Geologic Evaluation of Waste-Storage Potential In Selected Segments of the Mesozoic Aquifer System Below the Zone of Fresh Water, Atlantic Coastal Plain, North Carolina Through New Jersey

GEOLOGICAL SURVEY PROFESSIONAL PAPER 881

Sponsored by the Department of Defense
Defense Advanced Research Projects
Agency, DARPA Order No. 1813,
Amendment No. 1

Geologic Evaluation of Waste-Storage Potential In Selected Segments of the Mesozoic Aquifer System Below the Zone of Fresh Water, Atlantic Coastal Plain, North Carolina Through New Jersey

By PHILIP M. BROWN *and* MARJORIE S. REID

GEOLOGICAL SURVEY PROFESSIONAL PAPER 881

Sponsored by the Department of Defense
Defense Advanced Research Projects
Agency, DARPA Order No. 1813,
Amendment No. 1

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1976

UNITED STATES DEPARTMENT OF THE INTERIOR

THOMAS S. KLEPPE, *Secretary*

GEOLOGICAL SURVEY

V. E. McKelvey, *Director*

Library of Congress Cataloging in Publication Data

Brown, Philip Monroe.

Geologic evaluation of waste-storage potential in selected segments of the Mesozoic aquifer system below the zone of fresh water, Atlantic Coastal Plain, North Carolina through New Jersey.

(Geological Survey professional paper 881)
"Sponsored by the Department of Defense, Defense Advanced Research Projects Agency, DARPA order no. 1813, amendment no. 1."
Bibliography: p.

Supt of Docs. no.: I 19.16:881

1. Geology—Middle Atlantic States. 2. Aquifers—Middle Atlantic States. 3. Geology, Stratigraphic—Mesozoic. 4. Waste disposal in the ground—Middle Atlantic States. I. Reid, Marjorie S., joint author. II. Title. III. Series: United States. Geological Survey. Professional paper 881.
QE78.3.B7 557.5 74-16110

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402
Stock Number 024-001-02738-1

CONTENTS

ILLUSTRATIONS

[Plates follow text in case]

TABLES

GEOLOGIC EVALUATION OF WASTE-STORAGE POTENTIAL IN SELECTED SEGMENTS OF THE MESOZOIC AQUIFER SYSTEM BELOW THE ZONE OF FRESH WATER, ATLANTIC COASTAL PLAIN, NORTH CAROLINA THROUGH NEW JERSEY

By PHILIP M. BROWN and MARJORIE S. REID

ABSTRACT

This report describes the distribution of subsurface environments in the Atlantic Coastal Plain—North Carolina through New Jersey, that are seen to have geologic potential for the storage of toxic waste. The environments described consist of layers of sand or sandstone, 20 feet or more in thickness, that are immediately overlain and underlain by layers of shale or clay, 20 feet or more in thickness, and which occur in Units F, G, and H of Mesozoic age in areas where the top of each of these units lies at a depth equal to or greater than 1,500 feet below mean sea level.

Using a group of geologic parameters derived from or combining 20 categories of basic data, established from study of well cuttings and geophysical logs, a series of 18 regional maps was constructed. For each of three geologic units delineated in the subsurface, the maps illustrate the distribution of potential waste-storage reservoirs in terms of their areal extent, depth below land surface, and the thicknesses of the component reservoir and reservoir-seal rocks.

The depth of burial, physical character, and extent and thickness of the reservoirs that have waste-storage potential are variable. The range in variability appears to be broad enough to satisfy the geologic requirements for different types of waste storage.

INTRODUCTION

In the past and to a limited extent, the void space (porosity) in underground rocks has been used as a receptacle in which to inject waste that was obnoxious or detrimental when stored or dispersed at the land surface. Today, significant increase in the volume and detrimental components of waste products, coupled with increasing demand for a clean environment, has led government and industry to give additional consideration to this void space as a possible storage reservoir for some types of fluid waste—especially those that are toxic and will remain so for a long time.

To determine the volume of void space available and to consider its use for this purpose, those concerned with waste management must be able to forecast the waste-storage potential of different rock layers underground (their capacity to receive and retain various types and volumes of waste), to assess cost-risk-benefit factors associated with potential sites, and to select experimental and operational sites for waste injection. To make these forecasts, assessments, and selections, management must have certain geologic, hydrologic, chemical, and engineering information that defines the physical-chemical boundaries and complexities of subsurface environments.

To evaluate the waste-reservoir potential of underground sediments both general and specific geologic information is required. The general information required is that which will provide an understanding of the geometry of the sediment mass, the conditions extant during its emplacement, and how it was affected and modified by tectonic and structural events during and after its emplacement. The specific geologic information required is that which will delineate rocks of high porosity and permeability (potential waste-storage reservoirs) and rocks of low permeability (potential waste-storage reservoir seals), describe their external and internal geometry and their relative spatial distribution within the sediment mass.

Some of this information may be obtained by analysis, interpretation, and extrapolation of stratigraphic and geophysical data from a relatively few, widely scattered boreholes. Other required information may be derived only from data obtained from closely spaced boreholes and cored geologic sections.

Interpretation of the data from widely scattered boreholes serves several purposes. It provides a relatively rapid and inexpensive method for the screening of large geographic areas to delineate favorable

waste-reservoirs. Thus, it identifies the areas where the drilling of closely spaced boreholes will be required and where they will have the greatest chance of success in defining waste reservoirs. Also, it identifies areas to be considered in locating industrial sites that may require nearby facilities for subsurface waste disposal. Most importantly, interpretation of these data permits the definition and presentation of quantitative geologic parameters that are the base for establishing hydrologic, chemical, and engineering correlation and prediction.

Accordingly, in September 1971, as part of the U.S. Geological Survey's waste-storage research program and using the data available from a relatively few widely spaced boreholes, an investigation was begun to evaluate the waste-storage potential of selected segments of the Mesozoic aquifer system in that part of the Atlantic Coastal Plain extending from North Carolina through New Jersey. This is the report of the investigation.

This research was supported by the Defense Advanced Research Projects Agency and was monitored by the U.S. Geological Survey under Order No. 1813, Amendment No. 1.

The work was done under guidelines established by the Chief Hydrologist of the U.S. Geological Survey.

The opinions and conclusions contained in this report are those of the senior author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Defense Advanced Research Projects Agency or of the U.S. Geological Survey.

PREVIOUS WORK

A comprehensive annotated bibliography for the storage of liquids underground was compiled by Rima, Chase, and Myers (1971). The geologic requirements for storage are described in many publications, including those written or edited by Russell (1960); Katz, Tek, Coats, Katz, Jones, and Miller (1963); Young and Galley (1965); Katz and Coats (1968); Witherspoon, Javandel, Neuman, and Freeze (1967); Galley (1968); and Cook (1972).

Many of the basic data used to prepare this report were included in or were assembled during preparation of a report by Brown, Miller, and Swain (1972). The earlier report provides the general and many of the specific geologic data required to make an evaluation of waste-storage potential in the study area. It contains analyses of the regional stratigraphic framework, the spatial arrangement of sediments within that framework, and the regional distribution of intrinsic permeability as a function of lithologic variance. It integrates the tectonic, structural, and sedimentary historical events in the region and provides an understanding of its geologic complexities. In addition, it provides type-reference and lithologic-reference sections in the subsurface for the geologic units herein considered to have waste-storage potential.

The present report uses the key-well network defined in the earlier report, to which recently drilled wells have been added, and it expands the discussion of the sedimentary geometry in the earlier report to define, in greater detail, the sand-shale relations that apply specifically to delineation of potential waste-storage reservoirs. For practical reasons, the earlier report, with its maps and geologic sections, should be used in conjunction with the present report. To facilitate this conjunctive use, the well-location map in this report (pl. 1) is an updated version of a map (pl. 4) in the earlier report that shows the locations of all key wells in the study area and of lines of geologic sections.

NATURE OF THE PROBLEM

The primary research problem was to select and map favorable waste-reservoir environments in the Atlantic Coastal Plain study area. The problem included several interconnected elements as follows:

1. Given a large geographic area that contained scattered borehole data, to select criteria and develop techniques that would permit rapid and inexpensive screening of the study area for potential waste-storage reservoirs, whose initial selection or rejection could be guided by a set of quantitative mappable geologic parameters.
2. In the absence of information about the specific volumes and types of waste that might be available for injection into the subsurface, to select those geologic parameters whose cartographic presentation could be interpreted to indicate the types of reservoirs available for storage of different volumes and kinds of waste throughout the region.
3. Using the Atlantic Coastal Plain as a prototype area, to apply the selected criteria and techniques to evaluation of potential waste-reservoirs in such a manner that the methodology and results could be used by management to derive guidelines for defining and delineating similar environments in

other geographic areas underlain by clastic sedimentary geological formations.

METHOD OF APPROACH

Viewed broadly, the fundamental processes that take place in a subsurface waste-storage reservoir consist of complex interactions between the substance injected, the physical and chemical components of the reservoir and its boundary rocks, and the native fluid, liquid or gaseous, that is being compressed within or forced out of the reservoir by the pressure on the injected substance.

The principal geologic problem in evaluating subsurface waste-storage potential is to locate and describe rocks that have the potential capacity either to store or contain waste in areas where these interactions, some of which are unknown or undefinable at present, may take place without producing harmful side effects. Rocks that may have potential as waste reservoirs or reservoir seals for toxic waste are deeply buried and have locally differing geometries and degrees of chemical complexity. Therefore, a direct approach to solution of the problem, the drilling of closely spaced core holes, is prohibitive from a cost standpoint alone. An indirect approach is necessary. From the subsurface environments present in the region, an environment is selected that has the potential for meeting the geologic requirements for injection, storage, and containment of waste. The occurrences and pattern of distribution of potential reservoirs can then be shown by a set of quantitative geologic parameters which can be plotted directly on maps and charts. This indirect method of regional evaluation of waste-reservoir potential is used in this report. The principle or screening mechanism involved, applied commonly in exploration geology, is that the chances for locating suitable waste-reservoirs are much greater if the search concentrates in areas where waste-reservoirs are most abundant. The minimum prerequisites needed to use this exploration method in the study area are:

1. Definition of the geometry of the sediment mass in order that its component environments can be recognized and classified, both genetically and physically.
2. Availability of lithologic and geophysical data that can be used to derive geologic parameters which have a relation to the geometry of potential waste reservoirs and which can be plotted on maps and charts.
3. Information about the geologic complexities of the study area that is sufficient to permit data extrapolation using data available from a minimum of boreholes.

SELECTION OF A WASTE-STORAGE RESERVOIR ENVIRONMENT

In the study area the basic geologic requirements for selection of a potential waste-reservoir environment are its depth of burial, physical character, areal extent and thickness, and hydrological isolation.

The environment must be present at a depth that precludes any possible contamination of fresh-water resources and where any waste introduced into the subsurface will not be a detriment to the recovery or in situ use of other underground resources.

The selected environment must have two types of rock, with one type (characterized by a relative high porosity and permeability, and sufficient thickness and lateral extent to qualify as a potential reservoir) being immediately underlain and overlain by the second type (characterized by relative low permeability, an absence of fractures, and sufficient thickness and lateral extent to qualify as a reservoir seal). The candidate reservoir rock may have either a high or a low waste-sorption potential, depending upon the nature of the injected fluid, its storage requirements, and optimum rates and volumes of injection.

Ideally, the reservoir rock should be connected laterally with rock having the capacity to accept the native fluid that moves out of reservoir storage in response to injection pressure. This arrangement would reduce the danger of fracturing and breaching of the reservoir seals.

In the study area, as shown by analysis of the sediment mass (Brown and others, 1972), relatively porous and permeable layers of sand are the only deeply buried rocks having sufficient thickness, areal extent, and degree of interconnection to qualify as potential waste reservoirs regionally. Other relatively porous and permeable rocks in the sediment mass, such as limestone or dolomite, either are too near the land surface or do not have the requisite thickness or areal extent to qualify. Similarly, layers of relatively impermeable shale are the only deeply buried rocks in the sediment mass having sufficient thickness and areal extent to qualify as potential waste-reservoir seals regionally.

Taking these two rock types and postulating their arrangement within the desired waste-reservoir configuration, which dictates that the relatively porous

and permeable rock must be immediately underlain and overlain by relatively impermeable rock, and imposing an economic constraint and a general safety constraint, we can define a potential waste-storage reservoir environment quantitatively and map its occurrence throughout the study area. A preliminary definition of this environment is as follows:

A sand or sandstone layer 20 feet or more in thickness that is directly underlain and overlain by a shale or clay layer 20 feet or more in thickness.

The minimum thickness of 20 feet for a sand layer is an economic constraint imposed by exploration and development requirements. The minimum thickness of 20 feet for underlying and overlying shale layers is a safety constraint imposed by the minimum thickness judged to be required for a reservoir confining layer (Russell, 1960).

On the basis of their distribution in the subsurface and their sand-shale geometry, three geologic units of Mesozoic age seemed to have the greatest potential for containing waste-storage reservoirs in the study area. They are Units F, G, and H. These units, which range from Early Cretaceous to Early Cretaceous-Jurassic(?) in age, were described, mapped, and illustrated in stratigraphic cross sections by Brown, Miller, and Swain (1972, pls. 7–9).

The requirement that fresh-water systems be protected from natural or induced contamination by injected waste limits the waste-storage potential of these geologic units to their more deeply buried segments that contain saline water. Seemingly, this constraint requires determination of the location of the fresh-saline water boundary zones within these units. In the study area and except in a general way, the point-source data required to make this determination either are not available or have not been correlated using a valid geologic base. Therefore, to be reasonably certain that the environments considered to have waste-storage potential contain saline water, it is necessary to add a safety or depth-of-burial factor to the known or projected depth of fresh-water occurrence in these geologic units.

From a background of knowledge gained through a study of the geohydrology of the region for more than 20 years, we judge that Units F, G, and H generally may contain fresh water to a depth of as much as 600 feet below mean sea level. Locally, and especially in the case of Unit F, they may contain fresh water to a depth of as much as 1,000 feet below mean sea level. Thus, the constraint imposed by the approximate maximum depth of fresh-water occurrence in these units is about 1,000 feet below mean sea level. On maps in this report (pls. 2, 5, and 8) this boundary is labeled and is defined as the projected maximum depth of fresh-water occurrence. We consider a satisfactory added safety or depth-of-burial factor to be 500 feet below mean sea level, one-half of the projected maximum depth of fresh-water occurrence. Thus, the depth-of-burial safety factor, 500 feet below mean sea level, added to the projected depth of fresh-water occurrence, 1,000 feet below mean sea level, gives a depth of 1,500 feet below mean sea level as the projected depth at which all the potential waste-storage reservoir environments in Units F, G, and H may be expected to contain saline water. On maps in this report (pls. 2–10) this boundary is labeled and is defined as the projected minimum depth of saline-water occurrence.

Identification of these new constraints imposed by selection of specific geologic units and a required depth-of-burial factor permits us to amend our previous definition of a potential waste-storage reservoir to read as follows:

A sand or sandstone layer 20 feet or more in thickness that is directly underlain and overlain by a shale or clay layer 20 feet or more in thickness and which occurs in Units F, G, and H where the top of each of these units lies at a depth of 1,500 feet or more below mean sea level

Within the constraints imposed by the amended definition, and using the data from widely scattered boreholes, it is now possible to establish a set of quantitative geologic parameters and use them to map the distribution of this environment in selected segments of the study area.

BASIC DATA AND DERIVATION OF MAPPABLE GEOLOGIC PARAMETERS

The selection of segments of Units F, G, and H for evaluation of waste-reservoir potential is based on their distribution in the subsurface, their sand-shale geometry, and projection of the occurrence of saline water in them.

Within or adjacent to areas where the tops of these units lie at depths of 1,500 feet or more below mean sea level, 51 wells pentrate Unit F, 44 wells penetrate Unit G, and 31 wells penetrate Unit H. These wells comprise the key-well network in the waste-reservoir evaluation study. Their location and the locations of what we consider to be other key stratigraphic wells in the North Carolina–New Jersey segment of the Atlantic Coastal Plain are shown on plate 1. Geologic data for wells in the key-well network are listed on well-data sheets in this report.

On these sheets, the wells in the network are identified in the manner described by Brown, Miller, and Swain (1972, p. 35–36) and by a record number. This number is an identifying number for the well data stored in the U.S. Geological Survey's computer record file which contains more complete geologic data for the well than given in this report. These data, in automated form are available upon written request to the Chief Hydrologist, U.S. Geological Survey, National Center, Reston, Va. 22092. The request should list the record numbers for the wells for which data are desired and should specify if the data are desired in the form of printed tables, magnetic tape, or punched cards. The original geophysical logs for the key wells used in the waste-reservoir study are available in the offices of the State Geologists in the States where the wells are located and in the U.S. Geological Survey Office, 3509 Haworth Dr., Raleigh, N.C. 27609.

Definition of the potential waste-reservoir environment (see preceding section) was followed by delineation of the environment in the wells available for study. Using a combination of lithologic, geophysical, and paleontologic data, a top and a thickness was established for Units F, G, and H in the wells that comprise the key-well network. In each well, the stratigraphic column for these units was evaluated in terms of the number of occurrences and thicknesses of the unit's sand, shale, and carbonate components. This evaluation was made by analysis of lithologic logs. The logs were constructed on the basis of microscopic examination of well cuttings and by construction of a "shale line" and a "sand line" on the Self Potential curve of electric logs and by analysis of Gamma-Ray curves of radioactivity logs. The thicknesses of sand and shale were scaled off the logs and were entered on the well-data sheets or computed as ratios and percentages. In a similar manner, the potential waste-reservoir environments were identified. Their number and the thickness of their component sand and shale parts were scaled off the logs and entered on the well-data sheets.

The entries on the well-data sheets consist of 20 categories of data that relate either to the depth of occurrence or thicknesses of the three geologic units, to the depth of occurrence or thickness of the unit's sand and shale components, or to useful combinations of these data. The 20 categories of data were used directly or were combined or averaged so as to derive quantitative geologic parameters that could be mapped or graphed to show the occurrence and distribution of potential waste-storage reservoirs in the study area.

For each of the three geologic units considered to have waste-storage potential, six maps were constructed as follows:

1. Averaged depth to the tops of the unit's potential waste-reservoir sands.

   A plot of the altitude of the top of the unit was contoured, using the minus 1,000-foot altitude (the projected maximum depth of freshwater occurrence), the minus 1,500-foot altitude (the projected minimum depth of saline-water occurrence), and 500-foot increments of altitude below minus 1,500 feet. The altitude of the top of each potential reservoir sand at a given control point was determined. These altitudes were then averaged, plotted, and contoured. The resulting regional map shows the contoured average depth for the tops of the unit's potential waste-reservoir sands superimposed on the contoured depth of the top of the unit.

2. Unit-thickness and sand thickness map.

   This map was constructed by obtaining values for the thickness of the unit at given control points and contouring these values on a regional base. In a similar manner, values for sand thickness were contoured. The resulting regional map shows total sand thickness superimposed on total unit thickness.

3. Map of thickness of potential waste-reservoir sand.

   The map was constructed by determining the thickness of each potential reservoir sand at a given control point, obtaining an average thickness value for the sand at that control point, and mapping the extent of the average thickness by means of six categories. The resulting map shows the relative thickness of potential waste-reservoir sand regionally.

4. Map showing the averaged thickness, per foot of potential waste-reservoir sand, for the shale seals that immediately overlie the reservoir sands.

   The map was constructed by calculating the ratio/thickness value, in feet, of overlying shale or clay seal per foot of reservoir sand for each potential waste-reservoir at each control point. These values were then averaged for each control point. The averaged value was assigned to one of four categories on an arbitrary thickness scale, and the extent of each

category was mapped on a regional base. The resulting regional map shows the relative thickness of the overlying shale or clay seal per foot of reservoir sand in areas where potential waste-reservoirs have been delineated.

5. Map showing the averaged thickness, per foot of reservoir sand, for the shale seals that immediately underlie the reservoir sands.

