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ASSESSMENT OF IMPACT OF AGRICULTURAL CHEMICALS IN THE HURRICANE HUGO DISASTER REHABILITATION PROGRAM ON AQUATIC SYSTEMS IN DOMINICA

Conducted for:

United States Agency for International Development
Regional Development Office for the Caribbean
(U.S.A.I.D./RDO/C)

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SUMMARY AND RECOMMENDATIONS

Monitoring was conducted in Dominica to determine the actual and potential problems from using fertilizers that U.S.A.I.D./RDO/C provided in the Hurricane Hugo Disaster Rehabilitation Program. U.S.A.I.D./RDO/C did not provide pesticides in this Program but selected pesticides were monitored also. The monitoring was conducted in January and March 1990.

FERTILIZER MONITORING

Actual Fertilizer (Nutrient)-Related Problems: As far as nutrients are concerned, water quality in the representative sampled areas is excellent. Although fertilizer application may be intense during certain periods, the high rainfall and steep stream gradients provide rapid dilution of nutrient inputs. Measured nutrient levels were always at or near the detection limits of the instrumentation, whether samples were collected during a relatively dry period or after a significant rainfall. The only situation not studied (due to the limitations of the site visit periods) was the worst-case scenario of a rainfall event immediately following an intense application of fertilizer in a particular watershed. However, it is clear that even if such an event were to temporarily raise water-column nutrient concentrations to higher levels, this effect would be temporary. Nutrient problems must be of a chronic nature to damage ecosystem health seriously. Therefore, based on results, there does not appear to be a nutrient-related (fertilizer-related) water quality problem in any of the representative watersheds sampled.

Potential Fertilizer (Nutrient)-Related Problems: Increased fertilizer use and expansion of cultivated acreage could lead to problems in the future. Such problems could be critical to the nation. Dominica already exports fresh water to other Caribbean nations. Plans have begun for a dedicated water tanker docking facility near Roseau and cruise ship terminal at the Cabrits, which will entail pipeline construction leading to exports of large amounts of water. It should therefore be a priority to protect what is potentially a valuable, renewable economic resource. This is also in keeping with the Commonwealth of Dominica's stated policy of making environmental quality a prime objective. A monitoring program should be established to ensure that the state of water quality continues to be good.

Specific Recommendations for a Nutrient (Fertilizer)-Related Water Quality Monitoring Program in the Commonwealth of Dominica: The monitoring plan described below would in effect provide an "early warning" system for aquatic ecosystem health. Nutrient parameter values are so low at present that a monitoring program could detect significant upward trends long before an environmental crisis situation was reached. Pesticide and pesticide residue parameters could also be added to the program.

1) Study areas. It is recommended that the monitoring include fourteen stations in three watersheds: Layou River, Pagua River and Melville Hall River.

The locations of the most important potable water intakes do not coincide with the selected representative watersheds. The monitoring network should,

therefore, include separate stations at water intakes. The three sampled potable water intakes (identified as WA1A, WA1B, WA1C in the assessment) constitute virtually the entire water supply for the capital city of Roseau and its suburbs, encompassing nearly 40% of the total population of Dominica. It is recommended that these stations be included as part of the monitoring program. The Freshwater Lake will be the source of water for the planned water tanker docking facility. A hydroelectric dam soon to be completed will increase the lake's surface area and could lead to temporary water quality problems due to nutrient leaching from newly flooded soils. The lake also receives input from some geothermally heated streams with higher than normal mineral content. The potential impact of these inputs should be investigated before completing the water tanker facility design. For these reasons, inclusion of Freshwater Lake in the monitoring program is strongly recommended.

Finally, the future cruise ship docking facility at the Cabrits will be supplied with water piped from the Picard River near Glanvillia. It is recommended that a station at the water intake be established and included in the monitoring program. The total number of stations recommended in the monitoring program is therefore 19.

2) Frequency of sampling. The personnel that would be involved in sampling and analysis under a nutrient-related quality monitoring program all have many other duties. It would be futile to propose a sampling frequency that the resources of the Government could not support. The recommended frequency of sampling the network as proposed would be four

times per year. If this should prove to be impractical, a frequency of twice per year is suggested.

3) Parameters. Recommended parameters for measurement are the following: Field parameters - pH, temperature, conductivity and dissolved oxygen; laboratory parameters: orthophosphate phosphorus, total phosphorus, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen and total Kjeldahl nitrogen. Chlorophyll is not recommended as an analysis parameter.

4) Sampling logistics. The primary roads in Dominica, while generally good, are treacherous and difficult for the uninitiated. Secondary and tertiary roads are in poorer condition. A four-wheel drive vehicle is necessary for sampling surveys. Even for experienced Dominican drivers, travel between sampling locations is usually longer than one would expect from a simple estimation of map distances. Ease of access is, therefore, a major factor in determining station locations. For this reason, no stations in the ocean off the mouths of the study rivers are recommended, although this was originally planned.

5) Field personnel. It is recommended that Forestry Division personnel, under the supervision of Mr. Arlington James (Forest Officer), be designated to collect samples for the monitoring program. Each sampling cycle would entail 7 to 10 person-days. These responsibilities should be clearly defined in a protocol with the consent of the Forestry Division, the Produce Chemist Laboratory, and the Chief Technical Officer.

6) Laboratory personnel. The Produce Chemist Laboratory would be the site of nutrient analyses. Mrs. Claudia Bellot, Produce Chemist, has a great number of other duties that occupy her time: supervision and administration (20%); food product development (30%); quality control and technical assistance to the agricultural industry (20%); and other assignments such as chairing the Pesticide Control Board and serving on the Food and Nutrition Council (10%). It is unlikely, therefore, that Mrs. Bellot will be available to perform chemical analyses of nutrient monitoring samples. This task would then devolve to Ms. Jayceline Alexander, Laboratory Technician. Unfortunately, Ms. Alexander is now the only technician assigned to the Produce Chemist Laboratory (where there were previously two). Her duties include routine analysis of water, food, soil, leaf material, essential oils and animal food (55%); assistance in food product development (30%); equipment maintenance (10%) and inventory (5%). She is currently completing a course in Pesticide Residue Analysis, and so will undoubtedly assume that responsibility in the near future. Each sampling cycle would require 10 to 15 person days, and it is difficult to wee where Ms. Alexander would find the time for this, even at a frequency of only two sampling cycles per year. It is strongly recommended that the previous complement of two Laboratory Technicians be restored to the Produce Chemist Laboratory. Otherwise, the analysis component of a water-quality monitoring program is probably not feasible.

7) Materials and supplies. The reagent chemicals supplied with the Hach DRFL-2000 instrument were sufficient for training, but more supplies would be needed to set up the Produce Chemist Laboratory for two cycles of a

monitoring program. The table lists the required chemicals and current stocks. It is recommended that these supplies be purchased with funds from the current U.S.A.I.D. project.

Supplies required for initial implementation of nutrient-related water quality monitoring program, available from Hach Chemical Co.

Item	Parameter(s)	Current stock	Additional needed
Phosver 3 pillows	Orthophosphate, Total Phosphorus	40	500
Potassium persulfate Pillows	Total Phosphorus	185	250
Nitraver 6 pillows	Nitrite, low range	0	250
Nitraver 3 pillows	Nitrite, low range	90	5000
Nessler reagent	Ammonia nitrogen Total Kjeldahl nitrogen	250 mL	750 mL
Rochelle Salt - PVA reagent	Ammonia nitrogen Total Kjeldahl nitrogen	500 mL	500 mL
12N Potassium Hydroxide solution	Total Kjeldahl nitrogen	700 mL	250 mL

8) Cooperation with DOWASCO. The Dominica Water and Sewerage Company (DOWASCO) is a privatized, government-sanctioned monopoly utility. DOWASCO is also the driving force behind the rapidly expanding exportation of fresh water supplies. It is recommended that DOWASCO personnel be invited by the Ministry of Agriculture to participate in the monitoring program by assisting in the sampling and laboratory analyses. If DOWASCO is willing to commit personnel to the program, it is conceivable that the number of potable water intake sampling sites could be expanded.

Steps Taken to Implement the Recommended Monitoring Program: At the conclusion of the second site visit of CICP personnel (12-22 March 1990), the equipment and knowledge to implement a monitoring program were already in place. Given the Commonwealth of Dominica's strong commitment to environmental protection, it was expected that their Government would follow through on the above recommendations. A 29 May 1990 letter from the Forest Officer (Appendix II) indicates that this is indeed the case, as the first sampling cycle carried out entirely by host-country professions was scheduled for June 1990.

