(10)

ADDENDUM #4

HYDROLOGY STUDY

to

MARTIN DOWNS

DEVELOPMENT OF REGIONAL IMPACT

APPLICATION FOR DEVELOPMENT APPROVAL

2nd Edition

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

* NOTE: Revised on April 11, 1980

EXECUTIVE SUMMARY

A comprehensive hydrologic investigation was performed on the Martin Downs property in compliance with DER requirements as specified in the Informational Adequacy Statement (IAS), Part D, regarding the availability of a potable water supply source for the proposed development. The scope of the investigation is outlined as follows:

- A network of 18 observation wells were constructed to act as future monitoring wells for water levels and water quality, and potential saltwater intrusion on the property. Lithologic descriptions, interpretations, cross sections and aquifer thickness determinations were made from the cutting samples obtained during well construction.

- A 72-hour aquifer test was conducted for the purpose of wellfield design and management.

- A chloride and iron survey was conducted to determine a regional perspective and background water quality.

- Geophysical logging was performed to aid in lithologic interpretation.

- An ongoing monitoring program has been implemented involving surface and groundwater monitoring to obtain long-term variations in the water resources of the area. It will also serve to monitor any potential saltwater intrusion or other adverse impacts resulting from supply well withdrawals.

Development of a potable water supply system requires a thorough evaluation of the area geology, aquifer characteristics and water quality. Hydrogeologic data collected as part of this study indicates that sufficient quantities of potable water can be developed from the surficial aquifer to supply Martin Downs. Municipal supplies can be developed in the sandy shell with limestone unit, and limestone unit between depths of 60 to 140 feet. Based on aquifer test results, the aquifer coefficients of transmissivity and storage are 84,800 gpd/ft and 0.14 respectively. Under these conditions four wells with separations of about 3,000 feet with capacities of 650 gpm each would be sufficient to serve the average day demand at buildout of 2.55 MGD. To meet projected maximum day demands of 4.06 MGD, four wells pumping at 750 gpm each would be required. Well spacing would not be significantly affected by this change. Wells completed in the sandy shell unit should be screened and gravel packed to optimize well efficiency and production rates. Wells completed in the underlying grey limestone unit may be developed open hole. Ideal well locations would be in the western areas of the property near the Florida Turnpike where the aquifer tends to be thickest and most productive based upon litholcgy and aquifer characteristics.

Water quality throughout the water producing zones of the aquifer is potable. It is typically hard, high in dissolved solids, iron and color. Sulphate and chloride concentrations are low, although a slight increase occurs north of the Martin Downs property in the upper reaches of Bessey Creek.

The Hawthorn Formation forms the confining layer at the base of the aquifer system. It separates the potable surficial aquifer from the highly mineralized Floridan (artesian) aquifer water. Uncontrolled flowing artesian wells from depth will cause gradual degradation of the surface water and surficial aquifer water quality. It is recommended these free-flowing wells be plugged to prevent deterioration in water quality of the upper potable zones. Major degradation of surface waters adjacent to Martin Downs property are primarily in the tidal reaches of Bessey Creek north of the property boundary.

Monitoring of the water levels in the observation wells showed a northeasterly flow gradient across the property with a range in elevation from approximately 13.5 feet msl in the southwest part of the property with a decline to 1.64 msl in the northeast part of the property. Maintaining a high freshwater head and steep hydraulic gradient is sound water management practice which helps to minimize possible impacts due to saltwater intrusion into the proposed municipal and existing domestic potable supply wells.

A spray irrigation and effluent recharge study is to be implemented at a later date when the wastewater treatment facilities are constructed. At that time, all efforts will be made to comply with all current state and local government regulations regarding disposal and monitoring.

LIST OF FIGURES

Figure

LIST OF FIGURES (Continued)

Figure

LIST OF TABLES

Table

APPENDICES

1.0 PURPOSE AND SCOPE

Gee & Jenson Engineers-Architects-Planners, Inc., was contracted by First Southern Holdings, Inc. to perform a comprehensive hydrologic investigation at the proposed Martin Downs Development (Figure 1-1). The purpose of this program was to satisfy the DRI requirements as specified in the Informational Adequacy Statement (IAS), Part D, regarding the availability of a potable water supply source for the project property (Appendix 1).

The scope of the program is outlined as follows:

- A network of wells was constructed on the property. These consisted of 6 deep observation wells, 8 shallow observation wells and 4 observation wells for the aquifer test. The purpose of these wells is to act as future monitoring wells for determining water table configuration, water quality and potential salt water intrusion on the property. By analyzing the cutting samples from these wells, lithologic interpretations have been made over the study area. The thickness and areal extent of the aquifer could also be determined from this information.

- A 72-hour aquifer test was conducted to determine on-site aquifer parameters for the purposes of well field design and management. In the analysis is included determination of the cone of depression due to pumping and potential impacts on adjacent users.

- Existing wells on and abutting the property were sampled for chloride and iron concentrations. The purpose was to obtain a regional perspective of existing water quality over the area.

- The deep observation wells were geophysically logged with a gamma ray probe to obtain additional information for lithologic interpretation.

- Ongoing hydrologic information will be collected by the existing monitoring program which involves both surface water and groundwater monitoring. This will enable determination of long-term seasonal variations in the water resources of the area. It will also serve to monitor any potential salt water intrusion or other adverse impacts resulting from supply well withdrawals. Monitoring data for April 1980, has been collected and is included in the report.

2.0 OBSERVATION WELL CONSTRUCTION

2.1 Scope Of Work

A network of 18 observation wells was constructed on the Martin Downs property between March 6, 1980 and March 17, 1980. During construction, cutting samples were collected from each well. The well locations were selected to provide maximum coverage of the property. The purpose of the well construction was to provide data necessary for lithologic and hydrogeologic interpretation of the subsurface strata. This was to include delineation of the water producing zones and determination of the thickness of the aquifer accomplished by studying cutting samples from the wells (This is further discussed in Section 3.0). In addition, the wells are to serve as permanent observation wells to be monitored for water levels and water quality in ongoing monitoring programs. The locations of the observation wells are shown in Figure 2-1.

2.2 Method Of Construction

A total of 18 wells were drilled, of which 10 are deep and 8 shallow. These include the observation wells used in the aquifer test. Shallow wells were drilled to depths of 30 and 60 feet and deep wells to about 140 feet. All wells were constructed using the mud rotary drilling method. A nominal 5-inch bore hole was drilled to the designated well depth. Cutting samples were collected at five feet intervals and described according to lithology (See Section 3.0). Well construction consisted of the installation of 2-1/2 inch Schedule 40 PVC casing from land surface to 10 feet for the shallow wells and about 80 feet for the deep wells. 2-1/2 inch Schedule 40, #40 slot PVC screen was installed below the casing to the bottoms of the wells. Silica sand of 0.75 mm grade was installed as annular gravel pack between the casing and the formation from the base of the screens up to 10 feet above the screen. In the deep wells a 10 foot grout plug was installed. Natural fill was used to backfill the remaining annular space to ground level. The wells were developed by lowering the drill rod to within one foot of the bottom and pumping to remove all mud and sediment. Then a 150 cfm air compressor was used to fully develop the fines from the well, gravel pack and adjacent formation. The well was pumped until clear water was attained for water quality sampling. On completion of development, a 30" x 30" x 4" reinforced concrete pad was constructed around each well. The elevation of each well was taken at the top of the casing and at ground surface. Figure 2-2 shows the typical deep and shallow observation well construction and Table 2-1 lists the well construction data for each well.

3.0 GEOLOGY

3.1 Lithology Description

Lithologic logs of well cuttings are described in detail for each observation well in Appendix 2. Geologic cross sections between wells illustrate trends in the regional geology of the area. An understanding of the geology is essential in discerning potential and corresponding optimum well construction for efficiently withdrawing water from the water producing zones. Locations of lithologic cross sections are shown in Figure 3-1. This figure shows four cross sections, A-A' west to east along the northern part of the study area, B-B' west to east along the southern part, C-C' north to south along the western part, D-D' north to south along the eastern part of the study area.

In general, the upper 15 to 50 feet of surficial sand is fine grained, light to dark brown silica sand with a well developed hardpan. This hardpan is characterized by a strong gamma ray deflection which makes a good stratigraphic indicator. In the eastern part of the study area, this sand unit includes a calcareous marl layer that exceeds 25 feet in thickness. The silica sand unit is typically unconsolidated except for varying degrees of cementation within the hardpan layer. Limestone gravel and some shell fragments occur in the marl which generally makes an abrupt transition into the underlying sandy shell unit. A potential semi-confining zone may be inferred from this marl layer, but only two well groupings (1-S, 1-D, 6-S and 6-D) indicate a significant head differential between the sands above the marl zone and the shell and limestone below the marl. Although areally expansive, a low permeable strata of this nature will create semi-confined aquifer conditions in the underlying water bearing sediments during early time drawdowns; with long-term pumping, this aquifer will respond as an unconfined aquifer as dewatering of the surficial aquifer occurs.

The sandy shell unit underlying the silica sand unit is typified by unconsolidated light brown to black mollusc fragments with very fine grained phosphatic silica and carbonate sand interlayered with lenses of grey fossiliferous, well lithified limestone. This sandy shell unit ranges in thickness from 75 feet in the west to 40 feet in the eastern part of the study area. Eastward thinning of this unit is due to the overlying easterly thickening marl layer.

A grey to light brown fossiliferous lithified limestone underlies the sandy shell unit. This unit averages about 45 feet in thickness, thinning slightly to the northeast. It is the major water producing zone in the study area.

An olive green silty sand is encountered below the limestone unit and marks the top of the Hawthorn Formation. These olive green silty sands are encountered at depths of 130 to 135 feet msl in the western part of the study area, and 120 to 125 feet msl in the east. The Hawthorn Formation forms the base of the surficial aquifer in south and eastern Florida.

Major lithologic units being differentiated for hydrologic significance are the upper silica sand, sandy shell with limestone, limestone and olive green silty sand.

In the west to east cross section A-A' (Figure 3-2) the silica sand unit extends to an average depth of 20 feet. A marl layer in the eastern half of the cross section has been incorporated into the silica sand unit. This marl layer is up to 25 feet thick in Well 1-D, pinching out to the west of well 7-S and thinning east of well 1-D. The sandy shell with limestone unit is 75 feet thick in wells 4-D and 6-D, thinning to 35 feet beneath the marl layer in wells 7-S and 1-D. As the marl layer thins eastward, the sandy shell unit again thickens to 46 feet in well 5-S. This unit can produce significant quantities of potable water with proper well construction. A grey limestone ranges from 45 to

50 feet thick in wells 4-D and 6-D, but thins eastward to 25 feet in well 5-S. Eastward thinning of this limestone unit appears to be controlled by a westward dip to the top of the silty sand of the Hawthorn Formation. This confining layer is encountered at depths of 120 feet msl in well 5-S and 1-D, and at depths of 140 and 135 feet in wells 6-D and 4-D.

In the west to east cross section B-B', (Figure 3-3) a similar stratigraphy occurs. An upper silica sand unit thickens from 18 feet in the west to 49 feet to the east. This thickening is again coincident with a calcareous marl layer which first ranges in thickness from 22 feet in well 8-S to 10 feet in well 2-D. A second 20 feet thick silica sand layer occurs beneath the marl layer in well 2-D. The sandy shell with limestone unit is 80 feet thick in well 3-D, thinning eastward to 40 feet of thickness in well 2-D. Thinning of this unit corresponds to thickening of the overlying marl layer. The limestone unit is approximately 30 feet thick in well 3-D, thinning in well 5-D, and thickening eastward again in well 2-D. Thinning of this unit in the central part of the cross section is a result of a rise in the top of the basal Hawthorn Formation in well 5-D. Top of the silty sand unit is approximately 128 to 126 feet msl in wells 3-D and 5-D, rising to 112 feet msl in well 5-D.

North to south cross section C-C' (Figure 3-4) along the west boundary of the study area shows very consistent stratigraphy in this direction. The upper silica sand unit is approximately 18 feet thick, with a hardpan overlying the sandy shell with limestone unit. The sandy shell unit averages about 78 feet in thickness with a slight southerly dip. The underlying limestone unit also dips slightly southward as well as thickening from 42 feet in well 4-D to 52 feet in well 3-D. Top of the Hawthorn Formation is encountered at 112 feet msl, in well D-4 and 130 feet msl in well D-3.

North to south cross section D-D', (Figure 3-5) also shows similar stratigraphic trends along a north-south trend, but there are significant variations in lithology in the eastern part of the study area when compared to the western part. The presence of the marl layer is prominent in the upper silica sand unit in easterly wells such as D-1 and D-2. In these wells this layer thins southward from 28 feet in D-1 to 18 feet in D-2. The underlying sandy shell with limestone unit is primarily limestone in this section as compared to the westerly sections containing wells 3-D, 4-D, 5-D and 6-D. A reduction in degree of deflection on the gamma ray logs is indicative of the reduced shell content in well D-2. However, in well D-2, a carbonate phosphatic sand comprises the lower 12 feet of this unit and it produces a strong gamma ray deflection. The lower limestone unit thickens from 26 feet in well D-1 to 44 feet in well D-2. This southerly thickening coincides with the southerly dip of the top of the Hawthorn Formation, also observed in cross section C-C'.

3.2 Geophysics

Each well was geophysically logged for natural gamma radiation. The purpose of the logging was to verify and substantiate drill cutting descriptions, and to aid in subsurface correlation and mapping.

Gamma ray logging measures the natural gamma radiation from radioactive elements that occur in varying amounts in subsurface formations by lowering a down-hole sensor into a well. The relative emission of gamma rays by the geologic formations traversed, is then plotted in vertical profile. Some formations contain higher concentrations of naturally occuring radioactive elements and isotopes such as thorium, uranium, potassium and phosphate. In most cases, as an example, clay emits more radiation than limestone and sand. Changes in water quality have little effect on the gamma ray log. For proper interpretation of the gamma ray log, it should be correlated with the lithologic log and any other geologic data available. Gamma ray profiles were plotted next to the lithologic cross sections in Figure 3-2 to 3-5 for direct correlation.

When comparing gamma ray logs to lithology logs, certain correlations may be made. In all wells, the amplitude of the gamma ray profile increases dramatically in the cemented hardpan of the upper silica sand unit. A low gamma ray response typically follows the high peak. This low area is coincident with unconsolidated silica sand which immediately overlies the sandy shell with limestone unit. This unit is characterized by four strong peaks with deep troughs in between. The peaks correlate with shell beds and the troughs correlate with limestone beds. Top of the lower limestone unit is typified by a gamma trough generally 10 to 15 feet thick. Below this trough, gamma activity gradually rises until the olive green silty sand of the Hawthorn Formation is encountered. The Hawthorn Formation characteristically creates a large deflection due to its high phosphate content.

In summary, gamma ray logs are used as lithologic markers for stratigraphic correlations. Pertinent to the study area, gamma ray logs serve to identify the tops and thicknesses of hydrogeologic units which are primary and secondary water producing zones.

4.0 AQUIFER TEST

4.1 General Description

An aquifer test was conducted for First Southern Holdings, Inc., on Martin Downs property to determine aquifer parameters necessary for the planning and management of the water resources of the area and the proposed public water supply system. The test was started on March 16, 1980. It involved pumping one well at a constant rate of 850 gpm for a duration of 72 hours and observing resulting drawdowns and changes in water levels in nearby observation wells and lakes. The site of the aquifer test was in the northwest part of the property, near the Florida Turnpike (Figure 4-1). Figure 4-2 shows the configuration of the wells used and the distances between wells including two distant observation wells, 3-D and 4-D used for background data collection. There was one existing 10 inch diameter well used as the pumping well (PW). Four 2-1/2 inch diameter wells were installed as observation wells of which three were deep (OW-1D, OW-2D, OW-3D) and one shallow (OW-1S). Methods of well construction are described in Section 2.0. Staff gages were installed in nearby lakes (SG-1, SG-2, SG-3) to measure lake stages. SG-1 and SG-2 are located in the two lakes adjacent to the pumped well. SG-3 was located in a borrow pit 1.5 miles to the east (Figure 4-2A). This borrow pit has no inflow or or outflow points, and serves as a good indicator of natural surface water fluctuation from evapotranspiration. A temporary rain gage was installed at the site to measure any rainfall. Water was discharged from the site into a drainage ditch flowing away from the site about 450 feet from the pumped well. The data from the test was analyzed using analytical techniques to obtain aquifer parameters. The conjunctive use of drilling data and analytical solutions of the test results were used to determine the values of these aquifer parameters and to interpret the results. Jacob and Boulton Methods for aquifer analysis have been utilized and included in this report as the methods of analysis. The coefficients of transmissivity and storage are essential in determining the characteristics of the aquifer in this region.

Transmissivity is defined as the rate of flow of water at prevailing water temperature, in gallons per day per foot through a vertical strip of aquifer one foot wide extending the full saturated thickness of the aquifer under a hydraulic gradient of 100 percent. A hydraulic gradient of 100 percent means a one foot drop of water level in one foot of flow distance.

The coefficient of storage of an aquifer is the volume of water released from storage per unit of surface area of the aquifer, per unit change in head. In water table aquifers, the storage coefficient is the same as the specific yield of the material dewatered during pumping. In confined aquifers it is the result of compression of the aquifer and expansion of the contained water when the head (pressure) is reduced during pumping.

4.2 Methods of Data Analysis

4.2.1 Jacob Method

The Jacob method of aquifer analysis is based on the Theis formula, but is more restricted in its applicability. It is based on the following assumptions:

- aquifer is confined
- flow to the well is unsteady
- water removed from storage is discharged instantaneously with decline in head
- storage in the pumped well can be neglected
- the values of u are small ($u < 0.01$), i.e., r is small and t is large (the condition that u is small will be satisfied in confined aquifers for moderate distances from the pumped well in a short period of time. For unconfined aquifers, longer periods of pumping may be required).

The procedure used to calculate the parameters involves the plotting of drawdown against time on semi-logarithmic paper of the data obtained for each of the observation wells. The equations used were:

$$T = \frac{264Q}{s} \quad \text{and} \quad S = \frac{0.3Tt_o}{r^2}$$

where

T = transmissivity (gpd/ft)

S = storage coefficient (dimensionless)

s = slope of the time - drawdown graph expressed as a change in drawdown over one log cycle of time (ft)

Q = discharge from pumping well (gpm)

r = distance of observation wells from pumped well (ft)

t_o = intercept of the straight line at zero drawdown (days)

4.2.2 Boulton Method

Boulton (1963) assumes that the amount of water derived from storage within an aquifer, due to an increment of drawdown, Δs, between times r and r + r since pumping began consists of two components:

(1) A volume of water instantaneously released from storage per unit horizontal area.

