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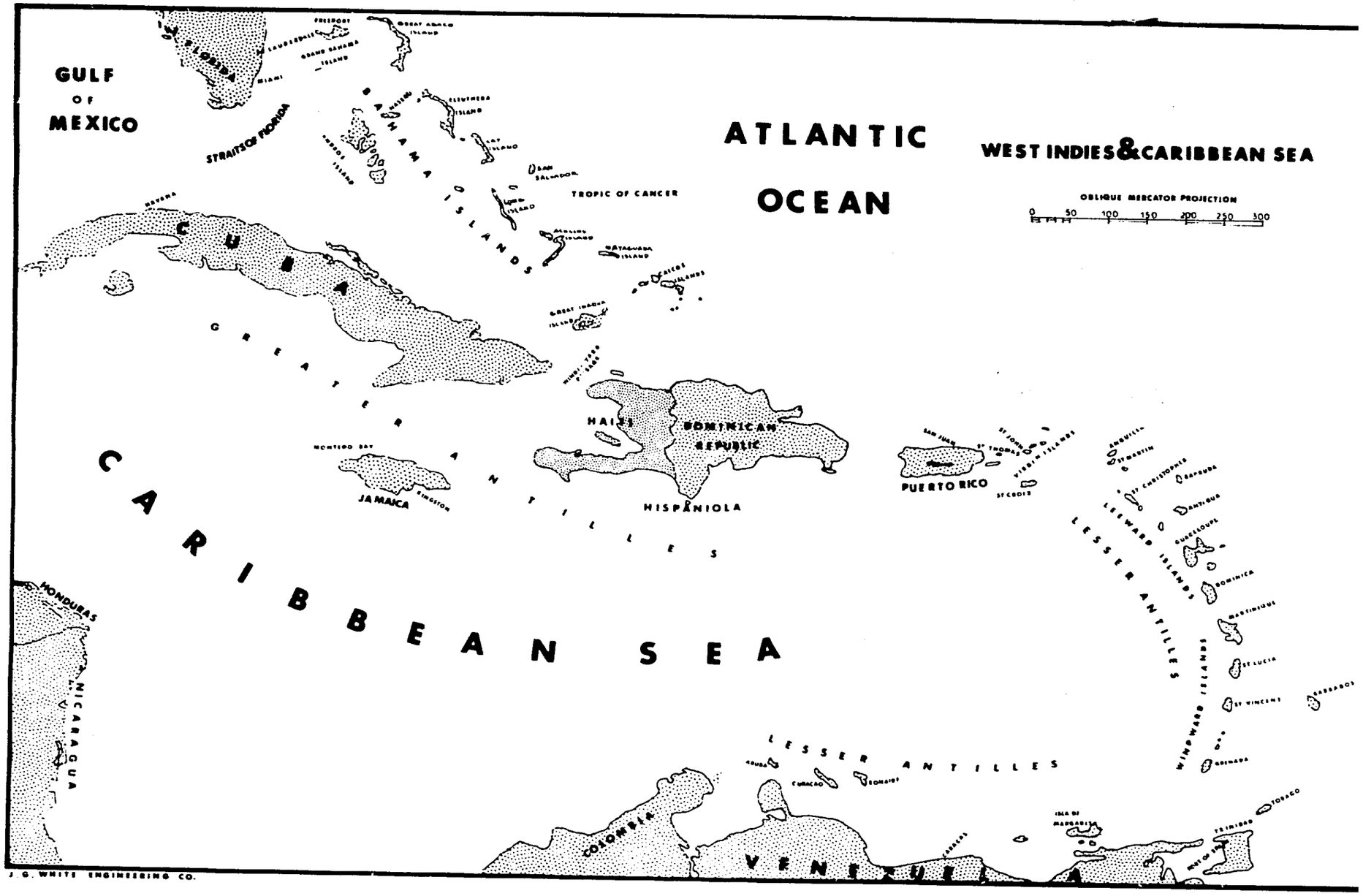
"TASK C"

Pre-feasibility Studies of Selected
Community Irrigation Systems

VOLUME I

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK



J. G. WHITE ENGINEERING CO.

INTRODUCTION

On October 22, 1975, the Agency for International Development, Washington, D.C. entered into a contract with The J.G. White Engineering Corporation for consulting services in connection with three projects in Haiti.

"TASK A"

Dubreuil Irrigation System Rehabilitation:
Implementation of an engineering and design report prepared by E.C.I. and the formation of an operating Dubreuil Irrigation District.

"TASK B"

1.- Feasibility Report ; Jean Rabel irrigation system. A preliminary engineering study and a plan for rehabilitation of the Jean Rabel irrigation system.

2.- Rehabilitation of the system, if feasible.

"TASK C"

Pre-feasibility report indentifying at least 6000 hectares of irrigable land with systems requiring hehabilitation. The areas to be screened from a list of priority projects provided to the contractor from USAID and the Government of Haiti.

This report concerns only the "TASK C" portion of the contract and includes twenty four separate possible projects investigated by the team. Each project has been given a priority rating from "A" to "D".

These ratings were established after field investigation and were based on, but not limited to, the following criteria:

1.- Availability of sufficient irrigation water.

2.- Soils that would support intensive agriculture under irrigation.

3.- Motivation and desire of the local inhabitants to have and maintain an irrigation system.

4.- Land ownership patterns in the project area permitting an irrigation system to benefit the largest possible number of individual farmers.

Upon investigation and rating, 13 projects totaling 4,337 hectares under full or partial irrigation were given an "A" priority. Four projects totaling 1,171 irrigated hectares received a "B" priority. Three projects with a total of 802 hectares, a "C" priority ; and four projects totaling 1,675 hectares a "D" priority.

Of the 13 systems receiving an "A" priority rating, improvements to the irrigation systems can reasonably be expected to double the number of hectares irrigable, bringing the total of "A" priority projects to approximately 8,600 hectares.

ACKNOWLEDGEMENTS

Grateful acknowledgements for assitance and cooperation rendered in preparation of this report are extended to:

Mombers of the Ministry of Agriculture, Natural Resources, and Rural Development (DARNDR) ;

Personnel of the Agency for International Development (USAID) Mission to Haiti ;

Other Officials of the Government of the Republic of Haiti and International Agencies.

The J.G. White Engineering Corporation team conducting the field work included:

W.D. Cameron,	Project Manager
Henry Gembala,	Irrigation Engineer - Erosion Control
Dr. Russell Odell,	Agronomist and Soils Scientist
Dr. R.J. Mutti,	Agricultural Economist
Dr. Roger Peebles,	Geo-hydrologist
Clarence Burgett,	Agricultural Extensionist
Thomas Ryan,	Topographer
Joseph Argo,	Cartographer

The expatriate members were ably assisted by a group of dedicated Haitians ; notably, Mme Marie Madeleine Price-Mars and Mr. Raymond Etienne.

Area	Total Ha
1 Los Angeles	
Moreno-Infinito	900
Chandler	300
St Lawrence de Sud	180
Rabel-Bellevue	205
Los Angeles	900
Quesnel	2700
Dominicaine	250
Nelson	165
Robert	120
	5720
2 Jean Rabel	
Jean Rabel	400 (?)
Mole St Nicolas	15
	415
3 Jacmel	
Marigot-Riviere	1400
Paderne	230 (?)
	1630
4th Port	
Dauphin-Mancenille	400
	8235 Ha

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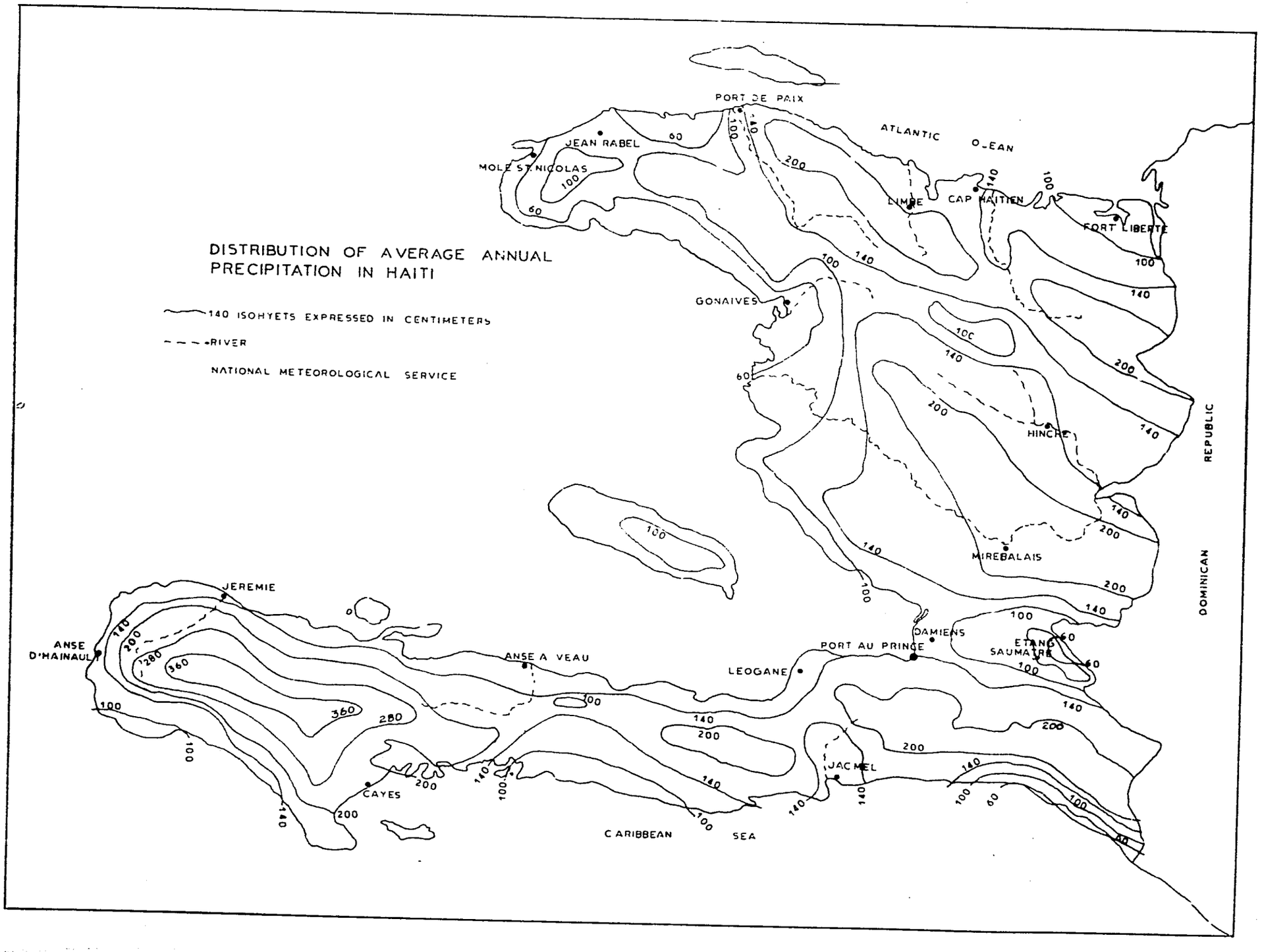
DISTRIBUTION OF AVERAGE ANNUAL PRECIPITATION IN HAITI
140 ISOHYETS EXPRESSED IN CENTIMETERS
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DOMINICAN
JEREMIE
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LEOGANE
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CAYES
JACMEL
CARIBBEAN SEA

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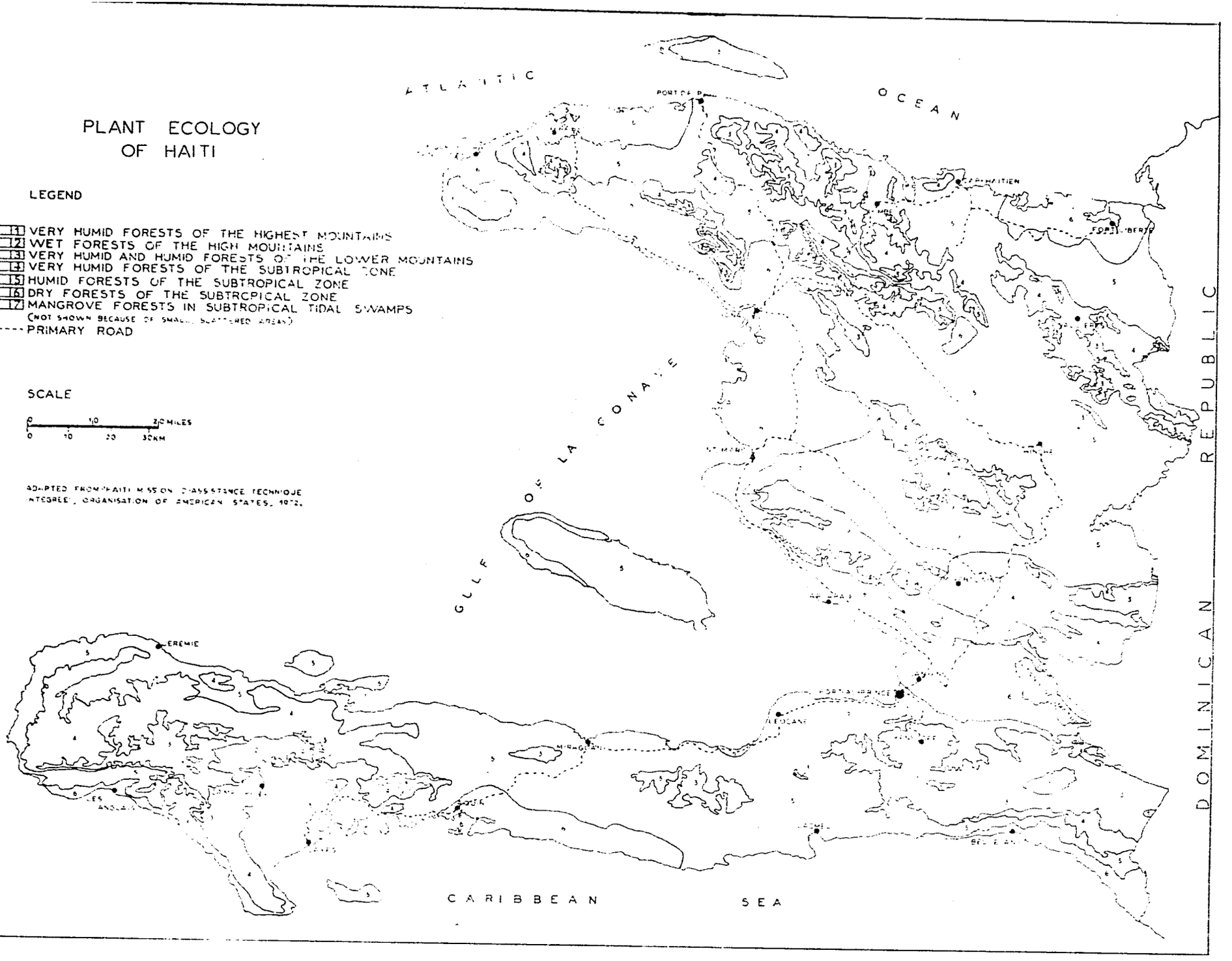
7. MANGROVE FORESTS IN SUBTROPICAL TIDAL SWAMPS (NOT SHOWN BECAUSE OF SMALL SCATTERED AREAS)

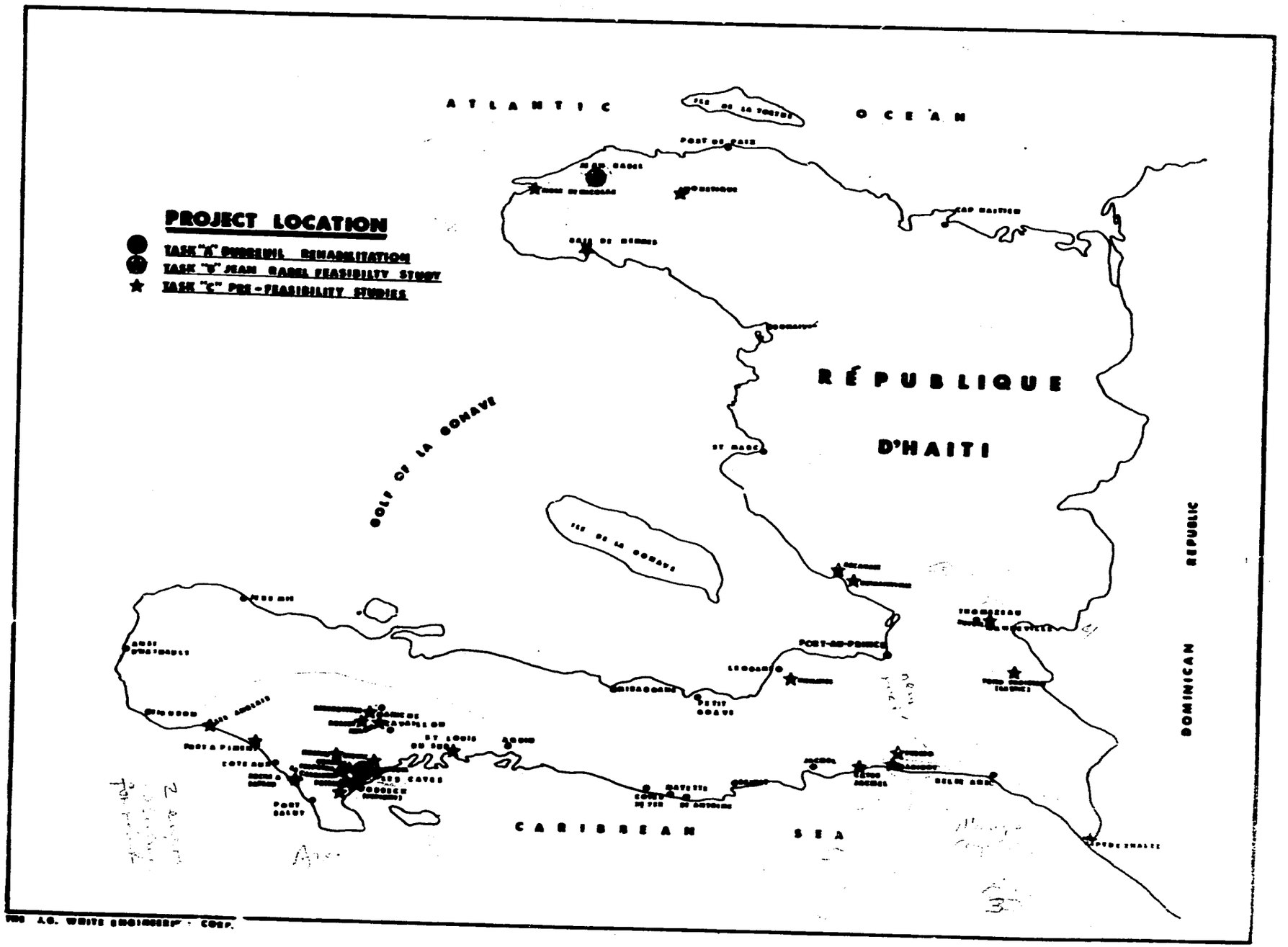
----- PRIMARY ROAD

SCALE

0 10 20 MILES
0 10 20 30KM

ADAPTED FROM HAITI MISSION DASSISTANCE TECHNIQUE INTEGREE, ORGANISATION OF AMERICAN STATES, 1972.



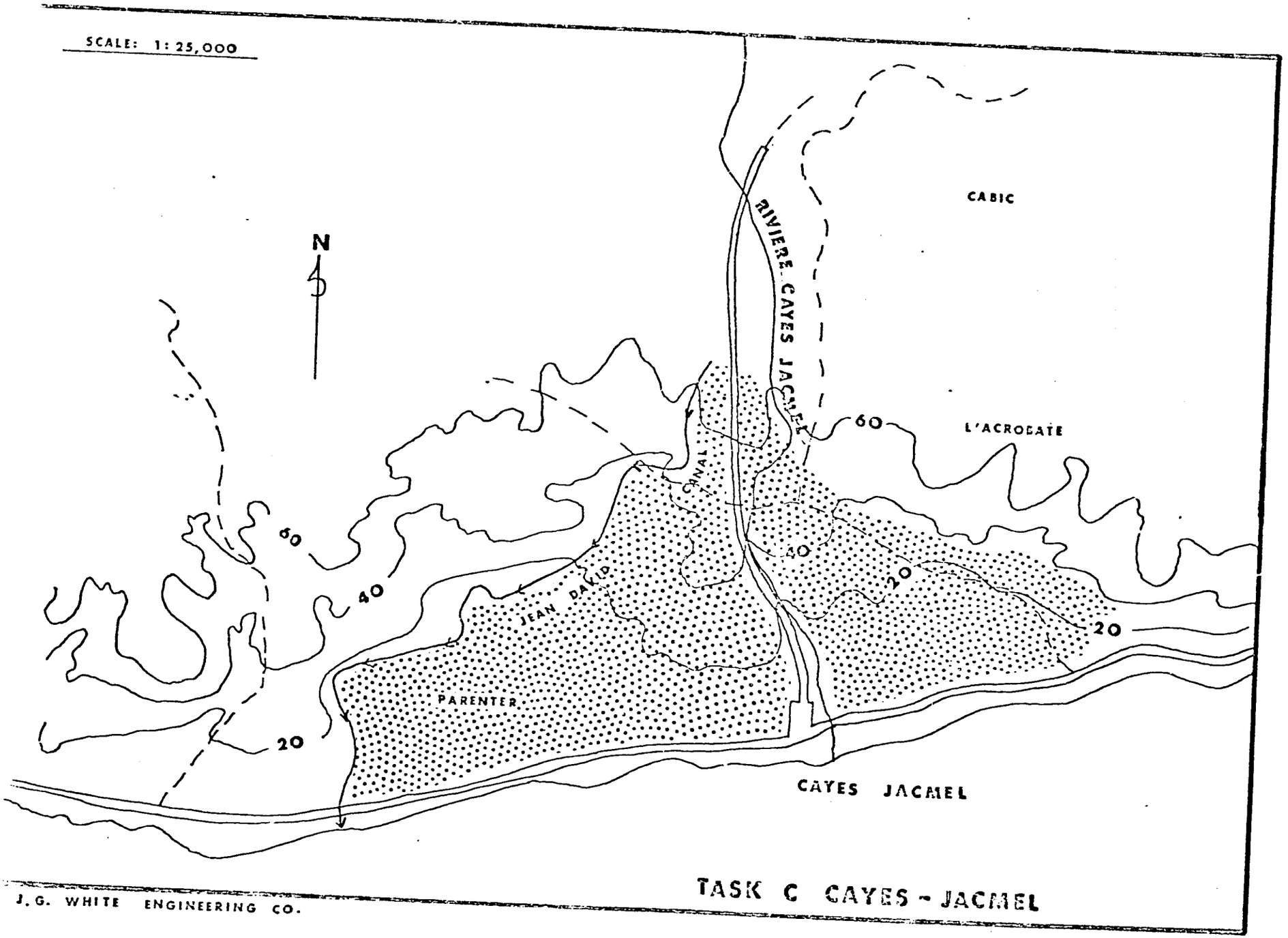


THE A.G. WHITE ENGINEERS CORP.

"TASK C"

CAYES - JACMEL

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK



TASK C CAYES - JACMEL

J.G. WHITE ENGINEERING CO.

"TASK" C REPORT - CAYES-JACMEL

IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION
HAITI Irrigation 4792

I INTRODUCTION

Cayes-Jacmel is a Commune located in the Arrondissement de Jacmel, some 15 kilometer to the east on the coastal road. The estimated urban population of the area is 2.000 while the rural sector accounts for some 24.000.

II SOILS, GEOLOGY AND CLIMATE

The plain of Cayes-Jacmel consists of alluvial material deposited by the Rivière Cayes-Jacmel and colluvial material derived from nearby hillslopes. The river drains a small watershed developed in Cretaceous basalts and Eocene limestones. The plain slopes steeply seaward (the gradient is about 4%) and there is some local variation in topography. Boulders and cobbles are found everywhere at the surface. It is likely that the depth of alluvial material is shallow throughout the plain.

Soils are recently developed from the calcareous alluvial fill. The predominant soil type is the brown silty to sandy loam typical of this area of the south coast.

Soil profiles have not developed. The productivity of soils at Cayes-Jacmel is limited for several reasons. These are low fertility, a high proportion of cobbles and boulders and shallow soil depths. The local topographic relief is also a drawback of the area as it tends to impede effective distribution of irrigation water.

The Rivière Cayes-Jacmel drains an area of 23 km^2. A small (250 kw) hydroelectric plant is located in the upper watershed. It is reported locally that the river discharge shows little variation. Streamflow data for the period 1928-1930 give a mean daily discharge of .36 m^3/sec. At the time of the visit to Cayes-Jacmel, May, discharge was estimated to be close to this figure.

At the irrigation system intake site, the river has cut a gully about 2 meters deep and 6 meters wide. The river is almost as wide as the gully. The wide, boulder strewn floodplain typical of many rivers along this portion of the coast is absent at Cayes-Jacmel. The reason is not clear.

The shallow alluvial fill contains only small quantities of ground water. Small domestic supplies could probably be developed.

Mean annual rainfall data do not exist at Cayes-Jacmel, but 1400 mm. seems to be a reasonable estimate. High rainfall months for the area are May and October ; low rainfall occurs in December and January. Rainfall in the upper watershed probably approaches 1600 mm.

III SOCIAL ATTITUDES

During the field investigations contacts were established with Francis Filey, Chef de Section, Cayes-Jacmel, and Agronome Cadet as well as Agronome Rick Noilles. In addition, the Chef de Service d'Irrigation in charge of the irrigation systems situated on the Jacmel and adjacent plains added considerably to the understanding of the attitudes of the people of the area. Extensionist Francis Filey did not appear too well versed in the feelings of the people towards a community effort to improved the current irrigation system serving the area.