PESTICIDE MONITORING

Pesticide Residues: Samples of potable water, surface water, river sediments, fish, and terrestrial wildlife were analyzed for residues of pesticides presently used in Dominica. None of the samples contained pesticide residues above the minimum detection level (MDL). The results indicated that pesticides were not concentrating in the environment sampled. However, even if below MDL, pyrethroid insecticides, which are used in Dominica, could effect small aquatic organisms. Also, the monitoring was done over a very short period of time and only a small number of samples were taken. More detailed monitoring should be carried out over a long period of time. It is recommended that left over FAO money for equipment be used to purchase a Tracer NPD and Labline Model 3088 Water Bath or a similar design for the Produce Chemist Laboratory, which would become the permanent monitoring facility. A technician should be hired to fill the vacant position in the laboratory.

Potentially Serious Pesticide Problems: Disposal of pesticide containers are a potential problem. Washing of backpack sprayers in rivers could lead to aquatic life kills. The population with the greatest risk from pesticides are the handlers of concentrates - transportation and storage personnel, mixers, loaders and applicators. No one in Dominica is trained in the diagnoses and treatment of pesticide poisonings. Therefore no records are available to assess the effects. The Dominica Ministry of Agriculture in cooperation with the Dominica Banana Growers Association (DBGA) should have periodic safety training sessions to include disposal of pesticide containers and rinsing backpack sprayers. Hospital personnel should be trained in the diagnosis and treatment of pesticide poisonings.

BACKGROUND

As part of a disaster relief program funded by U.S.A.I.D./RDO/C to help the Government of the Commonwealth of Dominica (GOCD) recover economically from the devastation of Hurricane Hugo, fertilizers were procured at the request of GOCD to assist farmers rehabilitate the plantings of bananas and other crops. Such fertilizers were already being used and available in Dominica.

Fertilizers were the largest U.S.A.I.D. purchase under the disaster relief package. It is widely believed that chemical pollution of surface waters, such as may occur from application of fertilizers, is poisoning coral reefs so important to tourism and fishing in the region. Improperly treated and discharged sewage contributes further to the problem of pollution.

U.S.A.I.D./RDO/C is aware of these issues and is concerned about the potential negative impact of contamination due to widespread use of agrochemicals in Dominica. Little quantitative data are available in the Caribbean on human/environmental contamination by agrochemicals. U.S.A.I.D./RDO/C therefore decided to determine the threat of contamination by fertilizers provided in the program. In addition, selected pesticides, although not provided by U.S.A.I.D. in the Disaster Relief Program, were monitored.

THE CONTRACTOR

The assessment was by the Consortium for International Crop Protection (CICP). The following CICP personnel conducted the monitoring and other work in Dominica and prepared this assessment:

Dr. Philippe Ross, Associate Aquatic Toxicologist, Illinois Natural History Survey, Champaign, Illinois/USA (Consultant to CICP)

Mr. Jon B. Mann, Chemist, University of Miami School of Medicine, Miami, Florida/USA (CICP Staff Chemist)

Ross was responsible for the fertilizer assessment and Mann for the pesticide assessment. Their schedules and work summaries in Dominica appear in Appendix I. They consulted and collaborated with many persons in Dominica, also appearing in Appendix I.

FERTILIZER MONITORING

Sample Inventory

1. 132 samples were collected for analysis at the Produce Chemist Laboratory. In the course of training Produce Chemist Laboratory personnel, some of these were analyzed during the second visit. The samples taken during the first visit (87 in number) were preserved in the same manner as the audit samples (see below), because the instruments for analysis at the Produce Chemist Laboratory had not arrived as expected during the first visit. Samples taken during the second visit (45 in number) could be analyzed immediately, and were therefore not preserved.

2. 27 samples were collected as (replicate) audit samples and preserved with sulfuric acid, to be analyzed at the Illinois Natural History Survey. The purpose of this was to verify the accuracy of analyses performed at the Produce Chemist Laboratory with the Hach DREL-2000 instrumentation purchased for the project.

3. During the second visit 9 samples were collected and preserved in the same manner as the audit samples, but were analyzed immediately at the Produce Chemist Laboratory personnel. The purpose of this was to provide a direct comparison between preserved samples and unpreserved samples.

Analyses

Sample group 1: for analysis at the Produce Chemist Laboratory.

At the conclusion of the second visit, analyses for all parameters were well underway. Determination of orthophosphate phosphorus was complete for nearly all samples, and total phosphorus, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen and total Kjeldahl nitrogen had been determined for varying numbers of samples. Mrs. Claudia Bellot and Ms. Jayceline Alexander of the Produce Chemist Laboratory are now competent in all of these analyses and are familiar with the appropriate equipment and procedures. More supplies are needed, however, to provide a monitoring capability.

Nutrient concentrations in this group of samples are extremely low. A good example of this is the data set for orthophosphate phosphorus, the parameter for which the most analyses were completed during training at the Produce Chemist Laboratory. For the samples analyzed up to the end of the second visit, the mean orthophosphate concentrations (mg/L, as P) for each of the study watersheds were as follows: Layou River, 0.02; Pagua River, 0.01; Melville Hall River, 0.02; Potable Water Supplies, 0.03. Samples were taken under a variety of conditions - after a dry period, after a heavy rain, during the rainy season, and during the dry season. Concentrations tended to be higher after a rain, but even the maximum values observed (0.08 mg/L) were low. Because the orthophosphate levers are so low, a number of samples were determined to have concentrations of zero, within the detection limits of the instrument. In this type of data set (very low values, several zero values) variability tends to be relatively high. This is not due to flaws in methods, equipment or materials, but rather because one is measuring parameters near the very limits for their detection.

Sample group 2: audit samples analyzed at the Illinois Natural History Survey.

Audit samples were preserved and returned to the Illinois Natural History Survey for analysis on a Technicon Nutrient Autoanalyzer. Table 1 shows concentrations for the six nutrient parameters measured in 27 audit samples.

Table 1. Nutrient concentrations (mg/L) in Dominica water samples. The notation <DL indicates a concentration below the detection limit of 0.009 mg/L. Parameter codes are: Total P = total phosphorus; o-PO_4 = orthophosphate phosphorus; NO_2-N = nitrite nitrogen; NO_3-N = ammonia nitrogen; TKN = total Kjeldahl nitrogen. Watershed codes are: LR = Layou River; PR = Pagua River; MR = Melville Hall River; WA1A = Check Hall-Antrim Valley water intake station.

Station	Date	Total P	o-PO_4	NO_2-N	NO_3-N	NH_3-N	TKN
LR3	01/17/90	0.07	0.04	<DL	0.10	0.09	0.41
		0.08	0.06	0.01	0.12	0.07	0.28
		0.07	0.04	0.01	0.12	0.12	0.36
PR4	01/18/90	0.03	<DL	0.01	<DL	0.08	0.04
		0.02	<DL	0.01	<DL	0.05	0.06
		0.01	<DL	0.01	<DL	0.06	0.05
MR5	01/18/90	0.03	<DL	<DL	0.04	0.12	<DL
		<DL	<DL	<DL	<DL	0.08	<DL
		0.02	<DL	0.01	<DL	0.07	0.10
WA1A	01/19/90	0.02	<DL	0.01	0.17	0.17	0.05
		0.02	<DL	0.01	0.10	0.16	<DL
		0.06	<DL	0.01	0.04	0.03	0.07
PR4	01/23/90	0.01	<DL	0.02	<DL	0.05	0.10
		<DL	<DL	<DL	0.01	0.12	0.02
		0.01	<DL	0.01	<DL	0.13	<DL
LR3	01/24/90	0.01	<DL	0.02	0.08	0.14	<DL
		0.01	<DL	0.01	0.20	0.12	<DL
		0.01	<DL	0.01	0.15	0.24	0.20
LR3	03/16/90	0.02	0.02	<DL	0.16	<DL	<DL
		0.01	0.01	<DL	0.16	<DL	<DL
		0.01	0.02	<DL	0.16	<DL	<DL
PR4	03/16/90	<DL	<DL	<DL	0.07	<DL	0.82
		0.01	<DL	<DL	0.07	<DL	0.76
		0.11	<DL	<DL	0.07	<DL	0.84
MR4	03/20/90	<DL	<DL	<DL	0.07	<DL	<DL
		0.03	0.02	<DL	0.07	<DL	<DL
		0.02	0.01	0.01	0.06	<DL	<DL

The main purpose of audit samples is to independently verify the accuracy of the main data set, in this case the samples analyzed at the Produce Chemist Laboratory (PCL) in Dominica. The complete accuracy verification for all parameters will be the purview of the Produce Chemist. This cannot be done until all sample sets that match the audit sample series have been analyzed for all parameters. For this report it will be instructive, however, to compare the results for the orthophosphate phosphorus analyses, most of which were completed during the project. This can be done by comparing matched sets of triplicate samples. Table 2 lists results for eight matched sets of samples. Given that all values are at or near detection limits, as mentioned above, the agreement between program samples and audit samples is relatively good. In most cases, the means of the matched sets do not differ by more than 0.02 mg/L. The only exception to this is the data from Layou River station 3 samples collected on 01/24/90. Here the program samples are inexplicably higher than the audit samples. Nevertheless, such differences at very low absolute concentrations must be considered normal.

