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Report on the Evaluation of Wastewater Discharges from Raw Cane Sugar Mills on the Hilo-Hamakua Coast of the Island of Hawaii

REPORT ON THE EVALUATION OF WASTEWATER DISCHARGES FROM RAW CANE SUGAR MILLS ON THE HILO-HAMAKUA COAST OF THE ISLAND OF HAWAII

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WATER
401 M STREET, S.W.
WASHINGTON, D.C. 20460

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EXECUTIVE SUMMARY

The Fiscal Year 1989 Housing and Urban Development (HUD) and Independent Agencies Appropriations Bill required that EPA form a Task Force to evaluate pertinent factors relating to wastewater discharges from sugarcane processing mills on the Hilo-Hamakua coast of the Island of Hawaii Senate debate leading to passage of the bill indicated the Task Force should determine the effects that relaxation of total suspended solids permit limitations would have on:

- public health
- marine environment
- nonwater quality environmental impacts
- energy requirements
- economic capability of mill owners or operators
- engineering aspects of the application of various types of control technologies and of process changes
- the reasonableness of the relationship between the costs and benefits of effluent reduction

The requirement of the Appropriations Bill was intended to respond to inquiries to EPA from the two Hilo-Hamakua coast sugar mills, Hamakua Sugar Company, Inc. (HSC) and Hilo Coast Processing Company (HCPC). These inquiries requested that effluent limitations guidelines based on Best Practicable Treatment (BPT) for total suspended solids (TSS) applicable to them be waived because of economic hardship.

The EPA responded to this requirement by forming a Task Force comprised of: the Assistant Administrator for Water (chair); the Assistant Administrator for Research and Development; the General Counsel; EPA Region IX; the State of Hawaii Department of Health (ex officio); and also the Office of Policy, Planning, and Evaluation.

The Clean Water Act (CWA) requires that wastewater discharges in compliance with effluent limitations guidelines also must be in compliance with water quality standards. Thus, violation of State of Hawaii (and/or EPA) water quality standards by <u>existing</u> discharges would prevent the Task Force from considering a recommendation to relax the technology-based BPT effluent limitations to the raw waste (untreated except for rock and trash removal) levels of TSS discharge being <u>proposed</u> by the mills.

Therefore, the approach of the Task Force was to initiate a study to address the above factors with primary emphasis on a preliminary field study of the environmental impact of the <u>existing</u> discharges on Pacific Ocean receiving waters.

Major activities of the Task Force included the following:

- performing a marine environmental effects field study between February 5 and 19, 1989 to evaluate the effects of existing mill wastewater discharges on ocean receiving waters and marine life, especially coral reefs

- collecting and analyzing mill wastewater samples and water column samples from ocean receiving waters to evaluate and document the potential for exceedances of water quality standards

- evaluating field data to determine whether existing discharges were in compliance with water quality standards, and qualitatively estimating the extent of any impacts attributable to the proposed discharges

Even though the primary focus of the Task Force was a preliminary assessment of water quality impacts, a preliminary assessment also was made to determine if the existing BPT effluent limitations guidelines applicable to these two mills were still appropriate when new engineering, economic, and nonwater quality impact information was considered.

Therefore, the other activities of the Task Force included:

- conducting site visits to each of the two Hilo-Hamakua coast sugar mills on January 23, 24, 25, and 26, 1989 to meet with mill management, gather engineering and financial data, and observe sugarcane harvesting and processing

- contacting State of Hawaii Department of Health (DOH) and U.S. Government agencies to gather information pertinent to the Task Force study

- evaluating the costs, effluent reduction benefits, economic impacts, and nonwater quality environmental impacts

- preparing several detailed reports and this summary report to the Administrator

The conclusions reached by the Task Force are:

1. The existing discharges cause substantial environmental impacts including elimination of coral and other benthos in areas surrounding the discharge points at both mills, and significant reduction in coral and other benthos within the mixing zone at HSC, and within and beyond the mixing zone at HCPC. Therefore, a beneficial use of the receiving waters, support and propagation of aquatic life, is being impaired by the discharges and thus violates narrative WQS within the mixing zones. Neither numeric Hawaiian water quality standards nor EPA water quality criteria are exceeded beyond the mixing zones.

Within the mixing zones at both mills, the levels of two classical water quality parameters (NO_3+NO_2 and turbidity) and several metals (copper, mercury lead, and arsenic at HSC; and copper and manganese at HCPC) were found to exceed Hawaii standards and/or EPA criteria. The levels of copper and mercury exceeded EPA acute criteria. The acute criteria exceedances also violated federal water quality requirements and policy for mixing zones under section 403(c) of the CWA.

