1986

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Charles Swann

Open-File Report 86-11

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February 17, 1986

ACKNOWLEDGEMENTS

In the course of any investigation a large number of people contribute their time, and suggestions. The author would like to express his gratitude to everyone who has contributed to this project. Particularly, however, I would like to acknowledge the following people:

Mr. Tracy Lusk and Mr. Henry Johnson, Mississippi Mineral Resources Institute, for their suggestions and critical review of the manuscript.

Ms. Renee Whiteaker, Mississippi Mineral Resources Institute, for providing the secretarial expertise which makes manuscript preparation much less difficult for the author.

Mr. Paul Mitchell, Mississippi Mineral Resources Institute, for constructing the geologic illustrations contained herein.

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ABSTRACT

Artificially recharging aquifers is a proven method of supplementing groundwater supplies. Although there is presently no groundwater supply problem in the Oxford-The University of Mississippi area, it is wise planning to have solutions available prior to acute water shortages. Artificial recharge is a potential solution and is geologically feasible. The source of groundwater supply for the Oxford-The University of Mississippi area is the unconfined Meridian-Upper Wilcox aquifer. The aquifer is recharged locally from rainfall and to an unknown degree by incidental recharge. Therefore groundwater supply is greatly influenced by rainfall. In the outcrop belt of the Meridian Sand, which crops out in the study area, the basin method of artificial recharge can be used to an advantage where there are no significant clay beds. The steep topography produced by the Meridian Sand and its well-sorted sand lithology should result in high infiltration rates from recharge basins. The advantages of artificial recharge include an increased supply of stored groundwater, a more dependable supply on which future growth could rely, and the recharge basins could provide holding areas for excess storm run off thereby providing flood control.

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INTRODUCTION

Artificial recharge of aquifers involves some man-made means of supplementing natural aquifer recharge. There are a number of techniques in which artificial recharge can be accomplished. Some examples include water spreading, recharge basins, and recharge wells. The water used in these systems is usually from surface run off or in some cases treated waste water has been used. In either case the objective is to increase groundwater supply.

The artificial recharge of aquifers is a method that could be used in various parts of Mississippi. The Oxford-The University of Mississippi (U.M.) area is being used as an example to illustrate some of the factors which should be evaluated as potential recharge sites. Municipalities located within the outcrop belt of the Meridian Sand would be prime targets for assessing the feasibility for recharge projects. Other geological units which could be suitable for surface recharge in their outcrop belts include the Cretaceous-aged Tuscaloosa Formation, Eutaw Formation, and McNairy Sand as well as the Tertiary-aged Meridan Sand and the Kosciusko Formation as well as other units.

The city of Oxford and The University of Mississippi are located in central Lafayette County, Mississippi. Lafayette County is in north-central Mississippi and is one of the most populous counties in the northern part of the state. Although the Oxford-U.M. area is not presently experiencing a paucity of groundwater, future industrial and population growth will place increased demands on groundwater supplies. It is therefore prudent to examine the advantages of artificial recharge prior to acute groundwater shortages.

LITHOSTRATIGRAPHY

Oxford and U.M. are located within the outcrop belt of the Eocene-aged Tallahatta Formation (Figure 1). In the southern part of the Tallahatta outcrop belt the formation is divisible into two members, the older Meridian Sand and the younger Basic City Member (Figure 2). The Basic City typically consists of interbedded sand and claystone. The Wilcox Group lies below the Tallahatta Formation and is often not subdivided into formations. The Wilcox Group lithology is typically a fine-grained clastic with complex internal facies relationships. Suspected onlap of younger units adds further confusion to the complex formational nomenclature of the Wilcox Group. Therefore no attempt has been made to subdivide the Wilcox Group in this report.