Sample group 3: Preservation correction samples.

In order to assess the effect of preservation on nutrient chemistry determinations, matched sets of 6 samples were collected where 3 were preserved (1 mL of concentrated sulfuric acid) and 3 were analyzed immediately. During the second in-country visit, two of these matched sample sets were analyzed for orthophosphate phosphorus. Table 3 gives the results of this comparison. From this small data set, it is impossible to

conclude that there is any bias from preservation of samples. Again, with values so close to detection limits any statistical inference is difficult.

Table 2. Comparison of results of orthophosphate phosphorus determinations (mg/L) on water samples analyzed at the Produce Chemist Laboratory (PCL) and the Illinois Natural History Survey (Audit). Watershed codes are: LR = Layou River; PR = Pagua River; MR = Melville Hall River; WA1A = Check Hall-Antrim Valley Water intake station.

Station/ Date	PCL Samples	Audit Samples	Station/ Date	PCL Samples	Audit Samples
LR3 01/17/90	0.02	0.04	PR4 01/17/90	<DL	<DL
	0.03	0.06		<DL	<DL
	0.05	0.04		<DL	<DL
MR5 01/18/90	<DL	<DL	WA1A 01/19/90	0.01	<DL
	<DL	<DL		0.03	<DL
	0.01	<DL		0.03	<DL
LR3 01/24/90	0.02	<DL	PR4 01/23/90	<DL	<DL
	0.08	<DL		<DL	<DL
	0.07	<DL		<DL	<DL
LR3 03/16/90	0.01	0.02	PR4 03/16/90	0.02	<DL
	<DL	0.01		0.02	<DL
	0.02	0.02		0.02	<DL

Table 3. Comparison of results of orthophosphate phosphorus determinations (mg/L) on preserved and unpreserved water samples analyzed at the Produce Chemist Laboratory. Watershed codes are: LR = Layou River; PR = Pagua River.

Station	Date	Unpreserved	Preserved
LR3	03/16/90	0.01	<DL
		<DL	0.01
		0.02	<DL
PR4	03/16/90	0.02	0.02
		0.02	0.02
		0.04	0.02

Identification of Watersheds. The contract called for identification of two representative watersheds, one on the leeward (Caribbean) side and one on the windward (Atlantic) side of the island. The leeward side choice was the Layou River, Dominica's longest river and an important agricultural valley. Five river stations were established, encompassing a substantial reach of the river, from its mouth at Layou Village to near the headwaters at D'Leau Gommier.

After discussion with Ministry of Agriculture Officials, it was decided that two watersheds on the windward side would be appropriate. The Pagua (Concorde) River is formed by the confluence (at Deux Branches) of a north branch and a south branch. The entire cachement area of the north branch lies within the Northern Forest Preserve and is therefore unaffected by agricultural chemicals. Sampling this branch gives a reference point, equivalent to background conditions. The south branch and the downstream reaches of the river drain lands that are partly forested and partly cultivated, including a portion of the Carib Reserve. Nowhere in the watershed is agricultural activity intense. Five stations were established: north branch, south branch, and three stations from the confluence to the river mouth at Pagua Bay.

The Melville River is one of the most intensely cultivated of the windward side rivers. Four stations were established, from near the headwaters at the Melville Hall Estate to the river mouth at Melville Hall Airport.

Training of host-country counterparts. All sample collections were performed in the company of Ministry of Agriculture personnel. Mr. Edgar Hunter and Mr. Arlington James (Forestry Division) and Ms. Jayceline Alexander (Produce Chemist Laboratory) are now fully trained in sample collection and field measurement techniques. Both Ms. Alexander and Mrs. Claudia Bellot of the Produce Chemist Laboratory were trained in nutrient chemistry analyses in the laboratory.

Design of a nutrient-related water quality monitoring program. The requirements for a monitoring program are now in place. In addition to the three watersheds selected (see item 1 above), four individual stations were established for monitoring water quality at potable water intakes: Antrim Valley (WA1A), River Douces (WA1B), Snug Corner (WA1C) and the Freshwater Lake. This forms a total network of 18 stations, which constitute a representative sampling of nutrient-related water quality in Dominica. An annotated map, as well as detailed location descriptions of all 18 stations, were provided to the Produce Chemist Laboratory. Equipment for sample collection, field parameter measurements (temperature, pH, conductivity and dissolved oxygen), and laboratory analysis (the Hach DREL-2000 system) were purchased and provided with appropriate training (see item 2 above) to host-country counterparts.

Conduct a baseline nutrient sampling survey during the period 15-24 January 1990. See Appendix I.

Conduct a follow-up survey during the period 12-22 March 1990. See Appendix I.

PESTICIDE MONITORING

A valley runs through Dominica from east to west making a natural watershed to the Layou River to the west and to the Pagua and Castle Bruce rivers in the east. Sampling sites for surface water and sediment were selected in the Layou and Pagua watersheds. A technician from the Dominica Produce Chemist Laboratory accompanied the CICP team to locate the sites and to learn sample collection techniques. This technician attended a pesticide residue training class at the University of Miami to insure that Dominica has the capability to continue the Environmental Monitoring Program instituted under this project.

Initial Baseline Sampling

Initial sampling was completed during the period January 14 - 26, 1990. This was not a true baseline result since it was not before the inception of pesticide use. Pesticides had and were continually being used before and after the project period. Instead, the results were used to determine future sampling sites.

Potable Water: One liter grab samples (duplicates) of water were taken at the following intakes for Roseau's water supply: 1) Antrim Valley inlet identified WA1A; 2) Snug Corner inlet identified WA1C; and, 3) Tap water

from Canefield identified WA1A since the supply intake is the Antrim Valley intake (replicate samples taken for reproducibility). Nothing is done to the water but chlorination, so theoretically there should not be any difference between intake and tap water, but samples were taken to verify this.

Surface Water: One liter grab samples (duplicates) were taken at the following sites: 1) Layou River mouth identified LR2; 2) at Deux Branch on the Pagua River identified PR6; and, 3) Pagua River mouth (replicates) identified PR2.

Sediments: Two - 6 ounce jars (duplicates) core samples of sediment were taken at a depth of 0 - 3 inches at the following sites: 1) Layou River mouth identified LR2; 2) Pagua River mouth identified PR2 (replicates); and, 3) Atrim Valley Inlet identified WA1A.

Follow-up Sampling: Approximately 1.5 months later (March 11 - 23, 1990, a second sampling was made based on the results of the first sampling, again coordinated with the fertilizer sampling and accompanied by a representative of the Forestry Service who will be responsible for collecting the samples in the future. The Produce Chemist Laboratory will be responsible for the analyses.

Potable Water: One liter grab samples (duplicates) were taken at the following sites: 1) Atrim Valley Inlet identified WA1A; and, 2) Roseau tap water identified WA1B since the water inlet WA1B is the supply source.

Surface Water: One liter grab samples (duplicates) were taken at: 1) the Layou River mouth (LR2); 2) Layou River spring bridge (LR4); 3) Layou River at Bells (LR5); 4) Pagua River mouth (PR2); 5) Pagua River (PR4); and, 6) the Melville Hall River (MHR4). Sampling sites were added and/or changed to give a more complete analysis of possible contamination.

Sediment: Two - 6 ounce jars (duplicates) of core samples 0 - 3 inches deep were collected at: 1) Layou River mouth (LR2) for a replicate of the first sampling; 2) Pagua River mouth (PR2); 3) Layou River (LR5); and, 4) Melville Hall River mouth (MHR2).