   The map was constructed in a manner similar to that described for map 4.

6. Map of Depth/Potential Reservoir factor.

   The map was constructed by calculating an averaged value for the depth to the tops of the potential waste-reservoir sands at a given control point and dividing this calculated average value by the total measured thickness of potential reservoir sand at the given control point. The resulting number, designated a Depth/Potential Reservoir factor and representing feet of overburden per foot of potential reservoir sand at a given control point, was assigned to one of six categories on an arbitrary footage scale. The scaled categories were then delineated on a regional base map. The resulting map shows the comparative thickness of overburden per foot of potential reservoir sand in areas where potential waste-storage reservoirs have been delineated.

For each of the three units considered to have waste-storage potential, graphs were prepared to supplement the data shown on the maps. The geologic parameters graphed, according to the percentage or to the number of wells in which they occur, are:

1. Ratio of unit's potential waste-reservoir sand thickness to unit's total sand thickness.
2. Ratio of unit's sand thickness to unit's shale thickness.
3. Number of potential waste-reservoir sands.
4. Maximum thickness of potential waste-reservoir sands.
5. Occurrence of potential waste-reservoir sands in upper third, middle third, and lower third of unit.

The various maps and graphs are discussed in the following section relative to their utility in defining potential waste reservoirs. In conjunction with other information, the discussions may serve as a geologic guide for future planning of waste-storage or other types of subsurface-storage facilities. They do not provide ultimate answers to questions about the possibility of waste storage in the reservoirs under consideration.

POROSITY AND PERMEABILITY

In evaluating potential waste-storage environments, two of the more important properties to be considered are a rock's effective porosity and permeability. The effective porosity of a rock is its volumetric percentage of connected voids. The permeability of a rock is a measure of the relative ease with which it transmits fluid through its interconnected pores. A magnitude for permeability, generally expressed in darcies or millidarcies, in waste-storage evaluation, is determined by the rate at which a fluid of standard viscosity moves through a given rock distance during a given interval of time. Permeability cannot exist in the absence of porosity, but porosity may exist in the absence of permeability.

The porosity and permeability requirements for rocks that have waste-reservoir and waste-reservoir seal potential, respectively, are relative. To have potential as a waste reservoir, a rock must be sufficiently porous and permeable to accept a given volume of waste at a given rate. To have potential as a waste-reservoir seal, a rock must be sufficiently low in permeability to either prevent or greatly retard the escape of waste from the reservoir. There are no generally assigned lower-limit values of porosity and permeability requirements for waste-storage reservoirs. There is no generally assigned upper-limit value of the permeability requirement for waste-reservoir seals.

However, in an analogous situation that is somewhat related to waste-storage environments, wherein reservoir rock and reservoir-seal rock constitute an aquifer gas-storage environment that involves a gas-liquid interface rather than a liquid-liquid interface, some limiting values for porosity and permeability have been published. Katz and Coats (1968, p. 56–57) considered that sandstone with porosity in excess of 10 percent and permeability in excess of 100 millidarcies (mD) is acceptable for gas storage. Katz and Coats (1968, p. 11) considered water-saturated caprock, such as shale, with porosity of 2–8 percent and permeability of from 10^{-4} to less than 10^{-6} millidarcy, to be acceptable for a gas-confining layer. These limiting values for porosity may be compared with the values given by Pettijohn (1957) for the average sandstone, 15–20 percent, and average shale, 13 percent.

In areas where potential waste-storage reservoirs are present in Units F, G, and H, the clastic rocks range from unconsolidated and loosely consolidated sand in the upper part of the sediment mass to well-consolidated sandstone in the more deeply buried parts of the mass. The clastic rocks with reservoir-seal potential range from clay and claystone in the upper part of the sediment mass, to their fissile counterpart, shale, in the more deeply buried parts of the mass.

Units F, G, and H have been sparsely tested where they contain saline water. Drill cuttings and a few random cores from only a few wells are available for study. These show that rocks with waste-storage potential in the upper part of the sediment mass are generally unconsolidated sand-clay mixtures, predominantly quartzose, containing illite and montmorillonite. Locally and where indurated, the interstitial cement in these mixtures consists of limonite, siderite, or calcite, and, less commonly, of dolomite or silica. (See Brown and others, 1972, pls. 23–58.)

From evaluation of limited core and geophysical-log data, the average porosity of the sand-clay mixtures is judged to be about 30–35 percent. Permeability values of the sand-clay mixtures, obtained from limited core and pumping-test data, range from less than 0.5 darcy to more than 200 darcies and are judged to average about 30 darcies. In contrast, the porosity and permeability of several sandstone cores, that may be representative of sandstone which occurs in the deeply buried parts of the sediment mass, are relatively low as shown by the core analyses in table 1. Evidently, the porosity and permeability of potential reservoir rocks decrease with depth of burial. The U.S. Geological Survey's Laboratory, Denver, Colo., provided the core analyses in table 1.

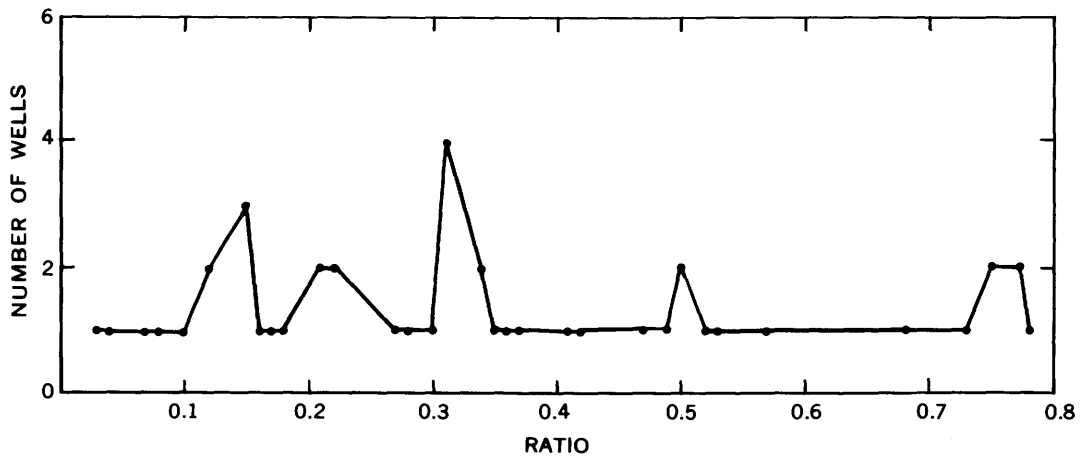
In regional studies of waste-storage potential, the measured thicknesses of sand and shale in well sections may be used indirectly to assess and compare relative-permeability variance in different areas. Thus, the ratio of the unit's potential reservoir sand thickness to the unit's total sand thickness indirectly denotes the relation between usable and available permeability in clastic sections. Also, the ratio of the unit's sand thickness to the unit's shale thickness indirectly denotes the relation between permeability and permeability-barrier potential in clastic sections considered for waste storage. These ratio values, calculated for sections cut in Units F, G, and H, are listed on the well-record sheets and are combined in figures 1*A–C* and 2*A–C*, respectively.

For any section, the greater the potential reservoir sand thickness relative to total sand thickness, the higher the ratio value and the greater the proportionate thickness of usable permeability in the clastic section. The ratio value is 1 if the total sand thickness comprises usable permeability, and 0.5 if one-half the total sand thickness comprises usable permeability. In figure 1*A–C*, the ratio values, calculated for sections in Units F, G, and H, are plotted according to number of well occurrences. In most wells where sands are present in Units F, G, and H,

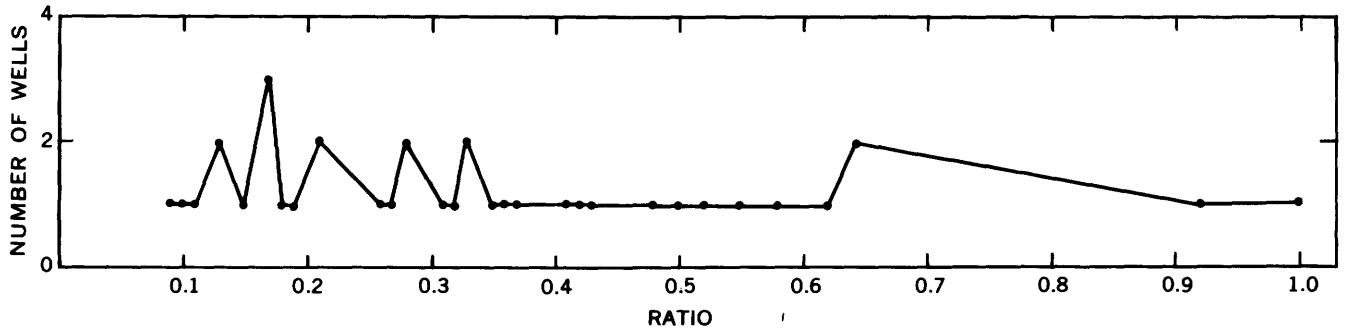
TABLE 1.—*Core analyses for Unit G, Standard Oil of New Jersey, Hatteras Light No. 1, Dare County, N.C. (NC–DA–OT–10)*

Core description	Depth (feet below mean sea level)	Specific gravity of solids	Total porosity (percent)	Effective porosity [1] (percent)	Pore pressures (psig) Input	Pore pressures (psig) Output	Confining pressure (psig)	Horizontal hydraulic conductivity (m/d)	Permeability (mD)
Limy sandstone. Quartz (65 percent), calcite (25 percent), sericite (5 percent), chlorite (2 percent), opaques (2 percent), feldspar (trace). Subrounded, well-sorted, medium fine sand grains and mica flakes cemented together by microcrystalline calcite. A few calcite fossil fragments, about 0.5 mm. Calcite is very dusky with fine inclusions. Poorly defined preferential orientation of mica flakes indicate bedding.	7,123–7,133	2.64	13.6	13.3	98 98	atm atm	2,000 2,000	3.7×10^{-5} 3.5×10^{-5}	0.04
Sandstone. Quartz (93 percent), chlorite (2 percent), feldspar (2 percent), calcite (1 percent), muscovite (1 percent), opaques (1 percent). Medium-fine-grained, well-sorted sandstone. Grains subangular to subrounded. Grains are very tightly packed; little apparent porosity. Rock uniform, without obvious bedding. Sparry calcite in small patches.	7,326–7,336	2.48	15.7	11.4	108 108	atm atm	1,700 1,700	1.1×10^{-6} 1.2×10^{-6}	.12
Sandstone. Quartz (85 percent), sericite (5 percent), biotite (+ chlorite) (5 percent), calcite (1–2 percent), opaques (1–2 percent). Well-sorted, tightly packed rock with minimal pore space. Clay-matrix-grains mostly in contact. Grains fairly well rounded. Very faint hint of bedding as shown by slight preferred orientation of micas.	7,705–7,715	2.61	16.5	15.8	103 103	atm atm	2,000 2,000	1.1×10^{-4} 1.0×10^{-4}	.13

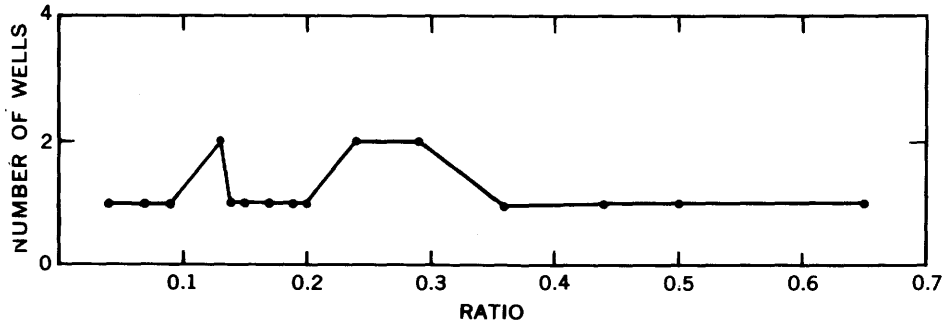
[1] Effectve porosity for pores having entrance diameters larger than 0.1 micron.



A. UNIT F (45 WELLS)



B. UNIT G (37 WELLS)



C. UNIT H (18 WELLS)

FIGURE 1.—Ratio of the unit's potential waste-reservoir sand thickness to unit's total sand thickness. *A*, Unit F. *B*, Unit G. *C*, Unit H.

Unit G has the greatest and Unit H has the least proportionate thickness of usable sand permeability for waste storage.

For any section, the greater the thickness of shale, relative to the thickness of sand, the lower the sand-shale ratio value and the greater the proportionate thickness of potential permeability-barrier zones in the section. For a section composed of half sand and half shale, the ratio value is 1 and the total thickness of permeability and permeability-barrier zones in sections considered for waste storage is equal. In Figure 2*A–C*, the ratio values, calculated for sections in Units F, G, and H, are plotted according to percentage of wells. For all the sections cut in Units F, G, and H, the permeability-barrier potential is greatest in Unit G's average section.

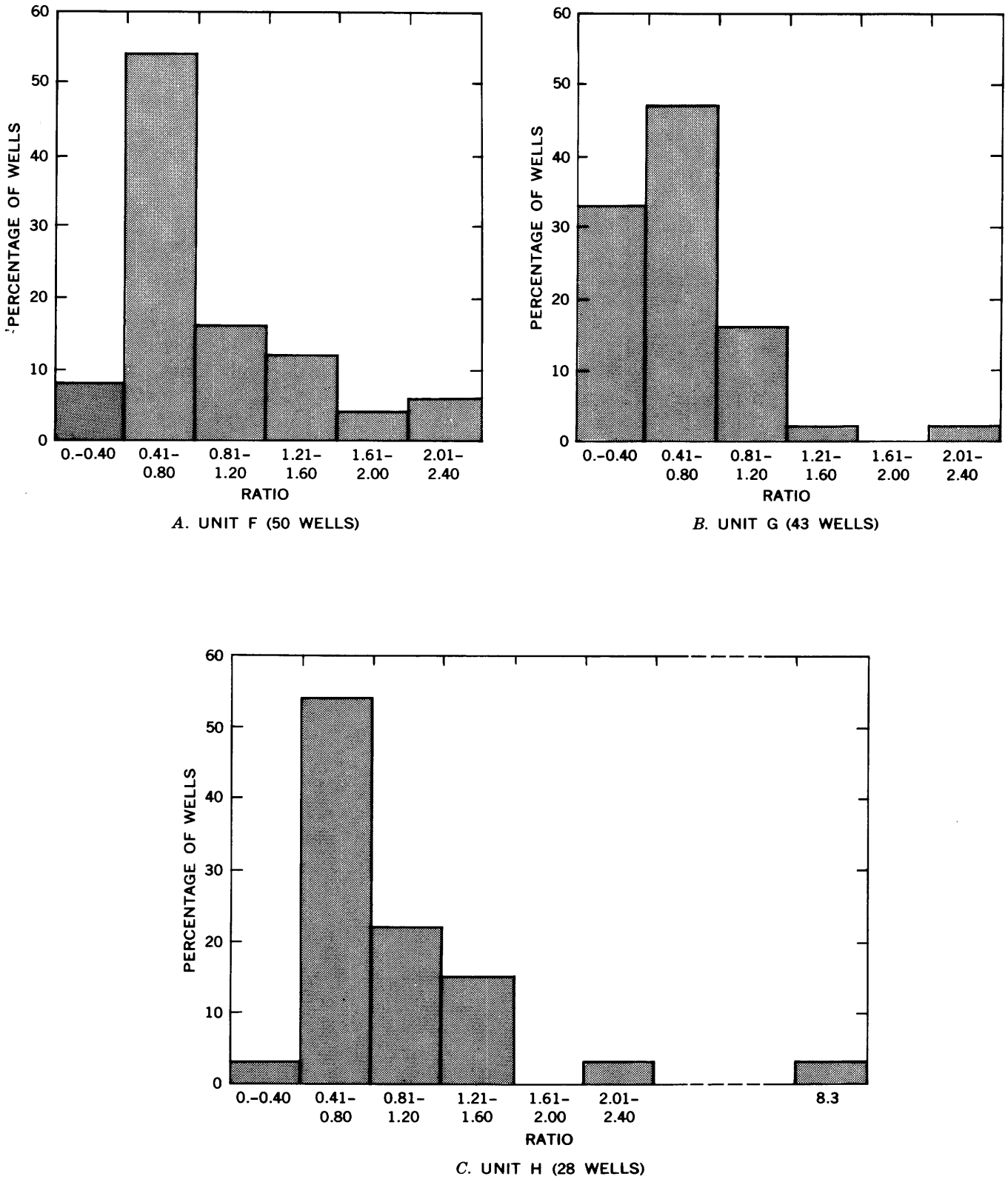


FIGURE 2.—Ratio of the unit's sand thickness to unit's shale thickness. *A*, Unit F. *B*, Unit G. *C*, Unit H.

Further generalization of the distribution of permeability in Units F, G, and H is not warranted from the available data.

DISCUSSION AND ANALYSIS OF MAPS AND CHARTS

Each waste-storage situation has its own geologic requirements and each potential waste-storage environment has its own local geology. Assessment of waste-storage potential must be made within a cost-risk-benefit framework. The assessment necessitates establishment of a mutually satisfying relation between the variable geologic requirements for waste storage and the variable geologic parameters of potential waste-storage environments.

Except in an individual case, the geologic requirements for waste storage cannot be predefined quantitatively, in terms of either minimum or optimum values of geologic parameters that may be used to delineate potential waste-storage environments. These parameters would include the depth of burial of an environment and the thickness and areal extent of its reservoir and reservoir-seal components. Also, within the cost-risk-benefit framework it is not possible to prejudge, positively or negatively, the relative importance that might be placed on any one geologic parameter for a waste-storage situation that might arise in the future. For example, the depth of burial of a potential waste-storage reservoir might constitute a prohibitive cost factor in one situation, whereas it might constitute a desirable safety factor in another situation. Similar correspondence may be established with respect to other geologic or geologically derived parameters inherent in the potential waste-storage environment and the relation they bear to geologic requirements for waste storage.

It is necessary to establish a mutually satisfying relation between the geologic requirements for waste storage and the geologic parameters of potential waste-storage environments. Since the geologic requirements for waste storage cannot be defined quantitatively, except perhaps in an individual case, it is appropriate to establish a quantitative range of values for the geologic parameters of the environments.

The selection of a set of geologic parameters having a range of values to show the distribution of potential waste-reservoir environments is based on an assessment of many physical-economic factors, but is dictated by the subsurface data that are available. In order to have waste-storage utility, the geologic parameters selected and as already given and the range of values established for them must be capable of providing for geologic definition in different waste-storage situations, most of which are not yet fully known.

For each of the three regional chronostratigraphic units (Units F, G, and H) judged to have waste-storage potential, six geohydrologic maps and five graphs were constructed, using the basic data tabulated on the well-data sheets for wells that comprise the key-well network. The maps and graphs depict a range of values for various combinations of geologic parameters that may be considered in assessing waste-storage potential. For any one unit, the maps and graphs should be considered collectively in assessing the unit's waste-storage potential. The maps and graphs for all three units may be considered in various combinations in a comparative or interunit assessment of waste-storage potential.

In a companion report (Brown and others, 1972) the external and internal geometry of Units F, G, and H was described and discussed in terms of the structural and tectonic events that controlled the sedimentary processes of deposition and erosion. That material supplements the brief interpretive analysis of the following maps and graphs constructed for each geologic unit in this report.

WASTE-STORAGE POTENTIAL OF GEOLOGIC UNITS

UNIT H—ROCKS OF CRETACEOUS AND LATE JURASSIC(?) AGE

The designated type-reference section for Unit H (Brown and others, 1972, p. 38, pl. 50) is a well section, 1,120 feet thick, in Pamlico Sound, Hyde County, N.C. (NC–HY–OT–11, pl. 1, Record No. 1151). The maximum thickness measured, 2,072 feet, is in a well in Worcester County, Md. (MD–WOR–OT–11, pl. 1, Record No. 3034).