In a complete stratigraphic section, the Claiborne Group overlies the Wilcox Group. The Claiborne is subdivided into the basal Tallahatta Formation, the younger Winona, Zilpha, and Kosciusko formations. The Tallahatta

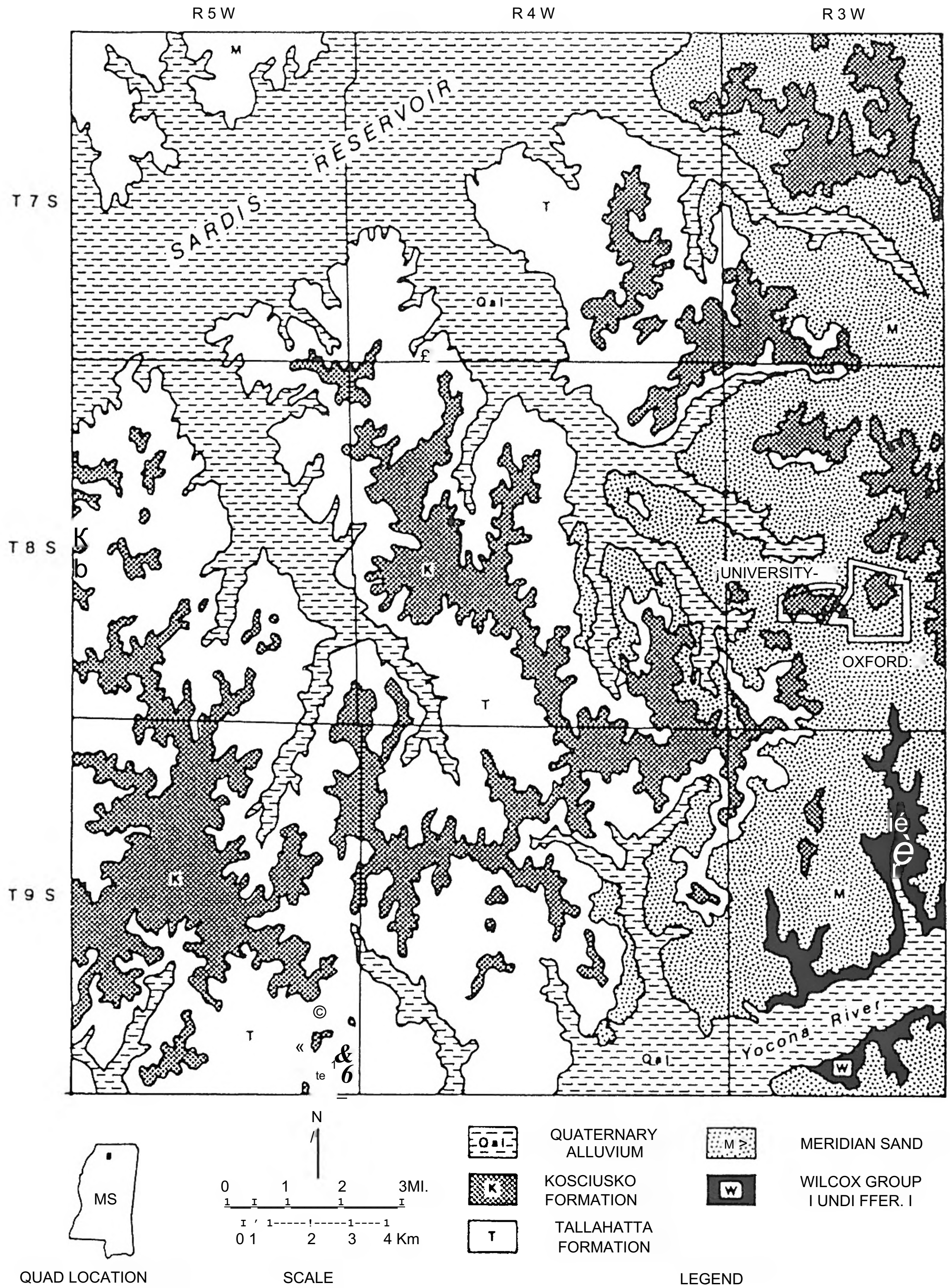


Figure 1 - Location map showing the city of Oxford, The University of Mississippi and the outcrop belts of the geologic units in the Oxford 15 minute quadrangle (from Attaya, 1951)