Terrestrial Wildlife: No dead birds were found in areas of pesticide use. A snake (identified GE1), a lizard (GE2), and some crickets (GE3) from Geneva Estates were purchased for analysis. The Forestry representative accompanying us was quick to point out that we were not allowed to collect wildlife or aquatic life without a permit. The hunting season for Agouti was over.

Aquatic Life: The Fisheries Division arranged for two (2) samples of fish ("titiwi") collected from the Check Hall River (CHR1) and a crayfish from the Layou River (LR4) was purchased from a fisherman. These samples were selected over marine life as being the most likely to be contaminated by pesticides.

Laboratory Analysis: Official methodology used by U.S. regulatory agencies were the methods used for the analyses, as follows:

U.S.E.P.A. Method 608

Bromacil, Chlorothalonil, Deltamethrin, Diuron, Butyl, Fluazifop, Karate, Kelthane, Metalaxyl, Permethrin

U.S.E.P.A. Method 614

Chlorpyrifos, Diazinon, Dimethoate, Ethion, Ethoprop, Malathion, Pirmiphos-Ethyl

U.S.E.P.A. Method 615

2,4-D

Chevron Chemical Company Method 740.01

Paraquat

U.S.E.P.A. Method 531

Asulam, Benomyl, Carbaryl, Carbofuran, Etridiazole, Methiocarb, Methomyl, Oxamyl

Kratos Application Report - HPLC

Glyphosate

After consulting with Dominica counterparts and the list of pesticides used in Dominica, a determination was made of which pesticides would be analyzed and in which samples (see Appendix III). Appendix IV shows registration status of the pesticides.

The University of Miami is a Florida Certified Environmental Laboratory (Certification #E76071) and participates in the U.S.E.P.A. Quality Control Program. Replicate samples were analyzed to give reproducibility. Spiked samples were analyzed to show recoveries.

The results are shown by sample type (for example Appendix Va is for water samples. The sample identification gives sample collection site.) The sampling date, extraction date and completion date is also shown. The pesticide compounds analyzed and the minimum detection level (MDL) is given for each compound. ND indicates that nothing was detected above the MDL.

The results are given in the following Appendices:

Appendix Va	Water samples collected in January
Appendix Vb	Water samples collected in March
Appendix Vc	Soil samples collected in January
Appendix Vd	Soil samples collected in March
Appendix Ve	Wildlife and Aquatic Life and a listing of all samples by sample number, sample type, data collected, location, and site I.D.

Data Interpretation and Synthesis

Potable Water: None of the pesticides analyzed were found above limits of detection, indicating no risk to the general population from the drinking water sampled.

Surface Water: None of the pesticides analyzed were found above limits of detection, indicating no danger to animals from drinking this water nor to animals and humans bathing or wading in this water. Pyrethroids, if

present below the limits of detection, could affect smaller aquatic life. There was not any physical evidence of this found during these visits, however. Analytical sensitivity has not reached the level to insure safety to aquatic life from pyrethroids by chemical analysis alone.

Sediment: Pesticides absorb onto dirt particles which in turn wash into rivers and waterways. If contamination from pesticides was significant, river sediment would be an indicator. None of the pesticides analyzed were found above limits of detection. This indicated that there was not a significant contamination of the rivers by pesticides at the time of sampling.

Terrestrial Wildlife: None of the pesticides analyzed were found above the limits of detection. However, only a very small sample was taken.

Aquatic Life: None of the pesticides analyzed were found above the limits of detection. The samples were from watersheds forming a worst case scenario and were in an enclosed ecosystem.

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APPENDICES

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APPENDIX I

Philippe Ross and Jon B. Mann
Schedules and Work Summaries

Philippe Ross

Saturday, 13 January 1990 - Traveled from Champaign, Illinois to Miami, Florida.

Sunday, 14 January 1990 - Met Mann at Miami. Traveled to Dominica. Met Mr. Bethel, Ministry of Agriculture, at Melville Hall Airport. Traveled to Roseau. Met Mr. Howard Batson, U.S.A.I.D. Representative, at Anchorage Hotel.

Monday, 15 January 1990 - 1) Planning meeting with Ministry of Agriculture personnel at Agricultural Experiment Station: Mann, Ross, Mr. Batson, Mr. Errol Harris (Chief Technical Officer), Mr. Charles James (Technical Officer), Ms. Claudia Bellot (Produce Chemist). Welcomed by Mr. Harris. Discussed potential watersheds and potable water intakes for monitoring program. 2) Procured topographic maps for locating stations and access. 3) Technical meeting: Mann, Ross, Mr. Arlington James (Forest Specialist) and Ms. Jayceline Alexander (Chemist). Discussed potential station sites, access roads.

Tuesday, 16 January 1990 - 1) Additional planning meeting: Mann, Ross, Mr. A. James, Mr. C. James, Ms. Alexander. More discussion of station locations, access roads. 2) Meeting with Dominica Water and Sewage Company (DOWASCO) personnel: Mr. G. Bud Meckling (Director), Mr. Christopher Sorhaindo (Water Quality Laboratory Manager). Discussed locations and access roads for sampling potable water intake sites. 3) Unpacked and verified function of portable instruments.

Wednesday, 17 January 1990 - First sampling expedition: Mann, Ross and Ms. Alexander. Established 5 sampling stations, from the mouth to the headwaters of the Layou River. 18 samples collected, including 3 audit samples. Established 2 stations near headwaters of Pagua River. 6 samples collected.

Thursday, 18 January 1990 - Second sampling expedition: Mann, Ross and Ms. Alexander. Established 3 more sampling stations down to mouth of Pagua River. 12 samples collected, including 3 audit samples. Established 4 stations from headwaters to mouth of Melville Hall River. 15 samples collected, including 3 audit samples.

Friday, 19 January 1990 - Third sampling expedition: Mann, Ross, Mr. A. James, Mr. Edgar Hunter (Ministry of Agriculture, Forestry Division). Sampled 3 potable water intake sites: Antrim Valley (WA1A), River Douce (WA1B), and Snug Corner (WA1C). 12 samples collected, including 3 audit samples. Sampled Freshwater Lake, scheduled to be hydroelectric impoundment. 2 samples collected.

Saturday, 20 January 1990 - 1) Transcribed field notes. 2) Detailed planning for following week.

Monday, 22 January 1990 - 1) Recalibrated field instruments. 2) Inquiries about shipping of Hach DREL-2000 Portable Water Quality Laboratory. 3) Arrangements for ocean sampling.

Tuesday, 23 January 1990 - 1) Fourth sampling expedition: Mann, Ross, Mr. Francis Richards (Ministry of Agriculture), Mr. Philipps (Coast Guard) and Mr. Paquette (Coast Guard). Sampled 1 station in Caribbean off mouth of Layou River from Coast Guard Boat: 2 samples collected. 2) Fifth sampling expedition: Ross, Mr. Hunter. Sampled 5 stations (second visit) on the Pagua River. 18 samples collected, including 3 audit samples.

Wednesday, 24 January 1990 - 1) Sixth sampling expedition: Ross, Mr. Hunter. Sampled 5 stations (second visit) along the Layou River. 18 samples collected, including 3 audit samples. 2) Final planning meeting: Mann, Ross, Ms. Bellot, Ms. Alexander, Mr. Richards.

Thursday, 25 January 1990 - Traveled from Canefield Airport to Antigua. At Antigua, learned that severe winter storm had closed O'Hare Airport (Chicago) indefinitely. Decided to change route, and proceeded to St. Louis, Missouri.

Friday, 26 January 1990 - Traveled from St. Louis to Champaign.

Saturday, 10 March 1990 - Traveled from Champaign, Illinois to Antigua.

Sunday, 11 March 1990 - Met J. B. Mann at Antigua, traveled to Dominica.

Monday, 12 March 1990 - 1) Met with Mrs. Claudia Bellot and Ms. Jayceline Alexander at Produce Chemist Laboratory. 2) Verified arrival of Hach Equipment. 3) Met with Mr. Errol Harris, Mr. Charles James and Mrs. Claudia Bellot; discussed sampling strategies, collaboration with DOWASCO; further training of J. Alexander in Pesticide Residue Analysis. Arranged meetings with Fisheries Officer and Permanent Secretary. 4) Composed letter to Permanent Secretary, recommending delegation of J. Alexander to U.S. for training course. 5) Met with Mr. Arlington James (Forestry Division) to coordinate field sampling.

Tuesday, 13 March 1990 - Unpacked and assembled Hach equipment. Rewired plugs for local configuration.

