AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

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Batch 1

1. SUBJECT CLASSIFICATION	A. PRIMARY: Food production and nutrition	AP12-0000-G324
	B. SECONDARY: Drainage and irrigation--Haiti	

2. TITLE AND SUBTITLE

Engineering services in Haiti; final report

3. AUTHOR(S)

(101) White (J.G.) Engineering Corp.,New York

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1978	270p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

White

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

(Includes monthly reports for Dec.1977 and Jan.1978)

9. ABSTRACT

10. CONTROL NUMBER: PN-AAG-003	11. PRICE OF DOCUMENT
12. DESCRIPTORS: Assessments, Cost analysis, Engineering, Feasibility, Haiti, Irrigation	13. PROJECT NUMBER: 521006900
	14. CONTRACT NUMBER: AID/la-C-1117
	15. TYPE OF DOCUMENT

AID 590-1 (4-74)

AID/[illegible]-C-1117
White

FINAL REPORT

INCLUDING MONTHLY REPORTS
FOR

DECEMBER 1977
JANUARY 1978

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK

FINAL REPORT

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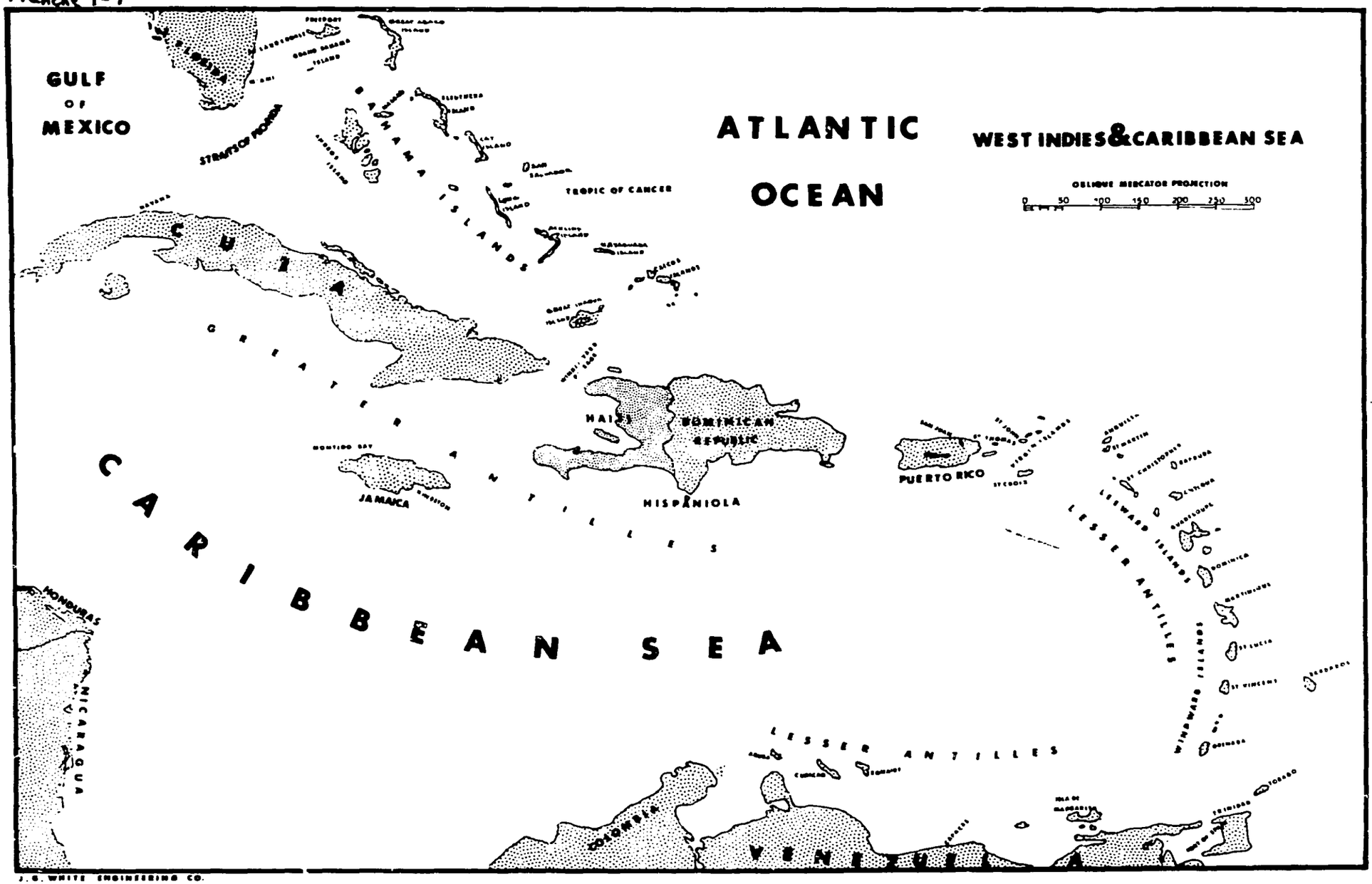

J. G. WHITE ENGINEERING CO.

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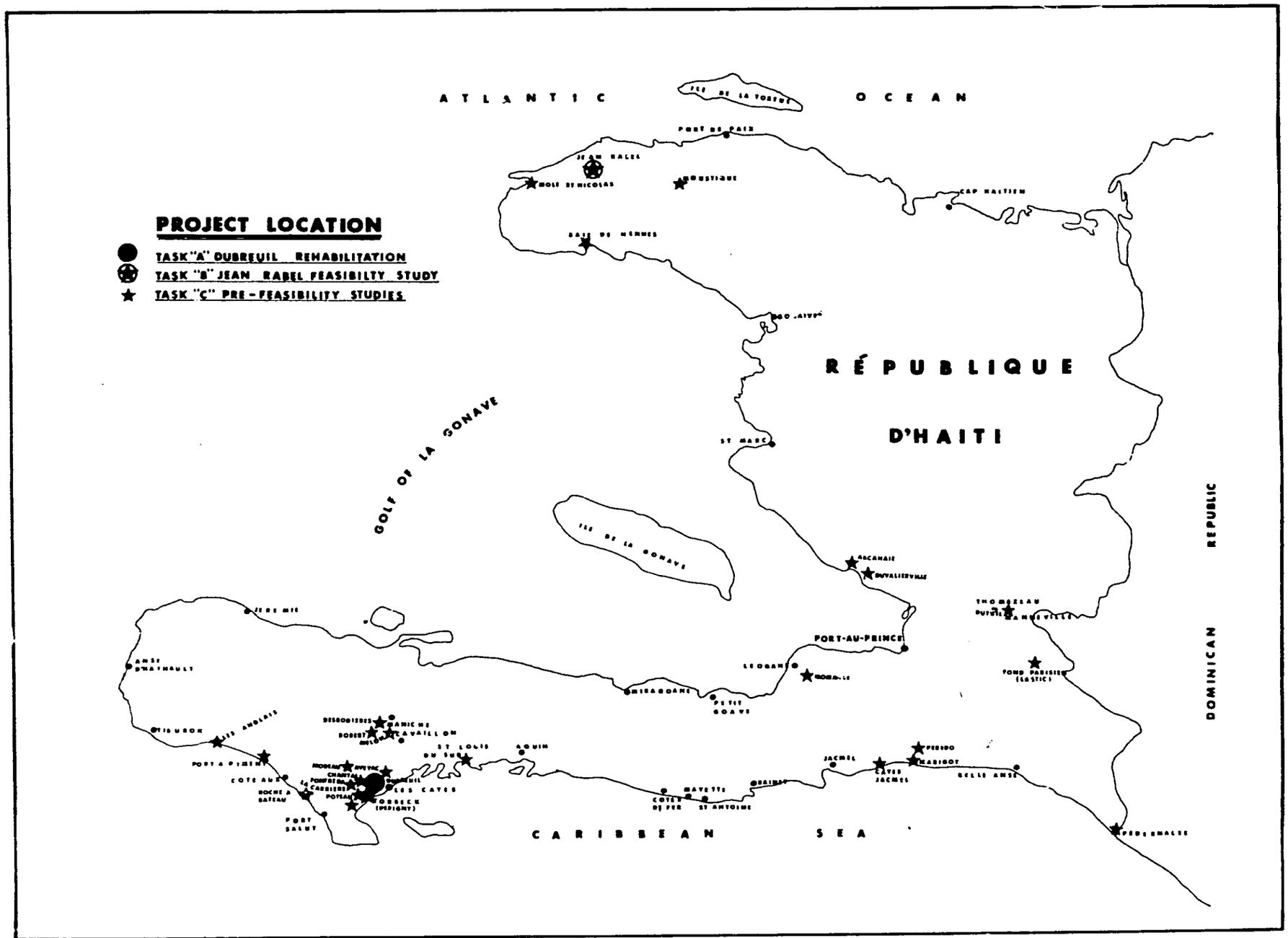
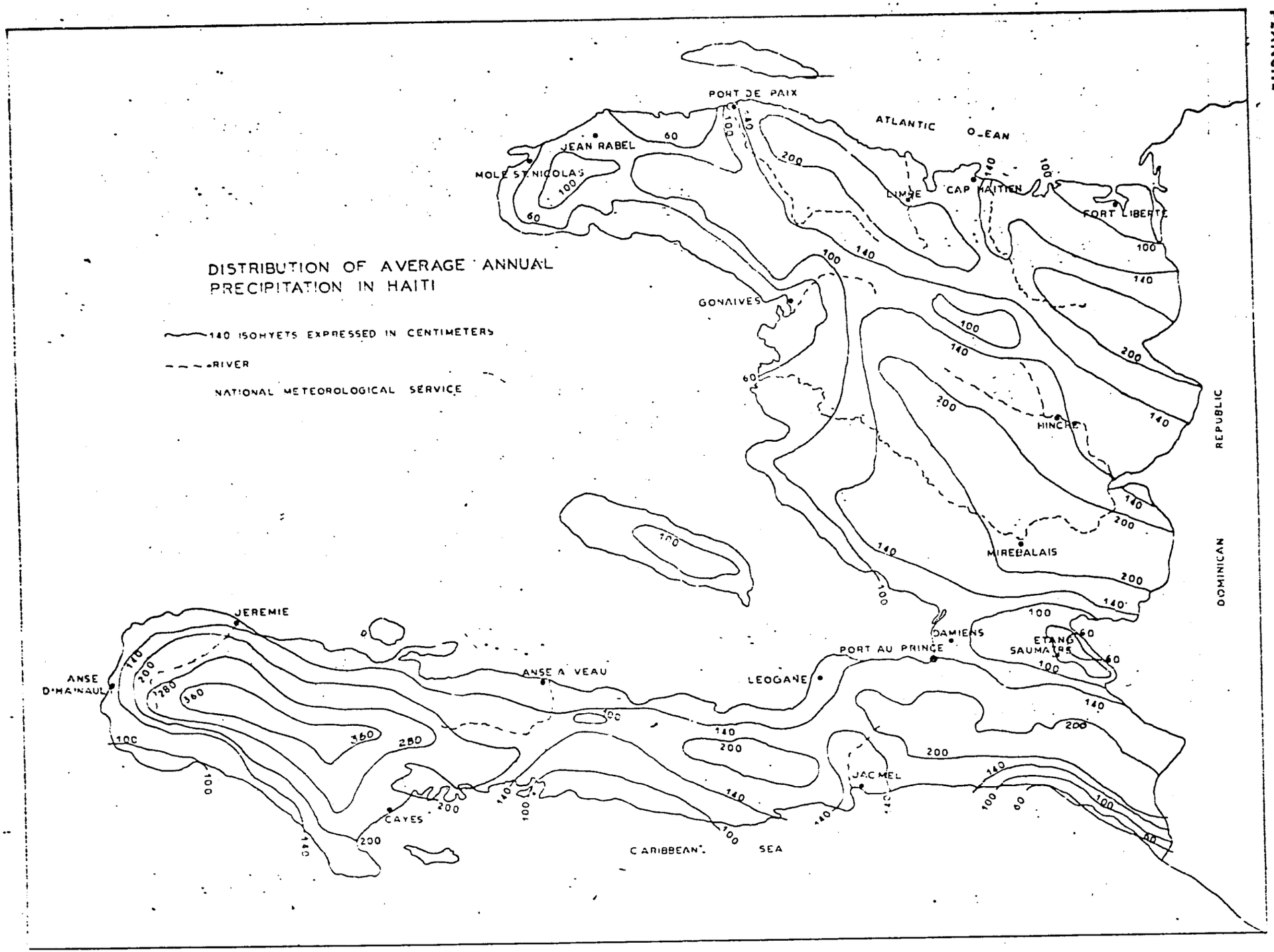


THE J.G. WHITE ENGINEERING CORP.