In the area where the unit is judged to have waste-storage potential (pl. 2), its total thickness ranges from less than 100 to more than 2,200 feet, and its total sand thickness ranges from zero to more than 1,300 feet (pl. 2). The maximum sand thickness measured, 1,206 feet, is in a well in Cape May County, N.J. (NJ–CM–OT–1, pl. 1, Record No. 5000). For 31 wells in which Unit H is present, the percentage thickness of sand in a given section ranges from zero (NC–PAM–OT–9, pl. 1, Record No. 1122) to 100 (NC–CAR–OT–8, pl. 1, Record No. 1080) and averages 40. Thus, on the basis of

available well data, 40 percent of any clastic section that represents a complete thickness of Unit H might be expected to have some degree of storage potential.

The number of potential waste-storage reservoirs present in Unit H varies with location. Although layers of sand 20 feet or more in thickness are common in the unit, there is a deficiency of shale layers, 20 feet or more in thickness, in many sections cut through Unit H. In general, the absence of reservoirs in Unit H may be attributed to the absence of a required thickness of overlying or underlying shale rather than to the absence of a required thickness of sand.

The number of potential waste-reservoir sands that are present in Unit H, per well, is shown in figure 3*C*. No potential reservoir sands are present in 13 wells, or 41 percent of the wells in which the unit occurs. The maximum number of potential reservoir sands recognized in the unit, seven, are present in two wells (MD–WIC–OT–11, pl. 1, Record No. 3032 and MD–WOR–OT–10, pl. 1, Record No. 3033). In wells that comprise the key-well network and in which potential reservoir sands are present, one sand occurs more frequently than any other number.

The thickness of individual reservoir sands present in Unit H ranges from 20 feet (NC–CAR–OT–12, pl. 1, Record No. 1085) to 85 feet (MD–WOR–OT–10, pl. 1, Record No. 3033) and averages 35 feet. However, for the greatest number of wells in which Unit H is present and as shown in figure 4*C*, the maximum thickness of a potential reservoir sand is 20–29 feet. On the basis of available data (figs. 3*C* and 4*C*), an average of one or two reservoir sands, with each sand having a thickness of 35 feet, could be expected to occur in Unit H in areas where it is judged to have waste-storage potential.

In the individual wells in which Unit H is present, the total thickness of the unit's potential reservoir sand ranges from 20 feet (NC–CAR–OT–12, pl. 1, Record No. 1085) to 339 feet (MD–WOR–OT–10, pl. 1, Record No. 3033) and average 83 feet. Plate 3 is a regional map that shows the distribution of a range of values for the total thickness of potential waste-reservoir sand in Unit H. In general, the total thickness of such sand is greater beneath parts of Sussex County, Del., and beneath all or parts of Caroline, Dorchester, Talbot, Wicomico, and Worcester Counties, Md.

Plate 2 is a regional map on which the averaged depth to the top of the unit's potential waste-reservoir sands is shown by contours. Basic data used to construct the map were calculated for individual wells and are listed in the well-record sheets. For Unit H, this range in depth below sea level is from about 1,800 feet in York and Gloucester Counties, Va., to about 8,500 feet in the vicinity of Cape Hatteras, Dare County, N.C.

Data that supplement those presented on plate 2 are shown in figure 5*C*. In the 18 wells for which data are available, 26 percent of the unit's potential waste-reservoir sand occurs in its upper third, 39 percent in its middle third, and 35 percent in its lower third. These percentage values suggest that the middle third of the unit has the greatest waste-storage potential and the upper third the least potential.

For Unit H, the Depth/Potential Reservoir factor (feet of overburden per foot of potential waste-reservoir sand) ranges in value from a low of 15 (MD–WIC–OT–11, pl. 1, Record No. 3032) to a high of 429 (NC–DA–OT–10, pl. 1, Record No. 1153). Plate 4 is a regional map that shows the distribution and a range of values for the D/PR factor in the area where Unit H has waste-storage potential. Basic data used to construct the map were calculated for individual wells and are listed in the well-record sheets. As indicated by the spatial distribution of the values on the map, a D/PR factor with a value >100 is dominant within Unit H.

As defined in this report, a potential waste-storage environment consists of a relatively permeable reservoir sand, or sandstone, in direct contact, above and below, with a relatively impermeable clay or shale that serves as a reservoir seal. The reservoir-sealing capability of the shale depends, in part, on its total thickness and, in part, on its thickness relative to the thickness of the reservoir sand with which it is in contact. A total thickness for the shale that is in contact, above and below, with each reservoir sand delineated in Unit H is listed on the well-record sheets, together with a calculated thickness for feet of shale per foot of reservoir sand.

In the area where Unit H has waste-storage potential, a maximum thickness of 135 feet is recorded for a shale seal that immediately overlies a reservoir sand (NC–CUR–OT–13, pl. 1, Record No. 1250), and the maximum value calculated for the thickness of a shale seal per foot of underlying reservoir sand is about 6.8 feet in the same well. Within the potential waste-reservoir environments present in Unit H, the average thickness of overlying shale seals is about 41.6 feet and the average value for the

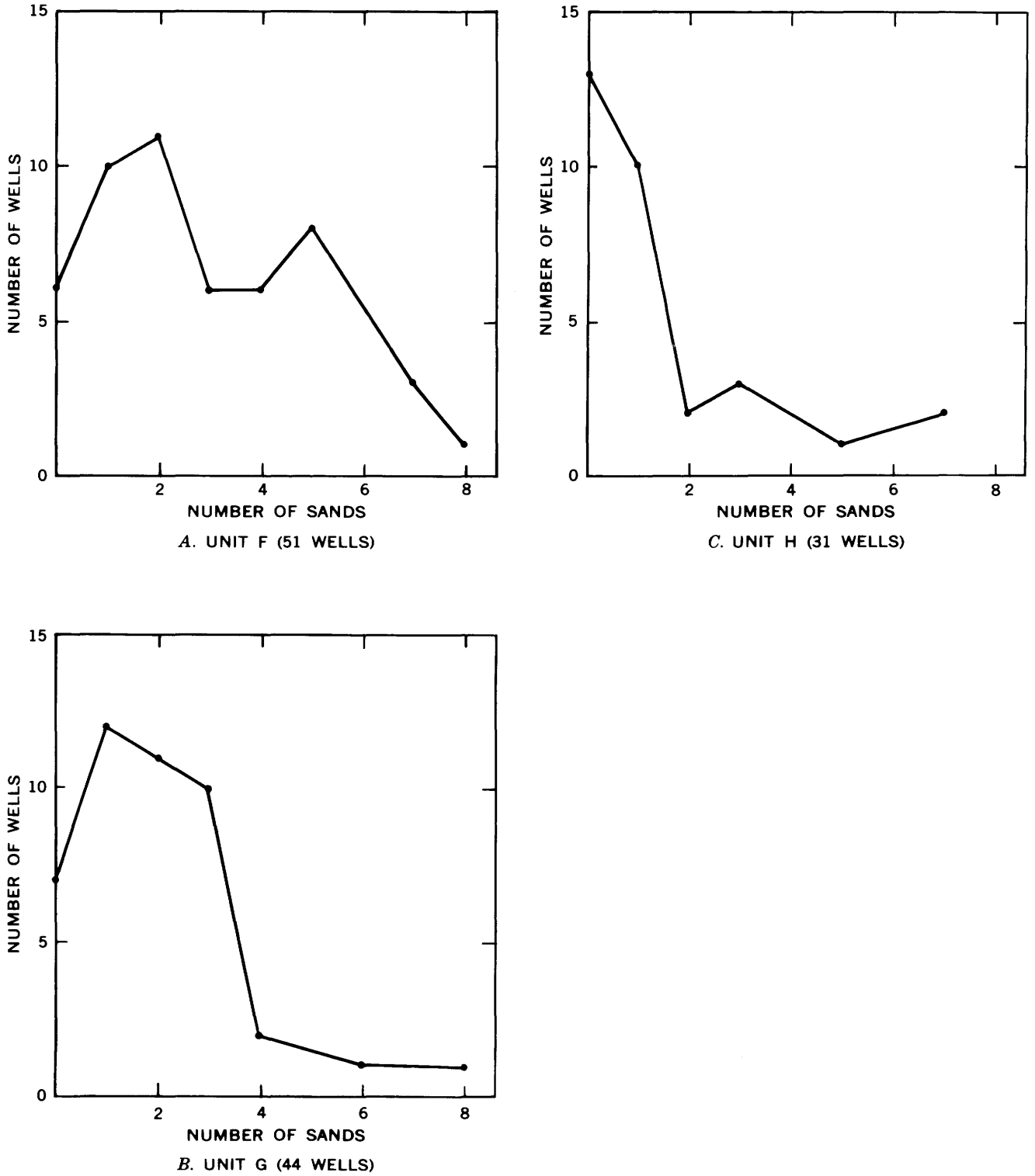


FIGURE 3.—Number of potential waste-reservoir sands occurring per well. *A*, Unit F. *B*, Unit G. *C*, Unit H.

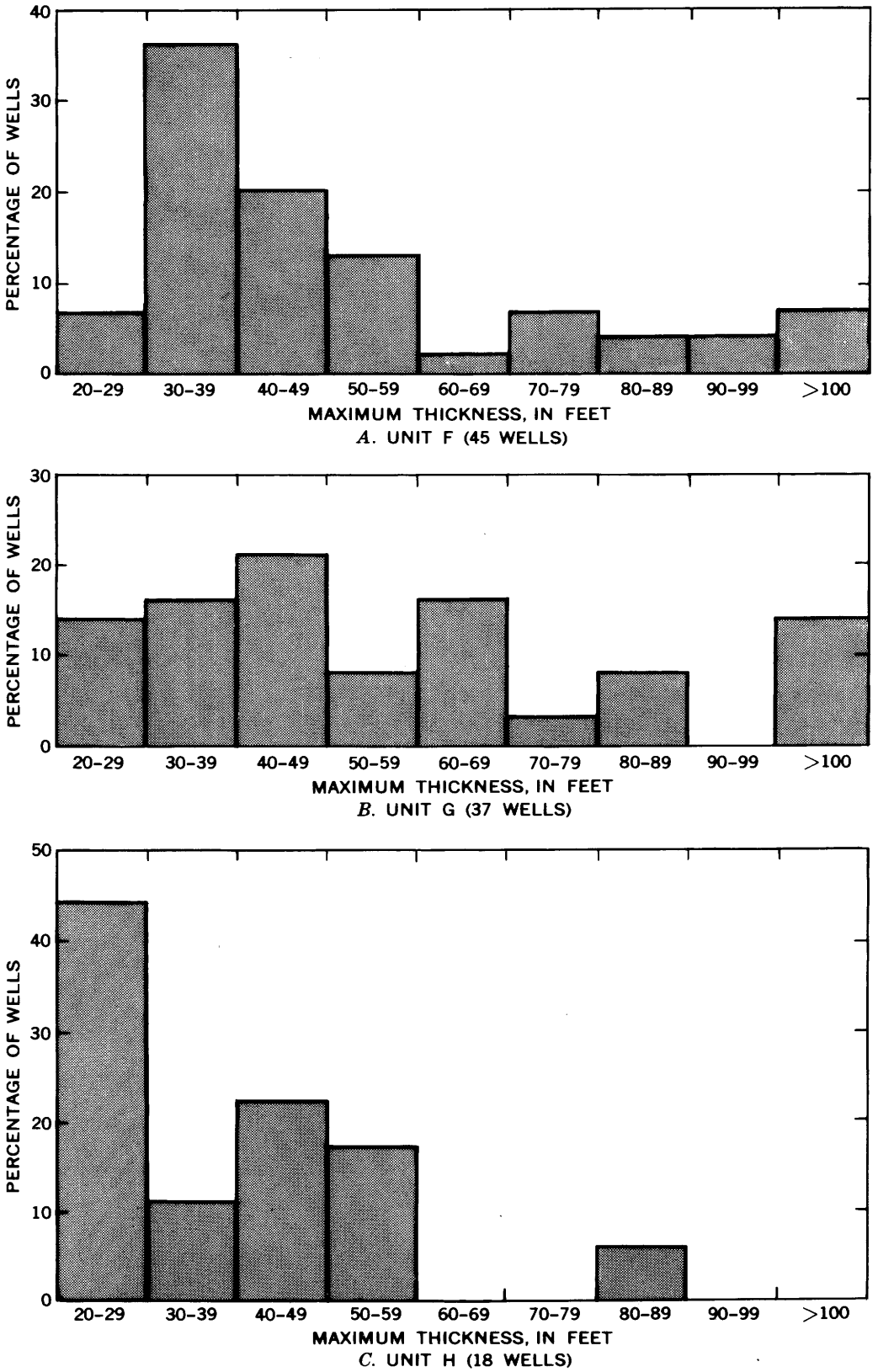


FIGURE 4.—Maximum thickness of potential waste-reservoir sands, according to percentage of wells. *A*, Unit F. *B*, Unit G. *C*, Unit H.

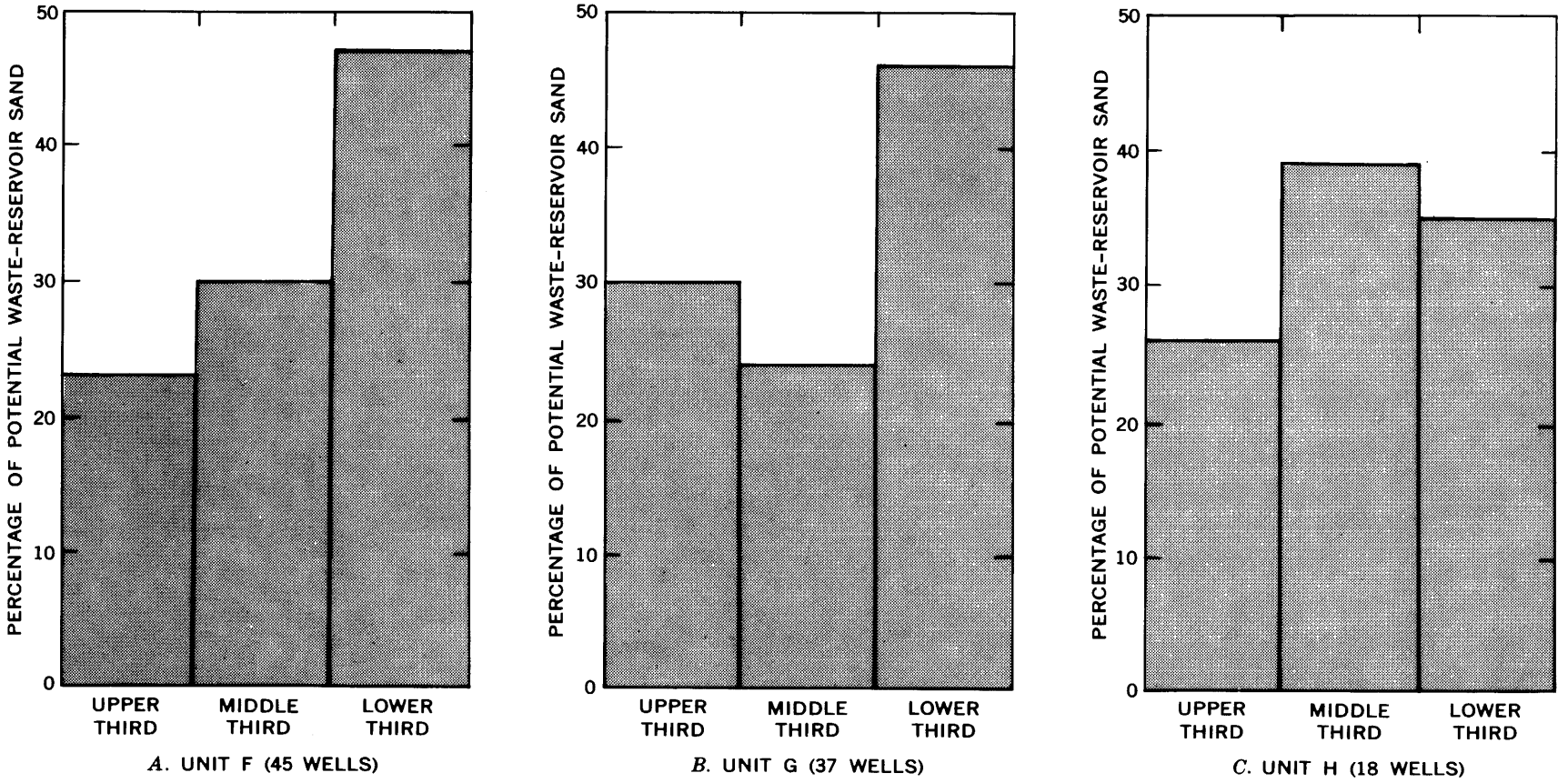


FIGURE 5.—Occurrence of potential waste-reservoir sands in percent, in upper third, middle third, and lower third of unit, according to percent well occurrence. *A*, Unit F. *B*, Unit G. *C*, Unit H.

calculated thickness of these shale seals per foot of reservoir sand is about 1.2 feet. Plate 3 is a regional map that shows the distribution of the averaged thickness (feet) per foot of potential waste-reservoir sand for the shale seals that immediately overlie the reservoir sands in Unit H. The scale of values ranges from less than 1 to more than 3 feet. The relative areal extent indicates that the dominant thickness is from 1.0 to 2.0 feet of shale per foot of reservoir sand. A maximum thickness of 95 feet is recorded for a shale seal that immediately underlies a reservoir sand (MD–WOR–OT–11, pl. 1, Record No. 3034), and the maximum value calculated for the thickness of a shale seal per foot of overlying reservoir sand is about 3.5 feet (NC–CUR–OT–12, pl. 1, Record No. 1240). In Unit H's potential waste-storage environments, the average thickness of underlying shale seals is about 38 feet and the average value for the calculated thickness of these shale seals per foot of reservoir sand is about 1.1 feet. Plate 4 is a regional map that shows the distribution of the averaged thickness (feet) per foot of potential reservoir sand for the shale seals that immediately underlie the reservoir sands in Unit H. The scale of values ranges from less than 1 to more than 3 feet. The dominant thickness is the one ranging from 1.0 to 2.0 feet of shale per foot of reservoir sand.

A summary of the data for Unit H is listed in table 2.

UNIT G—ROCKS OF CRETACEOUS AGE

The designated type-reference section for Unit G (Brown and others, 1972, p. 39, pl. 50) is a well section, 942 feet thick, in Carteret County, N.C. (NC–CAR–OT–5, pl. 1, Record No. 1090). The maximum thickness measured, 1,720 feet, is in a well in Pamlico Sound, Dare County, N.C. (NC–DA–OT–12, pl. 1, Record No. 1152).

In areas where Unit G is judged to have waste-storage potential (pl. 5), its total thickness ranges from less than 100 to more than 1,800 feet, and its total sand thickness ranges from less than 100 to about 685 feet (pl. 5). The maximum total sand thickness measured, 685 feet, is in a well in Dare County, N.C. (NC–DA–OT–10, pl. 1, Record No. 1153). In well sections in Unit G, the total proportionate thickness of sand occurring in any one section ranges from 17 percent (NJ–CU–OT–8, pl. 1, Record No. 5010) to 61 percent (NC–GA–OT–15, pl. 1, Record No. 1251) and averages 33 percent. Thus, based on available well data, 33 percent of any clastic section representing a complete thickness of Unit G might be expected to have some degree of storage potential.

The number of potential waste-storage reservoirs present in Unit G varies with location. In general, the absence of these reservoirs in Unit G, may be attributed to the absence of a required thickness of sand in the section rather than to the absence of required thicknesses of shale. The number of potential reservoir sands that occur in Unit G, per well, is shown in figure 3*B*. The unit contained no potential reservoir sands in seven wells, or 19 percent of the wells in which the unit is present. The maximum number of potential-reservoir sands recognized in Unit G, eight, occurs in only one well (NC–DA–OT–11, pl. 1, Record No. 1193). In wells that comprise the key-well network and in which potential reservoir sands are present, one sand occurs more frequently than any other number.