2. The impact of natural stream runoff on coastal waters is substantially smaller, less severe, and different in character than the impact of sugar mill discharges. Data are not available, however, for direct quantitative comparison. Sugarcane cultural practices cause soil erosion which contributes to nonpoint source discharges to both streams and coastal waters.

3. The receiving water (Pacific Ocean) is not a drinking water source and there are no beaches in the immediate area of the discharges, and therefore these uses are not impaired by the existing discharges. However, the potential exists for ciguatera poisoning from human consumption of fish taken from the vicinity of the mills.

4. Discharge monitoring report (DMR) data indicate the mills (with a few exceptions at HSC) are in compliance with, and achieving better TSS removals than required by, BPT effluent limitations. However, discharge permit violations may be occuring because of clarifier overloading and upsets at HSC, and cleaning plant breakdowns and wastewater bypasses at HCPC, but are unrecorded and not reported.

5. EPA was not able to identify an alternative harvesting method that would result in fewer solids being entrained with sugarcane during harvesting. In addition, EPA could not identify a less costly and equally effective wastewater treatment/control method (other than reduced treatment, as proposed by the mills). Long-term research and development by the mills has the potential to improve harvesting methods and reduce soil loads to the mills, thus reducing treatment requirments and costs.

6. The ratios of operating costs to effluent reduction benefits for the two mills (0.2 to 0.4 cents per pound of TSS removed) for the existing BPT treatment systems at the mills are among the lowest of all BPT effluent limitations guidelines.

7. Both HSC and HCPC are in poorer economic condition than in 1979 when the existing BPT limitations were promulgated; however, mill closure due to the cost of BPT alone is not projected. Wastewater treatment costs are only a small portion of total operating costs (approximately 1 to 4 percent).

8. The estimated savings resulting from the proposed reductions in pollution control activities would make a short-term difference in the economic picture of both mills, but both mills may close in the foreseeable future even without BPT costs. Closing both mills would directly eliminate 1,642 jobs, with an unemployment effect of approximately 3,700 on the community.

9. The increased level of discharge proposed by the mills (up to 49-fold increase in TSS loadings for one mill and up to 70-fold increase in loadings for the other mill) would substantially increase the areas of impact on corals and other benthic life, extending those impacts beyond the existing mixing zones, and would increase the exceedances of water quality criteria. The increases in the areas of impacts would not necessarily be as great proportionally as the increase in TSS loading in the discharges. The currently permitted mixing zones are one to three orders of magnitude larger than the mixing zones for seven industrial and four municipal discharges in Hawaii with comparable or substantially larger flows. Any such increases would violate a broad array of Federal and State requirements.

10. NPDES permits for the mills based on Best Professional Judgement (BPJ) and issued in 1978 contained TSS limitations less stringent than current BPT. The antibacksliding provisions contained in existing NPDES regulations and section 402(o) of the CWA prevent relaxing TSS limitations to the levels proposed by the mills because those limitations would be less stringent than the 1978 BPJ limitations.

11. Closure of the mills would not mean a loss of electric power now provided to HELCO by the mills; HSC could use fuel oil and HCPC could use fuel oil or coal to operate their boilers. Sulfur dioxide air emissions from power generated solely by fuel oil would be two to three times the current emissions, while particulate emissions (now attributable to burning bagasse) would be substantially reduced. Burning coal would result in sulfur dioxide emissions levels similar to those from burning fuel oil. Particulate emission levels would be similar to those from burning bagasse.

12. Increased sulfur dioxide emissions could exacerbate acid rain problems downwind of the mills; however, the volcanic emissions of sulfur dioxide by Kilauea (and the Eastern rift zone) are 200 to 300 times greater than the potential increased emissions from the mills and would have a substantially greater impact on regional air quality.

13. If the mills were to close, most of the 50,000 acres of sugarcane now in cultivation would probably become fallow. Alternative agricultural uses, such as macadamia nut groves, would only partially replace sugarcane. Major resort and/or residential development along the Hilo-Hamakua coast probably would be limited because of heavy rainfall.