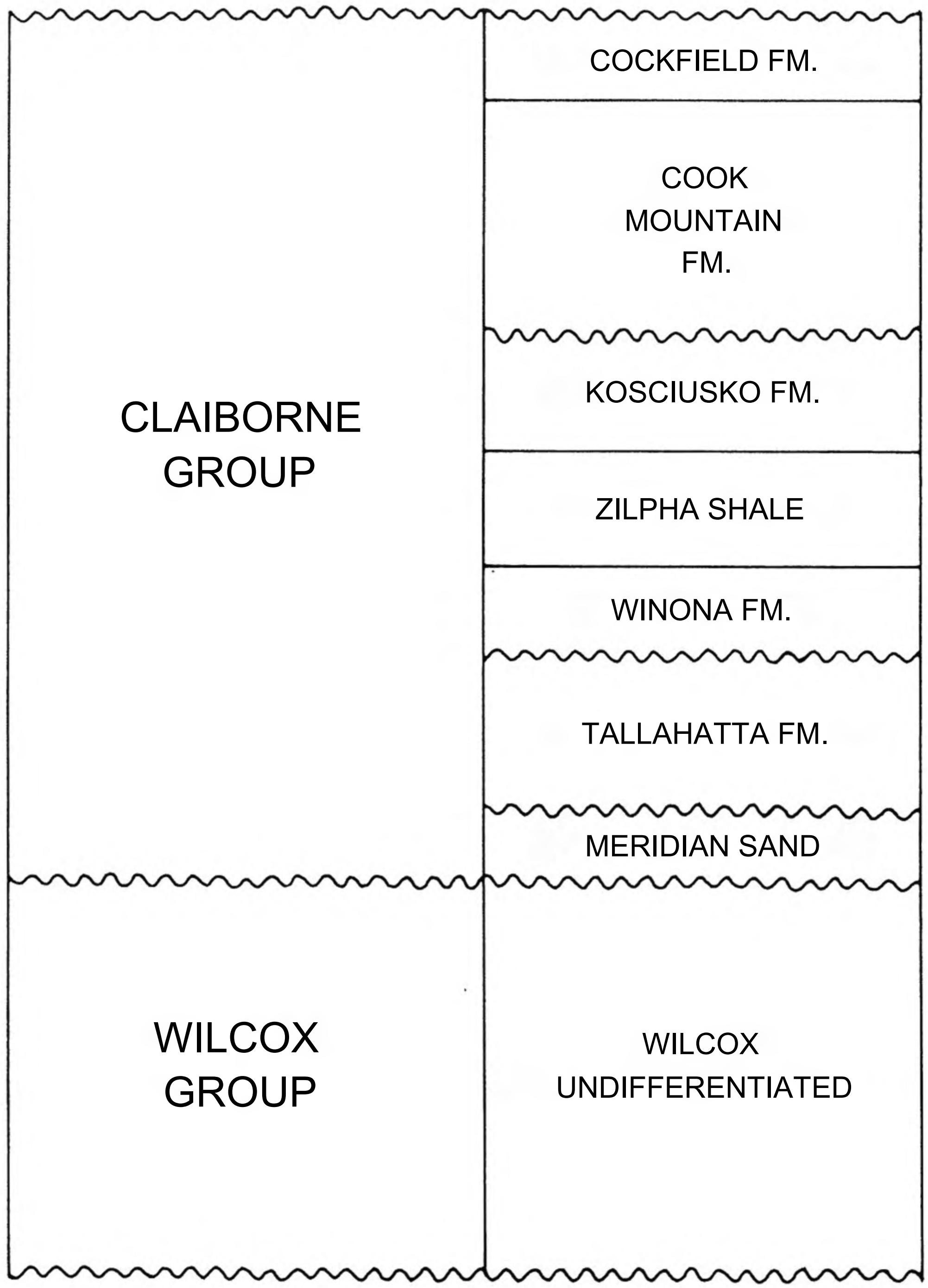


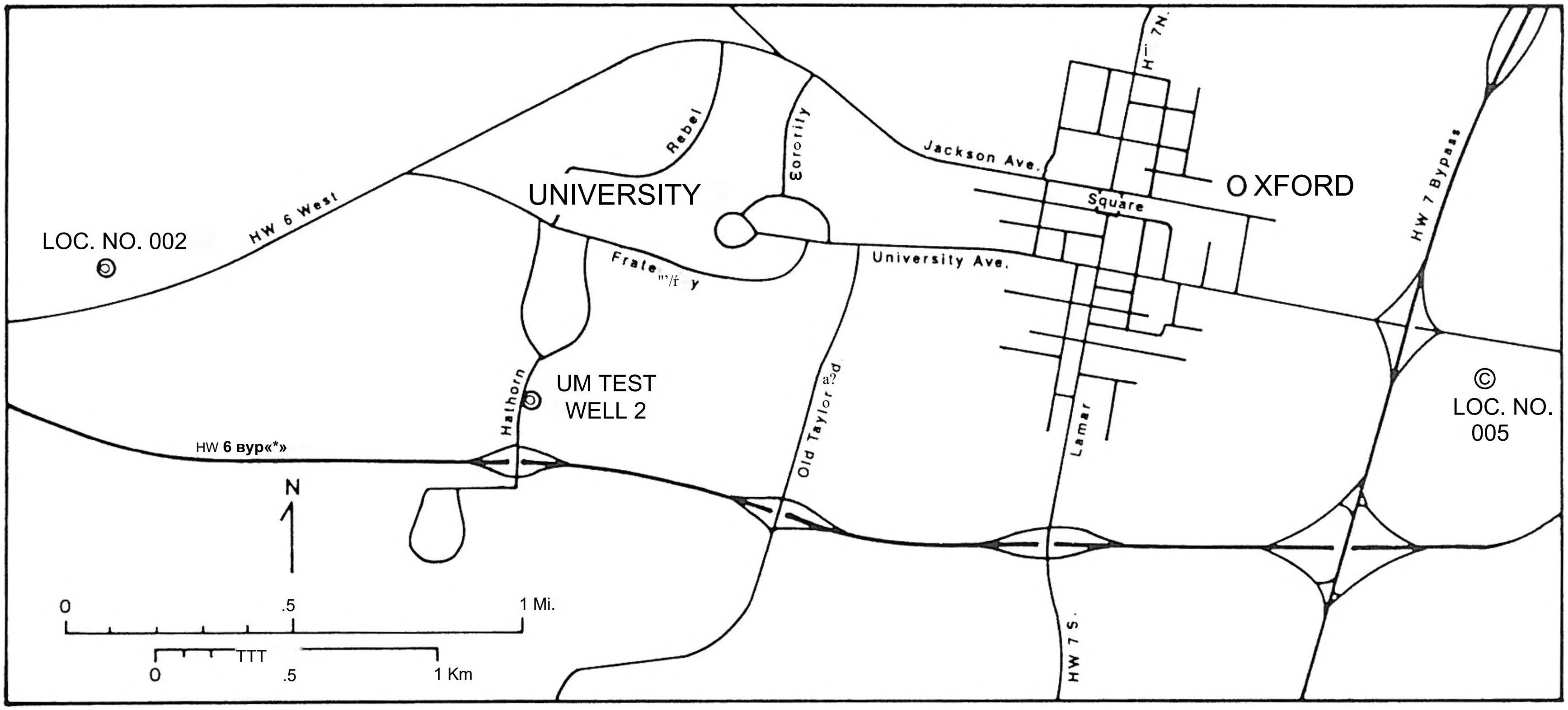
Figure 2 - Ideal stratigraphic column of the units of the Wilcox and Claiborne groups (modified from Dockery, 1981)

Formation of north Mississippi has been subdivided into two members, the Meridian Sand and the overlying Basic City Shale.

Attaya (1951) has mapped the Meridian Sand and the overlying Kosciusko Formation as cropping out in the Oxford-U.M. area. The Kosciusko is located at the highest elevations as outliers to the major outcrop belt to the west. Attaya (1951) suggests an onlap of the Kosciusko onto the Meridian Sand with the Winona and Zilpha formations having been removed by erosion associated with the basal Kosciusko unconformity.

The University of Mississippi Test Well 2, drilled in June, 1985, is located on a Kosciusko outlier as mapped by Attaya (1951). Surface outcrops as well as well logs were examined to determine if there were significant lithologic differences between the Kosciusko and Meridian Sand. The investigation revealed no major lithologic differences so in this report the entire section is assigned to the Meridian Sand.

