FINAL REPORT
EXPLORATORY TEST DRILLING
AND
PRELIMINARY WATER RESOURCE EVALUATION
PLAINE DE L'ARBRE – HAITI

PREPARED FOR

HARMONISATION DE L'ACTION DES COMMUNAUTES
HAITIENNES ORGANISEES (HACHO)

JULY 1980

HARZA ENGINEERING COMPANY

GENERAL CONTENTS

TABLE OF CONTENTS

EXPLORATORY TEST DRILLING
AND PRELIMINARY WATER RESOURCE EVALUATION

PLAINE DE L'ARBRE-HAITI

Harza Engineering Company (Harza) was retained by the Harmonisation de l'Action des Communuates Haitiennes Organisees (HACHO) to conduct a study to construct exploratory test wells and make a preliminary assessment of the ground water resources of the Plaine de l'Arbre (Plaine) in Haiti. The study area is located on the southern slopes of Haiti's northwestern peninsula and has an area of approximately 200 square kilometers (Exhibit 1). The study was conducted between September 1979 and July 1980 and involved review of previous reports and on-site reconnaissance and exploratory test drilling.

During the same period, Harza also conducted exploratory test drilling in the Plain under a separate agreement with the United States Agency for Internaional Development, Haiti Mission (AID/Haiti).

This report describes the work activities that were carried out under both programs and presents study findings.

Objectives

The principal objective of the study was to identify favorable well-drilling locations and to develop as many production wells as practicable within the limitations of the ground water resource and available funding. Specifically, the study was intended to: a) identify localities where there is potential for ground-water development by wells; b) substantiate the availability, quantity, and quality of supplies at specific locations by drilling and testing of exploratory wells; and c) develop the resource, whenever possible, by construction of production wells.

The long-term study objectives were to: a) provide a preliminary assessment of the quantity and quality of available ground-water resources in the Plain, and b) use study findings as a basis for subsequent investigations that may be required for a more complete evaluation of the available resource. Because of budget limitations, the long-term objectives were considered of secondary importance to the study.

Scope

The study was conducted in two phases. Phase I involved preliminary investigations that were directed at identification of test areas and formulation of a test drilling program. Phase II involved actual installation and testing of exploratory wells.

The results of test drilling were continually used to update the data base and revise drilling priorities. Liaison was maintained with HACHO and AID/Haiti throughout the study.

Preliminary Investigations

The preliminary investigations included a) literature review; b) inventory of water supply sources; c) a formulation of test drilling program; and d) preparation of technical specifications for well drilling, installation, and testing.

Literature Review

Previous reports on the local and regional geology and hydrogeology of the study area were reviewed. These reports had been collected during Harza's initial work for AID (Harza, 1979). Relevant sections were reviewed in the following reports: Woodring et al (1924); FAO (1969); and Martin and Moussu (1977).

The FAO report (FAO, 1969) was of significant relevance to the present study as it included the findings of an exploratory test drilling program and other field work that had been carried out by them in the study area over a five-year period (1962-1967). The geologic map and sections included in

1/ References are listed at end of text.

the FAO report were used extensively throughout the present study.

Inventory of Water Supply Sources

Surface springs are the source of water supply for the great majority of the inhabitants in the study area at present. Fifteen (15) springs have been identified. The springs issue from bedrock outcrops and are generally located at or near the base of the mountainous terrain which forms the inland boundary of the Plain. The locations of all springs are shown on the location map in Exhibit 1, and their characteristics including water quality data are summarized in Exhibit 2.

A much less significant source of water in the study are at present is a small number of large diameter shallow (generally less than 50 feet deep) hand dug wells that provide water supply locally. About half a dozen such wells were visited in the course of this study. All of these wells are located within about one kilometer from the coast, where the water table is nearest to the land surface, and the water in these wells is brackish (about 2000 parts per million total dissolved solids). A windmill-operated pump is used in one such well near Anse Rouge; in the remainder of the wells a bucket and rope are used for lifting the water.

Drilling Program Formulation

Formulation of the test drilling program was intended to identify and rank test areas and drilling sites based on available information. To achieve this objective, the following work activities were carried out.

1. Lithologic logs and geologic maps and sections available from the FAO report were used to identify potential shallow and deep aquifers.

2. Topographic maps and streamflow data were used to identify "disappearing" streams, considered to be indicative of shallow ground-water aquifers.

3. Earth Resources Technology Satellite (ERTS) imagery of the study area, including black and white and infrared, were obtained and used to delineate: a) drainage patterns; b) unconsolidated deposits and bedrock outcrop areas; and c) lineaments and surficial features of bedrock joints, faults, fractures, displacements, etc.

4. Limited field reconnaissance was made to verify available geologic information and to observe rock outcrops and surface geologic features.

Based on these activities, a tentative drilling program was prepared. Drilling sites were identified for shallow wells, to be completed in the unconsolidated deposits or upper 50-100 feet of underlying bedrock formations, and deep wells, to be completed in deeper bedrock units. Tentative sites for shallow wells were selected in four test areas as described below.

1. The alluvial area of the Colombier River was selected for test drilling on the assumption that the unconsolidated material there would be thick and well sorted. Also, the FAO study indicated the occurrence of some ground water supplies in this area.

2. The upper part of the plain area near the adjoining hills and mountains was selected as a test area on the assumption that the unconsolidated material there should be coarser than elsewhere in the Plain. Also any water obtained from wells located in this area can flow by gravity to the remainder of the Plain downslope.

3. Some test well locations were selected at the end of "disappearing" streams in the flat areas of the Plain.

4. One test well location was selected near the coast in an attempt to meet water supply needs for the coastal town of Coridon.

Tentative sites for deep wells were selected considering the following two criteria:

1. The estimated depth to the postulated bedrock aquifers was the controlling criterion used in selecting the deep well sites near the mountains and at locations where the bedrock aquifers were believed to be nearest to the land surface.

2. Another criterion used for selecting tentative sites for deep test wells was their proximity to springs and faulted, fractured, and jointed bedrock outcrop areas.

The initial ranking of test areas and drilling sites was determined considering the following criteria:

1. Shallow wells were given higher priority than deep wells.

2. Sites located near population concentrations were given higher priority than those that are far away.

3. Sites located in areas with higher possibility to develop ground water, based on information already available, were given high priority.

4. Travel time for mobilization and demobilization was to be minimized.

Technical Specifications

Technical specifications for drilling, construction, development, and testing of wells were prepared. A copy of these specifications is attached in Appendix A.

Drilling Program

Drilling and well construction work was carried out in two time intervals: 30 September through 21 November, 1979 and 14 April through 10 June 1980. This work was conducted by Haiti Water Supply, S.A., of Port Au Prince.

All drilling was done by direct rotary using a truck-mounted CF-15 drilling rig manufactured by George E. Failing Company of Enid, Oklahoma. A manufacturer's brochure describing this rig capability is included in Appendix B. Well development was conducted by air surging and backwashing using a portable air compressor and surging assembly. Pumping was conducted by air, or by using a submersible or vertical turbine pump, depending on well depth and depth to the water table.

The drilling program involved drilling, logging, and sample study; conversion of test holes into test wells by installation of casing and screen; and development and testing of wells. The work also included deepening, cleaning, and development of an abandoned old well that had previously been installed in the course of the FAO study. This well is located in the Colombier Basin about 3 kilometers northeast of H-1.

Test Hole Drilling

A total of 14 test holes (H-1 through H-14) and total footage of 4472 feet were drilled. This included 12 "shallow" holes (H-1 through H-12; 2892 feet) and 2 "deep" holes (H-13 and H-14; 1580 feet)2/. The locations of all holes are shown on Exhibit 1 and their characteristics are summarized in Exhibit 3.

All of the "shallow" test holes were drilled with a 12-inch diameter bit. The "deep" holes were drilled with a 12-inch bit to 400 or 420 foot depth; a 5 1/2-inch nominal diameter bit was used in drilling the lower sections of the "deep" holes.

In all of the test holes, lithologic samples were collected from five-foot intervals and described. In some of the holes, electric resistivity and spontaneous potential logs were run using a manual logger. All the logs prepared during this study are included in Appendix C.

Test Well Conversions

A total of 8 test holes were converted into test wells. This includes 6 "shallow" holes (H-1; H-2; H-3; H-10; H-11 and

2/ The test holes drilled under the HACHO contract are designated "shallow" and those drilled under the AID contract are designated "deep"

H-12) and two "deep" holes (H-13 and H-14). A test hole was converted into a test well by installing casing and screen. In the majority of the wells, this was done using a 6-inch diameter black-steel casing and hand slotted pipe. A 4-inch PVC casing and screen were used in Test Well H-10 and in the lower section of Well H-12. All of the wells were gravel-packed using locally sieved materials. Detailed well completion reports are included in Appendix E.

All of the test holes not converted into wells were backfilled and abandoned.

Development and Testing

All of wells were developed and tested. The development and testing operations were usually conducted several days after a well was completed. Water samples were collected and limited chemical analyses of the samples were made locally. The results of well testing and chemical analysis of water as provided by the drilling contractor are included in Appendix E.

A well was capped when operations on the well were halted and when testing of the well was completed. No permanent pumps were installed.

Findings

The results of the test drilling program are summarized in Exhibit 4. Based on the results of the test drilling conducted in this study, it appears that small to moderate water supplies are available in two zones in the study area. These include the unconsolidated alluvial deposits of the Colombier River Basin (Wells H-1 and H-11) and thin beds of consolidated bedrock formations, mainly limestone, which are interbedded with a predominantly claystone formation of several hundred feet thickness (Wells H-12 and H-14).

When completed, Wells H-12 and H-14 flowed at ground surface, indicating artesian conditions. Both Wells are completed at over 400-foot depth. The overlying claystone interval apparently acts as a confining bed. It is possible that the water producing zones below a 400-foot depth cover a large area, but this can only be confirmed by test drilling. A study of the geologic sections indicates that larger supplies may possibly be obtained by installing wells that are deeper than those completed. These prospects should be the subject of further investigation.

Wells H-3 and H-10, both located west of the Colombier Basin, obtain their supplies from shallow and possibly weathered bedrock formations but the water supply in both wells is small and may be only seasonal. Well H-2 contains bad quality water, clearly because of its nearness to the coast. H-13 did not produce sufficient water to justify a test.

Ground Water Resource Assessment

Hydrogeologic Setting

Topography. The L'Arbre Plaine encompasses a roughly rectangular area extending about 20 kilometers (km) along the coast of the Golfe De La Gonaves in the area of Anse Rouge and about 10 km inland. The Plain is a largely erosional surface of gentle to moderate relief rising from the coast, north to the base of rugged mountains. The mountains are divided into two ranges by a valley which cuts across the northern peninsula to the north coast. The Plaine is occupied in the east by the valley of the Colombier River and in the west by the Anse Rouge River, both intermittent streams. The Plaine area is dissected by intermittent streams and gullys and becomes increasingly more rugged near the base of the mountains. Low coastal ridges occur in the Anse Rouge area and to the west and also locally to the east.

Geology. The Plain is underlain by a thick sequence of claystones and sandy/silty claystones assigned to the Oligocene/Miocene (undifferentiated). The sediments are gray when fresh, compact, moderately indurated and locally contain thin marl interbeds. The unit was encountered in all of the test holes. Lithologic sample study indicates that the claystone may be slightly coarser grained in the north at the base of the mountains. Data are not available to determine the total thickness of the claystones, but they are likely to extend for several thousand feet in most of the area.

The coastal ridges in the Anse Rouge area consist of Pliocene/Pleistocene coral reef limestones reported to overlie the older claystones. These units are stratigraphically underlain by an older sequence of primarily marine sedimentary rocks with interbedded volcanic rocks, which outcrop in the mountains and hills to the north and east. The sedimentary rocks consist of calcareous lithologies ranging from marl to massive cherty limestone. The volcanic rocks include andesite and basalt. This stratigraphic sequence is assumed to underlie the Oligocene/Miocene claystones at unknown depths under the Plain.

Unconsolidated Quaternary deposits of potential relevance to this study are restricted to alluvial sands, gravels, cobbles and boulders in the valley of the Colombier River, and locally elsewhere. In the Colombier Basin the alluvium was encountered in wells to depths in excess of 100 feet and was underlain by the Oligocene/Miocene claystones.

Structure in the project area is characterized by complex folding and, locally, faulting in the mountains to the north and east and by nearly flat lying claystones and, presumably, underlying units in the plain area itself. Fold axes and faults generally strike about east-west, southeast-northwest and locally about north-south. Normal and reverse faults have been reported, particularly along the base of the northern mountains.

Ground Water Occurrence and Flow. The results of test drilling in the study area indicate that ground water occurs in sufficient quantities to be tapped by wells in two aquifers. These include the sand and gravel of the unconsolidated alluvial deposits of the Colombier River and older calcareous bedrock formations. Shallow coastal aquifers with brackish to saline water and others with shallow and seasonal ground water may be found locally but have no significance as dependable water sources.

The alluvial sand and gravel deposits in the Colombier Basin are saturated to a depth of approximately 60 feet. Water in this aquifer is under unconfined conditions and hydraulic gradients and ground water flow is toward the ocean southward. Data are not sufficient to construct potentiometric contour lines or delineate subsurface flow.

The other water bearing zone that was identified based on the results of the test drilling program is a zone of thin limestone beds at over a 400-foot depth. These beds underlie the Oligocene/Miocene claystone and are possibly interbedded with siltstone, marl, and other claystone beds. The claystone acts as a confining bed and this aquifer is essentially confined with an upward vertical gradient. There are no data to prepare piezometric contours for this zone but it can be assumed that the lateral gradient and flow is toward the ocean.

A study of the geologic sections provided by the FAO study indicates that there are deep limestone units that may be capable of producing water. These units, with estimated depth of 2000 feet or more, were not investigated in the present study. Water in these units is likely to be confined and may flow or can possibly be pumped economically. This prospect can be investigated but would require drilling equipment that is not available in Haiti at present.

Resource Assessment

Springs. Water from springs has been estimated at between 1500 gallons per minute (gpm) to 2700 gpm (FAO, 1969) and spring water is basically of good quality and can be used for irrigation and with limited treatment, human consumption. A portion of the water supply from springs is used at present. The unused capacity estimated at roughly 50 percent of the available supply, can be exploited by capping of those springs not presently in use and by more efficient use of the water. Since the water supply from Springs is generally seasonal, a preliminary study involving gauging of springs to determine monthly or weekly spring discharge may have to be conducted before an accurate assessment of spring capacity can be made. This is especially needed prior to development of springs of marginal capacity.

Alluvial Aquifers. The unconsolidated alluvial deposits of the Colombier River Basin are considered important sources of water that can be developed by wells. Based on the results of test drilling in the study area, individual wells of 250 gpm capacity may be completed in these deposits. The water is of moderate quality and can be used for irrigation as well as human consumption. Near the coast, however, the water may be too saline for most uses.

It is not possible to assess the long-term capability of the alluvial aquifer of the Colombier River Basin for lack of data to estimate annual recharge, subsurface flow, or seasonal water level fluctuations. A preliminary estimate of water in storage has been made considering a 10-square kilometer outcrop area and assuming a saturated aquifer thickness of 40 feet and specific yield of 20 percent. The water in storage was thus estimated at 6.4 x 10 B gallons. Recharge to this aquifer is from local precipitation and surface runoff of the Colombier River drainage area.

<u>Bedrock Units</u>. Information was obtained in the present study on the upper bedrock units. Three test holes penetrated the Oligocene/Miocene claystone, and two of these indicated the occurrence of water-bearing bedrock units of limited capacity within 700 foot depth. Well H-14 can be considered representative of wells deriving their supply from the upper bedrock interval. This well flowed at the surface upon completion indicating confined conditions. Short-term pumping of this well indicated that a specific capacity of 0.65 gpm/ft can be obtained from the upper bedrock aquifers. The water is of

moderate quality and can be used for irrigation. Considering that the available drawdown is at least 400 feet, it may be possible to obtain as much as 250 gpm from wells completed in this zone. Larger supplies might be possible from deeper wells.

Regional deep bedrock units could not be evaluated from data obtained in the present study. Neither the capability or water quality can be delineated from available information. It is likely that large supplies could be obtained from these units, based on the geologic setting and occurrence of springs. This can only be determined through extensive deep well drilling and testing.

Conclusions and Recommendations

Conclusions

Based on data and information generated by the present study, the following conclusions can be made.

1. Additional ground-water exploration and development in the L'Arbre Plaine appears to be justified by the results of this study. Further work should be aimed at investigating the inland edges of the Plaine and at further study and development of the Colombier River area. It does not appear that more shallow well drilling work in the central areas forming the bulk of the Plaine area would be productive.

2. The alluvial deposits of the Colombier River Basin constitute an unconfined aquifer that can be tapped by wells of less than 150 foot depth. Up to 250 gpm can possibly be obtained from individual wells. Well specific capacity is in the order of 6 gpm/foot of drawdown and water is generally of acceptable quality. This aquifer's long-term potential cannot be determined from available data. Shallow alluvial aquifers in other parts of the area may contain minor quantities of water, possibly seasonal, which may be suitable for local use only.

3. The alluvial deposits and other unconsolidated surface materials in the study area are underlain by an extensive claystone formation of low permeability that is several hundred feet thick. The claystone generally has no potential as a source of ground water.

4. Limited irrigation water supplies are available from thin sandstone, siltstone, and limestone/marl beds that either underlie or are interbedded with the claystone below a 400 foot depth. Water in these formations is under confined conditions and wells completed in these beds may have a specific capacity of 0.65 gpm/ft. The long term yield or water quality of this zone cannot be evaluated at present because of lack of data on recharge and subsurface flow.

5. It is likely that important bedrock aquifers can be found at great depths. Older marine sedimentary rock units have the potential, yet unproven, of supplying significant quantities of ground water. Available data on the depth to these potential aquifers are very sparse but indicate that the units are generally at substantial depths (2000-3000 feet) under most of the study area and could be reached only at considerable cost using equipment presently not available in Haiti. Considering the geologic setting of the study area, water in the deep bedrock units should be confined and may or may not be of useable quality.

6. The older marine sedimentary rocks occur at the surface in the northern and eastern mountains where they supply ground water to surface springs. These formations are inferred to occur at unknown, but relatively shallow depths in some of the areas located at the base of the mountains. When identified, these areas appear to have potential for high capacity wells. Vehicular access is not currently available to some sites which seem to have very good possibilities.

Recommendations

1. Four of the eight test wells installed should be converted into permanent production wells by installation of pumps. These include H-1, H-11, H-12,

and H-14. The remaining wells (H-2, H-3, H-10, and H-13) do not have sufficient supply of good quality water to justify permanent pump installation. The water level in these wells is too deep for hand pumps. Suggested pump installations and production rates for individual wells are given in Exhibit 5. The vertical turbine pump indicated was selected based on expected well capacity and pumping level and considering pump dependability and relative ease of operation and maintenance.

2. Consideration should be given to the exploitation of the unused capacity of surface springs. Possibilities include capping of uncapped springs, construction of storage facilities where needed, and improving the discharge from springs possibly by drilling horizontal wells or adits using labor intensive excavation techniques.

3. The existing water-supply system in the L'Arbre Plain appears to be amenable to improvement, which could provide additional water from sources already available. In particular, the primary water system to Anse Rouge from Source Tete Beouf, a natural spring, can be upgraded for greater reliability and less waste. The 4 inch PVC conveyence pipeline is frequently broken and should be upgraded by heavier pipe and/or deeper

burial or other protection. Continuous flow taps in remote areas should be replaced by concrete capped cisterns controlled by float valves and hand pumps to reduce waste. This would also provide a certain amount of storage capacity to the system during times when the line is broken or otherwise down.

4. An exploratory deep well testing program is recommended so as to verify the occurrence and evaluate the potential yield of deep bedrock units. Further drilling contracts should include provisions for creating vehicular access where needed, since this present program was severely hampered by not being able to reach potentially favorable sites.

5. The water level and quality should be periodically monitored in all of the wells to ensure satisfactory water quality and to evaluate subsurface flow and seasonal water level fluctuations. This information would be useful for determining the annual recharge and long term yield of aquifers.

6. Installation of new production wells should be preceded by on-site test drilling and sample study. The information obtained should be used to both confirm the amount and quality of available supply and to prepare production well design.