There are two agricultural groups in the area forming the basis for a Conseil Communautaire ; however, no group has the responsibility specifically for irrigation. Observations of their activities in the area left the impression that little cohesion exists among farmers and farm groups in the valley and that group activities are few, sporadic and lack central direction and control. There is however, an active credit cooperative and IDAI is active.

The general attitude of the people contacted concerning possible improvement of the existing irrigation system was one of lack of enthusiasm and failure to associate their personal needs with such improvements. One woman expressed herself simply by saying that she did not need irrigation because her crops received sufficient rainfall. Two others, when questioned, changed the subject and asked why such efforts were not being directed towards the Marigot system.

The conclusion reached through observations and contacts in the Cayes-Jacmel area is that the people of the area are not yet ready to accept the responsibility, nor do they feel the need at this time for massive improvements to their present irrigation system.

IV MARKETING PRACTICES AND LAND TENURE

Distribution of Irrigated Land Ownership

Computations from lists of water users assessed taxes by the Office of Contributions for 1975-1976 disclosed the following:

Size of Tract in Hectares	Percent of Tracts	Percent of Area
.32 or less	91.2	79.6
.33 to .99	6.8	13.6
1.00 to 2.99	1.9	6.8

There were 103 tracts and only 37.78 hectares on which the water tax was assessed. Eighty percent of the tracts were reported as only .32 of a hectare ; the next most common size was .64. The uniformity in size of tracts leads one to question whether these were the actual sizes. The tracts size is much lower and more the same decimal than in all other areas except adjacent Marigot-Peredo. Further investigation would be advisable if a feasibility study were to be made for this area.

Four persons owned more than one tract ; together these four owned 14 tracts, and 89 of the 93 owners held only one tract. One owner holding seven tracts accounted for 3.21 hectares, or 8½ percent of the area on which an irrigation tax was paid. The five largest owners owned almost 20 percent of the land assessed.

Land Use

Plantain, corn and beans, the latter two most often interplanted, and sweet potatoes were the most common field crops observed on May 3. Mango and palm trees were distributed widely throughout the area. On the rockiest and also the droughtiest soil manioc was often planted.

Much of the area along the canals was either a cobbly or a gravelly loam, with small pockets or depressed areas nearby in a dark brown or black loam to silt loam. The land topography was uneven, making uniform irrigation difficult. Shade covered most of the area and definitely restricted the growth of non-tree plants.

Market Outlets and Transportation

The community has a small market, and it is only 15 kilometers to a regional market at Jacmel. Prices are gathered on some commodities by IDAI at Cayes-Jacmel, and both IDAI and IPHCADE at Jacmel.

The road is poorly maintained, but camions serve the area on a regular basis. Considerable amounts of coffee move to Jacmel, and some limes are sold to a new processing plant on the east edge of Jacmel.

V EXISTING IRRIGATION SYSTEM

The original system at Cayes-Jacmel was built by J.G. White Engineering Corporation in 1938. Restoration work was done on the system in 1972. Only four years ago.

There are two diversions or take-outs from the River Cayes-Jacmel. Several small springs supply additional water to some of the canals which make up this system.

This irrigation system has two main canals. One main canal, the Gaillard, that goes to the left or easterly direction to an area of approximately 200 hectares. The other main canal goes to the right or in a wsterly direction which supplies water to an area of approximately 300 hectares. Data received from SNEM office shows that about 160 hectares are watered at the present time.

The structural part of the system appears to be in a reasonably good condition but the earth canals lack normal or regular maintenance which the local farmers should be able to do themselves. Irrigation efficiencies appear to be very low which results in yields much lower than should be expected from irrigated crops. This indicates the people do not have the desire and lack the interest to help themselves.

Flows of the Cayes-Jacmel River are estimated to be approximately 350 to 400 liters per second. We were told that during extended dry periods the amount of water in the river gets very low and the small springs dry up.

VI RECOMMENDATIONS AND CONCLUSIONS

Cayes-Jacmel as an irrigation district fully meets only one of the criteria established for the rating system used in these reports. There is sufficient water to irrigate the area. The soils however are poor. Social attitudes toward a cooperative effort to rehabilitate and maintain an irrigation system are negative.

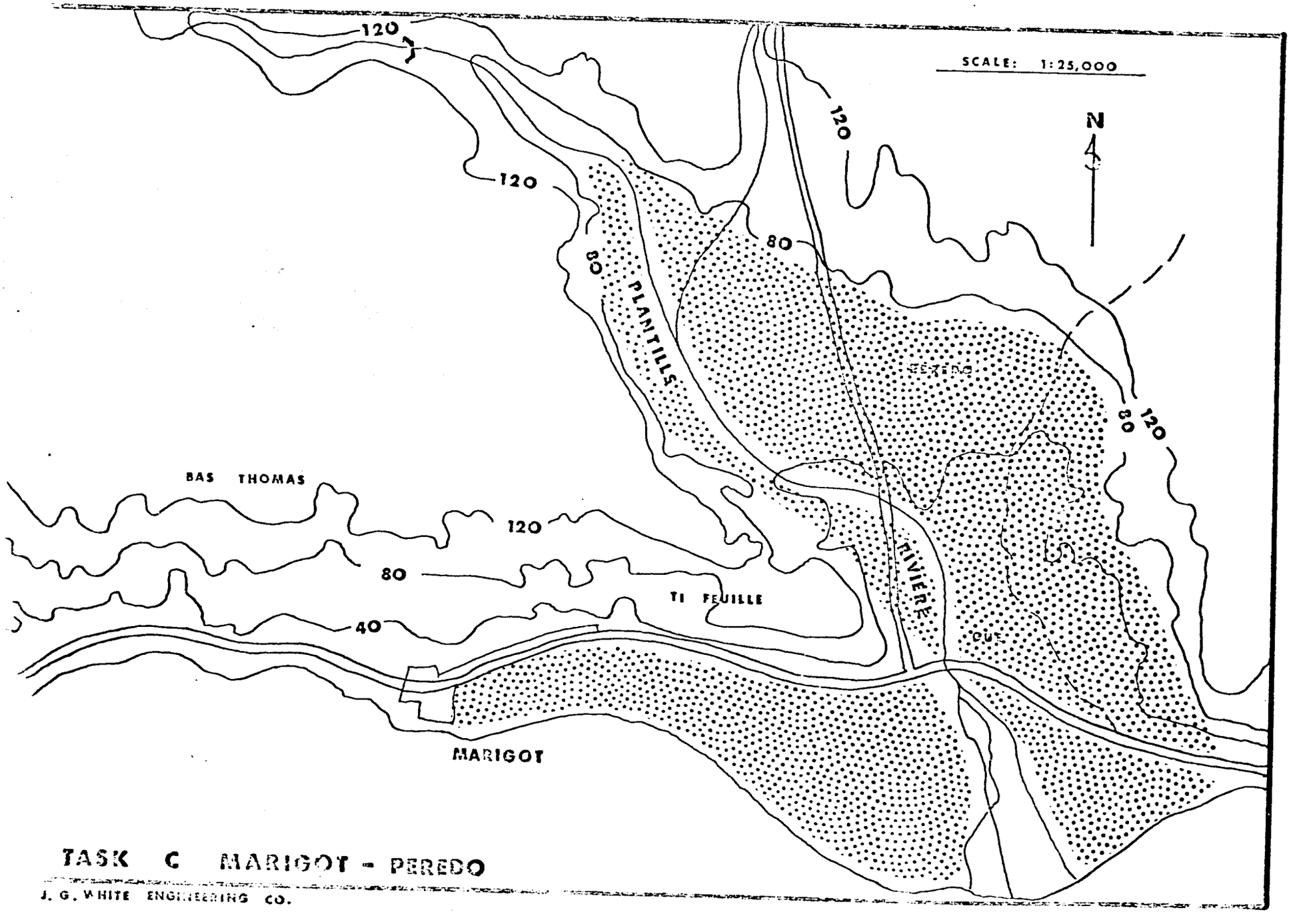
This plain does lend itself to increased production of tree fruits such as limes for the processing plant, improved varieties of mangoes and perhaps increased production of coconuts for export to Port-au-Prince.

Cayes-Jacmel received a "C" priority rating by the team.

"TASK C"

MARIGOT-PEREDO

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK



TASK C MARIGOT - PEREDO

J. G. WHITE ENGINEERING CO.

"TASK C" REPORT - MARIGOT-PEREDO IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE INGINEERING CORPORATION
HAITI Irrigation 4792

I INTRODUCTION

The Commune de Marigot is located in the Arrondissement de Jacmel on the coastal road 25 kilometers east of Jacmel. It has an urban population of approximately 2,000 persons and its 5 rural sections include some 35,000 inhabitants.

The Marigot-Peredo systems while serving 2 population centers geographically situated 2 miles apart, are considered as a single system.

In 1940, the J.G. White Engineering Corporation acting as agent of the Government of Haiti completed the design and construction of an irrigation system covering the areas of Marigot-Peredo.

Hurricane "Inez" in September 1966 distroyed by flooding, a major portion of the diversion structure, ie, the syphon crossing the river. This particular destruction was and is beyond the ability of the local inhabitants to repair without outside help. The entire system has also deteriorated because of lack of normal maintenance.

The following photographs give a general idea of portions of the original system. Also included are two "before and after" photographs for contrast.

II SOILS, GEOLOGY AND CLIMATE

Marigot is located on a relatively large alluvial plain at the mouth of the Rivière des Plantils (also called the Rivière Fesle). The river drains a portion of the south flank of the Massif de la Selle. The upper watershed is cut in massive Eocene limestones. These grade to older Eocene marls, sandstones and volcanics in the lower watershed. The plain is recent alluvial fill consisting primarily of calcareous sediments. Surface material in the upper plain contains some limestones boulders and cobbles. The alluvial fill covers an area of about 6 km^2 and it probably reaches depths of 30 meters near the mouth of the river.

Soils are recently derived from the calcareous alluvial materials. They are brown silty to sandy loams and, in the lower part of the plain, the soils are virtually free of rocks. Soil profiles are poorly developed. Productivity is high and the soils are both well drained and permeable. In some places the soil depth may be shallow.

The Rivière des Plantils drains an area of about 130 km^2. In the upper watershed, the river has a major tributary, the Rivière Blanche. At the point where the river reaches the head of the alluvial plain it is joined by a second tributary, the Rivière Massacre. Discharge measurements were made in the river just east of Marigot during the period 1928-1930. The mean daily discharge during this period was 2.4 m^3/sec. At the time of our visit to the river, May, discharge was estimated to be close to this figure. It is reported locally that the discharge remains fairly constant except in times of heavy rainfall when large and destructive floods occur. At the site of the irrigation system intake, it was reported that during Hurricane Inez, 1966, the river occupied the entire flood plain to depths exceeding a meter. The floodplain at this point is roughly 250 meters wide. With an average flow velocity of

2 m /sec, discharge would be 500 m^3/sec., (17,000 ft^3/sec.). This peak discharge estimate is conservative. Just east of Marigot, structures have been placed along the west bank of the river to keep flood waters from the town.

Abundant quantities of ground water are probably present in the alluvial fill. If the slope of the water table follows closely the rather steep seaward slope of the plain, a large quantity of ground water may be moving seaward to be discharged in submarine springs.

Mean annual rainfall at Marigot is 1410 mm. High rainfall months are May and October ; low months are December and January. In the upper watershed rainfall increases to about 2,000 mm. Potential evapotranspiration is estimated to be about 1,500 mm.

III SOCIAL ATTITUDES

Official reports for Marigot-Peredo show that the combined system is currently irrigating a total of 18.7 hectares divided into 48 parcels and distributed among 37 land holders. Observations do not bear this out, since there appears to be many times this amount of land and families currently utilizing the system. Further study in depth will be required to accurately determine exact members of families and hectares which would benefit from restoration of the total system.

Olance Wilson, Director de la Ferme Ecole at Marigot appears to be an active and interested leader in the area. There are two Conseils Communautaires operating in the area. At Marigot, the Conseil, 100 members, has been in existence for 4 years. Its president Laurent Logan Rosseau, observed that there is a great deal of enthusiasm and support for any action which would result in rehabilitation of the irrigation system at Marigot. The Conseil at Perido, 50 members, is headed up by its president Laderne Alexandre. Neither of these Conseils appears to be overly active. This is understandable since the nature of the massive damage to the system by Hurricane Inez is

such that repairs present an insurmountable problem for the people at the local level. There is also a local IDAI operating in the area and an Office of Contributions. An active protestant Pastor is also operating at Perido-Marigot.

Crops currently planted in the area consist of corn, planted in January-February; manioc, planted most any time ; peanuts, planted January-February ; and sweet potatoes. Some figue banana and plantain are harvested from the area but yields and quality are poor. May-September-October are the wet months in this area. The people of the area point out that if the irrigation system were rehabilitated, they could concentrate on production of figue banana and corn for the export market. The area is ideally suited to these crops but, of course, the present state of disrepair of the irrigation system coupled with the poor farm to market road conditions preclude production of any crop on a profitable scale.

Observations and contacts through out the Marigot-Peredo area indicate that favorable attitude towards participation in rehabilitation and organization for management of the present system exist. Acceptance of the fact that payment must be made for use of the water appears to present no problem. However, it is the general feeling of leadership representing the area that considerable assistance in farm and system management must accompany any rehabilitation effort.

IV MARKETING PRACTICES AND LAND TENURE

Distribution of Irrigated Land Ownership

Computations from lists of owners assessed water irrigation taxes for 1975-1976 disclosed the following:

Size of Tract in Hectares	Percent of Tracts	Percent of Area
.32 or less	79.1	58.5
.33 to .99	14.0	20.6
1.00 to 2.99	7.0	20.8

The three canals in this system had water tax assessments on a total of only 18.59 hectares in 43 tracts. Only three sizes of tracts were identified: .32, .64, and 1.29 hectares ; one-fourth, one-half and one carreau. More investigation is needed to verify or correct these figures.

There were 37 owners of the 18.59 hectares. Three owners reported 1.29 hectares, and another one .96 ; together these four owners held 26 percent of the area on which taxes were assessed. No one owner held as much as 7 percent of the total.

Land Use

Most of the upper part of the extensive canal system traverses rocky land on which plantain and manioc are the predominant crops. Mais and sweet potatoes were the most important crops on the loam to gravelly loam soils on the lower parts of the irrigated area ; beans had been harvested earlier from the same area. Several vegetables offered for sale in the Peredo market were apparently grown in the nearby hills.

Market Outlets and Transportation

There are local markets in both Marigot and Peredo. The regional market at Jacmel is only 24 kilometers from Marigot, and some vegetables grown in the Peredo area are reported as being head-loaded or moved by donkeys to Furcy, less than 15 kilometers, or on to buyers in Kenscoff.

Roads are poorly maintained. A road linking Kenscoff to Marigot is in the planning stage, but is reported to be opposed by merchants in Jacmel. Camions move frequently from Marigot to Jacmel.

If the contemplated road to Kenscoff is constructed, this area has considerable potential as an intensive fluid milk production area for the greater Port-au-Prince market, and as a source of supply for the most perishable fruits and vegetables.

V EXISTING IRRIGATION SYSTEM

Water for the Marigot-Peredo Irrigation System is diverted from the river Plantils (Fesle) by means of two diversion structures, both on the right hand bank of the river. The first, or highest, take-out is located at an elevation of approximately 95 meters. The second and lower take-out is located down-stream at a point indentified as the Belle Roche source and is of an elevation of approximately 40 meters. A temporary type diversion is presently in use at this location. The original concrete structure was distroyed by a series of floods over the past 10 years, aided by lack of maintenance.

The Marigot-Peredo system was installed with a sizable investment of work and money. Although considerable damage resulted from Hurricane Inez in 1966, most of the structures and parts of the distribution remain in reasonably good condition.

Three items in particular were severely damaged by high flood waters resulting from Inez. The first is the upper diversion structure on the Plantils river, which was almost completely distroyed, with headgate and sluiceway damaged. It was at this point that water was diverted from the river on the right bank, entered a 36 inch concrete pipe syphon which conveyed the water under the river to the left

bank, a distance of 365 meters, where it entered a covered masonry canal. The second item distroyed was approximately 60 meters of the syphon at the new and now current river crossing. The high flood waters swept away the connection between the syphon and the canal, leaving the exposed end of the covered masonry high above water-level on the left bank.

The third item is the deterioration, because of lack of maintenance, of the 5,000 meter section known as Fesle canal (Citronnier System). The major portion is in earth canal system, with the masonry sections remaining in reasonably good condition.

VI RECOMMENDATIONS

Serious consideration should be given to an early feasibility study of the economic advantages of rehabilitating the Marigot-Peredo Irrigation System.

Much of the system is still in good usable condition and therefore the rehabilitation costs compared to the investment in the system will be relatively low.

Field investigations indicate that the irrigated area can be increased by at least 500 hectares of good irrigable soils. The flow of water in the river Plantils is estimated to be in the range of 2 to 4 cubic meters/sec., depending on the season of the year. Water supply is therefore more than adequate to meet irrigation needs.

Some important engineering items to be considered in a feasibility study are :

1.- Replacement and repair of the two diversion structures ;
2.- Replace and provide the best protection possible for the syphon under the river to supply water to Canal Fesle ;
3.- Re-excavate and reshape the earth canals ;
4.- Incorporate structures in the system where needed such as distribution boxes, turn-outs and road crossing.

VI CONCLUSIONS

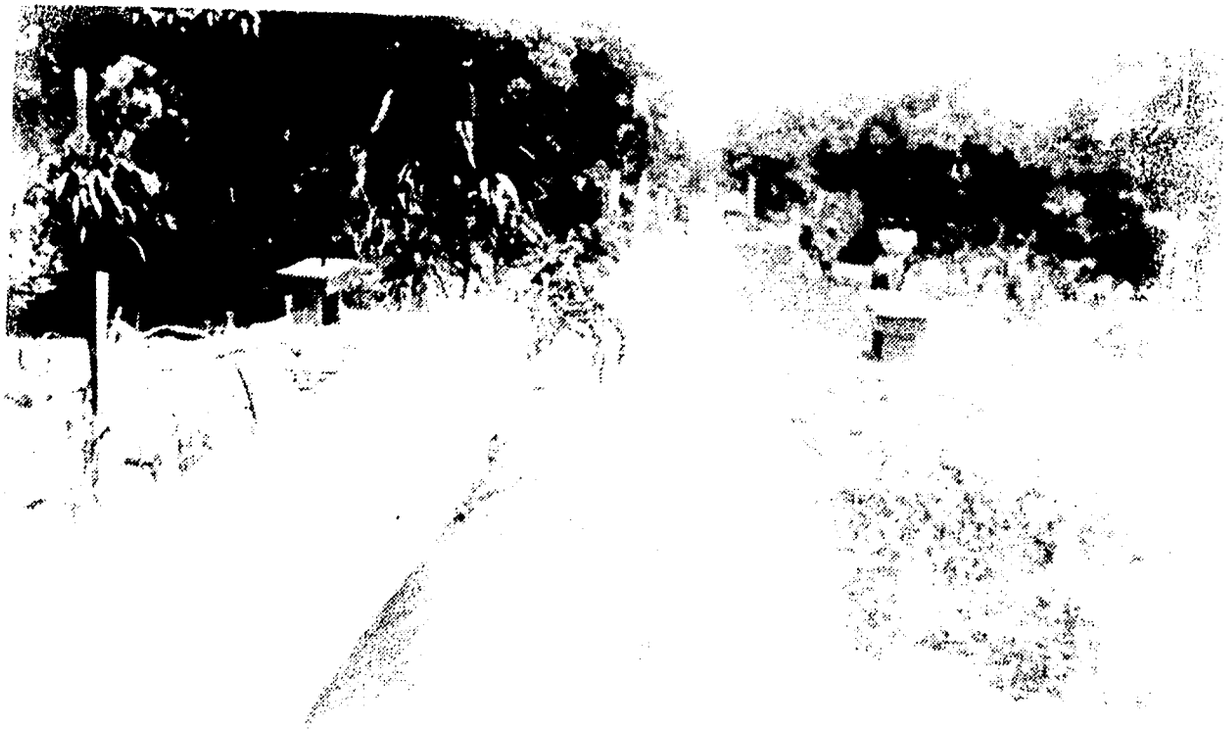
Marigot-Peredo Irrigation System meets the established rating criteria.

a) Sufficient water for irrigation is available.
b) The area has good soils suitable for estensive agriculture under irrigation.
c) The local farmers are motivated and ready to be helped to assume the responsibility for operating and maintaining their canal system.
d) Access to two prime markets, Jacmel and Port-au-Prince, are or soon will be comparatively easy.
e) Land owner-ship is in small parcels, so that a functioning system would benefit a large number of farmers.

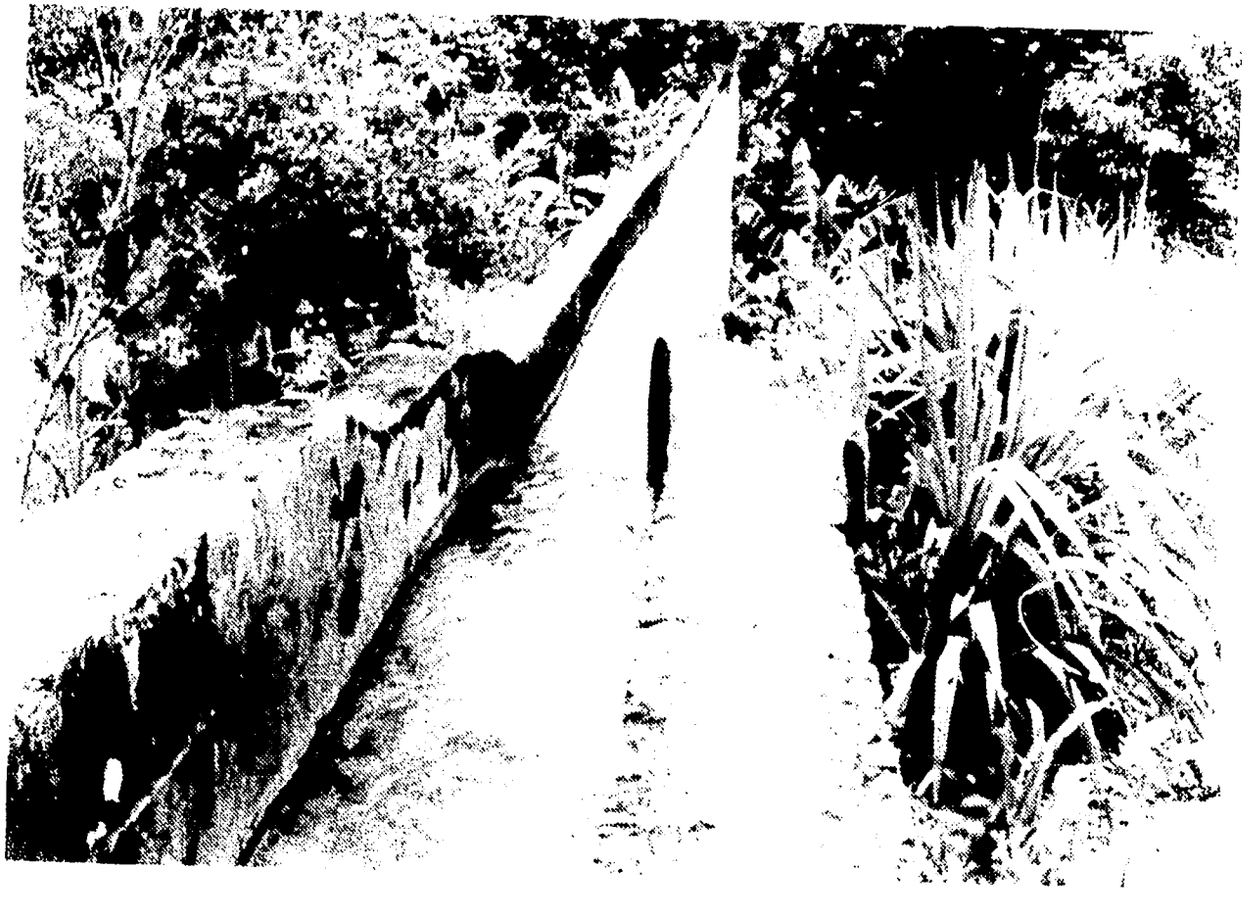
The J.G. White Engineering Corporation team places the Marigot-Peredo system in an "A" priority.

The J.G. White Engineering Corporation, Agent du Gouvernement Haitien
Proj. Irrigation Marigot, Proj. No.72, Film No.1 - 1/10/4
Title: Completed section Junction of masonry and Earth Canal at Bolle

MARIGOT MAY 1976



The J. C. White Engineering Corporation, Agent du Gouvernement Haitien.
Proj. Irrigation, Marigot, Proj. No. 72, Film No. 12 - 8/15/40
Title: Completed section of masonry canal, showing take-off at Sta. 1+200, Marigot System of Fesles.