(2) A delayed yield from storage, per unit horizontal area, at any time t, $(t > r)$ from the start of pumping.

The following assumptions apply when using the Boulton Method:

- aquifer has seemingly infinite areal extent
- the aquifer is homogenous, isotropic, and of uniform thickness over the area influenced by the pumping test
- prior to pumping, the phreatic surface is horizontal over the area influenced by the pumping test.
- the discharge rate is constant from the pumped well
- the pumped well penetrates the entire thickness of the aquifer and receives water by horizontal flow
- the aquifer is unconfined but showing delayed yield phenomena or the aquifer is semi-unconfined.
- the flow to the well is in an unsteady state
- the diameter of the well is small, i.e., the storage in the well can be neglected.

To calculate the aquifer parameters, drawdown is plotted against time on double logarithmic graph paper. By curve matching with the Boulton Delayed Yield Type Curves, match points are determined allowing the following equations to be used to calculate the transmissivity and storage coefficient for early time and late time data:

$$T = \frac{114.6Q}{s} W(u_{AY}, r/B) \quad \text{and} \quad S = \frac{Tt}{2693r^2} u_{AY}$$

where T, S, r, s and Q were defined earlier and

W (u, r/B) = "well function of Boulton"
subscript A = early time
subscript Y = late time

4.3 Results of the Aquifer Test

The aquifer at Martin Downs was pumped continuously for 72 hours at 850 gpm. Drawdown data was collected from four observation wells near the pumped well, and two additional observation wells further from the site. The locations are shown in Figure 4-2, and the well construction information and distances from the pumped well are summarized in Table 4-1. Figure 2-2 illustrates the typical deep and shallow well construction methods.

Adjustments were made in the raw drawdown data to account for dewatering of the aquifer from pumping and any other natural trends in water levels. This adjusted data was then used in the calculations to obtain the aquifer parameters.

Listed below are the results obtained from the various methods of analysis:

4.3.1 Jacob Method (See Figure 4-3)

OW-1D: T = 93,900 gpd/ft

$S = 7.1 \times 10^{-4}$

OW-3D: T = 97,600 gpd/ft

$S = 1.7 \times 10^{-2}$

It should be noted that this method utilizes only early drawdown data and therefore observes artesian storage and transmissivity values. These values are not to be used in determining well spacing or projecting water level declines.

4.3.2 Boulton Method (See Figures 4-4, 4-5, 4-6 for Wells OW-1D, OW-2D and OW-3D, respectively)

Early Time Results:

		T (gpd/ft)	S
For Well:	OW-1D	89,400	8.8×10^{-4}
	OW-2D	*	*
	OW-3D	90,200	3×10^{-3}
			.00194

Late Time Results:

		T (gpd/ft)	S
For Well:	OW-1D	84,700	0.07
	OW-2D	81,200	0.02
	OW-3D	88,600	0.33
Average (Late Time)		84,800	0.14

*Early time data for OW-2D was not available due to recorder malfunction.

$$S_a + S_y = \gamma S_a$$

$$\gamma = 1 + \frac{S_y}{S_a}$$

See addition to back Cover

Early time results using the Boulton Method still show artesian and semi-artesian storage values due to incomplete dewatering. During this early period of pumping, water is released instantaneously from storage by the compaction of the aquifer and by expansion of the water and the curve conforms to the Theis curve. During the second segment of the curve, the effects of gravity drainage are registered. The slope of the curve decreases relative to the Theis curve due to dewatering of the falling water table. The third segment, occuring at later times, once again conforms to the Theis curve.

Not evident

Carrying the analysis further, drawdown for various intervals of time were calculated. The intervals used were 1 day, 3 days, 10 days, 30 days and 100 days of continuous pumping, assuming no recharge. The calculations for this drawdown data are summarized in Table 4-2 for each of the deep observation wells.

The drawdown vs. distance data is summarized as follows (from Table 4-2):

Time Interval	OW-3D r = 51.8 ft	OW-1D r = 97.2 ft	OW-2D r = 216.1 ft
1 Day	4.9 ft	3.5 ft	1.7 ft
3 Days	6.1 ft	4.7 ft	2.9 ft
10 Days	7.5 ft	6.1 ft	4.2 ft
30 Days	8.8 ft	7.3 ft	5.5 ft
100 Days	10.1 ft	8.7 ft	6.9 ft

Plotting this data on a drawdown vs. distance graph (Figure 4-7) gives a graphical representation of the cone of influence.

From the graph, the one foot drawdown contour can be estimated. These results are summarized as follows:

DISTANCE OF THE 1-FOOT DRAWDOWN CONTOUR FROM THE PUMPING WELL (850 gpm):

t = 1 day	312 ft.
t = 3 days	530 ft.
t = 10 days	935 ft.
t = 30 days	1625 ft.
t = 100 days	3160 ft.

Using drawdown data from Table 4-2, the drawdown vs. time curve is plotted in Figure 4-8. The calculated drawdowns can then be compared with actual field data by extrapolation of the curves in Figure 4-3 to the designated time intervals. A comparison of the results is shown in Table 4-3.

4.4 Discussion of Results

In using analytical methods to calculate the hydraulic properties of an aquifer, consideration should be given to the limiting conditions associated with each method. The degree to which a particular method fits the actual field conditions has a significant effect upon the results obtained. From the results it can be seen that some variations in transmissivities and storage coefficients occurred using the different methods.

The Jacob Method yields the poorest results due to the limiting conditions with storage coefficients for all wells indicating confined conditions.

It was felt that Boulton's Late Time data gave the most reliable set of aquifer parameters. From Section 4.3.2, which summarizes the results, the storage coefficients from the early-time data indicate confined conditions. The late-time data shows storage coefficients for unconfined conditions as suggested by geologic data. The first segment of the curve indicates that an unconfined aquifer reacts initially as a confined aquifer due to an instantaneous release of water from storage. The storage coefficient computed from the early segment should not be used to predict long-term drawdowns in the water table. The central part of the curve shows a decrease in slope due to replenishment by gravity drainage. During the later part of the curve, equilibrium has been established between gravity drainage and the rate of fall of the water table. Therefore, the Boulton Late Time gave an average transmissivity of 84,800 gpd/ft and an average storage coefficient of 0.14.

Delayed yield effects will influence water levels for a specific period of time. After this point, effects of gravity drainage have stabilized and the drawdown curve follows the Theis curve. Walton's equation for calculating the delayed yield index is:

$$= \frac{(r/B)^2 \; 1/U_y}{4t}$$

Times for effects of gravity drainage to have negligible effects on the observation wells are calculated to be:

OW-1D	9000 min
OW-2D	9600 min
OW-3D	10,800 min

These results can be carried further to determine the cone of depression around a pumping well at varying pumping rates, and optimal distances between proposed supply wells.

4.5 Projected Cone of Depression

The cone of depression around a pumping well is dependent upon the transmissivity, storage coefficient and pumping rate. Given these factors, the shape and extent of the cone of depression may be predicted. Maintaining Boulton's Late Time transmissivity and storage coefficient of 84,800 gpd/ft and 0.14 respectively, constant, and varying the pumping rate, the drawdown with distance from the pumping well is determined after 30 and 100 days of continous pumping, assuming no recharge. The drawdown vs. distance graph for selected pumping rates after 30 days of continuous pumping is shown in Figure 4-9 and for 100 days in Figure 4-10. These are considered worst case situations since no recharge is assumed. Distance of the one foot drawdown contour from the pumping well at varying pumping rates may be determined from the graphs.

This data is summarized in Table 4-4. For example, at a pumping rate of 650 gpm, the one foot drawdown contour would extend a distance of 1,450 feet from the pumping well after

30 days of continuous pumping. This is represented schematically in Figure 4-11. It is felt that the cones of influence represented by pumping continuously for 30 days, assuming no recharge is a sufficiently conservative estimate for wellfield planning and design.

4.6 Wellfield Design

The proposed Martin Downs development will require 2.55 million gallons per day (MGD) on an average day basis at buildout. The geology and hydrology of the aquifer indicate that these requirements can be adequately met. Four wells, including one standby with capacities of 650 gpm each satisfy these requirements. A tentative wellfield configuration is shown in Figure 4-12, including the estimated one foot drawdown contours under worst case situations. The supply wells are shown aligned parallel to the Florida Turnpike about 800 feet inside the western border of the property. Table 4-5 summarizes well spacings at varying pumping rates. The exact location and capacity of each well will be subject to site-specific variations in the lithology and hydrology of each location. This is determined during supply well construction.

5.0 WATER QUALITY

5.1 Groundwater Quality

5.1.1 Chloride and Iron Survey of Surficial Aquifer Wells

Domestic water supply wells were inventoried for chloride and iron content from properties on and abutting Martin Downs Development. Purpose of the survey was to obtain background water quality data and determine the location of the freshwater/saltwater interface, if present. Figure 5-1 shows the areas sampled. These include domestic wells in Crane Creek, regions north of Martin Downs on tributaries of Bessey Creek, the region northeast of the property adjacent to the South Fork of the St. Lucie River, and an area inland. Most of the wells surveyed are considered to be shallow wells tapping the upper (20 to 50 feet) silica sand unit of the surficial aquifer. Exact depths are not available for most of the wells. A total of 347 wells were sampled for chloride content and 323 wells were sampled for iron content. This data is tabulated in Appendix 3. The maximum recommended potable limits according to DER Standards are 250 mg/l for chloride and 0.3 mg/l for iron. Chloride concentrations in wells that were sampled ranged from 15 to 182 mg/l, and for iron from less than 0.2 mg/l to greater than 10 mg/l throughout the area. Table 5-1 graphically depicts these ranges which are then plotted on area maps as shown in Figure 5-1. There were a total of eight areas that were sampled. Figures 5-2 to 5-9 depict the chloride concentrations, and Figures 5-10 through 5-17 depict the iron concentrations throughout the eight areas sampled.

Chloride Survey

Analysis of chloride samples indicate all wells are within the DER limits, with the highest concentration of 182 mg/l occuring in Area 8. Only Area 4 and Area 8 beyond the north central property line, experienced chloride concentrations in the 93 to 182 mg/l range. In all other areas the chloride content was less than 92 mg/l in the wells surveyed. These results indicate that the aquifer system on and abutting Martin Downs property contains potable quality water with respect to chloride concentration. Chloride concentrations are generally in the 15 to 66 mg/l range in the study area.

Iron Survey

Of all samples analyzed for iron content only about 30 samples had concentrations less than 0.2 mg/l. All other samples are in excess of the DER potable limit. These wells are scattered throughout Areas 1, 2, 4 and 6 intermingled with wells of higher iron content. There are two wells that contained water with an iron concentration in excess of 9 mg/l. These are both located in Area 6. Generally, iron concentrations in the Martin Downs region is high and areally erratic. For example, the range in iron content in Area 4 is from less than 0.2 to 9 mg/l, with most wells being in the 0.2 to 6 mg/l range. Excessive iron concentrations are associated with wells developed in the shallow sand aquifers throughout Florida. Iron rich heavy metals are transported and deposited along with these marine sands. Changing the natural chemical equilibrium of the groundwater system by pumping will promote dissolution of the iron minerals, initiating increased iron concentrations in the groundwater. Once the ferrous ion in the groundwater is exposed to air, a change to ferric oxide promotes precipitation and hence the red staining so prevalent in the Martin Downs area.

5.1.2 Floridan Aquifer Wells

Chloride concentrations exceeding potable limits occur in samples obtained from free flowing artesian wells tapping the Floridan aquifer. A well inventory of existing on-site wells indicated the presence of four such wells. The locations of these wells are shown in Figure 5-18. Each of these wells tap water from a depth in excess of 700 feet. The results of the analyses are summarized as follows:

Well No.	Depth (ft)	Chloride (mg/l)	Date Sampled	Source
1	950	1225	02-07-80	Gee & Jenson
2	773	1115	02-07-80	Gee & Jenson
3	775	1130	04-23-57	Lichter (1960) USGS
4	950	1425	02-22-80	Gee & Jenson

(Analyses by the Water Works)

These results indicate the Floridan (artesian) aquifer wells yield water of high mineral content. It is recommended that these free flowing wells be plugged to prevent further contamination of the shallow potable aquifer system.

5.1.3 Standard Potable Analysis of Surficial Aquifer

The surficial aquifer water was sampled for standard potable analysis. Six deep observation wells and the pumping well (PW) used for the aquifer test were sampled. These wells are located around the periphery of the property (Figure 2-1). Table 5-2 shows the results of the analyses.

Water quality in the surficial aquifer is satisfactory for potable use. Chloride content ranges from 30 to 163 mg/l, which is considerably below the recommended DER maximum of 250 mg/l. Fluoride content ranges from 0.17 to 0.24 mg/l and has a maximum DER regulation limit of 1.5 mg/l. Nitrate content is less than 0.1 mg/l for all samples collected which is well below the maximum DER limit of 1.0 mg/l. Total dissolved solids range from 260 to 604 mg/l. The range in iron concentration is from 0.5 mg/l to 4.3 mg/l. Sulphate content is low, ranging from less than 5 to 18 mg/l. Color is high reaching values upwards of 70 units. Treatment will be required to reduce primarily the color and iron concentrations and reduce hardness for use as a municipal water supply.

5.2 Surface Water Quality

Martin Downs is drained primarily by the Bessey Creek and Fox Run systems to the north of the property and the Danforth Creek system which borders the southeast edge of the property (Figure 5-19). These systems, including many of their tributaries, were monitored for conductivity on February 24, 1980. The results are listed in Table 5-3 and the sampling points shown in Figure 5-20. The readings were made during a falling tide such that the saltwater intrusion in the channels were ebbing.

The conductivity surveys were made at points along the length of both major and minor tributaries draining Martin Downs. Figure 5-19 shows all the primary, secondary, tertiary and other water bodies sampled.

Using conductivity as a general indicator for water quality (the potable limit for chlorides is 250 mg/l according to DER standards. 250 mg/l is approximately equal to 1500 umhos/cm), it was found that all surface waters on the site were well below this range. Specific sampling points are shown in Figure 5-20. The exception to this is at FR-c where the conductivity was recorded at 4500 umhos/cm, and a proliferation of sulfer bacteria in the water was noted. This is resulting from a free-flowing Floridan aquifer (artesian) well discharging into the Fox Run Channel. Localized degradation of groundwater quality may also be occurring from such artesian well discharge.

Downstream of this at FR-e, the conductivity dropped to 550 umhos/cm. This potential problem, and any similar occurrences can be remedied by plugging these free-flowing wells.

The South Fork St. Lucie River was monitored in two locations, at M-a and DC-d at the mouth of Danforth Creek. The conductivities were 940 and 1030 umhos/cm, respectively.

Danforth Creek, abutting the southeast edge of the property had conductivities in the 400 umhos/cm range (DC-a, DC-b, DC-c) on February 24, 1980. The presence of Rhizophora mangle along the banks of Danforth Creek at DC-b indicates this stretch of the creek is subject to saline tidal waters. The area to the north of the property, drained by Bessey Creek, a tributuary of the North Fork St. Lucie, was monitored extensively. Self-contained lakes, free from tidal influences, appear to be maintaining fresh water. Lake X was found to have a conductivity of 105 umhos/cm and TFR-1a and TFR-1b conductivities of 95 and 82 umhos/cm respectively. TTFR-a, which flows into the above canal system was 96 umhos/cm.

It should be noted that these are extremely low conductivities for this area and that the elevation in this canal system is maintained by a structure between sampling sites TFR-1b and FR-g preventing saltwater intrusion and contamination of this freshwater system. FR-g across from TFR-1b had a conductivity of 7800 umhos/cm. This is considered a typical conductivity level for the tributaries identified as TBC-1.

In the Bessey Creek tributary, identified as BC, the saltwater/ freshwater interface was delineated. With reference to Figure 5-20 and Table 5-3, the potable limit occurred between stations BC-d (520 umhos/cm) and BC-e (9500 umhos/cm). The distance between these sampling points was less than 300 feet. Downstream along this tributary, the conductivity was measured at 12,500 umhos/cm at BC-i. TBC-2b (2500 umhos/cm) and FR-f (9500 umhos/cm) both abutting the northern property boundary exceeded the potable limits.

The above sampling was conducted during the dry season on a falling tide. Prior to development, groundwater inflow was the primary source of surface water runoff with the highest rates occurring during the wet season. Consequently, mineral concentration in these tributaries are higher during the dry season or low flow conditions than during the wet season or high runoff periods.

Modifications to the natural tributary system have various effects. By maintaining surface water elevations throughout the property and along the northern boundary, the fresh groundwater head is maintained, thereby preventing surface water contamination further inland through tidal action. The lake at TBC-4a is being augmented by water from a freshwater well. North of the Martin Downs property boundary, an extensive navigatable canal system has been constructed, lacking any salinity control structures, which permits saline water to intrude abnormally far up Bessey Creek's northern tributaries. The presence of saline water in these canals is enhanced by the depth of canal excavation as compared to the natural incision depth observed in the natural Bessey Creek tributaries (TBC-4, TTBC-4). Further support for the detrimental impact of these deep canals is the existence of the previously described shallow freshwater lakes and ponds within 200 feet and completely surrounded by the saline excavated canals (Lake X, 105 umhos/cm). The large freshwater canal system, previously described, to the northeast of Martin Downs exhibits very low conductivities. Other shallow lakes within Martin Downs exhibited similarly low conductivities.

Water quality data collected February 10, 1980, at the weir station FR-e shows the potential impact of tidal fluctuation on water quality. An inflow of brackish water may occur on a regular basis, causing degradation of the lakes upstream of the weir. On February 2, 1980, FR-e had a conductivity of 1730 umhos/cm compared to the 550 umhos/cm measured on February 24, 1980.

Nutrient analysis of surface water sites BC-a, TBC-4b, BC-b, FR-f, DC-a and FR-e indicate consistently low concentration of nitrate, phosphate, filterable residue and nonfilterable residue. These waters are generally of good water quality.

Major degradation of surface waters adjacent to Martins Downs property are the tidal reaches of Danforth and Bessey Creek.

7.0 STEP DRAWDOWN TEST ON GOLF COURSE IRRIGATION WELL (PW)

A step drawdown test is used to determine the yield per increment of drawdown from a discharging well. This data is necessary for designing the size and type of pump, depth of bowl setting and optimum withdrawal rate to maintain high well and pump efficiency. Repetitive use of the step drawdown test also provides an indication for the necessity of well development.

In a pumping well the observed drawdown s_w at any time is composed of two parts. One part represents the formation loss as the water flows towards the well, and the other represents head loss related to water flowing into the well and to the intake of the pump. In a paper in 1947, Jacob suggested that the formation head loss varies as the first power of discharge (BQ), and that the turbulent head loss related to the well varied with the square of the discharge (CQ^2).