The thickness of individual reservoir sands present in Unit G ranges from 20 feet in several wells (NC–CAR–OT–12, pl. 1, Record No. 1085) to 165 feet (NC–DA–OT–12, pl. 1, Record No. 1152) and averages 43 feet. However, for the greatest number of wells in which Unit G is present and as shown in figure 4*B*, the maximum thickness of a potential reservoir sand is 40–49 feet. On the basis of available data (figures 3*B* and 4*B*), an average of two

TABLE 2.—*Summary of selected waste-storage data, Units F, G, and H*

Basic geologic-data elements associated with the waste-storage potential of Units F, G, and H	Unit F	Unit G	Unit H
Average number of potential waste-reservoir sands per well	2.8	2.0	1.4
Maximum thickness of potential waste-reservoir sand per well ft	185	295	339
Average thickness of potential waste-reservoir sand per well ft	122	100	83
Average thickness of individual sands with waste-storage potential ft	52	57	37
Average thickness of overlying shale seal per well ft	48.8	62.9	41.6
Average thickness of overlying shale seal per foot of potential waste-reservoir sand ft	1.3	1.5	1.2
Average thickness of underlying shale seal per well ft	47.3	57.1	38.1
Average thickness of underlying shale seal, per foot of potential waste-reservoir sand ft	1.2	1.3	1.1
Range for the average depth of unit's potential waste-reservoir sands ft	<1800 to >8500	<1700 to >7000	<1600 to >5900
Range in value for unit's D/PR factor (feet of overburden per foot of potential waste-reservoir sand) ft	15–429	15–147	7–291

reservoir sands, each sand having a thickness of 43 feet, could be expected to occur in Unit G in areas where it has waste-storage potential.

In the 37 individual wells in which Unit G is present, the total thickness of the unit's potential reservoir sand ranges from 20 feet in several wells (see, NC–CAM–OT–10, pl. 1, Record No. 1234) to 295 feet (NC–DA–OT–10, pl. 1, Record No. 1153) and averages 100 feet. Plate 6 is a regional map showing the distribution of the total thickness of potential waste-reservoir sand in Unit G. In general, the total thickness of such sand is greatest beneath parts of Pamlico Sound, N.C.

Plate 5 is a regional map on which the averaged depth to the top of the unit's potential waste-reservoir sands is shown by contours. Basic data used to construct the map were calculated for individual wells and are listed on the well-record sheets. For Unit G, this range in depth below sea level is from about 1,700 feet in Chesapeake Bay, adjacent to Mathews County, Va., to about 7,000 feet in Dare County, N.C.

Data that supplement those presented on plate 5 are shown in figure 5*B*. In the 37 wells for which data are available, 30 percent of the unit's potential reservoir sand occurs in its upper third, 24 percent in its middle third, and 46 percent in its lower third. These percentage values suggest that the lower third of the unit has the greatest waste-storage potential and the middle third the least such potential.

For Unit G, the Depth/Potential Reservoir factor (feet of overburden per foot of potential waste-reservoir sand) ranges in value from 15 (NC–DA–OT–11, pl. 1, Record No. 1193) to 147 (NC–TY–OT–4, pl. 1, Record No. 1371). Plate 7 is a regional map showing the distribution and a range of values for the D/PR factor in the area where Unit G has waste-storage potential. As indicated by the relative areal extent of the values on the map, a D/PR factor of less than 20 is dominant within Unit G.

A total thickness for the shale that immediately overlies and underlies each potential reservoir sand delineated in Unit G is listed on the well-record sheets, together with a value for the calculated thickness (feet) of shale per foot of reservoir sand.

In areas where Unit G is judged to have waste-storage potential, a maximum thickness of 350 feet is recorded for a shale that immediately overlies a reservoir sand (NC–CUR–OT–12, pl. 1, Record No. 1240), and the maximum value calculated for the thickness of a shale seal per foot of reservoir sand is about 11.7 feet in the same well. Within the potential waste-storage environments present in Unit G, the average thickness of overlying shale seals is about 62.9 feet and the average calculated thickness of these shale seals per foot of reservoir sand is about 1.5 feet. Plate 6 is a regional map that delineates the distribution of the averaged thickness (feet) per foot of potential reservoir sand for the shale seals that immediately overlie the reservoir sands in Unit G. The scale of values ranges from less than 1 to more than 3 feet. The relative areal extent of the values mapped indicates that the dominant thickness is from 1.0 to 2.0 feet of shale per foot of reservoir sand.

A maximum value of 350 feet is recorded for a shale seal that immediately underlies a reservoir sand (NC–CUR–OT–12, pl. 1, Record No. 1240), and the maximum value calculated for the thickness of a shale seal per foot of overlying reservoir sand is about 7.8 feet in the same well. For Unit G's potential waste-storage reservoirs, the average thickness of underlying shale seals is about 57.1 feet, and the average value for the calculated thickness of these shale seals per foot of reservoir sand is about 1.3 feet. Plate 7 is a regional map on which a distribution of the averaged thickness (feet) per foot of potential reservoir sand, for the shale seals that immediately underlie the reservoir sands in Unit G is shown by means of patterns for values ranging from less than 1 to more than 3 feet. As indicated by the relative areal extent of the value patterns mapped, the dominant pattern is one ranging from 1.0 to 2.0 feet of shale per foot of reservoir sand.

A summary of the data for Unit G is listed on table 2.

UNIT F—ROCKS OF CRETACEOUS AGE

The designated type-reference section for Unit F (Brown and others, 1972, p. 40, pl. 43) is a well section, 83 feet thick, in Halifax County, N.C. (NC–HAL–T–2, pl. 1, Record No. 1197). The maximum thickness measured, 1,267 feet, is in a well in Worcester County, Md. (MD–WOR–OT–10, pl. 1, Record No. 3033).

In areas where Unit F is judged to have waste-storage potential (pl. 8), its total thickness ranges from less than 300 to more than 1,200 feet, and its total sand thickness ranges from less than 100 to more than 800 feet (pl. 8). The maximum total sand thickness measured, 876 feet, is in a well in Dare County, N.C. (NC–TY–OT–3, pl. 1, Record No. 1370). In well sections in Unit F, the total propor-

tionate thickness of sand occurring in any one section ranges from about 20 percent (MD–QA–T–15, pl. 1, Record No. 3129) to 94 percent (NC–TY–OT–3, pl. 1, Record No. 1370) and averages 43 percent. Thus, on the basis of available well data, 43 percent of any clastic section representing a complete thickness of Unit F might be expected to have some degree of storage potential.

The number of potential waste-storage reservoirs present in Unit F varies with location. In general, the absence of these reservoirs in Unit F may be attributed to the absence of a required thickness of overlying or underlying shale rather than to the absence of a required thickness of sand. The number of potential reservoir sands that occur in Unit F, per well, is shown in figure 3*A*. The unit contained no potential reservoir sands in five wells, or 11 percent of the wells in which the unit is present. The maximum number of potential-reservoir sands recognized in Unit F, eight, occurs in only one well (MD–WOR–OT–10, pl. 1, Record No. 3033). In wells that comprise the key-well network and in which potential reservoir sands are present, two sands occur more frequently than any other number.

The thickness of individual reservoir sands in Unit F ranges from 20 feet in several wells (see, NC–DA–OT–10, pl. 1, Record No. 1153) to 185 feet (MD–WOR–OT–11, pl. 1, Record No. 3034) and averages 38 feet. However, for the greatest number of wells in which Unit F is present and as shown in figure 4*A*, the maximum thickness of a potential-reservoir sand is 30–39 feet. On the basis of available data (figures 3*A* and 4*A*), an average of about three reservoir sands, each sand having a thickness of 38 feet, could be expected to occur in Unit F in areas where it has waste-storage potential.

In the 45 individual wells in which Unit F is present, the total thickness of the unit's potential-reservoir sand ranges from 20 feet (NC–DA–OT–10, pl. 1, Record No. 1153) to 510 feet (NC–HY–OT–11, pl. 1, Record No. 1151) and averages 122 feet. Plate 9 is a regional map showing the distribution of the total thickness of potential waste-reservoir sand in Unit F. In general, the total thickness of such sand is greater beneath parts of Pamlico Sound and contiguous areas in North Carolina and beneath parts of Worcester County, Md., and Sussex County, Del.

Plate 8 is a regional map on which the averaged depth to the top of the unit's potential waste-reservoir sands is shown by contours. Basic data used to construct the map were calculated for individual wells and are listed on the well-record sheets. For Unit F, this range in depth below sea level is from about 1,600 feet in Kent County, Del., to about 5,900 feet in Dare County, N.C.

Data that supplement those presented on plate 8 are shown in figure 5*A*. In the 45 wells for which data are available, 23 percent of the unit's potential waste-reservoir sand occurs in its upper third, 30 percent in its middle third, and 47 percent in its lower third. Assuming uniform porosity and permeability, these percentage values suggest that the lower third of the unit has the greatest waste-storage potential and the upper third the least such potential for a given unit thickness.

For Unit F, the Depth/Potential Reservoir factor (feet of overburden per foot of potential waste-reservoir sand) ranges in value from 7 (MD–WOR–OT–11, pl. 1, Record No. 3034) to 291 (NC–DA–OT–10, pl. 1, Record No. 1153). Plate 10 is a regional map that shows the distribution and a range of values for the D/PR factor in the area where Unit F has waste-storage potential. As indicated by the relative areal extent of the value patterns on the map, a D/PR factor ranging in value from 20 to 40 is dominant within Unit F.

A total thickness for the shale that immediately overlies and underlies each potential reservoir sand delineated in Unit F is listed on the well-record sheets, together with a value for the calculated thickness (feet) of shale per foot of reservoir sand.

In areas where Unit F is judged to have waste-storage potential, a maximum thickness of 270 feet is recorded for a shale that immediately overlies a reservoir sand (NC–DA–OT–12, pl. 1, Record No. 1152). The maximum value calculated for the thickness of a shale seal per foot of reservoir sand in the same well is 9 feet. Within the potential waste-storage environments present in Unit F, the average thickness of overlying shale seals is about 48.7 feet, and the average value for the calculated thickness of these shale seals per foot of reservoir sand is about 1.3 feet. Plate 9 shows the regional distribution of the averaged thickness (feet) per foot of potential waste-reservoir sand for the shale seals that immediately overlie the reservoir sands in Unit F. The scale of values ranges from less than 1 to more than 3 feet. The relative areal extent of the values indicates that the dominant thickness is from 1.0 to 2.0 feet of shale per foot of potential reservoir sand. A maximum thickness of 270 feet is recorded for a shale seal that immediately underlies a reservoir sand (NC–DA–OT–12, pl. 1, Record No. 1152),

and the maximum value calculated for the thickness of a shale seal per foot of reservoir sand is about 6.8 feet in the same well. In Unit F's potential waste-storage environments, the average thickness of underlying shale seals is about 47.3 feet, and the average value for the calculated thickness of these shale seals per foot of reservoir sand is about 1.2 feet. Plate 10 shows the distribution of the averaged thickness (feet) per foot of potential reservoir sand for the shale seals that immediately underlie the reservoir sands in Unit F. As indicated by the relative areal extent of the patterns mapped, the dominant value is the one ranging from 1.0 to 2.0 feet of shale per foot of reservoir sand.

A summary of the data for Unit F is listed in table 2.

SUMMARY

The subsurface data derived from the study of well cuttings and geophysical logs of scattered boreholes were used to select an environment having the geologic requirements for waste storage. The environment is defined as follows:

A sand or sandstone layer, 20 feet or greater in thickness, that is directly overlain and underlain by a shale layer, 20 feet or greater in thickness, and which occurs in Units F, G, or H, in areas where the top of each of these units lies at a depth greater than 1,500 feet below mean sea level.

By definition, the environment contains relatively porous and permeable rock (reservoir rock, sand or sandstone) that is directly overlain and underlain by relatively impermeable rock (reservoir-seal rock, shale or clay). The distribution of the environment in the regional sediment mass (pls. 2–19) is shown, indirectly, by means of mappable geologic parameters that show the distribution of the reservoir and reservoir-seal components of the environment and their interrelationship.

The geologic parameters mapped for each of the geologic units judged to have waste-storage potential include:

1. Unit thickness and sand thickness.
2. Averaged depth to the tops of the unit's potential waste-reservoir sand.
3. Thickness of potential waste-reservoir sand.
4. Thickness of overlying shale per foot of potential waste-reservoir sand.
5. Thickness of underlying shale per foot of potential waste-reservoir sand.
6. Overburden thickness per foot of potential waste-reservoir sand.

The maps and other data make available to management a range of values for the geologic parameters that define waste-storage environments. The maps may be used, within a cost-risk-benefit framework, to assess the relative waste-storage potential of different parts of the sediment mass and to select, for detailed drilling, the areas which seem to be favorable.

The criteria and techniques presented in this report may, with only slight modification, be used as guidelines for defining and delineating waste-storage environments in other geographic areas. Also, they may be used to delineate other types of sedimentary environments in the subsurface that have economic potential.

REFERENCES

Brown, P. M., Miller, J. A., and Swain, F. M., 1972, Structural and stratigraphic framework, and spatial distribution of permeability of the Atlantic Coastal Plain, North Carolina to New York: U.S. Geol. Survey Prof. Paper 796, 79 p., 59 pl.

Cook, T. D., ed., 1972, Underground waste management and environmental implications, Symposium Proc.: Am. Assoc. Petroleum Geologists Mem. 18, 412 p.

Galley, J. E., ed., 1968, Subsurface disposal in geologic basins—A study of reservoir strata: Am. Assoc. Petroleum Geologists Mem. 10, 253 p.

Katz, D. L., and Coats, K. H., 1968, Underground storage of fluids: Ulrich's Books, Inc., Ann Arbor, Mich., 575 p.

Katz, D. L., Tek, M. R., Coats, K. H., Katz, M. L., Jones, S. C., and Miller, M. C., 1963, Movement of underground water in contact with natural gas: New York, N.Y., Am. Gas Assoc., Monograph for Michigan Univ. Project No.–31, 323 p.

Pettijohn, F. J., 1957, Sedimentary rocks [2d ed.]: New York, Harper and Brothers, 718 p.

Rima, D. R., Chase, E. B., and Myers, B. M., 1971, Subsurface waste disposal by means of wells—a selective annotated bibliography: U.S. Geol. Survey Water-Supply Paper 2020, 305 p.

Russell, W. L., 1960, Principles of petroleum geology: New York, McGraw-Hill Book Co., 490 p.

Witherspoon, P. A., Javandel, I., Neuman, S. P., and Freeze, R. A., 1967, Interpretation of aquifer gas storage conditions from water pumping tests: Am. Gas Assoc., Monograph for Univ. Calif. Project No. NS–38, 273 p.

Young, Addison, and Galley, J. E., eds., 1965, Fluids in subsurface environments—A symposium: Am. Assoc. Petroleum Geologists Mem. 4, 414 p.

BASIC DATA

Well No.: NC-CAR-OT-7

Record No.: 1035
State: North Carolina
County: Carteret

Well name: Coastal Plains, Huntley Davis No. 1
Latitude: 344350
Longitude: 0763430

Depth of well____ft____4,965
Depth of well (SLD)____ft____4,945
Elevation of measuring point above ground level____ft____12
Elevation of ground level____ft____8

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—3,195	—3,670	—4,600
Thickness of unit (feet)	475	930	338
Unit's total sand thickness (feet/percent)	155/33	250/27	250/74
Unit's total shale thickness (feet/percent)	300/63	380/41	30/9
Unit's sand-shale ratio	0.5	0.7	8.3
Number of potential reservoir sands in unit	3	0	0
Total thickness (feet) of unit's potential reservoir sands	80	----------	----------
Average thickness (feet) of unit's potential reservoir sands	27	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	40	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.17	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.52	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	26–20–140 90–40–20 80–20–90	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.30:1:7.00 2.25:1:0.50 4.00:1:4.50	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	3,410	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	3,650	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	3,526	----------	----------
Percent of potential reservoir sand in upper third of unit	0	----------	----------
Percent of potential reservoir sand in middle third of unit	24	----------	----------
Percent of potential reservoir sand in lower third of unit	76	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	42	None	None

Geophysical logs: Electric, Gamma

Well No.: NC-CR-OT-30

Record No.: 1071
State: North Carolina
County: Craven

Well Name: Carolina Pet. Co., Bryan No. 1
Latitude: 345055
Longitude: 0765745

Depth of well____ft____2,435
Depth of well (SLD)____ft____2,394
Elevation of measuring point above ground level____ft____9
Elevation of ground level____ft____32

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,069	Absent	Absent
Thickness of unit (feet)	300	----------	----------
Unit's total sand thickness (feet/percent)	120/40	----------	----------
Unit's total shale thickness (feet/percent)	180/60	----------	----------
Unit's sand-shale ratio	0.7	----------	----------
Number of potential reservoir sands in unit	2	----------	----------
Total thickness (feet) of unit's potential reservoir sands	90	----------	----------
Average thickness (feet) of unit's potential reservoir sands	45	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	70	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.30	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.75	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	60–70–60 30–20–60	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.86:1:0.86 1.50:1:3.00	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,129	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	2,254	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	2,191	----------	----------
Percent of potential reservoir sand in upper third of unit	0	----------	----------
Percent of potential reservoir sand in middle third of unit	78	----------	----------
Percent of potential reservoir sand in lower third of unit	22	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	24	----------	----------

Geophysical logs: Electric

Well No.: NC-CAR-OT-8

Record No.: 1080
State: North Carolina
County: Carteret

Well Name: F. L. Karston, Laughton No. 1
Latitude: 344540
Longitude: 0764330

Depth of well____ft____4,044
Depth of well (SLD)____ft____4,025
Elevation of measuring point above ground level____ft____9
Elevation of ground level____ft____10

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,711	—3,214	—3,931
Thickness of unit (feet)	503	717	80
Unit's total sand thickness (feet/percent)	288/57	300/42	80/100
Unit's total shale thickness (feet/percent)	215/43	362/50	0
Unit's sand-shale ratio	1.3	0.9	∞
Number of potential reservoir sands in unit	5	1	0
Total thickness (feet) of unit's potential reservoir sands	210	85	----------
Average thickness (feet) of unit's potential reservoir sands	42	85	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	80	85	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.41	0.19	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.73	0.28	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	55–30–40 45–40–55 20–25–25 50–35–20 25–80–50	50–85–175	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.83:1:1.33 1.13:1:1.38 0.80:1:1.00 1.43:1:0.57 0.31:1:0.63	0.59:1:2.06	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,811	3,736	----------
Depth to top of lowermost potential reservoir sand (SLD)	3,141	3,736	----------
Average depth to top of unit's potential reservoir sand (SLD)	2,979	3,736	----------
Percent of potential reservoir sand in upper third of unit	14	0	----------
Percent of potential reservoir sand in middle third of unit	48	0	----------
Percent of potential reservoir sand in lower third of unit	38	100	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	14	44	None

Geophysical logs: Electric

Well No.: NC-CAR-OT-9

Record No.: 1082
State: North Carolina
County: Carteret

Well name: Carolina Pet. Co., Phillips No. 1
Latitude: 345850
Longitude: 0763900

Depth of well____ft____3,964
Depth of well (SLD)____ft____3,952
Elevation of measuring point above ground level____ft____7
Elevation of ground level____ft____5