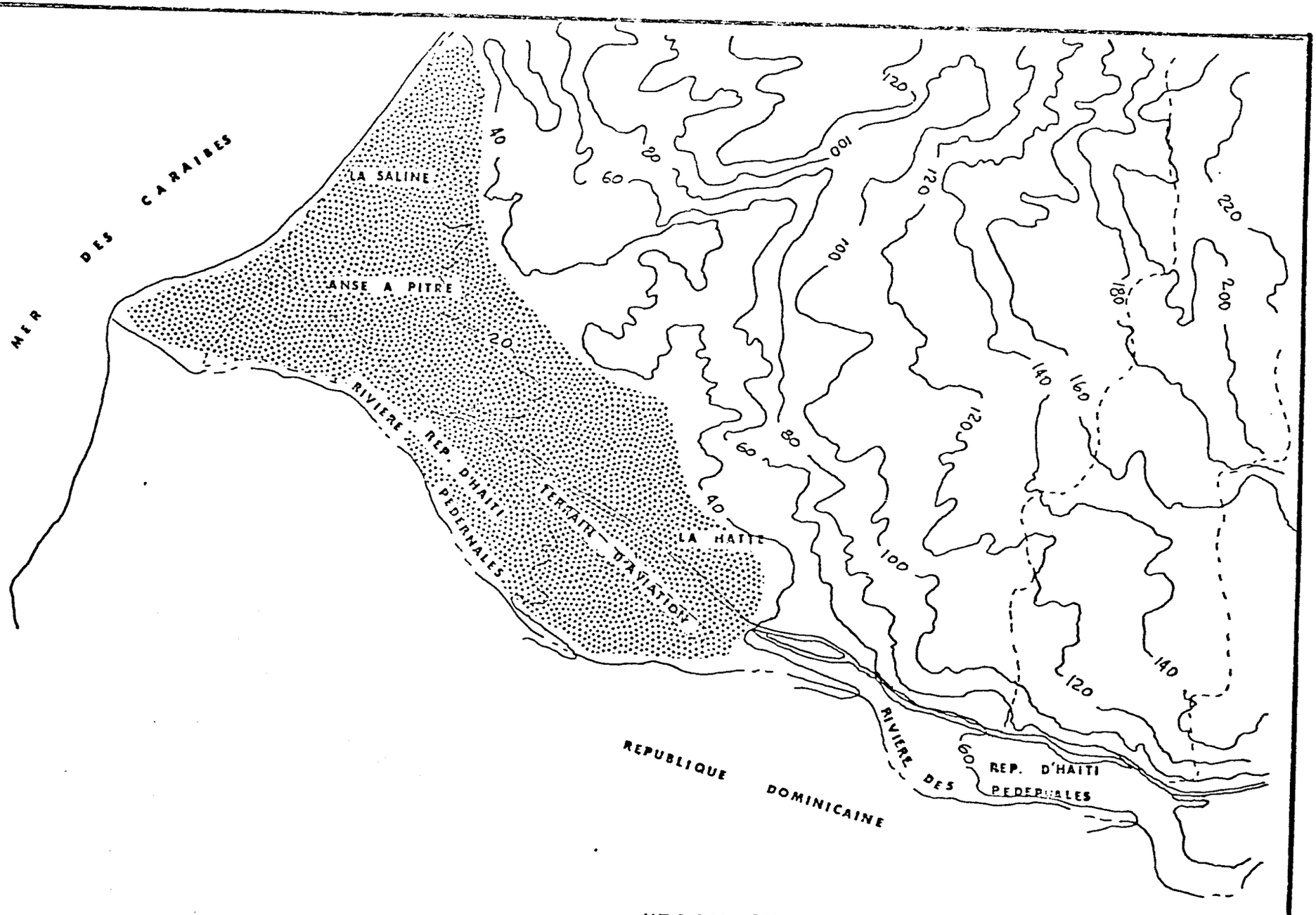


MARIGOT MAY 1976

"TASK C"

PEDERNALES

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK



"TASK C" PEDERNALES

THE J.G. WHITE ENGINEERING CO.

"TASK C" REPORT - PEDERNALES

IRRIGATION AREA

PROJECT: 521-15-190-069 THE J.G. WHITE ENGINEERING CORPORATION

HAITI Irrigation 4792

I INTRODUCTION

The Pédernales irrigation area is located in the extreme southeast corner of Haiti directly adjacent to the République Dominicaine border. This area is under military control and permits for the team to make field investigations had not been issued at the time of the drafting of this report.

Included within this presentation are the data available on the system from various sources. When permits become available for field investigation, a full report will be issued as an addendum.

II SOILS, GEOLOGY AND CLIMATE

The Pédernales area is located at the extreme eastern end of the south coast. The name is taken from the Rivière des Pédernales, which is the boundary between Haiti and the Dominican Republic at this point. The town of Anse-à-Pitres is in the Pédernales plain.

On the Haitian side of the river, the plain extends inland about 4 kilometers and is about 2 kilometers wide at the coast. Unlike the alluvial coastal plains to the west (Marigot and Cayes-Jacmel) the Pédernales plain is underlain by alluvial

material only in a narrow band along the river. The rest of the plain is developed on a pitted, brecciated limestone of Oligocene age that is presumably a wave cut bench.

Soils are developed from the brecciated limestone and from the thin alluvial materials along the river. They are highly calcaceous; calcium carbonate contents are reported to range from 78 to 95 percent. The soils grade from sandy loams at the seaward edge of the plain to clay loams at higher elevations in the interior of the plain. They tend to be shallow and, in some places they have a high content of gravel and cobbles. The soils are light brown in color except near the western edge of the plain where color becomes reddish due to an increased content of iron and aluminum oxides. Caliche is found at shallow depths in some places.

The watershed of the Rivière des Pédernales has a drainage area of 170 km on the Haitian side of the border. It drains a portion of the south slopes of the Massif de la Selle. Discharge records for the year 1930 show a mean daily discharge of .46 m^3/sec. Mean monthly discharge for the year varied little suggesting that the flow may be reliable.

Ground water is probably not available in significant quantities. This is due to both the lack of alluvial material and the small likelihood of finding ground water in the brecciated limestone. The climate is semi-arid. Mean annual rainfall is about 400 mm. This value ranks among the lowest in Haiti. No data showing annual distribution of rainfall could be found. Potential evapotranspiration is probably close to 2000 mm.

III SOCIAL ATTITUDES

No reliable information on this subject is available.

Meaningful data will require a field investigation.

IV MARKET PRACTICES AND LAND TENURE

Distribution of Irrigated Land Ownership

Computations from the list of proprietors assessed water taxes for 1975-76 show the following:

Size of tract in hectares	Percent of tracts	Percent of area
.32 or less	20.3	4.9
.33 to .99	32.0	19.1
1.00 to 2.99	41.1	48.9
3.00 to 4.99	3.3	9.2
5.00 or more	3.3	17.9

Assessments were made on 421 tracts totaling 321.11 hectares, and owned by 176 proprietors (with an average of 1.82 hectares per owner).

Multiple tract owners were common, with 37 proprietors together owning 102 tracts totaling 159.86 hectares (an average of 4.32, and half of all the assessed area.) One proprietor owned six tracts, and two others each owned five tracts.

One hundred thirty-nine single tract owners owned 161.25 hectares, an average of 1.16 each. Among 13 proprietors owning five or more hectares, the largest owned 19.62 hectares accounting for 6.1 % of the assessed area, and together the 13 accounted for 114.22 hectares, or 35.6 percent of the assessed area.

A higher percent (49) of the assessed area was in tracts of 1.00 to 2.99 hectares than in any other of the irrigation systems studied.

Land Use

Our team was unable to personally travel over the area covered by the irrigation system.

Land use in the Marigot-Peredo system, the system nearest to the Pédernales, should be comparable in part in the two areas. Both are on the southeastern of the southern peninsula, and both have mountains stretching up behind them. Because of its extreme distance from major markets, one would expect products grown for local food consumption to dominate the irrigated land area.

Corn, beans, sweet potatoes, plantain, bananas and a variety of vegetables can be anticipated. In addition, mango, coconut palm and breadfruit trees would be anticipated. If soil, water and drainage conditions permit its growth, rice would be expected.

Market Outlets and Transportation

A semi-rural public market serves the community each Friday; up to 500 persons usually are in the market. Sellers do not have covered places in which they can display their products. Road transport facilities are poor, and relatively few trucks from Haiti serve the market. Produce is brought in and carried out by foot (head-load), by animals, and by boats. Produce is reported as moving in and out from the market by trucks to the Dominican Republic.

Agricultural Credit

IDAI is unable to service this area with loans at the present time because of the lack of a usuable road from Marigot, and the great distance by way of Fond Parisien. IDAI hopes to be able to serve this area at some future date; for it has personnel at Jacmel, serving the Department de L'Ouest.

V EXISTING IRRIGATION SYSTEM:

Data for this portion of the report was obtained from several departments of the Ministry of Agriculture, Geodesic Service, plus other reports and maps.

The Pédernales Irrigation System receives irrigation water from the Rivière des Pédernales.

Water is diverted from the river by means of primitive type of diversion structures at the present time.

There are 680 hectares in the whole area. It is estimated that approximately 350 to 400 hectares could be irrigated if sufficient water were available.

From published data, river flows are shown to have a fairly uniform average annual flow of 460 liters per second. Plans are under consideration to build a diversion structure on the river to divert water to both sides.

It is proposed that this be a cooperative effort between the Republique of Haiti and Republique Dominicaine. It is also proposed that the water be divided equally to each side of

the river. If such a plan is carried out only one-half or 230 liters per second would be available which is approximately enough water to irrigate about 230 hectares of land depending on the variation in seasonal flows.

In addition to the diversion structure, it appears from information available that it will probably be necessary to build or rehabilitate much of the irrigation system plus a drainage system to dispose of surplus water.

VI RECOMMENDATIONS

No firm recommendations can be made on this project without field investigation. From information received from recent visitors to the area it appears that the existing irrigation system has been poorly maintained. According to these visitors, only about one-third of the original system is presently functioning.

VII CONCLUSIONS

Should Haiti decide to enter into a cooperative effort with the Republique Dominicaine to build a barrage on the Pédernales river, it would be essential to have firm data on the irrigation system requirements.

We were informed that it is almost a certainty that the bi-national dam will be constructed at an early date. The J.G. White team therefore recommends an "A" priority for this project.

"TASK C"

DUTHIL-MANNEVILLE

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK

"TASK C" REPORT - DUTHIL-MANNEVILLE IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION
HAITI Irrigation 4792

I INTRODUCTION

The Duthil-Manneville irrigation system is located in the Cul-de-Sac, Grande Plaine Sections of the Commune of Thomazeau in the Arrondissement of Port-au-Prince.

Population in the area is quite dense. In 1965, the population of Thomazeau was 1,400 and the rural population of the Grande Plaine 1 section was 11, 896. By 1976, the population of Thomazeau and the rural population of the Grande Plaine were estimated as 1,950 and 14,500, respectively. Between 1965 and 1976, the population in Grande Plaine 1 section increased approximately 2.1% annually from 128 to 158 people per square kilometer. However, the population density in the Duthil-Manneville area is much greater (more than 400 people per square kilometer) than the average for the Grande Plaine 1 section of which it is a part.

II GEOLOGY, SOILS AND CLIMATE

The Duthil-Manneville irrigation area lies on a gently sloping to flat alluvial surface that extends from low hills to the north to the Etang Saumâtre (Salt Lake) on the southeast. On the east is a range of low hills that extend southward to a marsh at the edge of the lake. The hills to the north are mapped as Pleistocene reefs ; the hills to the east are chalky to massive limestones of upper Oligocene or lower Miocene age. A fault is mapped at the intersection of the alluvial plain and the hills to the east to explain the contact between the alluvium and the limestone hills.

The climate at Duthil-Manneville is semi-arid. Average annual rainfall at Thomazeau is 480 mm. Rainfall is exceeded by evapo-transpiration. No exact figures exist at the area, but potential evapotranspiration porbably lies between 1500 and 2000 mm. There are two rainy seasons. Peak rainfall months are May and October. The driest month is January with another dry period in July and August.

The water supply in the area is from ground water which appears at the surface as springs at Duthil and Manneville. Both springs, as well as a nearby spring of Trou Caiman, appear to derive their water from solution cavities in massive limestone, suggesting that the source area may be the mountains to hte north, the Montagne du Trou d'Eau. This hypothesis is supported by a chemical analysis of water done in 1921. The silica content of the water is high (119 mg/l) ; which suggests that the water has rended for some time in volcanic deposits or siliceous limestones. The total dissolved solids value at the spring is 370 mg/l.

Ground water is also stored in the alluvial material of the plain, where it moves downslope to appear as small sups at the edge of the lake. It is likely that some water is fed to the alluvial material from solution cavities in the underlying limestone formations.

The six major kinds of soil are shown on the accompanying "General Soil Map" (page 5) and the area of each is listed below :

KIND OF SOIL		HECTARES
1.	Well drained rocky loam	40
2.	Well drained sandy loam	30
3.	Bas Boen fine sandy loam	90
4.	Duthil silty clay (below canal)	270
	" " " (above canal)	200
5.	Imperfectly drained clay	110
6.a	Poorly and very poorly drained clay (fresh water)	120
6.b	Poorly and very poorly drained clay (Etang Saumâtre)	140
	Total	1,000

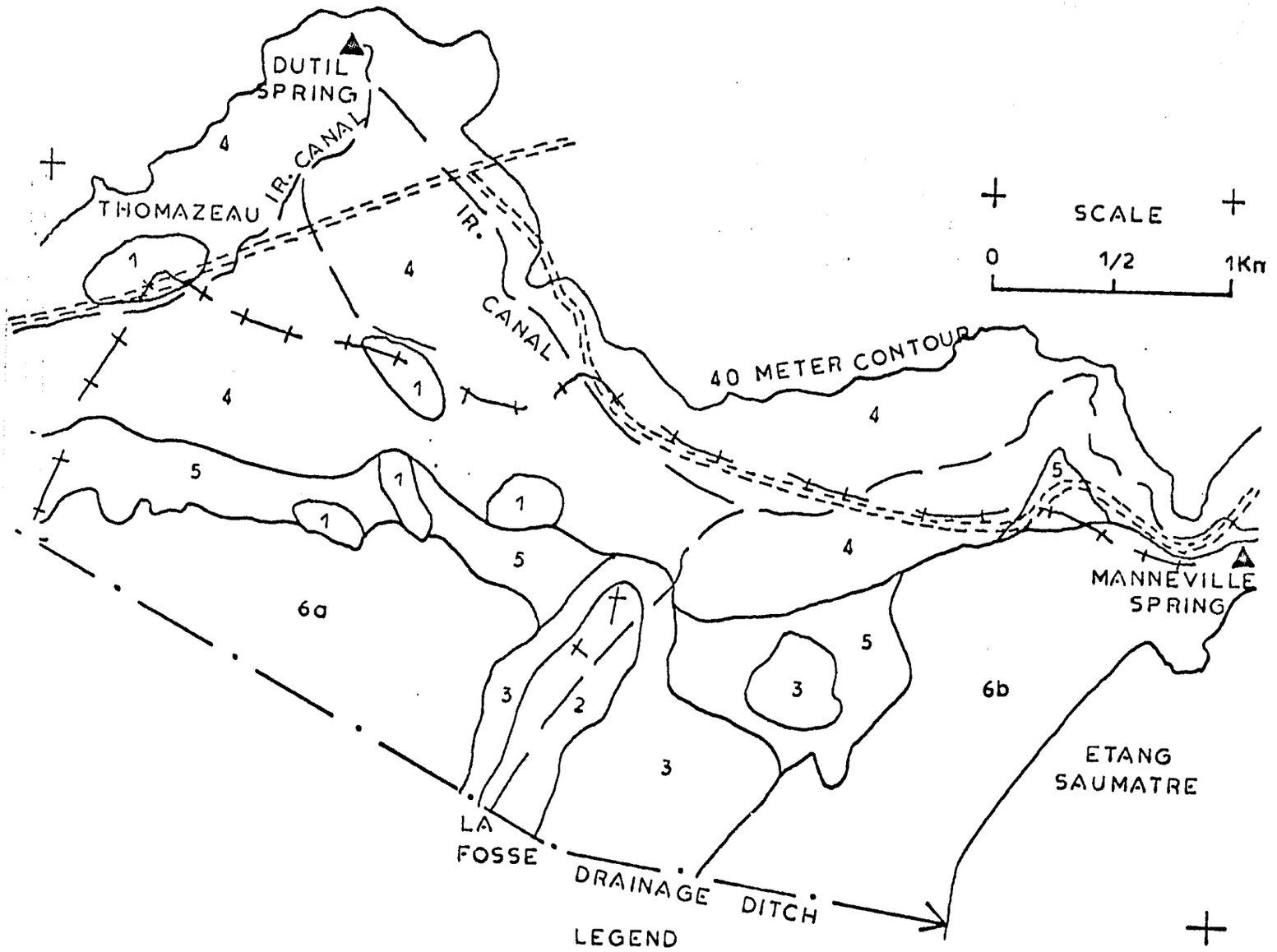
All of the soils are calcareous, with a pH of approximately 8.0 throughout the profiles. The sandy soils Nos. 1, 2, and 3 have light colored surface horizons, whereas the fine textured clay soils Nos. 4, 5, 6a, and 6b have dark colored surface horizons.

The best and most extensive soil is No. 4, Duthil silty clay, which occurs both below and above the main irrigation canal. A detailed profile description of Duthil silty clay is given in Table I. This soil is in the fine, mixed, isohyperthermic family of Udic Haplustolls.

TABLE I

Location	Topographic map of Haiti, scale 1:25,000, Thomazeau sheet 5771-I-NE, coordinate $8_{07.3}$-$20_{64.7}$; from Thomazeau cathedral, 0.9 kilometer east and 0.1 kilometer north ; also 21 meters southeast of road.
Physiography	Middle part of colluvial fan.
Relief	Nearly level, 0.5% slope south. Altitude 35 meters.
Precipitation	Average annual 84 cm (33 inches).
Vegetation	Sweet potatoes.
Drainage	Moderately well drained.
Parent material	Calcareous sediments from mountains to the north.
A_1 0-25 cm 0-10 inches	Dark brown to very dark grayish brown (7.5YR-1)YR 3/2); silty clay; moderate, fine to medium granular; friable; calcareous, pH 8.1; clear smooth boundary to horizon below.
A_3 25-56 cm 10-22 inches	Dark brown (7.5YR 4/3); clay; moderate, fine, subangular blocky; slightly firm; calcareous, pH 8.0; clear, smooth boundary to horizon below.
B_2 56-91 cm 22-36 inches	Brown (7.5YR 4/4); clay; moderate, fine to medium. subangular blocky, with few, faint, dark brown (7.5YR 4/2) coatings on pads; firm; calcareous, pH 8.0; clear, smooth boundary to horizon below.
B_3 91-122 cm 36-48 inches	Brown (10YR 5/3); clay loam; moderate, medium, blocky; firm; calcareous, pH 8.2.

GENERAL SOIL MAP
DUTIL AND MANNEVILLE AREAS, HAITI



LEGEND

SOILS

1 WELL DRAINED ROCKY LOAM
2 WELL DRAINED SANDY LOAM
3 BAS BOEN FINE SANDY LOAM
4 DUTIL SILTY CLAY
5 IMPERFECTLY DRAINED CLAY
6a POORLY AND VERY POORLY DRAINED CLAY (FRESH WATER)
6b POORLY AND VERY POORLY DRAINED CLAY (ETANG SAUMATRE)

NATURAL AND CULTURAL FEATURES

SPRING
IRRIGATION CANAL
DRAINAGE DITCH
ROAD
RAILROAD
CEMETERY

Duthil silty clay is fertile, has good natural drainage, and has high available moisture-holding capacity. It is adapted to a wide range of crops and is used to produce sugar cane, plantain, corn, sorghum, rice, beans, sweet poratoes, shallot, eggplant, okra, and tomatoes in this area.

Soil No. 5 is similar in many characteristics to No. 4 except that No. 5 is not as well drained and, therefore, is not adpated to quite as wide a range of crops. Soil No. 5 is well adapted to rice production.

Soil No. 6a is so poorly drained that it is suitable only for some vegetables during the dry season or for rice production. In the wetter areas, the water table is so high that only water-loving plants can be grown for pasture; but rice could be grown if proper moisture control was provided. Soil No. 6b is similar in some characteristics to No. 6a. However, as Etang Saumâtre is approached, the level of soluble salts in No. 6b is likely to increase and become progressively more harmful; but specific data have not been obtained concerning this point.

Bas Boen fine sandy loam No. 3 is imperfectly drained and is not used intensively. A detailed description and results of laboratory analyses are given on the following facing pages for a profile of Bas Boen fine sandy loam. This is a saline-alkali soil in which chloride and sulfate are the principal soluble anions and sodium is the dominant soluble cation. Soluble salts and exchangeable sodium are greatest in the upper horizons. Soluble salts probably decrease as the distance from Etang Saumâtre increases. This soil is easy to cultivate and has a medium available moisture-holding capacity, but many crops cannot be produced satisfactorily on it unless excess soluble salts and exchangeable sodium are removed from the rooting zone. Most areas of these soils are currently in native pasture, and this is probably the best use except where soluble salts are low enough to permit the production of cultivated crops.

Sandy loam soil No. 2 is droughty, low in moisture-holding capacity, and low in productivity except for crops such as melons. Rocky loam soil No. 1 is droughty, difficult to cultivate, and poorly adapted to cultivated crops.

In the Duthil-Manneville area, the best soils for irrigation are Nos. 4 and 5, with No. 4 (Duthil silty clay) being the most desirable. There is a total of 380 irrigable (below canal) hectares of these two soils.

BAS BOEN FINE SANDY LOAM

Described by R. T. Odell and Raymond Etienne on January 21, 1976.

Location	Topographic map of Haiti, scale 1:25,000, Thomazeau sheet 5771-I-NE, coordinate $8_{08.3}$-$20_{62.6}$, 2.5 kilometers west and 1.0 kilometer south of Manneville spring.
Physiography	Lower part of colluvial fan and 0.2 kilometer east of irrigation canal on crest of former beach ridge of Etang Saumâtre.
Relief	Nearly level, 0.5 percent slope southeast. Altitude 30 meters.
Precipitation	Annual average 84 cm (33 inches).
Vegetation	Scattered Prosopis juliflora (Bayahonde) trees with a ground cover of grasses and Portulaca oleracea (Pourpier).
Drainage	Imperfectly drained. Water table 127 cm (50 inches) below surface on January 21, 1976.
Parent material	Mixed sediments from colluvial fan and from former beach ridge of Etang Saumâtre.
A_1 0-23 cm 0-9 inches	Dark brown (10YR 3/3-4/3); fine sandy loam; moderate, medium, crumb; friable; calcareous, with common, very fine, white (10YR 8/1) $CaCO_3$ concretions; very many roots; clear, irregular boundary to horizon below.
A_3 23-58 cm 9-23	Brown to yellowish brown (10YR 5/3-5/4); fine sandy loam; weak, medium, subangular blocky; friable; calcareous; many roots; clear, smooth boundary to horizon below.
B_1 58-86 cm 23-34 inches	Brown to grayish brown (10YR 5/3-5/2); fine sandy loam; weak, medium, subangular blocky; friable; calcareous; common roots; clear, smooth boundary to horizon below.
B_2 86-122 cm 34-48 inches	Grayish brown (10YR 5/2); fine sandy loam; very weak, medium, blocky; friable; calcareous; few roots; abrupt, smooth boundary to horizon below.
C_1 122-132 cm 48-52	Grayish brown (10YR 5/2); loamy sand; single grain; loose; calcareous, with many, white (10YR 8/1) snail shells 1mm in diameter.
Diagnostic horizons	Ochric epipedon, 0-23 cm (0-9 inches). Cambic horizon, 23-122 cm (9-48 inches).

BAS BOEN FINE SANDY LOAM[a]

TABLE II

Classification : Fluvaquentic Halaquept, coarse-loamy, carbonatic, isohyperthermic

Horizon	A_1	A_3	B_1	B_2	C_1
Depth of horizon (cm)	0-23	23-58	58-86	86-122	122-132
Particle-size distribution of 2mm (%) :					
Sand 2.0- .05 mm	66	74	73	66	82
Silt .05- .002 mm	24	12	21	25	8
Clay .002 mm	10	14	6	9	10
Organic carbon (%)	2.18	0.39	0.76	0.22	0.46
Calcium carbonate equiv. (%)	64	36	64	62	72
Exch. cations (me/100g soil):					
Ca	24.0	28.0	30.0	36.0	16.0
Mg	—	—	—	—	—
K	2.56	2.40	1.92	1.28	0.45
Na	21.00	16.40	8.90	7.50	2.68
Exch. sodium percentage	83.7	89.6	73.6	59.5	40.6
Cation-exch. capacity (me/100g)	25.1	18.3	12.1	12.6	6.6
pH H_2O	8.0	8.2	8.0	8.2	7.8
Available nutrients:					
NO_3 (ppm)	3	3	3	3	3
P_2O5 (lbs/acre)	20	200	75	20	200
K_2O (lbs/acre)	100	120	180	100	100
Electrical conductivity (mmhos/cm)	16.00	8.50	4.00	3.00	2.40
Sat. extract sol. cations and anions (me/l):					
Ca + Mg	11.0	1.2	0.8	1.8	3.6
K	3.30	1.12	0.70	0.35	0.31
Na	132.6	63.0	57.6	29.3	26.1
CO_3	0	0	0	0	0
HCO_3	1.2	1.6	2.8	1.2	1.0
SO_4	126.6	40.5	24.2	15.9	9.2
CL	68.0	36.0	18.0	14.0	14.0
Sodium-absorption ratio	56.5	81.3	91.1	30.9	19.4

a Analyses by the Chemistry and Soils Laboratory, Department of Agriculture, Damiens, Haiti

The major crops and estimated hectares of each crop on the 380 hectares of hte best irrigable (below canal) land are listed in Table 3. There is some mixed cropping, with two crops such as manioc and beans planted in the same area, but the extent of this practice is not indicated. Only 240 hectares of land are currently being irrigated. Estimated yields per hectare and annual gross income are given for crops grown with irrigation and on land that is not irrigated. With irrigation, crops can be grown throughout the year. Therefore, two crops can be grown annually on a given tract if the crops (such as sorghum, corn, rice, and vegetables) mature and are harvested within periods of less than six months. For example, approximately 60 hectares of vegetables are currently planted annually after another crop is harvested. Unimproved pasture is grown on some good land that is not irrigated.