In these two relationships B represents a constant related to the formation loss and C is a constant related to the well loss. The equation for this concept is as follows:

$$s_w = BQ + CQ^2$$

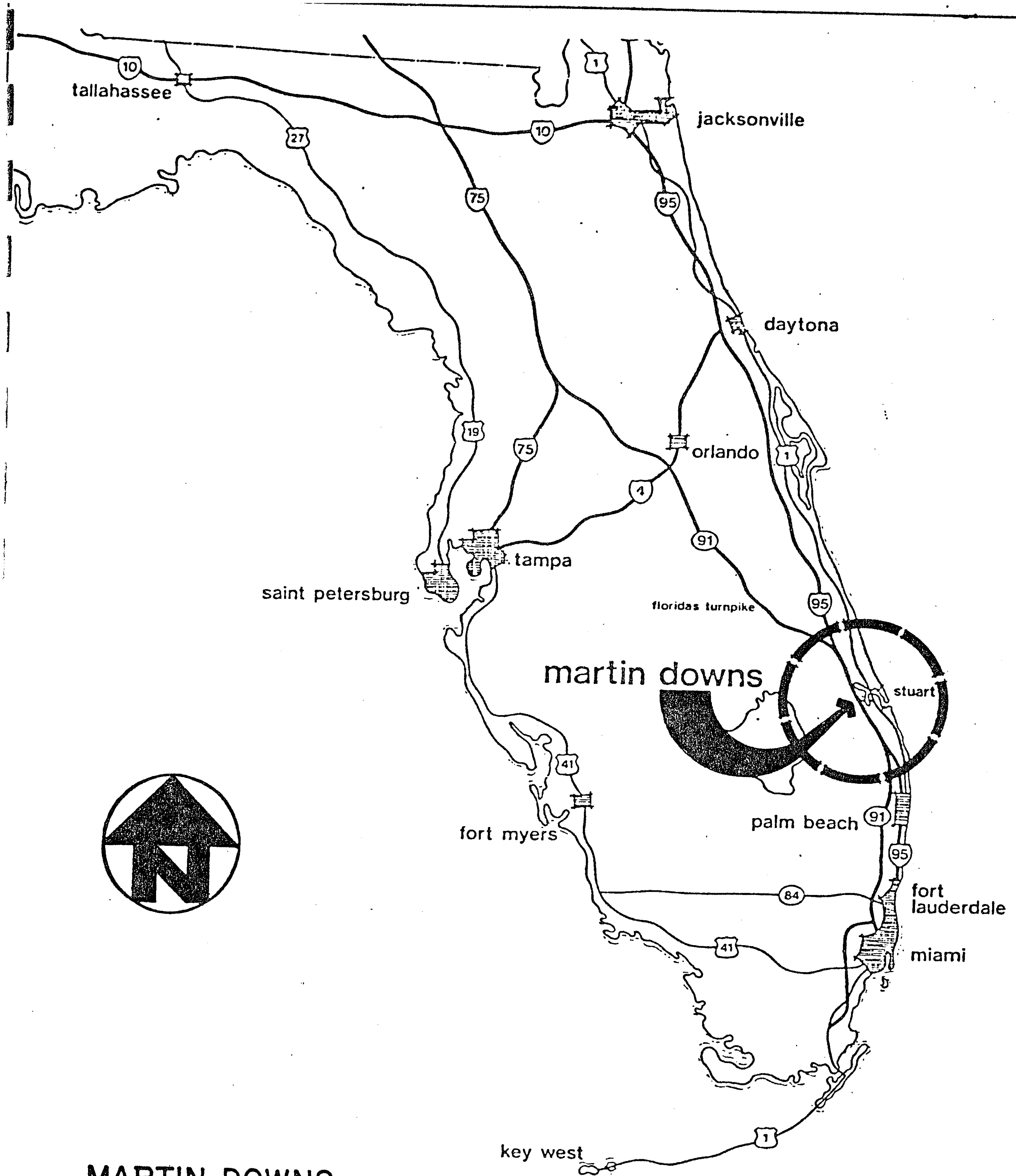
The term BQ relates to the Theis nonequilibrium equation and represents the factor s_{r_e} (s_{r_e} = QW(u)/4 T = BQ) and is directly related to the formation loss as water flows to the well. The factor CQ^2 represents strictly a head loss component related to the flow into the well, similar to any other hydraulic loss in pipeline flow.

A step drawdown test was run on the Crane Creek golf course irrigation well (PW) on 3-15-80. The well was pumped initially at a rate of 925 gpm fr 42.5 minutes and exhibited a drawdown of 12.66 feet (See Table 7-1). Specific capacity rates for these withdrawal rates are presented in Table 7-1. Utilizing Jacobs Method as presented above to calculate efficiency of the golf course well gives the following results:

Q of 925 gpm = 98.9% efficiency

Q of 700 gpm = 99.0% efficiency

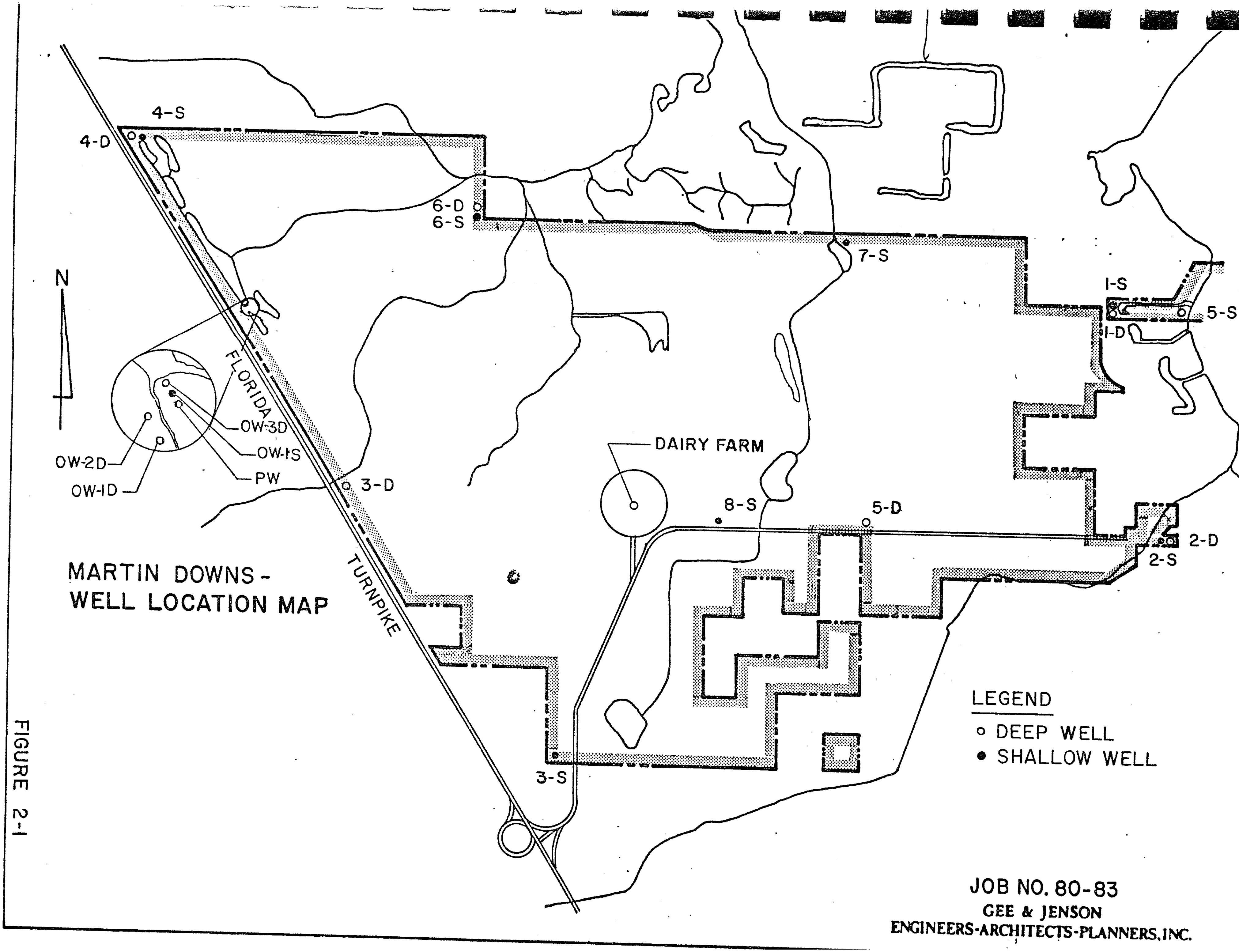
Q of 440 gpm = 99.0% efficiency



MARTIN DOWNS
GENERAL LOCATION MAP
JOB NO. 80-83

GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

FIGURE 1-1



MARTIN DOWNS-
WELL LOCATION MAP
N
4-S
4-D
6-D
6-S
7-S
1-S
5-S
1-D
FLORIDA
TURNPIKE
OW-3D
OW-1S
PW
OW-2D
OW-1D
3-D
DAIRY FARM
8-S
5-D
2-D
2-S
3-S
LEGEND
DEEP WELL
SHALLOW WELL
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

FIGURE 2-1

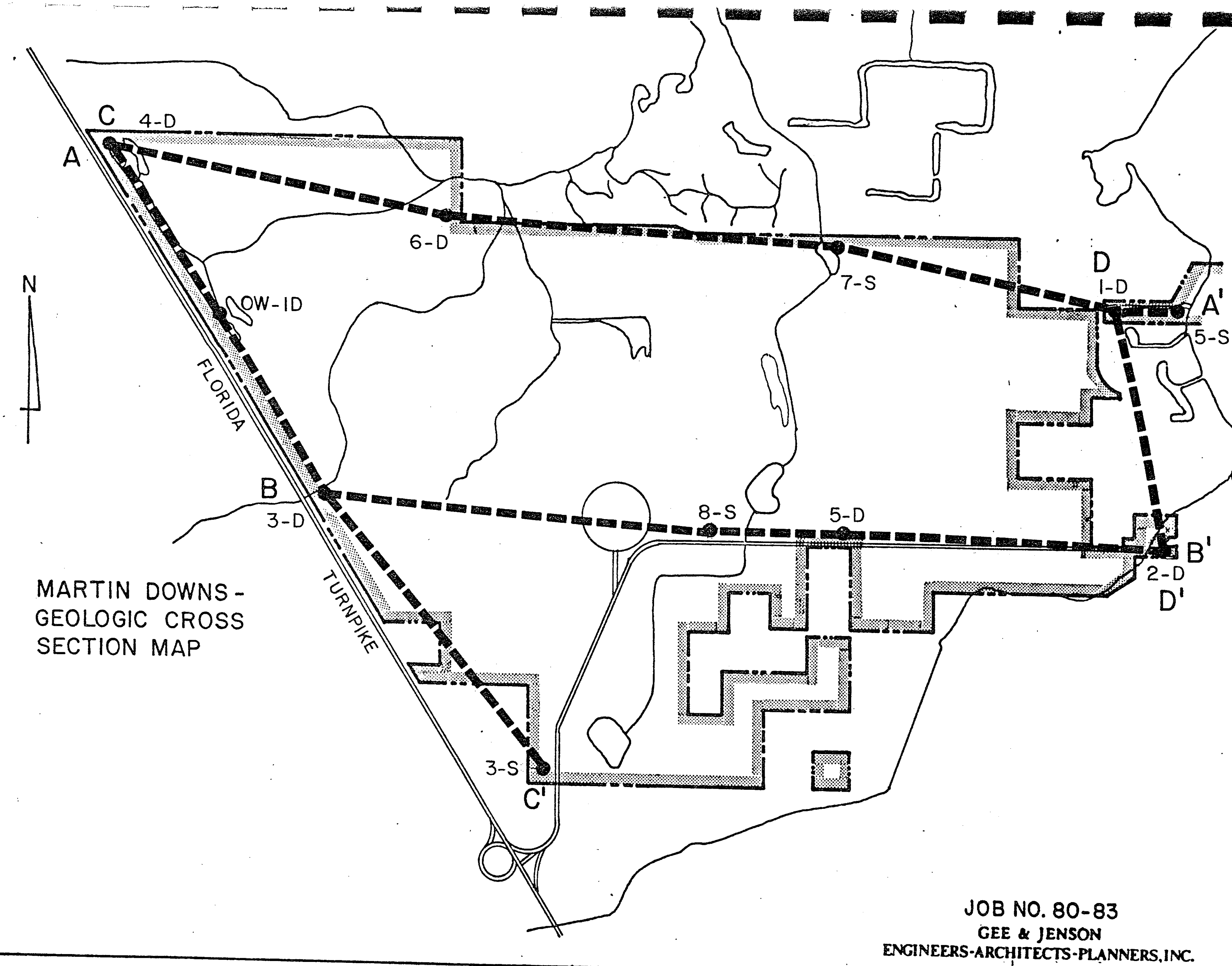
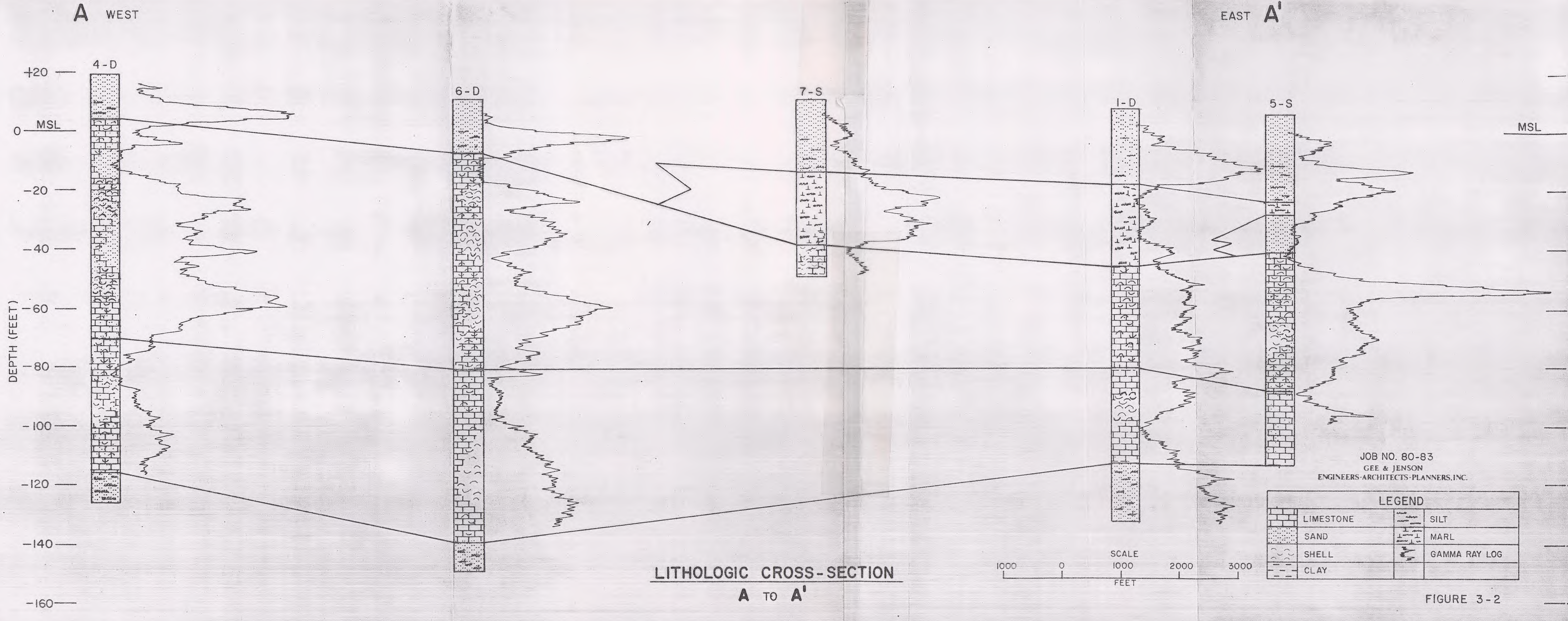

C
4-D
A
6-D
7-S
D
I-D
A'
5-S
N
OW-ID
FLORIDA
B
3-D
8-S
5-D
B'
2-D
D'
TURNPIKE
MARTIN DOWNS-
GEOLOGIC CROSS
SECTION MAP
3-S
C'
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

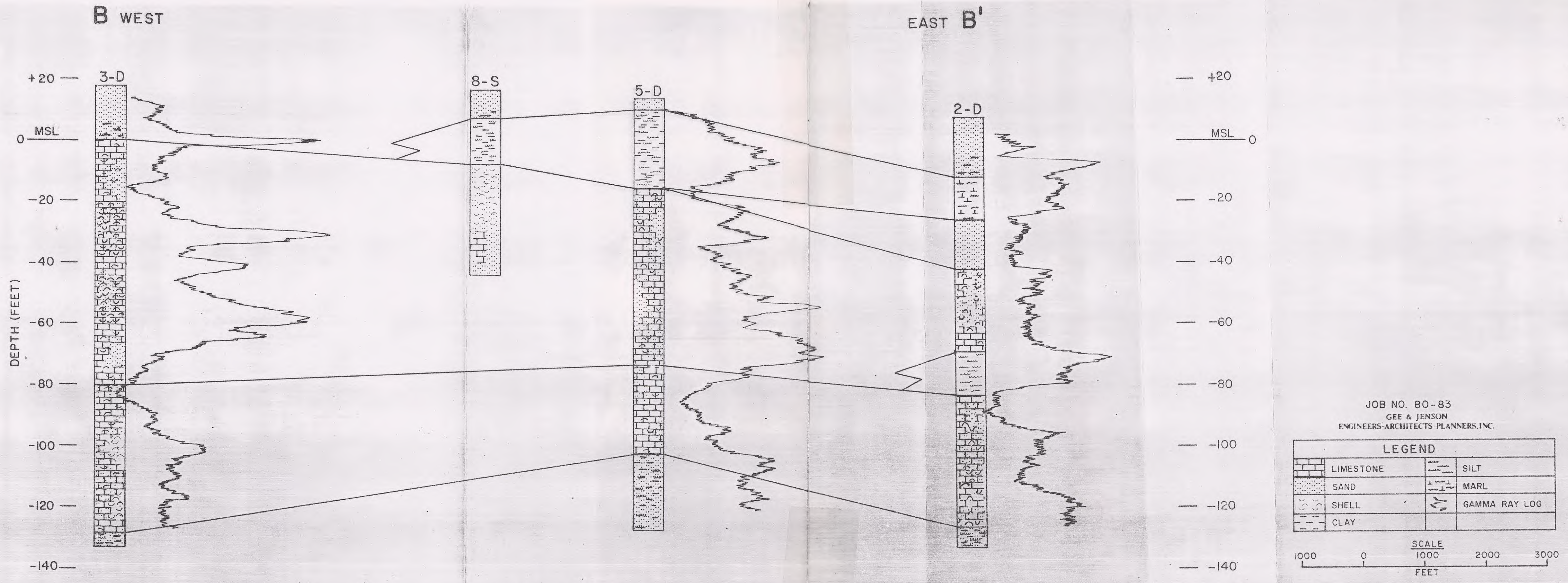
FIGURE 3-1



LITHOLOGIC CROSS-SECTION
A TO A'

JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

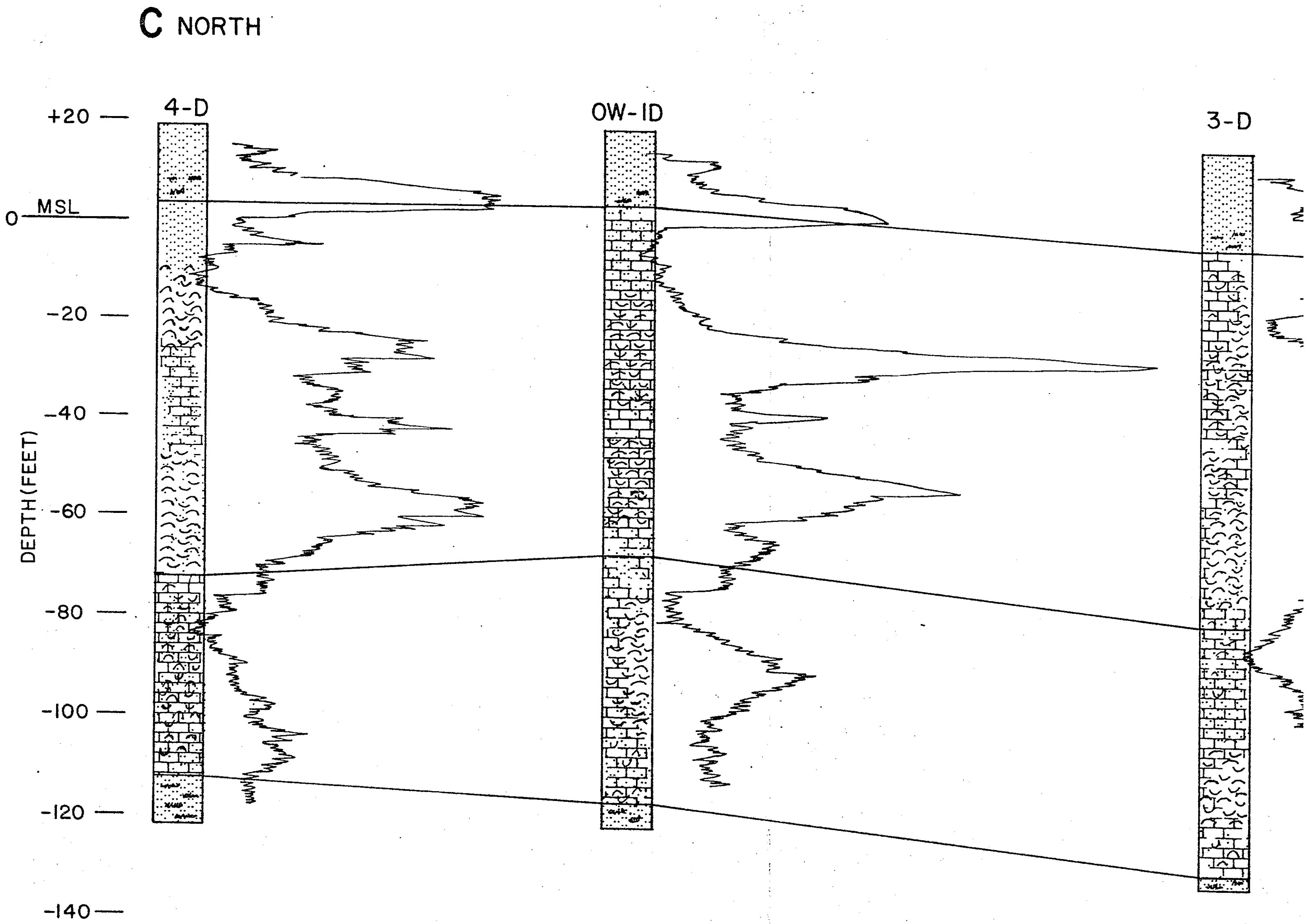
FIGURE 3-2



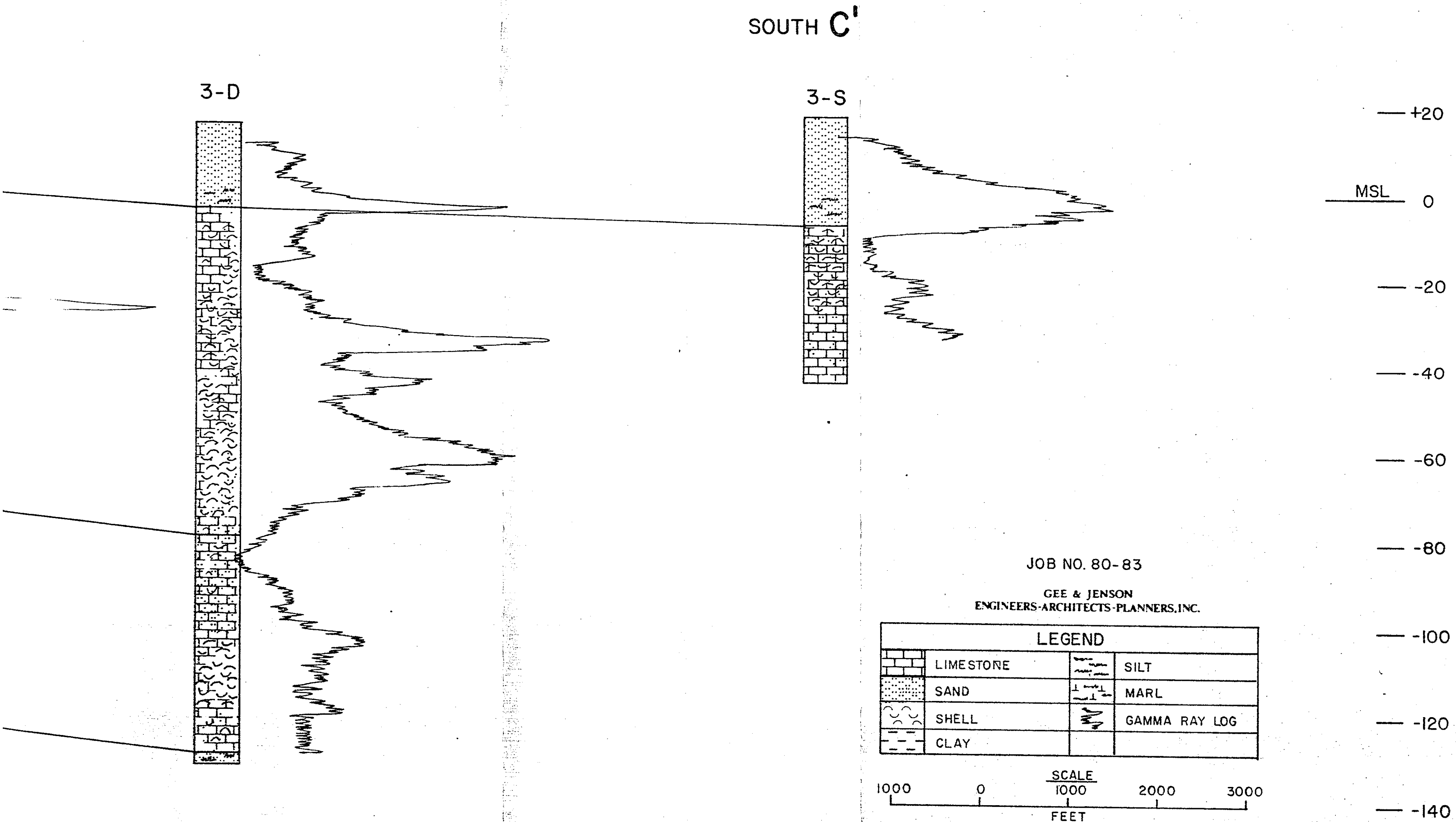
LITHOLOGIC CROSS-SECTION

B TO B'

FIGURE 3-3

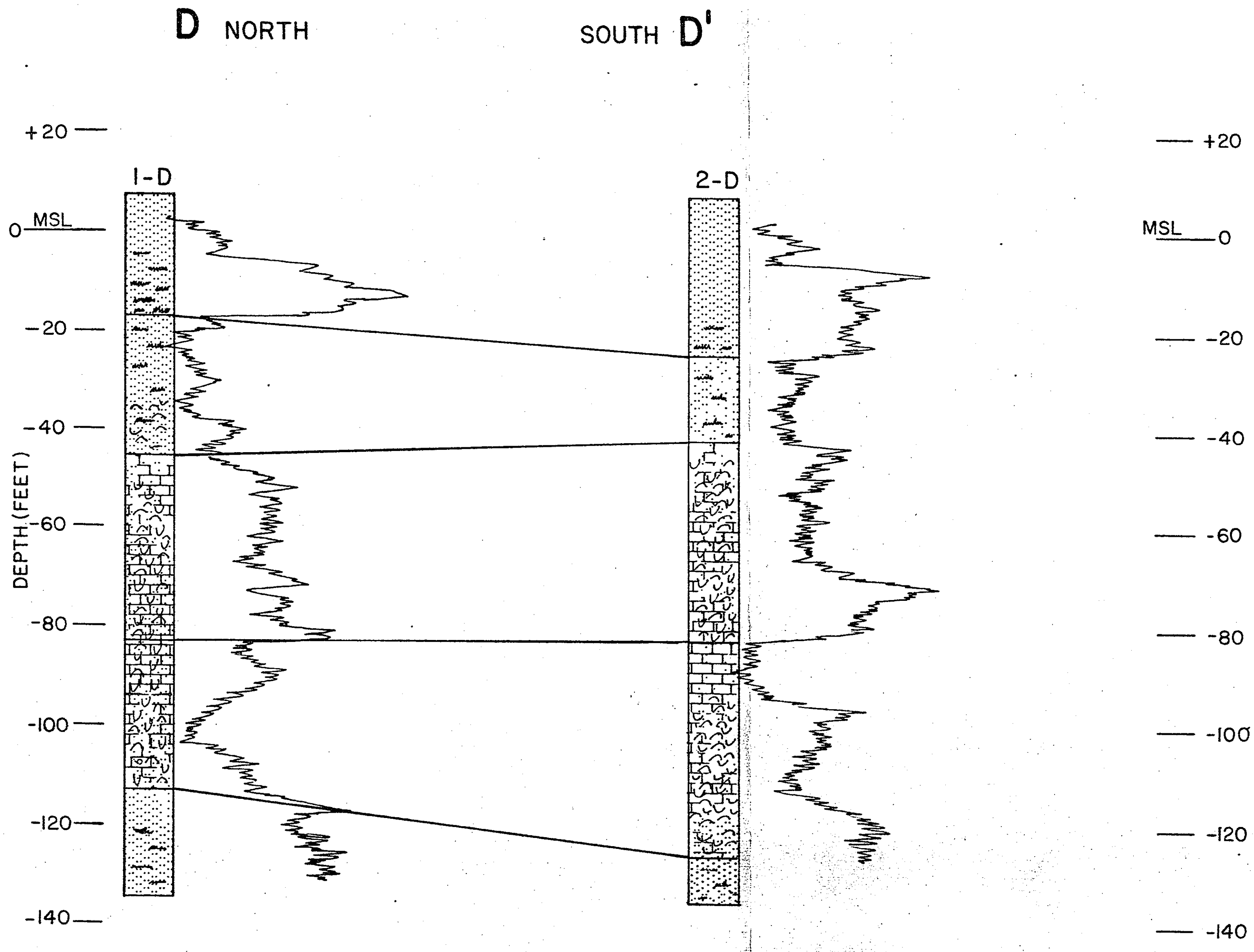


LITHOLOGIC CROSS - SECTION
C TO C'



ROSS - SECTION
C'

FIGURE 3-4



LITHOLOGIC CROSS - SECTIO

D TO D'

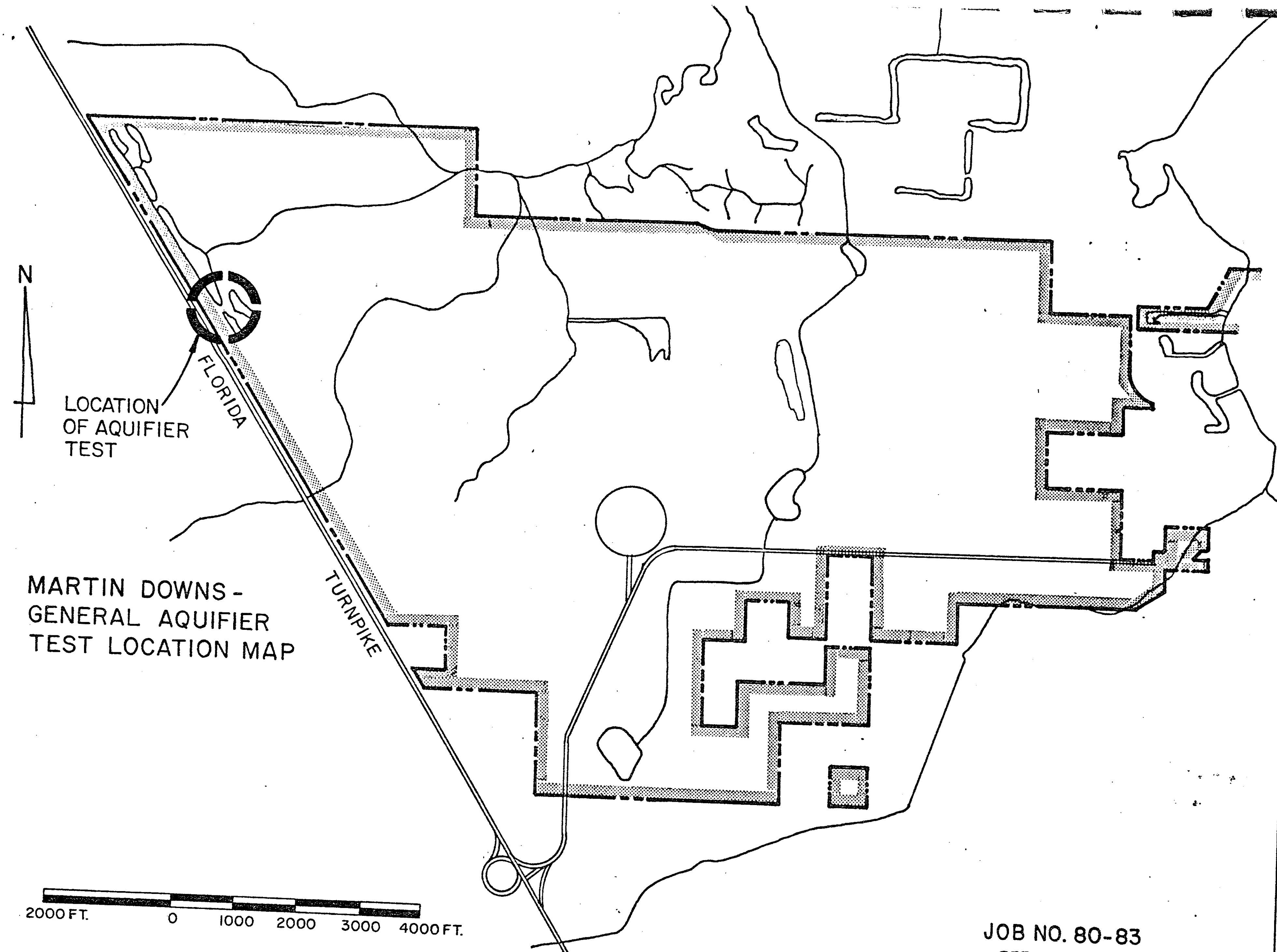
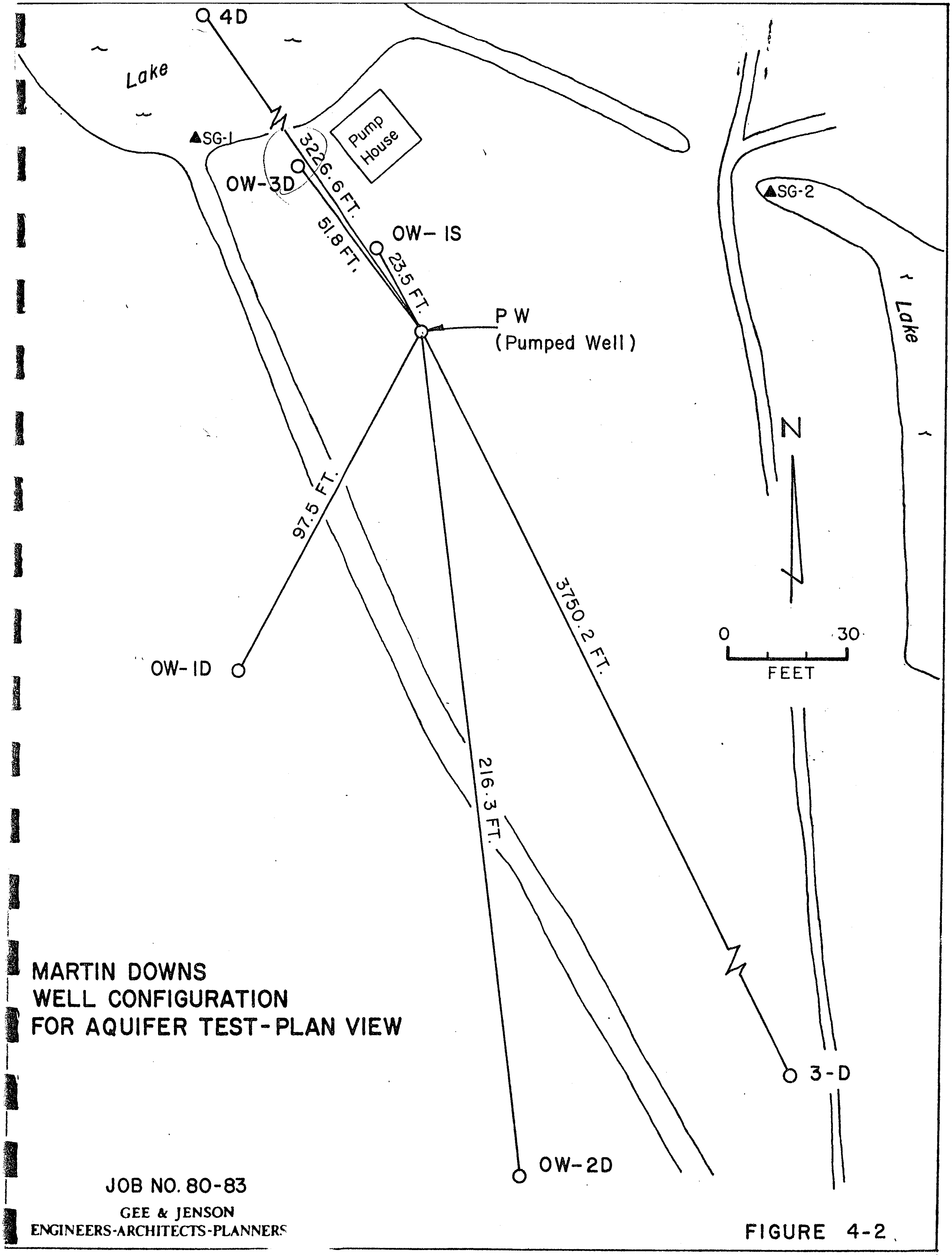


FIGURE 4-1

JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.