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,593	—3,173	—3,701
Thickness of unit (feet)	580	528	232
Unit's total sand thickness (feet/percent)	205/35	195/37	80/35
Unit's total shale thickness (feet/percent)	375/65	323/61	142/61
Unit's sand-shale ratio	0.6	0.6	0.6
Number of potential reservoir sands in unit	2	1	0
Total thickness (feet) of unit's potential reservoir sands	55	37	----------
Average thickness (feet) of unit's potential reservoir sands	28	37	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	30	37	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.09	0.07	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.27	0.19	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	45–25–50 60–30–60	115–37–38	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.80:1:2.00 2.00:1:2.00	3.11:1:1.03	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,948	3,348	----------
Depth to top of lowermost potential reservoir sand (SLD)	3,146	3,348	----------
Average depth to top of unit's potential reservoir sand (SLD)	3,047	3,348	----------
Percent of potential reservoir sand in upper third of unit	0	0	----------
Percent of potential reservoir sand in middle third of unit	55	100	----------
Percent of potential reservoir sand in lower third of unit	45	0	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	55	90	None

Geophysical logs: Electric

Well No.: NC-CAR-OT-11

Record No.: 1084
State: North Carolina
County: Carteret

Well name: Carolina Pet. Co., G. Carroway No. 1
Latitude: 345705
Longitude: 0763830

Depth of well____ft____4,069
Depth of well (SLD)____ft____4,053
Elevation of measuring point above ground level____ft____8
Elevation of ground level____ft____8

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,642	—3,249	—3,798
Thickness of unit (feet)	607	549	246
Unit's total sand thickness (feet/percent)	192/32	120/22	141/57
Unit's total shale thickness (feet/percent)	415/68	369/67	95/39
Unit's sand-shale ratio	0.5	0.3	1.5
Number of potential reservoir sands in unit	1	1	0
Total thickness (feet) of unit's potential reservoir sands	30	66	----------
Average thickness (feet) of unit's potential reservoir sands	30	66	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	30	66	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.05	0.12	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.16	0.55	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	80–30–110	30–66–20	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	2.67:1:3.67	0.45:1:0.30	----------
Depth to top of uppermost potential reservoir sand (SLD)	3,122	3,732	----------
Depth to top of lowermost potential reservoir sand (SLD)	3,122	3,732	----------
Average depth to top of unit's potential reservoir sand (SLD)	3,122	3,732	----------
Percent of potential reservoir sand in upper third of unit	0	0	----------
Percent of potential reservoir sand in middle third of unit	0	0	----------
Percent of potential reservoir sand in lower third of unit	100	100	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	104	57	None

Geophysical logs: Electric

Well No.: NC-CAR-OT-12

Record No.: 1085
State: North Carolina
County: Carteret

Well name: Carolina Pet. Co., Wallace No. 1
Latitude: 345845
Longitude: 0763800

Depth of well____ft____4,024
Depth of well (SLD)____ft____4,011
Elevation of measuring point above ground level____ft____9
Elevation of ground level____ft____4

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,601	—3,209	—3,759
Thickness of unit (feet)	608	550	246
Unit's total sand thickness (feet/percent)	225/37	I90/34	100/41
Unit's total shale thickness (feet/percent)	383/63	350/64	146/59
Unit's sand-shale ratio	0.6	0.5	0.7
Number of potential reservoir sands in unit	5	2	1
Total thickness (feet) of unit's potential reservoir sands	168	63	20
Average thickness (feet) of unit's potential reservoir sands	34	32	20
Maximum thickness (feet) of a potential reservoir sand layer in unit	55	43	20
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.28	0.11	0.08
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.75	0.33	0.20
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	50–27–40 40–55–70 70–30–75 20–22–35 45–34–22	20–20–70 110–43–20	20–20–35
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.85:1:1.48 0.73:1:1.27 2.33:1:2.50 0.91:1:1.59 1.32:1:0.65	1.00:1:3.50 2.56:1:0.47	1.00:1:1.75
Depth to top of uppermost potential reservoir sand (SLD)	2,727	3,382	3,965
Depth to top of lowermost potential reservoir sand (SLD)	3,177	3,627	3,965
Average depth to top of unit's potential reservoir sand (SLD)	2,961	3,505	3,965
Percent of potential reservoir sand in upper third of unit	15	68	0
Percent of potential reservoir sand in middle third of unit	31	0	0
Percent of potential reservoir sand in lower third of unit	54	32	100
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	18	56	198

Geophysical logs: Electric

Well No.: NC-CAR-OT-6

Record No.: 1086
State: North Carolina
County: Carteret

Well name: Coastal Plains, Yeatman No. 1
Latitude: 345430
Longitude: 0763730

Depth of well____ft____4,096
Depth of well (SLD)____ft____4,076
Elevation of measuring point above ground level____ft____10
Elevation of ground level____ft____10

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,750	—3,295	—3,990
Thickness of unit (feet)	545	695	>86
Unit's total sand thickness (feet/percent)	200/37	220/32	----------
Unit's total shale thickness (feet/percent)	345/63	385/55	----------
Unit's sand-shale ratio	0.6	0.6	----------
Number of potential reservoir sands in unit	5	1	----------
Total thickness (feet) of unit's potential reservoir sands	120	60	----------
Average thickness (feet) of unit's potential reservoir sands	25	60	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	30	60	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.22	0.08	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.68	0.27	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	95–20–90 90–30–40 35–20–85 85–20–60 60–30–42	35–60–42	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	4.75:1:4.50 3.00:1:1.33 1.75:1:4.25 4.25:1:3.00 2.00:1:1.40	0.58:1:0.70	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,840	3,920	----------
Depth to top of lowermost potential reservoir sand (SLD)	3,270	3,920	----------
Average depth to top of unit's potential reservoir sand (SLD)	3,046	3,920	----------
Percent of potential reservoir sand in upper third of unit	42	0	----------
Percent of potential reservoir sand in middle third of unit	17	0	----------
Percent of potential reservoir sand in lower third of unit	41	100	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	25	65	----------

Geophysical logs: Electric

Well No.: NC-CAR-OT-5

Record No.: 1090
State: North Carolina
County: Carteret

Well name: Coastal Plains, Bayland No. 1
Latitude: 345355
Longitude: 0762200

Depth of well____ft____5,609
Depth of well (SLD)____ft____5,591
Elevation of measuring point above ground level____ft____12
Elevation of ground level____ft____6

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—3,334	—4,092	—5,034
Thickness of unit (feet)	758	942	519
Unit's total sand thickness (feet/percent)	328/43	252/27	145/28
Unit's total shale thickness (feet/percent)	345/46	580/61	286/55
Unit's sand-shale ratio	1.0	0.4	0.5
Number of potential reservoir sands in unit	2	3	1
Total thickness (feet) of unit's potential reservoir sands	120	125	35
Average thickness (feet) of unit's potential reservoir sands	60	41	35
Maximum thickness (feet) of a potential reservoir sand layer in unit	90	80	35
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.16	0.13	0.07
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.37	0.50	0.24
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	30–30–25 25–90–40	85–80–25 50–20–30 30–25–20	70–35–20
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.00:1:0.83 0.28:1:0.44	1.06:1:0.31 2.50:1:1.50 1.20:1:0.80	2.00:1:0.57
Depth to top of uppermost potential reservoir sand (SLD)	3,802	4,512	5,444
Depth to top of lowermost potential reservoir sand (SLD)	3,912	4,952	5,444
Average depth to top of unit's potential reservoir sand (SLD)	3,857	4,679	5,444
Percent of potential reservoir sand in upper third of unit	0	0	0
Percent of potential reservoir sand in middle third of unit	0	36	0
Percent of potential reservoir sand in lower third of unit	100	64	100
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	32	37	156

Geophysical logs: Electric

Well No.: NC-PAM-OT-3

Record No.: 1121
State: North Carolina
County: Pamlico

Well name: Carolina Pet., Atlas Plywood No. 1
Latitude: 350515
Longitude: 0764035

Depth of well____ft____3,425
Depth of well (SLD)____ft____3,408
Elevation of measuring point above ground level____ft____9
Elevation of ground level____ft____8

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,353	—2,981	Absent
Thickness of unit (feet)	628	424	----------
Unit's total sand thickness (feet/percent)	225/36	155/37	----------
Unit's total shale thickness (feet/percent)	403/64	229/54	----------
Unit's sand-shale ratio	0.6	0.7	----------
Number of potential reservoir sands in unit	1	2	----------
Total thickness (feet) of unit's potential reservoir sands	32	55	----------
Average thickness (feet) of unit's potential reservoir sands	32	28	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	32	30	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.06	0.13	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.17	0.35	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	40–32–90	25–25–25 25–30–20	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.25:1:2.81	1.00:1:1.00 0.83:1:0.66	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,793	3,223	----------
Depth to top of lowermost potential reservoir sand (SLD)	2,793	3,278	----------
Average depth to top of unit's potential reservoir sand (SLD)	2,793	3,251	----------
Percent of potential reservoir sand in upper third of unit	0	0	----------
Percent of potential reservoir sand in middle third of unit	0	55	----------
Percent of potential reservoir sand in lower third of unit	100	45	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	87	59	----------

Geophysical logs: Electric

Well No.: NC-PAM-OT-9

Record No.: 1122
State: North Carolina
County: Pamlico

Well name: Carolina Pet., N.C. Pulpwood No. 1
Latitude: 350435
Longitude: 0763900

Depth of well____ft____3,666
Depth of well (SLD)____ft____3,654
Elevation of measuring point above ground level____ft____8
Elevation of ground level____ft____4

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,461	—3,083	—3,564
Thickness of unit (feet)	622	481	84
Unit's total sand thickness (feet/percent)	155/25	175/36	0
Unit's total shale thickness (feet/percent)	457/73	276/58	84/100
Unit's sand-shale ratio	0.3	0.6	0
Number of potential reservoir sands in unit	4	2	0
Total thickness (feet) of unit's potential reservoir sands	120	65	----------
Average thickness (feet) of unit's potential reservoir sands	30	33	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	35	35	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.19	0.14	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.77	0.37	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	35–35–55 90–30–30 32–30–55 55–25–155	20–30–80 80–35–20	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.00:1:1.57 3.00:1:1.00 1.07:1:1.83 2.20:1:6.20	0.67:1:2.67 2.29:1:0.57	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,638	3,238	----------
Depth to top of lowermost potential reservoir sand (SLD)	3,038	3,358	----------
Average depth to top of unit's potential reservoir sand (SLD)	2,813	3,285	----------
Percent of potential reservoir sand in upper third of unit	21	0	----------
Percent of potential reservoir sand in middle third of unit	25	100	----------
Percent of potential reservoir sand in lower third of unit	54	0	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	23	51	None

Geophysical logs: Electric

Well No.: NC-HY-OT-6

Record No.: 1150
State: North Carolina
County: Hyde

Well name: E. F. Blair & Assoc., Ballance No. 1
Latitude: 352725
Longitude: 0760150

Depth of well____ft____5,570
Depth of well (SLD)____ft____5,560
Elevation of measuring point above ground level____ft____8
Elevation of ground level____ft____2

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—3,125	—3,920	—4,910
Thickness of unit (feet)	795	990	>650
Unit's total sand thickness (feet/percent)	465/59	265/27	----------
Unit's total shale thickness (feet/percent)	280/35	675/68	----------
Unit's sand-shale ratio	1.7	0.4	----------
Number of potential reservoir sands in unit	5	3	----------
Total thickness (feet) of unit's potential reservoir sands	232	245	----------
Average thickness (feet) of unit's potential reservoir sands	46	81	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	110	140	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.29	0.25	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.50	0.92	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	100– 28– 25 25– 32– 25 25– 22– 35 35–110– 20 50– 40– 40	35–140– 90 90– 55–270 270– 50– 85	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	3.57:1:0.89 0.78:1:0.78 1.14:1:1.59 0.32:1:0.18 1.25:1:1.00	0.25:1:0.64 1.64:1:4.91 5.40:1:1.70	----------
Depth to top of uppermost potential reservoir sand (SLD)	3,325	4,260	----------
Depth to top of lowermost potential reservoir sand (SLD)	3,890	4,730	----------
Average depth to top of unit's potential reservoir sand (SLD)	3,695	4,527	----------
Percent of potential reservoir sand in upper third of unit	17	0	----------
Percent of potential reservoir sand in middle third of unit	0	20	----------
Percent of potential reservoir sand in lower third of unit	83	80	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	16	18	----------

Geophysical logs: Gamma Ray-Neutron

Well No.: NC-HY-OT-11

Record No.: 1151
State: North Carolina
County: Hyde

Well name: Socony Mobile, State of N.C. No. 3
Latitude: 351825
Longitude: 0754945

Depth of well____ft____7,314
Depth of well (SLD)____ft____7,290
Elevation of measuring point above ground level____ft____22.5
Elevation of ground level____ft____1.5

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—3,996	—4,954	—6,116
Thickness of unit (feet)	958	1,162	1,120
Unit's total sand thickness (feet/percent)	653/68	330/28	500/45
Unit's total shale thickness (feet/percent)	275/29	707/61	465/41
Unit's sand-shale ratio	2.4	0.5	1.1
Number of potential reservoir sands in unit	7	3	1
Total thickness (feet) of unit's potential reservoir sands	510	135	20
Average thickness (feet) of unit's potential reservoir sands	73	45	20
Maximum thickness (feet) of a potential reservoir sand layer in unit	120	80	20
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.53	0.12	0.02
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.78	0.41	0.04
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	25–110–35 35– 45–30 30– 40–40 40– 40–30 40– 45–40 20–110–30 30–120–25	140–80–60 150–35–55 55–20–45 1.75:1:0.75 4.29:1:1.57 2.75:1:2.25	20–20–50 1.00:1:2.50
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.23:1:0.32 0.78:1:0.67 0.75:1:1.00 1.00:1:0.75 0.89:1:0.89 0.18:1:0.27 0.25:1:0.21		

Well No.: NC-HY-OT-11—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Depth to top of uppermost potential reservoir sand (SLD)	4,121	5,186	6,491
Depth to top of lowermost potential reservoir sand (SLD)	4,906	6,036	6,491
Average depth to top of unit's potential reservoir sand (SLD)	4,567	5,494	6,491
Percent of potential reservoir sand in upper third of unit	45	41	100
Percent of potential reservoir sand in middle third of unit	22	0	0
Percent of potential reservoir sand in lower third of unit	33	59	0
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	9	41	325

Geophysical logs: Electric, Gamma, Sonic

Well No.: NC-DA-OT-12

Record No.: 1152
State: North Carolina
County: Dare

Well name: Mobile Oil Co., State of N.C. No. 2
Latitude: 352620
Longitude: 0753435

Depth of well____ft____8,386
Depth of well (SLD)____ft____8,362
Elevation of measuring point above ground level____ft____22.5
Elevation of ground level____ft____1.5

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—4,406	—5,246	—6,966
Thickness of unit (feet)	840	1,720	1,370
Unit's total sand thickness (feet/percent)	320/38	490/28	375/27
Unit's total shale thickness (feet/percent)	500/60	825/48	745/55
Unit's sand-shale ratio	0.6	0.6	0.5
Number of potential reservoir sands in unit	3	2	3
Total thickness (feet) of unit's potential reservoir sands	100	255	110
Average thickness (feet) of unit's potential reservoir sands	33	128	37
Maximum thickness (feet) of a potential reservoir sand layer in unit	40	165	55
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.10	0.15	0.08
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.31	0.52	0.29
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	40–30– 25 270–40– 40 50–30–270	35–165–30 55– 90–70	20–30–60 30–25–35 20–55–30
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.33:1:0.83 6.75:1:1.00 1.67:1:9.00	0.21:1:0.18 0.61:1:0.78	0.67:1:2.00 1.20:1:1.40 0.36:1:0.55
Depth to top of uppermost potential reservoir sand (SLD)	4,821	6,591	7,451
Depth to top of lowermost potential reservoir sand (SLD)	5,221	6,876	7,776
Average depth to top of unit's potential reservoir sand (SLD)	4,978	6,734	7,616
Percent of potential reservoir sand in upper third of unit	0	0	0
Percent of potential reservoir sand in middle third of unit	70	0	100
Percent of potential reservoir sand in lower third of unit	30	100	0
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	50	26	69

Geophysical logs: Electric, Gamma, Sonic

Well No.: NC-DA-OT-10

Record No.: 1153
State: North Carolina
County: Dare

Well name: Standard Oil N.J., Hatteras Light No. 1
Latitude: 351500
Longitude: 0753145

Depth of well____ft____10,044
Depth of well (SLD)____ft____10,019
Elevation of measuring point above ground level____ft____16
Elevation of ground level____ft____9

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—4,975	—6,100	—7,735
Thickness of unit (feet)	1,125	1,635	1,410
Unit's total sand thickness (feet/percent)	330/29	685/42	275/20
Unit's total shale thickness (feet/percent)	605/54	650/40	440/31
Unit's sand-shale ratio	0.6	1.1	0.6
Number of potential reservoir sands in unit	1	6	1
Total thickness (feet) of unit's potential reservoir sands	20	295	20
Average thickness (feet) of unit's potential reservoir sands	20	49	20
Maximum thickness (feet) of a potential reservoir sand layer in unit	20	100	20
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.02	0.18	0.01
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.03	0.43	0.07

Well No.: NC-DA-OT-10—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	55–20–30	35– 90– 50 55– 30–145 145– 25– 20 60– 30– 20 25–100– 90 40– 20– 40	20–20–25
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	2.75:1:1.50	0.39:1:0.56 1.83:1:4.83 5.80:1:0.80 2.00:1:0.67 0.25:1:0.90 2.00:1:2.00	1.00:1:1.25
Depth to top of uppermost potential reservoir sand (SLD)	5,825	6,220	8,587
Depth to top of lowermost potential reservoir sand (SLD)	5,825	7,640	8,587
Average depth to top of unit's potential reservoir sand (SLD)	5,825	6,985	8,587
Percent of potential reservoir sand in upper third of unit	0	51	0
Percent of potential reservoir sand in middle third of unit	0	0	100
Percent of potential reservoir sand in lower third of unit	100	49	0
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	291	24	429

Geophysical logs: Electric

Well No.: NC-BEA-OT-12

Record No.: 1167
State: North Carolina
County: Beaufort

Well name: Coastal Plains, Zeno Ratcliff No. 1
Latitude: 353545
Longitude: 0764810

Depth of well____ft____1,966
Depth of well (SLD)____ft____1,951
Elevation of measuring point above ground level____ft____0
Elevation of ground level____ft____15

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,385	Absent	Absent
Thickness of unit (feet)	560	----------	----------
Unit's total sand thickness (feet/percent)	210/37	----------	----------
Unit's total shale thickness (feet/percent)	345/62	----------	----------
Unit's sand-shale ratio	0.6	----------	----------
Number of potential reservoir sands in unit	2	----------	----------
Total thickness (feet) of unit's potential reservoir sands	75	----------	----------
Average thickness (feet) of unit's potential reservoir sands	38	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	45	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.13	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.36	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	30–45–60 20–35–60	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.67:1:1.33 0.57:1:1.71	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	1,495	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	1,627	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	1,561	----------	----------
Percent of potential reservoir sand in upper third of unit	40	----------	----------
Percent of potential reservoir sand in middle third of unit	60	----------	----------
Percent of potential reservoir sand in lower third of unit	0	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	21	----------	----------

Geophysical logs: Electric

Well No.: NC-BEA-OT-15

Record No.: 1168
State: North Carolina
County: Beaufort

Well name: Coastal Plains, West Dismal No. 1
Lattitude: 353900
Longitude: 0764810

Depth of well----ft----1,938
Depth of well (SLD)----ft----1,903
Elevation of measuring point above ground level----ft----0
Elevation of ground level----ft----35

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,305	Absent	Absent
Thickness of unit (feet)	563	----------	----------
Unit's total sand thickness (feet/percent)	245/44	----------	----------
Unit's total shale thickness (feet/percent)	318/56	----------	----------
Unit's sand-shale ratio	0.8	----------	----------
Number of potential reservoir sands in unit	4	----------	----------
Total thickness (feet) of unit's potential reservoir sands	121	----------	----------
Average thickness (feet) of unit's potential reservoir sands	30	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	35	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.21	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.49	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	20–32–35 25–34–44 44–20–75 20–35–40	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.63:1:1.09 0.74:1:1.29 2.20:1:3.75 0.57:1:1.14	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	1,435	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	1,760	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	1,600	----------	----------
Percent of potential reservoir sand in upper third of unit	29	----------	----------
Percent of potential reservoir sand in middle third of unit	17	----------	----------
Percent of potential reservoir sand in lower third of unit	54	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	13	----------	----------