The Meridian Sand is typically composed of fine- to coarse-grained, well sorted, cross-bedded sand. Dark, heavy minerals mark the crossbed sets in some outcrops such as LC-05 (Figure 3). Local clay beds are also present in the Meridian Sand. These clay lenses have been described by Lowe (1933), and as early as 1916 Berry described the flora found in these clay beds. The clay lenses are at different stratigraphic intervals within the Meridian and their



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Ficmre 3 - Map of cited location in the Oxford - The University of Mississippi vicinity presence is difficult to predict at any specific geographic location. Therefore, drilling is needed at any potential site in order to insure that there are no significant clay beds which may effect the rates of infiltration between the surface and the water table.

The University of Mississippi Test Well 2 (Figure 4) encountered 180 feet of sand that is assigned to the Meridian. The driller's log and the "down hole" geophysical logs do not indicate any significant clay beds. The driller's log indicates clay "streaks" or "bands". Examination of surface outcrops indicate that these "streaks" or "bands" could represent scour zones at the base of channels where abundant well rounded clay clasts are often present. Thin zones of clay laminae have also been noted in surface exposures and could be interpreted as "bands" or "streaks" in well cuttings. Neither the channel deposits nor the clay laminae are laterally extensive. Typically they are very localized.

GEOHYDROLOGY

Oxford and the U.M. presently derive their groundwater supply from the Meridian Sand. In the absence of confining beds, as in the section in U. M. Test Well 2, the aquifer is considered unconfined. Aquifer recharge takes place at the outcrop via rainfall. Some recharge is probably derived