MARTIN DOWNS WELL CONFIGURATION FOR AQUIFER TEST-PLAN VIEW

JOB NO. 80-83

GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS

FIGURE 4-2

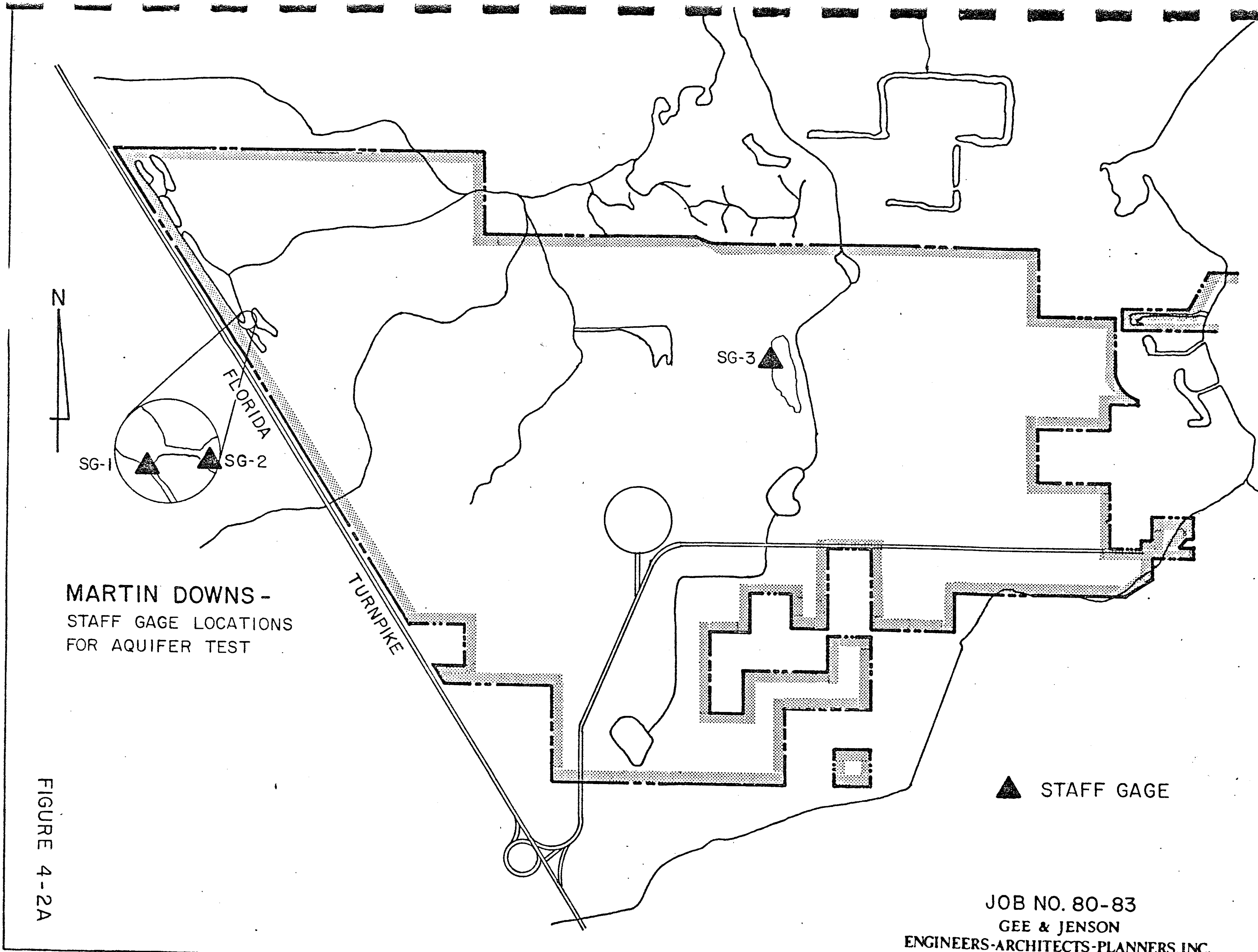

N
FLORIDA
TURNPIKE
SG-1
SG-2
SG-3
MARTIN DOWNS -
STAFF GAGE LOCATIONS
FOR AQUIFER TEST
STAFF GAGE
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

FIGURE 4-2A

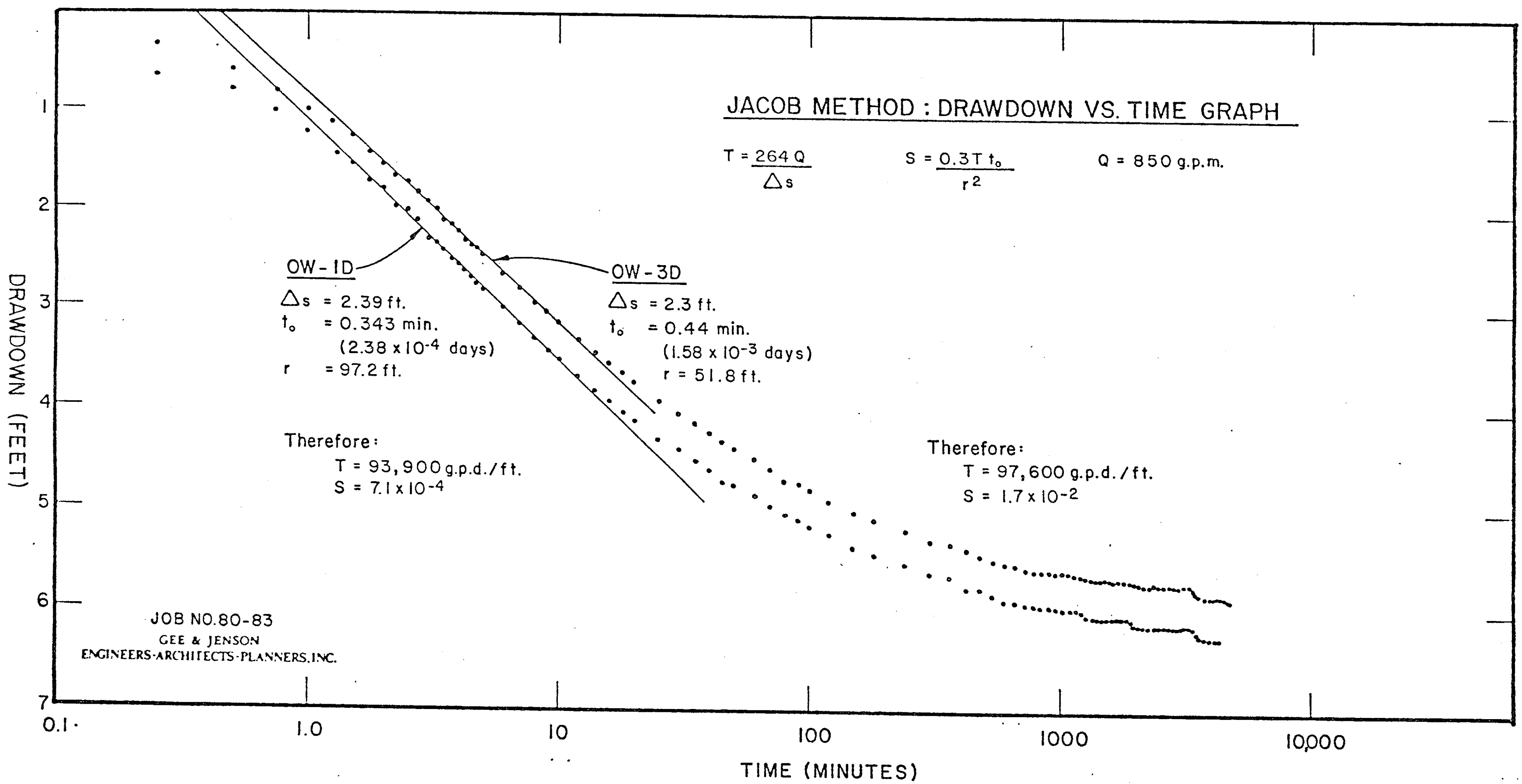
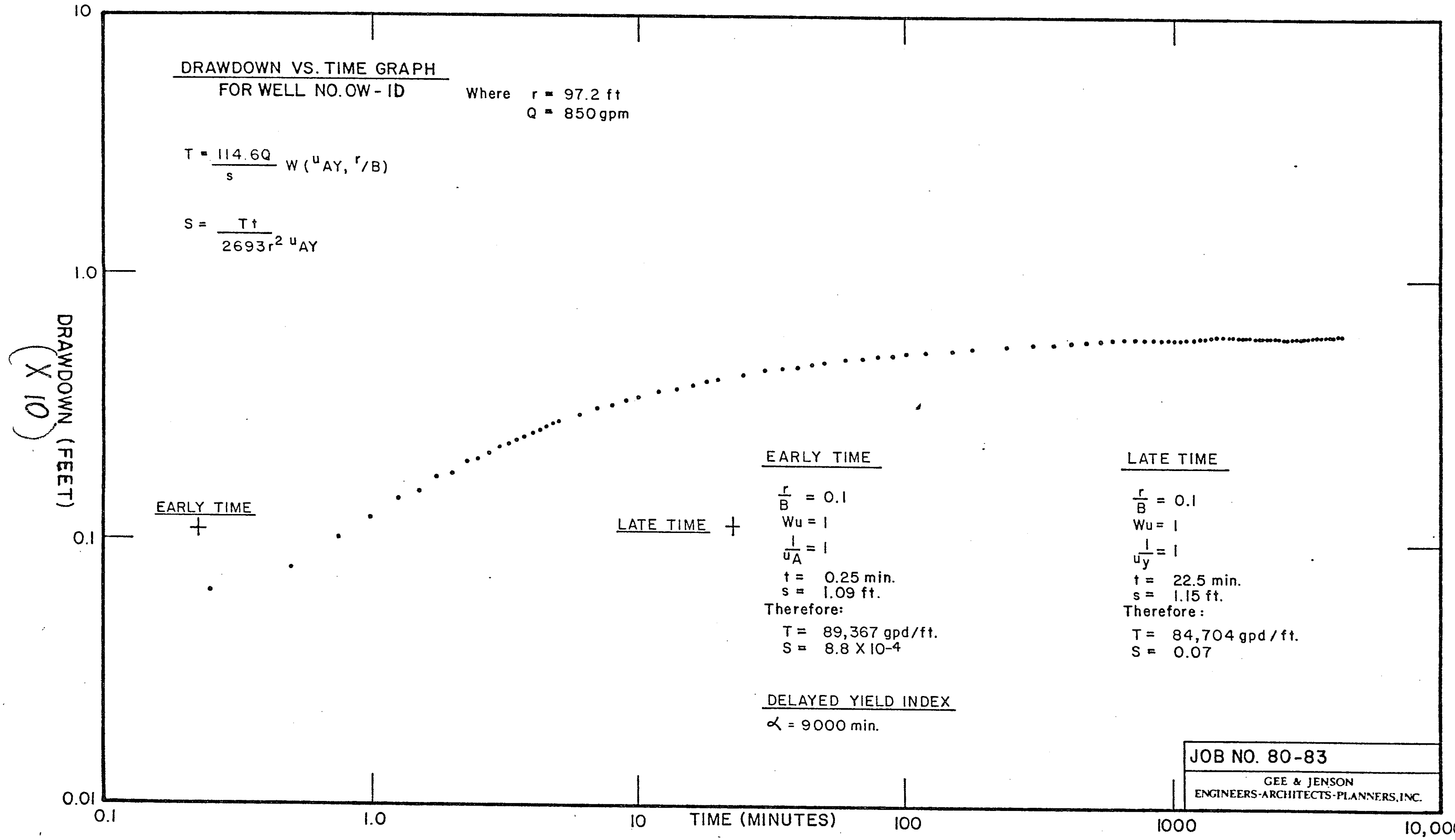
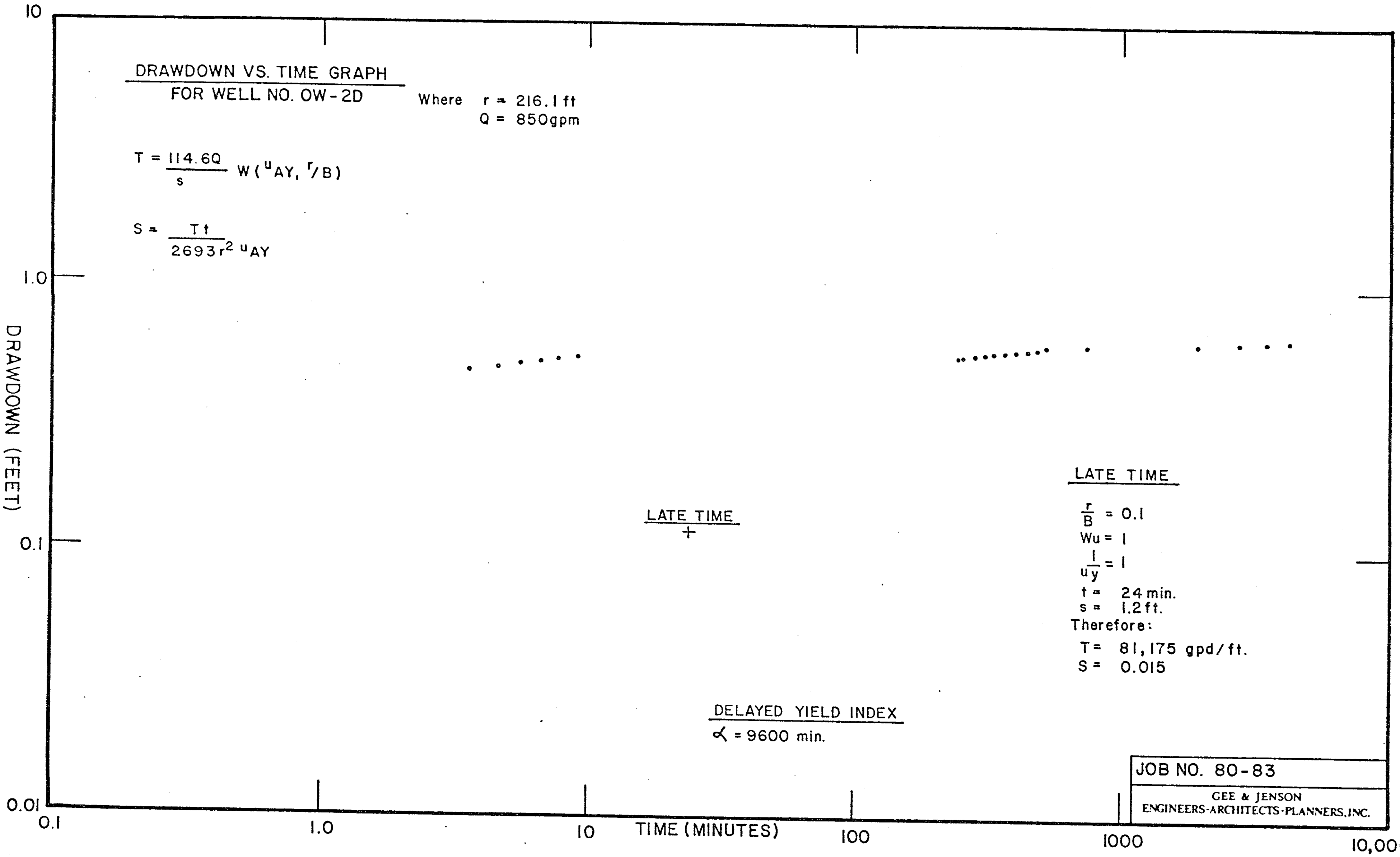

JACOB METHOD : DRAWDOWN VS. TIME GRAPH
T = 264 Q / △s
S = 0.3 T t₀ / r²
Q = 850 g.p.m.
OW-1D
△s = 2.39 ft.
t₀ = 0.343 min.
(2.38 x 10-4 days)
r = 97.2 ft.
Therefore:
T = 93,900 g.p.d./ft.
S = 7.1 x 10-4
OW-3D
△s = 2.3 ft.
t₀ = 0.44 min.
(1.58 x 10-3 days)
r = 51.8 ft.
Therefore:
T = 97,600 g.p.d./ft.
S = 1.7 x 10-2
DRAWDOWN (FEET)
1
2
3
4
5
6
7
TIME (MINUTES)
0.1
1.0
10
100
1000
10,000
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

FIGURE 4-3



DRAWDOWN VS. TIME GRAPH
FOR WELL NO. OW - ID
Where r = 97.2 ft
Q = 850 gpm
T = 114.6Q / s W (uAY, r/B)
S = Tt / 2693r² uAY
EARLY TIME
LATE TIME
EARLY TIME
r/B = 0.1
Wu = 1
1/uA = 1
t = 0.25 min.
s = 1.09 ft.
Therefore:
T = 89,367 gpd/ft.
S = 8.8 X 10-4
LATE TIME
r/B = 0.1
Wu = 1
1/uy = 1
t = 22.5 min.
s = 1.15 ft.
Therefore:
T = 84,704 gpd / ft.
S = 0.07
DELAYED YIELD INDEX
α = 9000 min.
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.
DRAWDOWN (FEET)
(X 10)
TIME (MINUTES)
10
1.0
0.1
0.01
0.1
1.0
10
100
1000
10,000

FIGURE 4-4



DRAWDOWN VS. TIME GRAPH
FOR WELL NO. OW-2D
Where r = 216.1 ft
Q = 850gpm
T = 114.6Q / s W(uAY, r/B)
S = Tt / 2693r2 uAY
LATE TIME
LATE TIME
r/B = 0.1
Wu = 1
1/uy = 1
t = 24 min.
s = 1.2 ft.
Therefore:
T = 81,175 gpd/ft.
S = 0.015
DELAYED YIELD INDEX
∝ = 9600 min.
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.
DRAWDOWN (FEET)
TIME (MINUTES)
10
1.0
0.1
0.01
0.1
1.0
10
100
1000
10,000