DISTRIBUTION OF AVERAGE ANNUAL PRECIPITATION IN HAITI
140 ISOHYETS EXPRESSED IN CENTIMETERS
RIVER
NATIONAL METEOROLOGICAL SERVICE
PORT DE PAIX
JEAN RABEL
MOLE ST. NICOLAS
ATLANTIC OCEAN
LIMBE
CAP HAITIEN
FORT LIBERTE
GONAIVES
HINCHE
MIREBALAIS
DOMINICAN REPUBLIC
JEREMIE
ANSE D'HAINAULT
ANSE A VEAU
LEOGANE
PORT AU PRINCE
DAMIENS
ETANG SAUMATRE
JACMEL
CAYES
CARIBBEAN SEA

1.0 INTRODUCTION

The Republic of Haiti is part of the island of Hispaniola, which is located about 700 miles southeast of Florida between the islands of Cuba and Puerto Rico. It lies between latitudes 17°39' and 20° north and longitudes 68°20' and 74°30' west. Hispaniola is the second largest island in the greater Antilles. Haiti occupies the western third of the island; the eastern two-thirds is the Dominican Republic. Haiti is shaped roughly like a horseshoe with two prominent peninsulas enclosing a large bay that opens to the northwest in the direction of Cuba. Haiti's land area is 27,750 square kilometers (10,714 square miles).

Eighty percent of the land area in Haiti is mountainous. There are five principal mountain chains. The Massif du Nord forms the northeast peninsula. To the southeast lie Montagnes Noires followed by the Chaîne des Matheux. The Massif de la Selle, with the highest peak in the Republic at 9400 feet (2860 meters) is located in the southeast. The Massif de la Hotte forms the western half of the southwest peninsula. All ranges trend roughly southeast to northeast.

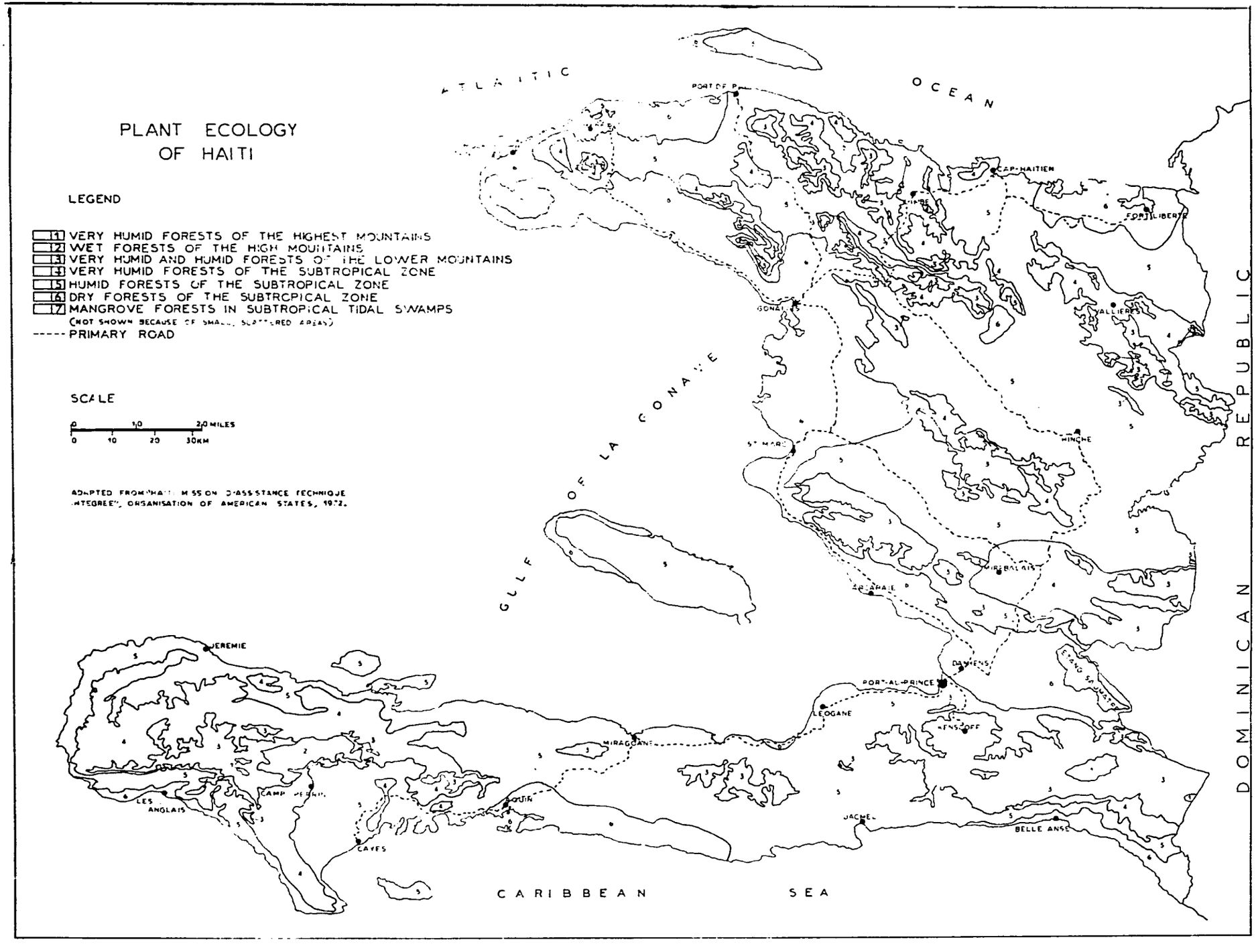
The four major plains and plateaus are: The Plaine du Nord on the Atlantic side - the Plateau Central between the Massif du Nord and the Montagnes Noires and the Plaine de l'Artibonite between the Montagnes Noires and the Gulf de la Gonave. The Plaine du Cul de Sac divides the country into the two peninsulas.

The Rivière de l'Artibonite is Haiti's only major river. A dam at Peligre controls flooding, supplies a constant source of irrigation water for the Artibonite Valley and hydro-electric power for the capital city of Port-au-Prince. Many other rivers of shorter length rise in the mountains, but most are seasonal or lose the greater portion of their flow volume through percolation en route to the sea.

Haiti is the Western Hemisphere's second smallest republic but is by far the most densely populated with an estimated 4.5 million inhabitants.

Eighty-eight percent of the population is rural and considering only cultivated and pasture land, population density approaches 950 per square mile. Of this rural population, 93% are self-employed family workers farming a family holding of less than one hectare of land. The continued fragmenting of land ownership from the colonial period to the present time has resulted in drastic change in cropping patterns. Where formerly cash crops such as sugar and coffee requiring large tracts for efficient production were grown, the breaking up of the large colonial estates to small individual plots has created a small farmer who produces for personal consumption and barter. This in turn has resulted in almost a total loss of the export trade which had made Haiti the most prosperous of all of France's colonies.

During the colonial period numerous irrigation systems were constructed which served single estates (habitations) and in several areas joint efforts created large irrigation districts.


PLANT ECOLOGY
OF HAITI
LEGEND
1 VERY HUMID FORESTS OF THE HIGHEST MOUNTAINS
2 WET FORESTS OF THE HIGH MOUNTAINS
3 VERY HUMID AND HUMID FORESTS OF THE LOWER MOUNTAINS
4 VERY HUMID FORESTS OF THE SUBTROPICAL ZONE
5 HUMID FORESTS OF THE SUBTROPICAL ZONE
6 DRY FORESTS OF THE SUBTROPICAL ZONE
7 MANGROVE FORESTS IN SUBTROPICAL TIDAL SWAMPS
(NOT SHOWN BECAUSE OF SMALL, SCATTERED AREAS)
PRIMARY ROAD
SCALE
0 10 20 30 MILES
0 10 20 30 KM
ADAPTED FROM "HAITI: MISSION D'ASSISTANCE TECHNIQUE INTEGREE", ORGANISATION OF AMERICAN STATES, 1972.
ATLANTIC OCEAN
GULF OF LA GONAVE
CAPE HAITIEN
FORT LIBERTE
GONAIVES
ST MARC
HINCHE
ARCAHAIE
PORT-AU-PRINCE
DAMIENS
LEOGANE
JEREMIE
LES ANGLAIS
CAMP PERRIN
CAYES
JACMEL
BELLE ANSE
CARIBBEAN SEA
DOMINICAN REPUBLIC

1.01 ACKNOWLEDGEMENTS

Grateful acknowledgements for assistance and cooperation rendered to the consultant during the course of the contract are extended to :

Members 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

Personnel of many of the International Agencies, particularly, HACHO.

The expatriate members of the consultant's team were most ably assisted by a group of dedicated Haitians; notably Mme Marie Madeleine Price-Mars, Melle Joelle Barthelemy and Engineer Lionel Estime.

1.1 The J.G. White Corporation Staff

Periods of Haitian assignments

Project Manager	Walter D. Cameron Arrived 7 November 1975 to 31 January 1978 27 man months
Topographer	Joseph Argo Arrived 21 November 1975 to 1 January 1976 critical illness 1 man month
Soil Scientist Agronomist	Dr. Russell Odell Arrived 2 December 1975 to 2 April 1976 4 man months
Irrigation Engineer	Henry Gembala Arrived 16 January 1976 to 11 January 1977 12 man months
Topographer Construction Engineer	Thomas Ryan Arrived 4 March 1976 to 8 December 1976 10 man months
Agricultural Economist	Dr. R.J. Mutti Arrived 6 March 1976 to 30 July 1976 6 man months

Extensionist-Sociologist	Clarence E. Burgett, Jr. Arrived 6 March 1976 to 15 January 1978 22 man months
Geohydrologist	Dr. Roger Peebles Arrived 1 April 1976 to 31 August 1976 5 man months
Construction Engineer	Anthony Vassilaros Arrived 2 February 1977 to 30 April 1977 3 man months
Irrigation Engineer	Warren Leatham Arrived 2 February 1977 to 30 April 1977 3 man months
Construction Engineer	Edward Jorgensen Arrived 17 May 1977 to 31 January 1978 8.5 man months
Irrigation Engineer	Paul Holm Arrived 17 May 1977 to 15 August 1977 3 man months

HAITIAN STAFF

Design Engineer Liaison (Paup)	Lionel Estime Employed 1 May 1977 to 31 31 January 1978 9 man months
Liaison (Jean Rabel)	Ricot Jean Employed 1 May 1977 to 31 January 1978 9 man months
Office Manager (Paup)	Mme Marie Madeleine Price-Mars Employed 15 November 1975 to 31 January 1978 26.5 man month
TOTALS	104.5 man months U.S. staff 44.5 man months senior Haitian staff 8.5 man months home office support

1.11 Contract Requirements

The total number of man months under the one year contract was 52 of which at least 24 man-months should represent long-term assignments in the fields of project management and engineering for irrigation and drainage. The remaining 28 or less man-months will be for shorter term assignments by specialists. In addition approximately 3.5 man-months of home office professional support should be provided.

1.12 The above averages out at 4 expatriates for 26 project months in the field.

1.13 With the first year having 60 man months and the remaining 15 months 44.5 man months.

1.2 CONTRACT HISTORY

On October 22, 1975, The Agency for International Development, Washington D.C. entered into a one year contract with The J.G. White Engineering Corporation for engineering services in connection with three assigned tasks in Haiti.

Task A Dubreuil Irrigation System Rehabilitation: To advise and assist the Dubreuil Project Manager in the implementation of the engineering report prepared by Engineering Consultants, Inc. and the formation of an operating Dubreuil Irrigation District.

Task B 1.- Feasibility study, Jean Rabel; preliminary study and plan for rehabilitation of the Jean Rabel irrigation system.

2.- If feasible: the rehabilitation of the Jean Rabel system, with the contractor to advise and assist the Jean Rabel Project Manager.

Task C Pre-feasibility report identifying at least 6000 hectares of irrigable land within neglected irrigation systems needing rehabilitation. The areas to be screened from a list of priority projects provided to The J.G. White Engineering Corporation from USAID and the Government of Haiti.

During orientation sessions at AID/WASH, the J.G. White Project Manager was informed that Task A of the project; the Dubreuil Irrigation System Rehabilitation was to be held in abeyance until further instructions. The balance

of the contract work was to proceed under the assumption that this portion, Task A, might be excluded from the contract. Thus Task B, Jean Rabel feasibility study became the primary assignment and Task C secondary.

This changed condition required a completely new concept of project scheduling, base of operations and timing of personnel arrivals.

By the first week of January 1976 the J.G. White team had established a staff house in Jean Rabel and had started field work for both Task B and Task C.

Late in January 1976, notice was received from USAID/WASH rescinding the "hold order" on the Dubreuil Irrigation System Rehabilitation, however USAID/H recommended delaying the start until the Task B and Task C reports were well under-way. As only one vehicle at this time was available for the entire team, activities had to be planned around its availability.

1.21 In April 1976 additional vehicles were received permitting team activities to be divided among the Task B and Task C projects. USAID/H also agreed at this time to start the Dubreuil project. Major requirements before actual work can start are, official authorization, with notification by the Ministry of Agriculture to Les Cayes field level personnel, funding of project, tools and assignment of counter-part personnel. In addition an information program to reach all the formers of the area is urgently required.

At a meeting in May 1976, Mr. Leroy Rasmussen ADO - USAID/H pointed out that AID was taking a new look at the agricultural extension services and sociological patterns of Haiti. It was emphasized that J.G. White must necessarily follow AID procedures. Plans are underway to combine conservation, new technologies, improved agricultural practices and agricultural credit in watershed areas. It was reiterated that : J.G. White report immediately to AID/H any road-blocks encountered, the J.G. White effort could be considered as a testing mechanism possibly serving as the forerunner for expanded development programs of similar nature.

The Task C report was completed and copies distributed as required.