Geophysical logs: Electric

Well No.: NC-BEA-OT-13

Record No.: 1170
State: North Carolina
County: Beaufort

Well name: Coastal Plains, Rodman No. 1
Latitude: 353245
Longitude: 0764645

Depth of well----ft----2,012
Depth of well (SLD)----ft----1,996
Elevation of measuring point above ground level----ft----0
Elevation of ground level----ft----16

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,414	Absent	Absent
Thickness of unit (feet)	550	----------	----------
Unit's total sand thickness (feet/percent)	200/36	----------	----------
Unit's total shale thickness (feet/percent)	340/62	----------	----------
Unit's sand-shale ratio	0.6	----------	----------
Number of potential reservoir sands in unit	3	----------	----------
Total thickness (feet) of unit's potential reservoir sands	70	----------	----------
Average thickness (feet) of unit's potential reservoir sands	23	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	30	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.13	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.35	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	33–30–25 50–20–40 40–20–30	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.10:1:0.83 2.50:1:2.00 2.00:1:1.50	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	1,519	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	1,696	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	1,598	----------	----------
Percent of potential reservoir sand in upper third of unit	57	----------	----------
Percent of potential reservoir sand in middle third of unit	43	----------	----------
Percent of potential reservoir sand in lower third of unit	0	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	23	----------	----------

Geophysical logs: Electric

Well No.: NC-WAS-OT-2

Record No.: 1174
State: North Carolina
County: Washington

Well name: Davidson Oil Co., Furbee No. 1
Latitude: 344330
Longitude: 0763730

Depth of well____ft____2,693
Depth of well (SLD)____ft____2,674
Elevation of measuring point above ground level____ft____3
Elevation of ground level____ft____16

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,558	—2,511	Absent
Thickness of unit (feet)	953	162	----------
Unit's total sand thickness (feet/percent)	375/39	66/41	----------
Unit's total shale thickness (feet/percent)	578/61	96/59	----------
Unit's sand-shale ratio	0.7	0.7	----------
Number of potential reservoir sands in unit	5	2	----------
Total thickness (feet) of unit's potential reservoir sands	175	42	----------
Average thickness (feet) of unit's potential reservoir sands	35	21	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	55	22	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.18	0.26	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.47	0.64	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	30–50–120 120–20– 35 35–55– 20 20–30– 55 55–20– 95	50–20–30 20–22–50	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.60:1:2.40 6.00:1:1.75 0.64:1:0.36 0.67:1:1.83 2.75:1:4.75	2.50:1:1.50 0.91:1:2.27	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,056	2,561	----------
Depth to top of lowermost potential reservoir sand (SLD)	2,459	2,611	----------
Average depth to top of unit's potential reservoir sand (SLD)	2,241	2,586	----------
Percent of potential reservoir sand in upper third of unit	0	48	----------
Percent of potential reservoir sand in middle third of unit	11	0	----------
Percent of potential reservoir sand in lower third of unit	89	52	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	13	62	----------

Geophysical logs: Electric

Well No.: NC-DA-OT-9

Record No.: 1178
State: North Carolina
County: Dare

Well name: Standard Oil N.J., N.C. Esso No. 2
Latitude: 354212
Longitude: 0753554

Depth of well____ft____6,410
Depth of well (SLD)____ft____6,389
Elevation of measuring point above ground level____ft____21
Elevation of ground level____ft____0

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—3,859	—4,904	—6,249
Thickness of unit (feet)	1,045	1,345	>140
Unit's total sand thickness (feet/percent)	720/69	280/21	----------
Unit's total shale thickness (feet/percent)	315/30	810/60	----------
Unit's sand-shale ratio	2.3	0.4	----------
Number of potential reservoir sands in unit	2	3	----------
Total thickness (feet) of unit's potential reservoir sands	70	100	----------
Average thickness (feet) of unit's potential reservoir sands	35	33	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	45	50	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.07	0.07	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.10	0.36	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	60–25–20 20–45–50	70–25–45 20–25–50 30–50–30	---------- ---------- ----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	2.40:1:0.80 0.44:1:1.11	2.80:1:1.80 0.80:1:2.00 0.60:1:0.60	---------- ---------- ----------
Depth to top of uppermost potential reservoir sand (SLD)	4,491	5,019	----------
Depth to top of lowermost potential reservoir sand (SLD)	4,559	5,864	----------
Average depth to top of unit's potential reservoir sand (SLD)	4,525	5,361	----------
Percent of potential reservoir sand in upper third of unit	0	75	----------
Percent of potential reservoir sand in middle third of unit	64	0	----------
Percent of potential reservoir sand in lower third of unit	36	25	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	65	54	----------

Geophysical logs: Electric

Well No.: NC-DA-OT-14

Record No.: 1192
State: North Carolina
County: Dare

Well name: E. F. Blair, West Va. Pulp & Paper No. 1
Latitude: 355150
Longitude: 0755530

Depth of well____ft____5,147
Depth of well (SLD)____ft____5,136
Elevation of measuring point above ground level____ft____8
Elevation of ground level____ft____3

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,547	—3,644	—4,699
Thickness of unit (feet)	1,097	1,055	420
Unit's total sand thickness (feet/percent)	582/53	190/18	145/34
Unit's total shale thickness (feet/percent)	505/46	790/75	180/43
Unit's sand-shale ratio	1.2	0.2	0.8
Number of potential reservoir sands in unit	2	2	0
Total thickness (feet) of unit's potential reservoir sands	90	60	----------
Average thickness (feet) of unit's potential reservoir sands	45	30	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	50	30	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.08	0.06	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.15	0.32	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	20–40–55 50–50–20	32–30– 30 80–30–250	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.50:1:1.38 1.00:1:0.40	1.07:1:1.00 2.67:1:8.33	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,879	4,179	----------
Depth to top of lowermost potential reservoir sand (SLD)	3,073	4,659	----------
Average depth to top of unit's potential reservoir sand (SLD)	2,976	4,419	----------
Percent of potential reservoir sand in upper third of unit	56	0	----------
Percent of potential reservoir sand in middle third of unit	44	50	----------
Percent of potential reservoir sand in lower third of unit	0	50	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	33	74	None

Geophysical logs: Electric, Gamma

Well No.: NC-DA-OT-11

Record No.: 1193
State: North Carolina
County: Dare

Well name: Mobil Oil Co., State of N.C. No. 1
Latitude: 355955
Longitude: 0755200

Depth of well____ft____5,269
Depth of well (SLD)____ft____5,245
Elevation of measuring point above ground level____ft____22.5
Elevation of ground level____ft____1.5

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,486	—3,586	—4,676
Thickness of unit (feet)	1,100	1,090	470
Unit's total sand thickness (feet/percent)	440/40	425/39	180/38
Unit's total shale thickness (feet/percent)	650/59	595/55	195/42
Unit's sand-shale ratio	0.7	0.7	0.9
Number of potential reservoir sands in unit	5	8	1
Total thickness (feet) of unit's potential reservoir sands	182	265	55
Average thickness (feet) of unit's potential reservoir sands	36	33	55
Maximum thickness (feet) of a potential reservoir sand layer in unit	45	50	55
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.17	0.24	0.06
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.41	0.62	0.13
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	25–45–130 130–30–120 120–30– 20 45–45– 40 40–32– 20	35–25–45 45–40–75 75–20–50 30–50–75 55–35–30 30–20–40 40–35–30 30–40–70	40–55–20
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.56:1:2.89 4.33:1:4.00 4.00:1:0.67 1.00:1:0.89 1.25:1:0.63	1.40:1:1.80 1.13:1:1.88 3.75:1:2.50 0.60:1:1.50 1.57:1:0.86 1.50:1:2.00 1.14:1:0.86 0.75:1:1.75	0.73:1:0.36
Depth to top of uppermost potential reservoir sand (SLD)	3,014	3,716	4,908
Depth to top of lowermost potential reservoir sand (SLD)	3,536	4,346	4,908
Average depth to top of unit's potential reservoir sand (SLD)	3,245	4,013	4,908
Percent of potential reservoir sand in upper third of unit	0	49	0
Percent of potential reservoir sand in middle third of unit	42	42	100
Percent of potential reservoir sand in lower third of unit	58	9	0
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	18	15	89

Geophysical logs: Electric, Gamma, Sonic

Well No.: NC-DA-OT-13

Record No.: 1194
State: North Carolina
County: Dare

Well name: E. F. Blair & Assoc., Collins No. 1
Latitude: 355300
Longitude: 0754015

Depth of well____ft____6,295
Depth of well (SLD)____ft____6,282
Elevation of measuring point above ground level____ft____9
Elevation of ground level____ft____4

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—3,286	—4,357	—5,532
Thickness of unit (feet)	1,071	1,175	734
Unit's total sand thickness (feet/percent)	526/49	560/48	204/28
Unit's total shale thickness (feet/percent)	485/45	425/36	360/49
Unit's sand-shale ratio	1.1	1.3	0.6
Number of potential reservoir sands in unit	4	2	1
Total thickness (feet) of unit's potential reservoir sands	163	145	20
Average thickness (feet) of unit's potential reservoir sands	41	73	20
Maximum thickness (feet) of a potential reservoir sand layer in unit	48	110	20
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.15	0.12	0.03
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.31	0.26	0.09
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	30–48–20 20–45–28 28–38–20 35–32–60	20–110–20 20– 35–35	25–20–50
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.63:1:0.42 0.44:1:0.62 0.74:1:0.53 1.09:1:1.88	0.18:1:0.18 0.57:1:1.00	1.25:1:2.50
Depth to top of uppermost potential reservoir sand (SLD)	3,617	4,672	5,613
Depth to top of lowermost potential reservoir sand (SLD)	4,309	5,417	5,613
Average depth to top of unit's potential reservoir sand (SLD)	3,986	5,044	5,613
Percent of potential reservoir sand in upper third of unit	20	26	100
Percent of potential reservoir sand in middle third of unit	23	0	0
Percent of potential reservoir sand in lower third of unit	57	74	0
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	24	35	281

Geophysical logs: Electric, Gamma

Well No.: NC-HAL-T-2

Record No.: 1197
State: North Carolina
County: Halifax

Well name: Town of Scotland Neck, Palmyra Rd.
Latitude: 360655
Longitude: 0772235

Depth of well____ft____338
Depth of well (SLD)____ft____245
Elevation of measuring point above ground level____ft____0
Elevation of ground level____ft____93

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—161	----------	----------
Thickness of unit (feet)	83	----------	----------
Unit's total sand thickness (feet/percent)	36/43	----------	----------
Unit's total shale thickness (feet/percent)	47/57	----------	----------
Unit's sand-shale ratio	0.8	----------	----------
Number of potential reservoir sands in unit	0	----------	----------
Total thickness (feet) of unit's potential reservoir sands	----------	----------	----------
Average thickness (feet) of unit's potential reservoir sands	----------	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	----------	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	----------	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	----------	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	----------	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	----------	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	----------	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	----------	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	----------	----------	----------
Percent of potential reservoir sand in upper third of unit	----------	----------	----------
Percent of potential reservoir sand in middle third of unit	----------	----------	----------
Percent of potential reservoir sand in lower third of unit	----------	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	None	----------	----------

Geophysical logs: Electric

Well No.: NC-CAM-OT-10

Record No.: 1234
State: North Carolina
County: Camden

Well name: E. F. Blair, Weyerhouser No. 1
Latitude: 362440
Longitude: 0761030

Depth of well----ft----3,741
Depth of well (SLD)----ft----3,725
Elevation of measuring point above ground level----ft----8
Elevation of ground level----ft----8

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,324	—2,226	—2,602
Thickness of unit (feet)	902	376	212
Unit's total sand thickness (feet/percent)	405/45	160/43	40/19
Unit's total shale thickness (feet/percent)	497/55	216/57	172/81
Unit's sand-shale ratio	0.8	0.8	0.2
Number of potential reservoir sands in unit	5	1	1
Total thickness (feet) of unit's potential reservoir sands	138	20	20
Average thickness (feet) of unit's potential reservoir sands	28	20	20
Maximum thickness (feet) of a potential reservoir sand layer in unit	35	20	20
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.15	0.05	0.09
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.34	0.13	0.50
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	35–23–65 65–30–40 40–30–85 35–20–30 20–35–45	40–20–50	60–20–60
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.52:1:2.83 2.17:1:1.33 1.33:1:2.83 1.75:1:1.50 0.57:1:1.29	2.00:1:2.50	3.00:1:3.00
Depth to top of uppermost potential reservoir sand (SLD)	1,324	2,494	2,714
Depth to top of lowermost potential reservoir sand (SLD)	2,099	2,494	2,714
Average depth to top of unit's potential reservoir sand (SLD)	1,763	2,494	2,714
Percent of potential reservoir sand in upper third of unit	25	0	0
Percent of potential reservoir sand in middle third of unit	14	0	100
Percent of potential reservoir sand in lower third of unit	61	100	0
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	13	125	136

Geophysical logs: Electric, Gamma

Well No.: NC-CUR-OT-12

Record No.: 1240
State: North Carolina
County: Currituck

Well name: E. F. Blair & Assoc., Twiford No. 1
Latitude: 361810
Longitude: 0755530

Depth of well----ft----4,553
Depth of well (SLD)----ft----4,541
Elevation of measuring point above ground level----ft----7
Elevation of ground level----ft----5

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,918	—3,023	—3,998
Thickness of unit (feet)	1,105	975	518
Unit's total sand thickness (feet/percent)	535/48	272/28	158/30
Unit's total shale thickness (feet/percent)	570/52	683/70	300/58
Unit's sand-shale ratio	0.9	0.4	0.5
Number of potential reservoir sands in unit	7	4	3
Total thickness (feet) of unit's potential reservoir sands	223	130	70
Average thickness (feet) of unit's potential reservoir sands	32	33	23
Maximum thickness (feet) of a potential reservoir sand layer in unit	40	45	25
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.20	0.13	0.14
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.42	0.48	0.44
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	30–40–20 20–30–30 30–40–25 35–35–50 22–28–80 80–30–40 40–20–20	20–35– 70 54–30–350 350–45– 25 25–20– 80	60–25–20 70–20–35 35–25–30
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.75:1:0.50 0.67:1:1.00 0.75:1:0.63 1.00:1:1.43 0.79:1:2.86 2.67:1:1.33 2.00:1:1.00	0.57:1: 2.00 1.80:1:11.67 7.78:1: 0.56 1.25:1: 4.00	2.40:1:0.80 3.50:1:1.75 1.40:1:1.20

Well No.: NC-CUR-OT-12—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Depth to top of uppermost potential reservoir sand (SLD)	2,108	3,358	4,148
Depth to top of lowermost potential reservoir sand (SLD)	2,868	3,968	4,323
Average depth to top of unit's potential reservoir sand (SLD)	2,486	3,628	4,226
Percent of potential reservoir sand in upper third of unit	22	0	36
Percent of potential reservoir sand in middle third of unit	28	50	28
Percent of potential reservoir sand in lower third of unit	50	50	36
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	11	28	60

Geophysical logs: Electric, Gamma

Well No.: NC-ON-OT-32

Record No.: 1247
State: North Carolina
County: Onslow

Well name: Colonial Oil & Gas, No. 1 Parker
Latitude: 344540
Longitude: 0771135

Depth of well____ft____2,009
Depth of well (SLD)____ft____1,972
Elevation of measuring point above ground level____ft____7
Elevation of ground level____ft____30

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,520	Absent	Absent
Thickness of unit (feet)	255	----------	----------
Unit's total sand thickness (feet/percent)	52/20	----------	----------
Unit's total shale thickness (feet/percent)	203/80	----------	----------
Unit's sand-shale ratio	0.3	----------	----------
Number of potential reservoir sands in unit	0	----------	----------
Total thickness (feet) of unit's potential reservoir sands	----------	----------	----------
Average thickness (feet) of unit's potential reservoir sands	----------	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	----------	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	----------	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	----------	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	----------	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	----------	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	----------	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	----------	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	----------	----------	----------
Percent of potential reservoir sand in upper third of unit	----------	----------	----------
Percent of potential reservoir sand in middle third of unit	----------	----------	----------
Percent of potential reservoir sand in lower third of unit	----------	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	None	----------	----------

Geophysical logs: Electric, Gamma Ray-Density

Well No.: NC-DA-OT-16

Record No.: 1248
State: North Carolina
County: Dare

Well name: Rapp Oil Co., Laverne Twiford No. 1
Latitude: 354200
Longitude: 0754636

Depth of well____ft____5,940
Depth of well (SLD)____ft____5,927
Elevation of measuring point above ground level____ft____10
Elevation of ground level____ft____3

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—3,351	—4,193	—5,515
Thickness of unit (feet)	842	1,322	>412
Unit's total sand thickness (feet/percent)	528/63	424/32	----------
Unit's total shale thickness (feet/percent)	280/33	650/49	----------
Unit's sand-shale ratio	1.9	0.6	----------
Number of potential reservoir sands in unit	3	3	----------
Total thickness (feet) of unit's potential reservoir sands	165	131	----------
Average thickness (feet) of unit's potential reservoir sands	55	44	----------
Maximum thickness (feet) of a potential reservoir sand laver in unit	90	50	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.20	0.12	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.31	0.33	----------
Thickness (feet)—Immediatelv underlying shale seal–potential reservoir sand–immediately overlying shale seal.	43–45–66 66–30–24 45–90–39	50–50–43 34–38–50 65–43–43	----------

Well No.: NC-DA-OT-16—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.96:1:1.47 2.20:1:0.80 0.50:1:0.43	1.00:1:0.86 0.89:1:1.30 1.50:1:1.00	----------
Depth to top of uppermost potential reservoir sand (SLD)	3,351	4,237	----------
Depth to top of lowermost potential reservoir sand (SLD)	4,149	4,747	----------
Average depth to top of unit's potential reservoir sand (SLD)	3,850	4,440	----------
Percent of potential reservoir sand in upper third of unit	55	67	----------
Percent of potential reservoir sand in middle third of unit	0	33	----------
Percent of potential reservoir sand in lower third of unit	45	0	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	23	34	----------

Geophysical logs: Electric, Gamma

Well No.: NC-DA-OT-15

Record No.: 1249
State: North Carolina
County: Dare

Well name: Rapp Oil Co., Ethridge No. 1
Latitude: 355600
Longitude: 0754135

Depth of well----ft----6,049
Depth of well (SLD)----ft----6,023
Elevation of measuring point above ground level----ft----10
Elevation of ground level----ft----16

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—3,133	—4,109	—5,350
Thickness of unit (feet)	976	1,241	>673
Unit's total sand thickness (feet/percent)	543/56	570/46	----------
Unit's total shale thickness (feet/percent)	403/41	616/49	----------
Unit's sand-shale ratio	1.4	0.9	----------
Number of potential reservoir sands in unit	4	3	----------
Total thickness (feet) of unit's potential reservoir sands	116	97	----------
Average thickness (feet) of unit's potential reservoir sands	29	32	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	35	45	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.12	0.08	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.21	0.17	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	47–26–25 85–20–25 25–35–22 20–35–42	20–24–28 38–45–25 20–24–20	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.81:1:0.96 4.25:1:1.25 0.71:1:0.63 0.57:1:1.20	0.83:1:1.17 0.84:1:0.56 0.83:1:0.83	----------
Depth to top of uppermost potential reservoir sand (SLD)	3,239	4,392	----------
Depth to top of lowermost potential reservoir sand (SLD)	4,084	4,830	----------
Average depth to top of unit's potential reservoir sand (SLD)	3,736	4,596	----------
Percent of potential reservoir sand in upper third of unit	30	25	----------
Percent of potential reservoir sand in middle third of unit	0	75	----------
Percent of potential reservoir sand in lower third of unit	70	0	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	32	47	----------