FIGURE 4-5

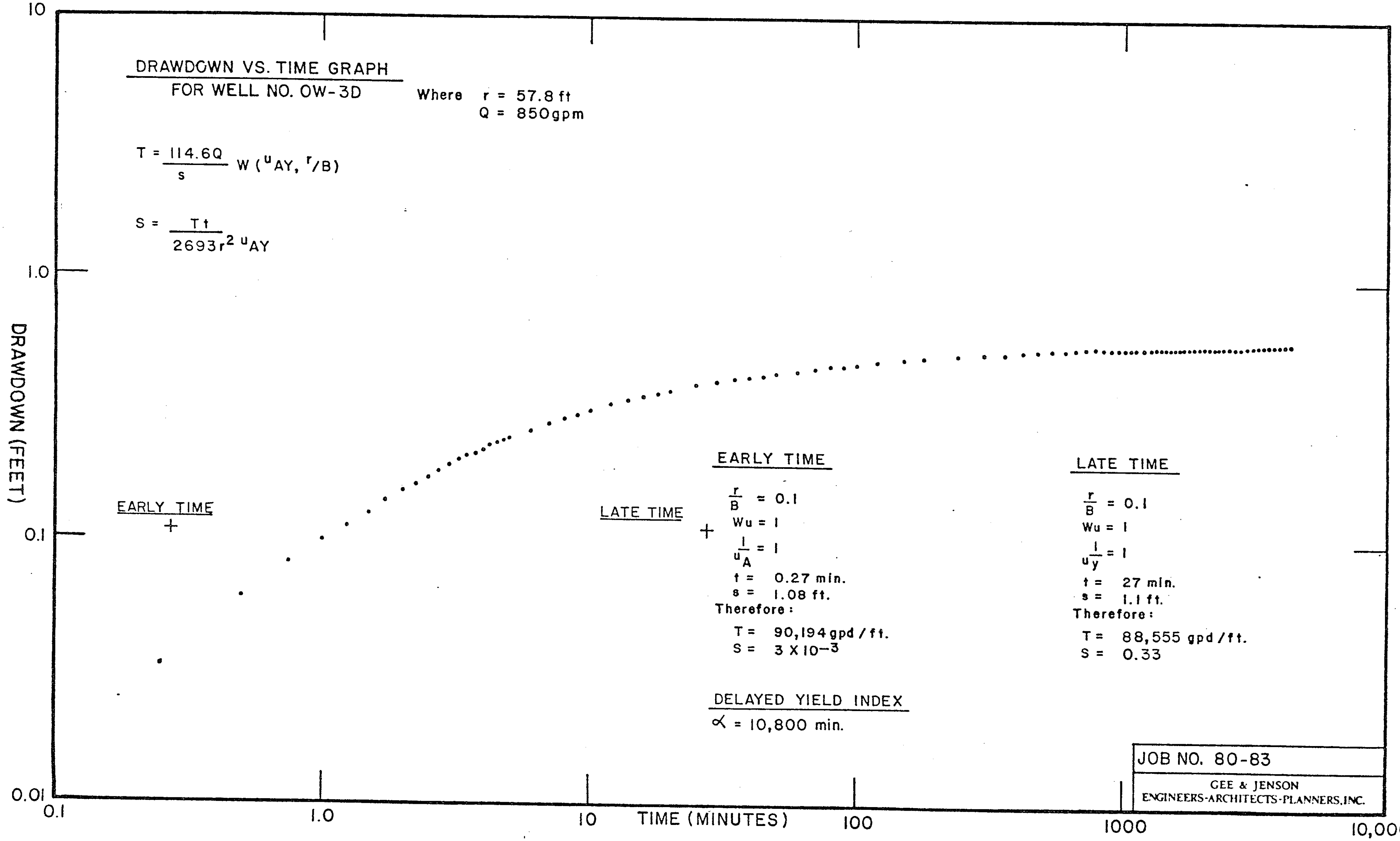

DRAWDOWN VS. TIME GRAPH
FOR WELL NO. OW-3D
Where r = 57.8 ft
Q = 850 gpm
T = 114.6Q / s W (uAY, r/B)
S = Tt / 2693r² uAY
DRAWDOWN (FEET)
10
1.0
0.1
0.01
TIME (MINUTES)
0.1
1.0
10
100
1000
10,000
EARLY TIME
LATE TIME
EARLY TIME
r/B = 0.1
Wu = 1
1/uA = 1
t = 0.27 min.
s = 1.08 ft.
Therefore:
T = 90,194 gpd/ft.
S = 3 X 10−3
LATE TIME
r/B = 0.1
Wu = 1
1/uy = 1
t = 27 min.
s = 1.1 ft.
Therefore:
T = 88,555 gpd/ft.
S = 0.33
DELAYED YIELD INDEX
α = 10,800 min.
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

FIGURE 4-6

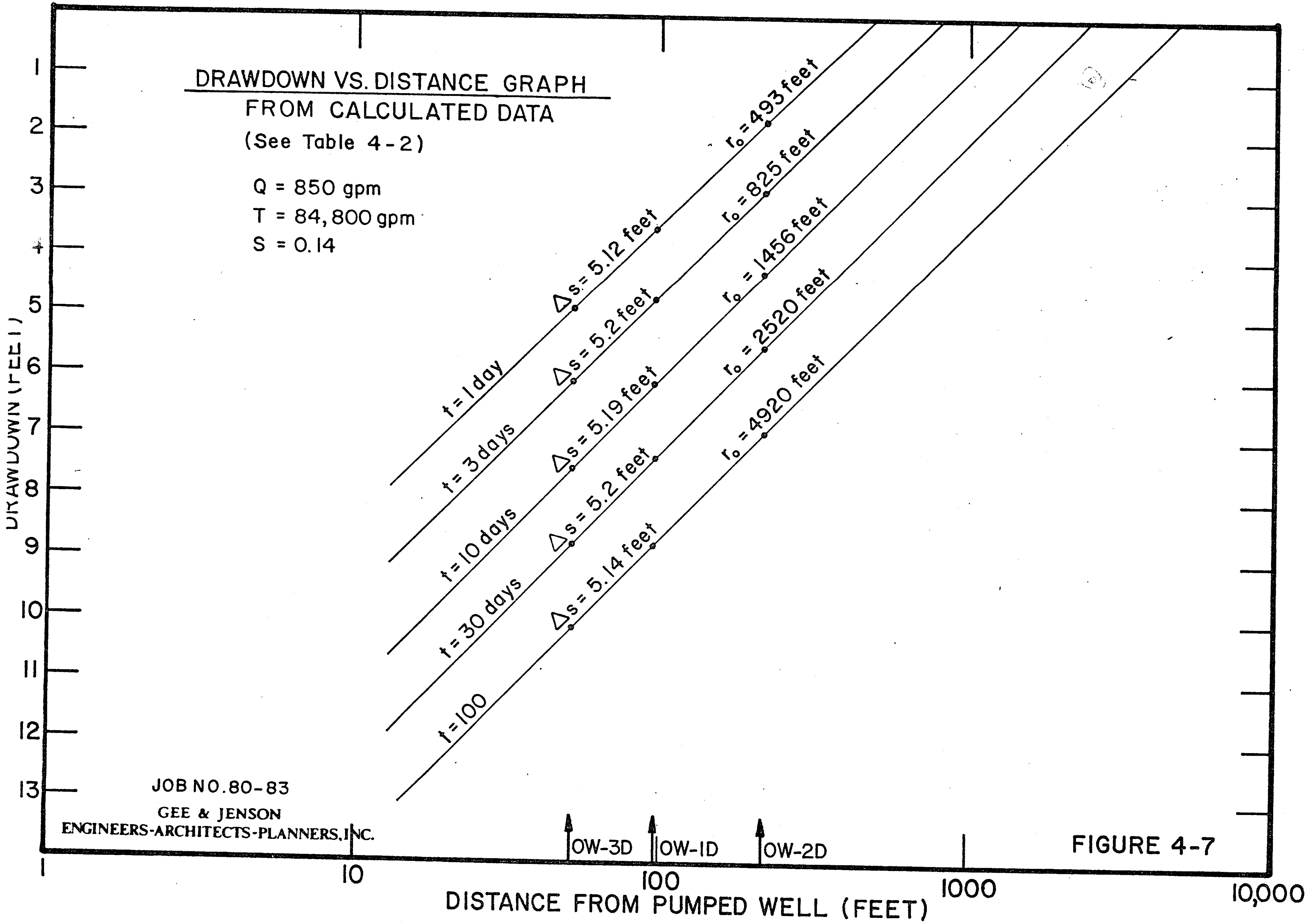

DRAWDOWN VS. DISTANCE GRAPH
FROM CALCULATED DATA
(See Table 4-2)
Q = 850 gpm
T = 84,800 gpm
S = 0.14
t = 1 day
t = 3 days
t = 10 days
t = 30 days
t = 100
Δs = 5.12 feet
Δs = 5.2 feet
Δs = 5.19 feet
Δs = 5.2 feet
Δs = 5.14 feet
r₀ = 493 feet
r₀ = 825 feet
r₀ = 1456 feet
r₀ = 2520 feet
r₀ = 4920 feet
OW-3D
OW-1D
OW-2D
DRAWDOWN (FEET)
DISTANCE FROM PUMPED WELL (FEET)
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

FIGURE 4-7

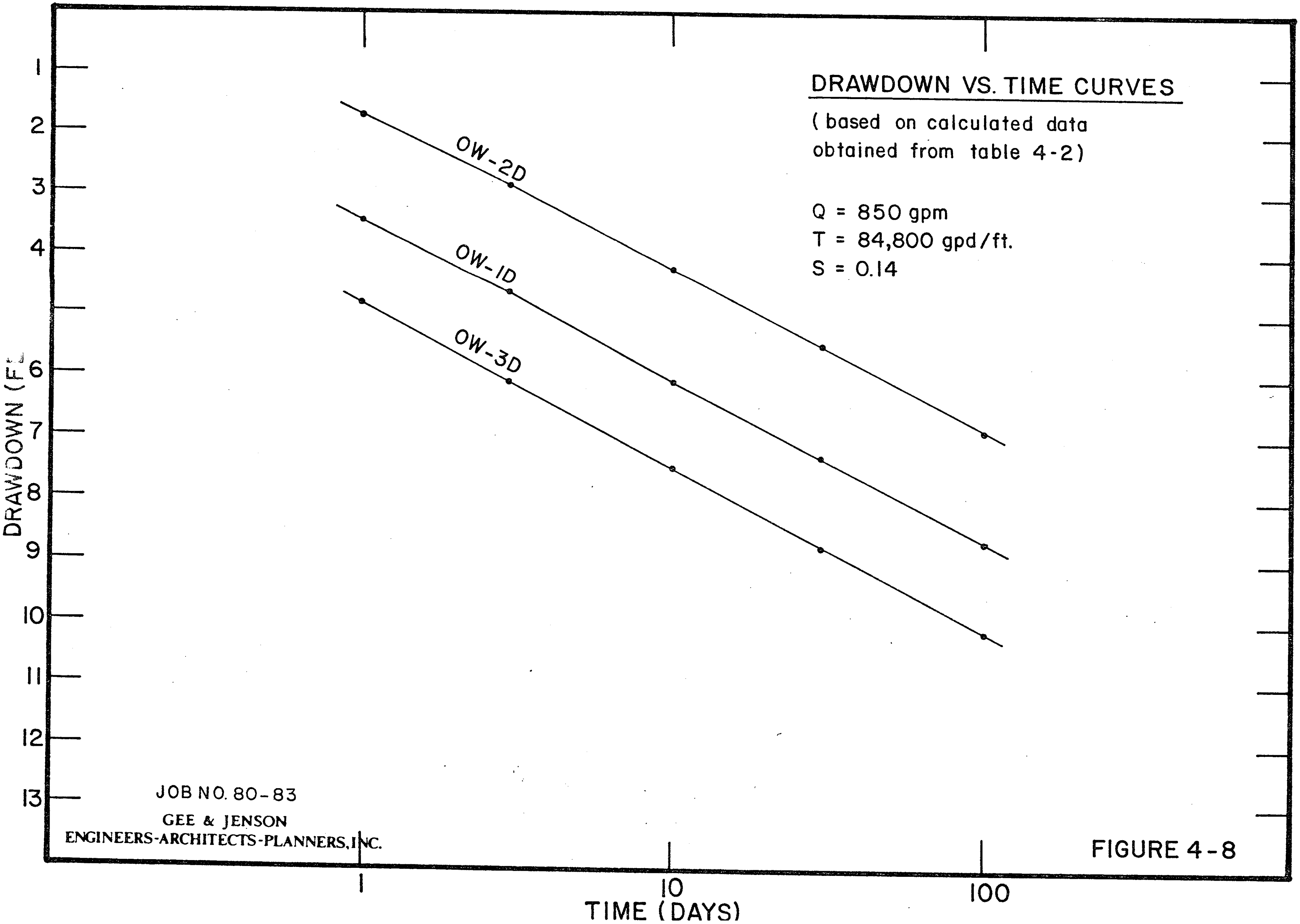
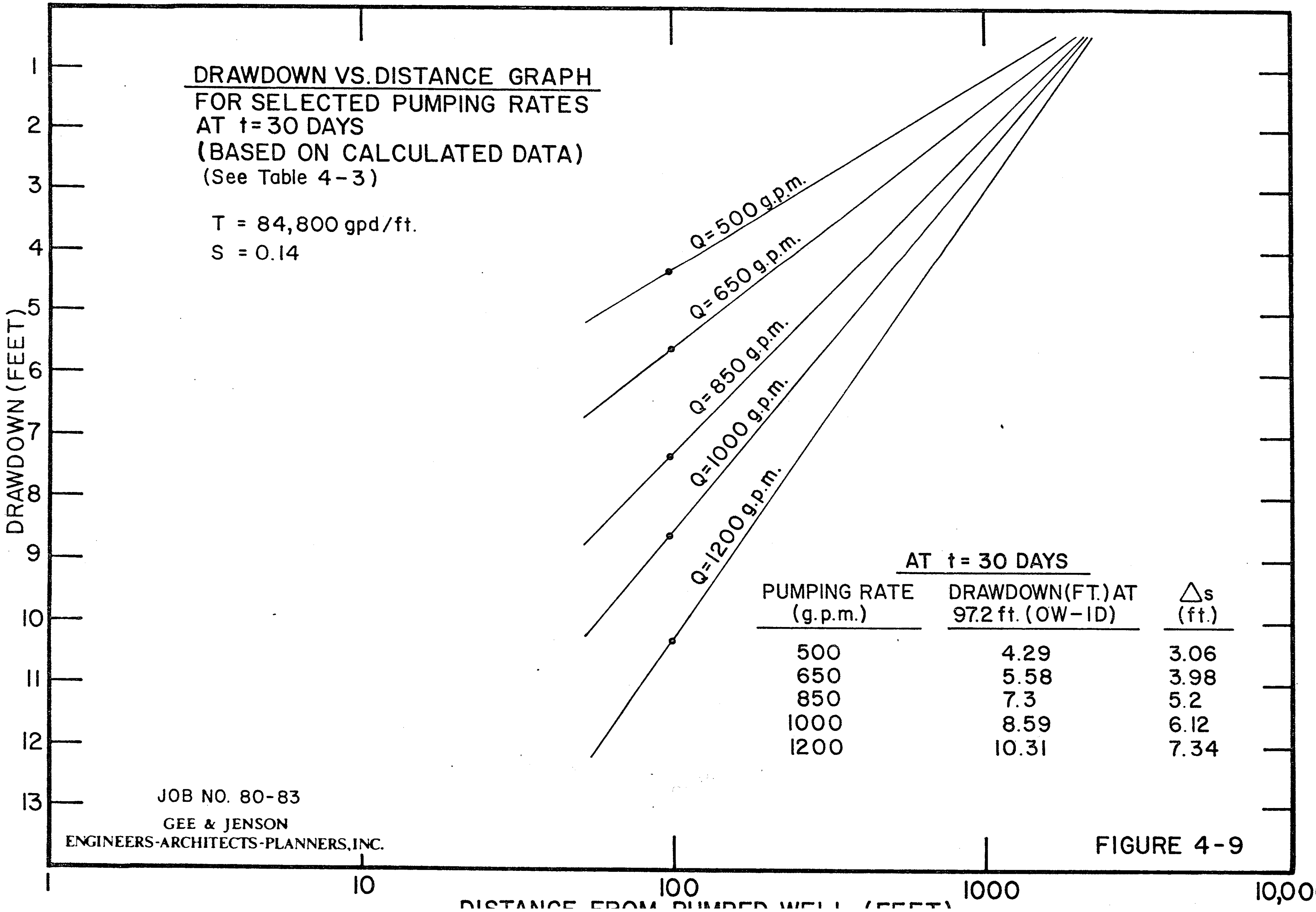

DRAWDOWN VS. TIME CURVES
(based on calculated data obtained from table 4-2)
Q = 850 gpm
T = 84,800 gpd/ft.
S = 0.14
OW-2D
OW-1D
OW-3D
DRAWDOWN (FT)
1
2
3
4
6
7
8
9
10
11
12
13
1
10
100
TIME (DAYS)
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