The Task Force makes the following recommendations based on the information gathered during the study:

1. The proposed shutdown of wastewater treatment systems and resulting 50-70 fold increases in TSS discharges should not be allowed because:

- <u>existing</u> sugar mill discharges cause almost complete elimination of coral and other benthic life, and exceedances of water quality criteria, including acute criteria, for certain pollutants (e.g., metals) within the mixing zones

- <u>proposed</u> discharges would cause major increases, although not necessarily in direct proportion to increased solids loadings, in coverage of soil deposits, benthic (coral and other bottom organism) impacts, and would cause violation of a number of regulatory requirements

2. The existing BPT/BCT effluent limitations guidelines are still appropriate and should be retained because:

    - the cost of wastewater treatment, as in 1979 and 1983, is only a part of the current difficult economic circumstances; the mills may close within the foreseeable future even with relief

    - the operating costs and effluent reduction benefits remain among the lowest (0.2-0.4 cents/lb of TSS removed) of all BPT effluent limitations guidelines

    - no less costly and equally effective wastewater treatment or cane harvesting technologies were identified

    - DMR data indicate the mills are achieving substantially better removals than required by BPT/BCT TSS effluent limitations, except during periods of upsets and bypasses

3. Antibacksliding rules apply and will not allow the proposed increases in discharges of TSS.

4. The engineering, economic, and environmental data gathered from this Task Force study are considered sufficient to make a sound determination regarding appropriate permit limitations for the mills.

1.0 INTRODUCTION

1.1 RULEMAKING HISTORY

EPA promulgated interim final Best Practicable Treatment (BPT) effluent limitations for raw cane sugar processors on February 27, 1975 (40 FR 8498, 40 CFR Part 409). The Agency found that differences in raw materials, harvesting techniques, land availability, length of grinding season, climate, soil, and other related factors substantiated the need to establish separate subcategories for sugar mills located in Louisiana (Subpart D), Florida and Texas (Subpart E), the Hilo-Hamakua Coast of Hawaii (Subpart F), Hawaii - those not covered by Subpart F (Subpart G), and Puerto Rico (Subpart H). EPA concluded that sugar mills on the Hilo-Hamakua coast of the island of Hawaii are subject to different local conditions (rainfall, soil, and harvesting techniques) than sugar mills in the rest of the State of Hawaii. Because of these factors, as much as 50 percent of the solids entering the mills are soil, rock, and leafy trash which must be removed before the cane can be processed. EPA found very little application of wastewater treatment technology by plants in the Hilo-Hamakua Coast subcategory at the time the regulations were developed. Therefore, the Agency based the limitations for this subcategory on data from bench- and pilot-scale studies of sedimentation systems.

On January 17, 1977, EPA suspended the Subpart F regulation until March 1, 1978 to allow review of data from a full-scale treatment test to be conducted at one of the mills that had installed a majority of the treatment system upon which the BPT limits were based. The suspension was subsequently extended until May 30, 1979, because the data were not provided as quickly as anticipated and additional time was needed for data evaluation.

EPA issued revised BPT limits for this subcategory on November 6, 1979. The total suspended solids (TSS) limits were made significantly less stringent numerically than before (Table 1-1), the basis for reporting discharges was changed from pounds of net cane per day to pounds of gross cane per day, including soil, rocks, and trash, and the pH limits were eliminated.

Effluent limitations based upon best conventional pollutant control technology (BCT) for this subcategory and all other cane sugar subcategories were set equal to the BPT limits on July 9, 1986 (51 FR 24974, 40 CFR Part 409.67).

The currently-applicable BPT/BCT effluent limitations guidelines for the Hilo-Hamakua Coast subcategory are the least stringent of the limitations for the five subcategories of the raw cane sugar processing industry. Sugar mills in the Florida and Texas subcategory and the Hawaii subcategory (which includes mills not covered by Subpart F) are required to achieve no discharge of process wastewater (i.e., cane wash water) pollutants. Sugar mills in the Louisiana subcategory and the Puerto Rico subcategory have less stringent requirements than the no discharge requirements: they are required to meet effluent limitations for five-day biochemical oxygen demand (BOD5) and TSS based on the performance of biological treatment systems.

TABLE 1-1

COMPARISON OF ORIGINAL AND REVISED BPT LIMITATIONS FOR HILO-HAMAKUA COAST SUGAR MILLS

Pollutant or Pollutant Property	Original Limitations Established in 1975	
	Maximum For Any One Day	Maximum For Monthly Average
	kg/kkg(or lbs/1000 lbs)net cane	
TSS	4.2	2.1
pH	(1)	(1)

(1) Within the range of 6.0 to 9.0

Pollutant or Pollutant Property	Revised Limitations Established in 1979	
	Maximum For Any One Day	Maximum For Monthly Average
	kg/kkg (or lbs/1000 lbs)gross cane	
TSS	9.9	3.6
pH	no limitation	no limitation

The Subcategory F regulations allow Hilo-Hamakua mills to discharge cane wash waters that comply with effluent limitations for TSS based on fundamental primary sedimentation technology. EPA concluded that different local conditions (primarily rainfall, soil, and harvesting techniques) justified establishing separate effluent limitations for treated sugarcane washwaters from mills on the Hilo-Hamakua coast of the island of Hawaii.