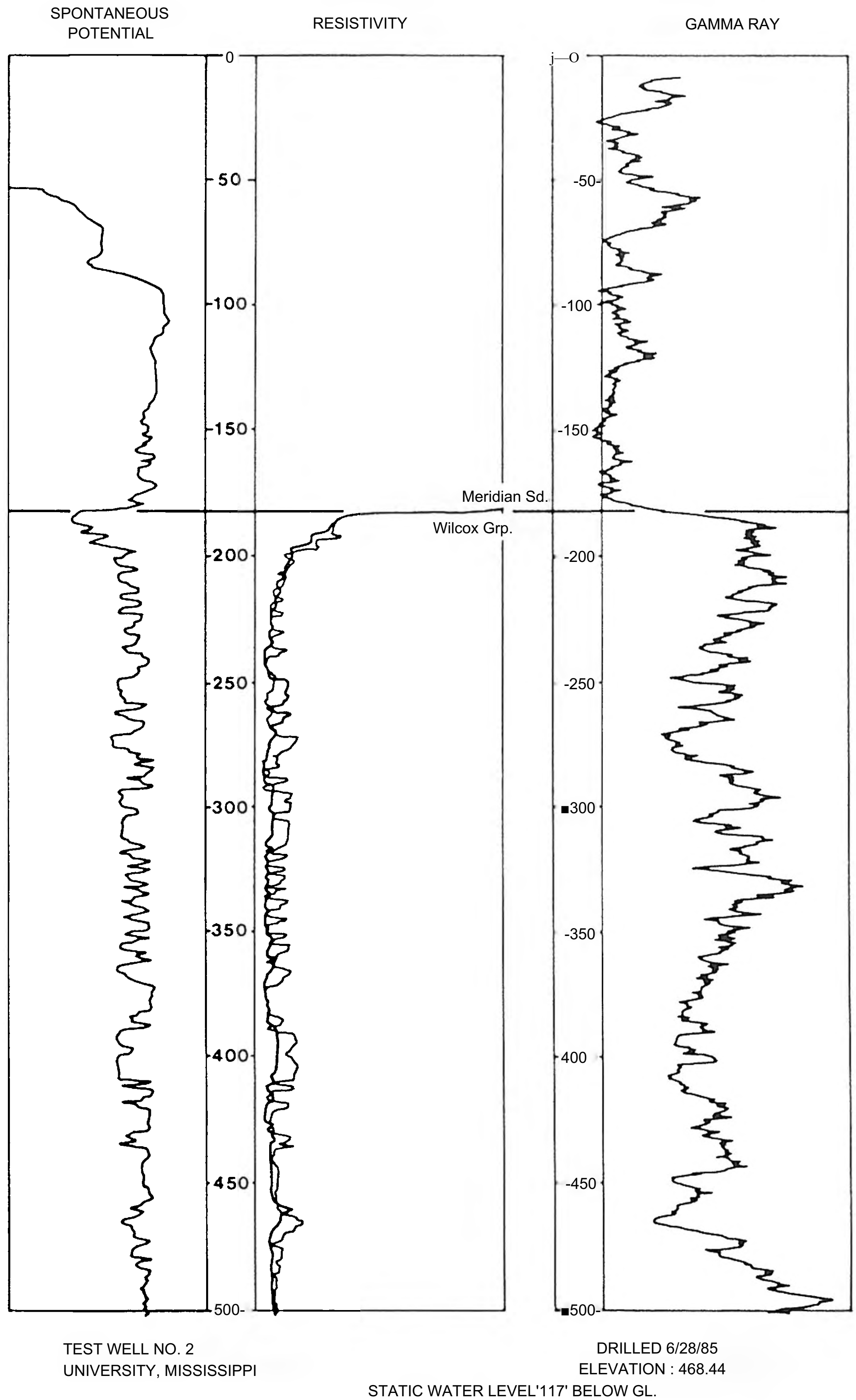

Figure 4 - l'felí logs from U.M. Test Well 2

from surface waters such as lakes and streams, although the amount of contribution is unknown.

Gandi (1982) includes the Meridian in the Meridian-Upper Wilcox aquifer. These stratigraphic units are placed in the same geohydraulic unit because they are hydraulically connected. Gandi also notes that the Wilcox becomes more argillaceous and less permeable in the northern part of the state. Examination of well logs in the Oxford-U.M. area supports Gandi’s conclusion, as the Wilcox is very argillaceous and could be considered a confining unit.

Significant local clay beds are present within the Meridian Sand. These clay beds often result in perched water tables which are marked by seepage areas at the upper clay-sand contact. Figure 5 is a photograph of a clay lense in the western edge of Oxford. The location of the unit is labeled as LC-002 on the location map (Figure 3).

METHODS OF ARTIFICIAL RECHARGE

There are several methods by which an aquifer may be artificially recharged. The recharge well method consists of constructing one or more wells and pumping surface water into the aquifer. This method of recharge is usually applied to confined aquifers or used where available space prohibits other surface recharge methods.

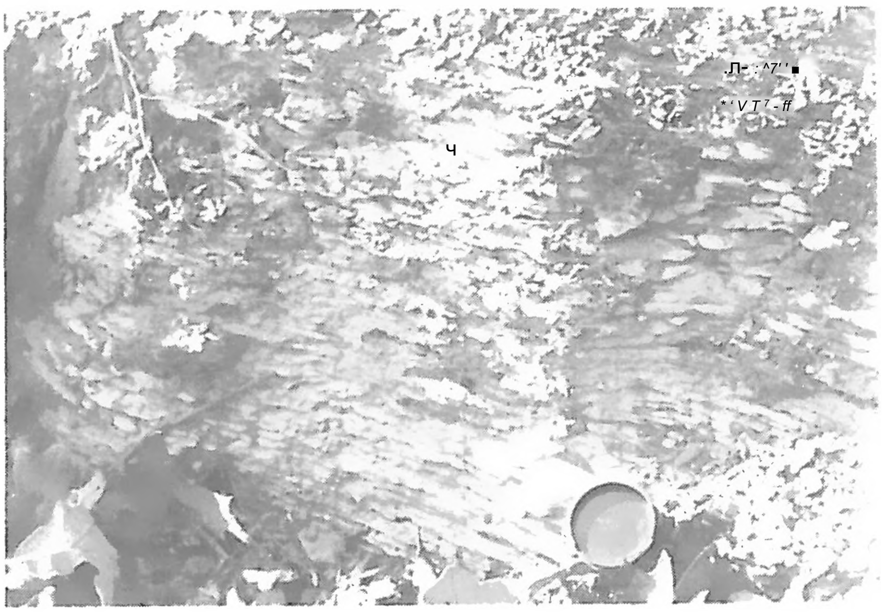

Figure 5 - Photographs of a clay lense within the Meridian Sand at location LC-002