In June 1976 the sum of $20,000 was transferred from USAID/H funds to the Dubreuil Irrigation account at the bank in Les Cayes. This is the first funding for rehabilitation work for Dubreuil. By the end of June 1976, the first personnel were assigned to the Dubreuil project by DARNDR, with instructions to report to the project during the first week of July. Additional funds, $100,000 from G.O.H., and DARNDR personnel arrived in Les Cayes during the first week of August. Actual physical rehabilitation work on the Dubreuil Irrigation System started on 12 August 1976.

The Jean Rabel Feasibility Study (Task B) was completed in August 1976 and copies distributed as required.

Also during August 1976 a plan of work for Dubreuil was developed with the cooperation and assistance of DARNDR personnel. This plan was further refined and finalized in September, with actual work starting 20 Sept.

A particular effort was made by J.G. White engineers to maintain a low profile at the projects with advice and suggestions to DARNDR personnel being converted by them into orders for construction crews.

The J.G. White contract with USAID reached it's terminal date on 31 November 1976 and was extended by 3 months to 28 February 1977.

By March 1977 the Jean Rabel Feasibility Study had been reviewed and approved by both DARNDR and USAID with instructions to J.G. White to proceed in organizing for the rehabilitation of the system. The transfer of $60,000 established as the first working funds was delayed by G.O.H. administrative problems. However at a meeting of DARNDR and J.G. White staff it was decided to officially start the project as of 23 March 1977.

The White contract was extended by 3 months to the end of June 1977. Difficulty was encountered by J.G. White in obtaining and maintaining competent personnel in Haiti for short-term assignment. For the greater part, original team members holding one year or less assignments had completed their individual contracts and had accepted work in other areas. With only 3

month work-contracts available, recruited personnel were actively searching long-term contracts elsewhere and were inclined to consider the assignment to Haiti in terms of rest and vacation.

Agronome Gerard Nozine in April appointed Agronome Jean Eric Rene as project manager at Jean Rabel. Unfortunately operational funds had not as yet been transferred so that construction was again delayed.

Arrangement were made in May 1977 for monthly transfers of $2,000 to Port-de-Paix as operational funds for Jean Rabel. These monies are drawn against the $60,000 originally allotted to the project. The sum of $2,000 is completely inadequate as the monthly estimate prepared and submitted to DARNDR indicated a minimum of $6,000 per month will be required for the first 3 months and thereafter increased to $10,000 per month.

At the end of May, the J.G. White contract was extended for 3 months.

On 6 June 1977 project activity actually started at Jean Rabel with planning and coordination of future work by Agronome Nozine, his staff and J.G. White personnel.

At Dubreuil both design and construction work continued to fall seriously behind schedule due to the constant shortages of funds and DARNDR personnel. The original funding of $120,000 had been expended and in July only

$5,000 was transferred to meet the normal $15,000 monthly operating expenses. Jean Rabel received $2,000 to fund the anticipated $6,000 cash flow. After a visit by DARNDR personnel to the proposed diversion structure site at Jean Rabel, it was unilaterally decided by DARNDR to suspend all work at Jean Rabel until other sites had been evaluated.

The J.G. White contract was extended to 31 December 1977.

1.22 J.G. White engineers recommended that other work at Jean Rabel in connection with the irrigation system could profitably continue as most portions of the system would not be effected by any proposed minor relocations of the diversion structure. Access roads, culverts, flumes, plus several kilometers of secondary canals could be constructed. The decision never-the-less was made by DARNDR not to proceed with any work until the final location of the diversion struction was determined. The latter part of August $30,000 was transferred to the Dubreuil account, after paying outstanding invoices and delayed worker-wages $17,904.32 remained. Projections passed to DARNDR pointed out that operating funds will run out shortly after 1 October 1977. A chart showing cash flow projections for Dubreuil and Jean Rabel was also presented. The chart is included in the Dubreuil section of this report.

1.23 Jean Rabel remained at a stand-still from September 1977 until 31 January 1978 as first, diversion dam site location

was not finalized, then DARNDR personnel and operating fund were not available. J.G. White maintained during this time a construction engineer resident in Jean Rabel should DARNDR wish at a moment's notice, to resume work.

1.24 This construction engineer made his time and skills available to the Jean Rabel community and assisted the people in rebuilding the municipal spring capitation and pipeline.

From September 1977 through January 1978 the Dubreuil project continued to operate at something less the 25% of the planned progress rate due in the most part to the two cronic shortages: operating funds and DARNDR personnel.

1.25 On 31 January 1978 the J.G. White contract with USAID was terminated and team members returned to the New York office of the company.

A calendar of critical events follows:

1.3 CALENDAR OF CRITICAL EVENTS

22 October 1975	USAID - J.G. White contract signed
7 November 1975	J.G. White personnel arrive in Haiti
12 January 1976	Full J.G. White contract team in field Staff-house in Jean Rabel operating
30 June 1976	TASK C report submitted to USAID/H
30 June 1976	$20,000 USAID funds transferred to Dubreuil account
8 August 1976	Oral authorization from USAID to proceed on Dubreuil rehabilitation
12 August 1976	Official start of construction at Dubreuil
2 September 1976	TASK B report submitted to USAID
20 September 1976	Written authorization to proceed on Dubreuil rehabilitation received
26 October 1976	$100,000 transferred by G.O.H. to Dubreuil account at Les Cayes
31 November 1976	J.G. White original contract ends, USAID extends for 3 months

20 January 1977	Authorization to proceed with the Jean Rabel project.
28 February 1977	J.G. White contract extension ends, extended additional 3 months
23 March 1977	DARNDR personnel arrive at Jean Rabel. Immediate start on farmer organization and motivation
5 May 1977	First transfer of $2,000 in operating funds for Jean Rabel received
31 May 1977	J.G. White contract extension ends, extended additional 3 months
31 August 1977	White contract extended 3 months
30 November 1977	White contract extended 1 month
31 December 1977	White contract extended 1 month
31 January 1978	The J.G. White - USAID contract terminated

1.4 PROBLEMS, GENERAL

Two major problems plagued both construction projects but were particularly critical at Dubreuil.

1.41 First and foremost was a shortage of operating funds, a gross under-estimation of the monies required to enable the projects to operate smoothly.

Construction planning is usually completed months in advance of actual implementation. Plans are made for the most economical method and direction (critical path) a project should take. These plans are always based on the assumption that sufficient and regular funding will be available. Any interruption of the cash flow or a lessening of the amount available requires changes in planning -- always expensive in time and money, and when continuous, distructive to project morale.

1.42 The second, and interlocking with the above problem, was the serious shortage of technical personnel assigned to the projects by DARNDR.

1.43 For the starting month or two at Dubreuil and at Jean Rabel personnel furnished to the projects by DARNDR have been excited by the new concept of having the farmer build, operate and maintain his irrigation system. Unfortunately this enthusiasm erodes rapidly when salaries and supplement payments are delayed. The assigned personnel became far more interested in returning to Damien to investigate the delays in payments than in the progress of project.

1.431 The additional fact that Haitian technicians of equal educational background and abilities are working on various public works projects in the area and receiving salaries double or triple that of DARNDR people definately lessens project committment.

1.44 When the various G.O.H. ministries cooperate to standardize salary categories the above problem will cease to be critical.

1.45 At the Dubreuil project during the final year, no design engineer was available, two construction engineers were assigned to the project, both reportedly for 100% of their time. One engineer remained available and enthusiastic, working full days except when attending a month seminar in Mexico. The other engineer managed to develop interests in other projects or in Port-au-Prince requiring close to 90% of his time. In the area of sociology - farmer motivation, the assigned personnel managed to maintain a much better record of work-days in the field than did the engineers.

1.451 The administrative personnel at Les Cayes contributions to the Dubreuil project were whole-hearted and excellent.

1.46 Among minor problems which should be recognized in the planning of future similar projects:

As originally conceived, Dubreuil and Jean Rabel systems were to be labor intensive projects with as little mechanical equipment as possible. After over a year of experience it appears

obvious that much greater progress, without decreasing peasant participation, could have been obtained with the addition of some additional basic equipment.

1.461 The first shortage of equipment to effect project progress was that of transport for material. The projects were assigned one small dump truck each. Three heavy-to-medium duty dump trucks should have been furnished to maintain the working crews with needed supplies at each project.

1.462 The single 1/2 yard concrete mixer furnished to the Dubreuil project lasted but 2 months under the heavy regular project work requirements. Dubreuil project required two 2 yard mixers and one heavy duty 4 yard (model 14S) mixer. Jean Rabel, with no mixer, would require the heavier 14S model because of the barrage construction.

1.463 It would also be recommended that a combination unit, tractor dozer-shovel be supplied to each project.

1.464 It can not be emphasized enough; all vehicles and equipment purchased for projects in Haiti should be heavy-duty and tropicalized. Many of the mechanical break-downs encountered at both projects were largely due to unsuitable lightly-constructed equipment.

1.47 Personnel transportation was a problem during the life of the projects. The purchase of motor-bikes was authorized for both projects but lack of available funds prevented the purchases. On future projects, this item should be included in the original planning.

1.48 To recapitulate the heavy equipment requirements for a project similar to Dubreuil:

2 enclosed personnel vehicles (Cherokee Jeep type)
2 semi-enclosed personnel vehicles (CJ-7 Jeep type)
6 motor-bikes (Honda trail-bikes or equal)

2 - 2 to 3 ton flat-bed trucks (diesel engine preferred)
3 - 5 - 8 yard dump trucks (diesel engine preferred)

2 - two yard concrete mixers
1 - four yard concrete mixer (14S type)

1 - 250 cfm air compressor
with tools; jack hammers, spades etc.

1 200 Amp. portable welder
with cables, mask and supplies

1 Lubrication unit (portable)
Grease, oil, etc. for equipment (P.O.L.)

1 Tractor (medium duty unit)
combination shovel-dozer-back hoe

1.49 The manufacturer of all the above units should be asked to furnish a recommended list of spare parts for at least one year of usage. These parts can then either be purchased with the equipment (preferred) or later ordered by the project manager.

2.0 HISTORIC BACKGROUND

In the early 1700's Haiti, France's most prized possession supplied the mother country with a third of her imports. A total annual trade at that time of almost $132,000.000 ; a figure to put in its proper perspective was half again as much as the total exports of the 13 American colonies.

Commodities shipped from the thousands of plantations dotting the fertile plains were sugar, indigo, coffee, cocoa, cotton and tobacco.

Exports for two typical years are given:*

		1788	1789
Sugar, refined	(pounds)	70,227,709	48,000,100
Sugar, raw	"	93,177,512	93,014,600
Coffee	"	78,151,181	77,489,271
Cotton	"	6,286,126	7,120,000
Indigo	"	930,000	1,000,000
Hides		13,000	20,000
Rum	(barrels)	32,497	26,000
Tobacco	(pounds)	28,500	28,000

Much of the published information concerning irrigation systems in Haiti during the Colonial period is based upon the writings of Moreau de St. Méry. However, as he attempted to describe "topographie, physique, civile, politique et historique" in two medium sized volumes it is obvious that many details have been slighted. St. Méry does

* Histoire d'Haiti - A. Cabon, Col. Nemours, Pierre de Vaissière.

state that a highly developed irrigation system had been constructed by the French engineers, and indeed, this system is the basis of virtually all the present systems, although they have been re-built and rehabilitated many times during the ensuing years.

Based upon research through the writings of Moreau de St. Méry, Debien: Les Colons de St. Domingue et la Révolution, Edner Brutus, Etienne Charlier among many others, the following probabilities develop:

HAITI IRRIGATION 1750-1800

	Hectares
Les Cayes Plaine	10,040
Department du Sud (less Les Cayes)	7,400
Jacmel - Marigot	4,000
Cul-de-Sac	19,688
Leogane Plaine	10,400
Nord-Ouest	4,500
Artibonite Plaine (seasonal only)	6,750
Plains du Nord	18,700
Total	81,478

It is estimated that this total represents approximately 50% of the actual area of land under some form of irrigation, permanent or seasonal in 1789. Faulty communication from area to area and imperfect recording of land deeds and operations appear to have caused this short-fall.

In 1791 the revolt was started which was to end in the defeat of Napoleons forces and the establishment in 1804 of the first independent black nation in the western hemisphere.