TABLE III Estimated production and annual gross income for crops currently grown on the three best soils (Nos. 4, 5, and 3) below the canals in the Duthil-Manneville area

Crop	Irrigation	Hectares	Unit	Yield per hectare	Total Production	Price $	Gross Income
Sugar cane	Yes	60	ton	40	2,400	6.00	14,400
Plantain	Yes	35	stem	100	3,500	2.00	7,000
Manioc	Yes	10	kg	4,000	40,000	.04	1,600
"	no	20	kg	3,000	60,000	.04	2,400
Sorghum	Yes	50	kg	800	40,000	.13	5,200
"	no	45	kg	700	31,500	.13	4,095
Corn	Yes	10	kg	900	9,000	.15	1,350
"	no	5	kg	700	3,500	.15	525
Rice (paddy)	Yes	25	kg	1,200	30,000	.20	6,000
Vegetables*, 1st	Yes	50					10,500
"	no	10					1,500
Pasture	no	150					6,750
Subtotal		470					
Vegetables 2nd	Yes	75					15,750
Total		545					77,070

* The vegetables include sweet potatoes, beans, shallot, eggplant, okra, and tomatoes. The second (2nd) crop of vegetables each year is grown after harvesting sorghum, corn, rice and various vegetables.

Table IV lists the projected production and gross income expected from the same 380 hectares if they were all irrigated and if improved management practices, including proper fetrilization, better varieties, etc., were used. The projected yields are very modest and could easily be exceeded within a few years. Projected gross returns (Table IV) are three times greater than estimated current returns (Table III). The major added cash costs which must be deducted from gross returns are diesel fuel, fertilizer, and seed. In addition, the capital improvement costs of $12,650 would need to be amortized together with any part of the $6,200 other expenses which was a cash cost.

TABLE IV Estimated production and annual gross income for crops projected on the three best soils (Nos. 4, 5, and 3) below the canals wiht improved management and expanded irrigation in the Duthil-Manneville area.

Crop	Irrigation	Hectares	Unit	Yield per hectare	Total Production	Price $	Gross Income $
Sugar cane	Yes	120	ton	70	8,400	6.00	50,400
Plantain	Yes	70	stem	200	14,000	2.00	28,000
Manioc	Yes	20	kg	7,000	140,000	.04	5,600
Sorghum	Yes	90	kg	1,600	144,000	.13	18,720
Corn	Yes	20	kg	1,600	36,000	.15	5,400
Rice (paddy)	Yes	50	kg	2,400	120,000	.20	24,000
Vegetables*, 1st	Yes	100					41,000
Subtotal		470					
Vegetables*, 2nd	Yes	150					61,500
Total		620					234,620

* The vegetables include sweet potatoes, beans, shallot, eggplant, okra and tomatoes. The second (2nd) crop of vegetables each year is grown after harvesting sorghum, corn, rice and various vegetables.

III SOCIAL ATTITUDES, LAND TENURE AND MARKETING PRACTICES

The irrigable area of the plain consists of two areas of 220 hectares and 365 hectares respectively for a total of 585 hectares. (Local informants claim that there is as much as 4.000 areas of irrigable land available if water supply were adequate). At present, however, land being irrigated by the combined system includes Duthil (110 hectares) and Manneville (48 hectares) for a total of 158 hectares. This area is contributing to the support of approximately 199 families of 249 parcels of land averaging .64 hectares in size. Current efficiency in utilization of facilities is lonly 27% of the potential of the system. With 100% efficiency, including adoption of improved practices, the system could greatly increase the income of over 700 families. The present state of disrepair of the combined system indicates that there has been poor management of the system by water users. A Conseil Communautaire (President Armouse Avril) exists in the area but with only 30 members participating. This lack of participation is an indication that extensive assistance in leadership training is required before an effective organization can be molded which can manage maintenance, operation, and administration of an improved system. Some canal and bridge work has been done recently to improve deteriorated sections of the irrigation system in the community which is an indication that the people recognize the need to improve the operational condition of the system. Sporadic, limited government assistance in this direction has been received, yet observations point out that a fully coordinated effort of people and government will be required to effect total development requirements.

Collot Luckner, Controleur d'irrigation in the Thomazeau area indicated that while the people of the area desperately need assistance, they also need motivation. Nesta Joseph, President Communal, also pointed out that concentrated motivational assistance (ie: developing an understanding of costs/benefic relationships) would be required to develop the area peoples' full potential.

It is recommended that further study in depth be made to identify existing leaderships and social patterns so that a solid/cohesive group structural foundation can be established. People of the area are obviously poor and desperately in need of assistance to utilize the plentiful resources available to them.

DISTRIBUTION OF IRRIGATED LAND OWNERSHIP

Computation from the list of water users (land owners) assessed for irrigation taxes for 1975-1976 for each tract of land show the following :

Size of tract in hectares	Percent of tracts	Percent of area
.32 or less	44.6	22.4
.33 to .99	42.2	42.2
1.00 to 2.99	12.0	26.1
3.00 to 4.99	.8	4.5
5.00 or more	.4	4.9

There were 249 tracts with an area of 158.38 hectares. One hundred eleven tracts of .32 of a hectare, and 99 of .64 of a hectare were reported. Thirty three owners owned more than one tract. Twelve owners each held more than 2 hectares, and together they held 32 tracts which accounted for 13 percent of the tracts and 26 percent of the area. One owner held 7.74 hectares and accounted for 4.9 percent of the taxes assessed.

IV EXISTING IRRIGATION SYSTEM

The Duthil-Manneville irrigation system (1) extends from slightly west of Thomazeau eastward to Etang Saumâtre (Salt Lake). This integrated system serves part of a 1000-hectare area approximately 2 km wide from north to south and 5 km long from west to east.

Irrigation water is avialable from two sources, The first one is Duthil spring, which has a flow of about 115 to 120 litres per second. Approximately 225 hectares of level land are being irrigated by gravity flow from this source. About 200 meters downstream the spring flow is divided and channeled in two directions. One canal goes southwest through the village of Thomazeau, where water is supplied to the people living in the area for domestic use as well as for irrigation. This canal is approximately 1500 meters long, with only one secondary lateral that leaves the southwest canal about 550 meters below the point where the water is divided. The other canal goes southeast from the point where the water is divided. It has no secondary laterals.

The second source of water is the Manneville spring located at the northeast corner of the system. Very limited use has been made of the water from this spring because of its low elevation in regard to the land to be irrigated. Water must be pumped with a low-lift pump, powered by a Caterpillar engine, installed in 1957. The pump is operated at the rate of approximately 200 litres per second. The pump has been operated very few days during recent years because of the high cost of diesel fuel. Fuel consumption for the power unit is 7 gallons per hour. The water is forced up through a pipe to an outlet box at the head of a masonry canal. This masonry canal is 1.6 meters wide, 0.8 meter deep, and 1200 meters long ; it is in reasonably good condition. An attempt is being made to irrigate about 15 hectares by releasing water through several openings in the masonry canal. There are appoximately 2000 meters of earth canal which obviously have not been used for quite a number of years. It is silted

(1) See Irrigation Map, page 18

full the entire length, and in several places runoff water from above has completely washed away the canal banks.

The existing Duthil-Manneville irrigation system are incomplete, and the Manneville canal is in especially bad condition. It is recommended that hte existing system of canals be rebuilt, repaired, and extended. Structures such as division boxes, checks, road siphons, and siphons under waterways need to be added to the system in order to improve water distribution. In addition, a complete system of secondary and field laterals needs to be added to the Duthil-Manneville irrigation system for proper distribution of water. Surface drains should also be provided to dispose of excess water, especially during the rainy season.

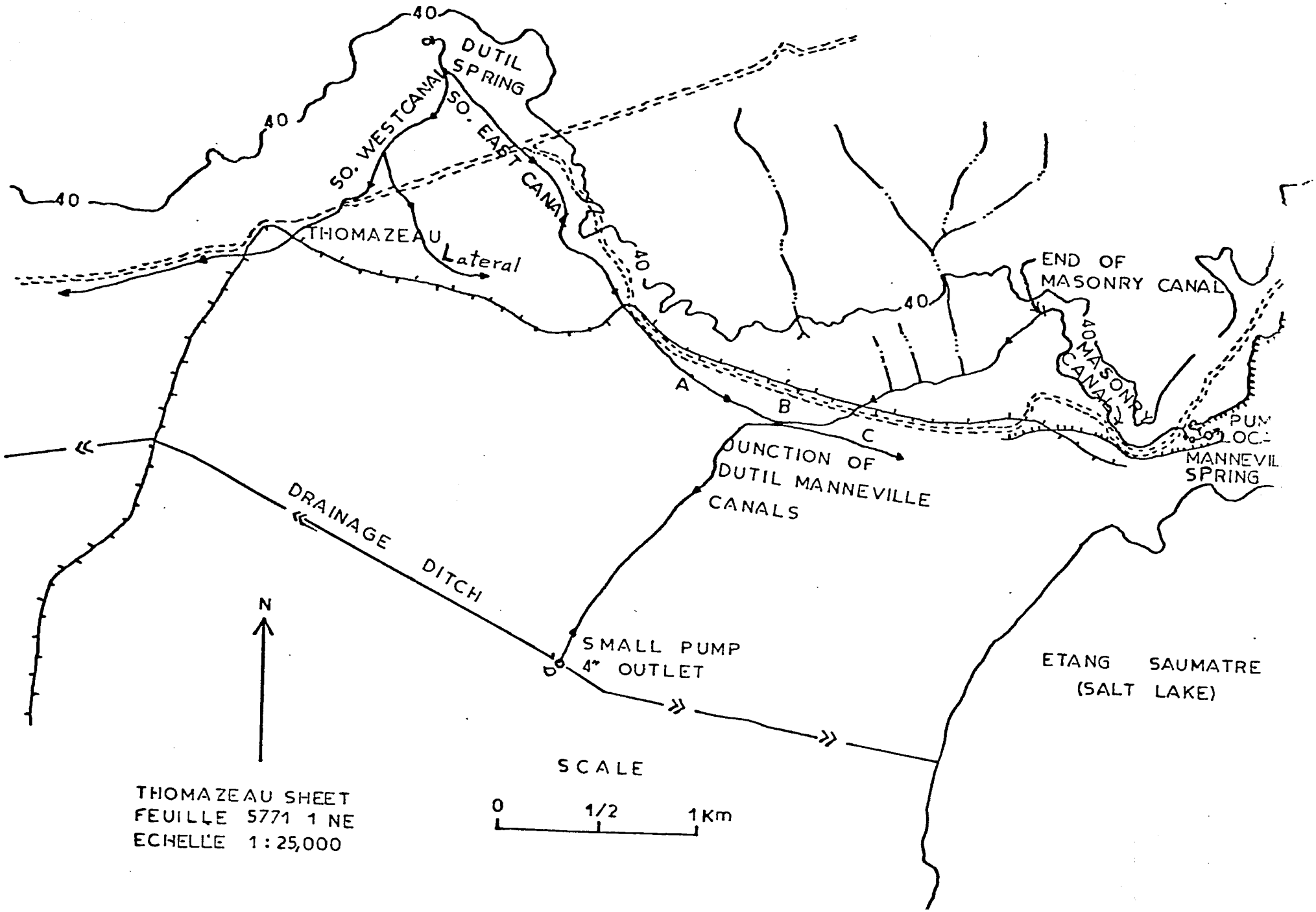
Studies need to be made to see if either one or both of the springs can be improved in order to increase flow rates.

At the Duthil spring, material could be excavated from beneath the rock face to expose a greater vertical section of rock. The purpose of this is to capture spring water that, at present, may be discharging beneath the surface into the alluvium, At Manneville, it has been suggested that spring flow might be intercepted at a higher elevation. This alternative does not appear to be feasible because it is possible that water moves to the surface not from above but from below the level of the spring.

The total flow from the two springs is approximately 320 litres per second. This will supply irrigation water to most of the best irrigable soils in the area (see discussion concerning soils). Making water available to approximately 470 hectares of the best land would double the hectares that are currently being irrigated.

It is recommended that the section of the canal between points A-C, be level (see Irrigation Map). During minimum irrigation periods,

IRRIGATION MAP DUTIL MANNEVILLE AREA



this would permit gravity flow of water from Duthil to the area between A-C. Then during the peak irrigation periods, water from the Manneville spring could be shifted to the level section of the canal between A-C. This arrangement would minimize pumping costs at Manneville spring and also minimize drainage problems during the rainy season. Water can be supplied from either spring to the canal between B-D. The canal is located on a sandy ridge. Part of the canal is a masonry ditch. A small pump at point D supplies water from the drainage ditch to irrigate some garden plots in the immediate area.

The estimated construction costs can be divided into two categories. Direct construction costs, $12,650, are for structures, material, and equipment. Other costs, $6,200, include labor used in repair, rebuilding of existing canals, construction of field lateral systems, and installing structures. Laborers are available in the area.

V RECOMMENDATIONS

As previously stated under section IV, it is recommended that the existing system of canals be rehabilitated and extended. The two systems of Duthil and Manneville should be inter connected to obtain the greatest volume of irrigation water at the lowest cost.

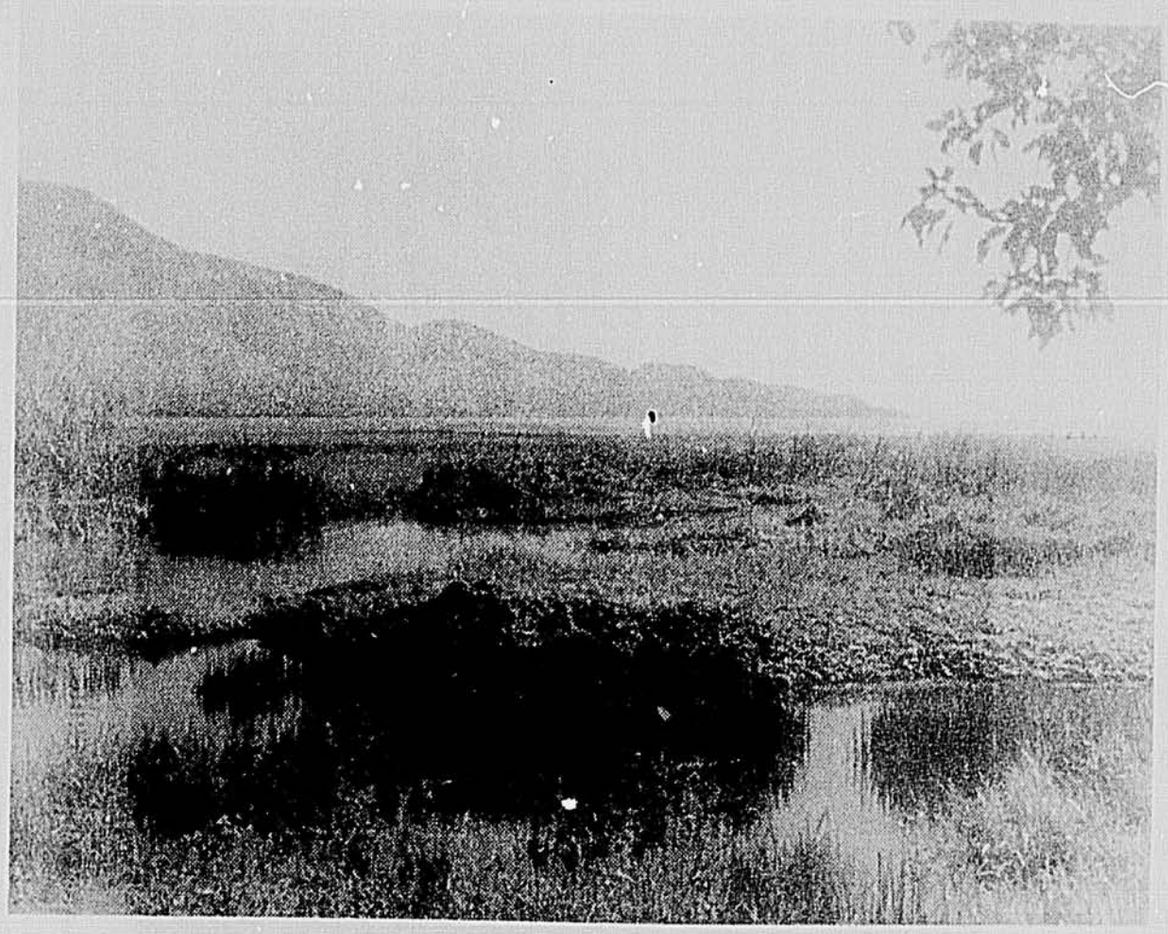
It is essential that early steps be taken to motivate the farmers to maintain their irrigation system and it is recommended that this be started during the design of rehabilitation period.

VI CONCLUSIONS

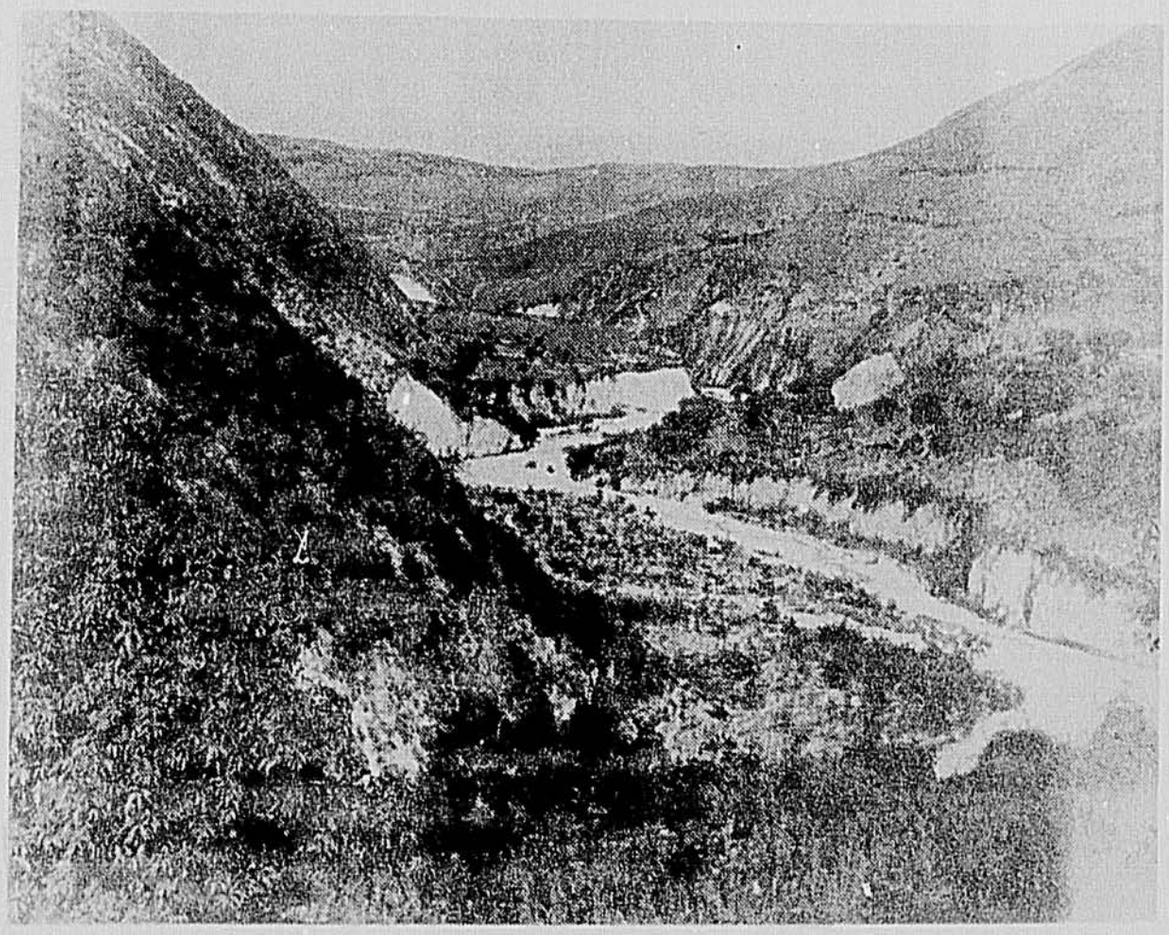
These preliminary analyses indicate that improvement of the Duthil-Manneville irrigation system is quite promising and should be pursued vigorously. The increased agricultural income would improve the living standard of farmers and benefit the entire area.

The rehabilitation and extension of canals as recommended will double the number of hectares of the best land. Improved agricultural practices can easily double production.

The J.G. White Engineering Corporation team places the Duthil-Manneville project in Priority "A" rank.



MANNEVILLE SPRING – EAST OF THOMAZEAU



FOND PARISIEN RIVER VALLEY FROM LASTIC

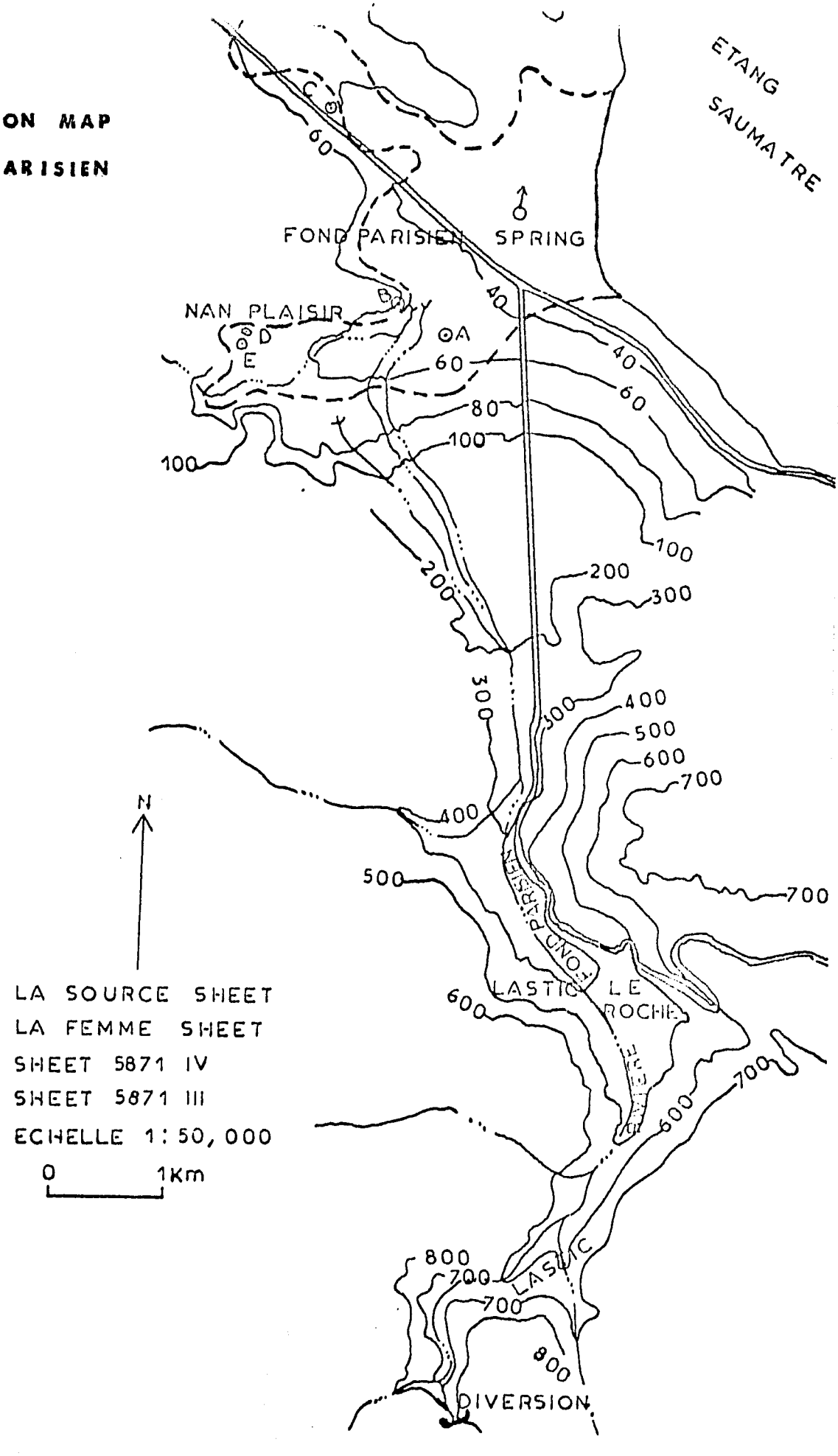
"TASK C"

FOND PARISIEN-LASTIC

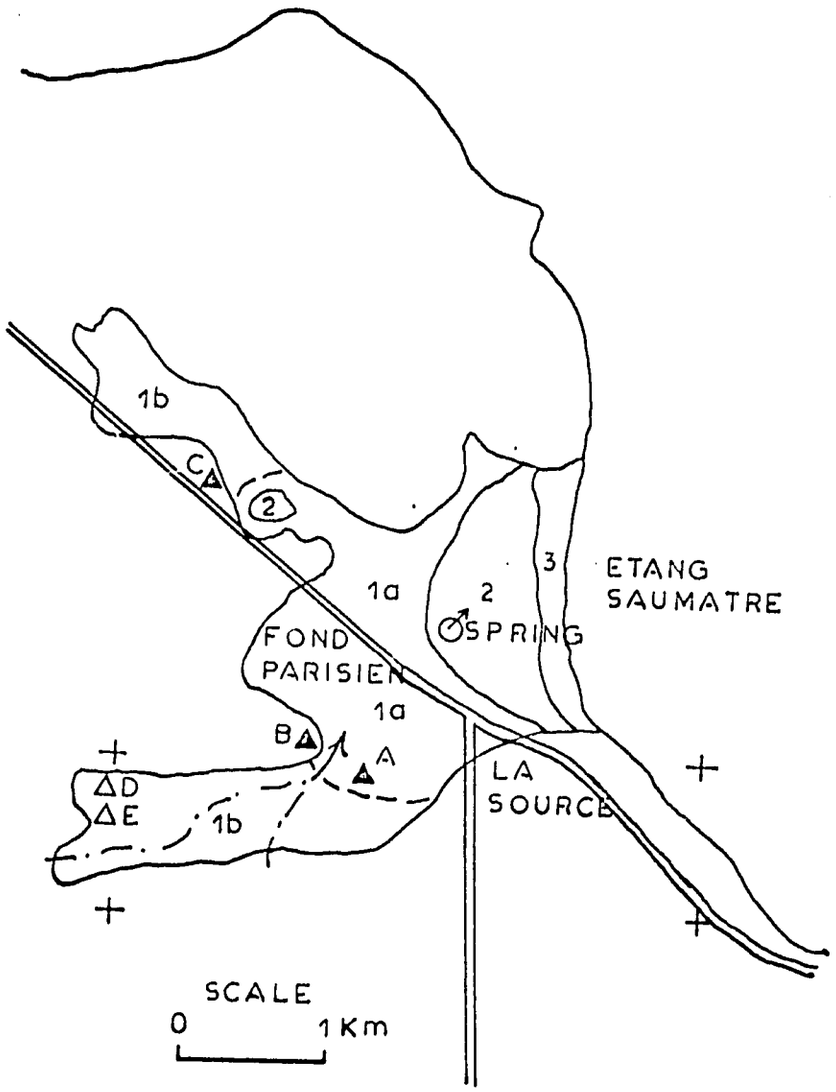
THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK

IRRIGATION MAP

FOND PARISIEN



GENERAL SOIL MAP
OF THE FOND PARISIEN AREA, HAITI



LEGEND

♂ SPRING

▲ IRRIGATION WELL WITH PUMP

△ ABANDONNED WELL

1a WELL DRAINED SILT LOAM (IRRIGATED)

1b WELL DRAINED SILT LOAM (NOT IRRIGATED)

2 IMPERFECTLY DRAINED SILTY CLAY LOAM (IRRIGATED)

3 POORLY DRAINED CLAY LOAM

"TASK C" REPORT - FOND PARISIEN IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION
HAITI Irrigation 4792

I INTRODUCTION

The Fond Parisien area is located at the mouth of the Fond Parisien river on the south shore of Etang SaumÂtre in the southeast corner of the Cul-de-Sac plain. The area comprises 510 hectares of irrigation soils, part of which are currently being irrigated (See Irrigation and Soils Maps). Some assistance to this area is being provided by a Mennonite group.