Wednesday, 14 March 1990 - 1) Trained Produce Chemist Laboratory personnel in orthophosphate analysis. Completed all January samples. While training Produce Chemist Laboratory personnel, began total phosphorus and nitrate nitrogen analyses. 2) Met with Mr. Avrum Shriar (Island Resources Foundation). Discussed ecological inventory of Dominica.

Thursday, 15 March 1990 - 1) With Produce Chemist Laboratory personnel, continued total phosphorus and nitrate nitrogen analyses and began nitrite nitrogen analyses. 2) Met with Mrs. Claudia Bellot and Mr. Nigel Lawrence (Fisheries Officer). Discussed needs for expanded public education and increased laboratory staff.

Friday, 16 March 1990 - Seventh sampling expedition. With Mr. Edgar Hunter (Forestry Division), sampled 5 Layou River stations, collecting 21 samples including 3 audit samples and 3 cross-correction samples. Sampled 3 Pagua River stations, collecting 15 samples including 3 audit samples and 3 cross-correction samples.

Monday, 19 March 1990 - 1) With Produce Chemist Laboratory personnel, performed orthophosphate analyses on samples collected on 16 March 1990, continued total phosphorus and nitrate and nitrite nitrogen analyses, and began ammonia nitrogen analyses. 2) Met with Mr. G. C. "Bud" Meckling (DOWASCO). Discussed collaboration between DOWASCO and Produce Chemist Laboratory. 3) Met with Mr. Paul Brown (Organization of American States). Discussed OAS funding of training course for Ms. Jayceline Alexander.

Tuesday, 20 March 1990 - Eighth sampling expedition. With Mr. Edgar Hunter (Forestry Division), sampled 2 Pagua River stations, collecting 6 samples. Sampled 4 Melville Hall River stations, collecting 18 samples including 3 audit samples and 3 cross-correction samples. Sampled potable water intake at station WA1A (Antrim Valley), collecting 3 samples.

Wednesday, 21 March 1990 - 1) With Produce Chemist Laboratory personnel, continued all previous mentioned analyses and began total Kjeldahl nitrogen analyses. 2) Met with Mrs. Claudia Bellot and Mr. Eluid Williams, Permanent Secretary. Discussed recommendations and needs of the Ministry of Agriculture relative to water quality monitoring.

Thursday, 22 March 1990 - 1) With Produce Chemist Laboratory personnel, continued chemical analyses. 2) Met with Mr. Colin Bully (Organization of Eastern Caribbean States). Discussed possible future water quality projects.

Friday, 23 March 1990 - 1) Met with Mr. Kim Bell (Memorial University, Canada, attached to Fisheries Office). Discussed fisheries and general productivity of rivers. 2) Traveled to Champaign, Illinois.

<u>John B. Mann</u>

Sunday, 14 January 1990 - Travel to Dominica.

Monday, 15 January 1990 - Meetings with Mr. Errol Harris - Chief Technical Officer, Dominican Ministry of Agriculture (DMAG); Mr. Charles James - Technical Officer, DMAG; Mr. Howard Batson - Regional Agriculture Officer, U.S.A.I.D./Barbados; Mrs. Claudia Bellot - Chief Chemist of Produce Laboratory, DMAG; Jayceline Alexander - Technician in Produce Laboratory, DMAG. Picked up maps at Bureau of Lands and Surveys.

Tuesday, 16 January 1990 - Meetings with Mr. Arlington James - Forestry Service, DMAG; Mr. Bixi Meckling - General Manager, Dominica Water and Sewerage Company (DOWASCO); and Chris Sorhaindo - Chemist DOWASCO. Received list of pesticides from Mrs. Claudia Bellot who is also head of the Dominica Pesticide Board.

Wednesday, 17 January 1990 - Collected water and sediment samples and established five monitoring stations in the Layou River Basin (west watershed) and two stations in the Pagua River Basin (west watershed).

Thursday, 18 January 1990 - Collected water and sediment samples and established three monitoring stations in the Pagua River Basin (east watershed) and four monitoring stations along the Melville Hall River.

Friday, 19 January 1990 - Collected water and sediment samples and established monitoring stations at the Atrim Valley drinking water inlet, the Snug Corner inlet, the River Duece inlet and at the Fresh Water Lake. Tap (potable) water was collected at a private residence in Canefield.

Monday, 22 January 1990 - Extracted water samples at Produce Lab, DMAG.

Tuesday, 23 January 1990 - Training Jayceline Alexander of Produce Lab.

Wednesday, 24 January 1990 - Training Jayceline Alexander of Produce Lab.

Thursday, 25 January 1990 - Meetings with Dr. E. I. Watty - Pathologist, Roseau Hospital and de-briefing with Mr. Charles James - Technical Officer, DMAG. Training of Jayceline Alexander.

Friday, 26 January 1990 - Travel to Miami, Florida.

Sunday, 11 March 1990 - Travel to Dominica.

Monday, 12 March 1990 - Installed ignitor in FPD. Meetings with Mr. Michael Didier of the Dominica Banana Marketing Corporation (DBMC) and Ms. Ruth Allport, DMAG, Livestock Division.

Tuesday, 13 March 1990 - Meeting with Mr. Kim Bell - Guest researcher, DMAG, Fisheries Division. Assembled the Hach DREL 2000 kits.

Wednesday, 14 March 1990 - Analyzed 86 water samples for Orthophosphate using the Hach kits. Started nitrate analyses.

Thursday, 15 March 1990 - Accompanied Mr. Michael Thomas, DMAG Extension Agent, to inspect the DBMC pesticide warehouse in Roseau, Flick Limited (Household pesticides), Mousson, and the Farmers Market facilities. Met with Mr. Nigel Lawrence - DMAG, Fisheries advisor. Analyzed 36 water samples for Nitrates.

Friday, 16 March 1990 - Collected water and sediment samples along the Layou River and started on the Pagua River.

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Monday, 19 March 1990 - Collected water and sediment samples for pesticides. Analyzed 12 water samples for phosphates.

Tuesday, 20 March 1990 - Collected water and sediment samples from the Pagua and Melville Hall Rivers and from WA1A inlet and Roseau tap water at the Botanical Gardens (WA1B).

Wednesday, 21 March 1990 - Meetings with Mr. Eluid Williams - Permanent Secretary, DMAG and with Mr. Bud Meckling - DOWASCO. Analyzed 9 water samples for nitrite.

Thursday, 22 March 1990 - Extracted water samples for pesticides. Met with Mr. Avrum Shriar - Island Resource Foundation.

Friday, 23 March 1990 - Travel to Miami, Florida.

APPENDIX II

MINISTRY OF AGRICULTURE
FORESTRY DIVISION

BOTANICAL GARDENS,
ROSEAU,
DOMINICA, W I.

Tel. 82731
Our Ref. F

29th May 1990

Dr. Philippe Ross
Illinois Natural History Survey
172 Natural Resources Bldg
607 East Peabody Drive
Champaign, Il 61820
U.S.A.

Dear Dr. Ross,

Many thanks for your letter dated 11th April 1990, and we are happy to hear that the Boiling Lake water samples arrived safely and quickly.

The Forestry Division has included the collection of the samples from the water catchments and other streams in its 1990-1992 work programs, and will be collaborating with the Division of Agriculture in this venture. The first set of samples to be collected/analysed by the Forestry Division/Produce Chemist Laboratory will be taken in June 1990. We hope that the weather 'co-operates' during the sampling.

I have not yet received the materials which you promised to send (your letter of 11th April 1990), but I wish to say thanks in advance.