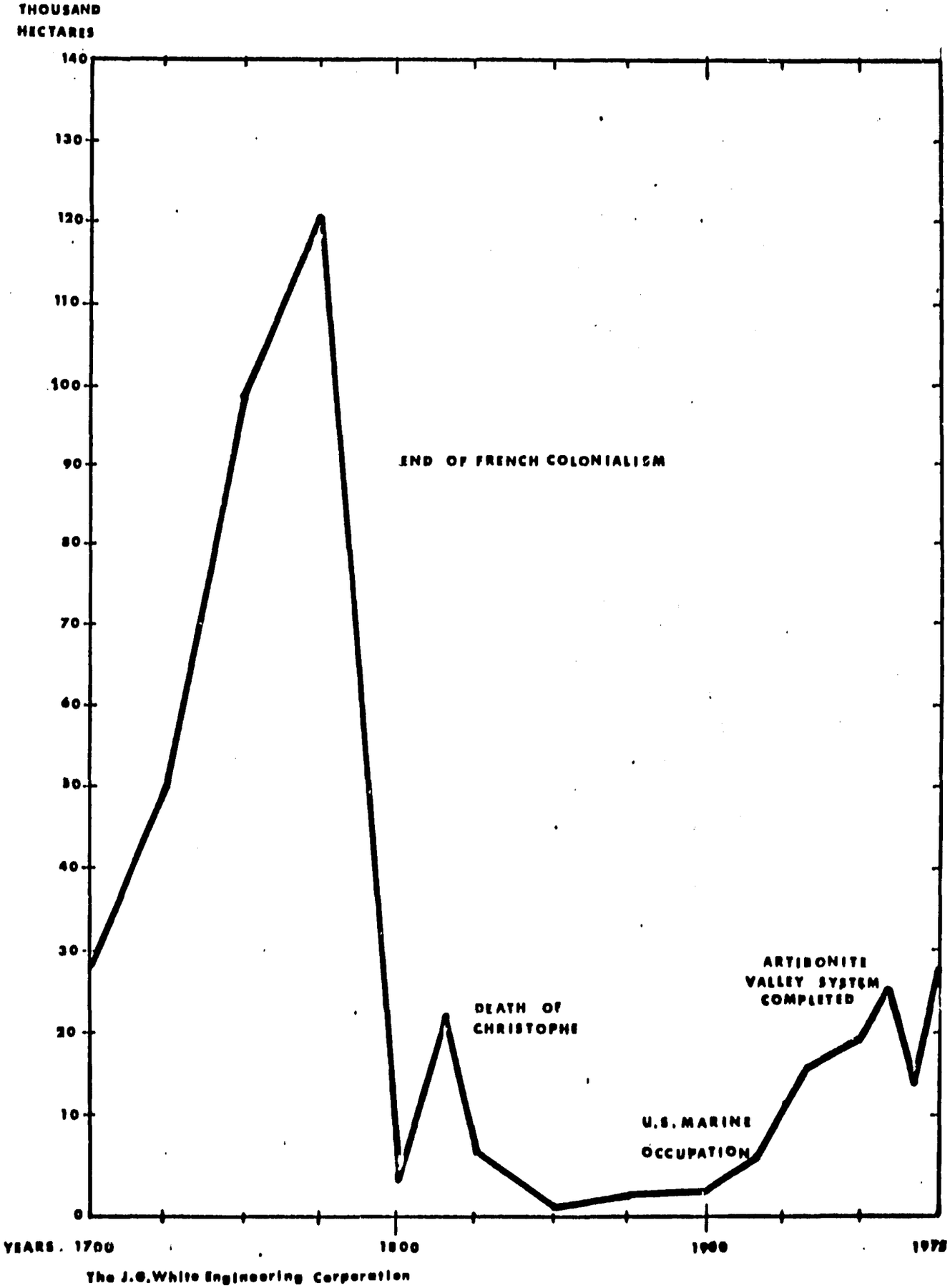
An important strategy of the war of independence was to destroy all structures built by the hated colonialists, including irrigation systems. After independence, Haitians devoted most of their effort to building fortifications and to repayment of the so-called independence debt. Therefore from 1800 to 1900 irrigated land was rare, probably amounting to a total of less than 5,000 hectares in all of Haiti.

Of the 600,000 hectares of arable land which require irrigation to enhance their value approximately 70,000 hectares have, at present, some irrigation. The efficiency of the total of these systems is rated at something less than 15%.

In 1920 the Bureau of Irrigation, under the Ministry of Agriculture was established and the first plans for rehabilitation of the various irrigation system was started.

PLATE 1.3-1

IRRIGATION IN HAITI
1700 – 1975



The J.G.White Engineering Corporation

DUBREUIL IRRIGATION SYSTEM REHABILITATION

THE J. G. WHITE ENGINEERING CORPORATION
NEW YORK

2.01 The French settlers, long before 1745, used the Acul River water for irrigation and as motive force for sugar cane factories. However, in 1761, a barrage was established and they really reaped benefits from it for the first time. Moreau de St. Mery in his book "Description de la Partie Francaise l'Ile de St. Domingue", reports on page 1280,

> "... that the volume of water from this river passes entirely into a general basin near Habitations le Duc and La Ferriere and from there it leaves by two unequal openings. The eastern branch of the canal is divided into three equal portions of water for three sugarcane factories and four crushing mills which were powered by water.
>
> "(1) At the Regnier sugar factory they were irrigating 100 carreaux (129 hectares) of sugar cane and had two crushing mills powered by water from the main canal.
>
> "(2) The Dubreuil sugar factory also had 100 carreaux of sugarcane under irrigation and had two water powered crushing mills. This Habitation gave up 2/5 of its water to another which did not pay its subscription but used the water from the canal for a fifth water powered crushing mill.
>
> "(3) The Bodou sugar factory also had 100 carreaux of sugarcane under irrigation but did not have a water powered crushing mill.

"The western branch of the canal had eleven equal portions of 100 carreaux each of sugarcane and each portion had eleven factories of which only four had water powered crushing mills. There were 14 Habitations on the left bank of the river which also received and used water from the Acul River."

The Dubreuil irrigation project has been restored several times; the most recent being by Service de la Cooperation Technique pour des Ressources Hydrauliques (SCTRH) with assistance of American Foreign Aid, and the project was terminated in 1962.

3.0 PROJECT DESCRIPTION

3.01 Project Location

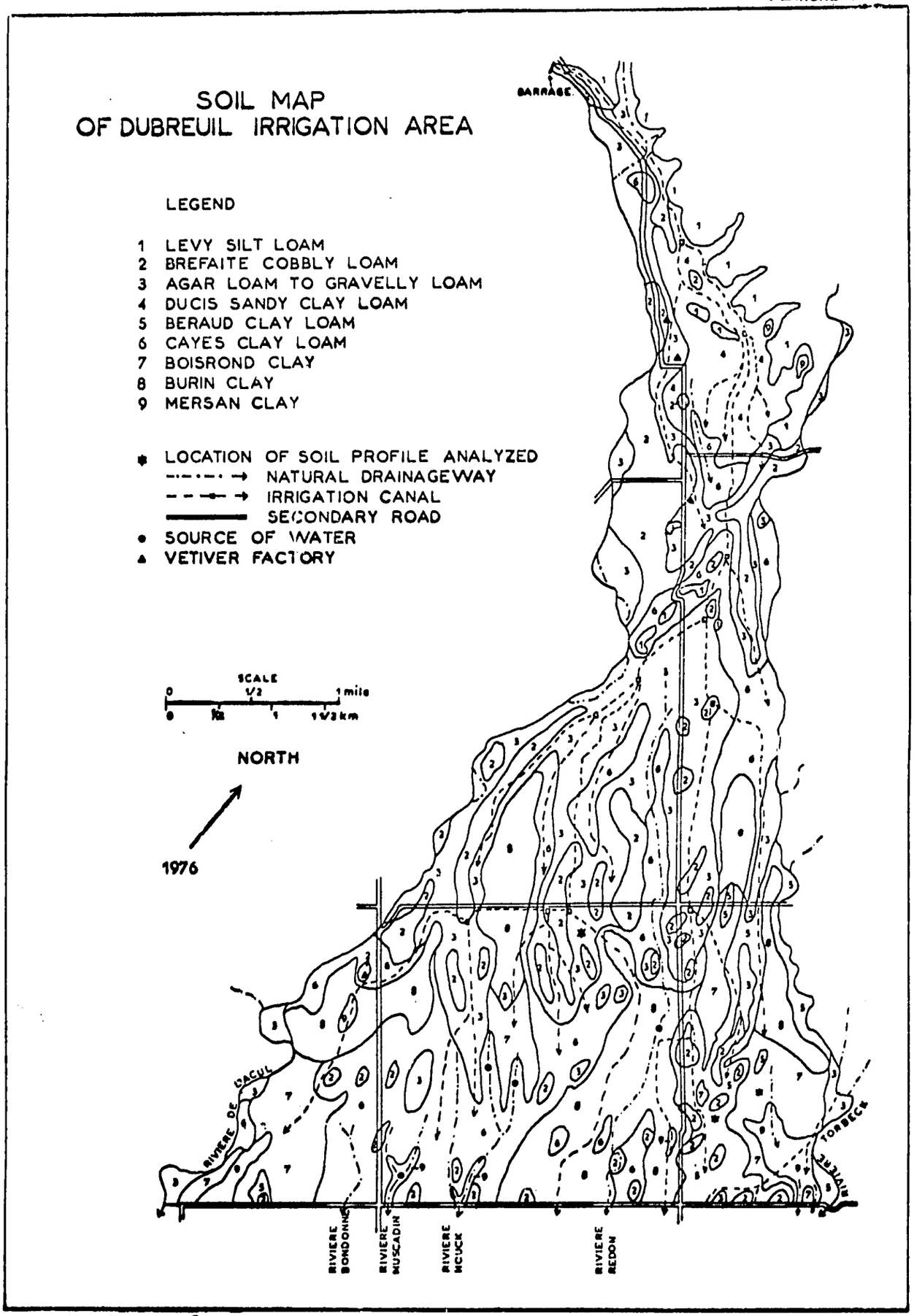
The Dubreuil Irrigation System is located in the Acul River Basin, which in turn is contained within the Cayes Plain. The Cayes Plain has an area of about 350 km^2 and is within the Arrondissement of Cayes, a division of the Departement du Sud.

3.02 Description of Area

Dubreuil is located in the north western corner of the Cayes Plain, between the Acul and Torbeck Rivers and its southern boundry is the Bois Landry Road, see base map, Plate 2.2-1.

Local topography varies from gently rolling in the north west to quite flat in the southeast. The hills along the north edge of the plain are Eocene limestones, argillite and some conglomerate. The alluvial fill is probably lying on Miocene marls that are exposed in areas. The major soil types are highly calcarous silt loams developed from these marls.

Abundant supplies of ground water are believed to exist in the alluvial aquifers beneath Dubreuil. Although depth of fill is unknown, it probably is sufficient to contain large volumns of water. The alluvial beds dip gently seaward and, at lower elevations in the project area there is good possibility that a deep well would flow at the surface. Floods reaching the dry channel in the plain lose large volumns of water into the


SOIL MAP
OF DUBREUIL IRRIGATION AREA
LEGEND
1 LEVY SILT LOAM
2 BREFAITE COBBLY LOAM
3 AGAR LOAM TO GRAVELLY LOAM
4 DUCIS SANDY CLAY LOAM
5 BERAUD CLAY LOAM
6 CAYES CLAY LOAM
7 BOISROND CLAY
8 BURIN CLAY
9 MERSAN CLAY
LOCATION OF SOIL PROFILE ANALYZED
NATURAL DRAINAGEWAY
IRRIGATION CANAL
SECONDARY ROAD
SOURCE OF WATER
VETIVER FACTORY
SCALE
0 1/2 1 mile
0 1/2 1 1 1/2 km
NORTH
1976
BARRAGE
RIVIERE DE CACUL
RIVIERE BONDONNE
RIVIERE MUSCADIN
RIVIERE MCUCK
RIVIERE REDON
RIVIERE TORBECK

streambed and may provide large quantities of water to the alluvial aquifer . Other sources recharge to the aquifer are infiltration of rain and subsurface discharge from the limestones that border and lie beneath the alluvial fill. It is likely that the severe deforestation of the upper watershed has increased rates and volumns of storm runoff. The result is that the mean discharge of the Acul River has decreased, floods have become severe and the river channel on the plain has become unstable.

3.03 Project Service Area

The Project Service Area is shown on the base map Plate 2.1-1. The gross area indicated in the E.C.I. report was 2,344 hectares and 1,165 hectares as irrigable. Final surveys indicate 2,665 and 1,439 hectares respectedly as being more nearly correct.