II SOILS, GEOLOGY AND CLIMATE

The irrigated area is located on an alluvial plain that extends from the steep slopes of the Massif de la Selle on the south to a range of east-west trending low hills on the north. The hills are Pleistocene reef limestones ; the slopes of the Massif are cut in massive Eocene limestones. The plain slopes gently to the northeast where it meets the Etang SaumÂtre (Salt Lake).

Alluvial material from the Rivière du Fond Parisien has formed a large alluvial fan to the southeast of the village. Water does not flow out onto the fan but disappears into the river bed several kilometers up to the valley near the village of Lastic. The river probably discharges onto the fan only in times of large floods.

Where the narrow flood plain of the river reaches the head of the fan, surface material in the stream is of large cobble and boulder size (10-40 cms in diameter), indicating that floods reaching this

point have light competency. These sizes grade to finer material (2-10 cm in diameter) near the toe of the fan. There is slight dissection at the head of the fan, suggesting an erosive environment.

In the sub-surface, the alluvial material consists of boulders grading to sand, silt and possibly some clay. According to Woodring, the materials underlying the alluvium are soft limestones, siltstones and marls of Miocene Age. The depth of the alluvial material is not known, but it is probably not greater than 50 meters. No well logs could be found for the four wells at Fond Parisien (See Table I).

There are no surface water supplies in the area. The nearest surface flow, as mentioned earlier, is several kilometers to the southeast near the village of Lastic (See Irrigation Maps).

There is probably abundant ground water at Fond Parisien. Data from three wells suggest that the water table is shallow. The permeability of the alluvial material is good judging from the data at well C, which shows a yield of 63 liters/second (1000 g.p.m.) with a drawdown of 6 meters (20 feet). Recharge to the aquifer is by underflow in the stream bed of the Rivière du Fond Parisien, by infiltration of rainfall and possibly some return of irrigation water. The most significant of these sources is the underflow in the river gravels. This water spreads through the alluvial fan, moves down slope beneath the surface and reappears at the edge of Etang Saumâtre as numerous seeps and samll springs.

The climate at Fond Parisien is semi-arid. Mean annual rainfall is about 910 mm. This is exceed by evapotranspiration. Although no exact figures exist in this area, potential evapotranspiration probably lies between 1500-2000 mm. There are two rainy seasons. Peak rainfall months are May and October. The mean annual temperature is 25.8 C.

Irrigation water is available from three wells (A, B, and C) and one spring, which are shown on the maps. Details concerning the wells and spring are given in Table I. The total flow of the four sources is approximately 155 litres per second. Water is being applied to about 300 hectares of land, but the available water is inadequate to properly irrigate this area. Water for domestic use is also supplied to the people living in the area.

Attempts were made to drill two wells (D and E) west of the village of Non Plaisir, but they were unsuccessful. The well at location D encountered sulfurous water and was never completed. The well at location E caved in during drilling operations by a German team and the site was abandoned.

The Mennonite group operates the pumps at locations A and B. The total flow of these two wells is about 60 litres per second. These wells supply most of the water for 165 hectares. Another 100 hectares of land are irrigated from a spring with an estimated flow of about 32 litres per second, it is located northeast of Fond Parisien. The Mennonite group has helped in developing a fair system of canals and laterals. Only about 35 hectares are being irrigated from the well at location C, even though the well is capable of pumping 63 litres per second. There is no regular time schedule for operating this pump. The problem seems to be a lack of funds to purchase diesel fuel. This area also lacks an adequate system of canals and laterals for proper water distribution.

Even if the pump at well C were operated at its rated capacity, There is not enough water to adequately irrigate 300 hectares of land. There are 210 additional hectares of good land (area 1b on the General Soil Map) that could be irrigated if water was available. This area is not receiving any irrigation water at the present time.

Therefore, there is a total of 510 hectares of good irrigable land in the Fond Parisien area. As shown above, the amount of water available to irrigate this area is inadequate and the hectares that are being irrigated do not receive enough irrigation water to produce high crop yields.

The irrigable alluvial soils in the Fond Parisien area are calcareous, light-colored, and occur on gentle slopes of 0.5 to 2 percent gradient. These soils have a high available moisture-holding capacity and are easy to cultivate. They are well adapted to intensive cultivation with irrigation. The three different kinds of soils that were delineated are shown on the accompanying "General Soil Map", and the hectares of each soil is listed in the following table.

KIND OF SOIL		HECTARES
1a.	Well drained silt loam (irrigated)	200
1b.	Well drained silt loam (not irrigated)	210
2.	Imperfectly drained silt loam (irrigated)	100
3.	Poorly drained loam	40
	Total	550

The well drained silt loam (1a) that is currently being irrigated occurs northeast of Fond Parisien at altitudes of 30 to 40 meters and southeast of the town at altitudes of 40 to 55 meters. This soil is adapted to a wide range of crops. Most of the irrigation water for this 200 hectares is supplied by two wells (A and B) that are operated by the Mennonite group. The well drained silt loam that is not irrigated (1b) occurs northeast of Fond Parisien at altitudes of 40 to 55 meters and southwest of town at altitudes of 55 to 75 m eters.

The imperfectly drained silt loam (2) occurs northeast of Fond Parisien at altitudes of 20 to 30 meters. This soil is well adapted to rice, especially during the rainy season, but it is not adapted to as wide a range of crops as is the well drained silt loam soil. Most of the imperfectly drained silt loam (2) is irrigated from a spring which is located at point "S" on the General Soil Map.

The poorly drained loam (3) occurs along the margin of Etang Saumâtre (Salt Lake). This soil has a high water table, and crops planted on it are subject to damage by soluble salts from Salt Lake.

The Fond Parisien River fan south of La Source is very rocky and unsuitable for crop production. The hilly areas southwest, west, and north of the three soils delineated on the General Soil Map are not suitable for irrigation.

On the unirrigated areas sorghum, corn, manioc, and some vegetables are grown during the rainy season. On irrigated areas a wider range of crop such as sorghum, corn, rice, manioc, plantain, beans, and sweet potatoes are produced throughout the year.

III SOCIAL ATTITUDES AND MARKETING

Fond Parisien is one of 6 sections of the Commune de Gonthier under the administration of the Arrondissement de Port-au-Prince. Total area population was reported (IHS) in 1965 as 42,249. There are approximately 4600 inhabitants living in 850 houses who would be affected by the 510 hectares of land which could be irrigated if the present 3 well system were fully developed. At present the three wells are producing enough water to utilize only 20% of the existing system. The previous system built in 1946-49 and destroyed

by hurricanes in 1953, irrigated 529 hectares. When that system was operating, the existing groups on the plain participated in its maintenance and repair.

At the present time there exist a Conseil Communautaire, composed of 3 agricultural groups (111 members), which is active on the plain. The President of the Conseil is Saffel Bona Polynice who is also President of one of the 3 agricultural groups. Mr. Dieumaitre Jacques, Superviseur des Agents Communautaires pointed out that there would be a great deal of cooperation from the people of the plain if the present irrigation system were to be improved. The general feeling was that people affected by such improvements would be willing to accomplish such work on the basis of one day work free and one day work with pay. They are at present operating the current irrigation system (including pump) on a communal basis through the Conseil Communautaire. Last year they reportedly marketed $35,000 worth of fresh vegetables to support operational costs of the system. No tax is collected for water use.

Ten active religious groups work with the people of Fond Parisien and the Mennonites were instrumental in assisting the group to get started in 1972 by donating 1000 gallons of fuel for the pumping station. While these groups are active, leadership in the area appears to be indigenous.

Cropping patterns and rotations followed under irrigation were maize, figue banane, and vegetables including beans. Areas without irrigation are planted in manioc, sweet potatoes, and beans (annual). Rotations generally followed are beans, (3 months) corn, (3 months) chicken corn/maize or vegetables (3 months), sorghum is planted throughout the year. 3 harvests are realized with irrigation. Generally, farmers owning irrigated land, also own non-irrigated land.

Rural health problems include a high incidence of tuberculosis, some malaria, and a typhoid epidemic which occured last year(1975). Lack of water and improper use of water has played a significant role in the creation of these problems.

A small clinic with 3 persons assisting is operating in the Fond Parisien area, making house calls and emphasizing family planning and maternity care. There are no doctors and no hospital beds.

There is one market in the area which is held on Tuesdays and Fridays. No local live stock market is held, yet observations indicate that there is a sizable cattle and goat population. Four trucks and one camionette ply daily between Port-au-Prince and the plain marketing produce (and probably live stock to some extent). Cattle are generally driven to market at Port-au-Prince.

Rural education is facilitated through 2 rural schools (religious) and 1 Ecole Rurale which together accommodate 850 students.

From observations and contacts throughout the area, it is apparent that a nucleus exists for formation of a cooperative organization which would be capable of maintaining, operating and making optimum use of an improved irrigation system. On this point, however, it is felt that technical as well as material assistance will be required on a fairly regular basis for a period of approximately 2 years. Since no agronome is assigned to the area (or at least operating in the area), training of such an individual will be required. Local extension agents working with the 3 agricultural groups will need extensive training in demonstrations of improved farm management practices.

IV RECOMMENDATIONS

It is recommended that further studies be made to determine if the future water supply for irrigation can be obtained from wells in the immediate area of Fond Parisien. Because the water table is relatively shallow (11 meters in two wells) it is suggested that the use of wind driven pumps to supply water be investigated.

Another possibility is the installation of an interceptor to collect under flow in the Rivière du Fond Parisien. The best location appears to be just down stream of the village of Lastic Le Roche water would then be brought by pipe or canal to the irrigated area.

A third possibility would be to divert water from the Fond Parisien river to the farming area. The river is a perennial stream to about 1 km below Lastic. A possibility would be to put a low-head diversion structure on the river at about 800 meters altitude to divert the water into a masonry canal to convey it 12 km to the area to be irrigated.

The estimated flow of the river at the diversion structure is 250 litres per second during the dry season. This 250 litres per second plus the 155 litres per second now available from the spring and three wells in the Fond Parisien area is not enough water to adequately irrigate the 510 hectares of good irrigable soils. The canal would go along the south and east sides of the valley and at that elevation the canal would not be endangered by river floods. The canal would have to cross or go around two significant gullies. Since the elevation decreases from 800 meters down to 70 meters, the canal could have steep gradients, thus permitting a reduction in the size of the canal. Attempts in the past have been made to construct a masonry canal beside the river along the east side of the valley. Hurricane Hazel (1954) damaged the canals. Attempts were made to

to rebuild the masonry canal but hurricanes in 1963, 1964, 1965, and especially Ines in 1966 almost completely destroyed the canal. Only a short section of the masonry canal is left near Lastic Le Roche.

Estimated construction costs for the 12 km masonry canal are divided into two categories. The direct construction costs such as structures, material, and equipment would be $101,800. The indirect costs for labor used in building canals, laterals and installing structures would be $8,000.

Estimated construction costs, drilling of nine wells, and installing pumps would be $171,000. This includes materials. Indirect costs for labor used in building canals, laterals, and installing irrigation structures would be $12,500. Laborers are available in the area.

The fourth possibility is to excavate several drainage canals in the poorly drained soils near the lake. Water would be pumped upslope, again possibly using wind diven pumps. This scheme would both irrigate the well drained soils and improve the drainage on the poorly drained soils.

Final choice among the alternatives would be determined during the course of further studies by economics and physical considerations.

V CONCLUSIONS

The Fond Parisien Irrigation project does not warrent a high priority and The J.G. White team suggests a "C" priority on a grading scale from A through D.

A well-field appears to be the simplest and least expensive method of obtaining sufficient water to suppor increased agricultural areas and yields. This method is presently functioning in the Fond Parisien area and several agencies are considering increased help.

TABLE I

Item	A Fd. Parisien No. 1	B Fd. Parisien No. 2	C Cite Well	D	E	SPRING
Year drilled	1968	1969	1969	1956	1972	
Depth, ft.	150	150	200			
Static water level, ft.	65	35	35			
Draw-down level, ft.	105	105	55			
Draw-down, ft.	40	70	20			
Diameter, in.	13 3/4	13 3/4	13 3/4	12	26	
Test pump flow rate, g.p.m.	700	700	1000			
Pumping flow, g.p.m.	700	250	1000			
Flow, l/s	44	16	63			32

"TASK C"

MÔLE ST. NICHOLAS

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK

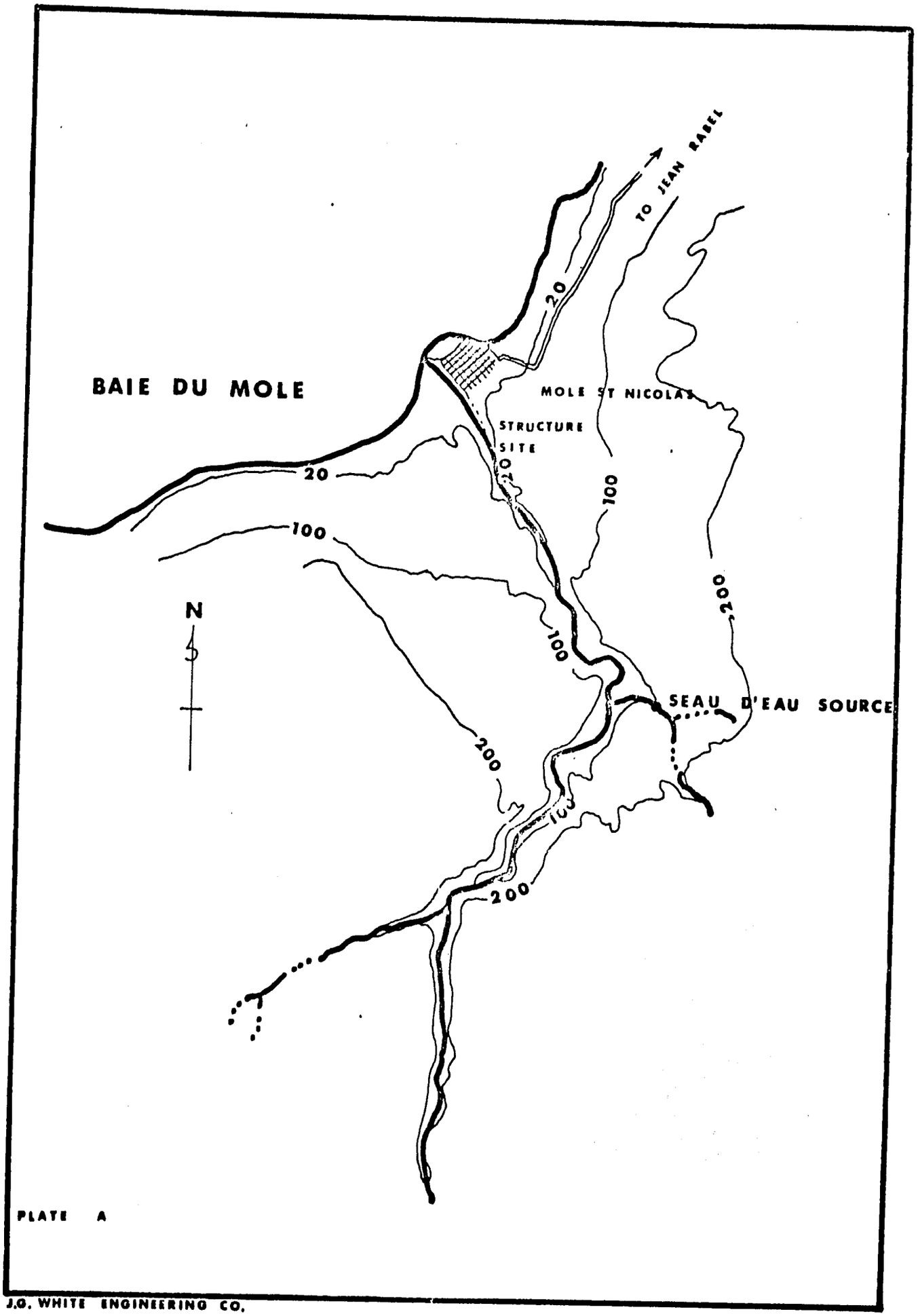


PLATE A

J.G. WHITE ENGINEERING CO.

"TASK C" REPORT - MOLE ST. NICOLAS IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION
HAITI Irrigation 4792

I INTRODUCTION

Môle Saint Nicolas, one of the oldest towns in Haiti, is at the mouth of Rivière du Môle, a small perennial stream which empties into Baie du Môle, a natural deep water harbor. Christopher Columbus stopped here when he discovered the island of Hispaniola. A number of ruins of Spanish-French forts and structures are located on the southeast shore of the Baie du Môle.

The current population of Môle St. Nicolas is estimated to be 950 people or 362 families living in 325 houses. The adjoining settlement of Carrenage includes an additional 35 houses with an undetermined number of families. There are many vacant lots in town with rubble from former buildings, which suggest that the population was greater at some earlier period. Rural population is very sparse within seven kilometers of the town because water is scarce and soils are very thin and unproductive. Major activities of the population are production and export of charcoal, some fishing and food production for home consumption. There are, however, very few garden plots in the town because of the lack of water for irrigation. At present, nearly all vegetables and fruits being sold in town are brought in from nearby irrigated lands. An estimated 1200 people from the area surrounding Môle St. Nicolas utilize the local market for trading and selling. Therefore the scarce supplies of fruits and vegetables have to be shared by a large number of people.

The climate at the Môle is semi-arid. Rainfall averages 590 mm per year with most of the rainfall in the months of May and October. The months of January, February, March, July, August and December each receive less than 50 mm of rain. Potential evapotranspiration probably exceeds 2000 mm. Except for the irrigated area south of the Môle, vegetation is dominated by cactus, grasses and xerophytic shrubs and small trees.

The town has ten wells. Of these, only four are reported to yield water that can be used for drinking or watering small garden plots. Water from the other wells has a high salt content. A dug well at the Catholic church, which yields a good quality water, has a static water level about 5 meters below ground surface. It is pumped by a small windmill.

II SOILS AND GEOLOGY

Môle St. Nicolas is situated on the small alluvial delta of Rivière du Môle. Uplifted Pleistocene reef limestones with well developed marine terraces lie along the coast in this area. The Rivière du Môle has cut a deep gorge into the limestones in a direction perpendicular to the coast. About two kilometers upstream of the Môle the gorge widens to a small valley about 500 meters wide. The valley floor consists of Miocene marls.

Near the head of the valley, which is about 2.5 kilometers in length, the river splits into two branches of roughly equal size. The east branch is fed by a nearby spring, called Saut d'Eau, located at the interface of the valley wall reef limestones and the marly valley floor.

The Môle depends on the river for its water supply. Estimated discharge in the river at a point about two kilometers upstream from the Môle, where the gorge widens into the narrow valley, is 300-400 liters/second. Discharge appears to remain constant where the stream traverses the valley floor. This may be explained by the low permeability of the valley floor marls. Downstream, at a point about 400 meters from the Môle, stream discharge is only 60-70 liters/second. While some water has been used for irrigation upstream, it is believed that water may also be moving into the streambed at this point.

Soils in the narrow valley of Rivière du Môle are calcareous. They vary greatly in texture from clay loam to gravelly loam. They range from poorly drained in the bottom of the valley to well drained on the sides. Most of the gently to moderately sloping areas in the narrow valley are irrigated with primitive diversions. Approximately 25 hectares are irrigated on the alluvial fan just west of Môle St. Nicolas and within the first kilometer upstream. Another 100 hectares are irrigated within the narrow valley along the next four kilometers upstream.

Plantain is the major crop. Chlorosis was evident in several areas of plantain. Corn is the second most important crop ; it is grown both under irrigation and on dry land. Taro is common on very poorly drained soils along the stream. Beans and other food crops are also grown.

III SOCIAL ATTITUDES AND LAND TENURE

At present nearly all vegetables and fruits being sold at the local market come from nearby irrigated lands controlled by only a few large landholders. An estimated 1000 uplanders also utilize the market for trading, and scarce available supplies of fruits and

vegetables must be widely shared. Price fixing may also be a problem here.

Principal organizations of a local nature include a charcoal cooperative, a fishing cooperative which does its own financing, and a Conseil d'Action Communautaire. It is through this latter organization that extensions of improved practices is accomplished. Agriculture and related extension work are generally effected by Agronome Mid: Jean-François who is headquartered in Jean Rabel, 20 miles away. There is also no IDAI agricultural credit assistance available in MÔle St. Nicolas.

Information received from Father John Breslin who operates a small dispensary in the town indicates that there is considerable problem with typhoid and other water carried disorders in the area. He indicated his strong support for any effort to supply potable water or water for irrigation to the town. In his opinion, increased variety and availability of food supply through family gardens would have significant impact in reducing health problems associated with dietary deficiencies. For example, he is currently treating over 400 active cases of tuberculosis, a disease known to be associated with poor nutrition.

Contacts with Prefect Jules Elysée of the Arrondissement of MÔle St. Nicolas, as well as the Magistrat and the President of the Conseil d'Action Communautaire resulted in their expressions of the needs of the community for increasing availability of both potable and irrigation water. They expressed no concern for opposition to the project (principally two large landholders, currently the principal suppliers of fresh fruits and vegetables to the market). The Prefect called a meeting at the market place and informed those present (80-90 persons) of :

1. The need for an expression of their interest in a potable or irrigation water supply ;
2. The need for an understanding that maintenance and operation of such systems would be the responsibility of the people of the town ;
3. The need to support an organization to control maintenance and operation of such a system ;
4. Fees required for water use ;

Response to all points was vocal and favorable with no dissenting opinions being expressed.

During discussions held with a sample cross-section of householders, all were found to be strongly in favor of either a project to supply water for irrigation or for drinking purposes. One attitude surfaced, however, which may influence the approach to be used during project implementation. "Why should we help develop anything that we have to share with others who do not help to construct it ?" Father Breslin experienced the same attitude when building his church and was unable to get any volunteer work donated for its construction. On the other hand, everyone contacted was enthusiastic about the possibilities of obtaining water in the town.

From all observations, the Conseil Communautaire would be the probable nucleus for organizing a group or cooperative to control operation and maintenance of an irrigation system. Mint Jean-François appears best suited to coordinate organization of such group : He should have a locally based agronomic assistant to assist with training, garden planting and implementation. Selected members of the newly formed control and maintenance group should be sent for one week training prior to completion of the system. After training,

they should receive on-the-job supervised training for 2 to 3 months. There is some question whether the collection of fees for water use and regulation of water usage can be entirely controlled by the group since these are functions respectively of :

1. The Tax Service ;
2. The Irrigation Service.

It may be possible to include officials of these services as ex-officio members of the executive board of the organization, but more research will be required to determine this possibility

IV PROJECT RECOMMENDATION

It is recommended that further studies be made to prepare a more detailed plan for the early implementation of this small irrigation project.

Two possible solutions to the serious water shortage within the town of Môle St. Nicolas: The first would be a pipe-line from Saut d'Eau into town, and the second possibility considered was to supply water by diverting it from the Rivière du Môle about 400 meters above the town. See Plate A - Môle St. Nicolas.

