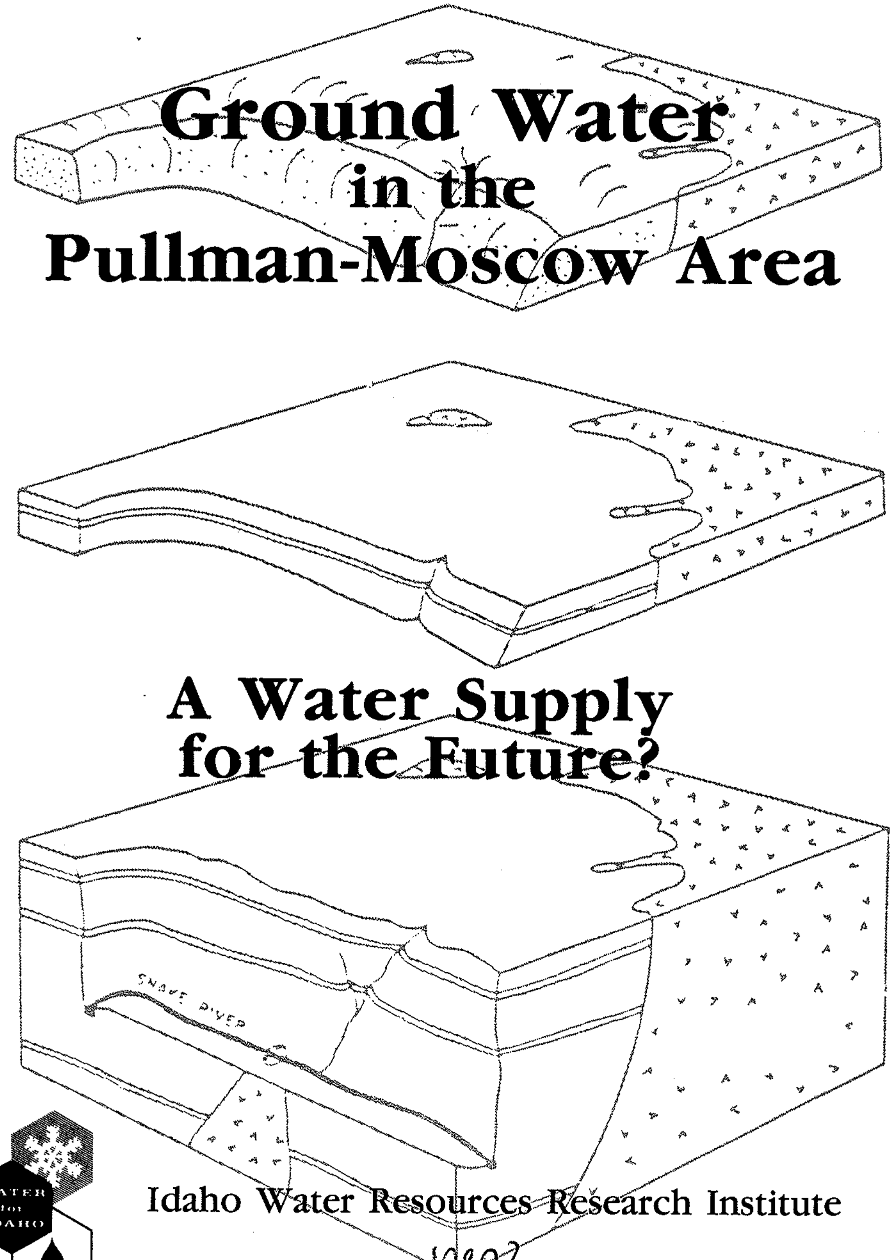
Ground Water in the Pullman-Moscow Area



A Water Supply for the Future?

Idaho Water Resources Research Institute

1989?