3.1 Existing System

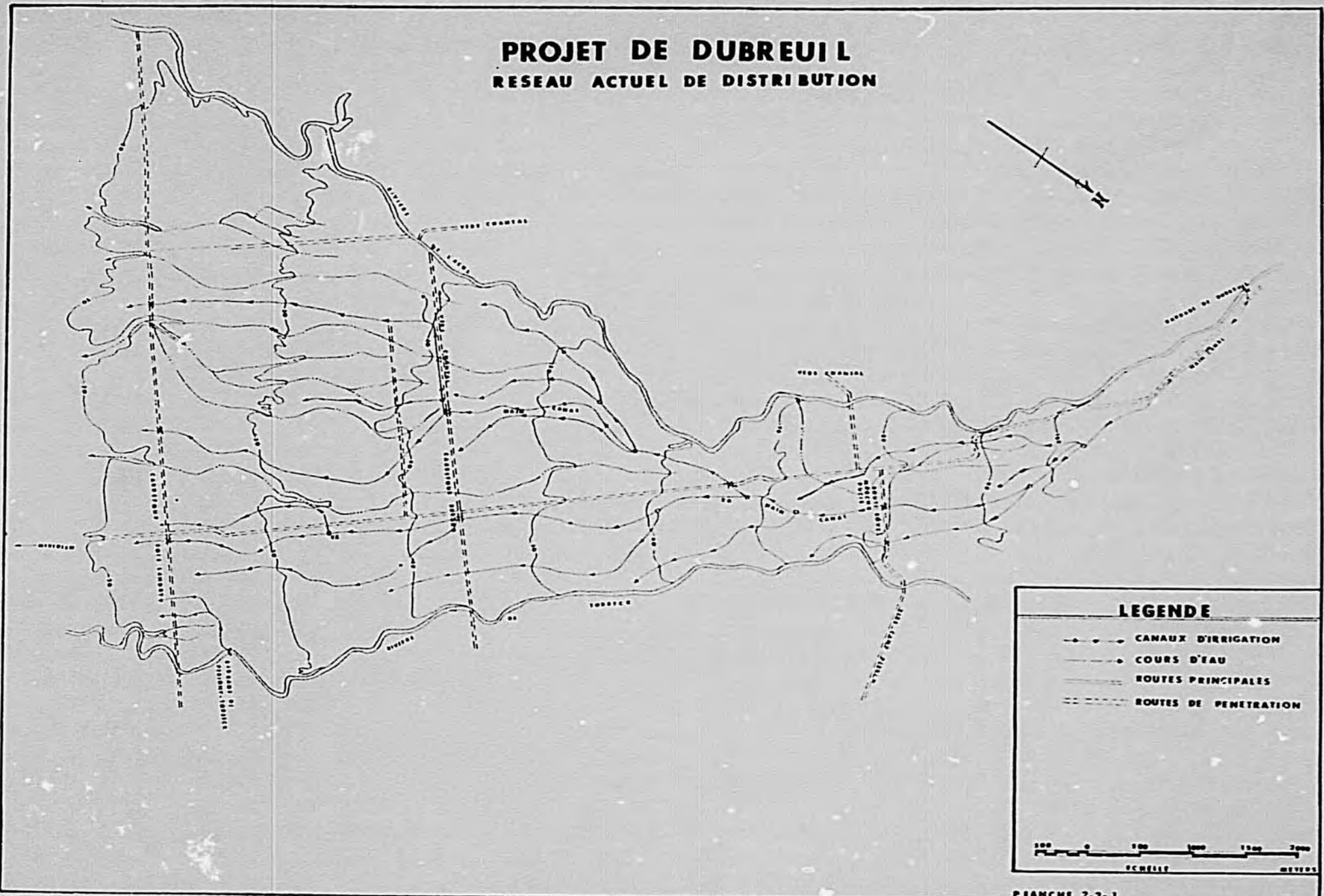
The existing Dubreuil Irrigation System is shown on base map, Plate 2.1-1. The water is diverted from the Acul River, carried through the main canal and distributed by the lateral system.

The Acul River diversion dam is a cyclopean ogee gravity type, 60 M long, 2.5 m. high above the river bed and 13 M wide including apron. Appurtenant structures include: a right retaining wall 60 M long and 5 M high, a left bank retaining wall 40 m long and 4.5 M high, a set of twist walls to facilitate sluicing, a steel radial sluice gate 3.5 M wide and 2 M high, and two rectangular steel irrigation gates.

The distribution system includes a main canal approximately 10 kilometers long, 12 main laterals and several sub- laterals totaling about 35 kilometers. The main canal is lined for most of its length with rubble masonry and has a design capacity of 4 M^3/sec at the headgate and 1.5 M^3/sec at the end. Some of the laterals have concrete linings for short distances. Their capacities vary from 150 to 1000 liters/sec.

PROJET DE DUBREUIL

RESEAU ACTUEL DE DISTRIBUTION



THE J.G. WHITE ENGINEERING CORPORATION

PLANCHE 2-2-1

3.2 Proposed System

The proposed system is shown on Plate 3.2-1. Indicated on the map are those areas where rehabilitation work has started. The dates shown on the laterals are estimated starting dates.

The basic concept of the rehabilitation of the Dubreuil Irrigation System is one of self-help. All work on the system is being performed by the inhabitants whose land will be benefitted. Their slogan is : " We are building our irrigation system for our use ". Work has been organized to be labor - intensive and to date only the following mechanical equipment is in use:

one transport truck - 3/4 ton
one dump truck - 5 ton
one concrete mixer - 1/2 yard.

Haul roads have been improved with some imported material from the nearby river bed and with material removed from the main canal, ie, rock, gravel and sand. All work is being performed by manual labor.

As noted on Plate 3.2-1, rehabilitation work started 12 August 1976 at station 0 + 00, the diversion gates of the main canal. Repairs were made to the gates themselves and clearing, cleaning operations of the main canal continued down grade.

At station 0 + 600 on 29 September construction was started for a flume in the main canal to over-pass the difficult spring area to station 1 + 003.

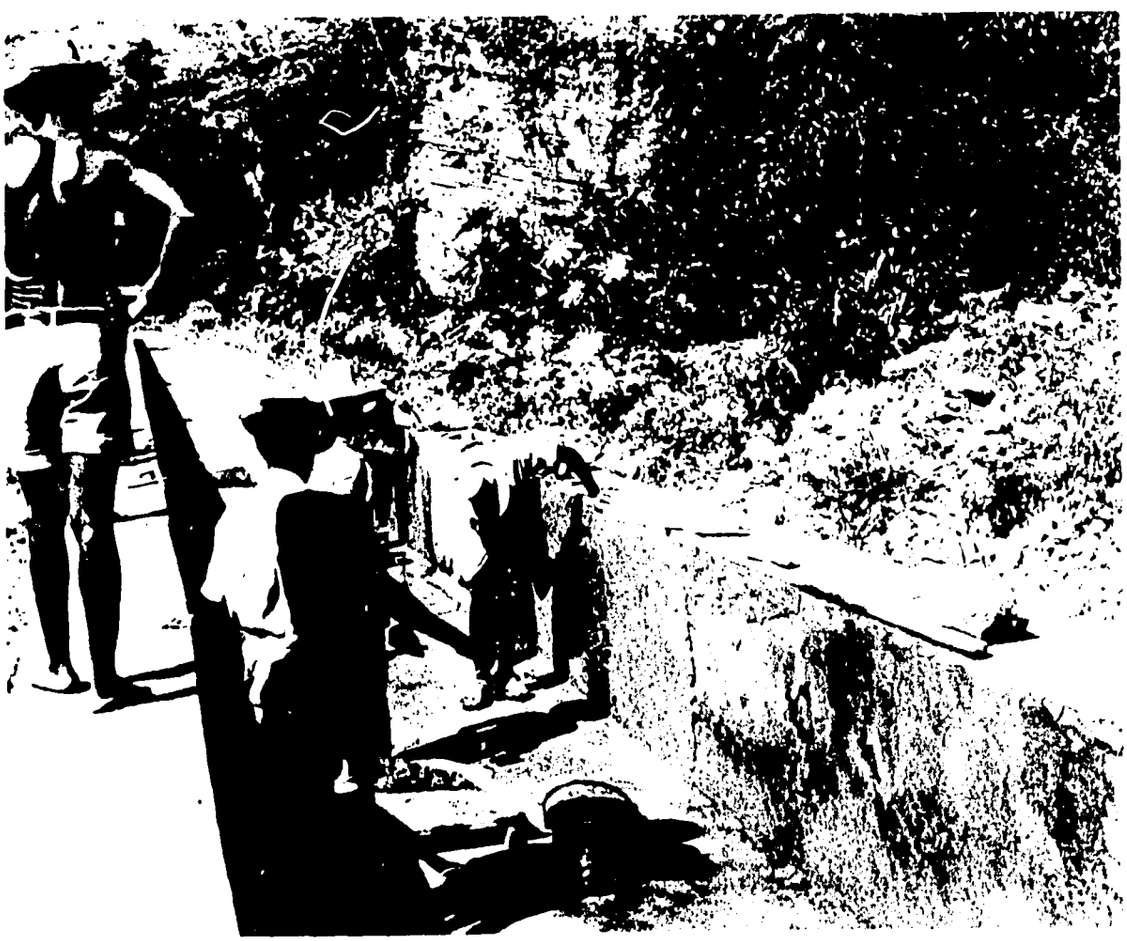
During the original construction at 1761 and through numerous repairs as late as 1962 this particular section of the main canal had been left open, without masonry walls or bottom, allowing the spring water to enter the main canal stream with no method of control. Reasons for this exception appear to have been design and/or construction difficulties rather than purposeful.

For two major reasons it is now felt that the spring flow must be controlled. The most important for the general welfare of the inhabitants of the area is the fact that the spring (s) produce approximately 200 liter/second of clean potable water, a very valuable asset anywhere in Haiti. Secondly, as this appreciable quantity of water enters the main canal uncontrolled, there is no simple way to close off the flow at lower levels when irrigation is not needed or the canals require maintenance. With the river furnishing more water than currently needed for irrigation, the spring flow is surplus.

A flume or overpass has been designed and construction is well under way. Controlled flow of river water will pass over the spring area without co-mingling of the poluted river water with that of the spring. The flow from the spring will be diverted into a parallel canal for disposal. For this, any of several methods can be used. Re-entry to the main canal through suitable control structure; discharge into the river; or construction of a reservoir and pipelines to furnish nearby villages with potable water. The third method is to be preferred and local groups are currently discussing ways and means to finance this scheme, as funding is not available from the Dubreuil Irrigation Project. Photographs of construction operations in the spring area are contained in this report.

Excavation of New Main Canal Section

Plastering Walls of Repaired Section of Main Canal



Scheduling of construction work has permitted daily use of the canal system after the work day ends at 1500 hours. Irrigation water is also available throughout the weekends and on legal holidays. So far the farmer has not been adversely affected by the canal rehabilitation.

Clearing of canal banks has been carried out in three stages. The first rough clearing permits survey crews to work, the second cutting removes all vegetation within 2 1/2 M of the canal bank on either side. The third clearing operation is the grubbing of roots to prevent regrowth and final leveling of the clear area. Photographs of this operation are presented in the report.

Other crews work within the canal proper, and in the case of masonry canals, remove vegetative growth sprouting from mortar joints. These crews are followed by masons who point-up mortar joints and make required repairs.

It had been expected that considerable objections would be encountered by the clearing crews as they cut a 2 1/2 meter swath on both sides of the canals. Much of this strip was being cropped and a goodly number of fruit trees were within the area to be cleared. Prior contact with the farmers affected, with pains-taking explanations of why the clearing was required all but eliminated any serious problems. Cooperation between work - crews and farmers, in allowing crops and fruits to ripen and be harvested was in large part instrumental in the trouble free operation.

PROJET DE DUBREUIL

RESEAU DE DISTRIBUTION PREVU

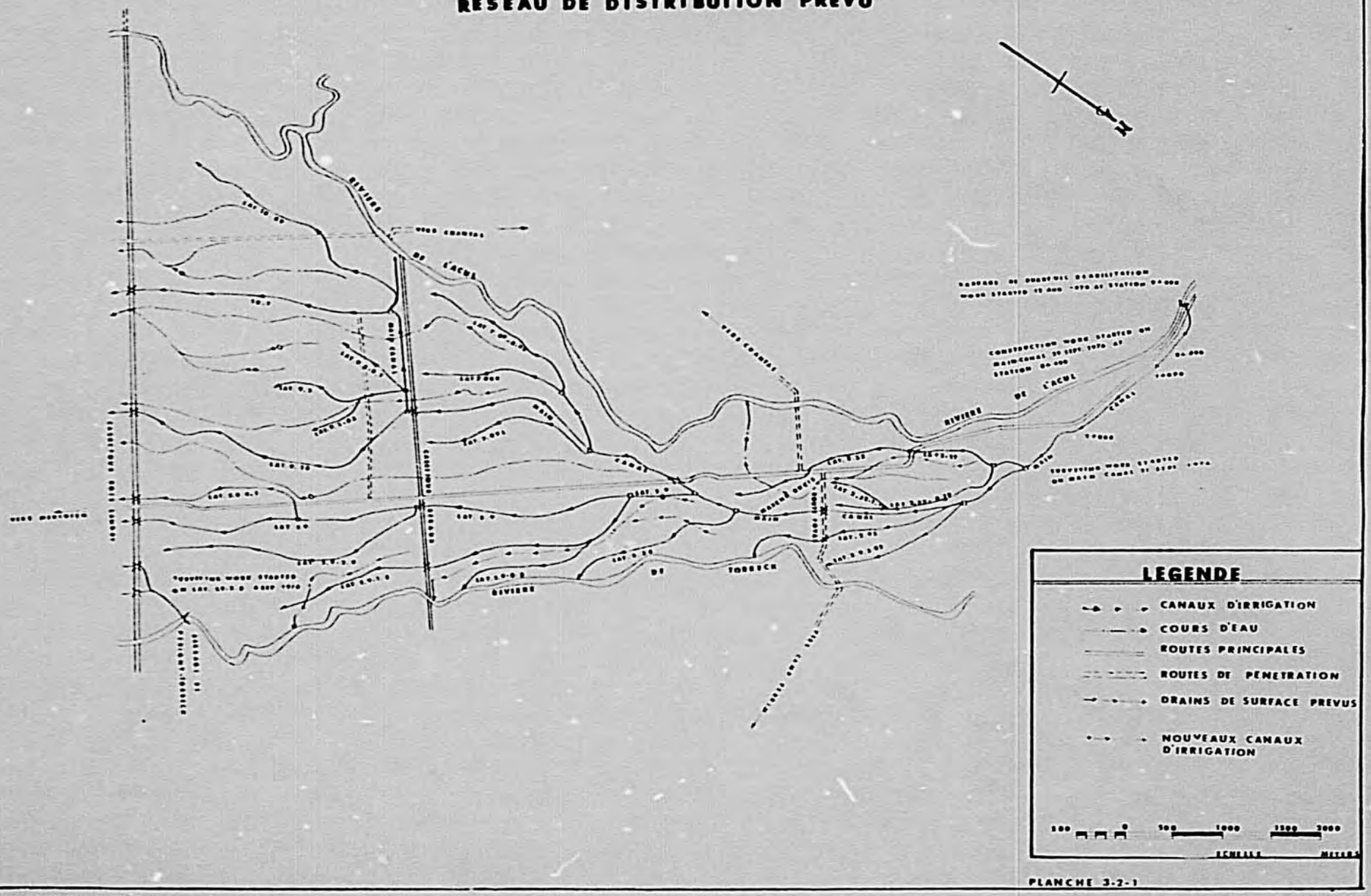


PLANCHE 3-2-1

THE J.G. WHITE ENGINEERING CORPORATION

3.3 CONSTRUCTION AND REHABILITATION

3.31 Barrage and Gates

The work completed to date on the barrage and appurtenances has been limited to gate repairs. The left gate was removed, the stem straightened and the slides re-alligned, the bottom stop plate and seal replaced. The special sluicegate seals, replacements for the deteriorated and worn units presently on the gates are on order but not as yet received. This is also true of the epoxy-cement admixture for repair of the worn face of the barrage.