Sincerely,

.....
ARLINGTON JAMES
FOREST OFFICER

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APPENDIX III
PESTICIDES USED IN DOMINICA

ANALYSIS SUBSTRATE	WATER	SEDIMENT	(1) AQUATIC LIFE	(1) ANIMAL LIFE
PESTICIDE				
Asulam	X	X		
Benomyl	X	X		
Bromacil	X	(2)		
Carbaryl	X	X		
Carbofuran	X	X		
Chlorothalonil	X	(2)		
Chlorpyrifos	X	X		
2,4-D	X	X		
Deltamethrin	X	X	X	X
Diazinon	X	X		
Dimethoate	X	X		
Diuron	X	X		
Ethion	X	X		
Ethoprop (Mocap)	X	X		
Etridiazole	X	(2)		
Fluazifop Butyl	X	(2)		
Flueroprop (Karate)	X	X	X	X
Glyphosate	X	(2)		
Kelthane (Dicofol)	X	X	X	X
Malathion	X	X		
Mancozeb	(3)			
Metaldehyde	(3)			
Metalaxyl	X	X		
Methiocarb	X	X		
Methomyl	X	X		
Oxamyl	X	X		
Paraquat	X	X		
Permethrin	X	X	X	X
Pirimiphos-Ethyl	X	X		

(1) Methodology only recovers lipophilic pesticides
(2) Does not recover through method
(3) Insoluble in water - No threat to water supply

APPENDIX IV
REGISTRATION STATUS OF PESTICIDES

	TOXICITY CATEGORY	U.S. REG.	Banana:	Grapefruit:	Coconut:	Cacao:	Cabbage:	Carrots:	Lettuce:	Celery:	Spinach:
ASULAM	III	Y	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
BENOMYL	III	Y	X	X	(1)	(1)	Y	Y	N.H.O.	Y	Y
BROMACIL	II, III	Y	(1)	X	(1)	(1)	(1)	(1)	(1)	(1)	(1)
CARBARYL	II, II, III	Y	X	X	(1)	(1)	Y	Y	Y	Y	Y
CARBOFURAN	I, II	RUa	X	(1)	(1)	(1)	Y	N.H.O.	N.H.O.	(1)	(1)
CHLOROTHALONIL	I, II	Y	X	N.H.O.	(1)	X	Y	Y	N.H.O.	Y	(1)
CHLORPYRIFOS	II, III	Y	(1)	N.H.O.	(1)	(1)	Y	N.H.O.	Y	N.H.O.	(1)
2,4-D	I, III	Y	(1)	X	(1)	(1)	Y	Y	Y	Y	Y
DELTAMETHRIN	N.C.		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
DIAZINON	II, III	Y	X	X	(1)	(1)	Y	Y	Y	Y	Y
DIMETHOATE	II	Y	(1)	X	(1)	(1)	Y	(1)	(1)	Y	Y
DIURON	II, III	Y	X	X	(1)	(1)	(1)	(1)	(1)	(1)	(1)
ETHION	II	RUb	(1)	X	(1)	(1)	(1)	(1)	(1)	(1)	(1)
ETHOPROP (MOCAP)	I, II	RUc	X	(1)	(1)	(1)	Y	(1)	(1)	(1)	(1)
ETRIDIAZOLE	I, II		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
FLUAZIFOP BUTYL	II, III	Y	(1)	(1)	(1)	(1)	(1)	Y	(1)	(1)	(1)
FLUKROPROP (KARATE)	N.C.	N	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
GLYPHOSATE	II	Y	(1)	X	(1)	(1)	Y	Y	Y	(1)	Y
KELTHANE (DICOFOL)	II, III	Y	(1)	X	(1)	(1)	Y	N.H.O.	Y	N.H.O.	Y
MALATHION	III	Y	(1)	X	(1)	(1)	Y	Y	Y	Y	Y
MANCOZEB(2)	III	Y	N.H.O.	(1)	(1)	(1)	Y	Y	Y	Y	Y
METALDEHYDE	II, III		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
METALAXYL	I, II	Y	(1)	X	(1)	(1)	Y	(1)	Y	(1)	(1)
METHIOCARB	II	Y	(1)	X	(1)	(1)	(1)	(1)	(1)	(1)	(1)
METHOMYL	I	RUd	(1)	X	(1)	(1)	Y	Y	Y	Y	(1)
OXAMYL	I	RUe	X	X	(1)	(1)	(1)	Y	(1)	Y	(1)
PARAQUAT	I	RUf	X	X	(1)	(1)	Y	Y	Y	(1)	(1)
PERMETHRIN	II, III	RUg	(1)	(1)	(1)	(1)	Y	(1)	Y	(1)	Y
PIRIMIPHOS-ETHYL	II		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)

(1) No M.H.O. Limits, not U.S.E.P.A. Registered
(2) Manufacturers voluntarrily withdrew use on 45 fruits and vegetables on Jan. 1, 1990. U.S.E.P.A. expected to enact in 1991
X U.S.E.P.A. Registered for use
N Not Registered
Y Registered-General Use
RU Restricted Use
a) Carbofuran-All liquid uses and all granules above 5%.
b) Ethion-All Formulations; All Uses.
c) Ethoprop-ECs Above 40%; All Granular
d) Methomyl-All liquids and 90% Wettable Powder
e) Oxamyl-All liquid formulations granulars on case by case.
f) All formulations above 0.44%; All uses
g) Permethrin-All granular liquids 65% or greater; E.C. and ready to use 0.05% to 38.4%; All uses.
M.H.O.- Limits Established By M.H.O.
N.C.-No Classification

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APPENDIX IV
REGISTRATION STATUS OF PESTICIDES

	TOXICITY CATEGORY	U.S. REG.	Tomatoes:	Yams:	Pumpkin:	Cucumber:	Eggplant:	Watermelon:	Peppers:	Okra:	Parsley:
ASULAM	III	Y	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
BENOMYL	III	Y	Y	Y	Y	Y	Y	Y	Y	(1)	(1)
BROMACIL	II, III	Y	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
CARBARYL	II, II, III	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
CARBOFURAN	I, II	RUa	N.E.O	Y	Y	Y	(1)	Y	Y	(1)	(1)
CHLOROTHALONIL	I, II	Y	Y	Y	Y	Y	(1)	Y	N.E.O.	(1)	(1)
CHLORPYRIFOS	II, III	Y	Y	Y	Y	(1)	N.E.O.	(1)	Y	(1)	(1)
2,4-D	I, III	Y	(1)	Y	(1)	(1)	(1)	Y	(1)	(1)	Y
DELTAMETHRIN	N.C.		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
DIAZINON	II, III	Y	Y	Y	(1)	Y	(1)	Y	Y	(1)	Y
DIMETHOATE	II	Y	Y	Y	(1)	(1)	(1)	Y	Y	(1)	(1)
DIURON	II, III	Y	(1)	Y	(1)	(1)	(1)	(1)	(1)	(1)	(1)
ETHION	II	RUb	Y	(1)	(1)	Y	Y	Y	Y	(1)	(1)
ETHOPROP (MOCAP)	I, II	RUc	(1)	Y	(1)	Y	(1)	(1)	(1)	Y	(1)
ETRIDIAZOLE	I, II		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
FLUAZIFOP BUTYL	II, III	Y	(1)	(1)	(1)	(1)	(1)	(1)	Y	(1)	(1)
FLUMEPROP (KARATE)	N.C.	N	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
GLYPHOSATE	II	Y	Y	Y	(1)	(1)	Y	Y	Y	(1)	Y
KELTHANE (DICOFOL)	II, III	Y	N.E.O.	(1)	(1)	N.E.O.	N.E.O.	(1)	N.E.).	(1)	(1)
MALATHION	III	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
MANCOZEB(2)	III	Y	Y	Y	Y	Y	Y	Y	Y	(1)	(1)
METALDEHYDE	II, III		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
METALAXYL	I, II	Y	Y	Y	(1)	(1)	Y	Y	Y	(1)	(1)
METHIOCARB	II	Y	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
METHOMYL	I	RUd	Y	Y	(1)	N.E.O.	Y	Y	Y	(1)	Y
OXAMYL	I	RUe	Y	Y	Y	Y	Y	Y	Y	(1)	(1)
PARAQUAT	I	RUf	Y	Y	(1)	(1)	Y	Y	Y	(1)	(1)
PERMETHRIN	II, III	RUg	Y	Y	(1)	(1)	Y	(1)	Y	(1)	Y
PIRIMIPHOS-ETHYL	II		(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)

(1) No M.E.O. Limits, not U.S.E.P.A. Registered
(2) Manufacturers voluntarrily withdrew use on U.S.E.P.A. expected to enact in 1991
Y U.S.E.P.A. Registered for use
N Not Registered
Y Registered-General Use
RU Restricted Use
a) Carbofuran-All liquid uses and all granules
b) Ethion-All Formulations; All Uses.
c) Ethoprop-ECs Above 40%; All Granular
d) Methomyl-All liquids and 90% Wettable Powde
e) Oxamyl-All liquid formulations granulars on
f) All formulations above 0.44%; All uses
g) Permethrin-All granular liquids 65% or grea to use 0.05% to 30.4%; All uses.
M.E.O.- Limits Established By M.E.O.
N.C.-No Classification