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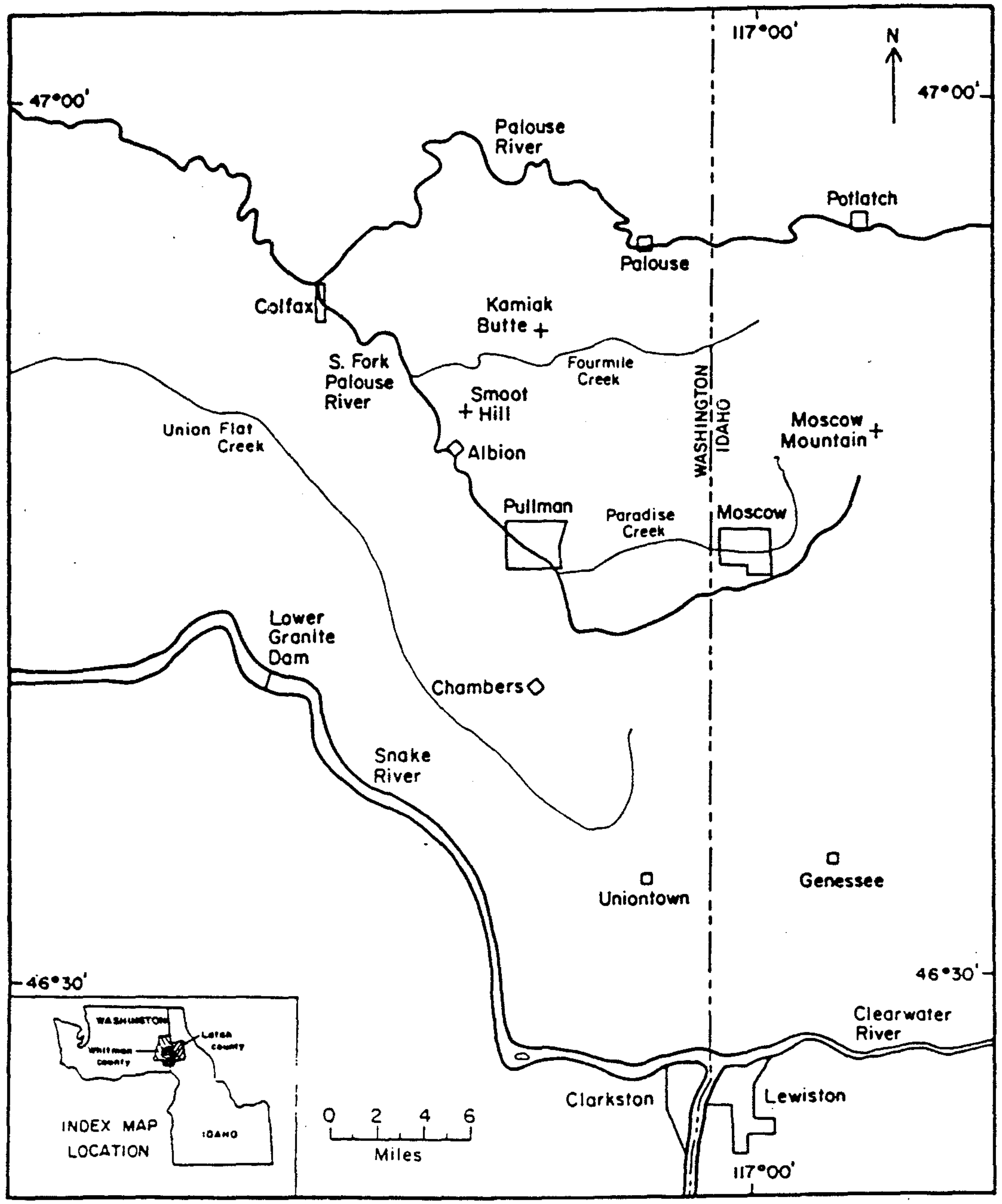

Figure 1. Location map of the Pullman-Moscow region.