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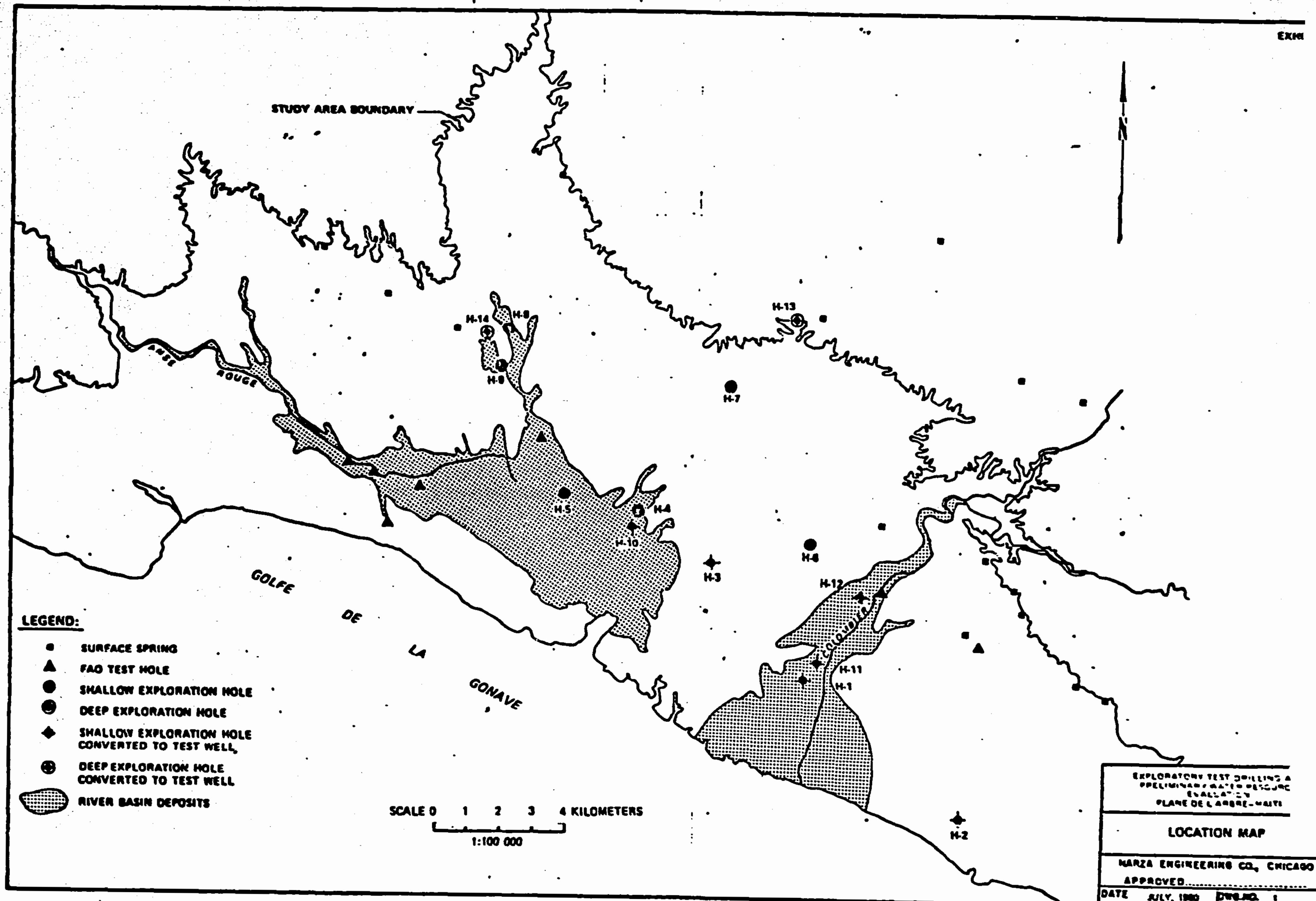

STUDY AREA BOUNDARY
GOLFE DE LA GONAVE
ROUGE
H-1
H-2
H-3
H-4
H-5
H-6
H-7
H-10
H-11
H-12
H-13
H-14
LEGEND:
SURFACE SPRING
FAO TEST HOLE
SHALLOW EXPLORATION HOLE
DEEP EXPLORATION HOLE
SHALLOW EXPLORATION HOLE CONVERTED TO TEST WELL
DEEP EXPLORATION HOLE CONVERTED TO TEST WELL
RIVER BASIN DEPOSITS
SCALE 0 1 2 3 4 KILOMETERS
1:100 000
LOCATION MAP
HARZA ENGINEERING CO., CHICAGO
APPROVED
DATE
DWG.NO. 1

L'Arbre - Inventory of Springs
(Source: FAO, 1969)

Name of Spring	Discharge L/s	Sampling Date	pH	Elec. Cond. µmhos/cm	TDS mg/L	HCO_3 meq/L	CO_3 meq/L	SO_4 meq/L	CL meq/L	Ca+Mg meq/L	Ca meq/L	Na meq/L	K meq/L
Ti Place	over 25	18/Feb/66		650	400	5.2			2.0	4.8	1.5	1.0	
L'Etang	over 25		7.6	620		7.5			2.5	5.0		0.56	0.13
Chaudes	5-25	18/Feb/66		700	544	4.4			2.2		1.0	2.6	0.2
Figuir	1-5		8.0	600		5.5		0.0	1.5	4.5		0.84	0.25
Manchette	less than 1		7.9	1800		7.0		traces	7.5	6.0		7.9	0.37
Marie Ann	5-25		8.1	550		5.0		traces	1.0	4.0		0.68	0.14
Nan Sceau	less than 1			950	605	6.0			3.0	9.22	1.9	2.62	1.25
Mahotiere	over 25												
Tete Boeuf	5-25												
Ramoneuse	1-5												
Satralle	1-5												
Nan de Haie	less than 1												
Marie Rose	less than 1												
Blanche	less than 1												
Foulle	less than 1												

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Exhibit 3

Summary of Drilling Program

Exploration Hole Number	Converted to Test Hole	Total Depth (feet)	Water Yielding Formations	Well Diameter	Casing Type : Length (feet)	Total Screen 1/	Static Water Level Depth / Date (feet below surface)	Geophysical Logs	Water Level Observation Pipe Installed 2/
H-1	YES	141'	Sand and Gravel	12"	6"φ steel: 75'	40'	61' 11/13/79	No	
H-2	YES	120'	Sand and Gravel	12"	6"φ steel: 62'	40'	39' 1/17/80	YES	
H-3	YES	137'	Sand and Gravel	12"	6"φ steel: 57'	30'		YES	
H-4	No	290'	–	–		–	57' 12/11/79	YES	
H-5	No	110	–	–		–		YES	
H-6	No	110	–	–	–	–		YES	
H-7	No	150	–	–	–	–		YES	
H-8	No	100	–	–	–	–		YES	
H-9	No	590	–	–	–	–		YES	
H-10	YES	500	Limestone stringers interbedded in claystone	12"	4"φ PVC: 120'	40'	–	YES	
H-11	YES	165	Sand and Gravel	12"	6"φ steel: 78'	60'	73' 1/80	YES	YES
H-12	YES	470	Limestone/ Limestone stringers interbedded in claystone	12" (0-310') 5½" (310-470')	6"φ steel: 230' 4"φ PVC: 120'	80' 40'	Artesian 1/80	YES 3/	YES
H-13	YES	880	–	12" (0-420') 5½" (420-880')	6"φ steel: 320'	100'	–	No	YES
H-14	YES	750	Sandstone/ Limestone	12" (0-400') 5½" (400-640')	6"φ steel: 200' 3"φ Galv 60'	200' 180'	Artesian 1/80	No	YES

1/ Field slotted screen made from same material as casing

2/ 1¼"φ pipe installed in gravel pack

3/ Logs not yet provided by drilling contractor

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Exhibit 4

Results of Well Testing 1/

Test Well Number	Test Discharge Rate (gpm)	Test Duration (hours)	Specific Capacity (gpm/ft)	Water Quality 2/
H-1	233	4	6 3/	good
H-2	24	4	1.1	brackish/saline
H-3	NA 4/	-	-	brackish
H-10	200 3/	-	-	-
H-11	90	6	7.5	good
H-12	400	2	10	good
H-13 5/	-	-	-	
H-14	75	4	0.65	brackish

1/ Figures based on drilling contractor reports

2/ Good: can be used for human consumption. Brackish: can be used for irrigation. Brackish/Saline: too salty for most uses.

3/ Estimated by drilling contractor but not confirmed by adequate testing.

4/ Not available

5/ Insufficient water to justify testing.

Exhibit 5

Suggested Pump Installations 1/

Well No.	Pump Type	Power Source	Rated Capacity (gpm)	Total Lift (ft)	Intake Depth (ft)
H-1	Vertical Turbine	Diesel, gasoline or kerosene powered engine	200	150	110
H-11	"	"	200	150	110
H-12	"	"	400	150	100
H-14	"	"	200	450	400
FAO Well	"	"	200	150	110

1/ A sufficient supply of good quality water does not exist to justify permanent large pump installations in Wells H-2, H-3, H-10, or H-13.

TECHNICAL SPECIFICATIONS

1-01.00 Definitions

Wherever the following terms appear in these specifications, they shall be interpreted as follows:

Owner - Haitian American Community Help Organization (HACHO)

Contractor - Haiti Water-Supply, S.A.

Engineer - Harza Engineering Company.

1-02.00 Purpose

The Contractor shall drill wells to obtain information about the depth, thickness, water quality and water yielding potential of the formations encountered. These exploratory wells may be converted to permanent production wells at the option of the Engineer or the Owner.

1-03.00 Scope

These specifications cover the construction of two types of wells; "shallow" wells to be drilled in unconsolidated deposits and the upper 100 feet of bedrock, and "deep" wells to be finished in the bedrock. Since information concerning the characteristics of the subsurface deposits is extremely limited, it is not possible to determine well construction details precisely. The specifications given here should be considered as type wells which can be modified in the field at the option of the Engineer. Specifications for drilling, sampling, casing, screening, developing and testing the wells are included, and options are provided for plugging and abandonment of the wells. The Contractor shall furnish all supervision, labor, materials, transportation, tools, supplies, equipment and appurtenances necessary for the satisfactory construction and completion of wells hereinafter described.

1-04.00 Location

The project is located on the Plaine de L'Arbre, on the southern slope of Haiti's northwest peninsula.

The exact sites will be staked in the field by the Engineer. The sequence of drilling shall be as directed by the Engineer.

1-05.00 General Requirements

The Contractor shall perform the work prescribed and provide and pay for materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water and sanitary facilities and all other facilities and incidentals necessary for the execution, testing, initial operation and completion of the work. All materials furnished under the Contract shall be new and all equipment shall be in good working order. If required by the Owner, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment. All work performed by the Contractor shall conform to the specifications described herein, and he must obtain approval in writing from the Engineer's representative in Haiti for any proposed modifications to or deviations from these specifications.

1-05.01 The contractor shall keep the site of the work and adjacent premises as free from material, debris and rubbish as is practicable and shall remove from the site, if in the opinion of the Engineer, such material, debris or rubbish interferes with the work or constitutes a nuisance to the public. The Contractor further agrees to remove all machinery, materials, implements, barricades, stagings, false work, debris and rubbish connected with or caused by said work immediately upon the completion of the same and to clean all structures and work constructed under this contract to the satisfaction of the Engineer and Owner; regrade all areas which have been rutted or disturbed so that the areas will drain without pockets; and to leave the premises upon completion of the contract, in at least as good condition as when he entered upon them. The use of inadequate or unsafe procedures, methods, structures or equipment will not be permitted, and the Owner or Engineer may disapprove and reject any of same which seem to him to be unsafe for the work hereunder, or for other work being carried on in the vicinity, or for work that has been completed or for the public or for any workmen, engineers and inspectors employed thereon.

1-05.02 The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations applicable to the work. If the Contractor observes that the specifications or drawings are at variance, he shall inform the Engineer by prompt written notice thereof, and any necessary changes will be as prescribed by the Engineer.

1-05.03 The actual drilling shall be performed under the direct supervision of experienced well drillers satisfactory to the Engineer. Only competent workmen shall be employed on the project and at least a two-man crew will be on the job for each well-drilling rig continuously during drilling operations.

1-05.04 The Owner and his representatives and the Engineer and his representatives shall at all times have access to the work for any inspection, or testing thereof by others.

1-05.05 The Contractor shall not assign the subcontract, the work, or any part thereof, without previous written approval by the Engineer.

1-05.06 At the option of the Engineer, additional work not specified herein may be authorized. Additional work shall be at prices not exceeding those for comparable work and materials listed in the Schedule of Payments (Appendix II).

1-05.07 The Owner will secure rights of access and egress to the test-site.

1-06.00 <u>Well Drilling Procedures</u>.

Wells shall be drilled by standard rotary drilling methods, or by other methods approved by the Engineer.

1-06.01 Should a drill hole tend to cave, slough or swell, the Contractor shall stabilize the hole to the satisfaction of the Engineer.

1-06.02 During drilling of each well, rock cuttings shall be collected and identified at 5-foot intervals, and at any pronounced change of formation. Samples shall be washed and preserved, in a manner approved by the Engineer, immediately after retrieval. Samples shall be clearly and indelibly labled with the well number and location, depth interval represented by the sample, and time and date taken. The Contractor shall be responsible for the driller lithologic log and safe storage of formation samples until accepted by the Engineer.

1-06.03 During drilling of each well, a daily detailed driller's report shall be maintained and submitted weekly to the Engineer, or more frequently as requested by the Engineer. The report shall give a complete description of all formations encountered, number of feet drilled, number of hours on the job, shutdown due to breakdown, the water level in the well at the beginning and end of each shift and at each change of formation (if measureable with the drilling method used), the depth and location of any lost drilling fluid, and other pertinent data requested by the Engineer.

1-06.04 Upon completion of each well, the Contractor shall submit to the Engineer a well-completion report to include the following:

1. the nominal hole diameter(s) and total depth of the completed well,

2. the diameters, depths and description of the well casings,

3. the complete description (including location, length, diameter, slot sizes, etc.) of any well screens,

4. the water-bearing strata, if any, and the exact location thereof,

5. the amount of gravel pack and cement used in the well, and

6. other pertinent data requested by the Engineer.

1-06.05 The Contractor shall run geophysical logs at the completion of drilling. Electric resistivity and possibly spontaneous potential on a continuous log shall be run and one copy shall be furnished to the Engineer immediately on completion of logging operations. The Engineer may require that certain logs be rerun.

1-06.06 Any well completed for a period prior to use for testing purposes or left uncompleted due to a delay in construction, and all wells at the end of the testing period; shall be capped by the Contractor. Caps shall be lockable with cemented, threaded or welded fittings, and provided with a 1/8-inch vent hole.

1-07.00 Construction Procedure and Details

A. Shallow Wells.

A 12-inch diameter hole shall be drilled through unconsolidated deposits and approximately 10 ft. into bedrock. After drill tools are removed, the Contractor shall sound to the bottom of the hole and run geophysical logging as described in Section 1-06.05. If the hole has caved, the Contractor shall clean the hole to the satisfaction of the Engineer without additional payment. If it is determined by the Engineer that there is sufficient quantity of water and of acceptable quality to warrant installation of a permanent production well, the well will be screened, cased, and gravel packed. The screen shall be of PVC (polyvinyl chloride) slotted plastic pipe, of 6 inch minimum nominal diameter. Slot size shall not exceed 1/8 inch. The screen shall be placed against the water-bearing sections in the well. The remainder of the well will be cased with 6 inch minimum nominal diameter PVC casing. Casing shall be new with minimum wall thickness of 0.280 inch. Casing and screen sections will be joined by the use of threaded and coupled, or cemented joints, and guides will be used for centering of the casing and screen column in the well above as described in 1.07.03.

After lowering of casing and screen assembly, the annulur between the screen and formation will be gravel packed. The Contractor shall sound to the bottom of the hole in the annulus as aproved by the Engineer. If the Engineer determines that the hole has caved prior to gravel emplacement, the Contractor shall remove the caved material so that there is assurance that the screen will be in direct contact with the gravel pack. The method of removal of caved material will be approved by the Engineer. No payment will be made for removing caved material. Gravel, approved by the Engineer will be set into place in the annulus between the screen and hole and also between the casing and hole until the top of the gravel is not less than 5 ft. above the top of the screen. The annular space between the casing and hole shall then be backfilled with drill cuttings to 10 ft. below ground level. The remaining 10 ft. shall then be grouted to the surface in accordance with 1-07.01.

If it is determined by the Engineer that there is not sufficient water in the unconsolidated formations, drilling will continue into the upper 50 or 100 feet of bedrock as directed by the Engineer. In this case, the unconsolidated material will be cased off and drilling will be resumed into the bedrock with a 6 inch drilling bit. No casing or screen should be required for the borehole in bedrock but this will depend on field conditions. The construction details of shallow wells are given schematically in Exhibit 1.

B. Deep Wells.

A 12 inch diameter hole shall be drilled from the ground surface through unconsolidated deposits and 20 ft. into the bedrock. After drill tools are removed, the contractor shall sound to the bottom of the hole under inspection by the Engineer. If the hole has caved, the contractor shall clean the hole to the satisfaction of the Engineer without additional payment. An 8 inch outside diamter (OD) casing shall then be placed and grouted. Surface casing shall be of black steel with minimum wall thickness of 0.250 inch.

A 6 inch minimum hole shall then be drilled from the bottom of the 12 inch hole until a sufficient water supply source has been located within a maximum total depth of about 1500 feet, as directed by the Engineer. No casing shall be placed in the 6 inch hole unless so directed by the Engineer. Immediately after completion of the 6 inch hole, the Contractor shall sound to the bottom of the hole under inspection by the Engineer. If the hole has caved, the Engineer may direct that the hole be cleaned and that appropriate size casing be placed at indicated depths. Geophysical logs will then be run.

If it is determined by the Engineer that there is sufficient quantity of water of acceptable quality, the well will be cleaned, developed and tested. Otherwise the borehole will be plugged as prescribed by the Engineer, and abandoned. The construction details of deep wells are given schematically in Exhibit 2.

1-07.01 The annular space between the casing and borehole shall be grouted by pressure-cement grouting equipment to the satisfaction of the Engineer. The grouting shall be done continuously and in one operation. Flushing of the annular space with water to assure the space is open and to remove loose material may be required by the Engineer before grouting is commenced. No drilling operations or other work in the well will be permitted until the grout has set for a minimum period of 24 hours and to the satisfaction of the Engineer.

1-07.02 The casing and screen (in shallow wells) shall be installed in a sufficiently straight manner to allow installation of a permanent turbine, submersible or other pump. If it is subsequently determined by the Engineer that the appropriate permanent pump assembly with components and 1-inch pipe (for water level measurements during non-pumping and pumping stages) cannot be installed and removed from the well or that accurate drawdown measurements cannot be made, no payment will be made for any work associated with this well. The determination of the acceptability of the well will be made by the Engineer after the well has been pumped.

1-07.03 In all wells centralizers will be placed at the bottom of the casing and every 25 feet thereafter.

1-08.00 Well Development

The Contractor shall supply all labor, material and equipment for well development.

1-08.01 The development of all wells will consist of air surging and air-lift pumping as prescribed by the Engineer. Wells finished in unconsolidated materials may be treated with Calgon (Sodium Hexametaphosphate). If Calgon is used, a water supply approved by the Engineer for injection of the Calgon mixture into the wells shall be required. A clean oil drum shall be used to mix the Calgon with water prior to the injection. In addition, chlorine or other compounds approved by the Engineer shall be used as disinfectants. The disenfectant shall be delivered to the site of the work in original closed containers bearing the original label indicating the percentage of available chlorine. The disinfectant shall be recently purchased. The quantity of chlorine compounds used for disinfection shall be sufficient to produce a minimum of 50 ppm (parts per million) available chlorine in solution when mixed with the total volume of water in the well.

1-08.02 Development operations shall cease when the completed wells produce no sand, gravel or abrasives when pumped within the discharge range of the test described in 1-09.00.

1-09.00 Well Testing

The Contractor shall furnish, install and remove the necessary measuring instruments and pumping equipment capable of pumping to the required point of discharge, a maximum of 80 U.S. gpm, with a maximum pumping level of 500 feet, and with satisfactory throttling devices, so that the discharge may be reduced. The pumping unit shall be complete with an ample power source, controls and appurtenances and shall be capable of being operated without interuption for a period of 8 hours.

Prior to starting the pump, water level measurements shall be made in the production well and these measurements shall be recorded. The well shall be "step"-tested at various rates of discharge. The complete test is estimated to require approximately 8 hours. The Contractor shall operate the pump and change the discharge as prescribed by the Engineer. Discharge of the pump shall be controlled by both gate valve and engine throttle, as the pump will be engine driven. The discharge shall be controlled and maintained at approximately the desired discharge for each step with an accuracy of plus or minus 5 percent. Pump discharge shall be measured by a method approved by the Engineer.

1-09.01 A 1-inch pipe suitable for measurement with electric sounder and open only at the bottom and top shall be installed for water level measurements. The bottom of the pipe shall be set 2 feet above the top of the pump bowl assembly.

1-09.02 Discharged water shall be conducted from the pump to the nearest surface-water body, storm sewer, or ditch, as approved by the Engineer or his representative. It is imperative to insure that no damage by flooding or erosion is caused to the chosen drainage structure or disposal site.

1-09.03 If a pumping test is started, then must be stopped due to equipment breakdown or inadequate supervision by the Contractor; no payment will be made for the time spent pumping before the test had to be stopped, or the time spent waiting for recovery before the test is restarted. If any part of the pumping equipment fails to operate properly or impairs the proper functioning of another element or instrument involved in the test, the equipment shall be removed and repaired at the expense of the Contractor and no payment will be made for the delay.

1-09.04 Water samples will be taken at least once from the pumped water at each step of the pumping rate. Samples will be collected and placed in approved containers, securely closed to avoid spillage and contamination, and labeled with the following information:

1. Number of well
2. Date and time taken
3. Pumping rate at time of sampling

1-10.00 Cement Plugging

If wells are to be abandoned the Engineer may direct that they be plugged by pressure-cement grouting in accordance with 1-07.01.

1-11.00 Additional Work and Protection of Wells

At the option of the Owner, additional work may be authorized. Additional work shall be at prices not exceeding those for comparable work and materials determined by the Engineer and Owner, as those for the unit prices in this Contract.

1-11.01 The Engineer will direct this work which may include construction of appurtenant structures. This work is not part of this contract. However, the Engineer will direct the Contractor to cap all wells with either welded, theaded or cemented covers at the conclusion of operations prior to any permanent adaptation. No payment will be made for this capping.