The second solution appears to be generally the more feasible and practicably, and incidently is the method used during the colonial period.

A simple low-head diversion structure would be located approximately 400 meters above the town, see Plate B - Irrigation Map. Water can be conveyed into the town through a masonry canal approximately 800 meters long. Distribution of water for domestic and household garden use could be accomplished by a system of laterals through turnouts from the main canal into five (5) streets going in a northeast direction. It is proposed that the laterals be located

on the left hand or lower side of the streets. The laterals will have to cross a number of street inter-section for which street crossings in masonry, about 8 per lateral, will have to be provided.

Cost estimates using labor intensive methods and in large part, local materials, have been prepared and are based on the following major items :

1, each Diversion structure, on-stream, including sluice way and head gate;

600 meters Masonry canal, labor and materials ;

1, each Drainage - Irrigation System ;
Labor and materials.

Including Supervision and Administration, costs are estimated to be, currently, between $60,000 to $65,000.

In addition to the above items, the following should be considered whenever a more detailed irrigation plan is developed. A wasteway should be provided from the end of the main canal down to the bay area, approximately 200 meters long. Such a wasteway or by-pass would permit water to be supplied into the town for domestic use on a regularly scheduled or daily basis. It would also eliminate the need for running the water through the lateral system, thus creating pools of stagnant water to harbour mosquitoes. To provide a place for washing and laundry, a short section of the main canal could be enlarged to one meter wide and 30 to 35 meters long.

This wasteway and widened canal section would add approximately $2,500 to the project cost.

V PROPOSED LOCAL MANAGEMENT

It is recommended that a simple cooperative be formed to administer operational maintenance and management control of the irrigation project. This cooperative is to be represented by a Board of Directors elected from four different zones (one from each zone) within the project area. Each zone is to be made up of an equal number of householders. The President of the local Conseil Communautaire should also serve on the Board and a representative of the Department of Agriculture should serve as an ex-officio member of the Board. The effective operation, maintenance, and management of the system is to include but not restricted to budgeting and assessment of tax for water usage. The Tax Service will collect the tax and turn the funds over to the cooperative to administer. A reserve of no more than 20% over operation and maintenance costs may be held by the Board with any amount over 20% of excess being returned to the general fund. This latter provision should be included to induce efficient management of funds and maximum cooperative benefits to members.

Specifically the Board will have the power to:

1. Establish its own policy, laws, and by-laws within the policy laid down by the Department of Agriculture ;
2. Employ and compensate personnel ;
3. Establish a budget and assess taxes for use of water ;
4. Operate, maintain, repair and regulate use of the system ;
5. Establish privileges and reponsibilities of water users ;
6. Make disporsments.

It is recommended that the Board elect a full set of officers. The ex-officio member will have no vote and may not be elected to office. He will serve in an advisory capacity only.

PROPOSED OPERATION AND MANAGEMENT

The Board of Directors is to employ a Water Master/Dam tender (part time basis) who will have the following responsibilities:

1. Execute operation, maintenance and management of project facilities ;
2. Operate headgate at diversion dam and diversions from main canal according to a rotational schedule established by the Board ;
3. Keep diversion dam, lateral diversions and individual turnouts clear of debris ;
4. Make minor repairs required ;
5. Report major repair requirements and infractions in the use of the water to the Board of Directors ;

Property owners receiving water will be responsible for water turnouts and ditches serving their individual plots.

It is recommended that the Department of Agriculture assign an Assistant Agronome on a full time basis to assits the cooperative in carrying out its responsibilities. His major responsibilities would be to assist the cooperative members to plan and implement improved garden practices as well as to assist the Board of Directors with organizational procedures and requirements.

A foreign extension agronomist will be required to assist on a part time basis during the organizational and implementation phases of establishing the cooperative and family garden plots. This technical assistance requirement is estimated at two months prior to and extending into the period immediately following the complementation of the construction phase of the project.

VI COST - BENEFIT RATIO

The proposed Môle St. Nicolas project does not fit into a logical cost-benefit bracket. It appears obvious that the expenditure of approximately $65,000 to bring domestic and household garden water to some 1000 inhabitants can not be repaid through water-use charges which can be met by the people of this destitute community. These charges can maintain and operate the system, but can not possibly meet capital and interest costs. The capital costs therefore would have to be considered as a grant. Benefits from the system would be in the improved health of the population through the use of household gardens and improved sanitation practices.

VII CONCLUSIONS

The J.G. White Engineering Corporation team concurred in placing the Môle St. Nicolas in an "A" priority group for implementation consideration by the Government of Haiti and USAID.

IRRIGATION MAP

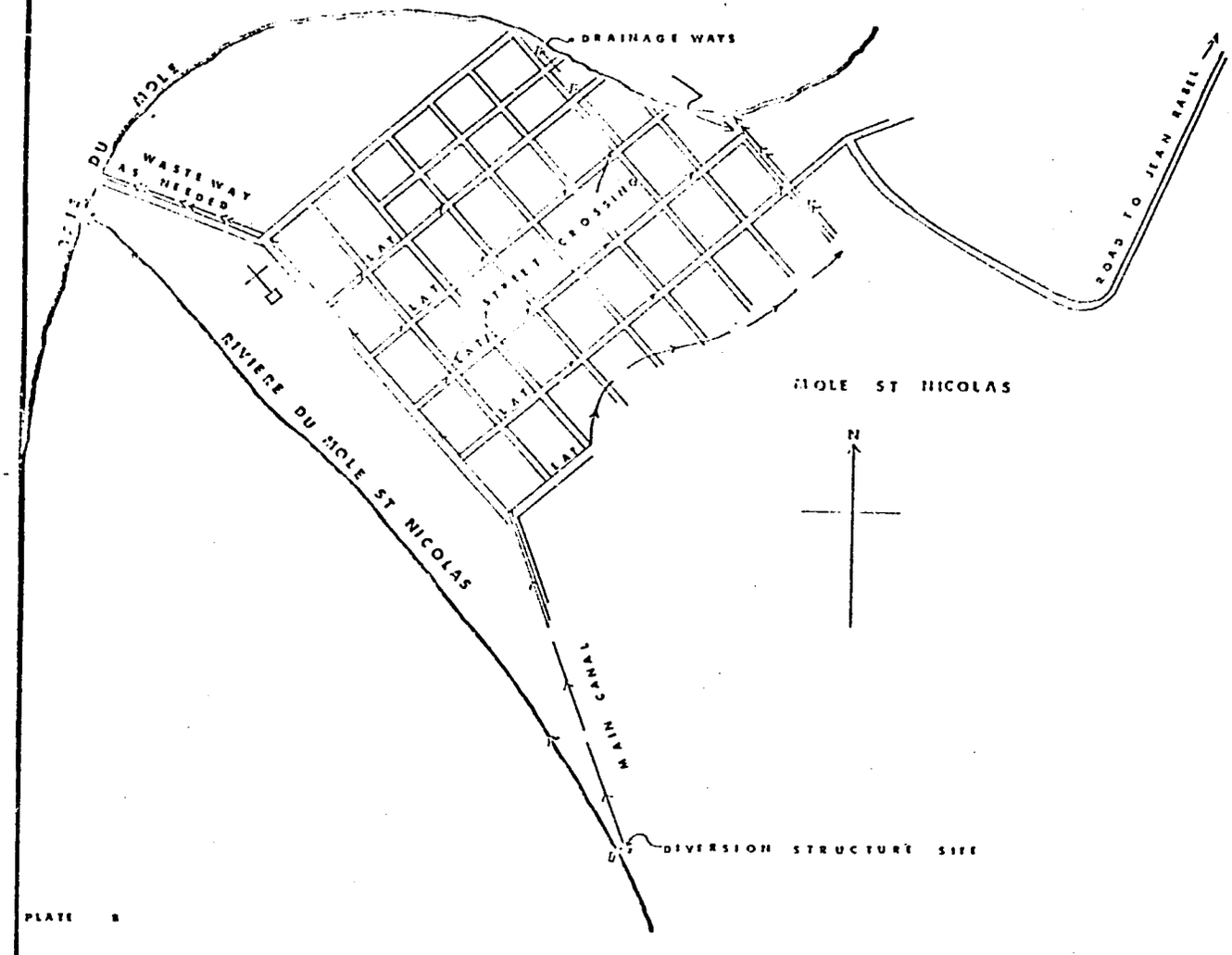


PLATE 8

THE J.G. WHITE ENGINEERING CO.

"TASK C"

BAIE DE HENNE

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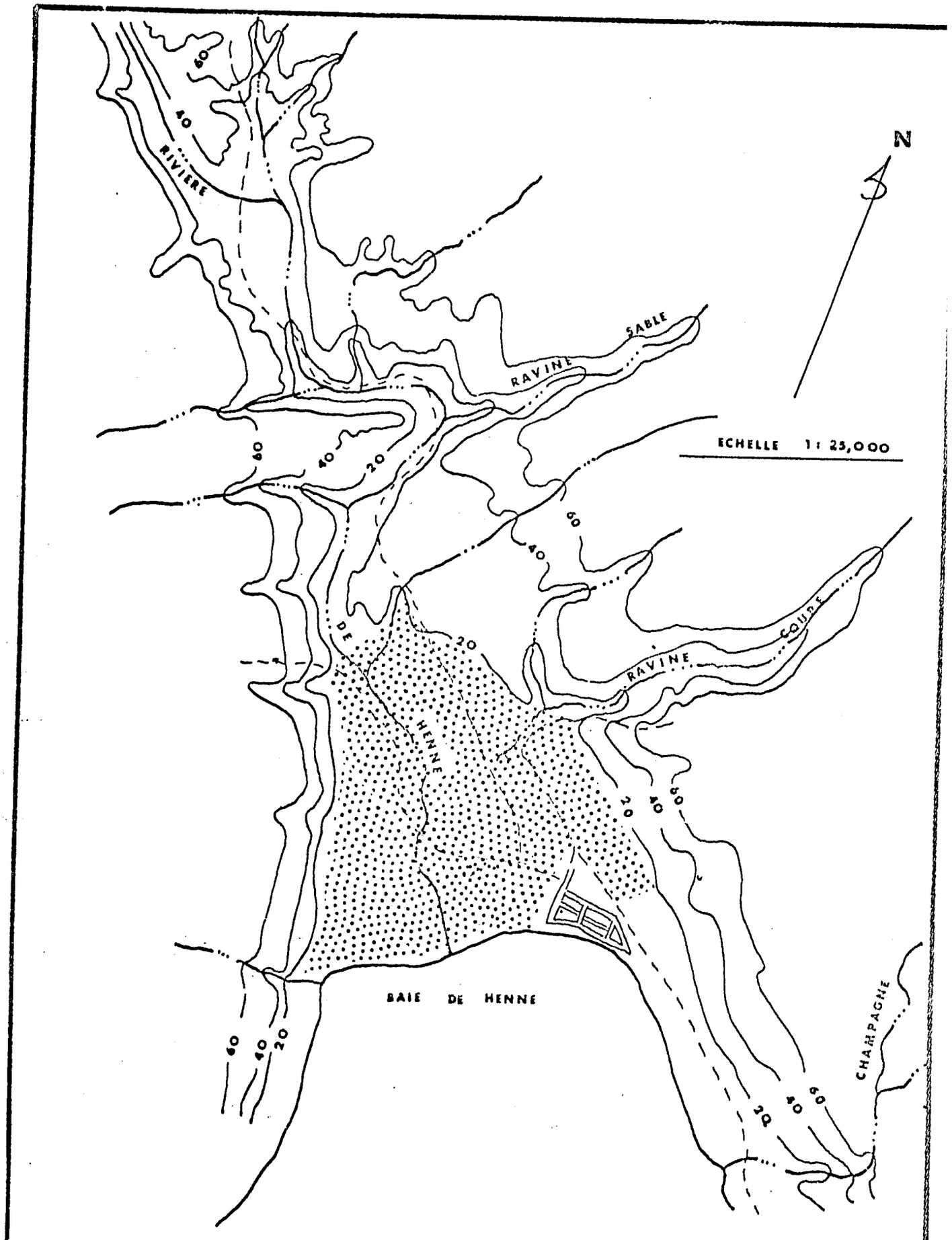

"TASK C" BAIE DE HENNE

THE J.G. WHITE ENGINEERING CO.

"TASK C" REPORT - BAIE DE HENNE IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION
HAITI Irrigation 4792

I INTRODUCTION

Baie de Henne is located in the southern bight of the peninsula of the Department du Nord-Ouest facing the Golfe de la Gonâve. Population is reported to be approximately 715 people of 208 families residing in 175 houses.

II SOILS, GEOLOGY AND CLIMATE

Soils in the valley are calcareous. The soils are well drained, except adjacent to the stream where they are more poorly drained. Silty clay loam and loam textures predominate, but some of the soils are coarser, especially along the edges of the valley and where tributaries join la Rivière de Henne. Most of the soils in the valley are suitable for irrigation, except those with coarse gravally texture. Available stream flow is insufficient to irrigate all suitable soils in Rivière de Henne valley.

Baie de Henne has the lowest average annual rainfall (40 cm - 16 inches) in Haiti. Irrigation is necessary for significant crop production.

III SOCIAL ATTITUDES, LAND TENURE AND MARKETING PRACTICES

About 1970, an irrigation cooperative was initiated with guidance from a religious group, and the cooperative is now functioning as an independent organization. On March 19, members were removing silt from the stilling basin above the barrage. Members have also constructed a drainage channel approximately 3 meters wide to promptly remove excess storm water from the irrigated land. The people in the Rivière de Henne valley seem to be solving their irrigation problems in an orderly manner, and they should be commended for this.

It appears that many of the inhabitants of Baie de Henne also own land in the highlands, in the area of Bombardopolis and the sale of produce from these lands form a major portion of their income. Land holdings in the irrigated section at Baie de Henne average .87 hectares with the largest individual holding being 3.1 hectares.

The major crops are corn and red beans, which occupy approximately 50 percent of the land. Corn and red beans are interplanted in December, and then another crop of corn is planted in April. To date, only two short-duration crops (such as corn, beans, etc.) are grown each year, but the agronome plans to introduce a third short-duration crop annually. Plantain grows on approximately 25 percent of the irrigated land, and small amounts of sugar cane are also produced for local consumption. Cotton is being introduced on about 5 percent of the land. Tomatoes and carrots have been grown previously, but there is no adequate market for commercial quantities. Taro is grown on poorly drained soils along the stream. Sorghum is produced, especially on inadequately irrigated or dry areas.

IV EXISTING IRRIGATION SYSTEM

The Rivière de Henne discharges at Baie de Henne into the Golfe de la Gonâve. About 1961, a barrage was constructed on Rivière de Henne 4.5 kilometers upstream from the mouth to divert water for irrigation.

Flow in the main irrigation canal at the barrage was approximately 1,800 g.p.m. on March 19, 1976. About 175 hectares are irrigated below the barrage for members of the cooperative. Members of the cooperative include people in Baie de Henne and Bombardopolis, as well as those who live in the Rivière de Henne valley. In addition to land in the cooperative, individual farmers, using primitive diversions, are irrigating approximately 75 hectares along Rivière de Henne as much as 10 kilometers above the barrage.

175
75
250

A spring, with a flow of about 2,000 liters per minute, issues from Quaternary coralliferous limestone at sea level at the southeast edge of Baie de Henne. This spring is contaminated with sea water at high tide, but is used at low tide in conjunction with a number of shallow hand-dug wells in town as a source of domestic water.

V RECOMMENDATIONS

The existing irrigation system appears to be functioning well under the management of the cooperative. It does not seem likely that an appreciable increase of irrigable land can be developed or that feasible additional irrigation water can be located.

It is recommended that the Department of Agriculture extend additional technical guidance to both the cooperative members and the farmers individually irrigating their small plots.

VI CONCLUSIONS

This area is rated priority C by the J.G. White Engineering Corporation team.

USTIQUE

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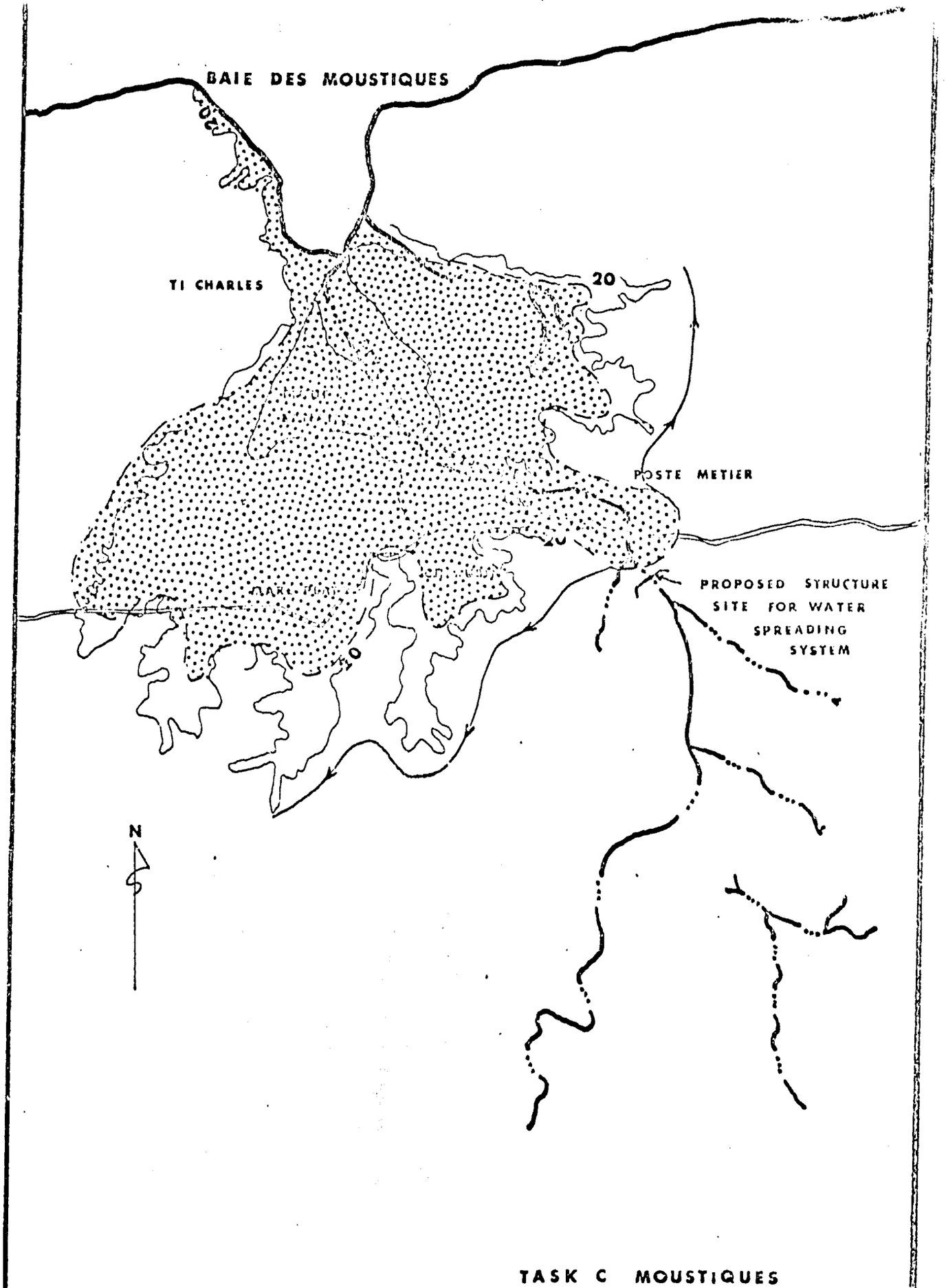


TASK C MOUSTIQUES

THE J.G. WHITE ENGINEERING CO.

"TASK C" REPORT - MOUSTIQUES
IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION
HAITI Irrigation 4792

I INTRODUCTION

The Plaine des Moustiques is the second rural Section of the Commune of Port-de-Paix. The Plaine consists of 900 to 1000 hectares of irrigable land below the 20 meter contour line. Of this area, some 300 hectares are suitable for general farming, 300 hectares will support only cropping of salt resistant crops and the remaining land is so highly saline that a long term leaching project would be required for any normal cropping pattern.

This considerable area of land supports a population of approximately 3700 people representing less than 900 families. Production of charcoal plus subsistance farming is the norm.

II SOILS GEOLOGY AND CLIMATE

The Plaine des Moustiques lies in the north coastal plain between Trois Rivières and the Plaine de Cabaret. It occupies a portion of a broad, well dissected lowland that extends from Port-de-Paix to Jean Rabel. Along the north coast is a range of hills made up of Pleistocene reef limestones that have been breached by the northward flowing Rivière des Moustiques to form the Baie des Moustiques. The plain itself consists of a thin alluvial cover overlying Miocene marls. These marls form hills along the southern edge of the plain.

Soils in the plain derive from the Miocene marl that forms the hills to the south. They are calcareous and contain little organic matter. Texture is clayey to silty and there are few rocks. Fertility is

high but salt content is also high in many areas. Lowest salinity occurs in the floodplain of the Rivière des Moustiques from a point about 4 kilometers upstream of Poste-Métier to a point about 2 kilometers downstream. Salinity increases toward the hills that surround the plain and toward the Baie des Moustiques.

The Rivière des Moustiques is intermittent to ephemeral in the plain. It has a drainage area of 164 km^2 at Poste-Métier. It is reported that discharge at this location varies from 10-50 l/second but these flows are probably of short duration. The river is subject to sudden and severe flooding, due primarily to the removal of vegetation which has increased both volumes and rates of strom runoff.

Ground water in the plain is shallow. An FAO study (1966) states that average depth to water is 3 meters. The quality of water is poor. Ground water becomes more salty at the margins of the plain and toward the sea. Recharge by infiltration or underflow from the river to the alluvial aquifer in the plain apparently does not exceed evapotranspiration with the result that the poor quality water is not displaced.

The climate is semi-arid. Mean annual rainfall varies from 800 mm at Poste-Métier to 1500 mm high in watershed. Rainfall is greatly exceeded by potential evapotranspiration, which probably lies between 1500 to 2000 mm. Highest rainfall months are November, December, January and June.

III SOCIAL ATTITUDES, LAND TENURE AND MARKETING PRACTICES

Administration leadership of the area is provided by a Chef de Section while Agricultural leadership consists of an Agronome and Agricultural technicians Gérard Nozime, Dalien Denis and Lozan Fritz who work out of Port-de-Paix. There is an office of IDAI (for agricultural loans) and an Office of Contributions.

The sole farm organization on the plain is a Conseil Communautaire (100 members) which is led by Florestal Husband (Président). The Conseil has been quite active in road improvement projects and, to a limited extent, in irrigation. Contacts with this group concerning the possibility of conserving (through spread irrigation) the water which is normally lost after a rain throughout the watershed caused considerable enthusiasm. No objections were voiced to paying for water if it is made available. In addition, the group indicated that they would be willing to assume responsibility for maintenance, repair, and control of such a system.

DISTRIBUTION OF IRRIGATED LAND OWNERSHIP

Computations from the list of assessed property owners using irrigation water for 1975-1976 disclosed the following:

Size of tract in hectares	percent of tracts	percent of area
.32 or less	17.0	5.5
.33 to .99	53.9	41.3
1.00 to 2.99	27.8	46.7
3.00 to 4.99	.6	2.4
5.00 or more	.6	4.0

There were 165 tracts with 161.49 hectares assessed. Nine proprietors owned more than one tract. The Cooperative Adventiste was shown as the largest land owner with 6.45 hectares. Eleven others held from 2.58 up to and including 5.15 hectares. The 12 largest owners held 26.1 percent of the irrigated land and constituted 7.7 percent of the total number of owners.

LAND USE

Plantain is grown extensively throughout the area, and together with corn, beans, manioc, grain sorghum and sweet potatoes contitute a major share of the crop land area. Large quantities of charcoal are produced in the surrounding area.

MARKET OUTLETS AND TRANSPORTATION

A small local market and a regional market at Port-de-Paix, about 20 kilometers away, serve the project area. On the shore of the Baie des Moustiques one boat leaves each month with a load of charcoal destined for Port-au-Prince ; other boats leave less regularly from this shipping point. Charcoal probably ranks first in value of products shipped out of the area.

Road transportation is slow, and at certain times of the year is nearly impassable, with the road being untravelable more often between Moustiques and Port-de-Paix than between Moustiques and Jean Rabel.

The present low level of production due to lack of water suggests that a high gross return could be realized from any increase in water that could be made available.

III EXISTING IRRIGATION SYSTEM

The existing primitive irrigation system is dependent upon collection of rain run-off from many intermittent sources plus temporary diversions in the Rivière des Moustiques when flowing, irrigation thus is only possible during and immediately following periods of extended rainfall.
Several studies have been made on methods to alleviate the water shortage problems of the area.

The following information is taken from a report prepared and published by FAO in 1969. They report that studies had been made to supply irrigation water to the Moustiques Plaine. Two possibilities were considered. They are :

1. Creating a storage dam on the Moustiques River ;
2. Diverting water from the Trois River.

Relative to the first suggestion, the report points out that the Moustiques River flows are intermittent and even during wet season the quantities of water are not sufficient to assure reasonable amounts to meet the needs of irrigation requirements in the area. The report also points out that the area of irrigable land is somewhat limited, making it difficult to justify the large expenditure of money in preparing and implementing such a plan.

SCIPA Engineers had studied the possibility of building a dam on the Moustiques River. They proposed placing the dam near Passe Catabois at an elevation of about 130 meters. Height of dam suggested to be about 55 meters, which would store approximately 20 to 25 million cubic meters of water. It was estimated that it would require 225,000 cubic meters of compact earth fill and 390,000 meters of rock to construct the dam. No cost estimates were given. They pointed out that these were just preliminary studies and they should be considered on the basis of hydrologic data, which does not exist as yet. This is necessary in order to make sure that the quantities of water are sufficient to meet the irrigation needs of Moustiuqes Plaine. Also that test holes need to be made in order to determine the kind of soils and materials that exist in the foundation of the dam site and in the reservoir area.