1.2 EVENTS LEADING TO THIS STUDY

In December 1982, Hamakua Sugar Company, Inc. (HSC) and Hilo Coast Processing Company (HCPC) submitted a petition to EPA for a waiver from BPT based on the poor economic condition of the Hamakua Coast sugar processors, and the asserted lack of significant water quality impact of the existing discharges of treated wastewater. In September 1983, EPA responded to the petition and indicated that (1) EPA has no statutory basis upon which to grant temporary waivers, (2) if new data different from those previously considered by EPA were received on the cost of control technology and achievability of the limitations EPA would review that data, (3) review of the information and data submitted in 1982 and 1983 revealed that the Agency would not have granted a petition for complete elimination of TSS limitations for cane wash waters, and (4) EPA would modify the regulations if new data indicated that the regulations were no longer consistent with the Clean Water Act (CWA).(1)

On January 15, 1988, the companies met with EPA Region IX staff to explore again all avenues of relief and present information regarding the current conditions at the mills. The companies claimed there are three reasons for EPA to grant relief: (1) the current magnitude and variability of waste loadings were not considered when EPA established the guideline, (2) the environmental impact of the increased discharge would be negligible, and (3) the companies are facing severe financial circumstances and may go out of business.

EPA responded to the companies on February 19, March 11, and May 24, 1988, to indicate that statutory changes to the CWA were open to consideration, and to specify the information that would facilitate Agency review of a petition for rulemaking to suspend or modify BPT and BCT effluent limitations for the Hilo-Hamakua Coast of the Island of Hawaii Raw Cane Sugar Processing Subcategory.

The companies did not submit a petition for rulemaking to EPA.

1.3 REQUIREMENTS OF THE FY 89 APPROPRIATIONS BILL

The Fiscal Year 1989 HUD and Independent Agencies Appropriations Bill signed by President Reagan on August 19, 1988 (P.L. 100-404; 102 Stat. 1014), required that an EPA Task Force be established to evaluate all pertinent factors relating to the discharges from the Hilo-Hamakua mills. Although the Conference Report for the Appropriations Bill deleted language included in Senate amendment number 36 earmarking funds for a Task Force, Conference amendment number 32 nonetheless referred to an evaluation based on the Senate language. The pertinent language in the Senate amendment is as follows:

(36): Provided further, That no more than $500,000 shall be made available for the expenses of a task force, consisting of the Assistant Administrator for Water (who shall chair such task force), the Assistant Administrator for Research and Development, the General Counsel, the Regional Administrator for Region IX, and as ex-officio member, the Director of the Hawaii State Department of Health, which shall evaluate all pertinent factors relating to discharges from sugarcane processing mills on the Hilo-Hamakua Coast of the island of Hawaii, and shall report to the Administrator of the EPA no later than 6 months after the date of enactment of this Act its recommendations concerning appropriate modifications within existing law to permit limitations, effluent guidelines, or other requirements of the Clean Water Act, pertaining to such discharges.

While the statutory language of the amendment does not list specific areas to be addressed, during debate in the Senate on this provision, Senator Inouye indicated the Task Force should determine the effects of modification of TSS permit limitations on the following factors (Congressional Record, July 12, 1988):

- public health
- marine environment
- non-water quality environmental impact
- energy requirements
- economic capability of the owner or operator
- engineering aspects of the application of various types of control technologies and process changes
- reasonableness of the relationship between the costs of attaining a reduction in effluents and the effluent reduction benefits derived

Senator George Mitchell indicated during the Senate debate that the Task Force also should consider long range plans to address the source of the problem (i.e., possibility to change harvesting methods).

1.4 TASK FORCE STUDY

In response to the requirements of the Appropriations Bill, EPA implemented a Task Force study. The primary objective of the study was to make a preliminary evaluation of the marine environmental and public health impacts of the discharges from the two Hilo-Hamakua coast sugar mills on the receiving waters. Secondary objectives were to evaluate costs, effluent reduction benefits, and economic and nonwater quality (i.e., energy and air emissions) impacts of continued compliance with BPT effluent limitations; investigate and document environmental impacts resulting from adjacent stream runoff; and compare the effects of sedimentation from natural runoff with impacts associated with sugar mill discharges. In addition, the study considered the items addressed by Senator Inouye during Senate debate. The study included the following major activities:

- site visits to meet with representatives of the mills, the Hawaii Sugar Planters Association, the State of Hawaii Department of Health (DOH), and the Sierra Club Legal Defense Fund
- a marine environmental study that included water column sampling and coral investigation
- analysis and evaluation of field data
- analysis and evaluation of engineering and economic data
- report preparation

During the site visits, January 23 through 26, 1989, EPA Task Force staff members and supporting contractors observed cane harvesting, cleaning, and processing methods; and wastewater treatment and disposal practices. Relevant mill discharge and economic data were also gathered. The marine environmental effects study was conducted from February 5 through 19, 1989.