GUIDELINES FOR PERFORMING PUMPING TESTS

Purpose and Scope of Tests

A pumping test is conducted to determine the hydraulic characteristics of an aquifer(aquifer test) or to provide information about the yield and drawdown of the well (well test).

Properly planned and carefully conducted aquifer tests are necessary to provide basic information for the solution of many regional as well as local ground-water flow problems. This information can be used to determine aquifer yield; number, design, and spacing of wells; and projected decline in water levels due to a specified rate of withdrawal. It is with these objectives that we are mainly concerned in this note.

Well test data can be used to determine the specific capacity of the well, select the type of pump, and estimate the cost of pumping. The specific capacity gives a measure of the effectiveness or productive capacity of the well. While well tests are primarily intended to determine the well specific capacity, the data also can be used to compute approximate values of aquifer characteristics.

Testing Principle and General Procedure

In principle the aquifer test consists of field measurements, of aquifer response to the effects of controlled pumping, that are used to compute hydraulic and elastic properties of the aquifer. Water is pumped at a controlled rate from a well completed only in the aquifer under evaluation while water levels are measured in the pumped well and in identically-completed observation wells. The hydraulic characteristics of the aquifer are then found by substituting the drawdowns, time of measurement, distance from the pumped well, and well discharge in appropriate formulas.

It is desirable that a step-test be conducted first before a constant-rate test is started. This involves pumping at three more successive discharge rates and analyzing the results to determine a discharge rate for the longer-term test. In certain cases, step-test data can be also used to determine approximate values of aquifer properties. The step test can be completed in a few hours and the long-term constant-rate test is usually run from one to several days.

Aquifer test results often are used to predict effects many miles distant and many years hence. Consequently, it is extremely important that the test be conducted under close control and that precise measurements records be maintained, particularly since the test period is relatively short and the sampled area relatively small.

Pre-Test Data Collection

Prior to the performance of an aquifer test, the necessary information of the subsurface geological and hydrological conditions has to be collected. This includes the geological features of the aquifer, for example the lithologic character and thickness of the aquifer, the aquifer boundaries, the direction of groundwater flow, the water table gradients, and the regional water-level trend. Knowledge of the geology and hydrology of the area of study will be helpful in deciding on the type of pumping equipment needed and on the number and location of the tests. Such knowledge may also be of great importance when the test data are being analyzed and boundaries have to be taken into account.

Records of the pumped well and piezometer construction details should be obtained and reviewed. This is to include well diameter, total depth, lithologic log, casing and screen record, sieve analyses of formation and gravel envelope, water levels, and any data relevant to the analysis or the geological conditions which define the regime.

The water level or artesian pressure at any well is normally changing due either to variations in pumpage from the aquifer, barometric changes, or the natural accretion or depletion of the groundwater reservoir. Ideally, a pumping test should not be started before the already existing water level changes in the aquifer are known, including both long-term regional trends and short-term variations of the water level. Hence, for some days prior to the actual test, the water levels in the piezometer should be measured and a hydrograph delineating the trend and rate of water level change is prepared. At the end of the test, i.e. after complete recovery, water level readings should continue for one or two days. With these data, the hydrographs are completed and the rate of water level change during the test can be determined. This information can then be used to correct the drawdowns induced by pumping alone.

When a pumping test is expected to last one or more days, the barometric pressure, the levels of surface waters, if present, and the precipitation should also be measured.

Test Set-up

Pump and Power Unit:

The pumping unit should be vertical turbine type driven by an electric motor or a gasoline (or diesel) engine capable of very stable speed regulation. The pump must be capable of continous operation for the full period of the test at a closely controlled rate; therefore, the pump and motor should have greater capacity than the anticipated requirement. The capacity of the pump and the rate of discharge should be high enough to produce good measurable drawdowns in piezometers as far away as 400 or 500 feet, depending on the aquifer conditions.

It is well to perform a trial run to check the capability of the equipment, to assure the free passage of water level measurement equipment down the well bore and to locate and eliminate any packing leaks or other obstructions to rapid and accurate observations. This would also provide a good opportunity for checking on whether or not all the piezometers are performing satisfactorily.

Discharge Piping:

The discharge pipe must be equipped with a gate valve for regulation of flow, and it is helpful to calibrate the valve setting during the above-mentioned trial test. An orifice tube (Figure 1), commercial meter, or other discharge measuring device should be installed and calibrated so that accurate measurements can be made. A weir box may also be used for discharge measurement.

Discharge Disposal Facility

Arrangements should be made prior to the test to ensure that water delivered by the well is ~~be~~ prevented from re-entering the tested aquifer. This can be done by conveying the water through a large-diameter pipe over a convenient distance, say 400 or 500 feet, and then discharging it into a canal or natural channel which is not in hydraulic connection with the tested quifer. The pumped water may also be conveyed through a shallow ditch; but unless it is certain that seepage will not reenter the aquifer, precautionary measures should be taken to seal the bottom of the ditch with clay or plastic sheets to prevent seepage.

The pumped water should be discharged away from the line of piezometers. If a ditch or open water course is used to discharge the pumped water, flow measurements should be made in these channels. Piezometers may be used to check whether water losses occur through the bottom during the test.

Performing the Test

Performing a pumping test involves pumping of a test well at a prespecified discharge rate and measurement and recording water level in the pumped well and piezometers during pumping and recovery. The discharge rate is to be monitored periodically and is to be controlled and recorded throughout the pumping period.

Discharge Measurement

The discharge rate should be kept constant throughout the long-term test. The discharge rate should be measured accurately and recorded periodically, at least once every hour, and necessary adjustments must be made from time to time to keep the discharge rate constant. This can be done by a valve in the discharge pipe, rather than by changing the speed of the pump, as a valve gives more accurate control. Discharge measurement must have a 95 percent accuracy, or better, no matter which measurement method is used.

When the orifice tube meter is used for discharge measurement, the chart and equation given in Figure 1 can be used to determine well discharge if standard reference tables or curves are not available. The orifice meter is preferred because it provides good sensitivity (small changes in rate are detectable) and direct, visible measurement (no computations or delay are involved).

42

Water Level Measurement

Water level observations are made in the pumped well and, for the constant-rate test, in as many piezometers and observation wells as practicable. These readings are obtained by any of several methods: Steel tape and chalk or indicator compound, steel tape and float, electric dropline, airline and altitude gage, or float actuated automatic recorder. The use of steel tape and chalk and the use of a recorder are preferred.

Water level changes due to uniform pumping vary exponentially with the elapsed time from the start or change in pumping rates. In other words, the same drawdown increment would be expected between ten and one-hundred minutes, as that observed between one and ten minutes. It is important, therefore, that water level readings be as accurate and frequent as possible in the initial minutes of the test. Frequency of measurement can be reduced as the test proceeds. The readings can be made every 30-60 seconds in the first 5 minutes of the test, 2-5 minutes in the subsequent hour, 10-15 minutes in the following two hours, and 30-60 minutes in the remainder of the test.

After the pump is shut down, the water level in the pumped well and the piezometers will start to rise. In the first hour it will rise rapidly, but as time goes on, the rate of rise decreases. This part of the pumping test is called a recovery test. Recovery test data can be used as a check on the calculations based on the drawdown data. The schedule for recovery measurements is the same as that followed to during the pumping period.

Obviously watches having sweep second hands are necessary and all watches should be synchoronized before the test is started, or when possible, arrange a signal for the moment pumping is started so that all observers know the exact starting time. If it is necessary to use an airline, the altitude gage should be re-calibrated before the test and verified by direct measurement. The gage dial should read in feet, directly if possible, and should be 8-inch or larger in diameter with the full dial displacement sufficient to encompass the full range of values expected but not much greater because of a sacrifice of accuracy.

Points from which measurements are made on various wells should be referred to a common datum, and if a recorder is used, the setting for the recorder chart verified by direct measurement when the chart is installed and again when the chart is removed.

The data should be recorded in a concise legible manner, of the general form shown by Figure 2. Recorder charts should be submitted with the data.

Duration of Test

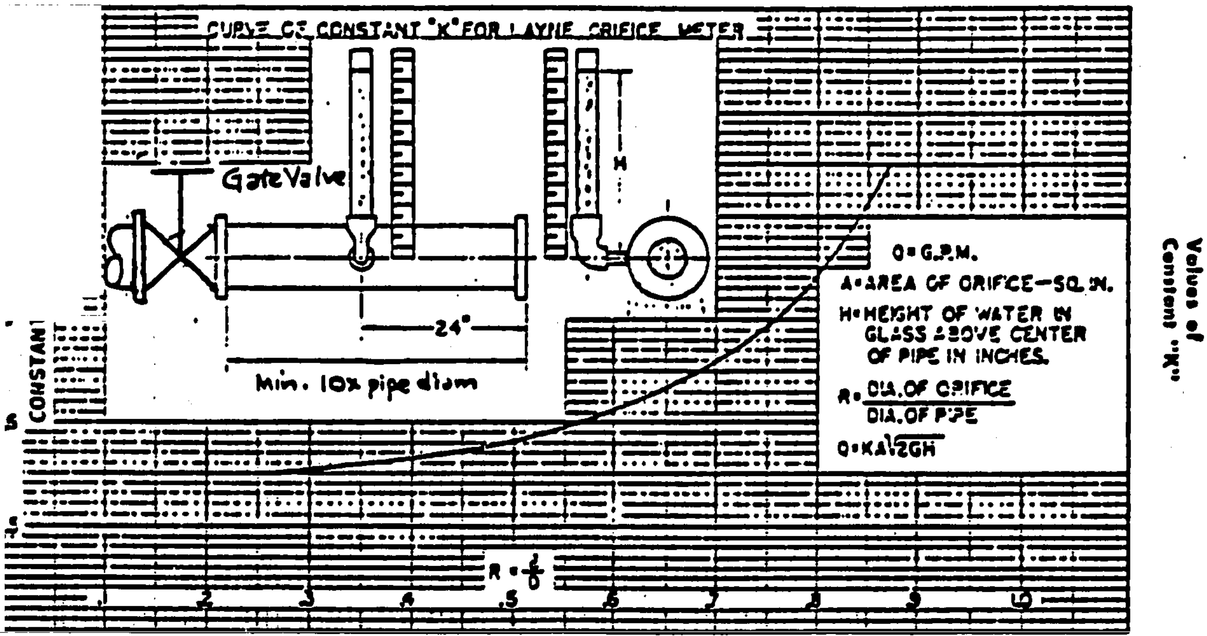
The question as to how many hours the well should be pumped continuously is difficult to answer because the period of pumping depends on the type of aquifer tested and the degree of accuracy desired in establishing the hydraulic properties. Economizing on the period of pumping is not recommended because the costs of running the pump a few extra hours are low compared with the total costs of the test, particularly when the wells have been specially constructed for test purposes. Morover, better and more reliable results are obtained if pumping continues till the water level has been stabilized or nearly stabilized and equilibrium is reached.

In some wells, conditions of steady flow or equilibrium occur a few hours after pumping starts; in others they occur within a few days or weeks, whereas in some wells they never occur even though pumping continues for years. If a pumping test is performed in a confined aquifer it is good practice to pump the well for a period of 24 hours. In a water table aquifer a longer period of pumping is required and it is common practice to pump the well for two or three days.

It is not absolutely necessary to continue pumping until a steady flow situation is reached because there are methods available to analyze nonsteady-state data. Nevertheless, it is recommended that pumping be continued until a steady flow is reached, especially when accurate information on the aquifer characteristics is desired, for example as a basis for pumping stations for domestic water supply or other expensive construction works. Simple equations can then be used for the analysis of the data and reliable results obtained. Another advantage is that a longer period of pumping may reveal the presence of boundary conditions previously unknown.

Preliminary plotting of drawdown data during the test will often show what is happening and may indicate how much longer a test should continue.

Discharge Measurement by the Orifice Tube Method



Source: Layne and Bowler, Inc., "Measurement of Water Flow through Pipe Orifice with Free Discharge:. Memphis, Tennessee, 1958.

PUMPING TEST DATA

Test conducted by: Alpha Engineering Co. and State Water Survey

Well Owner: City of Doeville Address: Doeville, Illinois

Pumped Well No.: 2 Location: Approx. 1000' N & 2000' W of SE Cor. of

Sec. 10 Twp. 1N. Range 3E. County Doe

Observation Well Locations: No. 1 – 1270' due west of Well No. 2

Airline Lengths: Pumped Well 97.3' Observation Wells

Remarks: Elevation of top of Casing Well No. 2 – 704.08' MSL

Elevation of top of Casing Well No. 1 – 705.72' MSL

Test observed by R.T.S. & G.H.N., Pumping rate measured with 8" x 10" orfice, water levels measured with airline in well No. 2 and recorder in Well No. 1.

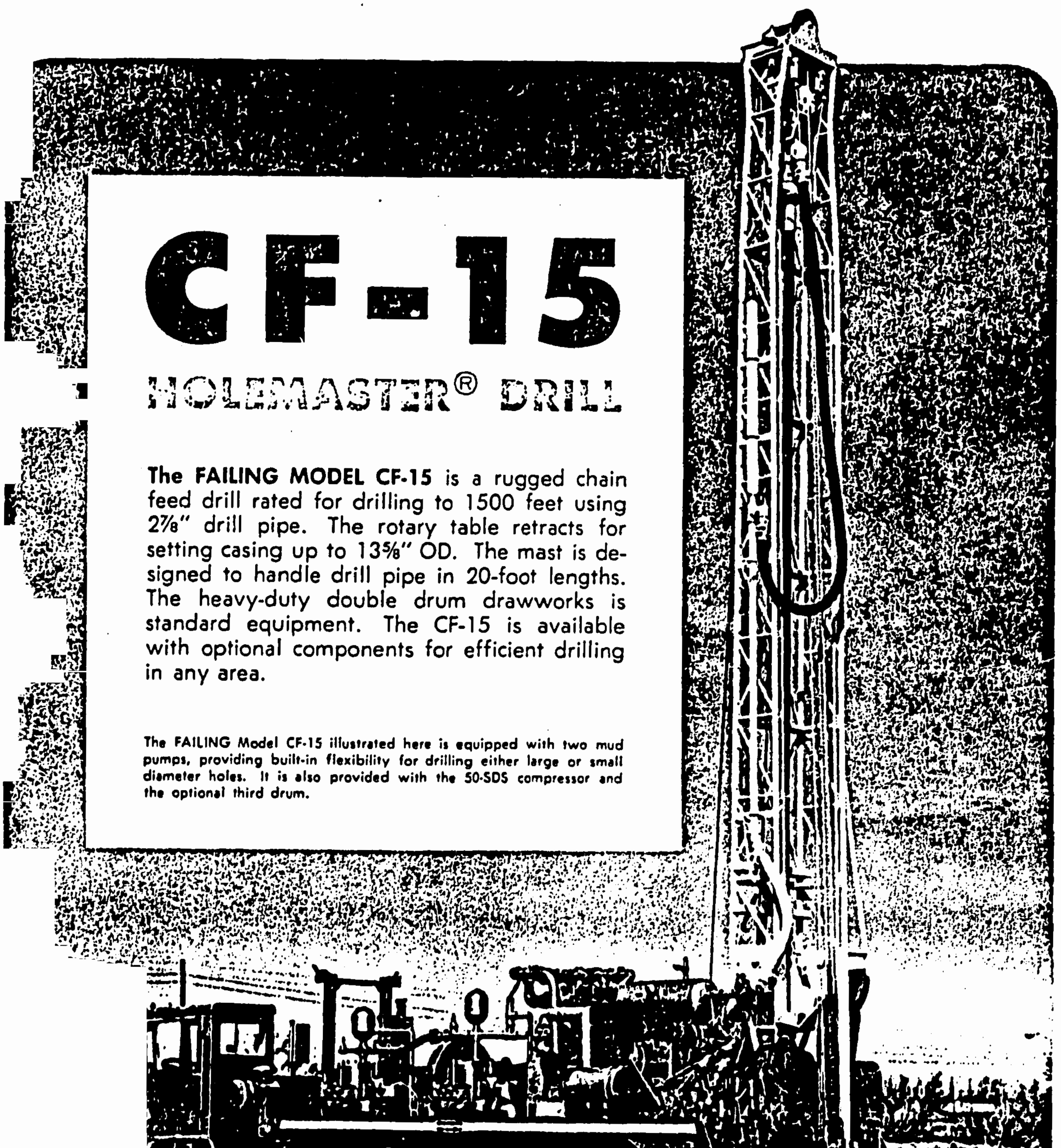
Pumped Well Data

Date and Time	Elapsed Time Min.	Flow Gage Reading Feet	Pumping Rate GPM	Pump Discharge Pressure	Altitude Gage Reading Feet	Feet to Water	Remarks
10-29-52							
8:00 AM					42.5	54.8	Non-Pumping Level
8:17	0						Started Pumping
8:17:30	0.5				35.5	61.8	
8:18	1.0				33.0	64.3	
8:18:30	1.5	2.00	1529				
8:19:30	2.5	2.64	1753		30.2	67.1	
8:21	4.0				29.7	67.6	
8:23	6	2.64	1753		29.5	67.8	
8:25	8				29.2	68.1	
8:27	10	2.71	1767		28.9	68.4	
8:30	13	2.71	1767		28.7	68.6	
8:40	23	2.73	1779		28.4	68.9	
9:00	43	2.71	1767		27.8	69.5	
9:15	58	2.73	1779		27.6	69.7	
9:30	73	2.74	1780		27.5	69.8	
9:45	88	2.74	1780		27.4	69.9	
10:05	108	2.74	1780		27.3	70.0	
10:30 AM	133	2.74	1780		27.2	70.1	
11:00	163	2.73	1779		27.1	70.2	
12:00 N	223	2.72	1775		26.6	70.7	
1:00 PM	283	2.69	1760		26.5	70.8	
2:00	343	2.69	1760		26.5	70.8	
3:00	403	2.69	1760		26.5	70.8	
4:00	463	2.71	1767		26.7	70.6	Sample No. 1 collected
5:00	523	2.75	1791		26.7	70.6	Temp. 54.4°F
6:00	583	2.75	1791		26.4	70.9	
7:00	643	2.75	1791		26.1	71.2	
8:00	703	2.71	1767		26.0	71.3	
9:00	763	2.71	1767		26.4	70.9	
10:00	823	2.69	1760		26.5	70.8	
11:00	883	2.71	1767		26.5	70.8	
12:00 M	943	2.71	1767		26.5	70.8	
10-30-52							
1:00 AM	1003	2.60	1760		26.5	70.8	
2:00	1063	2.71	1767		26.5	70.8	
4:00	1183	2.71	1767		26.5	70.8	

Source: State Water Survey Report of Investigation No. 25, 1955 (Illinois).

APPENDIX B

FAILI



CF-15

HOLEMASTER® DRILL

The FAILING MODEL CF-15 is a rugged chain feed drill rated for drilling to 1500 feet using 2⅞" drill pipe. The rotary table retracts for setting casing up to 13⅝" OD. The mast is designed to handle drill pipe in 20-foot lengths. The heavy-duty double drum drawworks is standard equipment. The CF-15 is available with optional components for efficient drilling in any area.

The FAILING Model CF-15 illustrated here is equipped with two mud pumps, providing built-in flexibility for drilling either large or small diameter holes. It is also provided with the 50-SDS compressor and the optional third drum.

GEORGE E. FAILING COMPANY / A DIVISION OF AZCON CORPORATION

using drill pipe . . .

features

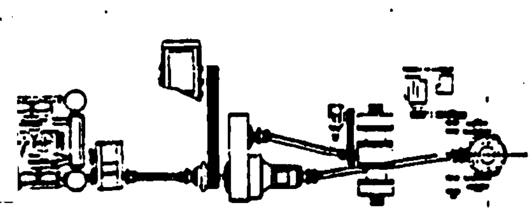
- two-speed hydraulic chain pulldown
- hydraulically retractable rotary table
- two identical heavy duty hoisting drums

choice of

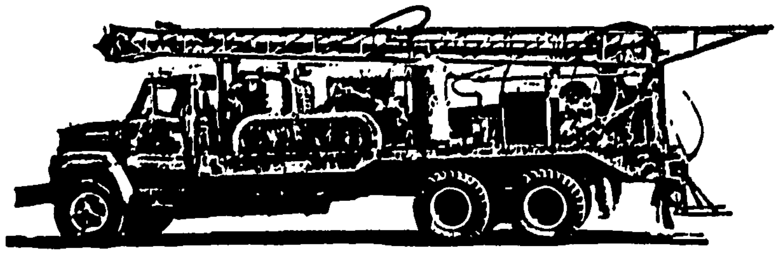
- 7½" or 5¼" rotary table
- 31' 6", 35' or 38' clearance in mast

options

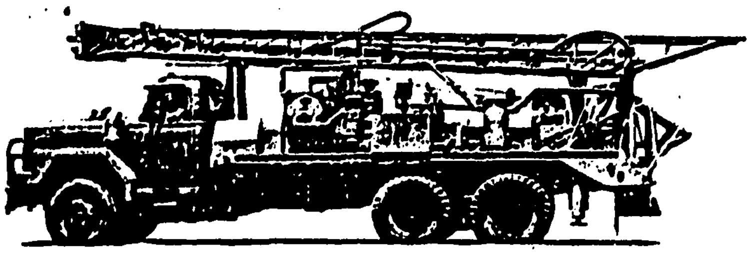
- air clutches
- hydraulic leveling jacks
- third drum (sand reel)
- 5x6¼, 5x6, 5x8 or 5½x8 mud pump
- two 5x6¼ mud pumps, side by side
- 3"x4" centrifugal pump
- 50-S1, 50-SDS, 100-SDS or 256-S2 air compressor
- hydrostatic driven rotary table
- variable hold-back on pulldown
- water injection system
- spudder attachment
- force-feed clear vision lubricator for down-the-hole tool



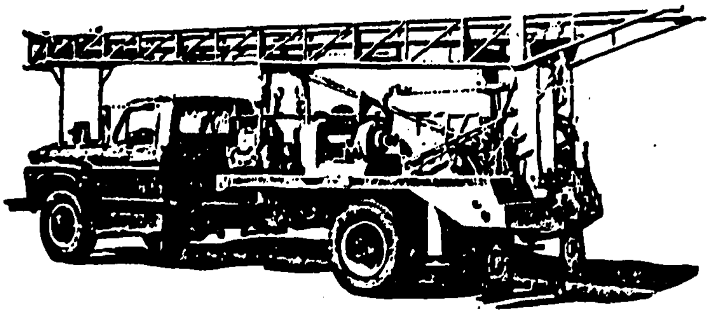
POWER TRAIN showing large compressor and FM-45 pump.