The second suggestion was for diverting water from the Trois River for irrigating the Moustiques Plaine. Preliminary studies were released in 1927 by the Bureau of Public Works and later taken up by SCIPA. Water would be deverted from the Trois River at Fond Citron, about 4 kilometers down stream from Bassin Bleu on the left bank of the river.

Needed would be 30 kilometers of main canal, some of it is masonry, 3 kilometers would be along the left bank of the river and a tunnel 1.4 kilometers long.

In 1951, Le Département des Travaux Publics made another study of this plan to see if an alternative route could be located. They thought the main canal could be shortened and that the tunnel was too long. But no conclusions were reported as to what they thought could be done. They point out that the construction of such an irrigation system would require large expenditures of money. At the time FAO prepared their report, 1966-1969, they estimated the cost to be 1.6 million to 2 million dollars. To justify the large expenditure of money, it was proposed that the plan include the following areas as part of the irrigation system :

490 hectares in Trois Rivières Plaine
1130 hectares in Moustiques Plaine
300 hectares in Plaine de Cabaret
500 hectares in Plaine de Lacoma.

V RECOMMENDATIONS

As a third alternative, we recommend that a feasibility study be made of the Moustiques River and Plaine to develop a plan for a water-spreading system.

At the time of the reconnaissance survey of the Moustiques Plaine in May, there was no flow in the river at Poste-Metier. However, there was evidence that a small flow had occured just a few days before we visited the area as a result of rains in the Haut Moustiques.

A typical water-spreading system would require a structure of some sort across the river or stream itself, which would divert water out on the land. A system of water-spreading ditches or laterals convey the water from a structure to the land on both sides of the river. The

structure is needed to facilitate dividing the water to both sides and to by-pass excess flows during big storms. The number and size of laterals should be determinated by the amount of water that is needed to be put out on the land. The water-spreading system would also help to supply additional quantities of water for leaching those soils which are affected by salinity.

The type of structure and water spreading system suggested would be relatively simple and inexpensive. The local farmers when properly organized in an irrigation district would be quite capable of maintaining and repairing the system. It is not felt that the amount of land effected could justify the magnitude of expenditure required to implement either of the first two studies

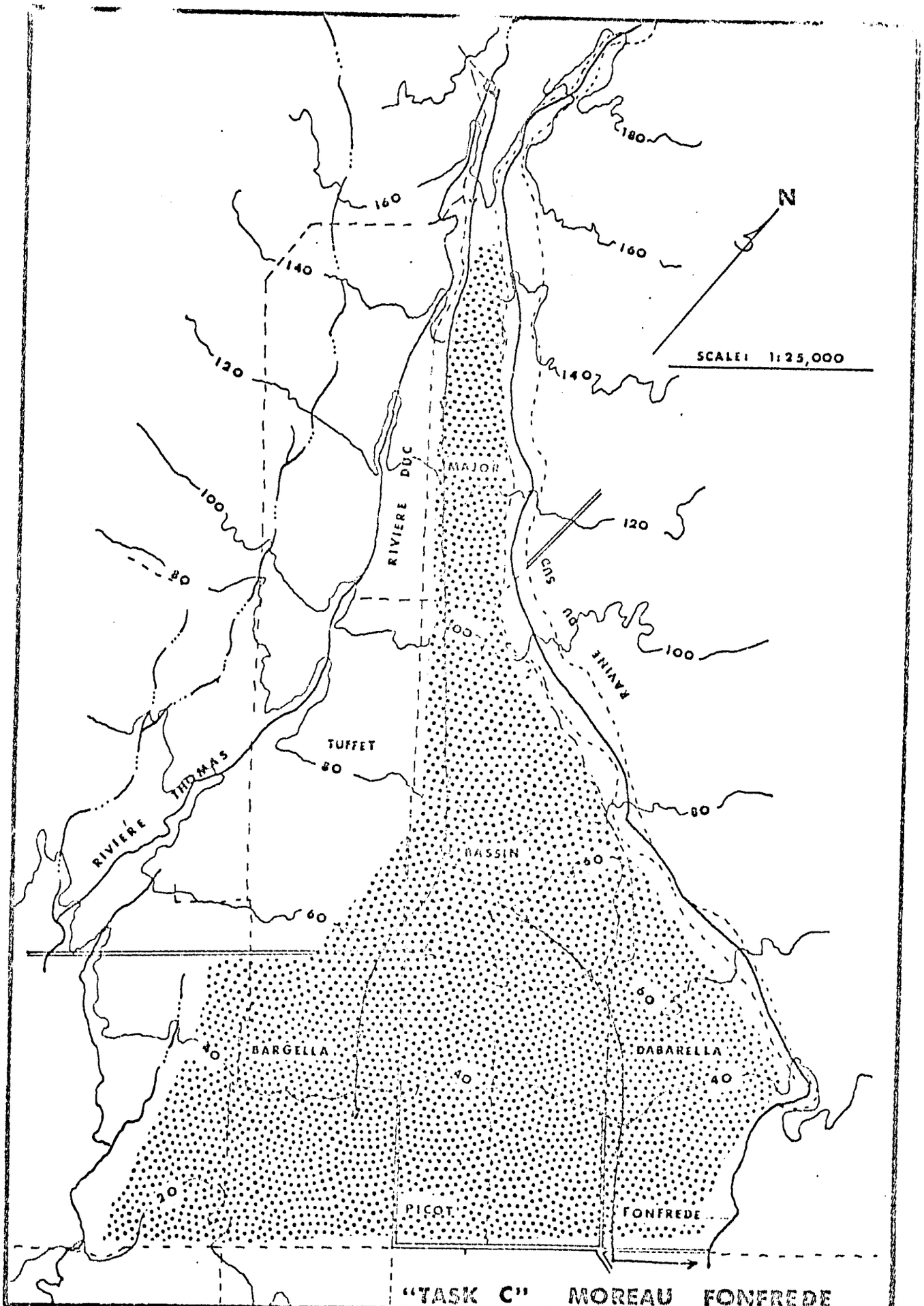
VI CONCLUSIONS

The J.G. White Engineering Corporation team places the Plaine des Moustiques in a "B" priority and recommends that a study be made of a economical water-spreading system when funds are available for this purpose.

"TASK C"

MOREAU-FONFREDE

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK



"TASK C" MOREAU FONFREDE

THE J.G. WHITE ENGINEERING CO.

'TASK C" REPORT - MOREAU-FONFREDE IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION
HAITI Irrigation 4792

I INTRODUCTION

The two areas, Moreau, North and Fonfrède, South, while administered under two separate Communes Cayes and Torbeck respectively, are both located within the Arrondissement des Cayes. Moreau is in the third Section, population 8,500, of the Torbeck Commune and Fonfrède is in the fourth Section, population 1,000, of the Cayes Commune. The two areas are operated as one irrigation system. Within the system area itself there are approximately 450 families. The area of irrigated land, currently 199 hectares, could be increased appreciably from all observations.

II SOILS, GEOLOGY AND CLIMATE

The Moreau-Fonfrède area is located in the center of the Cayes plain just west of the Ravine du Sud. It extends from the hills that border the plain on the north to Fonfrède, 11 kilometers to the southeast. It is underlain by Quaternary alluvial material consisting of gravel, sand and silt. These grade to finer material toward the southeast. The depth of alluvial material is unknown but it may exceed 30 meters near Fonfrède.

Soils are recently developed from the alluvial fill that covers the plain. They are brown silty loams. Near Moreau, the soils contain

some rocks, ranging in size from cobbles to gravel. In the direction of Fonfrède, the soils deepen, become more clayey and contain fewer rocks. The soils are fertile and potential productivity is high.

Water for irrigation is provided by a spring at the head of the Rivière Duc called Source Moreau. Discharge was estimated to be about 1.5 m^3/sec. at the time of the visit to the area in May. It is not known if this flow is reliable. The reason for the location of the spring is unknown, but it may issue from solution cavities in the massive Eocene limestone beneath the thin alluvial cover.

Groundwater is abundant throughout the Moreau-Fonfrède area. At Fonfrède, depth to the water table is reported to be between 7 and 15 meters. Recharge of large volumes of water takes place when flood waters reach the broad, permeable channel of the Ravine du Sud to the east.

Mean annual rainfall probably lies between the values at Camp Perrin and Les Cayes, which are respectively 2,200 and 2,000 mm. High rainfall months are May and October ; low months are December and January. Potential evapotranspiration lies close to 1,500 mm.

SOCIAL ATTITUDES

Moreau and Fonfrède depen upon the agronomes based at Les Cayes for extension assistance. A locally based Service d'irrigation is headed up by recently appointed Syndic, M. Balance.

One organization, 50 active members, exists within the system ; North in the Moreau Section, called "SCATET" or Société de Cooperative Agricole. Its motto is "Têtes ensemble de Tuffaite" ; Tuffaite being the community. Farmers contacted in this area were interested in improving the system. They pointed out that their canal was not large enough to supply the water needed and indicated that they would like very much to have the Ducis canal, (Dubreuil System), in their area. At present, the members of the group are cleaning the canals and performing minor repairs. The general opinion of these contacted was that they would be very interested in managing, maintaining, and learning improved cultural methods in conjunction with a rehabilitated irrigation system. No known groups formal or informal are operating in the Fonfrède, South, section of the system area ; however, opinions expressed there reflected those of their neighbors to the north.

Some agricultural education training is available to farmer and farm leaders at Laborde, some distance away. Home Economics training is available to some 50 girls (22-27 years) at Major, an isolated center within Moreau section of the system. This is a two year school with a teacher being supplied from Damien, (Department of Agriculture). Another centre d'Enseignement Ménager Agricole, 50 students, is operational in Fonfrède, South, which provides training to girls 17-20 years of age. Both schools teach basic improved methods of farming as well as Home Economics.

The only other school is ONAAC No. 50 with 32 students in the Rochepointe Community. It is basically an adult education (reading) effort.

IV MARKETING PRACTICES AND LAND TENURE

Distribution of Irrigated Land Ownership

Computations from the list of owners assessed water taxes in 1975-1976 show the following :

Size of Tract in Hectares	Percent of Tract	Percent of area
.32 or less	41.4	14.2
.33 to .99	45.1	34.5
1.00 to 2.99	12.0	21.0
3.00 to 4.99	-	-
5.00 or more	1.5	30.2

A total of 133 tracts and 119.45 hectares were assessed taxes. These 133 tracts were owned by 126 different proprietors ; five proprietors owned 2 tracts and one owned three tracts.

Ownership is more concentrated within this irrigation system than in any other of those investigated. One proprietor, a family, owned 24 percent of the hectares assessed, and the five proprietors with the largest holdings, all of which exceeded 2½ hectares, accounted for 37 percent of the total area, but constituted only 4 percent of the owners.

Land Use and Cropping Practices

In the upper narrow width part of the system, corn, beans and manioc are the major crops, with tobacco important in Habitation Tuffaite. Brown and dark brown loam and gravelly loam soil types predominate in this part of the system for the crops named. Vetiver and congo beans are grown on the cobbly loam soils in the area. Corn plants in this section showed a lack of phosphorus. Somewhat more of the

land in the upper half of the system is in woodland pasture than in most of the Cayes Plain.

In the lower and much wider part of the system sugar cane is the dominant crop ; tobacco is an important source of income on the farm of the largest proprietor in the system.

A little rice and taro are grown on the depressed clay loam and clay soils, though these crops were mostly grown further below the Fonfrède irrigation system.

A number of farmers in Habitation Tuffaite operate as associates, that is, they receive a portion of the crop for growing it. In Habitation Fonfrède No. I, owned by the largest proprietor, hired labor performs the field operations on sugar cane and tobacco. In the middle part of the system, owner operators predominate. A cooperative group collectively takes care of 1½ carreaux of corn in the Moreau area.

Agricultural Credit

IDAI made loans this past year to finance production costs on 20 hectares of corn and beans. This area was equal to 1/6 of the assessed irrigated hectares in the Moreau-Fonfrède system, but was only three percent of the total crop loans made within nine irrigation systems in the Cayes region.

Market Outlets and Transportation

The Centrale Dessalines sugar factory is only five kilometers northeast of the Fonfrède crossroad. The Fonfrède district west and south-west of this plant supplied 38 percent of the total sugar cane purchased by this factory in 1975, and is the largest supplier.

A clairin plant operated by the largest proprietor processes the sugar cane produced on his holdings. He also buys some cane from other producers. A new industrial alcohol on the north edge of Cayes, about 12 kilometers distant, provides an outlet for a small amount of cane.

A tobacco manufacturer in Port-au-Prince has current contracts for about 100 hectares of tobacco in the Cayes Plain. We observed a large curing shed in Habitation Fonfrède No. I, and five in Habitation Tuffaite, with one or two more under construction.

Corn and beans move readily for sale in the Cayes urban market, and to merchant truckers who transport them to Port-au-Prince.

There is a small local market at Fonfrède and several roadside stands and shops within the irrigation system area which serve as outlets to the local population.

Transportation to the sugar factory and to Cayes is on a relatively wide, but rough road. The road running northwest from the Fonfrède crossroad deteriorates rapidly ; the middle section of the canal system is reached with difficulty and all parts of it are not accessible to motor vehicles. Nevertheless, the nearness of this system's area to Cayes, and the expected improvement in the highway from Cayes to Port-au-Prince will enhance market possibilities for the area.

V EXISTING IRRIGATION SYSTEM

The Moreau-Fonfrède Irrigation System is actually in two parts. The upper section on the north is a part of the Moreau Habitation. This is where the diversion structure is located. The Moreau area is long and narrow with gravelly and cobbly soils. The topography is quite uneven and rolling. The lower end is known as the Fonfrède area has the best soils on more uniform slopes. It is almost as long as the Moreau area, but is much wider.

The diversion structure at the water collection basin is a wall made with gabions. The barrage has deteriorated because of holes between the rocks and cracks in the gabions. Much of the stream flow is lost through the holes and where the gabions are washed out around the ends. The headgate is in good condition and is functioning satisfactorily. Water flow above the headgate was estimated to be approximately 0.85 cubic meters and varies from 0.7 to 1.5 cubic meters depending on the season and time of the year.

Most of the irrigated area at the north end is to the left of the Moreau-Fonfrède canal. This strip of land is 5.5 km long and about 0.5 km wide. The next section is 3.5 km long and 0.5 km wide at the north end and 4 km wide at the south end of this section. Much of the land in these two areas is not irrigated and the land is cobbly and gravelly. The topography has a tendency to be undulating or rolling. The Fonfrède area extends another 3 km to the south and is about 5 km wide.

Approximately 119 hectares are being irrigated at the present time, there are approximately 2,140 hectares in the Moreau-Fonfrède area. So there is considerable additional land which could be irrigated.

The main canal is divided into two canals at the lower end of the project area. The canal to the right of the diversion structure is heavily silted and apparently has not been used for some time.

VI RECOMMENDATIONS

For rehabilitation and improvement of the system the major items would be :

a) Construction of a collector basin at the headgate to replace the deteriorated gabion structure.

b) Rehabilitation of the masonry canal immediately below the headgate where it crosses the low, flat area.

c) Construction of division and outlet structures, several road crossings and some gully crossings.

d) Investigation of the possible need of a drainage system.

VII CONCLUSIONS

The potential increase of approximately 800 meters of irrigated land coupled with an increased productivity will raise the income of the Moreau-Fonfrède inhabitants immeasurably.

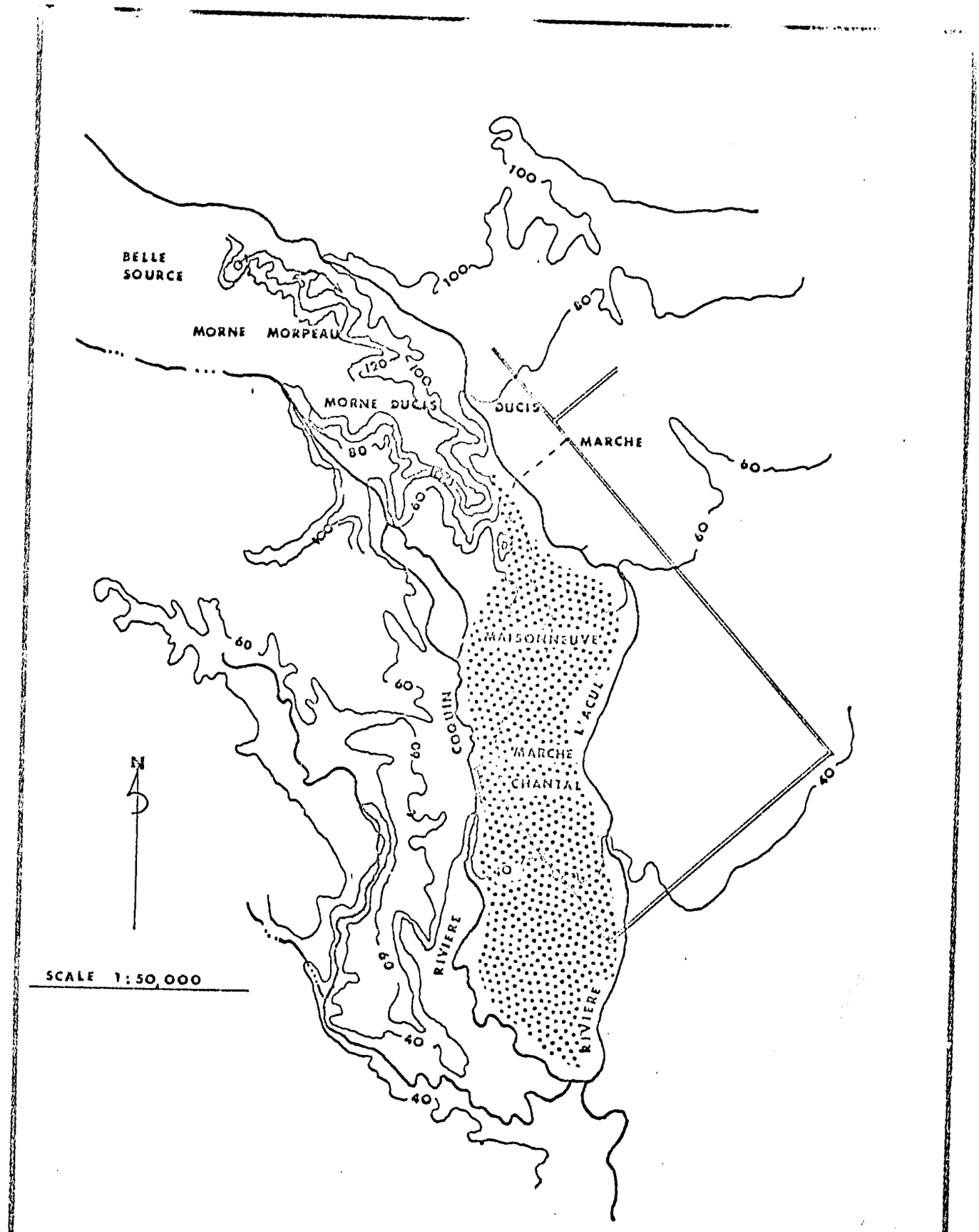
The social attitude of the farmer toward working cooperatively to successfully operate and maintain a rehabilitated system is positive. Although there are several larger than average sized land holdings within the system, these owners are working farmers who apparently act cooperatively with their smaller neighbors.

Moreau-Fonfrède is rated "Priority A" for a feasibility study leading to rehabilitation.

"TASK C"

CHANTAL

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK



"TASK C" CHANTAL

THE J. G. WHITE ENGINEERING CO.

"TASK C" REPORT - CHANTAL

IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION
HAITI Irrigation 4792

I INTRODUCTION

Chantal is a Commune located in the Arrondissement of Cayes. Its three sections total approximately 25,000 rural and 1000 urban population, however it is estimated that of this number only 15,000 to 18,000 actually live on the plain.

Access to Chantal is via fairly rough but passable roads. Most products marketed or sold in the area are brought in on foot, driven, or by pack animals. Trucks move frequently over the rough roads freighting the more bulky items such as barrels of clairin, plantains, charcoal, and hogs which are moving to the more distant markets of Cayes and Port-au-Prince.

II SOILS AND GEOLOGY

Chantal occupies the west bank of the Rivière L'Acul. Two small intermittent streams, the Rivière Coquin and the Rivière des Mornes drain the slopes to the west of Chantal. Their watersheds are developed in Cretaceous marls and Eocene limestones. The Chantal area itself is underlain by Quaternary alluvium, the depth of which is unknown. The Rivière L'Acul at Chantal is dry except at times of flood. Its channel is wide and covered by limestone boulders and cobbles, suggesting that floods are sudden and destructive.

Soils are recently developed from the alluvium and profiles are

poorly developed. They are primarily light textured, brown, silty loams. Potential productivity is high. Fertility is good and the soils appear to be well drained. At the northern end of the Chantal area and close to the slopes on the west, soils tend to become rockier

There is no perennial surface flow in the Chantal area. Water for the Chantal irrigation system is obtained from a spring, called Belle Source, located about 4 kilometers north of the town on the west side of the Acul. The spring flows from the base of a steep, south facing hill composed of thin-bedded limestones. Water may come to the surface along a fault, for there is a major fault zone trending from the town of Chantal to the area of the spring. Discharge is estimated to be 150-200 liters/second and it is reported locally that the flow is reliable.

Mean annual rainfall is 2490 milimeters. This value is higher than the other stations in the Cayes plain reporting rainfall (Camp Perrin and Les Cayes). The high rainfall is probably due to the orographic effect of the hills to the west of Chantal. Potential evapotranspiration is estimated to be about 1500 milimeters. There are no temperature records.

III SOCIAL ATTITUDES

The Chief representative of the Commune of Chantal is Magistrat Elomond St Paul, a long time resident of the area. There is an office of Notaire and a Bureau des Contributions which occupies most of its time with the relatively large market operations which occur on Fridays. They collect no tax from farmers owning irrigated land. The Agronome assigned the area, Teleus St Paul, is stationed at Beroud but is currently in New York. Pierre Guerrier, IDAI agent (Supervised Agricultural Credit), who has been assigned to

his position for four months, is providing the bulk of official agricultural leadership to farmers in the area.

There is a small inactive farm group located in the system area. Opinions expressed were that the group would expand and cooperate to manage an improved irrigation system provided they were assured of water. The IDAI agent indicated that he would like to cooperate in forming an association of farm groups for management of the system and that he felt this would not be difficult. He plans to call a meeting on the first Sunday in June of farmers concerned with irrigation and irrigation possibilities to further observe their reactions.

There are two church affiliated schools, one Ferme Ecole and one Primary School serving the project area. No secondary schools exist however. A small hospital is operated by Catholic Sisters; however, there is no doctor assigned to the area.

The Chantal system lies in close proximity to the Dubreuil system and is separated from it by the Acul River. The people of the two areas are interdependent socially and economically. With the rehabilitation of the Dubreuil system beginning in the immediate future, it is imperative that priority consideration be given to further improvement of the Chantal system. Opinions of those contacted reflect a positive attitude of the people towards managing their own system and revenues.

IV MARKET PRACTICES AND LAND TENURE

Distribution of Irrigated Land Ownership

There was no list available from the Service of Irrigation of proprietors assessed a water tax. We were informed by an IDAI official (and confirmed by an Office of Contributions official) that no tax was paid because too small and too irregular a water supply was available.

We were informed that some farmers owned more than six hectares of land; one large farmer had about 64 hectares, and a second nearly as much.

An estimate of 30 percent of the area of the two largest farms was irrigated, but for another farm of 45 hectares, only 10 percent was irrigated. Farms receiving credit from IDAI averaged 2.5 hectares each, or nearly double that of the majority of farms in the area.

Land Use

The leading crops grown on irrigated land are corn, sweet potatoes, beans, rice and bananas (both figue and plantain). On the non-irrigated land peanuts and grain sorghum are the most important crops, but vetiver, manioc, and other crops are produced.

Both coffee and cocoa trees are found in the shade under larger trees in some parts of the area.

Market Outlets and Transportation

The public market at Chantal is very active on Friday; livestock sales are especially important, but sellers and buyers of many goods use the market. Price data are assembled by IDAI from this market, and for the regional market held on Wednesday at nearby Ducis (also a very important livestock market). Vetiver moves to a factory at Ducis.

Corn is sold both in the local market and to merchant truckers coming from Les Cayes. Part of each of the leading crops moves out of the area to its ultimate users. Many trucks come into the area, especially on Friday. Traffic coming to the area from the northeast and southeast must cross the Acul River bed; there is no bridge. Improvements in the road from Les Cayes to Chantal would help in attracting more buyers to the area, especially after the Port-au-Prince to Les Cayes road is improved.

Agricultural Credit

The IDAI office in Les Cayes reported that production loans for 25 hectares of beans and corn had been made in the past year; this amount is low compared to the 75 hectares in Les Anglais and the 80 for the Perigny irrigation system areas.

V EXISTING IRRIGATION SYSTEM

The Chantal System is located on the west side of the Acul River and gets its water from springs called the Belle Source. It is just across the Acul River from the Dubreuil Irrigation Project, and activities in these two project areas are closely associated. Flow from the spring was estimated to be about 200 liters/second.

At the time of this investigation there was no water flowing in the Acul River and apparently there had been none for several months. There is evidence that at one time attempts were made to divert water from the river, but the flows of the Acul River are forceful and severe during heavy rain storms. It would be very difficult to maintain a diversion structure on the river without the expenditure of a large sum of money.