It was observed after a flood on the Acul river in the fall of 1976 that the right-hand (looking downstream) bank of the river was being eroded at a rate dangerous to a number of dwellings on that bank. There also appears to be a possibility that should a large flood occurs the barrage could be bypassed on this bank, distroying the wing-wall. Early steps were taken to obtain a bull-dozer to straighten the river channel and to reinforce the right bank with the "spoil" material. Unfortunately because of regular break-down of this dozer, hardly more than 2 weeks work was obtain during the six months the tractor was in the area.

During future construction work at Dubreuil, some protection must also be developed for the left hand bank down-stream of the barrage. During the summer and

Protection des rives de la rivière.

early fall of 1977 high waters in the river eroded approximately 6 feet from this vertical embankment. An actual 2 feet was cut from the road directly in front of the school.

The bank at this point ranges from 20 to 30 feet almost vertically from the river bed. The embankment material is cobbly-gravel, sandy loam and has little resistance to an angled flow of water.

The use of gabions is counter-indicated for this particular river erosion problem. It is more than likely that the force of flood waters in this location would immediately distroy the gabions unless they were cement coated to prevent surges of water from passing to the back.

A practical solution would be to pin 4" by 4" wire reinforcement mesh directly to the gravel walls of the endangered section. This should be done during low river waters, with as much flow as possible diverted into the main Dubreuil canal. It should then be possible to anchor the bottom of the mesh firmly to the normal river bed working in the dry. After the mesh has been installed, 3 to 4 inches of hydraulically applied concrete would be sprayed on (Gunnite Progress). This method, properly applied should give positive protection against further erosion of the bank, baring the possibility of a so-called 100 year flood.

3.32 Main Canal

The total length of the main canal, 10165 meters, was cleared of rock, gravel and waste. Both banks of the canal were cleared of trees, brush and grasses 2½ meters on either side. Areas which during rains, could deposit rocks and soil into the canal were cut back with drainage improved. An access road paralleling the canal was improved by imported material; gravel, sand and rocks.

Although plant growth was removed several times from the cracks in the masonry walls it was not possible to repair the damaged walls. This work will have to be accomplished after the "spring by-pass" is completed and it is possible to completely stop the flow of water in the main canal.

An education program was created to explain that large rocks must not be placed in the canal for seats while bathing. The canal must not be used as a laundry, water for the purpose may be taken from the canal but clothes may not be washed in the flowing waters. Animals must be staked so they can not graze closer than 2½ meters from the canal bank. The animals may not be led into the canal for washing or watering, rather water must be taken to the animal. As certain penalties were connected with infractions of the regulations a slow improvement in the care given the canals could be seen.

3.33 Laterals -- Secondary Canals

There are a total of 43,738 meters of lateral (secondary) canals planned for the Dubreuil system of which originally 16,300 meters were to receive masonry lining. The balance, 27,438 was planned as simple earth channels with compacted embankments.

Experience indicated that perhaps an additional 10,000 meters of the planned earth channels would require lining. As canal excavation proceeded it was discovered that several large areas of river-bed gravel unlaid sections of the system. To prevent unacceptable losses of irrigation water these canal sections required lining.

Of the 16,300 meters of originally planned masonry lateral canals a total of 2,142 meters were constructed, 13% of the original total and approximately 8% of the proposed.

Work on earth canals and embankments started very slowly but picked up some momentum as the workers learn the correct methods of earth placement and compaction. Of a total of 27,438 meters planned 6432 were actually completed, 23% of the total.

A number of farm ditches, an item which was to be the farmer's direct responsibility, were constructed by paid field forces on a demonstration basis. A total of 1241 meters were constructed in various areas.

DUBREUIL PROJECT

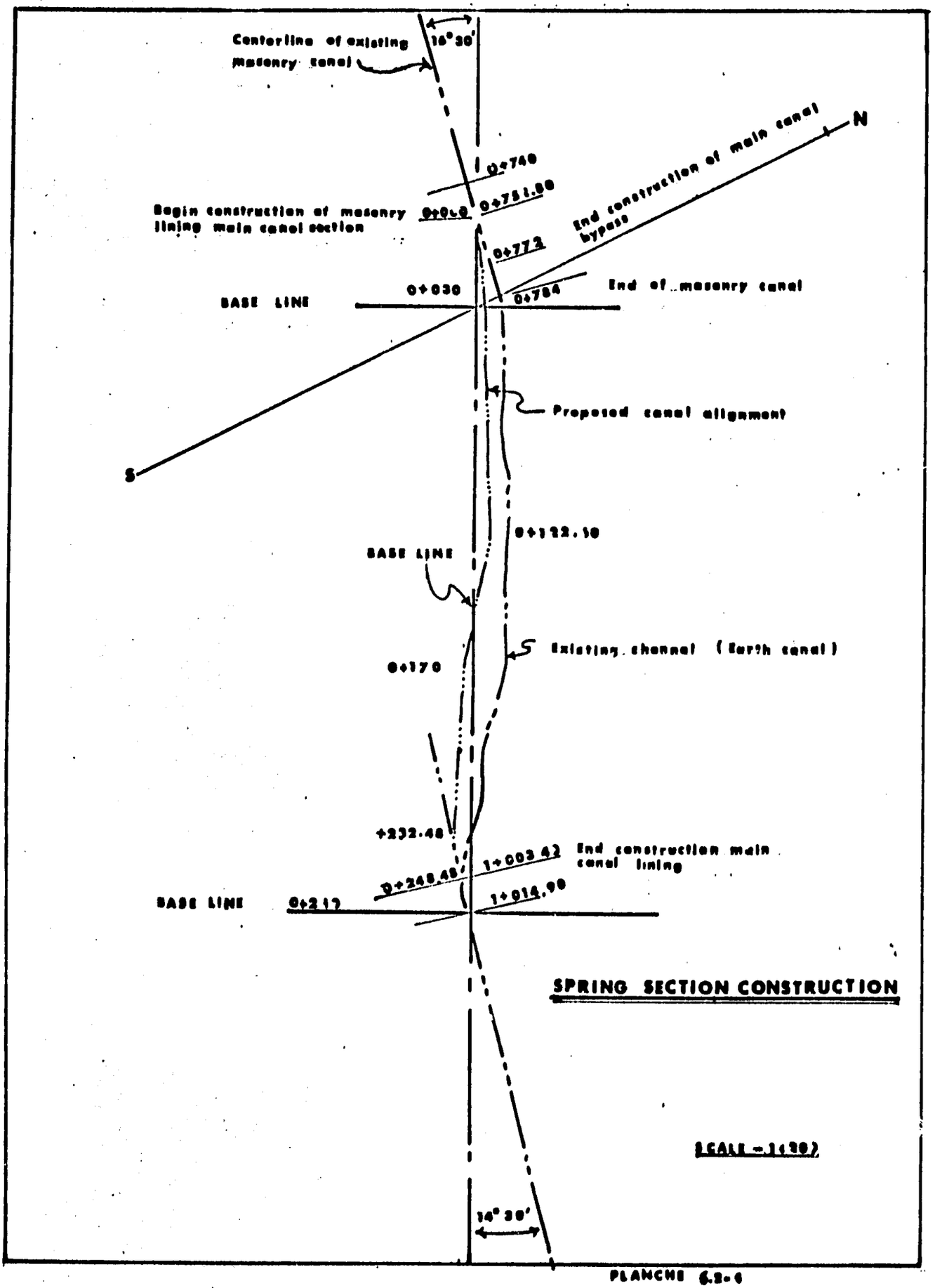
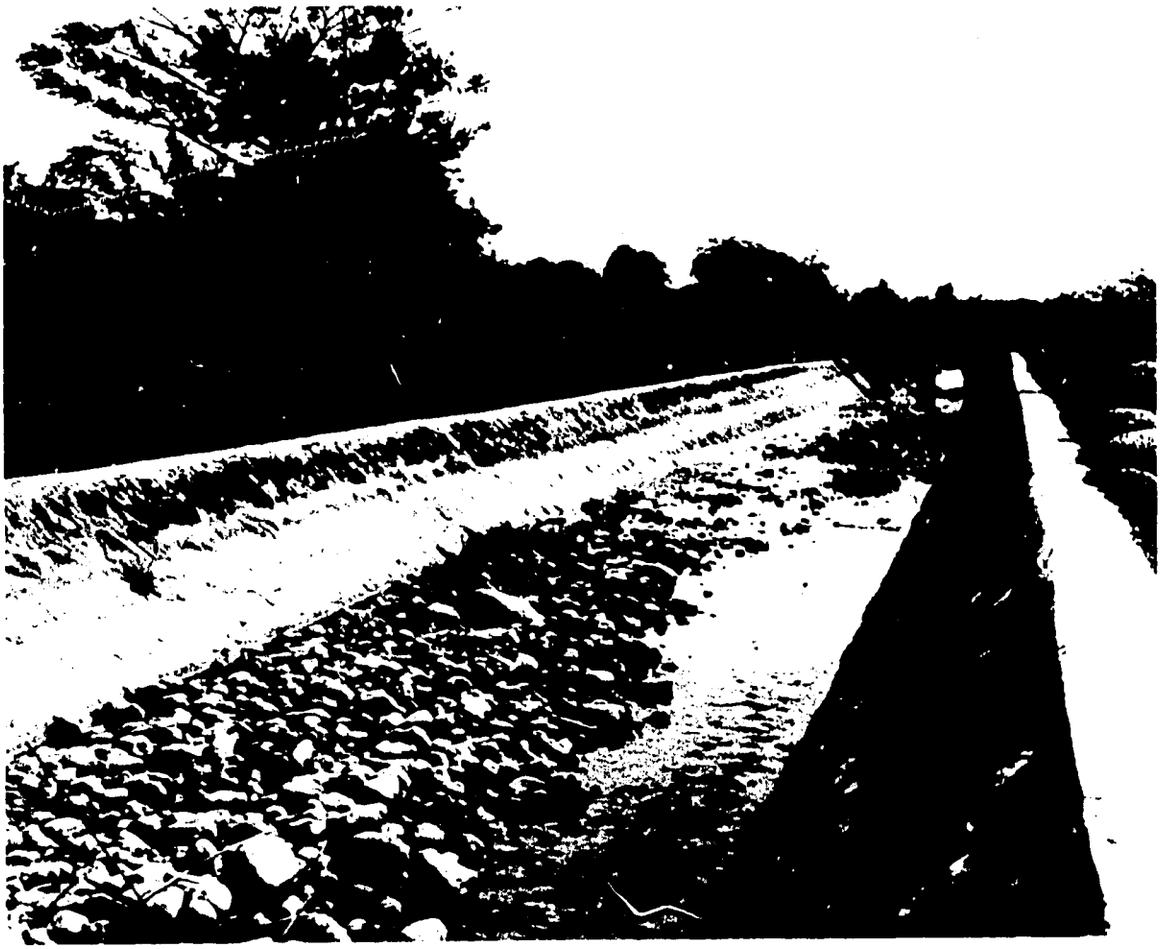


PLANCHE 6.2-6

Typical Section of Main Canal Before Cleaning

Section of Main Canal after clearing, note Side branks have had all vegetation stripped 2.5 meters on both sides of canal. Side walls have not in this photograph been repaired.