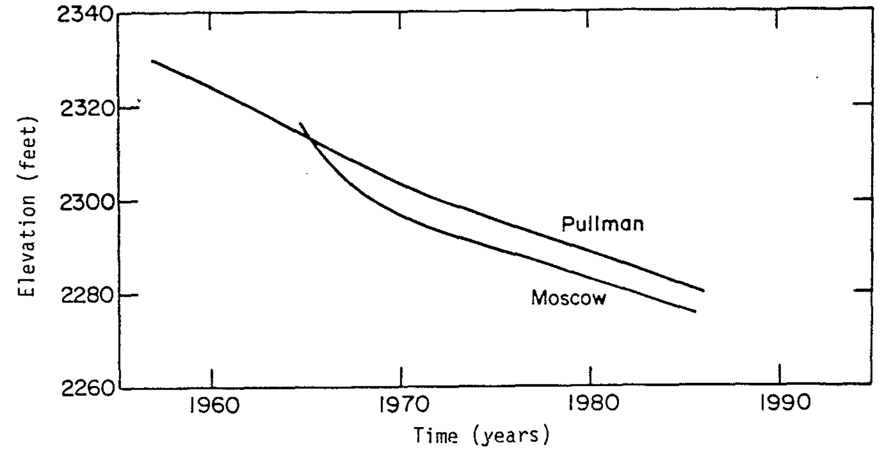

Figure 2. Hydrographs showing ground-water level declines at Pullman-Moscow.

Recent Ground Water Study

In 1984, the four major water users in the area, with matching monies from the United States Geological Survey (U.S.G.S.), funded a study of the ground water resources in the area leading to the construction of a computer management model. The research was conducted jointly by investigators from the U.S.G.S. and the University of Idaho.

The results of the study were presented in a report by John Smoot and Dale Ralston published in 1987 through the Idaho Water Resources Research Institute. A U.S.G.S. report is in review and will be published. This brochure provides a summary of the research results.

What Are Characteristics Of The Ground Water System?

Highly productive ground water zones or aquifers occur in basalt rock that underlies the Pullman-Moscow area. The basalt is underlain by much less permeable granitic rock. The basalt was deposited in layers in the ancestral granitic basin. The surface contact of the basalt and the granite forms the boundary of the ground water system on the east (figure 3). Except for isolated hills made up of the older rock, the basalt extends to the west on into the Columbia Plateau.

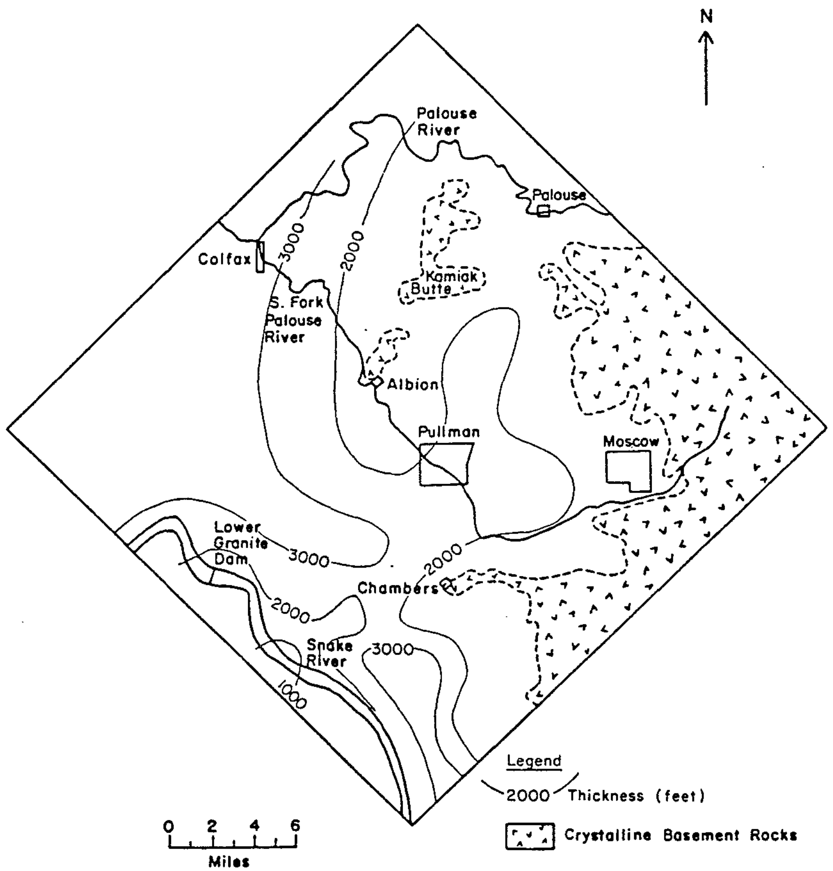

Figure 3. Thickness of the basalt (modified from Klein and others, 1987).