There is no structure for collecting the water at the spring and to control and direct the flow into the main canal. All the spring water is diverted into the irrigation system but much of it is wasted into the drainage system and through deep percolation, therefore project efficiencies appear to be very low. Much more of the water is lost in conveying it to the lower end of the area because of the poor system of canals and laterals.

The main canal traverses terrain that is rather rough and rugged in the upper end. Some of the canal is located on steep hill sides which are subject to deterioration after the canal becomes saturated. At one point in the canal the water is taken down a steep slope with the aid of structures. The water flows over natural

stream bed of limestone and siltstone and because of the high velocities the sides of the canal are subject to severe erosion. Sections of the main canal have masonry lining, some at the upper end and some in the lower area of the system.

The gross area of the system is about 700 hectares but only 300 hectares are estimated to be irrigable. About 120 hectares are now being irrigated.

VI RECOMMENDATIONS

Because of the close proximity of this area to the Dubreuil Irrigation System it is imperative that serious consideration should be given to the improvement of the Chantal system. Since the amount of irrigation water is limited to spring flow and little likelihood of diverting water from the Acul River, studies will need to be made in order to determine best use of the water. Irrigated area can be increased during wet seasons and restricted to smaller number of hectares in dry periods.

A structure to collect and control the flow of water into the main canal is necessary. This canal should be masonry lined. Additional masonry lining for canals and laterals on the distribution system will be required plus diversion boxes, turnouts and drops, road crossings and several gully crossings. This project should include the construction of a complete drainage system, utilizing the existing drains where possible.

VII CONCLUSION

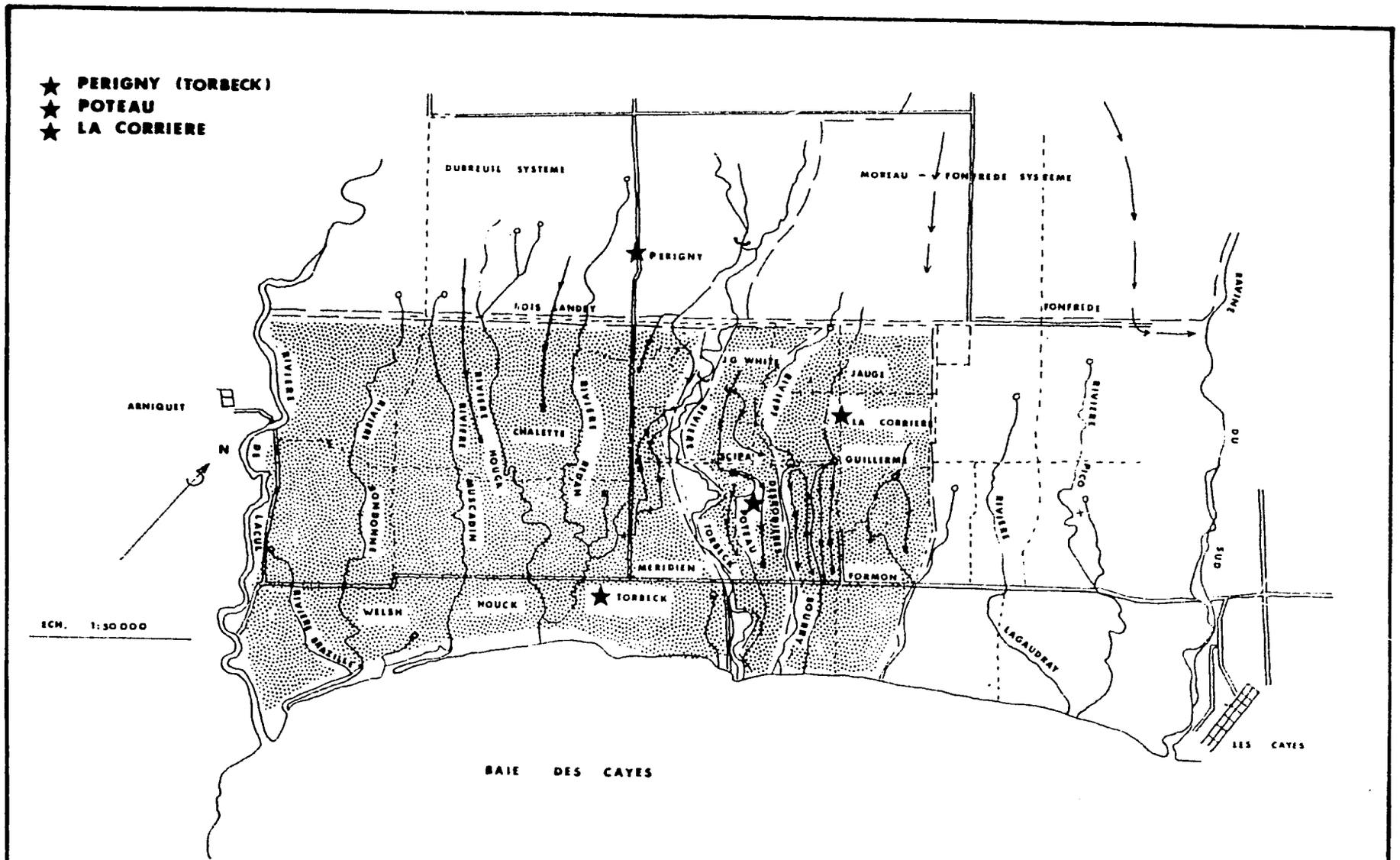
It is estimated that the number of hectares presently being irrigated can almost be doubled. The soils are fertile and potentially productive. The land ownership is such that a large number of inhabitants will benefit from the rehabilitation of the system. The area farmers have indicated at several meetings their desire to cooperate in operating and maintaining an improved system.

Chantal Irrigation System rehabilitation is therefore placed in an "A" priority for a feasibility study.

"TASK C"

PERIGNY (TORBECK)

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK



"TASK C"

THE J.G. WHITE ENGINEERING CO.

"TASK C" REPORT - PERIGNY (TORBECK)

IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION

HAITI Irrigation 4792

I INTRODUCTION

The Perigny Irrigation System is located within the Commune de Torbeck in the Arrondissement des Cayes. Known locally as the "Torbeck", the system occupies most of Bourry, the 2nd Rural Section of the Commune de Torbeck. The "System" involved is actually a composite of several completely separate smaller systems, each receiving water from a different source.

Population of Section Rurale de Bourry is 22,000 (3600 families). The total project area is close to 2700 hectares; however, only a small percentage (15% or 400 hectares) are currently being irrigated. Much of the original complex of canals is in a state of disrepair or not functioning at all. These conditions have deprived most of families living on the Plaine of Torbeck of much needed water for irrigation. Only 360 families, approximately 11% are enjoying such benefits at the present time. If restored the systems together, which originally irrigated 800 hectares, could possibly provide water to close to 1600 Has. and serve an additional 1100 family farm units.

II SOILS, GEOLOGY AND CLIMATE

The Torbeck area is located west of Les Cayes between the Rivière de Torbeck and the Rivière l'Acul. It extends northward from the shoreline to a road that runs parallel to the

coast about 5 kilometers inland. This area of the Cayes plain is underlain by alluvial materials ranging in size from gravels to silts and clays. Close to the shore, there may be some sands derived from uplifted beaches. The depth of unconsolidated alluvial till is not known. The highest elevation in the Torbeck area is about 27 meters. The land surface is flat and slopes evenly toward the shore with a gradient of about 0.5 percent.

Soils are mostly clay loams and clays. They are heavy and range in color from dark brown to black. They have developed primarily from fine grained alluvial materials, they are deep and profiles are well developed. Calcacrous material has been leached from some soils by ground water movement at shallow depths. Fertility and moisture retention are good, permeabilities are generally low and some areas are swampy. Despite their proximity to the shoreline, the soils are free of salt. This is attribute to a shoreward movement of ground water at shallow depths that has flushes the salts and prevents intrusion of sea water.

Torbeck has abundant water, Irrigation water is obtained from the Rivière de Torbeck and several small spring fed streams that originate near the north boundary of the Torbeck area. The Rivière de Torbeck receives water from springs and storm runoff from the Rivière Saint Thomas during periods of rainfall. The drainage area at the town of Torbeck is 89 km^2. Mean daily discharge during the period 1923-1931 was 2.66 m^3/sec at the town of Torbeck.

The largest flow during this period was 188 m^3/sec.

The springs that supply the Rivière de Torbeck and the small streams to the west are fed by ground water moving shoreward through the alluvial aquifer of the Cayes plain. The springs surface near the 30 meter elevation contour. This elevation represents the intersection of the water table and the surface of the plain. The small streams that carry spring flow are generally entrenched to depths of about one meter.

Mean annual rainfall is estimated to be near 2100 mm. Rainfall is highest in May and October and lowest in December and January. Potential evapotranspiration is about 1700 mm.

III SOCIAL ATTITUDES

Three small farm groups exist in the project area. A group of 18 at Welch is led by President Edrisse Jozcelyn. The group is quite active in cleaning and rehabilitating canals in their vicinity. They also operate a small grain storage cooperative. When asked if they pay tax for usage of water, they responded "no—why should we when we do most of the work involved in its upkeep". Membership of this group is still growing and its president feels that rehabilitation of their irrigation system will motivate farmers to become involved in group activities. Another farm group (21 members) in the Mayard Habitation has been inactive for years. Its President Emanuel Bernard pointed out that the group has no common purpose

that it is impossible to repair their irrigation system without outside assistance, and that his group would gladly work together to get their system in operating condition and maintain it if outside technical assistance were provided. Approximately 450 has. are involved in this section of the Perigny system.

A third group at Chalette is quite active. They have shown considerable interest in the maintenance and improvement of their irrigation system. The group expresses a very positive attitude concerning acceptance of increased responsibilties for their system.

Official Department of Agricultural representatives operating in Perigny live in Aux Cayes and commute to work in Torbeck. Principal contacts for the farmers are M. Nerva Gassion, Extensionist and Animateur and M. Frnatz Blaise, Agricultural Technician. Syndic (Ditch Tender) Emil Permie assists farmers with the management of their irrigation systems.

Considerable additional organizational work will be required to prepare farmers of the Torbeck Plain to work together to manage maintain, and administer the various systems. In most sections of the plain, soils have been negleted and depleted. While sugar cane, rice, corn, sweet potatoes, and beans are grown in great quantities, yields are far below those that could be expected if farmers employed improved farming practices. Much additional education (extension) will need to be injected into the area. Agricultural Credit, while supplied by IDAI to some extent, is insufficient and supervision under the program has lacked in quality according to several farmers questioned.

Primary education is available on the Plaine of Torbeck but children attend secondary schools in Les Cayes. A church affiliated dispensary serves Perigny.

IV MARKET PRACTICES AND LAND TENURE

Distribution of Irrigated Land Ownership

The Irrigation Department has been unable to locate a list of proprietors assessed water for 1975-76. It seems likely that no taxes were paid because little or no water was available.

If the ownership pattern existing in the next two systems to the northest prevails, there are no large concentrations of land in a few hands. We did not discover any when in the area.

Land Use

Corn, rice and sugar cane are the principal crops grown, with somewhat more land in trees and pasture, and interspirced with drainage ditches somewhat more than in the Poteau and La Corrière systems.

A variety of fruit tree crops are growing; beans are important and to a lesser extent peanuts and sweet potatoes. A field of tobacco of about five hectares was growing in the extreme northeast part of the areas.

Markets Outlets and Transportation

Rice and sugar cane move to market in or near Les Cayes.

Markets at l'Acul and Torbeck serve this area. Livestock moves northest to large markets at Chantal and Ducis, which also serve as outlets for food crops. Roads are readily accessable, and traffic is heavy. Several parts of the road to Ducis need filling, repairs of several culverts and bridges are needed.

Agricultural Credit

The IDAI office at Les Cayes reported production loans this past year for 80 hectares, mostly for corn. This is fairly high on a comparative basis, and it suggests that many farmers in the area have earned a respectable credit rating.

V EXISTING IRRIGATION SYSTEM

The Périgny-Torbeck Irrigation System has a total area of approximately 2720 hectares. Originally this area had 800 hectares being irrigated. At the present time water is to apply only a part of the area, about 400 hectares. However, there is additional land that could be watered and it is estimated that a total of 1200 hectares of irrigable land could be added to this project. Because of the manner in which water is supplied to the area from rivers or streams, excess runoff from other areas and from springs, there is a very complicated system of canals and laterals; these are now largely silted in and filled with rubble and in very poor condition over most of the irrigated area.

There are three different sources from which water is/or was supplied to this area. The first source was the Torbeck River - where two diversion points were located. Both have been destroyed by floods on the Torbeck River, with only the canal systems still remaining. The first diversion point was about 1500 meters north of the Bois Landry road, situated in the locality or the Perigny Habitation, the other diversion site was about 800 meters south of the Bois Landry road.

The second source is excess water from the Dubreuil Irrigation System to the north. Water available from this source depends on how much becomes excess runoff from the Dubreuil area.

The third and most important sources of irrigation water are the springs in the area which are fed by underground flows with water that percolates into the coarse gravelly and cobbly strata. Water enters these stratas at the upper end of the plain and emerges as springs in the lower end of the area. Many of these springs are large enough to start small rivelets or perennial streams and the location of the important ones are shown on the map. There are quite a number of small systems within Torbeck that are being irrigated from springs. Some of the larger systems are Welsh and Chalette. Because of the many springs from which water is used, it is most difficult to arrive at quantities of water that are available for irrigation purposes. From observations in the field, there are large amounts of water which are presently unused for irrigation.

VI' RECOMMENDATIONS

Coupled with the fact that much of the water supplied to the Plaine de Torbeck is runoff from the Dubreuil system (North) and from springs which may be affected by rehabilitation and redistribution of water in that system, further study of the Perigny system should be delayed till Dubreuil is completed. One possible exception which should receive close attention is the Mayard Area which in the past received its water from the Torbeck River. Yields could be at least doubled in the 450 Ha. involved.

Some major items to be considered in any future feasibility study are: first determination of the amount of excess runoff water that is available form the Dubreuil system to irrigate the upper part of Torbeck. Next determine the feasibility of diverting water from the Torbeck River to the areas that were irrigated in the past from the river. And finally develop an intergrated system of canals and laterals to distribute irrigation water from the various spring flows.

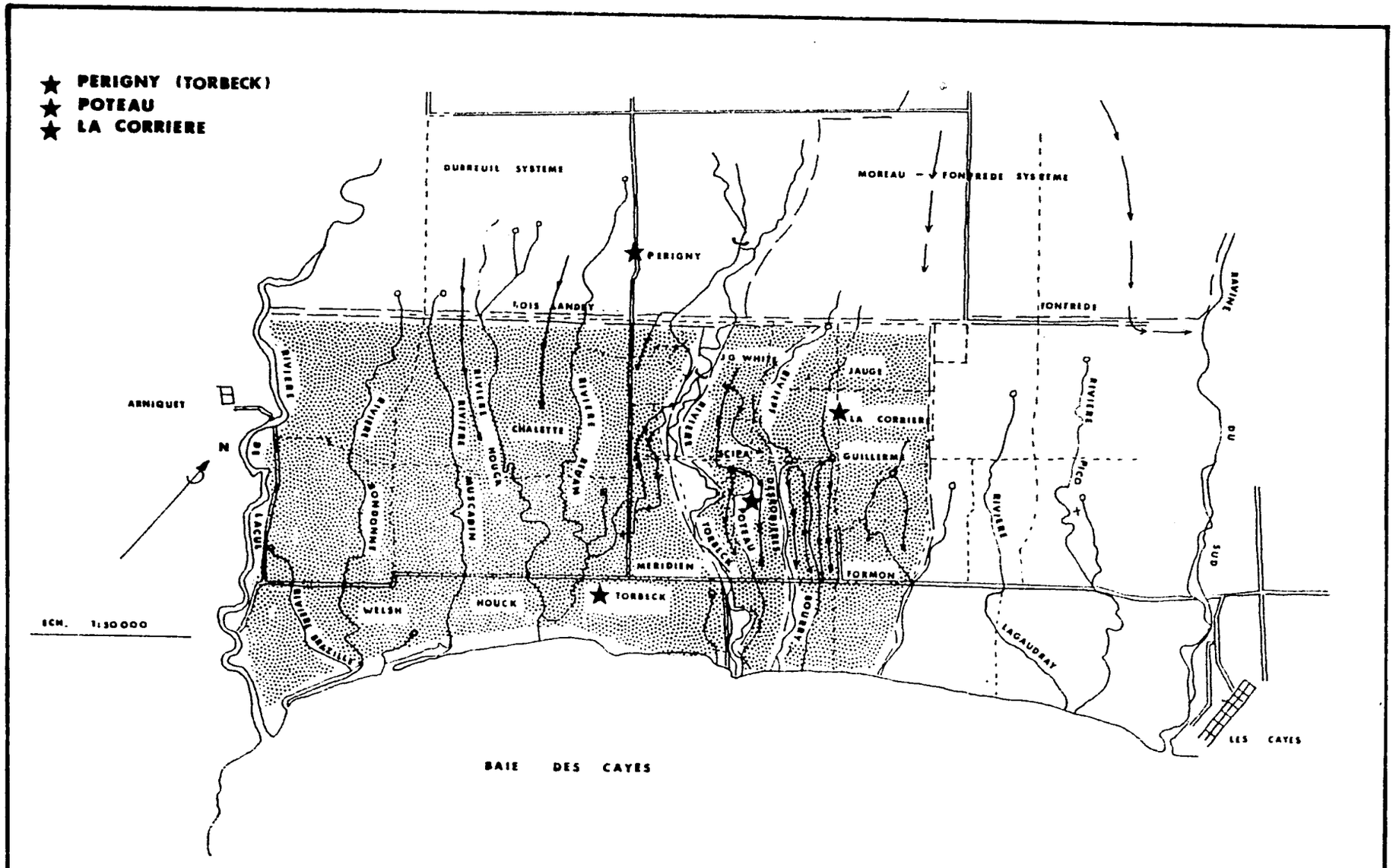
VII CONCLUSIONS

Perigny (Torbeck) is given a "B" priority, based largely upon the number of farmers who would be beneficially effected by an improved system. It is recommended however that a feasibility study for this area be delayed until the total effects of the Dubreuil rehabilitation on run-off can be accurately determined.

"TASK C"

POTEAU

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK



THE J. G. WHITE ENGINEERING CO.

"TASK C" REPORT - POTEAU

IRRIGATION AREA

PROJECT: 521-15-190-069

THE J.G. WHITE ENGINEERING CORPORATION

HAITI Irrigation 4792

I INTRODUCTION

The Poteau Irrigation System lies just to the Southwest of the Torbeck River in the Section Rurale de Bourry, Commune de Torbeck, Arrondissement des Cayes. There are approximately 2800 people (450 families) living in this area of 460 hectares.

Farms in the project area are predominately in rice (South) and in divertified crops (North). Farm sizes vary between - 1 - 1½ hectares with many of these holdings fractionalized into several smaller units.

II SOILS, GEOLOGY AND CLIMATE

The Poteau area occupies a narrow strip between the Rivière de Torbeck on the west and the Rivière Desrodières on the east. The strip extends inland from the shoreline a distance of 5 kilometers. It is underlain by fine grained alluvial materials typical of the seaward edge of the Cayes plain. Some uplifted beach sands may be found close to the shore. The depth of alluvial materials is not known. The land surface is flat and slopes gently toward the sea with a gradient of about 0.5 percent.

Soils range from clay loams to clays. They are heavy and dark brown to black in color. They have developed from fine grained alluvial material and they are deep. Soil profiles are well developed.

In some places, calcaceous materials have been removed by circulating ground water. Fertility and moisture retention are good, permeabilities are generally low and some areas are poorly drained or swampy. Poteau has abundant water. Irrigation water is obtained from springs that are fed by ground water moving to the surface through the alluvial till of the Cayes plain. Spingflow is probably reliable. No discharge estimates were made at springs in the Poteau area.

Mean annual rainfall is about 2100 mm. Highest rainfall months are May and October; low months are December and January. Potential evapotranspiration is estimated to be 1700 mm.

III SOCIAL ATTITUDES

One Agricultural Group exists at Poteau (13 members.) Its president, Oscar Jean beleives that the reason that their former irrigation system failed was that there was no farm group to take care of the canals. He pointed out that his group was in favor of managing their own system. He also stated that while farmers do not pay tax for water at the present time, they realize that an organization would need income in order to effectively maintain an improved system. Such an improved system, in his opinion, would necessarily incorporate a collection basin, stabilized canals and water distribution, and improved drainage. While a fragile nucleus exists for formation of a group to manage, administer, and maintain the Poteau system, such an organization should be incorporated as a federation of groups with the La Corrière (Gaugue/Guilliam) system.

Such a federation of groups would strengten the group and provide increased unity of purpose in the area.

Technical agricultural assistance from DARNDR (Department of Agriculture) is provided to farmers in the Poteau area by Nerva Caission, Extensionist Animateur and Frantz Blaise, Agricultural Technician.

Educational Services (primary School) and health services (dispensary) are provided at Torbeck and not in the project area.

IV MARKET PRACTICES AND LAND TENURE

Distribution of Irrigated Land Ownership

Computations from the list of proprietors assessed water taxes in 1975-76 show the following:

Size of tract in hectares	Percent of tracts	Percent of area
.32 or less	32.4	9.9
.33 to .99	48.5	41.5
1.00 to 2.99	14.7	26.2
3.00 to 4.99	2.9	13.2
5.00 or more	1.5	9.2

The fractionization of holdings is high, with many different fractions of a hectare existing.

Assessments were made on 68 tracts totaling 55.22 hectares, with an average of .81 hectare per tract. Five owners owned more than one tract (11 tracts in total). Fifty-seven proprietors (92 percent) owned only a single tract. Hectares owned per proprietor averaged .89.

Only four owners had assessed areas exceeding 2 hectares. Together they accounted for 27.5 percent of the assessed area, but only 6.4 percent of the number of owners. The largest land holder accounted for 9.2 percent of the assessed area.

Land Use and Cropping Practices

Rice in the predominant crop in this system, being grown of approximately 40 percent of the area. Sugar cane is the second most important crop; bananas, corn and taro occupy lesser but significant areas. Usually two crops of rice are harvested within one year, and often two crops of corn.

Market Outlets and Transportation

The nearby market at Torbeck, and numerous shops and stands on the road between Cayes and the area, and near the Bois Laudry crossroad enroute to Ducis serve producers in this area. Considerable rice moves to Les Cayes.

The sugar mill north of Cayes receives a significant amount of sugar cane from this area (13 percent of its 1975 supply came from its Torbeck district). There are other outlets for sugar cane: the clairin factory near Fonfrede, the industrial alcohol plant in Les Cayes, and sales by shops and stands by the piece for direct human consumption.

Transportation is readily accessible to the above markets, and the roads are wider than average.

Serious cave-ins at bridges between Les Cayes and the road to Ducis, and at the ford across the Torbeck river, have occured in 1976, and if not repaired soon will seriously affect product movement from this area. Traffic is extremely heavy (on to Ducis, Chantal, Port Salut), and road maintenance merits a high priority from those responsible.

Overall, this area is well served by roads crossing the area and on two sides of it.

Agricultural Credit

The IDAI office in Les Cayes reported that loans for production of 10 hectares of rice were made in the Poteau system in 1975. This is relatively low, being only 18 percent of the assessed area, compared to 73 percent for the La Corrière system.

V EXISTING IRRIGATION SYSTEM

The Poteau Irrigation System is the area between Perigny (Torbeck) System, which is on the west side, and the La Corrière System which is on the east side. The gross total area of the Poteau System is 460 hectares. We were told that about 55 hectares of land are being irrigated. The main source of water for this area is a spring fed stream called River Poteau.

Attempts were made to identify the different parts of the irrigated area with guidance from the local people. Because of the complex system of canals and laterals, the three systems,

namely Perigny, La Corrière and Poteau depend on each other on the way the irrigation systems distribute water to the irrigable areas. All three of the systems depend upon springs in large part for their irrigation water.

Water is diverted from the River Poteau at two locations. The diversion structure at the upper end of the area was built originally by J. G. White Engineering Corporation. It was later rebuilt and washed out and primitive methods are being used at the present time to divert water from the river. The second diversion structure is located about 1200 meters down stream, built by SCIPA, it is a masonry structure and appears to be in reasonably good condition. However, the main canal below the haedgate is in a fairly deep channel with a very heavy growth of vegetation along the banks. Through neglect and lack of maintenance the canal channel is almost completely plugged. An ancient aquaduct and sugar mill is located near this structure site.

There is additional land in the area that could be irrigated if additional supplies of water were available. However, the water supply to this area is limited to spring flows and not much can be done to increase the amount of water that could be made available for irrigation purposes. Inspection of this area indicates that irrigation efficiencies are very low. Because of the nature of springs as they emerge in this area it was difficult to arrive at estimated flows.

VI RECOMMENDATIONS

It is recommended that further studies on this area be done in conjunction with the Perigny-Torbeck and La Corrière Systems whenever they are considered for feasibility studies. It is further recommended that these studies should not be started until rehabilitation of the Dubreuil system is completed.

In the prospective feasibility study important items to consider are, first the restoration and repair of the diversion structures. The construction of masonry canals and laterals; diversion structures with turnouts; the repairing of road crossings and addition of some gully crossings; the addition of drainageways in addition to those all ready in existence.

Since this area gets water from a spring, and depends in part on what is taken out of the river above before it percolates into the aquifer, there is not too much that can be done to increase water supply within the area. The water flowing now tends to maintain the water table fairly near the surface, for the land is relatively level. The benefits in relation to costs are not likely to be high were this system to be rehabilited.

VII CONCLUSIONS

The Poteau system is rated as a "C" priority.