Geophysical logs: Electric, Gamma

Well No.: NC-CUR-OT-13

Record No.: 1250
State: North Carolina
County: Currituck

Well name: Rapp Oil Co., Kellogg No. 1
Latitude: 360645
Longitude: 0755050

Depth of well----ft----5,118
Depth of well (SLD)----ft----5,101
Elevation of measuring point above ground level----ft----7
Elevation of ground level----ft----10

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,334	—3,463	—4,568
Thickness of unit (feet)	1,129	1,105	487
Unit's total sand thickness (feet/percent)	391/35	308/28	132/27
Unit's total shale thickness (feet/percent)	693/61	731/66	300/62
Unit's sand-shale ratio	0.6	0.4	0.4
Number of potential reservoir sands in unit	3	4	1
Total thickness (feet) of unit's potential reservoir sands	120	130	20
Average thickness (feet) of unit's potential reservoir sands	40	30	20

Well No.: NC-CUR-OT-13—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Maximum thickness (feet) of a potential reservoir sand layer in unit	60	40	20
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.11	0.04	0.04
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.31	0.31	0.15
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	20–20–50 50–60–40 45–40–20	50–40– 70 70–22– 28 45–38–130 35–30– 20	30–20–135
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.00:1:2.50 0.83:1:0.67 1.13:1:0.50	1.25:1:1.75 3.18:1:1.27 1.18:1:3.42 1.17:1:0.67	1.50:1:6.75
Depth to top of uppermost potential reservoir sand (SLD)	2,795	3,528	4,725
Depth to top of lowermost potential reservoir sand (SLD)	3,048	4,210	4,725
Average depth to top of unit's potential reservoir sand (SLD)	2,925	3,960	4,725
Percent of potential reservoir sand in upper third of unit	0	23	100
Percent of potential reservoir sand in middle third of unit	100	46	0
Percent of potential reservoir sand in lower third of unit	0	31	0
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	24	30	236

Geophysical logs: Electric, Gamma, Sonic

Well No.: NC-GA-OT-15

Record No.: 1251
State: North Carolina
County: Gates

Well name: Cullinan-Weyerhauser No. 1
Latitude: 362610
Longitude: 0763005

Depth of well____ft____2,138
Depth of well (SLD)____ft____2,112
Elevation of measuring point above ground level____ft____11
Elevation of ground level____ft____15

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—793	—1,327	—1,932
Thickness of unit (feet)	534	605	156
Unit's total sand thickness (feet/percent)	299/56	367/61	49/31
Unit's total shale thickness (feet/percent)	235/44	238/39	107/69
Unit's sand-shale ratio	1.3	1.5	0.5
Number of potential reservoir sands in unit	1	2	1
Total thickness (feet) of unit's potential reservoir sands	37	67	32
Average thickness (feet) of unit's potential reservoir sands	37	34	32
Maximum thickness (feet) of a potential reservoir sand layer in unit	37	40	32
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.07	0.11	0.21
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.12	0.18	0.65
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	20–37–37	20–27–30 50–40–50	20–32–50
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.54:1:1.00	0.74:1:1.00 1.25:1:1.25	0.63:1:1.56
Depth to top of uppermost potential reservoir sand (SLD)	1,004	1,749	1,986
Depth to top of lowermost potential reservoir sand (SLD)	1,004	1,894	1,986
Average depth to top of unit's potential reservoir sand (SLD)	1,004	1,827	1,986
Percent of potential reservoir sand in upper third of unit	0	0	0
Percent of potential reservoir sand in middle third of unit	100	0	100
Percent of potential reservoir sand in lower third of unit	0	100	0
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	27	27	32

Geophysical logs: Electric

Well No.: NC-DA-OT-18

Record No.: 1344
State: North Carolina
County: Dare

Well name: Citgo, No. 2 Westvaco
Latitude: 355230
Longitude: 0755230

Depth of well____ft____5,817
Depth of well (SLD)____ft____5,794
Elevation of measuring point above ground level____ft____17
Elevation of ground level____ft____6

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,745	—3,822	—4,982
Thickness of unit (feet)	1,077	1,170	425
Unit's total sand thickness (feet/percent)	621/57	357/31	142/33
Unit's total shale thickness (feet/percent)	387/36	728/62	237/56
Unit's sand-shale ratio	1.6	0.5	0.6

Well No.: NC-DA-OT-18—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Number of potential reservoir sands in unit	4	1	0
Total thickness (feet) of unit's potential reservoir sands	186	60	----------
Average thickness (feet) of unit's potential reservoir sands	47	60	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	78	60	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.17	0.05	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.30	0.17	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	30–20–25 48–50–26 20–38–34 20–78–30	30–60–20	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.50:1:1.25 0.96:1:0.52 0.53:1:0.89 0.26:1:0.38	0.50:1:0.33	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,997	4,847	----------
Depth to top of lowermost potential reservoir sand (SLD)	3,647	4,847	----------
Average depth to top of unit's potential reservoir sand (SLD)	3,340	4,847	----------
Percent of potential reservoir sand in upper third of unit	42	0	----------
Percent of potential reservoir sand in middle third of unit	20	0	----------
Percent of potential reservoir sand in lower third of unit	38	100	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	18	81	None

Geophysical logs: Electric

Well No.: NC-DA-OT-17

Record No.: 1364
State: North Carolina
County: Dare

Well name: Citgo, No. 1 Westvaco
Latitude: 353936
Longitude: 0754640

Depth of well____ft____6,288
Depth of well (SLD)____ft____6,268
Elevation of measuring point above ground level____ft____15
Elevation of ground level____ft____5

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—3,440	—4,275	—5,520
Thickness of unit (feet)	835	1,245	588
Unit's total sand thickness (feet/percent)	424/51	360/29	218/37
Unit's total shale thickness (feet/percent)	374/45	805/65	340/58
Unit's sand-shale ratio	1.1	0.5	0.6
Number of potential reservoir sands in unit	0	1	0
Total thickness (feet) of unit's potential reservoir sands	----------	41	----------
Average thickness (feet) of unit's potential reservoir sands	----------	41	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	----------	41	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	----------	0.03	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	----------	0.11	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	----------	55–41–25	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	----------	1.30:1:0.61	----------
Depth to top of uppermost potential reservoir sand (SLD)	----------	4,382	----------
Depth to top of lowermost potential reservoir sand (SLD)	----------	4,382	----------
Average depth to top of unit's potential reservoir sand (SLD)	----------	4,382	----------
Percent of potential reservoir sand in upper third of unit	----------	100	----------
Percent of potential reservoir sand in middle third of unit	----------	0	----------
Percent of potential reservoir sand in lower third of unit	----------	0	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	None	107	None

Geophysical logs: Electric

Well No.: NC-TY-OT-1

Record No.: 1368
State: North Carolina
County: Tyrrell

Well name: Exchange Oil and Gas, Westvaco No. 1
Latitude: 3550
Longitude: 07610

Depth of well____ft____4,242
Depth of well (SLD)____ft____4,236
Elevation of measuring point above ground level____ft____16
Elevation of ground level____ft____20

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,224	—3,084	Absent
Thickness of unit (feet)	860	980	----------
Unit's total sand thickness (feet/percent)	245/28	200/20	----------
Unit's total shale thickness (feet/percent)	615/72	780/80	----------
Unit's sand-shale ratio	0.4	0.3	----------
Number of potential reservoir sands in unit	1	3	----------
Total thickness (feet) of unit's potential reservoir sands	30	115	----------
Average thickness (feet) of unit's potential reservoir sands	30	38	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	30	45	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.03	0.12	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.12	0.58	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	50–30–38	75–45–36 32–38–75 28–32–22	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.67:1:1.27	1.67:1:0.80 0.84:1:1.97 0.88:1:0.69	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,454	3,344	----------
Depth to top of lowermost potential reservoir sand (SLD)	2,454	4,004	----------
Average depth to top of unit's potential reservoir sand (SLD)	2,454	3,607	----------
Percent of potential reservoir sand in upper third of unit	100	39	----------
Percent of potential reservoir sand in middle third of unit	0	33	----------
Percent of potential reservoir sand in lower third of unit	0	28	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	82	31	----------

Geophysical logs: Electric

Well No.: NC-TY-OT-2

Record No.: 1369
State: North Carolina
County: Tyrrell

Well name: Exchange Oil and Gas, Westvaco No. 2
Latitude: 3555
Longitude: 07610

Depth of well____ft____4,148
Depth of well (SLD)____ft____4,120
Elevation of measuring point above ground level____ft____16
Elevation of ground level____ft____12

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,132	—2,972	Absent
Thickness of unit (feet)	840	910	----------
Unit's total sand thickness (feet/percent)	362/43	182/20	----------
Unit's total shale thickness (feet/percent)	478/57	728/80	----------
Unit's sand-shale ratio	0.8	0.3	----------
Number of potential reservoir sands in unit	1	1	----------
Total thickness (feet) of unit's potential reservoir sands	56	24	----------
Average thickness (feet) of unit's potential reservoir sands	56	24	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	56	24	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.07	0.03	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.15	0.13	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	50–56–40	55–24–140	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.89:1:0.71	2.29:1:5.83	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,932	3,377	----------
Depth to top of lowermost potential reservoir sand (SLD)	2,932	3,377	----------
Average depth to top of unit's potential reservoir sand (SLD)	2,932	3,377	----------
Percent of potential reservoir sand in upper third of unit	0	0	----------
Percent of potential reservoir sand in middle third of unit	0	100	----------
Percent of potential reservoir sand in lower third of unit	100	0	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	52	141	----------

Geophysical logs: Electric

Well No.: NC-TY-OT-3

Record No.: 1370
State: North Carolina
County: Tyrrell

Well name: Exchange Oil and Gas Corp., Westvaco No. 3
Latitude: 3545
Longitude: 07610

Depth of well____ft____4,855
Depth of well (SLD)____ft____4,829
Elevation of measuring point above ground level____ft____16
Elevation of ground level____ft____10

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,479	—3,414	—4,404
Thickness of unit (feet)	935	990	340
Unit's total sand thickness (feet/percent)	876/94	275/28	134/39
Unit's total shale thickness (feet/percent)	59/6	715/72	206/61
Unit's sand-shale ratio	14.8	0.4	0.7
Number of potential reservoir sands in unit	1	2	1
Total thickness (feet) of unit's potential reservoir sands	37	85	26
Average thickness (feet) of unit's potential reservoir sands	37	43	26
Maximum thickness (feet) of a potential reservoir sand layer in unit	37	60	26
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.04	0.09	0.08
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.04	0.31	0.19
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	34–37–85	40–60–60 110–25–60	65–26–28
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.92:1:2.36	0.67:1:1.00 4.40:1:2.40	2.50:1:1.08
Depth to top of uppermost potential reservoir sand (SLD)	3,214	3,459	4,646
Depth to top of lowermost potential reservoir sand (SLD)	3,214	4,324	4,646
Average depth to top of unit's potential reservoir sand (SLD)	3,214	3,892	4,646
Percent of potential reservoir sand in upper third of unit	0	29	0
Percent of potential reservoir sand in middle third of unit	0	0	0
Percent of potential reservoir sand in lower third of unit	100	71	100
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	87	46	179

Geophysical logs: Electric

Well No.: NC-TY-OT-4

Record No.: 1371
State: North Carolina
County: Tyrrell

Well name: Bee Tree–Whitehurst No. 1
Latitude: 354815
Longitude: 0762047

Depth of well____ft____3,564
Depth of well (SLD)____ft____3,546
Elevation of measuring point above ground level____ft____8
Elevation of ground level____ft____10

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,992	—2,772	Absent
Thickness of unit (feet)	780	710	----------
Unit's total sand thickness (feet/percent)	262/34	200/28	----------
Unit's total shale thickness (feet/percent)	518/66	510/72	----------
Unit's sand-shale ratio	0.5	0.4	----------
Number of potential reservoir sands in unit	1	1	----------
Total thickness (feet) of unit's potential reservoir sands	22	20	----------
Average thickness (feet) of unit's potential reservoir sands	22	20	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	22	20	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.03	0.03	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.08	0.10	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	70–22–40	90–20–38	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	3.18:1:1.81	4.5:1:1.90	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,572	2,932	----------
Depth to top of lowermost potential reservoir sand (SLD)	2,572	2,932	----------
Average depth to top of unit's potential reservoir sand (SLD)	2,572	2,932	----------
Percent of potential reservoir sand in upper third of unit	0	100	----------
Percent of potential reservoir sand in middle third of unit	0	0	----------
Percent of potential reservoir sand in lower third of unit	100	0	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	117	147	----------

Geophysical logs: Electric

Well No.: NC-PAS-OT-5

Record No.: 1372
State: North Carolina
County: Pasquotank

Well name: Hoerner Waldorf No. 1
Latitude: 3620
Longitude: 07622

Depth of well____ft____2,715
Depth of well (SLD)____ft____2,689
Elevation of measuring point above ground level____ft____11
Elevation of ground level____ft____15

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,064	—1,816	—2,436
Thickness of unit (feet)	752	620	160
Unit's total sand thickness (feet/percent)	330/44	260/42	0/0
Unit's total shale thickness (feet/percent)	422/56	360/58	160/100
Unit's sand-shale ratio	0.8	0.7	0
Number of potential reservoir sands in unit	5	3	0
Total thickness (feet) of unit's potential reservoir sands	189	167	----------
Average thickness (feet) of unit's potential reservoir sands	38	56	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	70	110	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.25	0.27	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.57	0.64	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	20–22–33 34–45–20 60–70–32 32–30–30 30–22–65	60– 37–40 50–110–30 45– 20–62	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.91:1:1.50 0.76:1:0.44 0.86:1:0.46 1.07:1:1.00 1.36:1:2.95	1.62:1:1.08 0.45:1:0.27 2.25:1:3.10	----------
Depth to top of uppermost potential reservoir sand (SLD)	1,259	1,894	----------
Depth to top of lowermost potential reservoir sand (SLD)	1,794	2,279	----------
Average depth to top of unit's potential reservoir sand (SLD)	1,467	2,286	----------
Percent of potential reservoir sand in upper third of unit	35	67	----------
Percent of potential reservoir sand in middle third of unit	37	0	----------
Percent of potential reservoir sand in lower third of unit	28	33	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	8	16	None

Geophysical logs: Electric

Well No.: VA-NOR-T-12

Record No.: 2041
State: Virginia
County: Norfolk

Well name: Norfolk USGS Test
Latitude: 365200
Longitude: 0761200

Depth of well____ft____2,582
Depth of well (SLD)____ft____2,567
Elevation of measuring point above ground level____ft____0
Elevation of ground level____ft____15

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—777	—1,523	—2,095
Thickness of unit (feet)	746	572	>472
Unit's total sand thickness (feet/percent)	501/67	277/48	----------
Unit's total shale thickness (feet/percent)	245/33	295/52	----------
Unit's sand-shale ratio	2.0	0.9	----------
Number of potential reservoir sands in unit	0	0	----------
Total thickness (feet) of unit's potential reservoir sands	----------	----------	----------
Average thickness (feet) of unit's potential reservoir sands	----------	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	----------	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	----------	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	----------	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	----------	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	----------	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	----------	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	----------	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	----------	----------	----------
Percent of potential reservoir sand in upper third of unit	----------	----------	----------
Percent of potential reservoir sand in middle third of unit	----------	----------	----------
Percent of potential reservoir sand in lower third of unit	----------	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	None	None	----------

Geophysical logs: Electric, Gamma

Well No.: VA-JC-T-11

Record No.: 2052
State: Virginia
County: James City

Well name: Dow Chemical, Lee Hall
Latitude: 371140
Longitude: 0763655

Depth of well____ft____1,560
Depth of well (SLD)____ft____1,540
Elevation of measuring point above ground level____ft____0
Elevation of ground level____ft____20

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—379	—964	—1,358
Thickness of unit (feet)	585	394	>182
Unit's total sand thickness (feet/percent)	237/41	110/28	>66
Unit's total shale thickness (feet/percent)	348/59	284/72	----------
Unit's sand-shale ratio	0.68	0.39	----------
Number of potential reservoir sands in unit	2	0	----------
Total thickness (feet) of unit's potential reservoir sands	52	----------	----------
Average thickness (feet) of unit's potential reservoir sands	26	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	30	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.09	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.22	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	20–22–66 66–30–55	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.91:1:3.00 2.20:1:1.83	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	718	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	836	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	777	----------	----------
Percent of potential reservoir sand in upper third of unit	0	----------	----------
Percent of potential reservoir sand in middle third of unit	58	----------	----------
Percent of potential reservoir sand in lower third of unit	42	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	15	None	----------

Geophysical logs: Electric, Gamma

Well No.: VA-AC-OT-5

Record No.: 2113
State: Virginia
County: Accomack

Well name: J & J Enterprises, Taylor No. 1
Latitude: 375303
Longitude: 0753101

Depth of well____ft____6,279
Depth of well (SLD)____ft____6,226
Elevation of measuring point above ground level____ft____10.5
Elevation of ground level____ft____42

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,559	—2,298	—3,266
Thickness of unit (feet)	739	968	1,810
Unit's total sand thickness (feet/percent)	240/32	452/47	573/32
Unit's total shale thickness (feet/percent)	496/68	516/53	1,237/68
Unit's sand-shale ratio	0.5	0.9	0.5
Number of potential reservoir sands in unit	0	3	2
Total thickness (feet) of unit's potential reservoir sands		110	76
Average thickness (feet) of unit's potential reservoir sands	----------	37	38
Maximum thickness (feet) of a potential reservoir sand layer in unit	----------	60	46
Ratio—unit's potential reservoir sand thickness:unit's total thickness	----------	0.10	0.04
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	----------	0.21	0.13
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	----------	24–60–108 108–20– 36 50–30–118	64–46–50 24–30–25
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	----------	0.40:1:1.80 5.40:1:1.80 1.67:1:3.93	1.39:1:1.09 0.80:1:0.83
Depth to top of uppermost potential reservoir sand (SLD)	----------	2,497	4,183
Depth to top of lowermost potential reservoir sand (SLD)	----------	3,207	4,547
Average depth to top of unit's potential reservoir sand (SLD)	----------	2,928	4,365
Percent of potential reservoir sand in upper third of unit	----------	27	0
Percent of potential reservoir sand in middle third of unit	----------	0	39
Percent of potential reservoir sand in lower third of unit	----------	73	61
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	None	27	57

Geophysical logs: Electric, Gamma, Sonic

Well No.: VA-NAN-T-26

Record No.: 2115
State: Virginia
County: Nansemond

Well name: State Obs. Well, Adams Swamp
Latitude: 363410
Longitude: 0763505

Depth of well____ft____2,017
Depth of well (SLD)____ft____1,954
Elevation of measuring point above ground level____ft____3
Elevation of ground level____ft____60

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—592	—1,068	—1,480
Thickness of unit (feet)	476	412	267
Unit's total sand thickness (feet/percent)	230/48	109/26	80/30
Unit's total shale thickness (feet/percent)	246/52	303/74	187/70
Unit's sand-shale ratio	0.9	0.4	0.4
Number of potential reservoir sands in unit	0	0	0
Total thickness (feet) of unit's potential reservoir sands	----------	----------	----------
Average thickness (feet) of unit's potential reservoir sands	----------	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	----------	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	----------	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	----------	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	----------	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	----------	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	----------	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	----------	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	----------	----------	----------
Percent of potential reservoir sand in upper third of unit	----------	----------	----------
Percent of potential reservoir sand in middle third of unit	----------	----------	----------
Percent of potential reservoir sand in lower third of unit	----------	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	None	None	None

Geophysical logs: Electric, Gamma

Well No.: MD-WIC-OT-11

Record No. 3032
State: Maryland
County: Wicomico

Well name: Ohio Oil Co., Hammond No. 1
Latitude: 381845
Longitude: 0752930

Depth of well____ft____5,568
Depth of well (SLD)____ft____5,498
Elevation of measuring point above ground level____ft____16
Elevation of ground level____ft____54