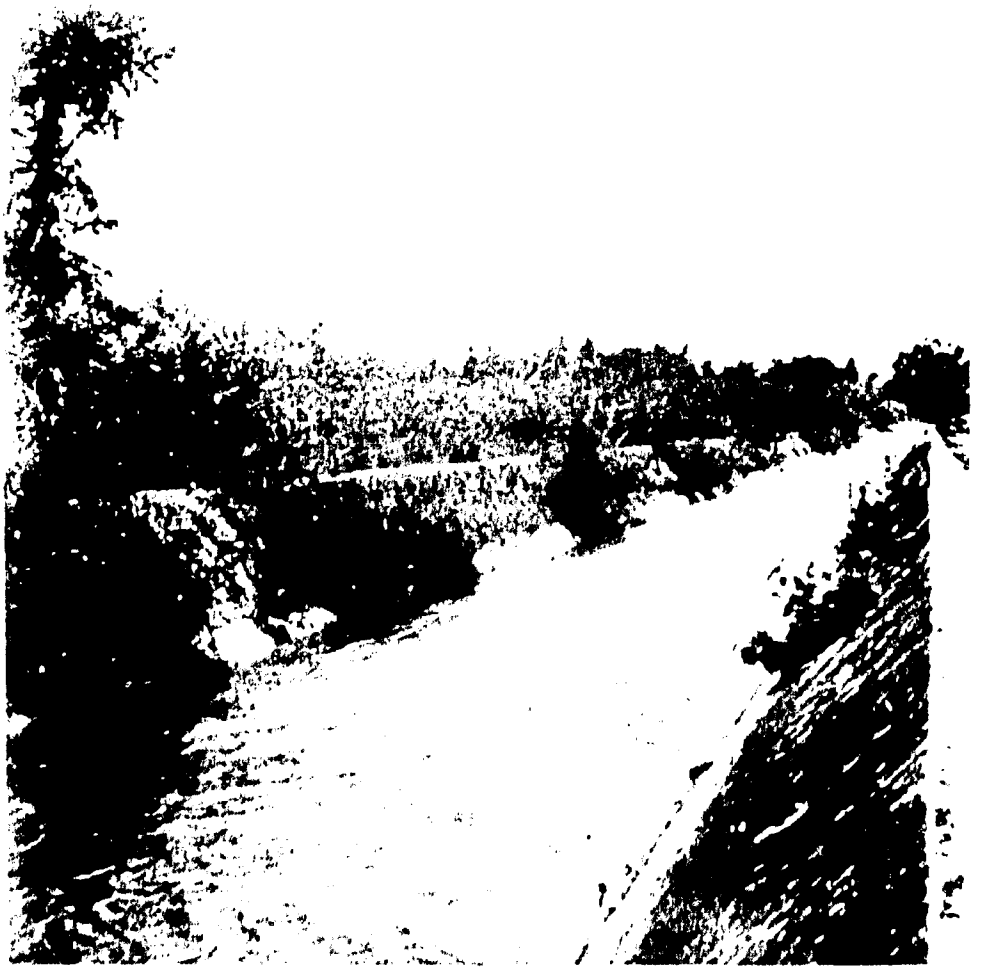


Ouvrage typique de prise d'eau dans un canal secondaire avant la restauration.

Canal secondaire typique après la restauration.

Brush and vegetative growth has been allowed to become established on the sides of the main canal in masonry throughout its entire length.

Considerable amount of damage has been caused so the masonry canal in many parts of the canal. The brush and weed growth will have to be removed and where the masonry is damaged, it will have to be repaired.



Most of the masonry canal has a trapezoidal cross-section. The side slopes are approximately 1 to 0.75. The sloping sides permit brush and other vegetative growth to establish itself more easily. Consequently the masonry canals with the trapezoidal cross-sections have sustained considerable amount of damage.

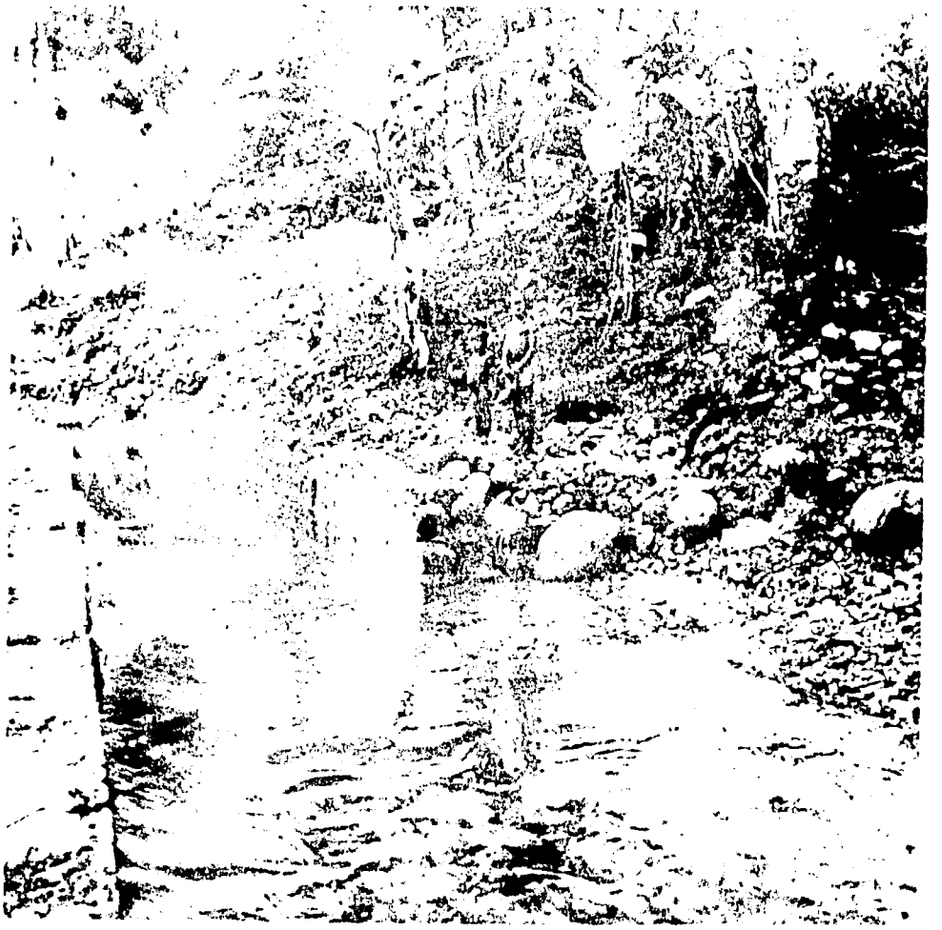
Tree and brush growth has been allowed to become established along the main canal or the lower end in the vicinity of Carrefour Beraud. In some sections of the main canal, tree roots have caused considerable amount of damage to the masonry lining.

Silt and cobbles being removed from the main canal. The canal banks are being sloped to a minimum of 1.5 to 1 in order to reduce bank erosion and silt getting into the canal. A diversion ditch will be constructed above the steep canal banks in order to reduce the amount of run-off to a minimum. A drop structure or chute and a canal water crossing over the top of the canal are to be constructed at the point where the canal turns to the left in the center of the picture. This structure will convey run-off water into a natural drainageway. Just about station 2 · 960 on the main canal.

Trees and brush growth are being removed that have become established along the masonry lined canal. The legal established right-of-way is usually 2.5 meters on either side of the canals and laterals, the distance out from the canal that is being cleared.

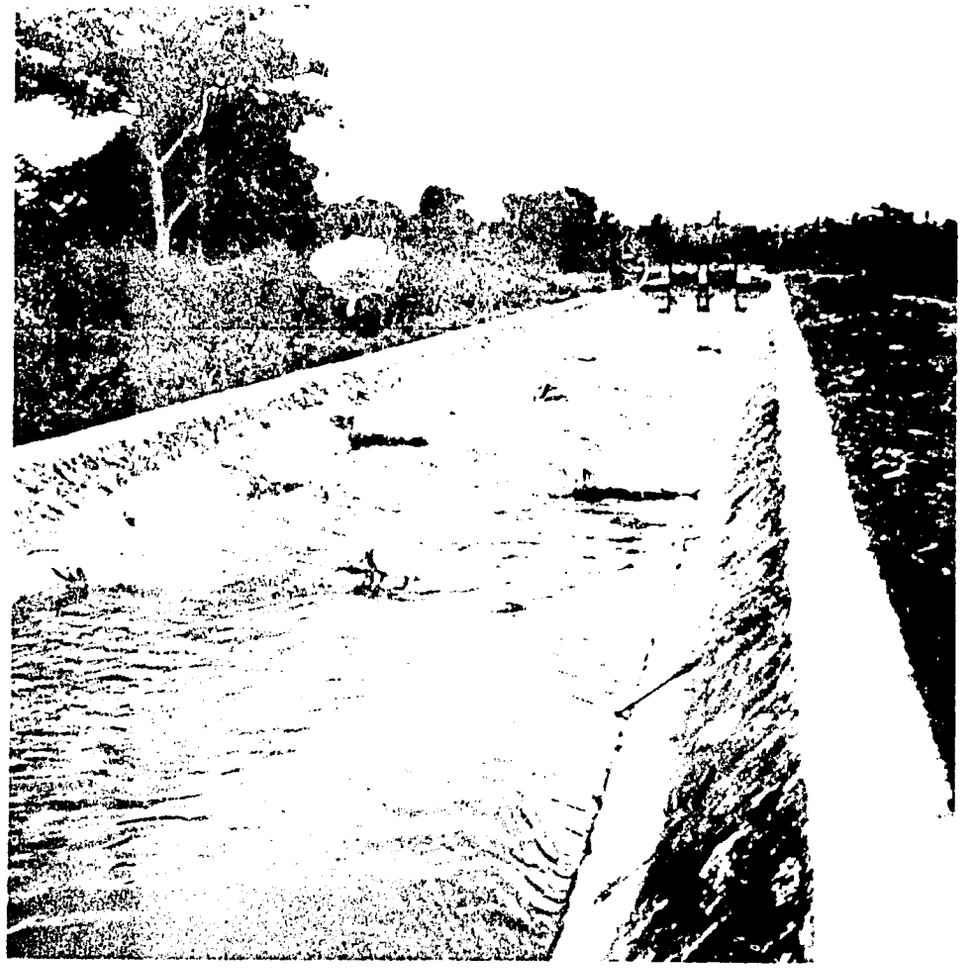
Shown is a short section of the main canal located in the spring area that has been allowed to deteriorate beyond repair.

The proposed new section of canal to be masonry lined is approximately 230 meters long. It is proposed to move the alignment of the new canal to the left bank of the spring area on the left side of the picture.



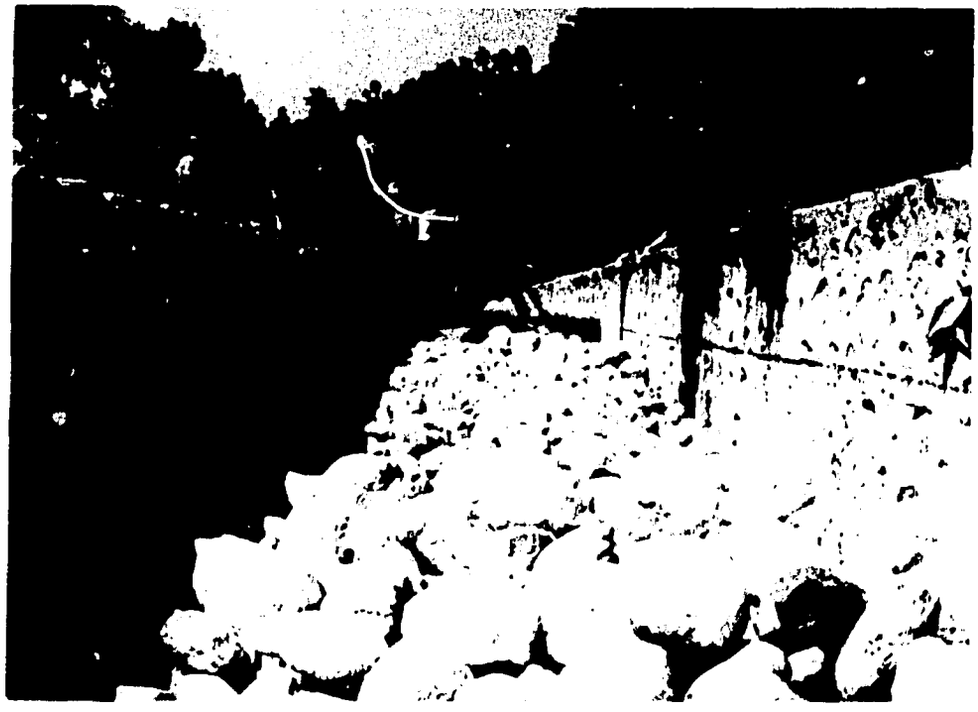
Steel check gates and turnouts are shown in the back-ground. Many of the steel check gates and turnouts are in need of repairs. Several will have to be replaced. Shown in the foreground is debris, vegetative growth and cobbles in a section of the main canal below the bridge across the main canal on the Boval Road.

Construction work on the rehabilitation of the main canal in masonry. In order to gain enough elevation to locate the new canal above the existing springs, rehabilitation work was started at station 0+600 and continues through station 0+784



The invert grade of the existing canal bottom is being changed form 0.007 meters per meter to 0.004meters per meter. This will permit the construction of the new proposed canal section to be about 1 meter above the water level in the spring area.

The proposed lining of about 230 meters of new masonry canal will begin at station 0.784 and continue trough station 1 +003. A drop structure (chute) will be constructed at the end of the new masonry canal in order to convey water flow back into the existing main canal in masonry, beginning at station 1 +003.



Primitive type of diversion structures are used to divert water from the main laterals into farm ditches. These are usually constructed by driving stakes across the channel and placing banana leaves, grass, other debris and soil to provide turnouts into secondary laterals and field ditches. None of these structures provivide measured amounts of water to the canals, laterals or into field ditches.

Water is supplied to the people living in the area for domestic use as well as for irrigation. This includes drinking, bathing & laundry as well as for watering livestock.

A food program was initiated at the inception of the project work. This provides a noon meal for the workers.

The food is prepared in a central outdoor kitchen on the project and delivered to the work brigade, working on the project. This consists of cornmeal fortified with meat principally fish.