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APPENDIX IV
REGISTRATION STATUS OF PESTICIDES

	TOXICITY CATEGORY	U.S. REG.	Chives:	Watercress:	Christophene:	Dasheen:	Tannia:
ASULAM	III	Y	(1)	(1)	(1)	(1)	(1)
BENOMYL	III	Y	(1)	Y	(1)	(1)	(1)
BROMACIL	II, III	Y	(1)	(1)	(1)	(1)	(1)
CARBARYL	II, II, III	Y	(1)	(1)	(1)	(1)	(1)
CARBOFURAN	I, II	RUa	(1)	(1)	(1)	(1)	(1)
CHLOROTHALONIL	I, II	Y	(1)	(1)	(1)	(1)	(1)
CHLORPYRIFOS	II, III	Y	(1)	(1)	(1)	(1)	(1)
2,4-D	I, III	Y	(1)	Y	(1)	(1)	(1)
DELTAMETHRIN	N.C.		(1)	(1)	(1)	(1)	(1)
DIAZINON	II, III	Y	(1)	Y	(1)	(1)	(1)
DIMETHOATE	II	Y	(1)	(1)	(1)	(1)	(1)
DIURON	II, III	Y	(1)	(1)	(1)	(1)	(1)
ETHION	II	RUb	(1)	(1)	(1)	(1)	(1)
ETHOPROP (MOCAP)	I, II	RUc	(1)	(1)	(1)	(1)	(1)
ETRIDIAZOLE	I, II		(1)	(1)	(1)	(1)	(1)
FLUAZIFOP BUTYL	II, III	Y	(1)	(1)	(1)	(1)	(1)
FLUVROPROP (KARATE)	N.C.	N	(1)	(1)	(1)	(1)	(1)
GLYPHOSATE	II	Y	(1)	Y	(1)	(1)	(1)
KELTHANE (DICOFOL)	II, III	Y	(1)	(1)	(1)	(1)	(1)
MALATHION	III	Y	(1)	Y	(1)	(1)	(1)
MANCOZEB(2)	III	Y	(1)	(1)	(1)	(1)	(1)
METALDEHYDE	II, III		(1)	(1)	(1)	(1)	(1)
METALAXYL	I, II	Y	(1)	(1)	(1)	(1)	(1)
METHIOCARB	II	Y	(1)	(1)	(1)	(1)	(1)
METHOMYL	I	RUd	(1)	Y	(1)	(1)	(1)
OXAMYL	I	RUe	(1)	(1)	(1)	(1)	(1)
PARAQUAT	I	RUf	(1)	(1)	(1)	(1)	(1)
PERMETHRIN	II, III	RUg	(1)	Y	(1)	(1)	(1)
PIRIMIPHOS-ETHYL	II		(1)	(1)	(1)	(1)	(1)

(1) No M.R.O. Limits, not U.S.E.P.A. Registered
(2) Manufacturers voluntarrily withdrew use on U.S.E.P.A. expected to enact in 1991
Y U.S.E.P.A. Registered for use
N Not Registered
Y Registered-General Use
RU Restricted Use
a) Carbofuran-All liquid uses and all granules
b) Ethion-All Formulations; All Uses.
c) Ethoprop-ECs Above 40%; All Granular
d) Methomyl-All liquids and 90% Wettable Powde
e) Oxamyl-All liquid formulations granulars on
f) All formulations above 0.44%; All uses
g) Permethrin-All granular liquids 65% or grea to use 0.05% to 38.4%; All uses.
M.R.O.- Limits Established By M.R.O.
N.C.-No Classification

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APPENDIX Va-

STATE OF FLORIDA
LAB CERTIFICATION #E76071

PESTICIDE RESIDUE ANALYSIS
IN WATER SAMPLES

SAMPLE NUMBER:		LR2	PR6	PR2	PR2	MA1C	MA1A	MA1A	MA1A
DATE SAMPLED:		1/17	1/17	1/18	1/18	1/19	1/19	1/19	1/19
DATE EXTRACTED:		1/22	1/22	1/22	1/22	1/22	1/22	1/22	1/22
DATE COMPLETED:		2/28	2/28	2/28	2/28	2/28	2/28	2/28	2/28
COMPOUNDS	MDL (ppb)								
ASULAM	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
BENOMYL	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
BROMACIL	(0.01)	ND	ND	ND	ND	ND	ND	ND	ND
CARBARYL	(5.0)	ND	ND	ND	ND	ND	ND	ND	ND
CARBOFURAN	(10.0)	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROTHALONIL	(0.004)	ND	ND	ND	ND	ND	ND	ND	ND
CHORPYRIFOS	(0.06)	ND	ND	ND	ND	ND	ND	ND	ND
2,4-D	(2.0)	ND	ND	ND	ND	ND	ND	ND	ND
DELTRAMETHRIN	(3.0)	ND	ND	ND	ND	ND	ND	ND	ND
DIAZINON	(0.06)	ND	ND	ND	ND	ND	ND	ND	ND
DIMETHOATE	(0.10)	ND	ND	ND	ND	ND	ND	ND	ND
DIURON	(10.0)	ND	ND	ND	ND	ND	ND	ND	ND
ETHION	(0.10)	ND	ND	ND	ND	ND	ND	ND	ND
ETHOPROP	(0.06)	ND	ND	ND	ND	ND	ND	ND	ND
ETRIDIAZOLE	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
FLUAZIFOP BUTYL	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
FLUEROPROP(KARATE)	(3.0)	ND	ND	ND	ND	ND	ND	ND	ND
GLYPHOSATE	(100)	ND	ND	ND	ND	ND	ND	ND	ND
KELTHANE	(0.012)	ND	ND	ND	ND	ND	ND	ND	ND
MALATHION	(0.06)	ND	ND	ND	ND	ND	ND	ND	ND
METALAXYL	(1.0)	ND	ND	ND	ND	ND	ND	ND	ND
METHIOCARB	(10.0)	ND	ND	ND	ND	ND	ND	ND	ND
METHOMYL	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
OXAMYL	(2.0)	ND	ND	ND	ND	ND	ND	ND	ND
PARAQUAT	(3.0)	ND	ND	ND	ND	ND	ND	ND	ND
PERMETHRIN	(3.0)	ND	ND	ND	ND	ND	ND	ND	ND
PIRIMIPHOS ETHYL	(0.10)	ND	ND	ND	ND	ND	ND	ND	ND

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APPENDIX Vb

STATE OF FLORIDA
LAB CERTIFICATION #E76071

PESTICIDE RESIDUE ANALYSIS
IN WATER SAMPLES

SAMPLE NUMBER:		LR2	LR4	LR5	PR2	PR4	MHR4	MA1A	MA1B
DATE SAMPLED:		3/16	3/16	3/16	3/20	3/16	3/20	3/20	3/20
DATE EXTRACTED:		3/19	3/19	3/19	3/21	3/20	3/21	3/21	3/21
DATE COMPLETED:		5/15	5/15	5/15	5/15	5/15	5/15	5/15	5/15
COMPOUNDS	MDL (ppb)								
ASULAM	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
BENOMYL	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
BROMACIL	(0.01)	ND	ND	ND	ND	ND	ND	ND	ND
CARBARYL	(5.0)	ND	ND	ND	ND	ND	ND	ND	ND
CARBOFURAN	(10.0)	ND	ND	ND	ND	ND	ND	ND	ND
CHLOROTHALONIL	(0.004)	ND	ND	ND	ND	ND	ND	ND	ND
CHORPYRIFOS	(0.06)	ND	ND	ND	ND	ND	ND	ND	ND
2,4-D	(2.0)	ND	ND	ND	ND	ND	ND	ND	ND
DELTRAMETHRIN	(3.0)	ND	ND	ND	ND	ND	ND	ND	ND
DIAZINON	(0.06)	ND	ND	ND	ND	ND	ND	ND	ND
DIMETHOATE	(0.10)	ND	ND	ND	ND	ND	ND	ND	ND
DIURON	(10.0)	ND	ND	ND	ND	ND	ND	ND	ND
ETHION	(0.10)	ND	ND	ND	ND	ND	ND	ND	ND
ETHOPROP	(0.06)	ND	ND	ND	ND	ND	ND	ND	ND
ETRIDIAZOLE	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
FLUAZIFOP BUTYL	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
FLUKROPROP(KARATE)	(3.0)	ND	ND	ND	ND	ND	ND	ND	ND
GLYPHOSATE	(100)	ND	ND	ND	ND	ND	ND	ND	ND
KELTHANE	(0.012)	ND	ND	ND	ND	ND	ND	ND	ND
MALATHION	(0.06)	ND	ND	ND	ND	ND	ND	ND	ND
METALAXYL	(1.0)	ND	ND	ND	ND	ND	ND	ND	ND
METHIOCARB	(10.0)	ND	ND	ND	ND	ND	ND	ND	ND
METHOMYL	(20.0)	ND	ND	ND	ND	ND	ND	ND	ND
OXAMYL	(2.0)	ND	ND	ND	ND	ND	ND	ND	ND
PARAQUAT	(3.0)	ND	ND	ND	ND	ND	ND	ND	ND
PERMETHRIN	(3.0)	ND	ND	ND	ND	ND	ND	ND	ND
PIRIMIPHOS ETHYL	(0.10)	ND	ND	ND	ND	ND	ND	ND	ND