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,510	—2,320	—3,430
Thickness of unit (feet)	810	1,110	1,998
Unit's total sand thickness (feet/percent)	300/37	495/45	960/48
Unit's total shale thickness (feet/percent)	510/63	615/55	1,038/52
Unit's sand-shale ratio	0.6	0.8	0.9
Number of potential reservoir sands in unit	3	2	7
Total thickness (feet) of unit's potential reservoir sands	85	105	274
Average thickness (feet) of unit's potential reservoir sands	28	52	39
Maximum thickness (feet) of a potential reservoir sand layer in unit	35	75	57
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.10	0.10	0.14
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.28	0.21	0.29
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	90–25–30 20–35–40 40–25–80	25–30– 65 40–75–185	47–35–55 23–57–25 48–30–32 32–45–55 35–22–35 35–50–30 30–35–50
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	3.60:1:1.20 0.57:1:1.14 1.14:1:3.20	0.83:1:2.17 0.53:1:2.47	1.34:1:1.57 0.40:1:0.44 1.60:1:1.07 0.71:1:1.22 1.59:1:1.59 0.70:1:0.60 0.86:1:1.43
Depth to top of uppermost potential reservoir sand (SLD)	1,615	2,485	3,707
Depth to top of lowermost potential reservoir sand (SLD)	1,810	3,025	5,110
Average depth to top of unit's potential reservoir sand (SLD)	1,700	2,755	4,195
Percent of potential reservoir sand in upper third of unit	71	71	55
Percent of potential reservoir sand in middle third of unit	29	0	11
Percent of potential reservoir sand in lower third of unit	0	29	34
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	20	26	15

Geophysical logs: Electric

Well No.: MD-WOR-OT-10

Record No.: 3033
State: Maryland
County: Worcester

Well name: Socony-Vacuum Bethard No. 1
Latitude: 381815
Longitude: 0751630

Depth of well----ft----7,174
Depth of well (SLD)----ft----7,116
Elevation of measuring point above ground level----ft----13
Elevation of ground level----ft----45

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,112	—3,379	—4,552
Thickness of unit (feet)	1,267	1,173	1,958
Unit's total sand thickness (feet/percent)	475/37	325/28	930/47
Unit's total shale thickness (feet/percent)	792/63	848/72	1,028/53
Unit's sand-shale ratio	0.6	0.4	0.9
Number of potential reservoir sands in unit	8	1	7
Total thickness (feet) of unit's potential reservoir sands	245	30	339
Average thickness (feet) of unit's potential reservoir sands	31	30	48
Maximum thickness (feet) of a potential reservoir sand layer in unit	55	30	85
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.19	0.03	0.17
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.52	0.09	0.36
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	30–20– 20 20–20– 30 60–25– 30 30–25– 70 70–55– 70 70–45–100 20–25– 30 30–30–175	65–30–75	50–40–20 20–27–25 25–45–50 30–37–38 38–30–85 25–85–25 25–75–20
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.50:1:1.00 1.00:1:1.50 2.40:1:1.20 1.20:1:2.80 1.27:1:1.27 1.56:1:2.22 0.80:1:1.20 1.00:1:5.83	2.17:1:2.50	1.25:1:0.50 0.74:1:0.93 0.56:1:1.11 0.81:1:1.03 1.27:1:2.83 0.29:1:0.29 0.33:1:0.27
Depth to top of uppermost potential reservoir sand (SLD)	2,120	4,017	4,812
Depth to top of lowermost potential reservoir sand (SLD)	3,347	4,017	6,472
Average depth to top of unit's potential reservoir sand (SLD)	3,148	4,017	5,913
Percent of potential reservoir sand in upper third of unit	23	0	22
Percent of potential reservoir sand in middle third of unit	18	100	25
Percent of potential reservoir sand in lower third of unit	59	0	53
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	13	134	17

Geophysical logs: Electric

Well No.: MD-WOR-OT-11

Record No.: 3034
State: Maryland
County: Worcester

Well name: Standard Oil of N.J., Maryland Esso No. 1
Latitude: 382430
Longitude: 0750345

Depth of well----ft----7,710
Depth of well (SLD)----ft----7,697
Elevation of measuring point above ground level----ft----4
Elevation of ground level----ft----9

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,725	—3,937	—5,099
Thickness of unit (feet)	1,212	1,162	2,072
Unit's total sand thickness (feet/percent)	612/51	500/43	1,202/58
Unit's total shale thickness (feet/percent)	600/49	642/55	870/42
Unit's sand-shale ratio	0.8	0.8	1.4
Number of potential reservoir sands in unit	7	1	5
Total thickness (feet) of unit's potential reservoir sands	470	60	165
Average thickness (feet) of unit's potential reservoir sands	67	60	33
Maximum thickness (feet) of a potential reservoir sand layer in unit	185	60	40
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.39	0.05	0.08
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.77	0.15	0.14
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	50– 25– 20 20– 50– 20 35– 60–105 105– 20–145 145–105– 50 50–185– 80 80– 25– 50	20–60–200	35–35–30 30–30–40 40–30–60 35–40–25 95–30–20

Well No.: MD-WOR-OT-11—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	2.00:1:0.18 0.40:1:0.40 0.58:1:1.75 5.25:1:7.25 1.38:1:0.48 0.27:1:0.43 3.20:1:2.00	0.33:1:3.33	1.00:1:0.86 1.00:1:1.33 1.33:1:2.00 0.88:1:0.63 3.17:1:0.67
Depth to top of uppermost potential reservoir sand (SLD)	2,837	4,197	5,185
Depth to top of lowermost potential reservoir sand (SLD)	3,902	4,197	6,512
Average depth to top of unit's potential reservoir sand (SLD)	3,389	4,197	6,097
Percent of potential reservoir sand in upper third of unit	45	100	43
Percent of potential reservoir sand in middle third of unit	26	0	36
Percent of potential reservoir sand in lower third of unit	29	0	21
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	7	70	37

Geophysical logs: Electric

Well No.: MD-QA-T-15

Record No.: 3129
State: Maryland
County: Queen Annes

Well name: USGS Test, Chestertown
Latitude: 391203
Longitude: 0760243

Depth of well____ft____1,995
Depth of well (SLD)____ft____1,970
Elevation of measuring point above ground level____ft____3
Elevation of ground level____ft____22

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—349	—752	—1,153
Thickness of unit (feet)	403	401	794
Unit's total sand thickness (feet/percent)	78/19	114/28	359/45
Unit's total shale thickness (feet/percent)	325/81	287/72	435/55
Unit's sand-shale ratio	0.2	0.4	0.8
Number of potential reservoir sands in unit	0	0	2
Total thickness (feet) of unit's potential reservoir sands	----------	----------	86
Average thickness (feet) of unit's potential reservoir sands	----------	----------	43
Maximum thickness (feet) of a potential reservoir sand layer in unit	----------	----------	46
Ratio—unit's potential reservoir sand thickness:unit's total thickness	----------	----------	0.06
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	----------	----------	0.24
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	----------	----------	76–46–108 64–40– 76
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	----------	----------	1.65:1:2.35 1.60:1:1.90
Depth to top of uppermost potential reservoir sand (SLD)	----------	----------	1,495
Depth to top of lowermost potential reservoir sand (SLD)	----------	----------	1,620
Average depth to top of unit's potential reservoir sand (SLD)	----------	----------	1,558
Percent of potential reservoir sand in upper third of unit	----------	----------	0
Percent of potential reservoir sand in middle third of unit	----------	----------	53
Percent of potential reservoir sand in lower third of unit	----------	----------	47
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	None	None	18

Geophysical logs: Electric, Gamma

Well No.: DEL-SUS-OT-5

Record No.: 4000
State: Delaware
County: Sussex

Well name: Sun Oil Co., Apple Orchard D-6
Latitude: 384325
Longitude: 0753200

Depth of well____ft____2,585
Depth of well (SLD)____ft____2,560
Elevation of measuring point above ground level____ft____0
Elevation of ground level____ft____25

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,630	Absent	Absent
Thickness of unit (feet)	>930	----------	----------
Unit's total sand thickness (feet/percent)	262/28	----------	----------
Unit's total shale thickness (feet/percent)	658/71	----------	----------
Unit's sand-shale ratio	0.4	----------	----------
Number of potential reservoir sands in unit	1	----------	----------
Total thickness (feet) of unit's potential reservoir sands	40	----------	----------
Average thickness (feet) of unit's potential reservoir sands	40	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	40	----------	----------

Well No.: DEL-SUS-OT-5—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.04	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.15	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	35–40–24	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.88:1:0.60	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	1,835	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	1,835	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	1,835	----------	----------
Percent of potential reservoir sand in upper third of unit	100	----------	----------
Percent of potential reservoir sand in middle third of unit	0	----------	----------
Percent of potential reservoir sand in lower third of unit	0	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	46	----------	----------

Geophysical logs: Electric

Well No.: DEL-NC-T-1

Record No.: 4011
State: Delaware
County: New Castle

Well name: Tidewater Oil Co., Vogel No. 2
Latitude: 392215
Longitude: 0753130

Depth of well----ft----2,312
Depth of well (SLD)----ft----2,286
Elevation of measuring point above ground level----ft----4
Elevation of ground level----ft----22

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—639	—1,361	—1,764
Thickness of unit (feet)	722	403	515
Unit's total sand thickness (feet/percent)	240/33	90/22	210/41
Unit's total shale thickness (feet/percent)	482/67	313/78	305/59
Unit's sand-shale ratio	0.5	0.3	0.7
Number of potential reservoir sands in unit	4	0	0
Total thickness (feet) of unit's potential reservoir sands	120	----------	----------
Average thickness (feet) of unit's potential reservoir sands	30	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	50	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.17	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.50	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	150–30–20 60–20–20 70–20–40 40–50–30	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	5.00:1:0.67 2.00:1:1.00 3.50:1:2.00 0.80:1:0.60	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	979	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	1,334	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	1,144	----------	----------
Percent of potential reservoir sand in upper third of unit	0	----------	----------
Percent of potential reservoir sand in middle third of unit	58	----------	----------
Percent of potential reservoir sand in lower third of unit	42	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	10	None	None

Geophysical logs: Electric, Gamma

Well No.: NJ-CM-OT-1

Record No.: 5000
State: New Jersey
County: Cape May

Well name: Anchor Gas Co., Dickinson No. 1
Latitude: 385720
Longitude: 0745700

Depth of well----ft----6,410
Depth of well (SLD)----ft----6,388
Elevation of measuring point above ground level----ft----8
Elevation of ground level----ft----14

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,420	—3,544	—4,522
Thickness of unit (feet)	1,124	998	1,776
Unit's total sand thickness (feet/percent)	390/35	265/27	1,206/68
Unit's total shale thickness (feet/percent)	734/65	713/71	570/32
Unit's sand-shale ratio	0.5	0.4	2.1
Number of potential reservoir sands in unit	2	2	3
Total thickness (feet) of unit's potential reservoir sands	110	74	98

Well No.: NJ-CM-OT-1—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Average thickness (feet) of unit's potential reservoir sands	55	37	33
Maximum thickness (feet) of a potential reservoir sand layer in unit	80	42	48
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.10	0.07	0.06
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.21	0.28	0.08
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	23–80–55 34–30–32	26–42–25 38–32–36	20–30–36 20–48–25 28–20–26
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.29:1:0.69 1.13:1:1.07	0.62:1:0.60 1.19:1:1.13	0.67:1:1.20 0.42:1:0.52 1.40:1:1.30
Depth to top of uppermost potential reservoir sand (SLD)	2,452	3,890	4,588
Depth to top of lowermost potential reservoir sand (SLD)	3,076	4,500	6,030
Average depth to top of unit's potential reservoir sand (SLD)	2,764	4,195	5,513
Percent of potential reservoir sand in upper third of unit	27	43	20
Percent of potential reservoir sand in middle third of unit	73	0	0
Percent of potential reservoir sand in lower third of unit	0	57	80
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	25	56	56

Geophysical logs: Electric, Gamma

Well No.: NJ-CU-OT-8

Record No. 5010
State: New Jersey
County: Cumberland

Well name: Anchor Gas Co., Ragovin No. 1
Latitude: 392530
Longitude: 0745225

Depth of well____ft____3,717
Depth of well (SLD)____ft____3,623
Elevation of measuring point above ground level____ft____9
Elevation of ground level____ft____85

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,667	—2,413	—3,108
Thickness of unit (feet)	746	695	508
Unit's total sand thickness (feet/percent)	220/29	120/17	278/55
Unit's total shale thickness (feet/percent)	526/71	575/83	230/45
Unit's sand-shale ratio	0.4	0.2	1.2
Number of potential reservoir sands in unit	0	1	0
Total thickness (feet) of unit's potential reservoir sands	----------	20	----------
Average thickness (feet) of unit's potential reservoir sands	----------	20	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	----------	20	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	----------	0.03	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	----------	0.17	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	----------	75–20–110	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	----------	3.75:1:5.50	----------
Depth to top of uppermost potential reservoir sand (SLD)	----------	2,919	----------
Depth to top of lowermost potential reservoir sand (SLD)	----------	2,919	----------
Average depth to top of unit's potential reservoir sand (SLD)	----------	2,919	----------
Percent of potential reservoir sand in upper third of unit	----------	0	----------
Percent of potential reservoir sand in middle third of unit	----------	0	----------
Percent of potential reservoir sand in lower third of unit	----------	100	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	None	146	None

Geophysical logs: Electric, Gamma Ray-Neutron

Well No.: NJ-CAM-T-2

Record No.: 5022
State: New Jersey
County: Camden

Well name: USGS Test, New Brooklyn State Park
Latitude: 394230
Longitude: 0745615

Depth of well____ft____2,090
Depth of well (SLD)____ft____1,979
Elevation of measuring point above ground level____ft____0
Elevation of ground level____ft____111

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—881	—1,727	Absent
Thickness of unit (feet)	846	192	----------
Unit's total sand thickness (feet/percent)	390/46	70/36	----------
Unit's total shale thickness (feet/percent)	456/54	122/64	----------
Unit's sand-shale ratio	0.9	0.6	----------
Number of potential reservoir sands in unit	2	0	----------
Total thickness (feet) of unit's potential reservoir sands	71	----------	----------

Well No.: NJ-CAM-T-2—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Average thickness (feet) of unit's potential reservoir sands	36	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	36	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.08	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.18	----------	----------
Thickness (feet—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	30–35–32 38–36–45	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.86:1:0.91 1.06:1:1.25	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	1,055		
Depth to top of lowermost potential reservoir sand (SLD)	1,542	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	1,299	----------	----------
Percent of potential reservoir sand in upper third of unit	51	----------	----------
Percent of potential reservoir sand in middle third of unit	0	----------	----------
Percent of potential reservoir sand in lower third of unit	49	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	18	----------	----------
		None	----------

Geophysical logs: Electric, Gamma

Well No.: NJ-BU-T-4

Record No.: 5037
State: New Jersey
County: Burlington

Well name: Butler Place, USGS Test
Latitude: 395145
Longitude: 0743025

Depth of well____ft____2,265
Depth of well (SLD)____ft____2,129
Elevation of measuring point above ground level____ft____4
Elevation of ground level____ft____132

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,234	—1,729	Absent
Thickness of unit (feet)	495	385	----------
Unit's total sand thickness (feet/percent)	210/42	200/52	----------
Unit's total shale thickness (feet/percent)	275/56	185/48	----------
Unit's sand-shale ratio	0.8	1.1	----------
Number of potential reservoir sands in unit	2	0	----------
Total thickness (feet) of unit's potential reservoir sands	72	----------	----------
Average thickness (feet) of unit's potential reservoir sands	36	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	48	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.15	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.34	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	60–48–25 46–24–21	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	1.25:1:0.52 1.92:1:0.88	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	1,400	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	1,600	----------	----------
Average depth to top of unit's potential reservoir sand (SLD)	1,540	----------	----------
Percent of potential reservoir sand in upper third of unit	0	----------	----------
Percent of potential reservoir sand in middle third of unit	33	----------	----------
Percent of potential reservoir sand in lower third of unit	67	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	21	None	----------

Geophysical logs: Electric, Gamma Ray-Neutron, Sonic

Well No.: NJ-OC-T-12

Record No.: 5044
State: New Jersey
County: Ocean

Well name: Toms River Chemical Test 84
Latitude: 395845
Longitude: 0741520

Depth of well____ft____2,254
Depth of well (SLD)____ft____2,186
Elevation of measuring point above ground level____ft____3
Elevation of ground level____ft____65

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—1,532	—2,072	Absent
Thickness of unit (feet)	540	>114	----------
Unit's total sand thickness (feet/percent)	236/44	----------	----------
Unit's total shale thickness (feet/percent)	304/56	----------	----------
Unit's sand-shale ratio	0.8	----------	----------
Number of potential reservoir sands in unit	2	----------	----------
Total thickness (feet) of unit's potential reservoir sands	52	----------	----------

Well No.: NJ-OC-T-12—Continued

Potential reservoir sand determination—Continued	Unit F	Unit G	Unit H
Average thickness (feet) of unit's potential reservoir sands	26	----------	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	32	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.10	----------	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.22	----------	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	20–32–30 23–20–20	----------	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	0.63:1:1.07 1.15:1:1.00	----------	----------
Depth to top of uppermost potential reservoir sand (SLD)	1,618	----------	----------
Depth to top of lowermost potential reservoir sand (SLD)	1,982	----------	----------
Average depth to top of unit's potential reservoir sands (SLD)	1,800	----------	----------
Percent of potential reservoir sand in upper third of unit	38	----------	----------
Percent of potential reservoir sand in middle third of unit	0	----------	----------
Percent of potential reservoir sand in lower third of unit	62	----------	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	35	----------	----------

Geophysical logs: Electric, Gamma

Well No.: NJ-OC-T-1

Record No.: 5049
State: New Jersey
County: Ocean

Well name: Island Beach USGS Test
Latitude: 394815
Longitude: 0740545

Depth of well____ft____3,881
Depth of well (SLD)____ft____3,868
Elevation of measuring point above ground level____ft____3
Elevation of ground level____ft____10

Potential reservoir sand determination	Unit F	Unit G	Unit H
Depth to top of unit (SLD)	—2,362	—2,966	—3,327
Thickness of unit (feet)	604	361	517
Unit's total sand thickness (feet/percent)	360/60	100/28	317/61
Unit's total shale thickness (feet/percent)	244/40	261/72	200/39
Unit's sand-shale ratio	1.5	0.4	1.6
Number of potential reservoir sands in unit	1	3	0
Total thickness (feet) of unit's potential reservoir sands	24	100	----------
Average thickness (feet) of unit's potential reservoir sands	24	33	----------
Maximum thickness (feet) of a potential reservoir sand layer in unit	24	38	----------
Ratio—unit's potential reservoir sand thickness:unit's total thickness	0.04	0.28	----------
Ratio—unit's potential reservoir sand thickness:unit's total sand thickness	0.07	1.00	----------
Thickness (feet)—Immediately underlying shale seal–potential reservoir sand–immediately overlying shale seal.	66–24–26	146–28–64 64–34–24 24–38–30	----------
Ratio (feet)—Thickness of immediately underlying shale seal:thickness of potential reservoir sand:thickness of immediately overlying shale seal.	2.75:1:1.08	5.21:1:2.29 1.88:1:0.71 0.63:1:0.79	----------
Depth to top of uppermost potential reservoir sand (SLD)	2,612	2,997	----------
Depth to top of lowermost potential reservoir sand (SLD)	2,612	3,153	----------
Average depth to top of unit's potential reservoir sands (SLD)	2,612	3,075	----------
Percent of potential reservoir sand in upper third of unit	0	72	----------
Percent of potential reservoir sand in middle third of unit	100	28	----------
Percent of potential reservoir sand in lower third of unit	0	0	----------
D/PR factor (average depth of potential reservoir sand occurrence/total thickness of unit's potential reservoir sand).	109	93	None

Geophysical logs: Electric, Gamma Ray-Neutron, Sonic