One of the objectives of the ground water study was to determine the thickness of the basalt system within the area. In Moscow, wells have been drilled through the basalt into the granite at depths of about 1,400 feet. A geophysical technique called magnetotullurics was used by the U.S.G.S. to prepare a map showing the thickness of the basalts (figure 3). The map shows the thickness of the basalts to range from zero east of Moscow to about 2,000 feet under Pullman and more than 3,000 feet near Colfax.

Ground water occurs in the basalt in fracture zones along the contacts between individual flows. The basalt flows are relatively flatlying in the Pullman-Moscow area. The productive aquifers in the basalt thus are flatlying. Production wells typically obtain water from a number of individual flow contact zone aquifers.

Geologists divide the basalts in the Pullman-Moscow area into two formations called the Wanapum Basalts and the Grande Ronde Basalt. A typical well in the Pullman-Moscow area would penetrate soil and the windblown sediments or loess that make up the Palouse hills, then enter basalt flows of the Wanapum formation, penetrate a thin sedimentary bed called the Vantage unit, then enter the Grande Ronde Basalts. The Grande Ronde Basalts make up the majority of the thickness of geologic material overlying the granite in the Pullman-Moscow area.

Most of the city and university production wells obtain water from the Grande Ronde Basalts. Most private wells and the older city wells in Moscow obtain water from the Wanapum Basalts. The ground water study focused on the Grande Ronde Basalts because of their importance for city and university water supplies.

How Much Ground Water Is Available For Development In The Basin?

Three aspects are important in answering the question of how much water is available for development. First, what are the characteristics and amounts of recharge to the ground water system? Second, how much water is in storage in the rock within reasonable distances of land surface? Third, what are the characteristics and amounts of natural discharge from the ground water system? A significant portion of the ground water study focused on answering these questions.

Recharge to the ground water system in the basalt in the Pullman-Moscow area occurs primarily from infiltration of water from precipitation of the overlying land surface. The non-patterned area on figure 3 shows the areal extent of the land underlain by basalt in the area of interest near Pullman and Moscow. Some water also recharges the basalt from streams that head on the mountain areas such as Moscow Mountain.

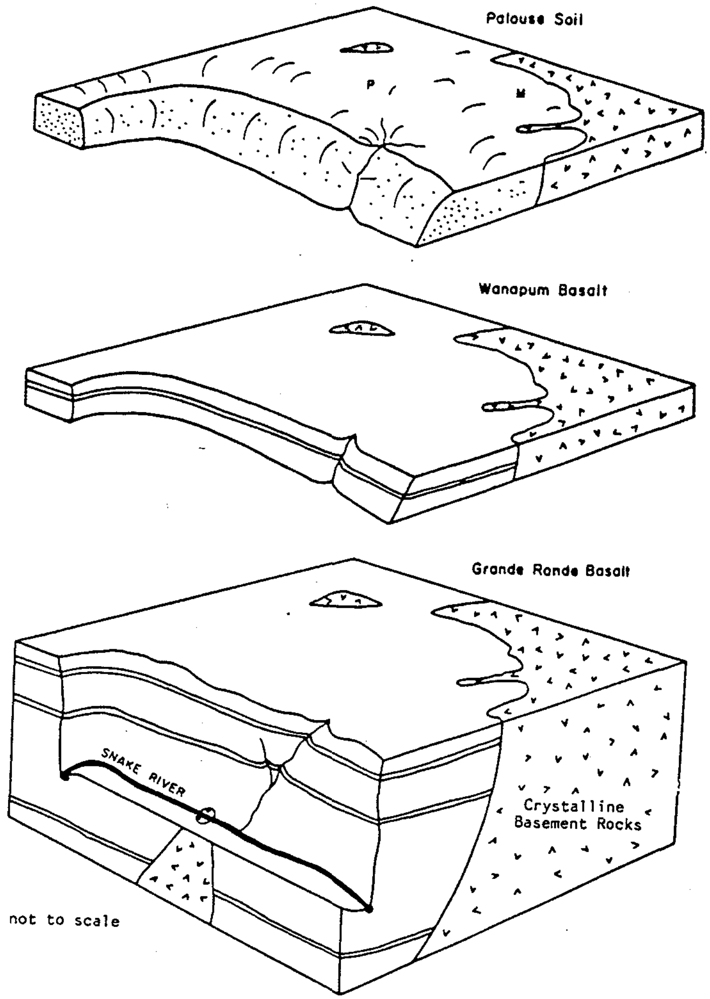

Figure 4. Three-dimensional perspective of the layered aquifer system, Pullman-Moscow area.