There are a number of methods of artificial recharge which involve some means of increasing surface infiltration into an unconfined aquifer. Within the Oxford-U.M. area, recharge pits and basins are the most feasible means of artificially recharging the unconfined Meridian-Upper Wilcox aquifer. The recharge pit method requires that a pit be excavated within the unit to be recharged and that the pit then be filled with water. Infiltration of water from the bottom and sides of the pit will then recharge the aquifer. An advantage of the pit method is that the steep walls of the excavation are not effected by silt and clay sized particles which would reduce permeability by clogging the pore spaces. These fine-grained clastics will usually settle to the bottom of the pit, leaving the permeability of the walls relatively unchanged. A disadvantage of the pit method is the cost associated with excavating the pit and the removal of the excavated material. An alternative to pit excavation would be to use pre-existing pits such as is associated with sand and gravel operations. The use of pre-existing pits avoids the costs associated with pit construction and disposal of the excavated material. As there are no suitable, pre-existing sand or gravel pits in the Oxford-U.M. area, this method is less desirable than the basin method.

The basin method is one of the most often used methods of artificial recharge because of the ease of maintenance and efficient use of space (Todd, 1980). The basin method requires the construction of one or more basins in such a manner as to maximize infiltration. Typically, storm runoff is used to fill the basin although silt and clay becomes a problem as it will clog pore spaces and reduce permeability. For this reason, periodic maintenance in the form of disking or scraping the bottom of the basin is required to maintain high infiltration rates (Task Group on Artificial Ground Water Recharge, 1963).

Infiltration rates will vary from site to site because of differing geologic and hydrologic factors. But studies of artificial recharge basins in California allowed Richter and Chan (1959) to derive a formula that is useful in estimating infiltration rates using the slope of the land surface. They found that if the slope within a basin varies between 0.1 and 10 percent the infiltration rate could be estimated by the formula:

$$W = 2.14 + 1.85 \text{ Log } I$$

where W equals the infiltration rate in feet per day and I equals the natural ground slope expressed in percent. It should be noted that the formula implies that the steeper slopes yield higher infiltration rates. The calculations are based on typical alluvial soil characteristics. It should also be emphasized that the use of the formula will give only an estimate of infiltration rates. Therefore each proposed site should be individually evaluated.

The basin method of artificial recharge appears to be ideally suited for the Oxford-U.M. area. The Meridian Sand