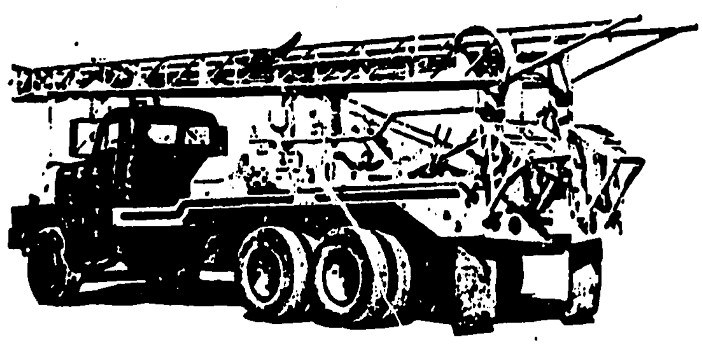
On the unit pictured above, an auxiliary engine is mounted on deck to drive the 256-S2 compressor for high pressure air drilling. Drill unit is powered by the truck engine through the FAILING power take-off. This arrangement gives a reserve of power and allows full control of the rotary rpm as required for down-the-hole tool operation. Note the optional third drum.



This drill is powered completely by the truck engine via power take-off. It is equipped with the 100-SDS air compressor and the FAILING 5x6¼ mud pump (covered). It also carries the optional third drum.



This drill is equipped with the FAILING FM-45 reciprocating mud pump and the 3x4 centrifugal pump. This compact unit is mounted on a 175" WB truck and is powered by the truck engine through the FAILING power take-off.



This CF-15 is equipped with the FAILING FM-45 5x6¼ mud pump for conventional rotary drilling. Entire unit is powered by the truck engine through the FAILING power take-off.

VERSATILE

With a choice of masts, rotary tables, mud pumps and/or air compressors, and with its many optional features, the FAILING CF-15 HOLEMASTER® drill is equipable for drilling any formation . . . anywhere.

PUMP and/or COMPRESSOR

When equipped with the FAILING 5x6¼ reciprocating mud pump, it is rated to drill water wells to 1500 feet, using 2⅞" drill pipe. Large diameter wells to shallower depths are possible with the (optional) 3x4 centrifugal pump. Or, with an (optional) air compressor, you have a combination unit for drilling with either air or mud.

or . . . TWO PUMPS

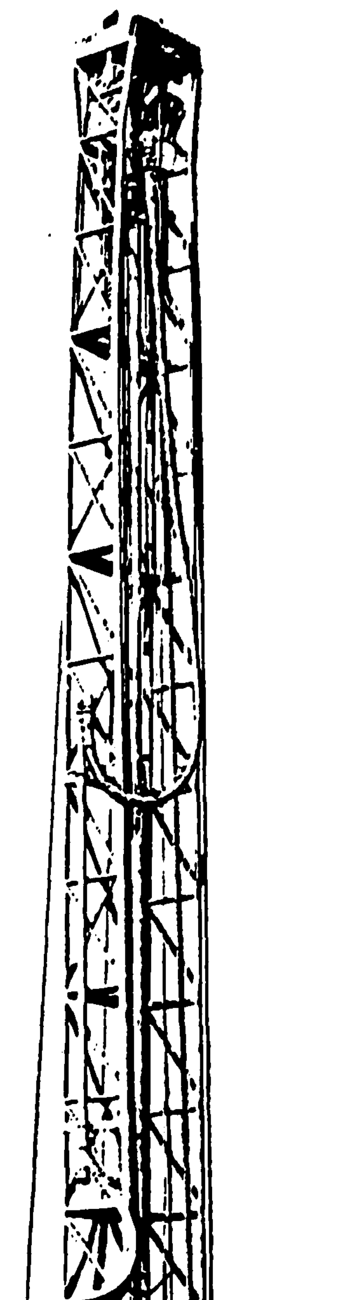
When your drill is scheduled to be used for both large and small diameter holes, such as for municipal wells and for private wells, greater flexibility may be provided by mounting two FAILING FM-45 pumps side by side. Users cite many advantages for this dual pump installation.

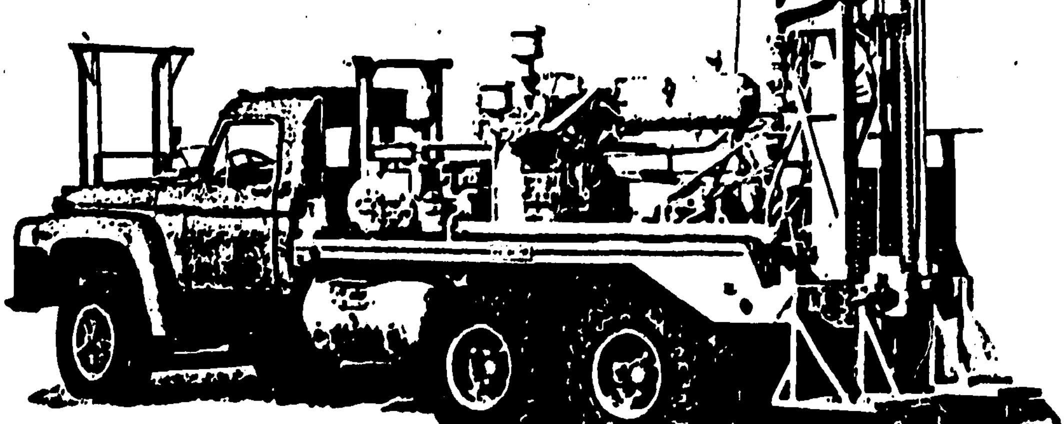
HIGH PRESSURE AIR

A choice of compressors is offered in sizes and capacities for down-the-hole tool drilling, for rock bit drilling, or for developing water wells. Operators using high pressure air and down-the-hole tools report success with this equipment in the hardest formations. For units so equipped, an optional HOLD-BACK feature is available, enabling the driller to control the amount of weight on the hammer bit for more efficient operation.

TWO-SPEED HYDRAULIC CHAIN FEED

The FAILING hydraulic chain feed consists of two pulldown chains actuated by one hydraulic motor. Drive is through a two-speed transmission via guarded chains to an equalizing jackshaft for even tension on both pulldown chains. Final drive sprockets are individually mounted on short shafts and are fitted with needle type anti-friction bearings. Feed chains run in a vertical plane over the table centerline, giving a straight pull down on the kelly. The two-speed transmission provides increased pulldown capacity with low hydraulic pressures. It shifts into neutral for free-wheel spudding and rod connections. Spring tension in crown block automatically maintains adjustment and proper tension on feed chains, which remain tight and in full engagement with the sprockets while raising or lowering the mast. **The hydraulic drive maintains a constant bit pressure, gives a smooth feed, prevents overstressing or breaking feed chains and insures longer life for your bits and down-the-hole tools.**





GEORGE E. FAILING COMPANY ®

RATED CAPACITY	1500 ft. (457.2 m) holes with 2⅞" (73.025 mm) drill pipe.	Designed to handle casing loads up to 25,000 lbs. with single sheave block.
MAST Choice of two lengths	Electrically welded from cold drawn steel tubing. Rigid structural sections. Raised and lowered by one large double-acting hydraulic cylinder. (Masts with expanded working areas are available.)	Height........31'-6" (9.61 m) or 35 ft. (10.7 m), or 38 ft. (11.51 m) clearance above table for using 20 ft. 6.1 m) drill pipe. Total gross capacity ....40,000 lbs. (18,144 kg) Max. hook load capacity..... 25,000 lbs. (10,340 kg) with single sheave block. Crown........2 sheaves for wire line; angled over hole and drums; roller bearing. (3-sheave crown available when drill is equipped with optional third drum. Spring tension provided in crown for each pulldown chain.
DRAWWORKS	Two identical drums. Spiral bevel gear drive. Oil bath lubrication. Friction clutch on each drum. Air clutches optional.	Spool diameter.......... 7"................ (17.78 cm) Spool length............ 8¾"............... (22.22 cm) Max. single line pull...... 15,000 lbs.............. (6,804 kg) Brakes................. 16" x 6" single....... (40.64 cm x 15.24 cm) Line capacity............½" x 500 ft...........(12.7 mm x 152.4 m) Clutches................14" 3-plate ....(35.56 cm)
	Third drum or sand reel for bailing. (Optional) Friction clutch standard. Air clutch optional.	Spool diameter..........7"................(17.78 cm) Spool length............24"...............(60.96 cm) Max. single line pull......4,000 lbs.............(1,814 kg) Brake..................16" x 4½" single..........(40.64 cm x 11.43 cm) Clutch.................11" 3-plate..........(27.94 cm)
ROTARY TABLE	Retractable hydraulically 14". Spiral bevel gears. Oil bath lubrication. Tapered roller bearings throughout.	Opening................ 7½"................ (19.05 cm) or............. 5¼"................ (13.34 cm)
PULLDOWN	Hydraulic motor drive. Two 1½" pitch chains. Two-speed transmission. Hold-back feature optional.	Pulldown in low gear.....4,680 lbs. per 100 psi hydraulic pressure. Pulldown in high gear.... 2,900 lbs. per 100 psi hydraulic pressure. (Actual stall or 80% theoretical.)
MUD PUMP (Optional)	V-belt drive. Choice of models. Friction clutch allows belts to remain idle when pump is not running.	FAILING Model FM-45, 5" x 6¼" (12.7 cm x 15.88 cm) duplex reciprocating type power pump. Optional mud pumps include the 5" x 6", 5" x 8" and 5½" x 8" (12.7 x 15.24 cm; 12.7 x 20.32 cm; and 13.97 x 20.32 cm).
CENTRIFUGAL PUMP (Optional)	V-belt drive.	Size .... 3" x 4".............(76.2 mm x 101.6 mm) Available only on certain units.
AIR COMPRESSOR (Optional)	V-belt drive. Choice of models. Equipped with safety valve, air cleaners, unloading mechanism and surge tank.	Model 50-S1 provides operating pressures up to 45 psi. Model 50-SDS or 100-SDS provides operating presures up to 125 psi. Model 256-S2 provides operating pressures up to 250 psi.
MECHANICAL ROTARY DRIVE	All helical gears. Single plate 12" (305 mm) rotary clutch ahead of transmission.	Four speeds forward; one speed reverse. Rotary speeds from 35 to 220 rpm with engine at 1800 rpm. Remote controlled from driller's station. An optional 3-speed auxiliary transmission is available, in addition to the 4-speed, when slower rpm, desirable when using down-the-hole tools, is required.
HYDROSTATIC ROTARY DRIVE (Optional)	Fluid motor flange-mounted to a 4-speed transmission.	Rotary speeds............0 to 115 rpm. Rotary torque............12,000 lb. ft. at stall.
SUB DRIVE	Three-shaft, chain drive. Ball bearing. Oil bath.	Quadruple roller chain, ¾" (19.0 mm) pitch. Unitized assembly with friction clutches for reciprocating pump, centrifugal pump, or small air compressor, if the drill is equipped with one or more of these options.
OIL PUMP	V-belt drive.	40-gal. (150 liters) per min. at 1000 psi (70.4 kg per sq cm) max.
CONTROLS	Engineered design.	Conveniently grouped at driller's station, including safety switch and engine starter button.
MOUNTING	Truck of suitable capacity. Specifications depend on drill components selected.	Truck engine powers rig through power take-off and sub drive arrangement. Truck axles, springs and tires must meet federal regulations pertaining to total vehicle weights.
WEIGHT	Varies with truck and optional equipment.	Front axle, 9,000 lbs.; rear axle, 18,500 lbs.; total weight, 27,500 lbs. (12,460 kg). Minimum.

Litho in U.S.A.

Bulletin No. DB-16-C

THE GEORGE E. FAILING COMPANY, WHOSE POLICY IS ONE OF CONTINUOUS IMPROVEMENT, RESERVES THE RIGHT TO DISCONTINUE MODELS OR CHANGE SPECIFICATIONS, DESIGN OR PRICES, AT ANY TIME, WITHOUT NOTICE AND WITHOUT INCURRING ANY OBLIGATION TO MAKE SIMILAR CHANGES ON EQUIPMENT PREVIOUSLY PRODUCED.

GENUINE PARTS FOR ALL FAILING AND/OR WABCO DRILLS ARE AVAILABLE FROM:

LARGO, FLORIDA	PLAINFIELD, INDIANA	HOUSTON, TEXAS	GRAND JUNCTION, COLORADO	IN CANADA:
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NEW ORLEANS, LOUISIANA	GRANTS, NEW MEXICO	ST. MICHAELS, MD	BLOOMINGTON, MINNESOTA	CALGARY, ALBERTA

GEORGE E. FAILING COMPANY

A DIVISION OF AZCON CORPORATION

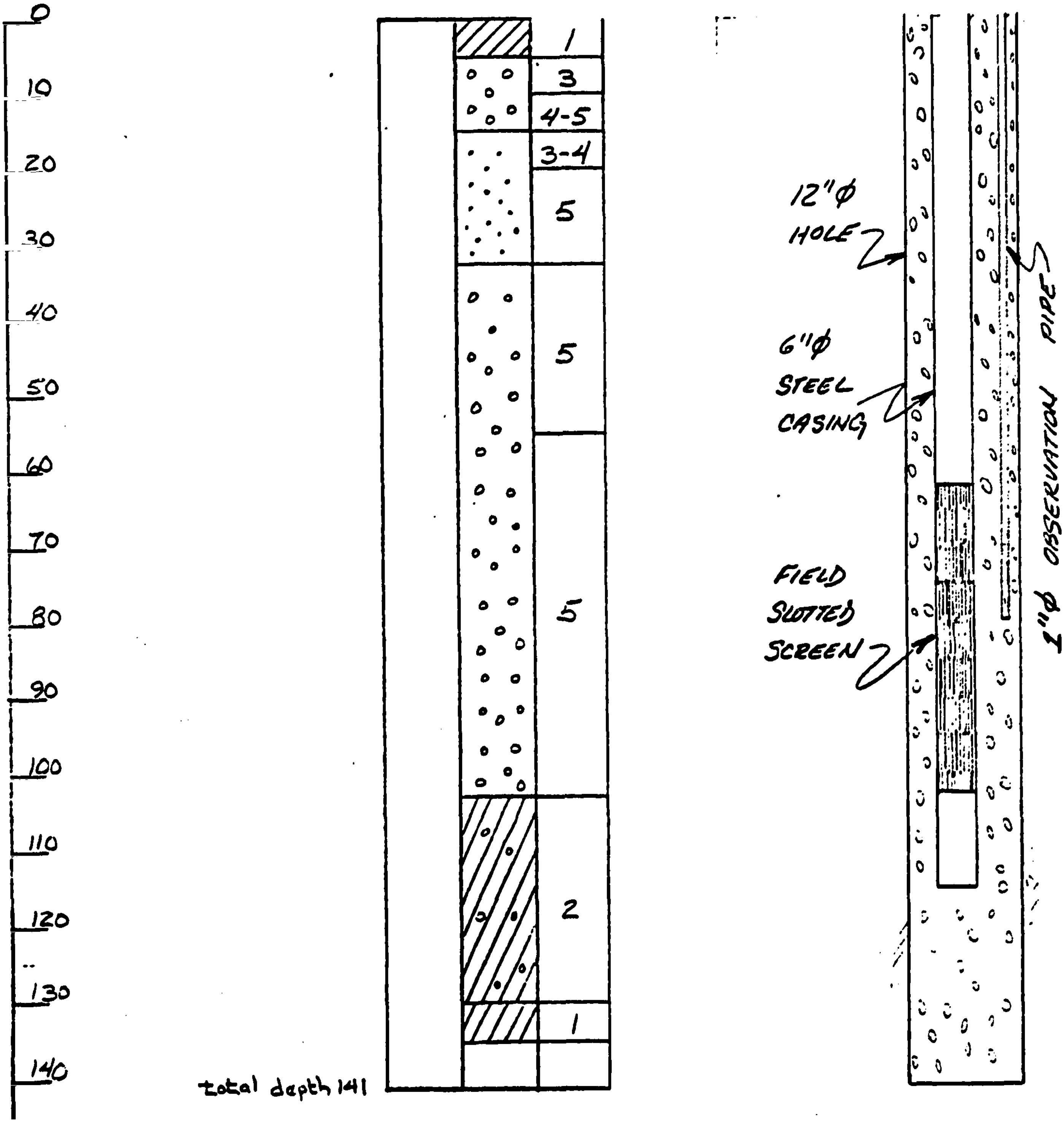
ENID, OKLAHOMA 73701, U.S.A.

57

APPENDIX C

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT [illegible] H-1 COMPUTED JJM @ 19 Nov CHECKED	PROJECT [illegible] FILE NO. 1191 DATE 1-5 Oct '79 PAGE 1 OF 1 PAGES

Depth in feet below ground	Elevation in feet MSL	Geol. 1/	Relative Perm. 2/	Well Construction



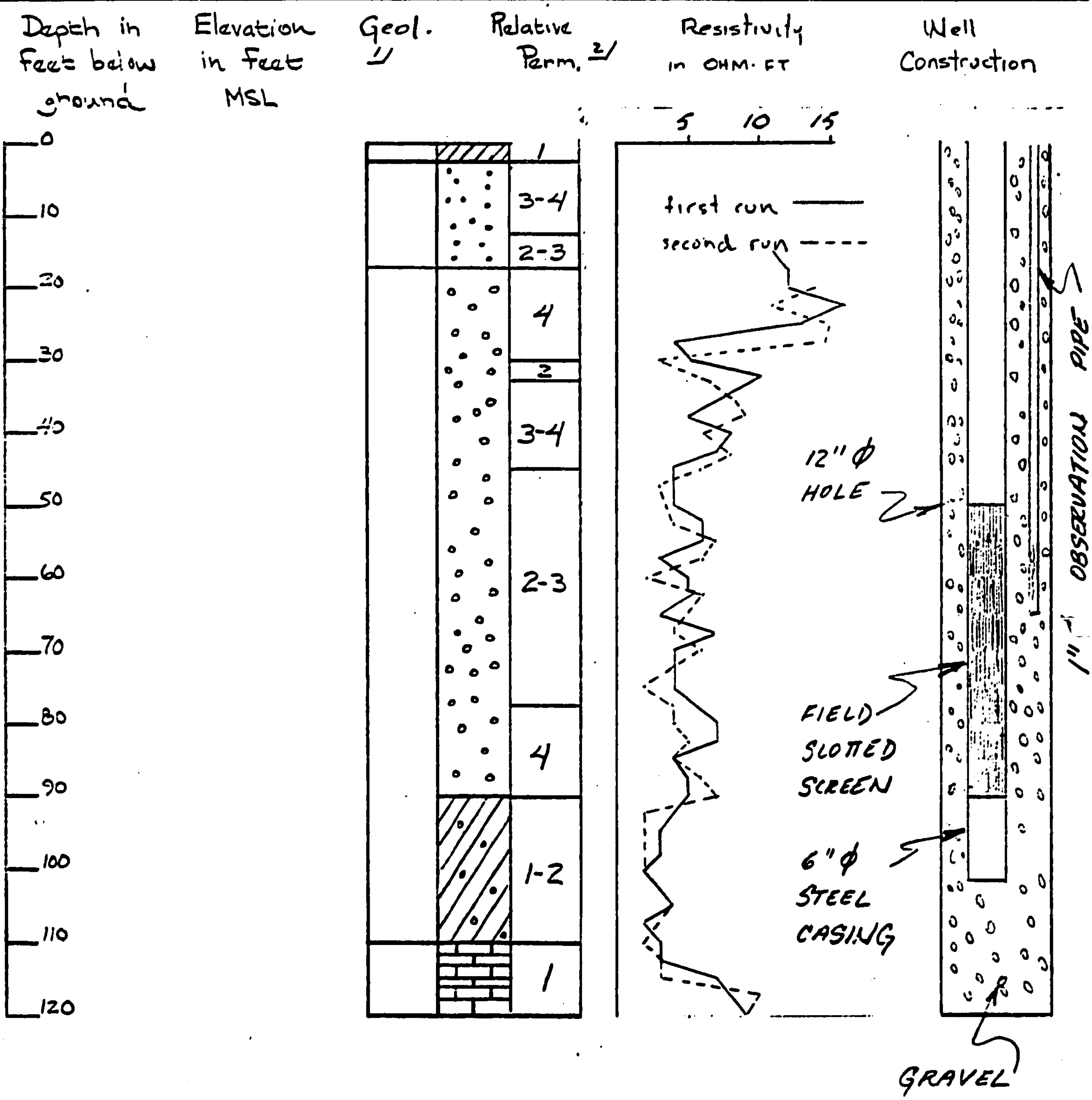
total depth 141

1/ Geologic Symbols: Clay, Sand, Gravel, Limestone

2/ Relative Permeability:
5 - very high
4 - high
3 - medium
2 - low

67

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT: laine de Tebre H - 2 COMPUTED: JJM @ 19 Nov. CHECKED:	PROJECT: Laiti FILE NO. 1191 DATE 15 Oct. 1979 PAGE 1 OF 1 PAGES