model of the ground water system. A field data collection program was initiated as part of the ground water study to obtain these data. Experience gained as a result of other ground water studies in basalt provided a guide for the magnitude of these input factors.

A computer ground water model consists of a program designed to handle large arrays of input data and solve equations representing ground water flow. A number of different computer models are available for this purpose. The model used for the Pullman-Moscow area was developed by McDonald and Harbaugh in 1984 and is known as the U.S.G.S. Modular Three Dimensional Ground Water Flow Model. This code was selected for use because of its suitability for this type of problem and its standard use by the U.S. Geological Survey.

A three layer computer model of the Pullman-Moscow area was constructed based on the conceptual model of the system. Each layer consisted of 2500 nodes in a 50 by 50 pattern with each node representing a one-half mile square. The model was jointly constructed and operated on the computer systems at the University of Idaho in Moscow and the U.S.G.S. in Tacoma.

The computer model was calibrated in a process of adjusting model inputs to allow the model generated water levels to match what has been historically measured in the area. The calibrated ground water levels for the Grande Ronde Basalt are shown on figure 5. Model calibration is critical to the development of a viable management tool. Considerable care was taken to create a mathematical model that matches the natural system to the greatest extent possible.

Results Of The Operation Of The Ground Water Computer Model

Once the computer model was constructed and calibrated, it was operated as a predictive tool to analyze alternative basin management options. Six different projections were examined in order to bracket potential future pumpage patterns. Three projections were based on stable pumpage rates at the 1985 rate, 25 percent above the 1985 rate and twice the 1985 rate. The other three projections were for continual growth in the pumpage rates at annual increases of one, two and three percent per year starting from the 1985 pumpage level. For reference, the 1985 pumpage rate was about 2.5 billion gallons per year; the ac-