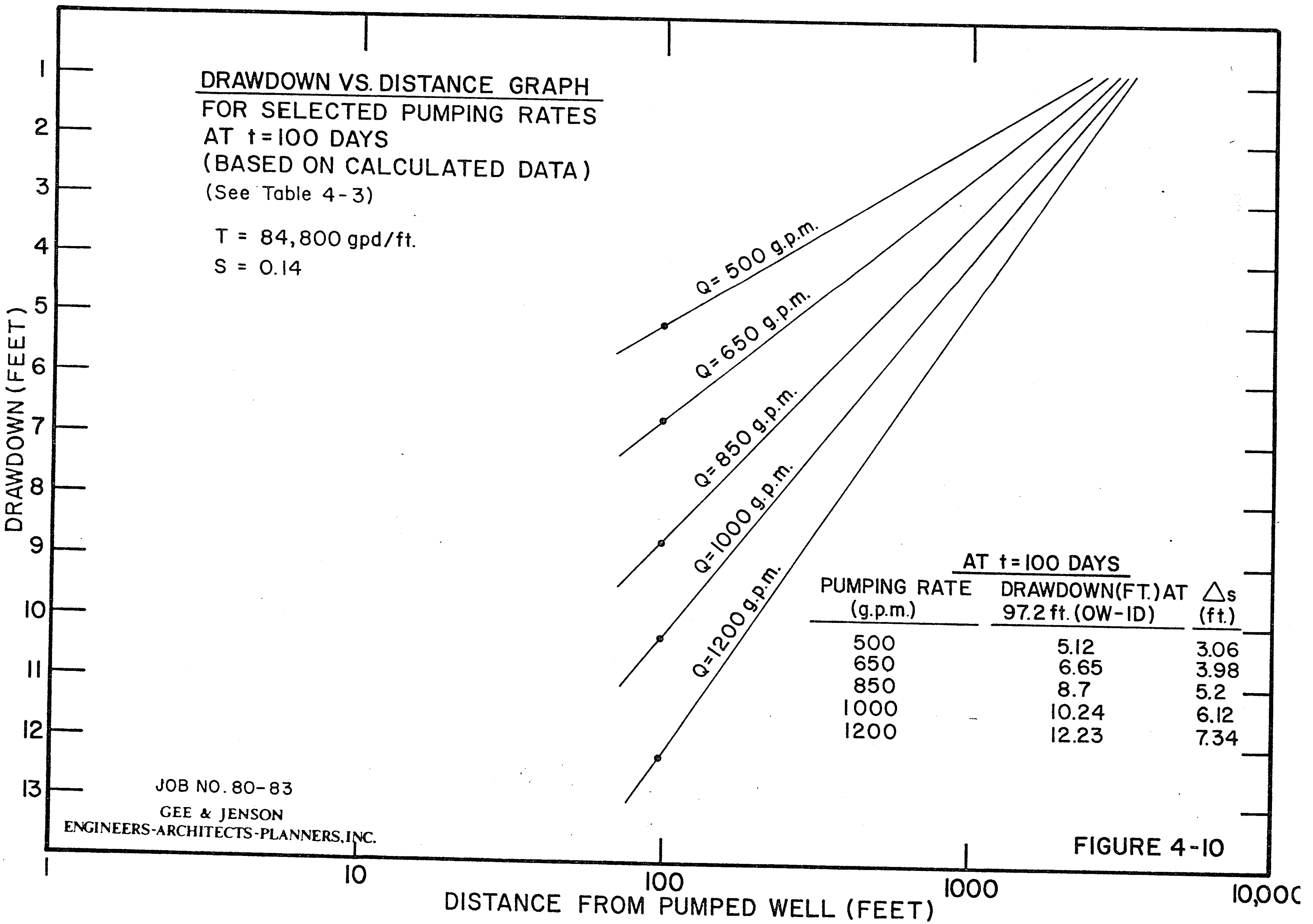
FIGURE 4-8



AT t = 30 DAYS

PUMPING RATE (g.p.m.)	DRAWDOWN (FT.) AT 97.2 ft. (OW-1D)	△s (ft.)
500	4.29	3.06
650	5.58	3.98
850	7.3	5.2
1000	8.59	6.12
1200	10.31	7.34

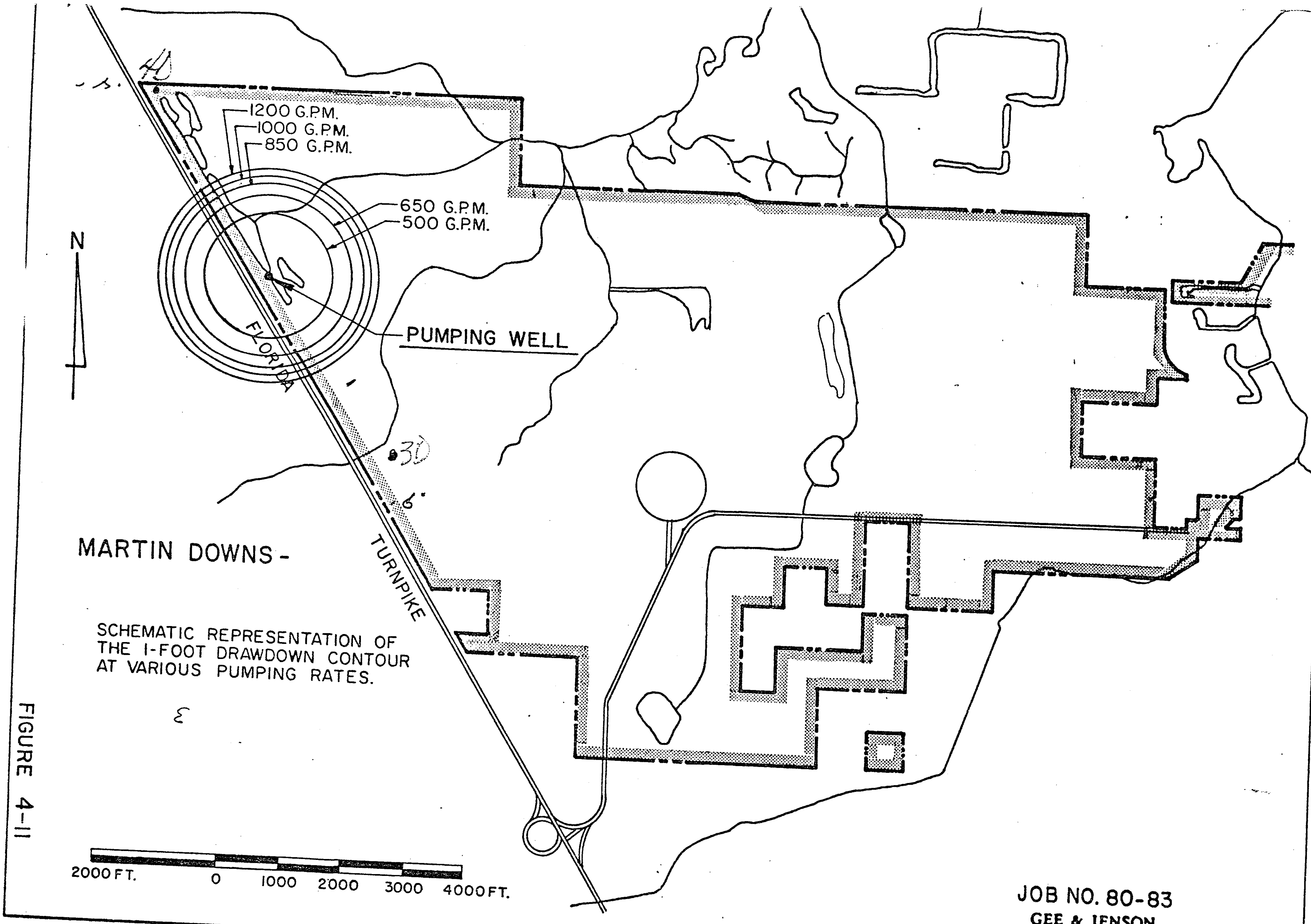
FIGURE 4-9



AT t = 100 DAYS

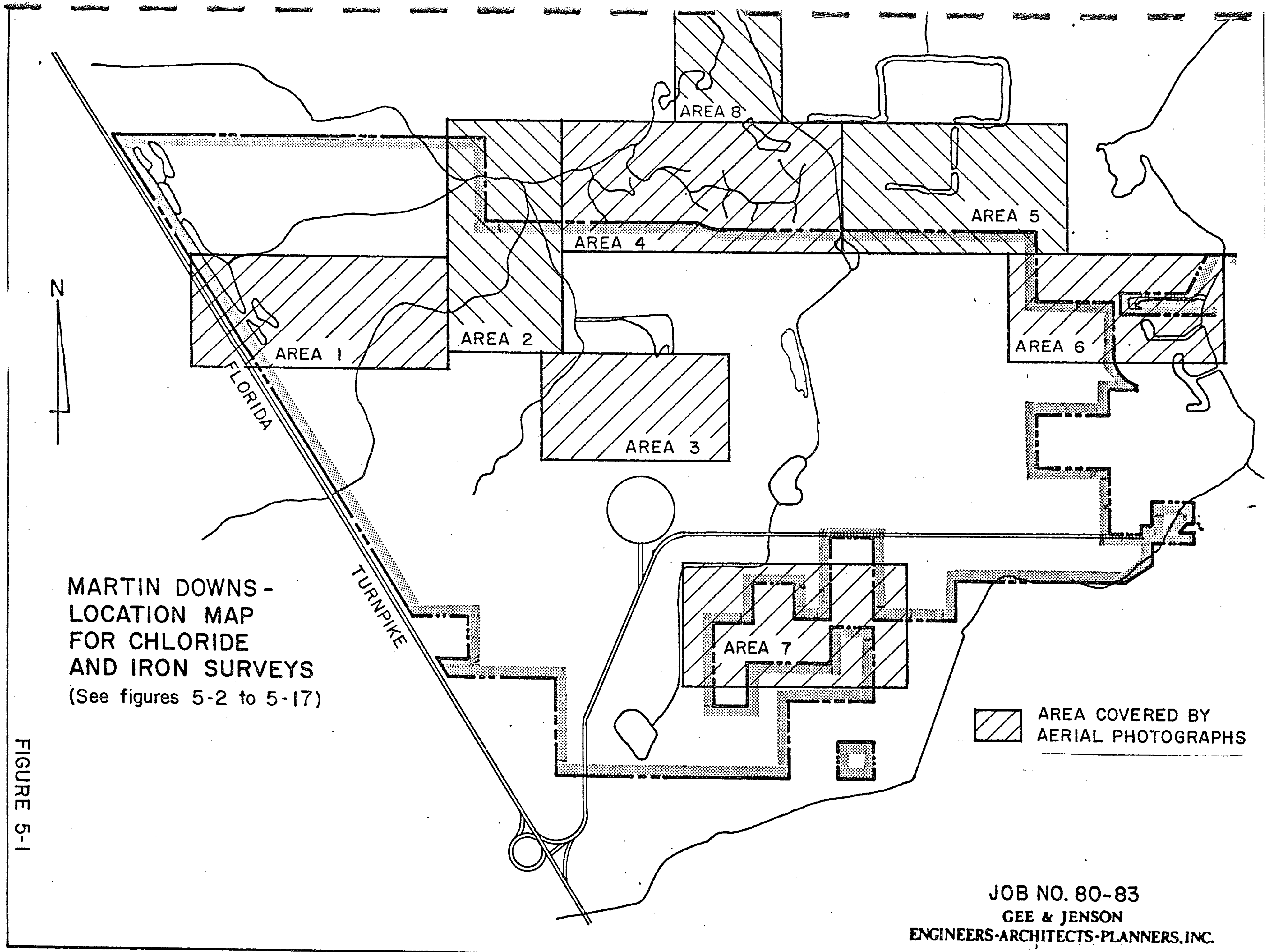
PUMPING RATE (g.p.m.)	DRAWDOWN (FT.) AT 97.2 ft. (OW-1D)	△s (ft.)
500	5.12	3.06
650	6.65	3.98
850	8.7	5.2
1000	10.24	6.12
1200	12.23	7.34

FIGURE 4-10



1200 G.P.M.
1000 G.P.M.
850 G.P.M.
650 G.P.M.
500 G.P.M.
N
PUMPING WELL
FLORIDA
TURNPIKE
MARTIN DOWNS -
SCHEMATIC REPRESENTATION OF THE 1-FOOT DRAWDOWN CONTOUR AT VARIOUS PUMPING RATES.
2000 FT. 0 1000 2000 3000 4000 FT.
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

FIGURE 4-11



AREA 8
AREA 5
AREA 4
AREA 2
AREA 1
AREA 6
AREA 3
AREA 7
N
FLORIDA
TURNPIKE
MARTIN DOWNS -
LOCATION MAP
FOR CHLORIDE
AND IRON SURVEYS
(See figures 5-2 to 5-17)
AREA COVERED BY
AERIAL PHOTOGRAPHS
JOB NO. 80-83
GEE & JENSON
ENGINEERS-ARCHITECTS-PLANNERS, INC.

FIGURE 5-1

TABLE 2-1
OBSERVATION WELL CONSTRUCTION DATA
MARTIN DOWNS

Well No.	Ground Elevation (ft)(MSL)	Elevation at m.p. (ft)(MSL)	Diameter (inches)	Total Depth (ft)	Cased Interval (ft)	Screened Interval (ft)	Date Drilled
1-D	6.93	6.79	2½	140	0-80	80-140	03-06-80
2-D	7.49	7.40	2½	140	0-80	80-140	03-07-80
3-D	17.83	17.66	2½	150	0-70	70-150	03-12-80
4-D	5.15	5.24	2½	140	0-80	80-140	03-14-80
5-D	13.39	13.45	2½	140	0-80	80-140	03-17-80
6-D	11.11	10.99	2½	150	0-80	80-140	03-15-80
1-S	7.19	7.09	2½	60	0-10	10-60	03-06-80
2-S	7.32	7.13	2½	30	0-10	10-30	03-07-80
3-S	16.41	16.83	2½	60	0-10	10-60	03-16-80
4-S	5.31	5.49	2½	60	0-10	10-60	03-14-80
5-S	4.57	4.40	2½	120	0-80	80-120	03-08-80
6-S	11.26	11.07	2½	60	0-10	10-60	03-16-80
7-S	9.10	9.24	2½	60	0-10	10-60	03-05-80
8-S	16.00	16.06	2½	60	0-10	10-60	03-18-80
OW-1D	18.02	18.08	2½	140	0-80	80-140	03-10-80
OW-2D	17.86	17.84	2½	140	0-80	80-140	03-10-80
OW-3D	16.34	16.23	2½	140	0-80	80-140	03-11-80
OW-1S	17.43	17.29	2½	27	0-7	7-27	03-11-80

TABLE 4-1
AQUIFER TEST OBSERVATION WELL DATA
MARTIN DOWNS

Well No.	Diameter (Inches)	Total Depth (ft.)	Cased Interval (ft.)	Screened Interval(ft.)	Distance from PW (ft.)
PW	10	140	0-100	100-140	0
OW-1D	2½	140	0-80	80-140	97.5
OW-2D	2½	140	0-80	80-140	216.3
OW-3D	2½	140	0-80	80-140	51.8
OW-1S	2½	27	0-7	7-27	23.5
3-D	2½	150	0-70	70-150	3750.2
4-D	2½	140	0-80	80-140	3226.6

TABLE 4-2
CALCULATING DRAWDOWN (s) FOR VARYING
INTERVALS OF TIME (t)*
AQUIFER TEST DATA
MARTIN DOWNS

$u = \frac{1.87r^2S}{Tt}$

$s = \frac{114.6Q}{T} W(u)$

T = 84,800 gpm/ft. (gpd)
S = 0.14
Q = 850 gpm

for OW-1D, r = 97.2 ft.
OW-2D, r = 216.1 ft.
OW-3D, r = 51.8 ft.

	OW-1D	OW-2D *	OW-3D
t = 1 day	$u = 2.87 \times 10^{-2}$ W(u) = 3.07 s = 3.5 ft.	$u = 1.42 \times 10^{-1}$ W(u) = 1.51 s = 1.7 ft.	$u = 8.16 \times 10^{-3}$ W(u) = 4.24 s = 4.9 ft.
✓ t = 3 days staff* s = 5.69	$u = 9.58 \times 10^{-3}$ W(u) = 4.08 real data s = 4.7 ft. s = 6.20	$u = 4.74 \times 10^{-2}$ W(u) = 2.52 real data s = 2.9 ft. ✓ s = 6.44	$u = 2.72 \times 10^{-3}$ staff W(u) = 5.33 real data s = 6.1 ft. s = 5.84, 6.95
t = 10 days	$u = 2.87 \times 10^{-3}$ W(u) = 5.31 s = 6.1 ft.	$u = 1.42 \times 10^{-2}$ W(u) = 3.69 s = 4.2 ft.	$u = 8.16 \times 10^{-4}$ W(u) = 6.53 s = 7.5 ft.
t = 30 days	$u = 9.58 \times 10^{-4}$ W(u) = 6.38 s = 7.3 ft.	$u = 4.74 \times 10^{-3}$ W(u) = 4.78 s = 5.5 ft.	$u = 2.72 \times 10^{-4}$ W(u) = 7.63 s = 8.8 ft.
t = 100 days	$u = 2.87 \times 10^{-4}$ W(u) = 7.56 s = 8.7 ft.	$u = 1.42 \times 10^{-3}$ W(u) = 5.98 s = 6.9 ft.	$u = 8.16 \times 10^{-5}$ W(u) = 8.84 s = 10.1 ft.

* Using results obtained from the Boulton Method of Analysis

* Data Suspect Recorder Malfunction

*

3 days	real	Staff G#
3-D;	s = .96'	.23 5.16
4-D;	s = .45'	

TABLE 4-3
COMPARISON OF DRAWDOWN VS. TIME RESULTS
(OBTAINED GRAPHICALLY AND CALCULATED)
MARTIN DOWNS

	Drawdown (ft)							
	OW-3 D			OW-1D			OW-2D	
	Calc.(1)	Graph.(2)	Real	Calc.(1)	Graph.(2)	Real	Calc.(1)	Graph.(2)*
1 day	4.9	8.1	5.63	3.5	6.0	6.0	1.7	-
3 days	6.1	9.2	5.82	4.7	6.2	6.2	2.9	-
10 days	7.5	10.4		6.1	6.4		4.2	-
30 days	8.8	11.5		7.3	6.6		5.5	-
100 days	10.1	12.7		8.7	6.8		6.9	-

(1) Calculated values obtained from Table 4-2

(2) Values obtained by extrapolation of Figure 4-3 using actual field data.

* data not available due to malfunction of water level recorder.

TABLE 4-4
DISTANCES OF THE 1-FOOT DRAWDOWN CONTOUR
FROM THE PUMPING WELL
AFTER 30 AND 100 DAYS OF CONTINUOUS PUMPING,
ASSUMING NO RECHARGE (FROM FIGURES 4-9 AND 4-10)
MARTIN DOWNS

Pumping Rate(gpm)	After 30 Days	After 100 Days
500	1150 ft.	2200 ft.
650	1450 ft.	2530 ft.
850	1650 ft.	2850 ft.
1000	1800 ft.	3050 ft.
1200	1900 ft.	3250 ft.