3.34 Canal Crossings -- Bridges

65 canal crossings of various sizes were planned, the largest being a truck bridge over the main canal near the spring section. The truck bridge is some 80% complete, with only the ramps on both sides remaining to be completed. An ancient foot bridge 200 meters upstream was repaired and a new section added. 14 slabs for canal crossings were cast but as yet have not been placed where required.

3.35 Grade Control Structures

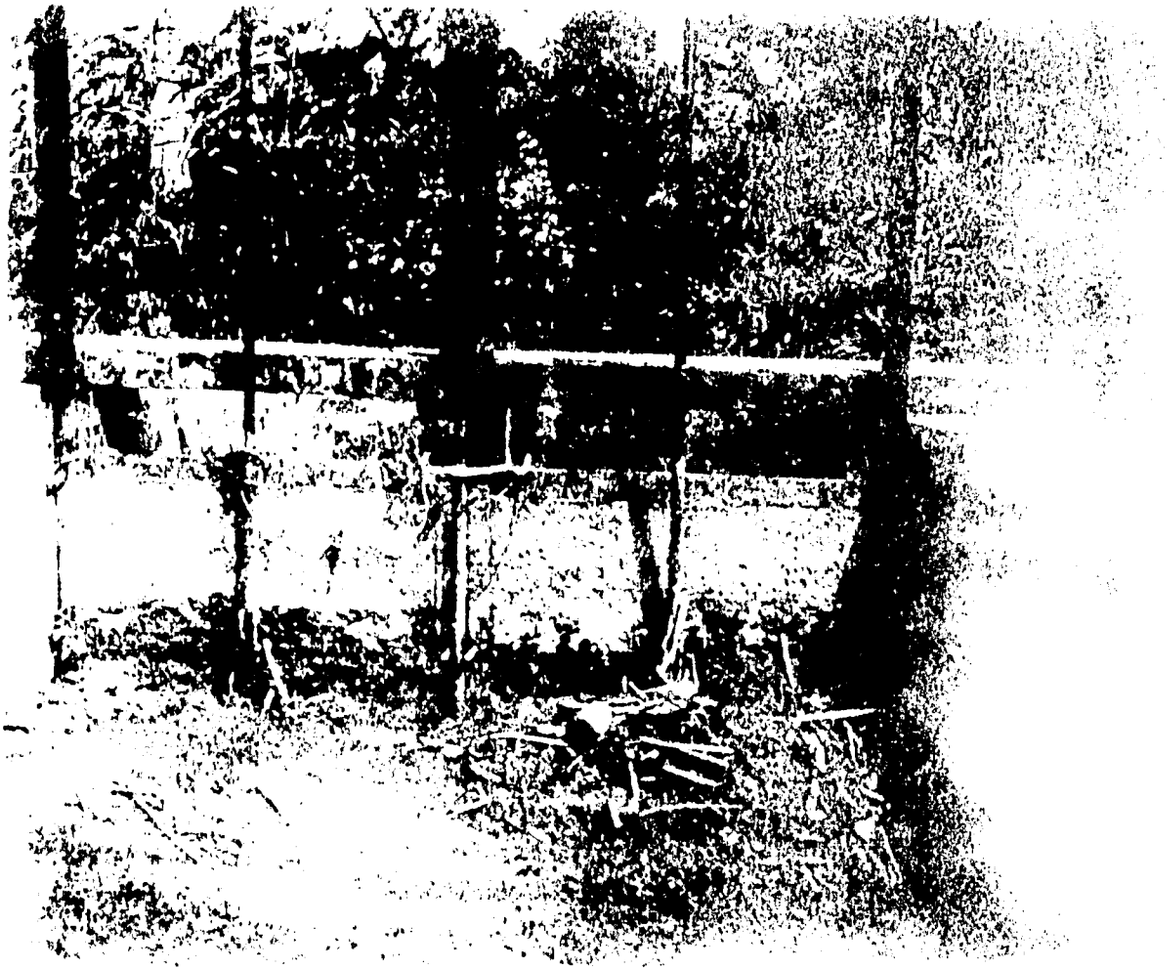
3.351 Drops, Chutes, Turn-outs, Checks, etc.

Of a planned total of 182 new grade control structures 41 were started and 12 completed as the required metal turn-out gates had not arrived. Also ordered but not received were 61 Armco lift-nuts to replace those missing or damaged on existing structures. Some 67 existing turn-out gates were repaired and made functional.

3.36 Drains

12 Kilometers of drains to dispose of run-off from storms and excess irrigation are included in the system 3.4 kilometers were either cleared and opened or rebuilt.

Non – functional diversion gates from Main to Secondary canal.



3.37 Service Roads

Of the planned total of 28.4 kilometers of roads to be repaired or constructed, 16.1 were completed.

3.38 Community Center

No work was done on this item as the necessary site was not acquired.

4.0 ESTIMATE OF CONSTRUCTED COSTS

E.C.I. Estimate vs Actual or Corrected Estimates
January 1978

Item - Rubrique	Dollars	
Barrage & Appurtenances - Barrage de Dérivation		
Repair Ogee Crest - Réparation Crete "Ogee"	1,000	
Sluice Gate - Pertuis de Chasse	400	
Main Canal Headgate - Vannes d'Alimentation Canal Principal	400	
		1,800
Main Canal - Canal Principal		
Cleaning Rock, Sediment & Vegetation from canal - Elèvement des Roches, des Sediments et de la Végétation dans le canal	1,200	
Repair Masonry - Réparation de la Maçonnerie	1,000	
Temporary Bypass - Dérivation Provisoire du Canal Principal	1,000	
Masonry Lining - Construction Revêtement en Maçonnerie	6,000	
3 Turnouts - 3 ouvrages de Prise d'Eau	300	
7 Weirs - 7 Déversoirs pour le Portage Proportional des Eaux	6,000	
1 Foot Bridge - 1 passage pour piétons et animaux	500	
		16,000

Laterals - Canaux Secondaires

Install 3 Metal Gates - Construction de 3 Vannes Métallique	300	
Install 14 Weirs - Construction de 14 Déversoirs	2,100	
Install 5 Drops - Construction de 5 chutes	500	
Install 4 Turnouts - Construction des 4 Ouvrages de Prise d'Eau	400	
Install 16.3km Masonry Lining - Construction de 16.3km de canaux avec Revêtement en Maçonnerie		
6,000 m^3 Masonry - 6,000 m de Maçonnerie	126,000	
7,690 m^3 Excavation - 7,690 m de Fouille	3,500	
18,460 m^3 Compacted Embankment - 18,460 m^3 de Remblai Compacté pour les Berges de Canaux	24,000	
Farm Turnouts and Concrete Structures - Prises de Distribution d'eau et Ouvrages d'Art	5,000	
		161,800

Drains 10 kms. - Canaux de Drainage 10 kms.

25,000 m^3 excavation - 25,000 m^3 Fouilles	10,000	
3 crossings - 3 Ponceaux	1,500	
		11,500

Office, Depot, Garage, Shop, Land, Etc. - Devis pour Bureau, Garage, Depot, Terrain, Etc.	15,100	15,100
Roads - Routes	1,500	1,500
Other Costs (10%) - Autre Dépenses (10%)	20,800	20,800
Supervision and Administration (10%) - Supervision et Administration (10%)	20,800	20,800
Contingencies (20%) - Imprévus (20%)	41,700	41,700
		291,000

4.01 Actual Costs and/or Corrected Estimates

Barrage and Appurtenances

Material:

1. Epoxy And Resin	700	
2. Cement, Sand and Gravel for Repair of Apron	280	
3. Gate Seals	200	
4. Headgates	200	

Labor:

1 Mason and 4 Helpers @ 3.00 + 5.20 = $8.20

4 Months = 17 weeks x 4 days per week = 68

68 days x $8.20 per day	560	
		1,940

Main Canal

Length:

0 + 000 to

4 + 515 Boval Bridge

9 + 115 To Beraud Road

10 + 165 To End @ Lat. 10.1 & 10.9

Repair Masonry Lining

Material: Cement for mortar 1:2 rate

2 Bags per 50 meters

Time: 50 meters per day, both sides of canal

1 mason & 1 helper = $4.30/day

$\frac{10,165 \text{ m}}{50\text{m}}$ = 233 days

233 days x $4.30 = 1,000

Material:

233 days x 2 bags per day = 466 sacks

466 x $ 3.50 = 1,630

72 m^3 x 5.00 Sand & Gravel screened 360

Install Bridge at Spring Area 500

Install Turnouts 300

Install Division Strs. (proportional Weirs) 5,000

8,790

Lat.	2.32	3600 m	150 L/S
	2.32 - 0.19	1800	150 L/S
	2.32 - 0.19 - 1.19	650 6050 m	
Lat.	2.93	2350	150 L/S
	2.93 - 02	1600 3950 m	
Lat.	5.34	1790 1790 m	150 L/S
Lat.	5.9	5750 5750 m	
		(4120+1630)	1000 L/S
Lat.	5.9 - 0.8	1920	150 L/S
	5.9 - 1.8	3350	200 L/S
	5.9 - 2.8	2150	150 L/S
	5.9 - 4.1	1743 9163 m	200 L/S
		14,913 m	
Lat.	7.09L	1900	150 L/S
	7.09R	2100	200 L/S
	7.09 - 0.65	1700 5700 m	150 L/S
Lat.	9.16	3289 3289 m	500 L/S
Lat.	9.3	1350	150 L/S
	9.3 - 0.1	750	
	9.3 - 0.3	700 2800 m	
Lat.	10.09	1900	300 L/S
	10.10	2650 4550 m	300 L/S
		43,042 m	
		- 5,750	
		37,292 m	

Laterals

1. Masonry Canal Lining

   16.3 km or 16,300 meters planned. This amount of masonry lining is needed to rehabilitate the system properly.

   16,300 m x 0.92 m^3 per lineal meter = 14,996 m^3 of masonry lining

   14,996 m^3 x \$35/m^3 = \$524,860 \$524,860

   (14,996 m^3 x \$27/m^3 = \$404,892)

2. Excavation - Canals, Laterals, and for Masonry Lining

   Based on cross sections taken and calculated for construction purposes on Lat. 5.9 - 2.8, the average amount of dirt to be moved is 0.57 m^3 per lineal meter of lateral.

   There are 16,300 m of laterals that will be masonry lined and only excavation is needed at the rate of

   3 m^3 per 1 man per 1 day.

   16,300 x 0.57 m^3 = 9291 m^3

   $\frac{9291\ m^3}{3\ m^3}$ = 3097 mandays x \$1.30/day \$ 4,026

   The remaining 26,742 meters of laterals will remain as earth channels and will require compacted earth embankment at the rate of

   2 m^3 per 1 man per 1 day.

$26,742 \times 0.57\ m^3 = 15,243\ m^3$

$\frac{15,243}{2\ m^3} = 7621$ man-days x \$1.30 = 9,900

3. Grade Control Structures (Drops, Chutes, etc.)

Based on data from Lat. 5.9 - 2.8

97 Drops @ \$75 7,275

85 Turnouts and checks @ \$85 7,225

4. Canal Road Crossings Structures

Pedestrian and Animal

65 ea @ \$45 2,925

546,311

5. Drains - 12 km of surface drains to dispose of run-off from storms and excess irrigation water

Excavation:

$3\ m^3$ per 1 man per 1 day

$2\ m^3$ per lineal water of drain ditch

$12,000\ m \times 2\ m^3 = 24,000\ m^3$

$24,000\ m^3 \div 3\ m^3 = 8000$ mandays

8000 mandays x \$1.30 = 10,400

Drain crossings for animals and pedestrians

35 ea @ \$65 2,275

12,675

Service Roads

1 crew 3 to 3.5 4 days to repair or construct 1 km of road.

Main Canal:

Labor: 1 crew @ $16.00

6.5 km left to be completed

6.5 km x 3.5 days = 22.75 days

22.75 days @ $16.00 — 364

Material:

3.5 charges (Loads) per km.

3.5 x 6.5 km = 22.75 loads

22.75 x $10 — 227.50

Laterals:

Labor: 1 crew @ $16.00

Lat. 5.9 = 5,000 8.0km x 3.5 days = 28 days

Lat. 9.16 = 1.6 km 28 days x $16 = — 448

Misc. = 1.4 km

8.0 km

Material: Rock and Gravel

7 loads x 8.0 km = 56 loads

56 loads x $10 — 560

1,599.50

($10 per load or charge ($3m^3$).

1 Dump truck hauls 9 loads per day or 27 m^3).

L'Acul River Channel Improvement

Dozer Work: DARNDR	
5 to 6 weeks (25 to 30 days)	
30 days x rate (8.00) per hour x 8 hrs/day	1,920
Community Center	10,000
Supervision and Administration	DARNDR
Contingencies 20%	116,311
	$ 699,546.50

Note: Items purchased on PLO/C and technical consultant requirements are excluded.

Using the 31 December 1977 final figure for the incompleted project :

$ 699,546.50

Amount expended to 31 December 1977 :

$ 163,425.71,

Future requirements :

$ 536,120.79

Lavage de sable et de gravier pour la restauration du projet de Dubreuil.

Visite au projet du Dubreuil du Ministre de l'Agriculture, Mr. Rémillot Léveillé et des officiels du DARNOR.

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