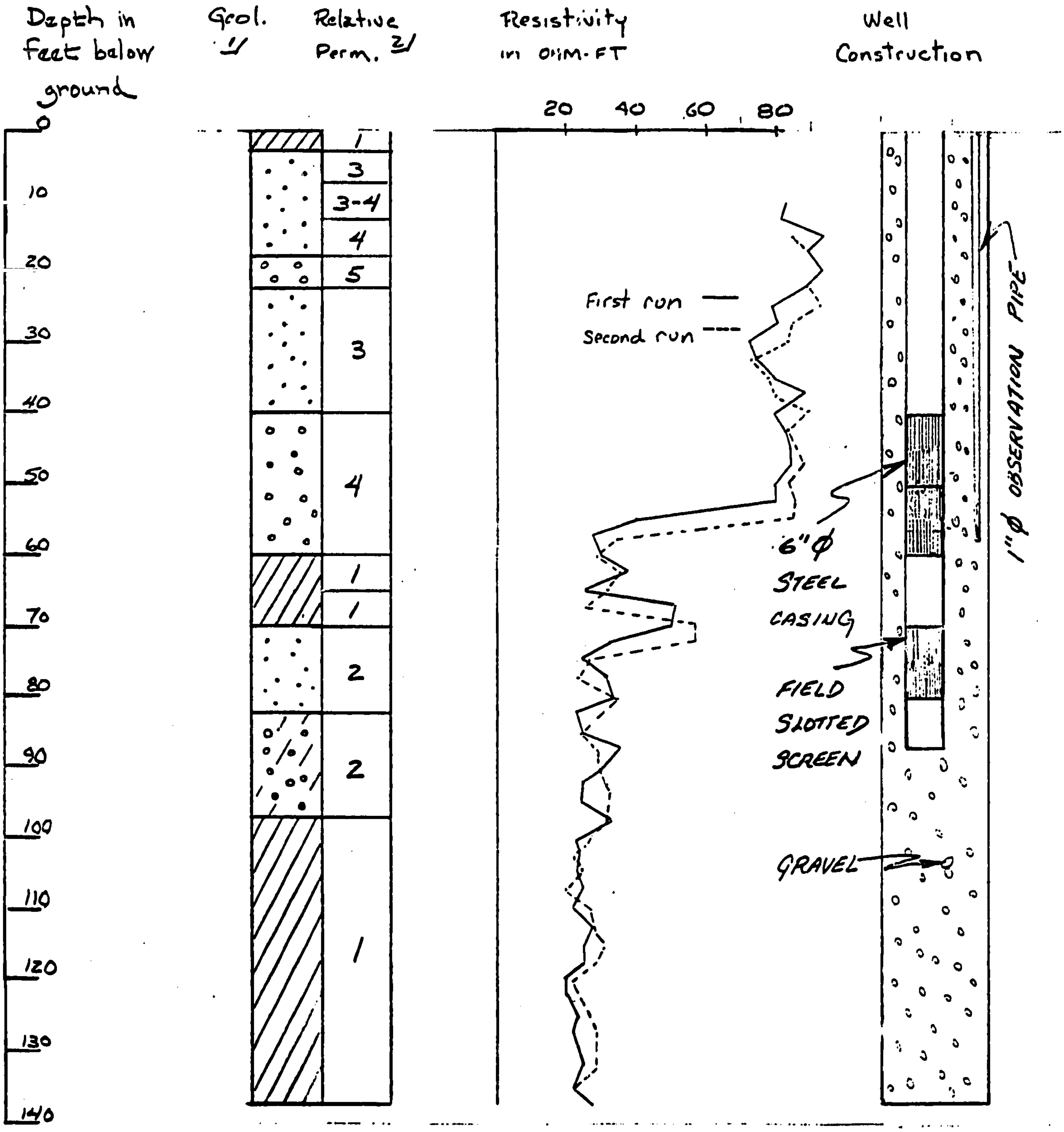


1/ Geologic Symbols
- Clay
- Sand
- Gravel
- Limestone

2/ Relative Permeability
- 5 - very high
- 4 - high
- 3 - medium
- 2 - low
- 1 - very low

56

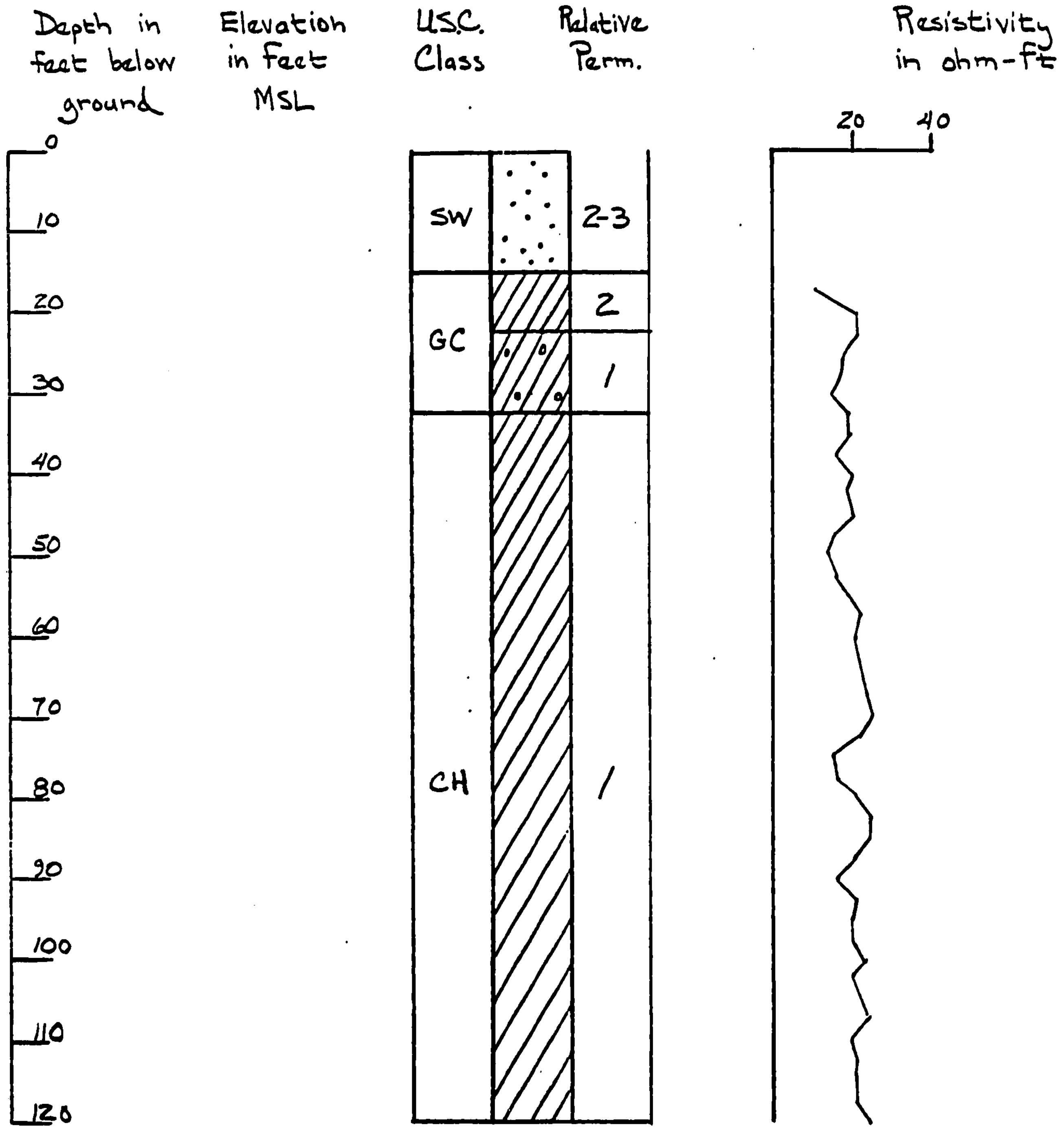
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT Plain de l Arbre H-3	PROJECT Haiti
	COMPUTED JJM @ 19 Nov '79 CHECKED	FILE NO. 1191
		DATE 23 & 24 Oct '79 PAGE 1 OF 1 PAGES



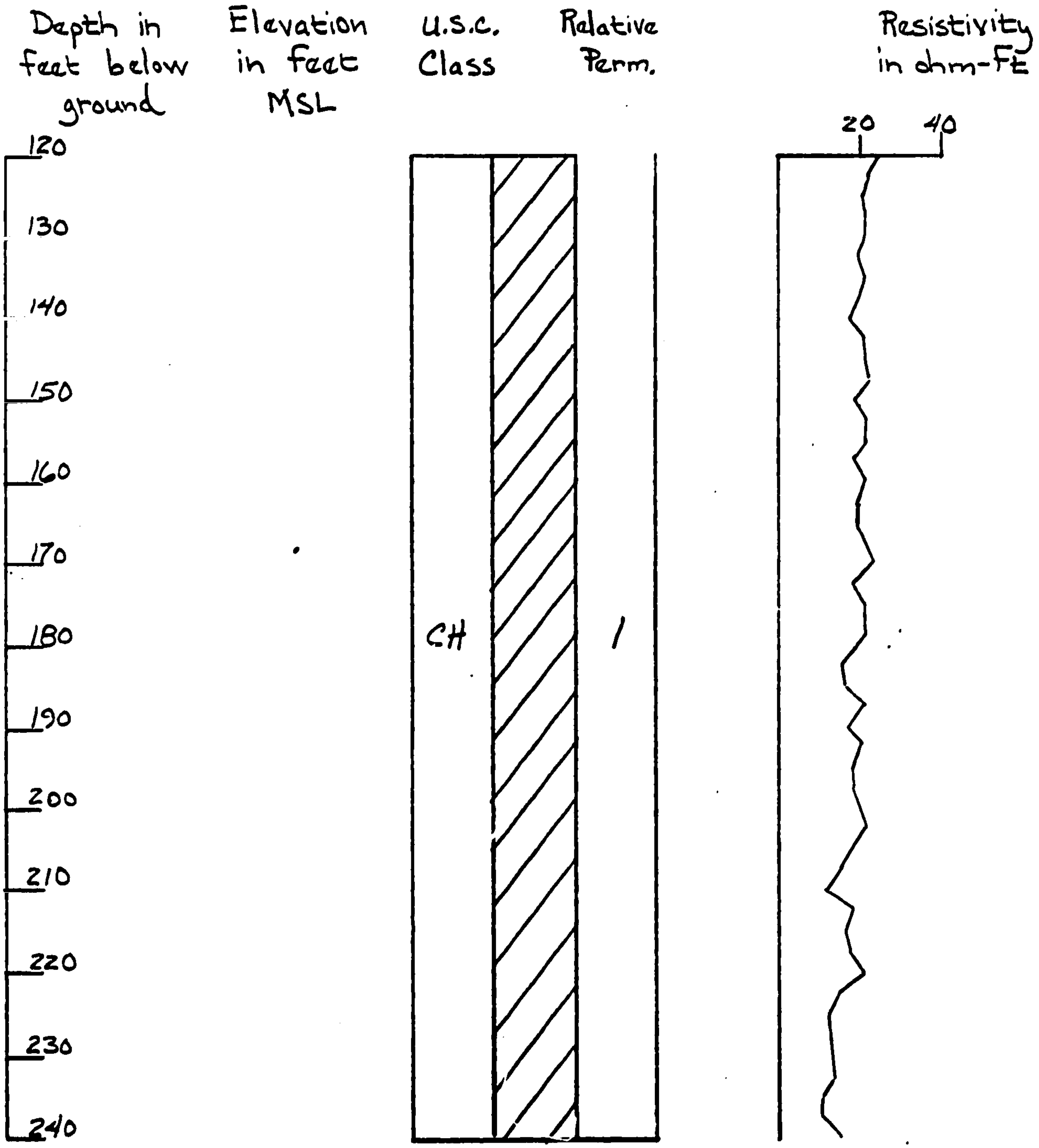
1/ Geologic Symbols: Clay, Sand, Gravel, Limestone

2/ Relative Permeability: 5- very high; 4- high; 3- medium; 2- low

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT Plain de l'Arbre H-4	PROJECT Haiti
	COMPUTED TJMC 19 Nov CHECKED	FILE No. 1191
		DATE 27 & 29 Oct '79 PAGE 1 OF 2 PAGES



continued on next page



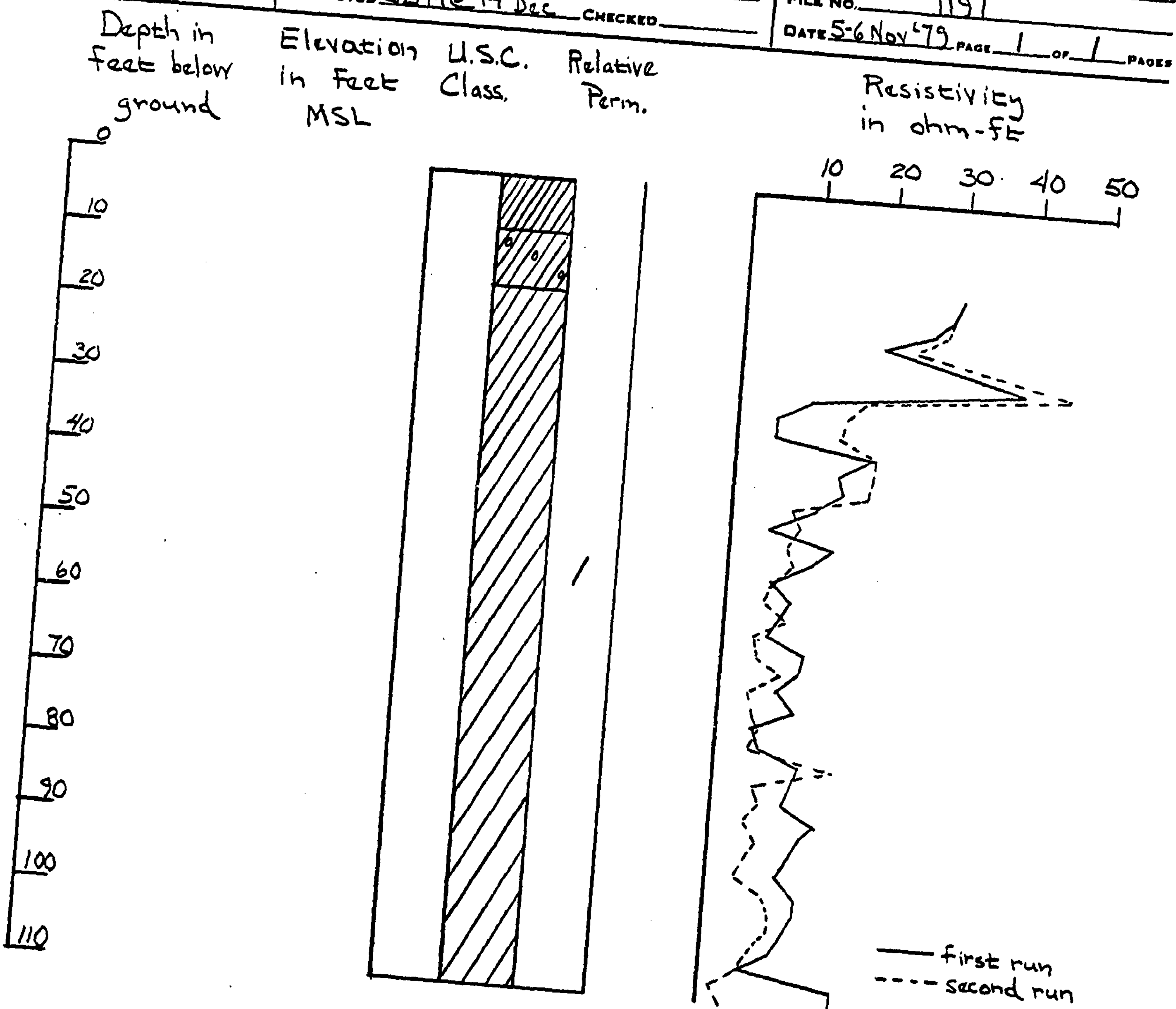
Geologic Symbols

- Clay
- Sand
- Gravel
- Limestone

Relative Permeability

- 5 - very high
- 4 - high
- 3 - medium
- 2 - low
- 1 - very low

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT Plaine de l'Arbre H-5	PROJECT Haiti
	COMPUTED J.J.M.@ 14 Dec CHECKED	FILE NO. 1191
		DATE 5-6 Nov '79 PAGE 1 OF 1 PAGES



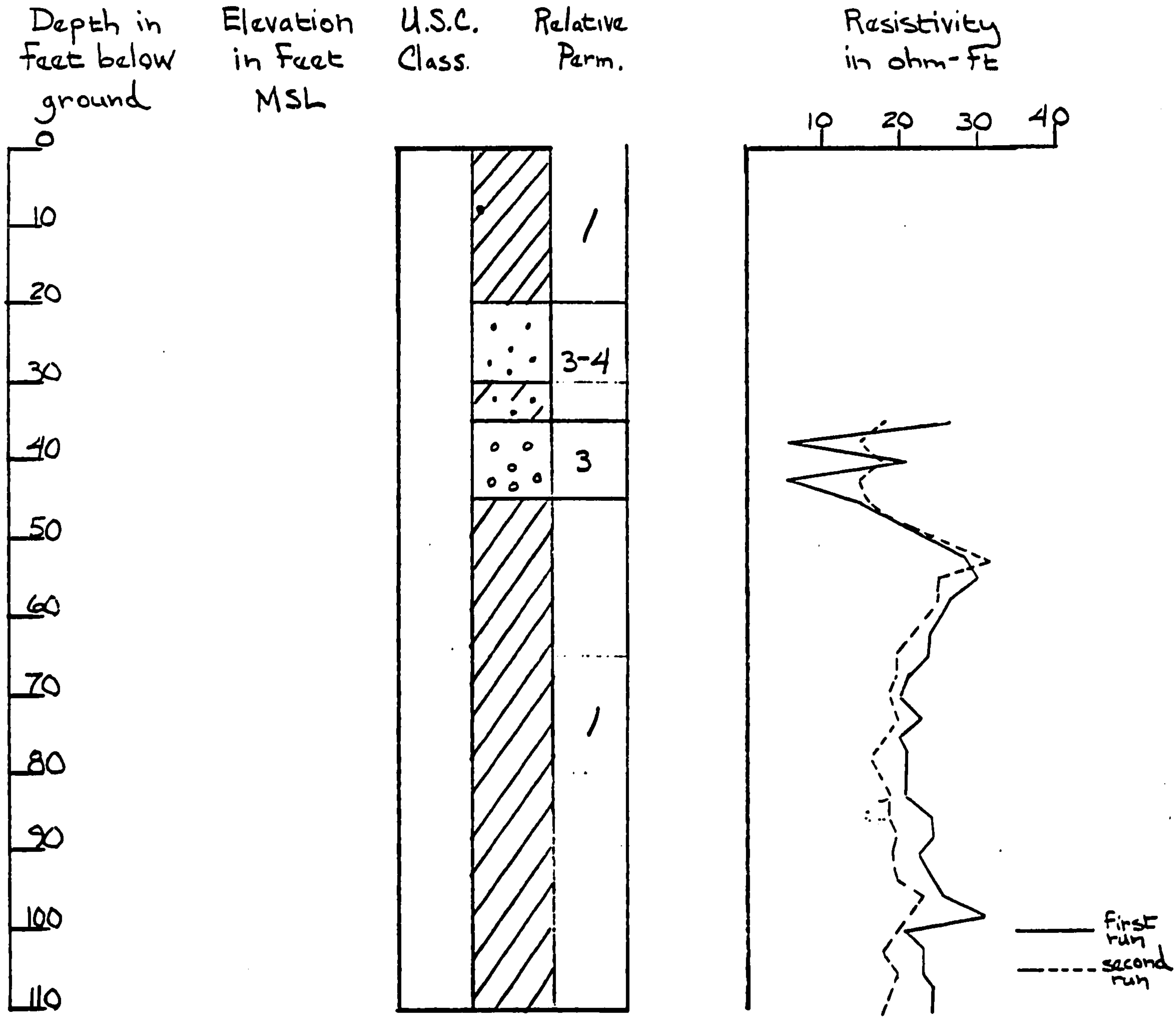
Geologic Symbols: Clay, Sand, Gravel, Limestone

Relative Permeability:
5 - very high
4 - high
3 - medium
2 - low
1 - very low

HARZA ENGINEERING COMPANY
CHICAGO

SUBJECT: Plaine de l'Arbre
H-6
COMPUTED: JJM@14 Dec CHECKED:

PROJECT: Haiti
FILE No. 1191
DATE 7-8 Nov '79 PAGE 1 OF 1 PAGES

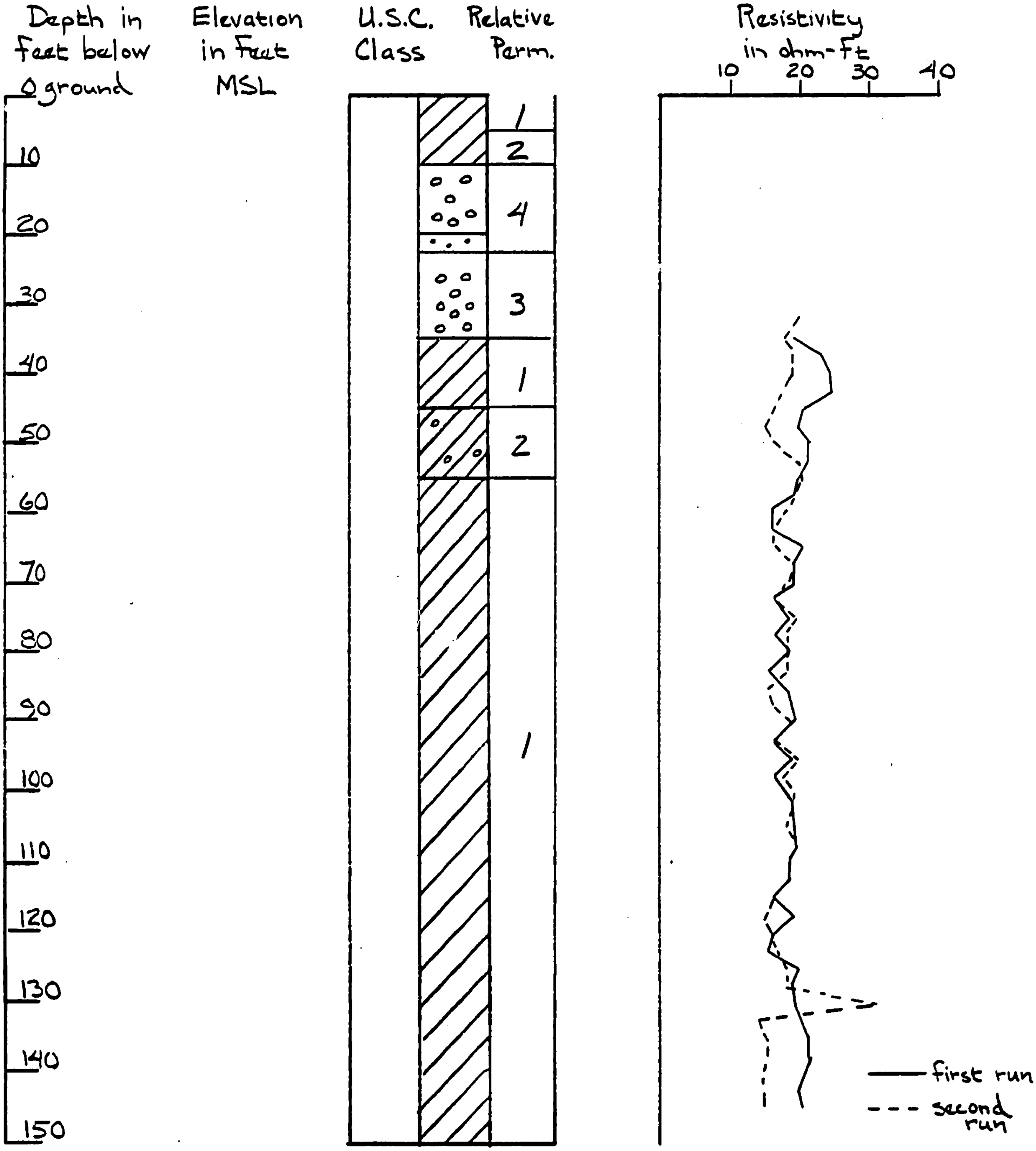


Geologic Symbols
- Clay
- Sand
- Gravel
- Limestone

Relative Permeability
- 5 - very high
- 4 - high
- 3 - medium
- 2 - low
- 1 - very low

6

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT Plaine de l'Arbre H-7 COMPUTED JJM@14 Dec CHECKED	PROJECT Haiti FILE NO. 1191 DATE 10-13 Nov'79 PAGE 1 OF 1 PAGES

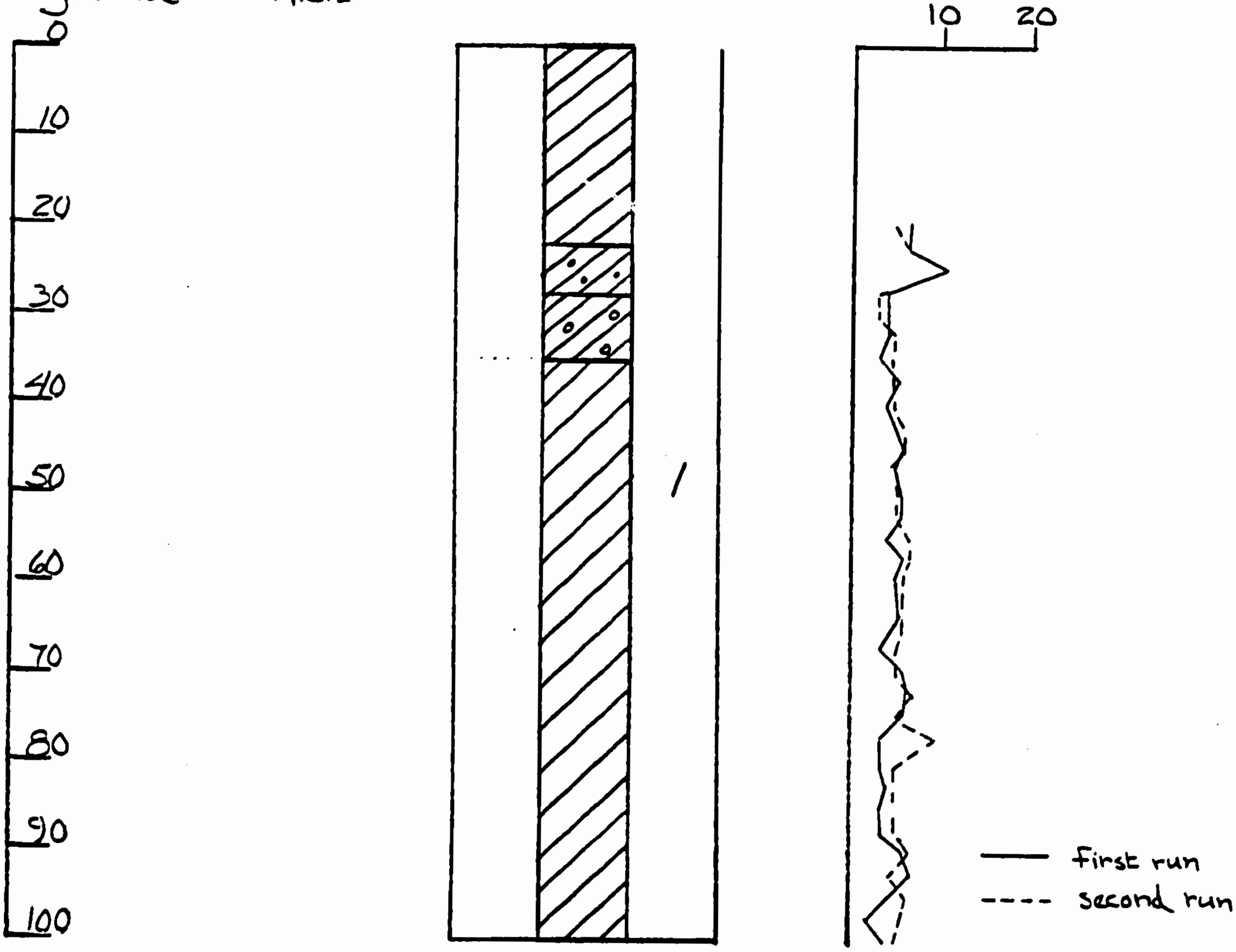


Geologic Symbols: Clay, Sand, Gravel

Relative Permeability:
5 - very high
4 - high
3 - medium

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT Plaine de l'Arbre H-8	PROJECT Haiti
	COMPUTED JJM @ 14 Dec CHECKED	FILE NO. 1191
		DATE 19-20 Nov '79 PAGE 1 OF 1 PAGES

Depth in feet below ground	Elevation in Feet M.S.L.	U.S.C. Class	Relative Perm.	Resistivity in ohm-Ft

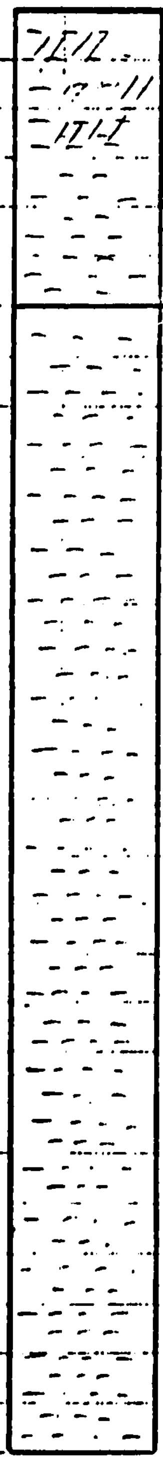


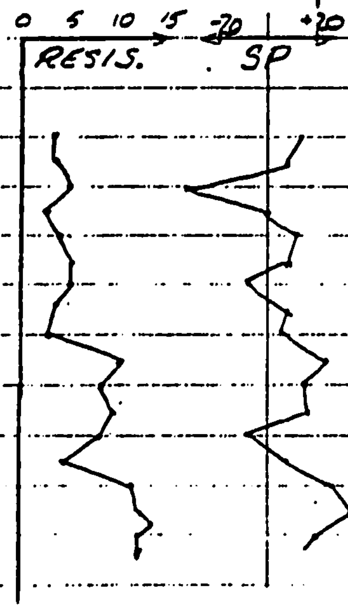
Geologic Symbols: Clay, Sand, Gravel, Limestone

Relative Permeability:
5 - very high
4 - high
3 - medium
2 - low
1 - very low

ENGINEERING COMPANY CHICAGO	H-9	FILE No. 1191
	COMPUTED MEJ CHECKED	DATE JL 7/80 PAGE 1 OF 1 PAGES

DEPTH IN FEET BELOW GROUND	ELEVATION IN FEET	GEOL. 1/	REL. PERM. 2/	A/ RESISTIVITY IN OHM-FT; B/ SP IN OHM-FT	WELL CONSTRUCTION
0					
			1		
100					
200					
			1		12" HOLE BACKFILLED
300					
400					
500					
590 = TOTAL DEPTH					





1/ GEOLOGIC SYMBOLS: CLAY, SAND, GRAVEL, MARL, LIMESTONE, CLAYSTONE, SILTSTONE, SANDSTONE

3/ RELATIVE PERMEABILITY: 5 VERY HIGH; 4 HIGH; 3 MEDIUM; 2 LOW

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT PLAINE DE L'ARBRE H-10	PROJECT HAITI
	COMPUTED MEJ CHECKED	FILE No. 1191
		DATE Jul 7/80 PAGE 1 OF 1 PAGES

DEPTH IN FEET BELOW GROUND	ELEVATION IN FEET	GEOL. 1/	REL. PERM. 2/	RESISTIVITY IN OHM-FT	WELL CONSTRUCTION

0

100

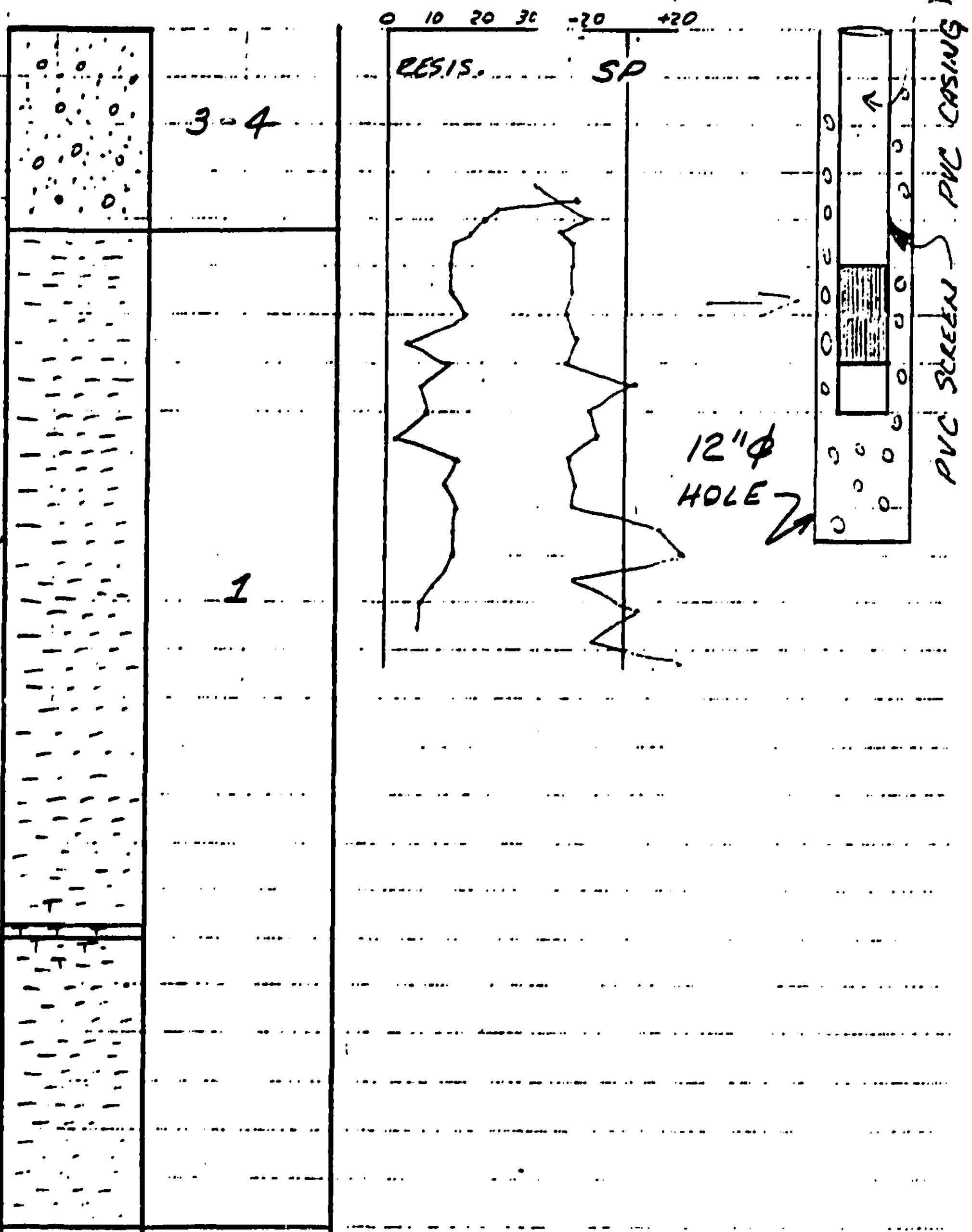
200

215 = TOTAL WELL DEPTH

300

400

500 = TOTAL EXPLORATION DEPTH



1/ GEOLOGIC SYMBOLS: CLAY, SAND, GRAVEL, MARL, LIMESTONE, CLAYSTONE, SILTSTONE, SANDSTONE

2/ RELATIVE PERMEABILITY: 5 VERY HIGH, 4 HIGH, 3 MEDIUM, 2 LOW

COMPANY CHICAGO

COMPUTED: MEJ — CHECKED:

FILE NO. 1191

DATE July 7/87 — PAGE 1 OF 1 PAGES

DEPTH IN FEET BELOW GROUND	ELEVATION IN FEET	GEOL. 1/	REL. PERM. 3/	RESISTIVITY SP IN OHM-FT	WELL CONSTRUCTION

0

50

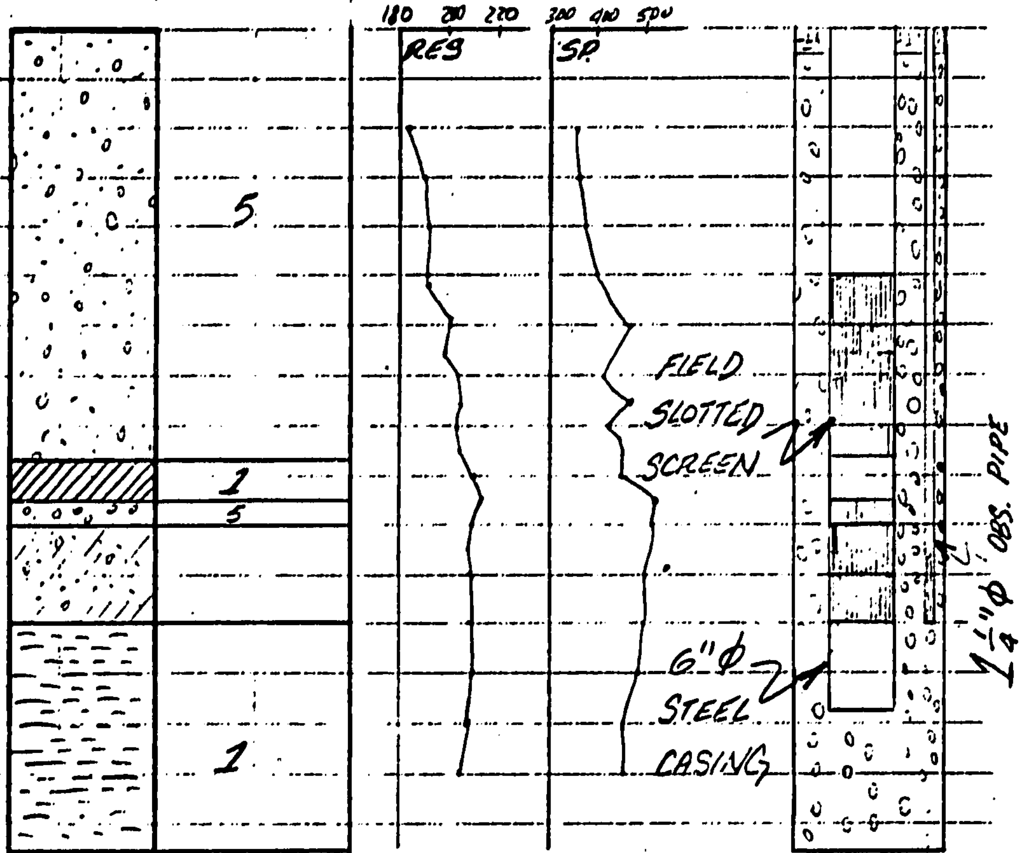
100

150

165 = TOTAL DEPTH

200

250

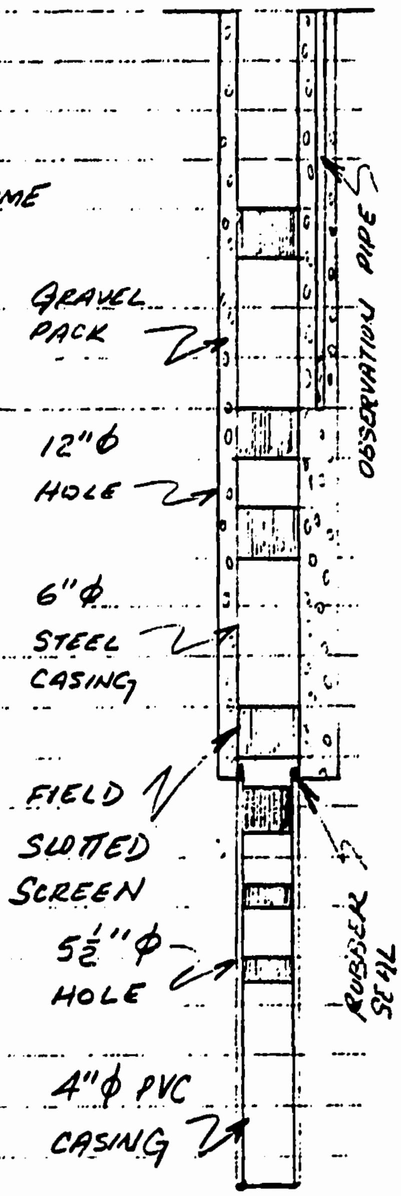


1/ GEOLOGIC SYMBOLS: CLAY, SAND, GRAVEL, MARL, LIMESTONE, CLAYSTONE, SILTSTONE, SANDSTONE

3/ RELATIVE PERMEABILITY:
5 VERY HIGH
4 HIGH
3 MEDIUM
2 LOW
1 VL

ENGINEERING COMPANY CHICAGO	H-12	PROJECT ____
	COMPUTED MFJ CHECKED ____	FILE NO. 1191
		DATE July 7/80 PAGE 1 OF 1 PAGES

DEPTH IN FEET BELOW GROUND	ELEVATION IN FEET	GEOL. 1/	REL. PERM. 2/	RESISTIVITY SP in OHM-FT	WELL CONSTRUCTION
0			4	LOGS WILL BE PROVIDED BY B. NEWSOME	
100					
200			1		
300			3-2		
400					
470 = TOTAL DEPTH			4?		
500					