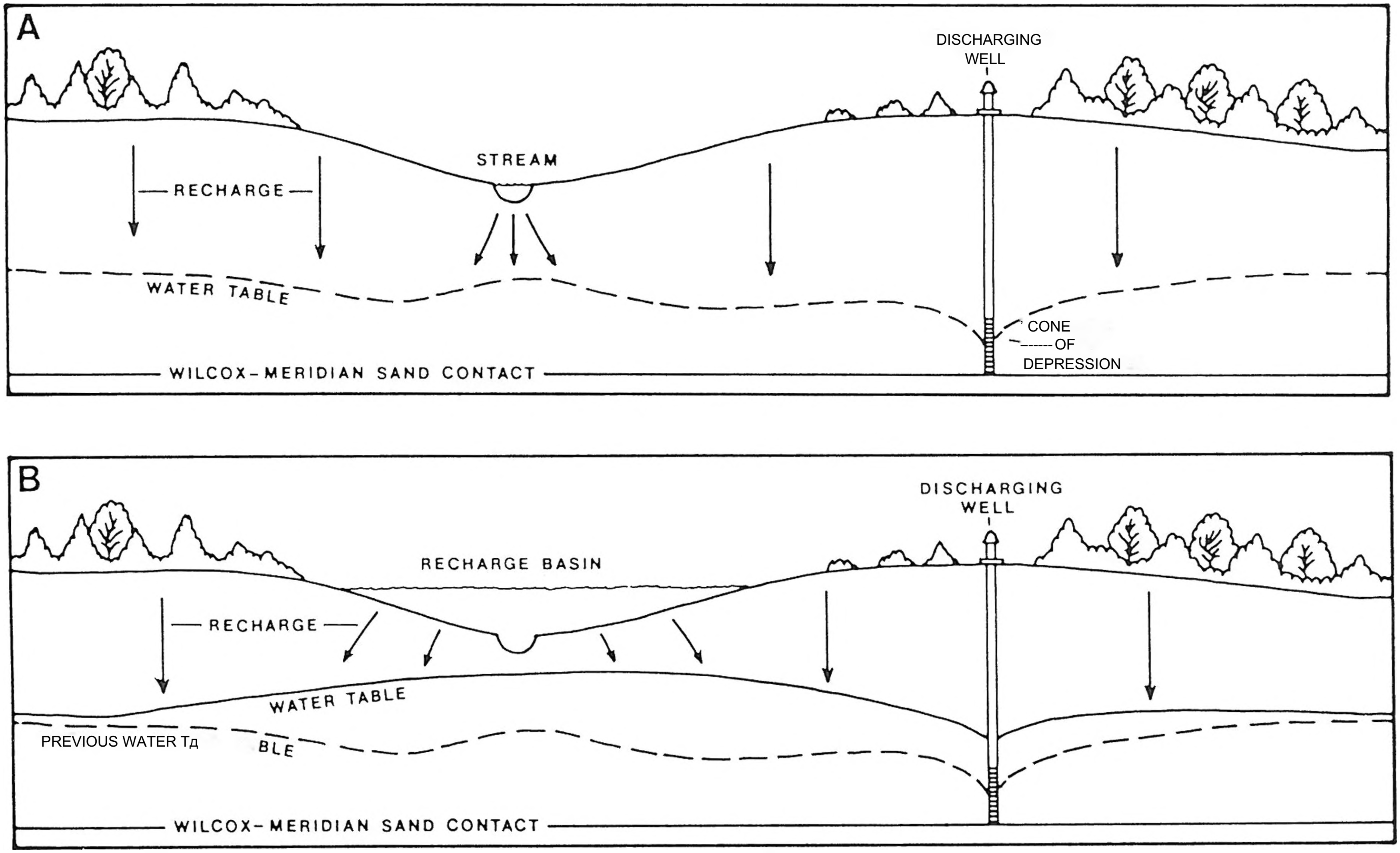

Figure 6 - Schematic diagram of the water table prior to recharge basin construction (A) and after (B) . Note in B the rise of the water table to form a mound below the recharge basin.

typically produces a topography with steep slopes and numerous valleys. The steep slopes should result in high basin infiltration rates. In areas such as U.M. Test Well 2 there are very minor or no clay units in the Meridian Sand. This area is close to water supply wells, therefore recharge basins should provide beneficial results (Figure 6). These results include greater holding areas for storm runoff, which will increase as more ground surface is paved or covered, additional stored groundwater supply, and the insurance of a more reliable groundwater source for future expansion. Recharge basins should be included in future plans for Oxford as well as The University of Mississippi.

CONCLUSIONS

1) The Oxford-U.M. groundwater supply is derived from the Meridian - Upper Wilcox aquifer. In the Oxford-University area this aquifer is unconfined and is recharged locally.

2) The Meridian Sand (basal member of the Tallahatta Formation) consists of a thick section of well-sorted, fine-to medium-grained sand. Local clay beds are scattered at different stratigraphic levels within the sand section. These localized clay beds are undesirable in an area proposed for aquifer recharge because the lack of permeability would not allow infiltration to reach the water table. There are areas, such as the vicinity of U.M. Test

Well 2, where there are no significant clay units and recharge from the surface is feasible.

3) Pits and recharge basins are the aquifer recharge technology best suited for the Oxford-U.M. area. Because of the costs associated with the construction of recharge pits and the lack of pre-existing pits, the basin method of recharge is preferred.

4) The topography in the Oxford-U.M. area is well suited to the use of recharge basins which should result in high infiltration rates. Wells located near the basins would be assured of a groundwater supply that is increased due to storage resulting from the artificial recharge of the aquifer. The basins could also provide a holding area to control excess storm runoff and provide some flood control.

5) The use of groundwater recharge in the Oxford-U.M. area should be included in plans for future development. Recharge basins will benefit the Oxford-U.M. area and will encourage sound groundwater management for one of the state of Mississippi's most important natural resources.

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