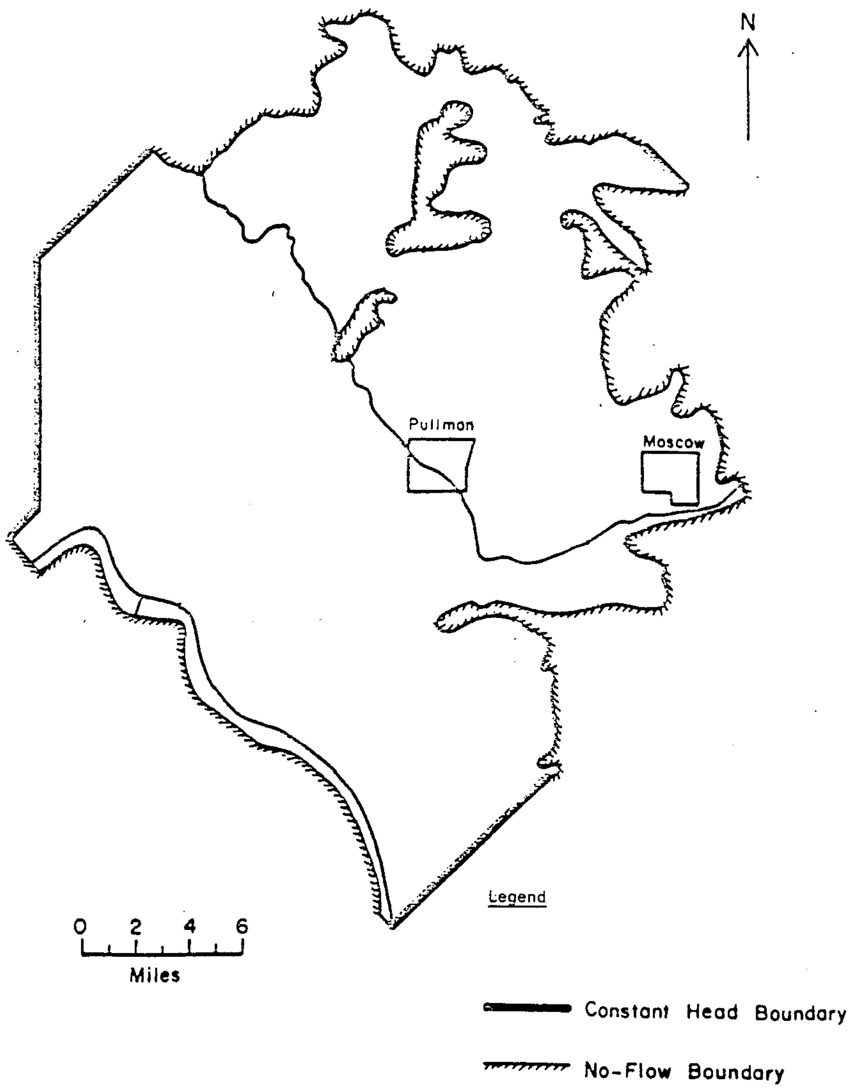

Figure 5. Model boundaries, Pullman-Moscow area.

tual rate of increase in pumpage has been about 1.7 percent per year since the 1940's.

Operation of the model suggests that ground water levels will stabilize if pumpage rates are held constant at any of the three rates. This conclusion is very important with respect to the long-term aspects of water supply in the area. The model results suggest that the ground water resource is capable of supplying the needs of the two cities and two universities into the forseeable future as long as pumpage rates are stabilized, even at rates twice that of 1985. Ground water levels will continue to decline for a period of time before reaching equilibrium conditions under any of the constant pumping alternatives evaluated. The lag time between pumpage stabilization and water level stabilization predicted by the model probably is less than will actually occur because of the single layer repesentation of the Grande Ronde Basalts. A time lag of ten to twenty years is possible before equilibrium conditions might be established under any pumping stablization program.

Results from operation of the model with annual increases in the pumping rate of one, two and three percent per year show continual water level declines into the future. The model runs of one and two percent per year increases in pumpage bracket the present pumpage pattern and show water level declines at rates similar to these presently measured in the area. The continued water level declines with annual increases in pumpage are to be expected from the ground water system in the area.

Limitations Of Model Predictions

The model incorporates many simplifying assumptions about treatment of the aquifer system that limit the applicability of the model results. Particularly important are the assumed model boundaries, the half-mile square areas represented by each node and the use of a single layer to represent the Grande Ronde Basalts. These limitations suggest that only general conclusions should be drawn from the model output. This does not lessen the value of the model but rather provides the proper perspective for interpretation of the predicted water level patterns.

Conclusions And Recommendations

The predictive runs of the model suggest that the cities and universities can rely on the existing ground water resource without extensive additional water level declines if pumpage rates are stabilized and held constant. Conversely, the model runs suggest that continued water level decline will accompany any continual pattern of increased annual pumpage.

The rates of future water level decline are directly related to the rates of increased ground water usage.

The model results do not suggest that the Pullman-Moscow area is in a situation where long term management decisions must be made immediately. However, the model results do illustrate the sensitivity of the resource to increased rates of pumpage. The model suggests that stabilization of water levels can occur at pumpage rates signficantly greater than 1985. This suggests that additional growth in pumpage is possible in the area without creating irreversible damage to the water resource system.

Model results suggest that several avenues of action are warranted in the Pullman-Moscow area. First, a continued effort is needed to upgrade the hydrogeologic knowledge of the area. A greater understanding is needed on the locations, controls for and magnitudes of both recharge and discharge. Second, the cities and universities should begin planning for measures to curtail continual water level decline in the region. Activities that are needed include water conservation, recharge enhancement, use of treated waste water and use of water from the Wanapum Basalts wherever possible.

Resource planning in the Pullman-Moscow area should continue to be a cooperative effort between all water users in the affected area. Past cooperation between the four major users has been excellent. Future planning and management efforts probably will require a formal agreement between the two states and the parties involved.