APPENDIX Vc

STATE OF FLORIDA
LAB CERTIFICATION #E76071

PESTICIDE RESIDUE ANALYSIS
IN SOIL SAMPLES

SAMPLE NUMBER:		LR2	PR2	PR2	W11A	REC
DATE SAMPLED:		1/17	1/18	1/18	1/19	N.A.
DATE EXTRACTED:		1/30	1/30	1/30	1/30	1/30
DATE COMPLETED:		2/28	2/28	2/28	2/28	2/28
COMPOUNDS	MDL (ppb)					
ASULAM	(2000)	ND	ND	ND	ND	
BENOMYL	(2000)	ND	ND	ND	ND	
CARBARYL	(100)	ND	ND	ND	ND	
CARBOFURAN	(1000)	ND	ND	ND	ND	70%
CHLORPYRIFOS	(6.0)	ND	ND	ND	ND	80%
2,4-D	(2000)	ND	ND	ND	ND	66.3%
DELTAMETHRIN	(300)	ND	ND	ND	ND	
DIAZINON	(6.0)	ND	ND	ND	ND	
DIMETHOATE	(10.0)	ND	ND	ND	ND	
DIURON	(1000)	ND	ND	ND	ND	
ETHION	(10.0)	ND	ND	ND	ND	
ETHOPROP	(6.0)	ND	ND	ND	ND	
FLUKROPROP(KARATE)	(300)	ND	ND	ND	ND	
KELTHANE	(1.2)	ND	ND	ND	ND	
MALATHION	(6.0)	ND	ND	ND	ND	
METALAXYL	(10.0)	ND	ND	ND	ND	
METHIOCARB	(2000)	ND	ND	ND	ND	
METHOMYL	(2000)	ND	ND	ND	ND	
OXAMYL	(200)	ND	ND	ND	ND	
PARAQUAT	(10.0)	ND	ND	ND	ND	88%
PERMETHRIN	(300)	ND	ND	ND	ND	
PIRIMIPHOS ETHYL	(10.0)	ND	ND	ND	ND	

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APPENDIX Vd

STATE OF FLORIDA
LAB CERTIFICATION #E76071

PESTICIDE RESIDUE ANALYSIS
IN SOIL SAMPLES

SAMPLE NUMBER:		LR2	LR5	PR2	MHR2	REC
DATE SAMPLED:		3/16	3/16	3/20	3/20	N.A.
DATE EXTRACTED:		3/27	3/27	3/27	3/27	3/27
DATE COMPLETED:		5/15	5/15	5/15	5/15	5/15
COMPOUNDS	MDL (ppb)					
ASULAM	(2000)	ND	ND	ND	ND	
BENOMYL	(2000)	ND	ND	ND	ND	
CARBARYL	(100)	ND	ND	ND	ND	
CARBOFURAN	(1000)	ND	ND	ND	ND	75%
CHLORPYRIFOS	(6.0)	ND	ND	ND	ND	80%
2,4-D	(500)	ND	ND	ND	ND	75%
DELTAMETHRIN	(300)	ND	ND	ND	ND	
DIAZINON	(6.0)	ND	ND	ND	ND	
DIMETHOATE	(10.0)	ND	ND	ND	ND	
DIURON	(1000)	ND	ND	ND	ND	
ETHION	(10.0)	ND	ND	ND	ND	
ETHOPROP	(6.0)	ND	ND	ND	ND	
FLUVOPROP(KARATE)	(300)	ND	ND	ND	ND	
KELTHANE	(1.2)	ND	ND	ND	ND	
MALATHION	(6.0)	ND	ND	ND	ND	
METALAXYL	(10.0)	ND	ND	ND	ND	
METHIOCARB	(2000)	ND	ND	ND	ND	
METHOMYL	(2000)	ND	ND	ND	ND	
OXAMYL	(200)	ND	ND	ND	ND	
PARAQUAT	(10.0)	ND	ND	ND	ND	88%
PERMETHRIN	(300)	ND	ND	ND	ND	
PIRIMIPHOS ETHYL	(10.0)	ND	ND	ND	ND	

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APPENDIX Ve

STATE OF FLORIDA
LAB CERTIFICATION #E76071

PESTICIDE RESIDUE ANALYSIS
IN AQUATIC AND ANIMAL LIFE SAMPLES

SAMPLE NUMBER:		LR4	CHR1	CHR1	GE1	GE2	GE3
DATE SAMPLED:		3/16	1/20	2/20	3/23	3/23	3/23
DATE EXTRACTED:		4/2	4/16	4/16	5/2	5/2	5/2
DATE COMPLETED:		4/5	4/20	4/20	5/11	5/11	5/11
COMPOUNDS	MDL (PPM)						
CHLORPYRIFOS	(0.06)	ND	ND	ND	ND	ND	ND
DELTAMETHRIN	(0.30)	ND	ND	ND	ND	ND	ND
DIAZINON	(0.06)	ND	ND	ND	ND	ND	ND
ETHION	(0.10)	ND	ND	ND	ND	ND	ND
FLUVROPROP(KARATE)	(0.30)	ND	ND	ND	ND	ND	ND
KELTHANE	(0.03)	ND	ND	ND	ND	ND	ND
PERMETHRIN	(300)	ND	ND	ND	ND	ND	ND

SAMPLE NO.	TYPE	DATE COLLECTED	LOCATION	SAMPLE DESIGNATION
1	WATER	1/17/90	LAYOU RIVER MOUTH	LR2
2	WATER	1/17/90	PAGUA RIVER(DEUX BRANCH)	PR6
3	WATER	1/18/90	PAGUA RIVER MOUTH	PR2
4	WATER	1/18/90	DUPLICATE	PR2
5	WATER	1/19/90	SNUG CORNER INLET	WA1C
6	WATER	1/19/90	ANTRIM VALLEY INLET	WA1A
7	WATER	1/19/90	CANEFIELD TAP WATER	WA1A
8	WATER	1/19/90	DUPLICATE	WA1A
9	SEDIMENT	1/17/90	LAYOU RIVER MOUTH	LR2
10	SEDIMENT	1/18/90	PAGUA RIVER MOUTH	PR2
11	SEDIMENT	1/18/90	DUPLICATE	PR2
12	SEDIMENT	1/19/90	ANTRIM VALLEY INLET	WA1A
21	WATER	3/16/90	LAYOU RIVER MOUTH	LR2
22	WATER	3/16/9	LAYOU RIVER(SPRING BRIDGE)	LR4
23	WATER	3/16/90	PAGUA RIVER	PR4
24	WATER	3/20/90	PAGUA RIVER MOUTH	PR2
25	WATER	3/16/90	LAYOU RIVER(BELLS)	LR5
26	WATER	3/20/90	MELVILLE HALL RIVER	MHR4
27	WATER	3/20/90	ANTRIM VALLEY INLET	WA1A
28	WATER	3/20/90	ROSEAU TAP WATER	WA1B
29	SEDIMENT	3/16/90	LAYOU RIVER MOUTH	LR2
30	SEDIMENT	3/20/90	PAGUA RIVER MOUTH	PR2
31	SEDIMENT	3/16/90	LAYOU RIVER	LR5
32	SEDIMENT	3/20/90	MELVILLE HALL MOUTH	MHR2
33	CRAYFISH	3/16/90	LAYOU RIVER	LR4
34	TITIWI	1/20/90	CHECK HALL RIVER	CH1
35	TITIWI	2/20/90	CHECK HALL RIVER	CH1
36	SNAKE	3/23/90	GENEVA ESTATES	GE1
37	LIZARD	3/23/90	GENEVA ESTATES	GE2
38	CRICKETS	3/23/90	GENEVA ESTATES	GE3

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