1/ GEOLOGIC SYMBOLS: CLAY, SAND, GRAVEL, MARL, LIMESTONE, CLAYSTONE, SILTSTONE, SANDSTONE

2/ RELATIVE PERMEABILITY: 5 VERY HIGH, 4 HIGH, 3 MEDIUM, 2 LOW

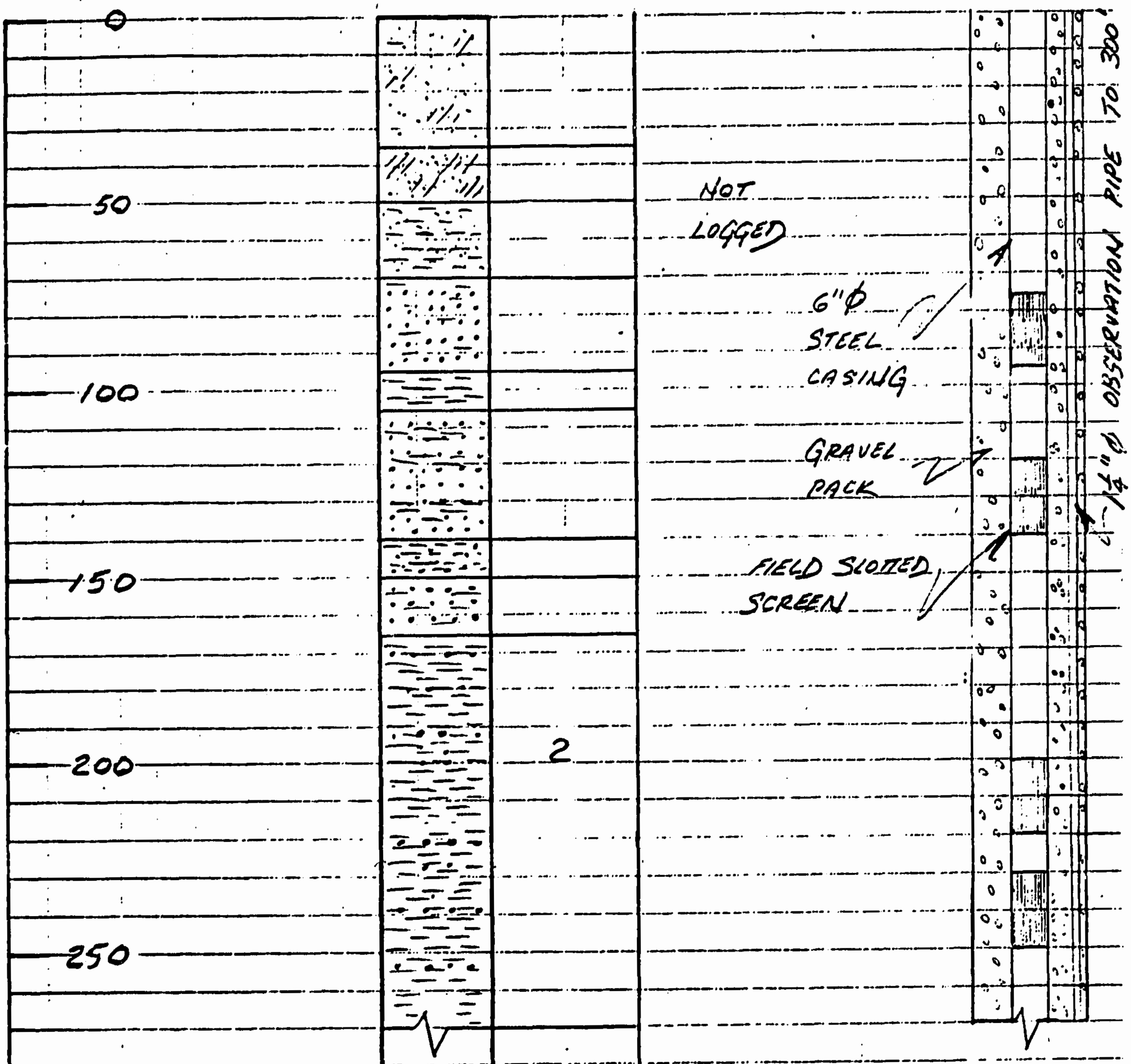
ENGINEERING COMPANY
CHICAGO

H-13

COMPUTED MEJ CHECKED

FILE NO. 1191
DATE July 7/80 PAGE 1 OF 2 PAGES

DEPTH IN FEET BELOW GROUND	ELEVATION IN FEET	GEOL. 1/	REL. PERM. 3/	RESISTIVITY SP in OHM-FT	WELL CONSTRUCTION



LOG CONTINUED ON PAGE 2

1/ GEOLOGIC SYMBOLS: CLAY, SAND, GRAVEL, MARL, LIMESTONE, CLAYSTONE, SILTSTONE, SANDSTONE

3/ RELATIVE PERMEABILITY: 5 VERY HIGH, 4 HIGH, 3 MEDIUM, 2 LOW

ENGINEERING COMPANY
CHICAGO

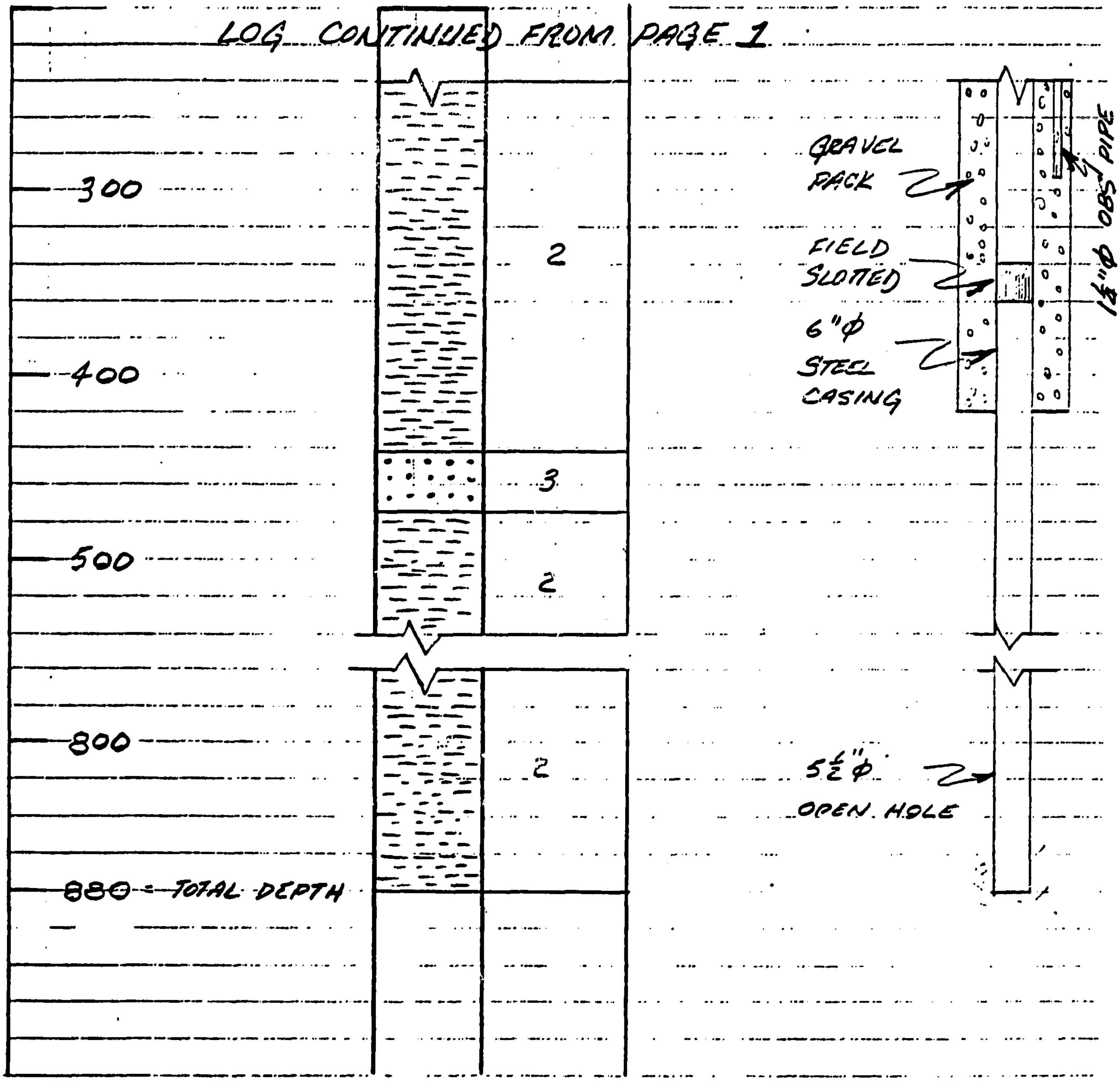
H-13 (CONTINUED)

COMPUTED MFJ CHECKED

FILE NO. 1191

DATE July 7/80 PAGE 2 OF 2 PAGES

DEPTH IN FEET BELOW GROUND	ELEVATION IN FEET	GEOL. 1/	REL. PERM. 2/	RESISTIVITY	WELL CONSTRUCTION

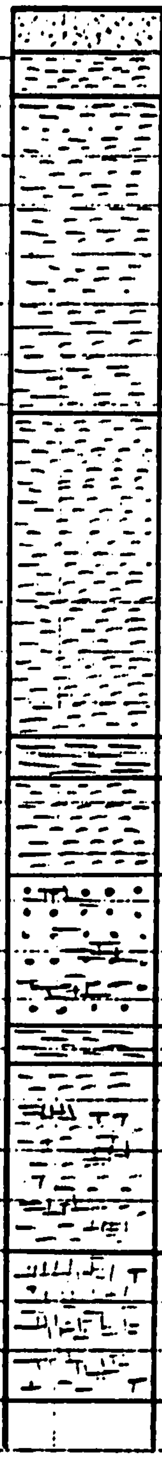


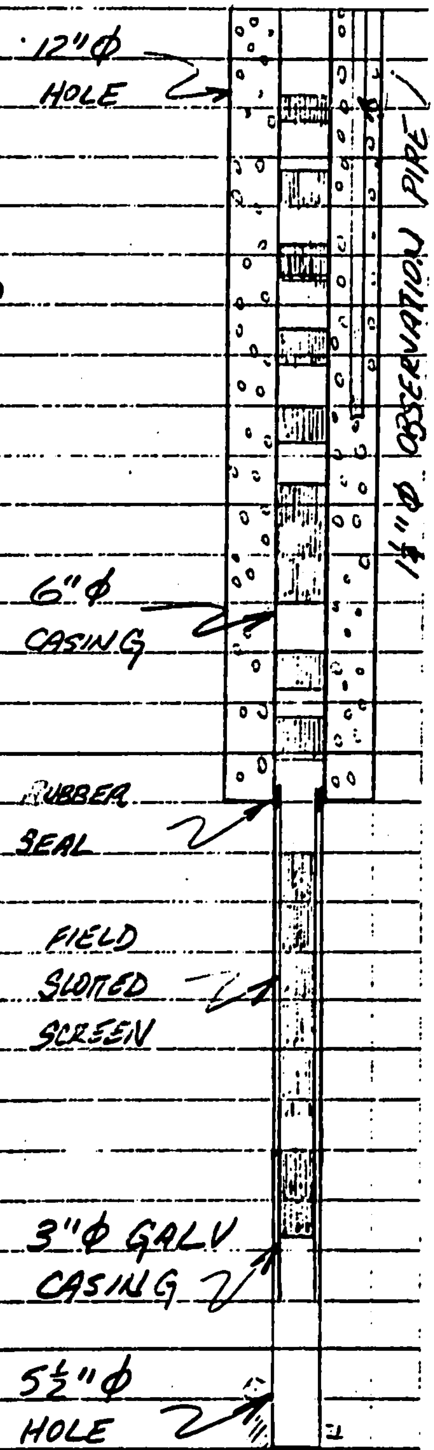
1/ GEOLOGIC SYMBOLS: CLAY, SAND, GRAVEL, MARL, LIMESTONE, CLAYSTONE, SILTSTONE, SANDSTONE

2/ RELATIVE PERMEABILITY:
5 VERY HIGH
4 HIGH
3 MEDIUM
2 LOW

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT PLAINE DE L ARBRE H-14	PROJECT HAITI
	COMPUTED MEJ CHECKED	FILE NO. 1191
		DATE July 7/80 PAGE 1 OF 1 PAGES

DEPTH IN FEET BELOW GROUND	ELEVATION IN FEET	GEOL. 1/	REL. PERM. 3/	RESISTIVITY SP	WELL CONSTRUCTION
0					
100			2	NOT LOGGED	
200					
300			1		
400			1		
500					
600			3?		
700			4?		
750 = TOTAL DEPTH					





1/ GEOLOGIC SYMBOLS: CLAY, SAND, GRAVEL, MARL, LIMESTONE, CLAYSTONE, SILTSTONE, SANDSTONE

3/ RELATIVE PERMEABILITY: 5 VERY HIGH; 4 HIGH; 3 MEDIUM; 2 LOW

Appendix D
Well Completion Reports 1/

Test-Well H-1

This well was drilled in the alluvial deposits of the Colombier River, to a total depth of 141 feet. The well encountered relatively high permeability sand and gravel between 5 and 102 feet. Some interbeds of silt and clay were identified. Below this, mostly low-permeability clay was found. The well was cased with 115 feet of 6" diameter steel casing including 40 feet of hand slotted screen. The well was step-tested at four different pumping rates ranging from 26 to 233 gpm, and the water is of good quality.

1/ Well logs and construction features are given in Appendix C.

Test Well H-2

H-2 was drilled in the southeast portion of the study area. It was drilled to a depth of 120 feet, the upper 90 feet of which consisted primarily of high permeability sand and gravel. From 90 to 110 feet, the well encountered limestone. The well was cased with 102 feet of 6" steel casing, including 40 feet of hand slotted screen. Subsequent test pumping indicated a discharge of 24 gpm and a specific capacity of 1.1 gpm/ft. Salt water unfit for most uses was found in this well.

Test Well H-3

This well is located approximately 1 kilometer northwest of Cabana Boeuf. It was drilled to a depth of 137 feet and primarily encountered sand and gravel from 5 to 60 feet, and 70 to 95 feet, with clay beds between 60 and 70 feet and below 95 feet. Steel casing of 6" diameter and 87 feet were installed in the 12" diameter and gravel packed hole. Of this, 30 feet was hand slotted . No discharge rate for this well is available.

Test Well H-10

H-10 is located in the central part of the study area about 10km east of Anse Rouge . H-10 encountered fine-to-medium grained alluvial sand from the surface to a depth of about 85 feet (75-80 feet on the electric log) and gray claystone from 85 feet to the total depth of 500 feet. Drill cuttings and drilling characteristics indicated that the alluvium is partly cemented with calcite and that thin marl or clacareous stringers occur locally in the claystone.

No ground water was encountered in the claystone in H-10, however, several days after completion, minor quantities were noticed to be cascading into the well from the alluvium and it was decided to install PVC casing. Due to problems encountered while installing the casing, a new H-10 hole was drilled to a depth of 215 ft approximately 100 ft from the original site. PVC casing, including 40 feet of screen was installed in the well to a depth of 160 feet.

Test Well H-11

This well is located in the Riviere Columbier basin in the east of the study area, about 0.8km north of H-1, completed previously. H-11 encountered alluvial and related sediments to a depth of 120 feet including very coarse and permeable gravels, cobbles and boulders from the surface to a depth of 87 feet. From 120 to the total depth of 165 feet, the well encountered gray, compact, low permeability clay and claystone with siltstone stringers.

The well was cased to a depth of 138 feet including 60' of field slotted casing. A six hour pumping test produced 90 gpm and a specific capacity of 7.5 gpm/ft.

Test Well H-12

Well H-12 is located in the Riviere Columbier basin in the east of the study area, about 2km south of Source Chaude. The well was drilled to a total depth of 470 feet and is cased to 310 feet, including 100 feet of slotted casing and gravel pack.

H-12 penetrated 55 feet of alluvial gravel containing minor water before entering Oligocene/Miocene claystones similar to those encountered in other wells. At a depth of about 325 feet, however, well cuttings began to include limestone fragments and from about 420 feet to 470 feet, limestone is generally prevalent. These limestones probably occur as thin stringers and interbeds in the claystone, rather than as a different geologic formation, and they appear to contain groundwater and may produce significant yields. One week after completion, the well was flowing an estimated 1-2 gpm at the surface. Subsequent pumping produced a yield of 400 gpm with a corresponding specific capacity of 10 gpm/ft.

Test Well H-13

H-13 is located at the base of the mountains north of Anse Rouge, near Source Tete Beouf, a surface spring which provides domestic water to Anse Rouge and intervening areas. The well encountered alluvial/colluvial silt and fine to medium sand from the surface to a depth of 50 feet, underlain by interbedded gray siltstones and sandstones to about 145 feet and generally uniform, gray, compact, very fine-grained clayey sandstones/siltstones to 420 feet. The well was thought to have encountered minor ground water in this upper sedimentary sequence and, consequently the upper 420 feet was completed with six-inch threaded and welded steel casing and gravel pack. Approximately 110 feet of field slotted screening was installed at various intervals between 80 and 420 feet.

The well was drilled at 5 1/2" and left uncased. Siltstone and claystone of low permeability were generally encountered throughout this entire interval with few limestone and marl stringers. Moderately permeable silty fine-grained sand was encountered from 442 to 475 feet.

Two weeks after completion, the fluid level in the well was at about 25 feet (estimated), indicating that enough water for a hand pump may have been available. However, subsequent well tests showed no yield.

Test Well H-14

Well H-14 is located about 3km north of L'Arbre Village and about 1km east of Source Moule a Manchette, a natural spring. The well was drilled to 400 feet at 12 inches diameter and then deepened to 50 feet at 5 1/2 inches diameter. H-14 was cased with six inch steel casing, including 200 feet of slotted casing to a depth of 400 feet.

H-14 encountered 20 feet of alluvial silt underlain by low permeability, weathered (tan) and fresh (gray) claystones to a depth of about 530 feet. This zone contained siltstone beds locally and a sandstone/limestone/marl zone from 435 to about 515 feet. From 530 feet to 750 feet well cuttings contained limestone chips which were numerous below about 625 feet. The limestones probably occur as thin interbeds in the claystone rather than an underlying geologic formation.

Immediately after completion of H-14, with the drill stem still in the hole, the well was flowing 1-2 gpm out of the casing. A subsequent four low test produced a continuous yield of 75 gpm and a specific capacity of 0.65 gpm/ft.

Haiti
Water Supply, S.A.

January 22, 1980

Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Gentlemen:

Please find enclosed the results of the Pump Tests and Well Developments performed in the area of Plaine de l'Arbre in Haiti.

We also include our invoice No. 3 for the amount of $6,253.90.

Considering the advance of $10,000.00 received by us November 8, 1979, we now owe Hacho a balance of $3,746.10.

We are keeping this balance at Hacho's disposal awaiting your decision regarding the completion of the program.

Hoping that these reports will help you reach a decision we remain,

Yours truly,

HAITI WATER SUPPLY S.A.

Boite Postale 2075 • Port-Au-Prince • Haiti, W.I. • Telephone 22205 • Cable: HAITI WATER
Telex: ITT 3490317 HAWATER

Haiti Water Supply, S.A.

January 22, 1980

WATER RESOURCES HACHO 01
EXPLORATION & WELL DEVELOPMENT PROGRAM
PLAINE DE L'ARBRE - HAITI

WELL No.1 (H-1)

Development:

1)	Pipe installed	100' x $2.90	$ 290.00	
2)	Development by air	27 h x $38.40	1,036.80	
3)	Pump Test:			
	a) Test Pump installed		350.00	
	b) Starting time Sat. 12/1	10.00 A.M.		
	Stop time Tues. 12/4	10.00 A.M.		
		72 h x $18.40	1,324.80	
4)	Chemicals and installation		100.00	
5)	Water analysis		80.00	
6)	Plugging well	15' x $8.50	127.50	$3,309.10

WELL [illegible] (FAO well)

Development:

1)	Pipe installed	70' x $2.90	203.00	
2)	Development by air	34 h x $38.40	1,305.60	
3)	Chemicals and installation		100.00	
4)	Pump Test:			
	a) Test Pump installed		350.00	
	b) Starting time Thurs. 1/17	11.00 A.M.		
	Stop time " "	21.00 P.M.		
		10 h x $18.40	184.00	
5)	Water analysis		80.00	2,222.60

WELL No. 4 (H-3)

Development:

1)	Pipe installed	80' x $2.90	232.00	
2)	Development by air	3 h x $38.40	115.20	347.20

WELL No. 8 (H-7)

Refill well	150' x $1.50	225.00

WELL No. 9 (H-8)

Refill well	100' x $1.50	150.00
	TOTAL	[illegible]

[illegible]

HAITI WATER SUPPLY S.A.