TABLE 6-7
WATER LEVELS
MARTIN DOWNS

	Elevation (ft) (msl) Casing	March 16, 1980 Below m.p.	March 16, 1980 msl (ft)	March 31, 1980 Below m.p.	March 31, 1980 msl (ft)
1-S	7.09			4.53	2.56
1-D	6.79			5.15	1.64
2-S	7.13			3.96	3.17
2-D	7.40			4.37	3.03
3-S	16.83			3.32	13.51
3-D	17.66	6.46	12.16	6.16	11.50
4-S	18.17			5.87	12.30
4-D	18.42	6.90	12.63	6.31	12.11
5-S	4.40			2.45	1.95
5-D	13.45			5.25	8.20
6-S	11.07			6.36	4.71
6-D	10.99			5.36	5.63
7-S	9.24			6.65	2.59
8-S	16.06			5.49	10.57
OW-1D (9-D)	18.08	6.20	12.48	6.19	11.84
OW-2D (10-D)	17.84	6.24	12.11	-	-
OW-3D (11-D)	16.23	4.73	12.35	-	-
OW-1S (12-S)	17.29	6.22	12.09	-	-
PW	17.11	4.86	12.25	-	-
SW-1	14.75			2.93	11.82
SW-2	9.33			2.08	7.25
SW-3	7.19			4.35	2.84
SW-4	2.64			2.12	0.52
SW-5	2.42			2.09	0.33
SW-6	6.59			2.46	4.13
SW-7	6.05			3.70	2.35
SW-8	3.12			3.10	0.02
SW-9	6.25			4.50	1.75
SW-10	7.29			2.25	5.04
SW-11	14.92			3.25	11.67
SW-12	11.93			6.26	5.67

TABLE 7-1

STEP DRAWDOWN TEST
MARTIN DOWNS

Test started 1440 hours on March 15, 1980
Measuring Point (M.P.) - top of well casing
6-inch x 5-inch orifice

Time from Test Start (Minutes)	Time at Constant Discharge Rate (Minutes)	Manometer Readings (Inches)	Discharge Rate (GPM)
0	0	56.5	925
1	1	56.5	925
1.5	1.5	56.5	925
2.0	2.0	56.5	925
2.5	2.5	56.5	925
3.0	3.0	56.5	925
3.5	3.5	56.5	925
4.0	4.0	56.5	925
4.5	4.5	56.5	925
5.0	5.0	56.5	925
7.5	7.5	56.5	925
8.5	8.5	56.5	925
10.0	10.0	56.5	925
12.5	12.5	56.5	925
15.0	15.0	56.5	925
16.5	16.5	56.5	925
18.0	18.0	56.5	925
20.0	20.0	56.5	925
22.5	22.5	56.5	925
23.0	23.0	56.5	925
23.5	23.5	56.5	925
25.0	25.0	56.5	925
27.5	27.5	56.5	925
32.5	32.5	56.5	925
33.5	33.5	56.5	925
35.0	35.0	56.5	925
37.0	37.0	56.5	925
38.5	38.5	56.5	925
40.0	40.0	56.5	925
41.0	41.0	56.5	925
42.5	42.5	56.5	925
50.0	50.0	54.5	908
55.0	55.0	54.5	908
56.0	56.0	54.5	908
58.0	58.0	54.5	908
60.0	60.0	54.5	908
61.0	61.0	54.5	908
65.0	0.0	32.75	700
72.0	7.0	32.75	700
73.0	8.0	32.75	700
74.0	9.0	32.75	700
80.0	15.0	32.75	700

TABLE 7-1 (Continued)

STEP DRAWDOWN TEST
MARTIN DOWNS

Test started 1440 hours on March 15, 1980
Measuring Point (M.P.) - top of well casing
6-inch x 5-inch orifice

Time from Test Start (Minutes)	Time at Constant Discharge Rate (Minutes)	Manometer Readings (Inches)	Discharge Rate (GPM)
81.0	16.0	32.75	700
82.0	17.0	32.75	700
90.0	25.0	32.75	700
95.0	30.0	32.75	700
97.0	32.0	32.75	700
100.0	35.0	12.5	440
106.0	6.0	12.5	440
107.0	7.0	12.5	440
108.0	8.0	12.5	440
110.0	10.0	12.5	440
115.0	15.0	12.5	440
120.0	20.0	12.5	440
125.0	25.0	12.5	440
130.0	30.0	12.5	440
131.0	31.0	12.5	440
132.0	32.0	12.5	440

APPENDIX 2

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 1-S

Depth (ft.)	Lithology
0-5	Sand: silica, light grayish brown, very fine to medium grained; minor medium brown clay and organic matter (roots, bark), unconsolidated.
5-20	Clayey sand: silica, light to medium brown, very fine to medium grained, hardpan (cemented sand), increasing clay content with depth, consolidated to poorly lithified.
20-40	Marl: medium grayish brown, carbonate, silty clay, very fine to medium-grained, silica sand, consolidated. Limestone: biomicrite, gray, fossiliferous.
40-50	Sand: silica, light brownish gray, very fine to fine-grained, some light gray clay, consolidated with minor lithification, minor shell fragments, very fine to fine-grained.
50-60	Shell: light brown, medium to very coarse-grained, juvenile and adult pelecypods (Chione sp., Tellina sp.). Sand: silica, light to medium gray, very fine to medium grained, some calcareous cement, light brown clay, unconsolidated, minor phosphatic sand.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 1-D

Depth (ft.)	Lithology
0-5	Sand: silica, light grayish brown, very fine to medium-grained, minor medium brown clay and organic matter (roots, bark), unconsolidated.
5-20	Clayey sand: silica, light to medium brown, very fine to medium grained, hardpan (cemented sand), increasing clay content with depth, consolidated to poorly lithified.
20-40	Marl: medium grayish brown, carbonate, silty clay, very fine to medium-grained, silica sand, consolidated.
	Limestone: biomicrite, gray, fossiliferous.
40-50	Sand: silica, light brownish gray, very fine to fine-grained, some light gray clay, consolidated with minor lithification, minor shell fragments, very fine to fine-grained.
50-60	Shell: light brown, medium to very coarse-grained, juvenile and adult pelecypods (Chione sp. , Tellina sp.).
	Sand: silica, light to medium gray, very fine to medium grained, some calcareous cement, light brown clay, unconsolidated, minor phosphatic sand.
60-115	Shell: light brown to gray, fine to very coarse-grained, mostly pelecypods (Chione sp., Tellina sp., Venus sp.), some gastropods (Olivilla sp.), worm tubes, unconsolidated.
	Limestone: light to medium gray, well lithified to friable, calcarenite to biomicrite.
	Sand: light to medium gray, very fine to medium-grained, some clay, phosphatic sand.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 1-D

Depth (ft.)	Lithology
115-135	Limestone: gray, well-lithified, fossiliferous, calcarenite.
	Sand: carbonate, light gray, very fine to fine-grained, abundant silty clay, with consolidated shell fragments, medium to very coarse-grained, mostly pelecypods, minor phosphatic sand.
135-140	Silty sand: silica sand, carbonate silt, medium grayish green, very fine to fine-grained, consolidated.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 2-S

Depth (ft.)	Lithology
0-5	Sand: silica, light grayish brown, fine to coarse-grained, abundant silt, unconsolidated.
5-25	Sand: silica, light brown, very fine to coarse-grained, friable, abundant silt and clay, minor phosphate, light to medium grayish brown hardpan (cemented sand) at 20-25 feet, fine to coarse-grained, friable, abundant clay; some phosphate.
25-30	Shell: light brownish gray, some silica sand, fine to coarse-grained, abundant carbonate silt and clay, unconsolidated, phosphate sand.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 2-D

Depth (ft.)	Lithology
0-5	Sand: silica, light grayish brown, fine to coarse-grained, abundant silt, unconsolidated.
5-25	Sand: silica, light brown, very fine to coarse-grained, friable, abundant silt and clay, minor phosphate, light to medium grayish brown hardpan (cemented sand) at 20-25 feet, fine to coarse-grained, friable, abundant clay some phosphate.
25-50	Marl: light brownish gray, some silica sand, fine to coarse-grained, abundant carbonate silt and clay, unconsolidated, phosphate sand, minor shell fragments at 45 feet.
50-75	Shell: light brownish gray, unconsolidated, very fine to medium-grained, abundant pelecypods (*Tellina sp.*), some gastropods (*Olivella sp.*)
	Sand: silica, very fine to medium-grained, some light brown clay, some phosphatic sand.
75-90	Sand: carbonate with minor silica, light grayish brown, very fine to medium-grained, abundant silt, unconsolidated, shell fragments, fine-grained, phosphate sand.
90-120	Linestone: light brown, very fine to medium-grained, well lithified, fossiliferous with abundant pelecypods.
	Sand: light gray, very fine to fine-grained, with some silty clay and phosphatic sand.
120-135	Limestone: light to medium gray, calcarenite, poorly-cemented, friable, abundant shell fragments, pelecypods (*Chione sp.*), gastropods (*Turitella sp.*), minor clay and sand.
135-140	Silty sand: carbonate, greenish gray, consolidated, minor limestone, as in 120-135 feet, minor shell fragments.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 3-D

Depth (ft.)	Lithology
0-20	Sand: silica, light yellowish to brownish gray, very fine to fine-grained, unconsolidated.
20-45	Sandy shell: fine to very coarse-grained, abundant pelecypods (Chione sp., Donax sp.), gastropods (Olivella sp.), unconsolidated.
	Limestone: medium to dark gray, calcarenite, 30-40 percent, well-cemented, fossiliferous, some fine-grained silica and phosphatic sand.
45-65	Shell: as in 20-45 feet; limestone decreasing to less than 10 percent.
65-95	Shell: as in 20-45 feet.
	Limestone: light grayish green to medium brown, calcarenite, 30-40 percent of sample.
95-145	Limestone: greenish gray, calcarenite, 60 percent, well cemented, silica sand, phosphate, shell fragments.
145-150	Silty sand: olive green, carbonaceous, abundant fine-grained silica sand with phosphate.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 4-S

Depth (ft.)	Lithology
0-5	Sand: silica, medium brown, very fine to fine-grained, minor organic debris.
5-15	Sand: silica, light brownish gray, abundant silt, very fine to fine-grained.
15-30	Shell: shell fragments, fine to coarse-grained, abundant pelecypods (Donax sp., Trachycardium sp.), juvenile to adult, gastropods, unconsolidated.
30-60	Shell: shell fragments, fine to coarse-grained, abundant pelecypods (Donax sp. , Venus sp.).
	Limestone: light greenish to dark gray, calcarenite, well-cemented, some silica and phosphate sand.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 4-D

Depth (ft.)	Lithology
0-5	Sand: silica, medium brown, very fine to fine-grained, minor organic debris.
5-15	Sand: silica, light brownish gray, abundant silt, very fine to fine-grained.
15-30	Shell: shell fragments, fine to coarse-grained, abundant pelecypods (Donax sp., Trachycardium sp.), juvenile to adult, gastropods, unconsolidated.
30-95	Shell: shell fragments, fine to coarse-grained, abundant pelecypods (Donax sp., Venus sp.).
	Limestone: light greenish to dark gray, calcarenite, well-cemented, some silica and phosphate sand.
95-135	Limestone: light greenish gray, calcarenite, well-cemented, silica and phosphatic sand, shell fragments.
135-140	Limestone: as in 95-135 feet.
	Clay: greenish gray, abundant.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 5-S

Depth (ft.)	Lithology
0-5	Sand: silica, light gray, very fine to medium-grained with organic matter (roots, bark), consolidated.
5-10	Clayey sand: silica, dark brown, very fine to fine-grained, abundant clay.
10-30	Clayey sand: silica, light grayish brown, very fine to fine-grained, with carbonate silty clay, consolidated (hardpan).
30-50	Marl: light grayish brown silica sand, carbonate silt and sand, phosphatic sand, unconsolidated, with fine to very coarse-grained shell fragments, abundant pelecypods (Chione sp., Trachycardium sp., Donax sp.), gastropods.
50-90	Shell: light brown to gray, fine to very coarse-grained, abundant pelecypods, some calcareous cement.
	Limestone: light to medium gray, calcarenite and biomicrite, well-lithfied.
	Sand: light gray, very fine to fine-grained, with minor silt.
90-120	Limestone: light gray, biomicrite and calcarenite, well-lithified fossiliferous, medium to very coarse-grained.
	Sand: very fine to fine-grained, silica, clay, less than 5 percent.
120-125	Silty sand: olive green, stiff, plastic, consolidated, calcareous, clayey.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 5-D

Depth (ft.)	Lithology
0-5	Sand: silica, dark brown, very fine to fine-grained, consolidated, some clay, some organic debris.
5-30	Silty clay: light brownish gray, abundant clay, consolidated.
30-40	Shell: light brown to gray, unconsolidated, fine to coarse-grained, abundant pelecypods (Tellina sp., Chione sp., Trachycardium sp.).
	Sand: silica, light brownish gray, very fine to fine-grained, minor clay.
40-90	Shell: unconsolidated mollusc fragments as in 30-40 feet.
	Limestone: light to dark gray calcarenite, lithified, some sand and shell fragments.
90-120	Limestone: light to medium greenish gray, calcarenite, well-cemented, silica and phosphate sand, shell fragments, fine-grained, some shell fragments.
120-145	Silty sand: light greenish gray, plastic consolidated, silica and phosphate sand, very fine to fine-grained.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 6-S

Depth (ft.)	Lithology
0-5	Sand: silica, light grayish brown, very fine to medium-grained, some silt, unconsolidated.
5-15	Silty sand: silica, yellowish gray, some silt and clay, very fine to medium-grained, consolidated.
15-60	Shell: light brown to gray, fine to medium-grained, abundant pelecypods (<u>Chione</u> <u>sp</u>., <u>Tellina</u> <u>sp.</u>)
	Sand: silica, light gray, fine-grained, unconsolidated.
	Limestone: medium gray, lithified, calcarenite, fossiliferous.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 6-D

Depth (ft.)	Lithology
0-5	Sand: silica, light grayish brown, very fine to medium-grained, some silt, unconsolidated.
5-15	Silty sand: silica, yellowish gray, silt and clay, very fine to medium-grained, consolidated.
15-90	Shell: light brown to gray, fine to medium-grained, abundant pelecypods (Chione sp., Tellina sp.).
	Sand: silica, light gray, fine-grained, unconsolidated.
	Limestone: medium gray, lithified, calcarenite, fossiliferous.
90-150	Limestone: gray, lithified, fossiliferous.
150-155	Silty clay: olive green, fine-grained silica sand and carbonate silt, consolidated.

GEE & JENSON ENGINEERS-ARCHITECTS-PLANNERS, INC.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 7-S

Depth (ft.)	Lithology
0-5	Sand: silica, dark brown, very fine to fine-grained some organic debris, unconsolidated.
5-30	Clayey sand: silican, light grayish brown, very fine to fine-grained, clay content, consolidated.
30-45	Marl: light brownish gray, carbonate, silty clay and silica sand, very fine to fine-grained with minor shell fragments.
45-60	Shell: light brown to gray, pelecypods abundant (Chione sp. , Trachycardium sp.), gastropods, juvenile to adult, worm tubes, unconsolidated.
	Limestone: light to dark gray, calcarenite, well-cemented, friable, shell fragments, minor silica sand.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL 8-S

Depth (ft.)	Lithology
0-10	Sand: silica, dark brown, abundant clay, very fine to fine-grained, consolidated.
10-25	Sand: silica, yellowish gray, abundant clay, very fine to fine-grained, consolidated.
25-45	Shell: medium grayish brown, unconsolidated with minor silty sand (carbonate and silica), fine to coarse-grained, abundant pelecypod fragments (*Trachycardium sp.*, *Chione sp.*, *Tellina sp.*), gastropods (*Terebra sp.*).
45-60	Shell: pelecypod fragments, as in 25-45 feet. Limestone: medium to dark gray, fossiliferous, calcarenite, lithified with minor unconsolidated silica and phosphatic sand.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL OW-1D

Depth (ft.)	Lithology
0-5	Sand: silica, dark grayish brown, fine to medium-grained, organic matter (roots), unconsolidated.
5-15	Clayey sand: silica, light brownish gray, fine to medium-grained, hardpan (cemented sand), abundant clay.
15-20	Sandy clay: as in 5-15 feet, with shell fragments pelecypods and echinoid fragments).
20-40	Shell: light brownish gray, medium to coarse-grained, abundant pelecypods (*Venus sp.*), some gastropods (*Olivella sp.*), echinoid fragments.
	Sand: silica, light gray, very fine to fine-grained minor clay.
40-65	Shell: as 20-40 feet, sand and clay absent.
65-85	Shell: light brown to gray, coarse to very coarse-grained, adult pelecypods.
	Limestone: light to medium gray, calcarenite, well-cemented, fossiliferous.
85-135	Limestone: light to medium gray, calcarenite, well-cemented with some shell fragments.
135-145	Silty sand: olive green, silica sand, carbonate silt, clayey, phosphatic, consolidated.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL OW-2D

Depth (ft.)	Lithology
0-5	Sand: silica, dark brown, very fine to fine-grained, abundant organic debris, unconsolidated.
5-20	Clayey sand: silica, light to medium grayish brown, abundant clay, very fine to fine-grained, unconsolidated.
6.25 static 12.98 72 HRS	
20-60	Shell: light brown to gray, fine to coarse-grained, abundant pelecypods (<u>Venus</u> <u>sp</u>., <u>Chione</u> <u>sp</u>.), juvenile to adult, few gastropods.
6ft 20-6= 14ft	
	Sand: silica, light grayish brown, fine to medium-grained, some calcareous cement, minor phosphate gravel.
60-95	Shell: light brown to gray, fine to coarse-grained, abundant pelecypods.
	Limestone: medium gray, calcarenite, coquina (cemented shell), well-lithified.
	Sand: silica, light grayish brown, phosphatic, very fine to fine-grained, some clay.
135 15 120 ft	
95-135	Limestone: light to medium gray, calcarenite, well lithified, some partially cemented shell fragments, medium to coarse-grained.
	Sandy clay: silica, yellowish gray, very fine to fine-grained, with minor phosphatic sand.
135-145	Silty sand: olive green, silica sand, carbonate silt, stiff, phosphatic, consolidated.

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL OW-3D

Depth (ft.)	Lithology
0-5	Sand: silica, dark brown, very fine to fine-grained, abundant organic debris, unconsolidated.
5-15	Clayey sand: silica, yellowish gray, abundant clay, very fine to fine-grained, consolidated.
15-30	Shell: light brown to gray, fine to very coarse-grained, unconsolidated, abundant pelecypods (<u>Venus sp.</u>), juvenile to adult.
	Sandy clay: light grayish brown silica, fine-grained, phosphatic sand, unconsolidated.
30-85	Shell: as in 15-30 feet
	Limestone: light grayish brown, calcarenite, well-lithified, with silica and phosphatic fine-grained sand.
85-135	Limestone: light olive gray, calcarenite, well-lithified, minor silica and phosphatic sand and shell fragments.
135-150	Silty sand: olive green, silica sand, carbonate silt, phosphatic, consolidated.

4.73 static

110 b

25
34
14
6
173

110

5 x 6'

LITHOLOGY DESCRIPTION
MARTIN DOWNS
WELL OW-1S

Depth (ft.)	Lithology
0-5	Sand: silica, dark brown, fine-grained, abundant organic debris, unconsolidated.
5-20	Sand: silica, light yellowish to dark brown, fine-grained, shell fragments, minor clay, phosphatic sand.
20-30	Shell: light brown to gray, very fine to fine-grained, minor clay, phosphatic sand.