DATE 1/22/80

/28/79	10.30 11.35	11.30 12.35	61' 61'			
	12.40 13.45	13.40 14.45	60' 54'			
	14.50 15.55	15.50 16.55	60' 60'			
	17.00 18.05	18.00 19.05	60' 60'			
	19.10 20.15	20.10 21.15	61' 61'			
	21.20 22.25	22.20 23.25	60' 60'			
/29/79	23.30 0.35	0.30 1.35	60' 60'			
	1.40 2.45	2.40 3.45	60' 60'			
	3.50 4.55	4.50 5.55	60' 60'			
	6.00 7.05	7.00 8.05	60' 60'			
	8.10 9.15	9.10 10.15	61' 61'			
	10.20 11.25	11.20 12.25	61' 61'			
	12.30 13.35	13.30 14.35	61' 61'			
	14.40 15.45	15.40 16.45	61' 61'			
	16.50	17.50	60'			
	TOTAL	27 heures				

/13/79	9.00	10.00	35'			
	10.05	11.05	36'4"			
	11.10	12.10	37'6"			
	12.15	13.20	38'8"			
	13.25	14.25	39'4"			
	14.30	15.30	40'7"			
	15.35	16.35	41'			
	16.40	17.40	40'			
	17.45	18.45	41'4"			
	18.50	19.50	40'6"			
	19.55	20.55	39'9"			
	21.00	22.00	38'			
	22.05	23.05	37'3"			
	23.10	0.10	38'			
/14/79	0.15	1.15	37'			
	1.20	2.20	36'			
	2.25	3.25	35'10"			
	3.30	4.30	35'			
	4 35	5 25	35'			
	5.30	6.30	37'2"			
	6.35	7.35	37'9"			
	7.40	8.40	38'3"			
	8.45	9.45	39'2"			
	9.50	10.50	38'			
	10.55	11.55	37'			
	12.00	13.00	37'4"			
	13.05	14.05	37'6"			
	14.10	15.10	38'2"			
	15.15	16.15	37'8"			
	16.20	17.20	37'4"			
	17.25	18.25	36'3"			
	18.30	19.30	37'5"			
	19.35	20.35	37'			
	20.40	21.40	37'8"			
	TOTAL	34 heures				

21/79	 7.00	 8.00	57' 64'			
	8.05 9.10	9.05 10.10	68'8" 68'8"			
	10.15 NO WATER	11.15	69'			
	RECOVERY					
		11.30 12.00	68'4" 68'3"			
 22/79		13.00 8.00	68'1" 66'4"			
 /80		18.00 13.00	65'9" 61'			

ESSAI DE POMPAGE PUITS No 2

PUMP TEST Well #2

7/1/80	8^{00}	39'	–	–	–
″	8^{15}	45'8"	4	4.3	15.48
″	8^{30}	52'11"	4	4.3	15.48
″	8^{45}	54'3"	3	2.80	10.08
″	9^{00}	56'6"	3	2.80	10.08
″	9^{15}	57'9"	3	2.80	10.08
″	9^{30}	58'11"	3	2.80	10.08
″	9^{45}	59'4"	2.5	1.50	5.40
″	10^{00}	59'6"	2.5	1.50	5.40
″	10^{15}	59'8"	2.5	1.50	5.40
″	10^{30}	59'8"	2.5	1.50	5.40
″	10^{45}	59'10"	2.5	1.50	5.40
″	11^{00}	59'9"	2.5	1.50	5.40
″	11^{30}	59'11"	2.5	1.50	5.40
″	12^{00}	60'	2.5	1.50	5.40
″	12^{30}	60'2"	2.5	1.50	5.40
″	13^{00}	60'3"	2.5	1.50	5.40
″	13^{30}	60'4"	2.5	1.50	5.40
″	14^{00}	60'4"	2.5	1.50	5.40
″	14^{30}	60'6"	2.5	1.50	5.40
″	15^{00}	60'8"	2.5	1.50	5.40
″	15^{30}	60'5"	2.5	1.50	5.40
″	16^{00}	60'7"	2.5	1.50	5.40
″	16^{30}	60'7"	2.5	1.50	5.40
″	17^{00}	60'6"	2.5	1.50	5.40
″	17^{30}	60'7"	2.5	1.50	5.40
″	18^{00}	60'7"	2.5	1.50	5.40

s = 60'-7" - 39'   = .396 [illegible] /s

DATE	HEURES	NIVEAU STATIQUE	CHUTE D'EAU/CM	L/Sec.	M³ HEURE	REMARQUES
	REMONTAGE D'EAU PUITS N° 2					
	RECOVERY/ WELL # 2					
17/1/80	18^{01}	49'				
"	18^{02}	48'2"				
"	18^{03}	47'4"				
"	18^{04}	46'8"				
"	18^{05}	46'3"				
"	18^{10}	45'11"				
"	18^{15}	45'9"				
"	18^{30}	45'5"				
"	18^{45}	45'4"				
"	19^{00}	45'2"				
"	19^{30}	45'1"				
"	20^{00}	45'1"				
"	21^{00}	44'11"				
"	22^{00}	44'9"				
"	23^{00}	44'9"				
"	24^{00}	44'8"				
18/1/80	1^{00}	44'8				
"	8^{20}	42'11"				
"	12^{00}	42'8"				
"	18^{00}	42'6"				

Haiti
Water Supply, S.A.

Forwarded for Filing by ______
Project Number ______
Classification ______
Subject Designation ______

June 24, 1980

Harza Engineering Co.
150 S. Wacker Dr.
Chicago, Ill. 60606

Att: Alan H. Schultz

Gentlemen:

Please find enclosed results of water analysis for Hacho 3B, Hacho 4B and AID #2.

No test was run on AID #1 because of the insignificant amount of water found in that well. Drilling in 5 1/2" down to 880' did not bring any positive result to justify any pump test.

Hoping that these facts will help you complete your report we remain,

Yours very truly

Smarck Michel

HAITI WATER SUPPLY, S.A.

Boite Postale 2075 • Port-Au-Prince • Haiti, W.I. • Telephone 22205 • Cable. HAITI WATER
Telex: ITT 3490317 HAWATER

Haiti
Water Supply, S.A.

HACH 2 B (H-1C)

Dril 12" Dia. Hole........215 ft.
Install 4" PVC............120.ft
Install 4 PVC screen.......40.ft
Gtavel Pack...............160 ft.

Note: Because of the amount of time HACH 2 B was left open, some problems were encountered while trying to install PVC. We move over about 100 ft. and drill another hole to a depth of 215 ft. Blowed well out; the well should produce 200 G.P.M.

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Telex: ITT 3490317 HAWATER

Haiti
Water Supply, S.A.

PUMP TEST HACH 3B (H-11)

Water level before test 73 ft.
3 HP. pump set to depth of 147 ft.
Draw down after 30 min. to 85 ft.
Pump had a pumping capacity at this depth with 2" discharge of 90 G.P.M.
Pumped for 6 hrs. - water level check at 85 ft.

HACH 3B should produce 200+ G.P.M.

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Haiti
Water Supply, S.A.

PUMP TEST HACH 4B (H-12)

Water Level before test - flowing
Pump set at 200Ft.
G.P.M. max R.P.A. (1800) 350 G.P.M. constant
Water level checked after 1hr 40ft.

Pump set to a depth of 150 ft.
Water level recovered to 5 ft. in 1 hr.
Water level at begining of test 5 ft.
G.P.M. 450 at begining drop to 400 after 30 mins.
Water level checked after 30 mins. 35 ft.
Pumped at this level 2 hrs.

Pump set at 100ft.
Water level before test 15 ft.
G.P.M. 500 at begining droped to 400 G.P.M. in 30 mins.
Maintained 400 G.P.M, for duration of test
Pumped 2 hrs.

Conclusion : Well will produce 400+ G.P.M. with pump depth setting of 175 ft.
Water good for human consumption.

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Telex: ITT 3490317 HAWATER

Haiti
Water Supply, S.A.

A.I.D. # 2

1. Water level before test flowing
240 240 ft., 3" Galvanize screen installed in well
Blowed well at 100 ft. with 650 CFM air conpressor started at 40 GPM for about 15 mins. , then droped to about 25 GPM
Blowed at this level for 1 hr.
Water level check after 1 hr. - 83 ft.
Note: A draw down of 83ft.

2. Blowed at 150 ft.
About 60 GPM
Blowed for 4 hrs.
GPM droped some (maybe to 40 GPM)
Water checked after 1 hr. 90 ft.
Water level check after 4 hrs. 93 ft.

3. Blowed at 200 ft.
About 75 GPM
Blowed for 4 hrs.
X Water after 1 hr. 110 ft.
Water level after 4 hts. 115 ft.

Note: Water has somme salt in it!
Conclusion: Well should produce at least 75 G.P.M. with pump setting of 200 ft.
OK for crop irrigation, not good for human consumption.

oite Postale 2075 • Port-Au-Prince • Haiti, W.I. • Telephone: 22205 • Cable: HAITI WATER

Haiti
Water Supply, S.A.

January 25, 1980

Harza Engineering Company
150 South Wacker Drive
Chicago, Illinois 60606

Gentlemen:

Please find enclosed the water analysis results to complete the report on Water Resources Program of Plaine de l'Arbre. Haiti.

Yours truly,

HAITI WATER SUPPLY, S.A.

L oratoire d nvestigations Biologiques

GLADYS ELIE LAUTURE M. T. CHAMP DE MARS 29 – Tel. : 2-3329 – 2-0578 MARLENE SIMON LIAUTAUD M. D.

Service du Dr. : Haïti Water Supply (H-1) Date : 23/1/80

Patient : Petite CARONAGE

BACTERIOLOGIE

Specimen Soumis : eau

Compte des Colonies Microbiennes : 19.000 /ml d'eau Normale < 100.000/ml d'urine

Coloration de Gram ....

[illegible]

....

Goutte Pendante .... Date Received 1/3/80

.... [illegible] A. Schultz

Recherche du Bacille de Loeffler (coloration d'Albert) .... [illegible]

Recherche de B.K: a) coloration de Ziehl Neelsen .... [illegible]

b) Méthode par la Fluorescence .... [illegible]

ulture BK sur Lowenstein après 8 semaines .... [illegible]

echerche de Tréponema Pallidum par Fluorescence ....

xamen mycologique ....

ulture : organismes isolés : Proteus Hauseri Mirabilis

....

....

ero-Type ....

is Uréthral ....

....

ANTIBIOGRAMME

	R	Sensible 1+	2+	3+	4+
.- Acide Mandélique					
.- Acide Nalidixique					
.- Acide Oxolinique					
.- Ampicillin					
.- Bacitracin					
.- Bactrim - Septrin					
benicillin					
.- Cephalosporin					
loramphénicol					
0.- Clindamycin					
1.- Cloxacillin					
2.- Colistin					
3.- Dicloxacillin					
4.- Erythromycin					
5.- Gentamycin					
Gabromycin					
7.- Hetacillin					

	R	Sensible 1+	2+	3+	4+
18.- Kanamycin					
19.- Lincomycin					
20.- Neomycin					
21.- Nitrofuracin					
22.- Nitrofuradantin					
23.- Nitrofuroxone					
24.- Novobiocin					
25.- Oxacillin					
26.- Penicillin					
27.- Polymixin B					
28.- Sisomycin					
29.- Spiramycin					
30.- Streptomycin					
31.- Sulfonamides					
32.- Tetracycline					
33.- Tobramycin					

Remarques ....

GLADYS ELIE LAUTURE M. T. CHAMP DE MARS 29 – Tél. : 2-3329 – 2-0578 MARLENE SIMON LIAUTAUD M. D.

Service du Dr. : Haïti Water Supply Date : 23/1/80
Patient : Plaine de l'Arbre Puits #2

BACTERIOLOGIE

Specimen Soumis: eau
Compte des Colonies Microbiennes: 12000/ml d'eau Normale < 100.000/ml d'urine
Coloration de Gram: [illegible stamp]

[illegible stamp] 11/3/80
Goutte Pendante: [illegible stamp] A Schultz

Recherche du Bacille de Loeffler (coloration d'Albert): [illegible stamp]
Recherche de B.K: a) coloration de Ziehl Neelsen: [illegible stamp]
b) Méthode par la Fluorescence: [illegible stamp]
Culture BK sur Lowenstein après 8 semaines: [illegible stamp]
Recherche de Tréponema Pallidum par Fluorescence:
Examen mycologique:
Culture : organismes isolés : Pseudomonas Sp

Sero-Type:
Pus Urétral:

ANTIBIOGRAMME

	R	Sensible 1+	2+	3+	4+
.- Acide Mandélique					
.- Acide Nalidixique					
.- Acide Oxolinique					
.- Ampicillin					
.- Bacitracin					
.- Bactrim - Septrin					
.- Carbenicillin					
.- Cephalosporin					
.- Chloramphénicol					
.- Clindamycin					
1.- Cloxacillin					
2.- Colistin					
3.- Dicloxacillin					
4.- Erythromycin					
5.- Gentamycin					
6.- Fabromycin					
7.- Hetacillin					

	R	Sensible 1+	2+	3+	4+
18.- Kanamycin					
19.- Lincomycin					
20.- Neomycin					
21.- Nitrofuracin					
22.- Nitrofuradantin					
23.- Nitrofuroxone					
24.- Novobiocin					
25.- Oxacillin					
26.- Penicillin					
27.- Polymixin B					
28.- Sisomycin					
29.- Spiramycin					
30.- Streptomycin					
31.- Sulfonamides					
32.- Tetracycline					
33.- Tobramycin					

Remarques

H.W.N.S.

HAITI WATER SUPPLY — TEL. 2-2205

ANALYSE D'EAU

		H-1	H-2
1.)	EC AND TDS	Puits Carrénage	Plaine de l'Arbre
2.)	CARBONATE HARDNESS		
3.)	NON-CARBONATE HARDNESS		
4.)	PH	7	7
5.)	NA — SODIUM	640	320
6.)	CA — CALCIUM		
7.)	MG — MAGNESIUM	2.32	2.17
8.)	FE — IRON	26.8	26.8
9.)	MN — MANGANESE		
10.)	CI — CHLORIDE	néant	néant
11.)	F — FLOURIDE		
12.)	NITRATES	néant	néant
13.)	COLI FORM - BACTERIES		

a

Haiti
Water Supply, S.A.

Released for Filing by ________
Project Number ________
Classification ________
Subject Designation ________

June 24, 1980

Harza Engineering Co.
150 S. Wacker Dr.
Chicago, Ill. 60606

Att: Alan H. Schultz

Gentlemen:

Please find enclosed results of water analysis for Hacho 3B, Hacho 4B and AID #2.

No test was run on AID #1 because of the insignificant amount of water found in that well. Drilling in 5 1/2" down to 880' did not bring any positive result to justify any pump test.

Hoping that these facts will help you complete your report we remain,

Yours very truly

Smarck Michel

HAITI WATER SUPPLY, S.A.

Boite Postale 2075 • Port-Au-Prince • Haiti, W.I. • Telephone: 22205 • Cable: HAITI WATER
Telex: ITT 3490317 HAWATER

A. E. Fieltz

Laboratoire d'Investigations Biologiques
GLADYS LAUTURE M. T. — MARLENE LIAUTAUD M. D.
29, CHAMP DE MARS - PHONE : 2-3329 - 2-0578
P. O. BOX 322

HACHO 3B.

H-11

Sheet 1 of 2

Date 18. 6. 83

Haiti Water Supply
Eau HACH 3B

Chimie -.
Calcium 8 mg %.
Phosphore néant
Magnesium 4 mg %.
Chlorure néant

Lauture

579 Imp. Le Natal

Laboratoire d nvesti ons ogiques

GLADYS ELIE LAUTURE M.T. CHAMP DE MARS 29 – Tel. : 2-3329 – 2-0578 MARLENE SIMON LIAUTAUD M.D.

Service du Dr. : .... Date : 20/1/80

Patient : HA CH 3B

BACTERIOLOGIE

Specimen Soumis: eau

Compte des Colonies Microbiennes: 150.000/ml — Normale < 100.000/ml d'urine

Coloration de Gram ....

Goutte Pendante ....

Recherche du Bacille de Loeffler (coloration d'Albert) ....

Recherche de B.K: a) coloration de Ziehl Neelsen ....

b) Méthode par la Fluorescence ....

Culture BK sur Lowenstein après 8 semaines ....

Recherche de Tréponema Pallidum par Fluorescence ....

Examen mycologique ....

Culture : organismes isolés : Pseudomonas Aeruginosa

Sero-Type ....

Frottis Uréthral ....

ANTIBIOGRAMME

	R	Sensible 1+	2+	3+	4+
1.- Acide Mandélique					
2.- Acide Nalidixique					
3.- Acide Oxolinique					
4.- Ampicillin					
5.- Bacitracin					
6.- Bactrim - Septrin					
7.- Carbenicillin					
8.- Cephalosporin					
9.- Chloramphénicol					
10.- Clindamycin					
11.- Cloxacillin					
12.- Colistin					
13.- Dicloxacillin					
14.- Erythromycin					
15.- Gentamycin					
16.- Gabromycin					
17.- Hetacillin					

	R	Sensible 1+	2+	3+	4+
18.- Kanamycin					
19.- Lincomycin					
20.- Neomycin					
21.- Nitrofuracin					
22.- Nitrofuradantin					
23.- Nitrofuroxone					
24.- Novobiocin					
25.- Oxacillin					
26.- Penicillin					
27.- Polymixin B					

28.- Sisomycin
29.- Spiramycin
30.- Streptomycin
31.- Sulfonamides
32.- Tetracycline
33.- Tobramycin

[illegible] for Filing by A. A. Tutt
Project Number

Laboratoire d'Investigations Biologiques

GLADYS LAUTURE M. T. — MARLENE LIAUTAUD M. D.
29, CHAMP DE MARS - PHONE : 2-3329 - 2-0578
P. O. BOX 322

HACHO 4B

H-12

Sheet 1 of 2

Date 18. 6. 80

Haiti Water Supply
Eau HACH 4B

Chimie -
Calcium 10 mgs %.
Phosphore néant
Magnesium 1.6 mgs %.
Chlorures présent

Glauture

Laboratoire d'Investigations Biologiques

LADYS ELIE LAUTURE M. T. CHAMP DE MARS 29 – Tel. : 2-3329 – 2-0578 MARLENE SIMON LIAUTAUD M. D.

ervice du Dr. : .... Date : 20/6/80

atient : HACH 4B

BACTERIOLOGIE

pecimen Soumis .... Lau

Compte des Colonies Microbiennes ....100.000/ml.......Normale < 100.000/ml d'urine

Coloration de Gram ....

....

....

Goutte Pendante ....

....

Recherche du Bacille de Loeffler (coloration d'Albert) ....

Recherche de B.K: a) coloration de Ziehl Neelsen ....

b) Méthode par la Fluorescence ....

Culture BK sur Lowenstein après 8 semaines ....

Recherche de Tréponema Pallidum par Fluorescence ....

Examen mycologique ....

Culture : organismes isolés : Pseudomonas Aeruginosa

....

....

Sero-Type ....

Frottis Urethral ....

....

ANTIBIOGRAMME

	R	Sensible 1+	2+	3+	4+
1.- Acide Mandélique					
2.- Acide Nalidixique					
3.- Acide Oxolinique					
4.- Ampicillin					
5.- Bacitracin					
6.- Bactrim - Septrin					
7.- Carbenicillin					
8.- Cephalosporin					
9.- Chloramphénicol					
10.- Clindamycin					
11.- Cloxacillin					
12.- Colistin					
13.- Dicloxacillin					
14.- Erythromycin					
15.- Gentamycin					
16.- Gabromycin					
17.- Hetacillin					

	R	Sensible 1+	2+	3+	4+
18.- Kanamycin					
19.- Lincomycin					
20.- Neomycin					
21.- Nitrofuracin					
22.- Nitrofuradantin					
23.- Nitrofuroxone					
24.- Novobiocin					
25.- Oxacillin					
26.- Penicillin					
27.- Polymixin B					
28.- Sisomycin					
29.- Spiramycin					
30.- Streptomycin					
31.- Sulfonamides					
32.- Tetracycline					
33.- Tobramycin					

E. Schultz

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Project Number
Classification
Subject Designation

Laboratoire d'Investigations Biologiques

GLADYS LAUTURE M.D. — MARLENE LIAUTAUD M.D.
29, CHAMP DE MARS - PHONE : 2-3329 - 2-0578
P. O. BOX 322

AID #2

H-14

Sheet 1 of 2

Date 18.6.80

Haiti Water Supply
Ecan Aid

Chimie.

Calcium	13.3 mgs %
Phosphore	1.1 mgs %
Magnésium	4.8 mgs %
Chlorures	192 mEq/l

Glauture

579 Imp. Le Natal

- L oratoire d nvestigations l ogiques

GLADYS ELIE LAUTURE M. T. CHAMP DE MARS 29 – Tel. : 2-3329 – 2-0578 MARLENE SIMON LIAUTAUD M. D.

Service du Dr. : .... Date : 22/6/80

Patient : A'O # 2

BACTERIOLOGIE

H-14

Specimen Soumis .... Eau

Compte des Colonies Microbiennes .... 450.000 /ml .... Normale < 100.000/ml d'urine

Coloration de Gram ....

....

....

Goutte Pendante ....

....

Recherche du Bacille de Loeffler (coloration d'Albert) ....

Recherche de B.K: a) coloration de Ziehl Neelsen ....

b) Méthode par la Fluorescence ....

Culture BK sur Lowenstein après 8 semaines ....

Recherche de Tréponema Pallidum par Fluorescence ....

Examen mycologique ....

Culture : organismes isolés : .... Pseudomonas sp.

....

....

Sero-Type ....

Frottis Uréthral ....

....

ANTIBIOGRAMME

	R	Sensible 1+	2+	3+	4+
1.- Acide Mandélique					
2.- Acide Nalidixique					
3.- Acide Oxolinique					
4.- Ampicillin					
5.- Bacitracin					
6.- Bactrim - Septrin					
7.- Carbenicillin					
8.- Cephalosporin					
9.- Chloramphénicol					
10.- Clindamycin					
11.- Cloxacillin					
12.- Colistin					
13.- Dicloxacillin					
14.- Erythromycin					
15.- Gentamycin					
16.- Gabromycin					
17.- Hetacillin					

	R	Sensible 1+	2+	3+	4+
18.- Kanamycin					
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Rema