This Task Force report is based largely on more detailed reports that provide documentation and evaluation of information gathered during the above activities. In particular, extensive use was made of the following:

- E.C. Jordan Co., Inc. Meeting Report, U.S. EPA Industrial Technology Division, Hilo-Hamakua Raw Cane Sugar Processors, Hamakua Sugar Company, Inc., May 3, 1989.
- E.C. Jordan Co., Inc. Meeting Report, U.S. EPA Industrial Technology Division, Hilo-Hamakua Raw Cane Sugar Processors, Hilo Coast Processing Company, February 9, 1989.
- Research Triangle Institute, Economic Analysis of Water Pollution Regulations: Hawaiian Sugar Mills, to be published, 1989.
- Tetra-Tech, Inc., Hawaii Sugar Mill Marine Environmental Study, Volume 1 Technical Report, to be published, 1989.
- Versar, Inc., Potential Public Health Effects-Hawaiian Sugar Cane Industry, to be published, 1989.

1.5 CANE SUGAR PRODUCTION IN HAWAII AND ALONG THE HILO-HAMAKUA COAST

1.5.1 The Hawaiian Industry

Raw cane sugar has been produced commercially in Hawaii since the establishment of a sugar plantation at Koloa, Kauai in 1835, over 150 years ago. The first harvest in 1837 produced two tons of sugar. The success of the sugar industry led to the establishment and growth of additional plantations. Production increased to 225,000 tons in 1898, and to approximately 1,000,000 tons by 1932, a level Hawaii has since maintained.(2) The number of plantations increased to about 52 by 1900 and to 62 by 1920. This number dropped, however, to 38 in 1940, 28 in 1950, 27 in 1960, 23 in 1970, and 15 in 1979. There were 12 plantations and 12 mills in the State of Hawaii in 1988 that manufactured raw cane sugar.(3)

Agriculture currently ranks third, after tourism and military expenditures, in its contribution to Hawaii's economy. In 1987, revenues from tourism were estimated at $6.4 billion, federal defense expenditures were $2.0 billion, and agricultural revenues were approximately $845 million. Sugar contributed $354 million of this total, while pineapples contributed $252 million and other agricultural products contributed about $239 million.(2)

There are currently 12 mills that manufacture cane sugar in Hawaii.(3) About 6,500 people are directly employed in Hawaii's sugar industry, and another 15,000 to 20,000 jobs are estimated to be indirectly tied to this industry.(4)

The production of raw sugar from sugarcane in Hawaii (Figure 1-1) is similar in most aspects to raw cane sugar production in other parts of the world: sugarcane is harvested, transported to the mills, and cleaned. The cleaned cane is then shredded and subsequently squeezed between high pressure rolls or mills to extract the juice. The juice is clarified and then concentrated by evaporation until raw sugar can be removed by crystallization. The liquid remaining is molasses, and it may either be reconcentrated to remove additional sugar or sold as a final product. The raw cane sugar is subsequently refined to yield a purer final product. All the raw cane sugar produced in Hawaii is marketed by the California and Hawaii (C&H) Sugar Company. Most is refined by C&H in Crockett, California; however, a small percentage is refined by C&H in Aiea, near Honolulu, for use in Hawaii.

The C&H refinery is a refining and marketing cooperative that is proportionately owned by its 13 member sugar companies in Hawaii. C&H makes advances to the growers, and pays its patrons the net return on the sale of raw and refined sugar after subtracting transport, processing, and selling costs.

There are two factors that distinguish cane sugar production in Hawaii, including along the Hilo-Hamakua coast, from cane sugar production in other parts of the world. First, growers do not harvest Hawaiian sugarcane until it is an average of two years old. In most other areas, sugarcane is harvested after one year of growth. The advantages of this approach are that it reduces the fraction of time during the crop cycle devoted to planting and harvesting, thus reducing production costs. In addition, because of Hawaii's favorable climate, the sugar yield per acre remains high, in spite of the extended growth period. The disadvantage of this approach is that while one-year-old sugarcane stands erect (soldier cane) and is easily harvested by mechanical means, the lower part of the cane stalks of older cane bend over and lie on the ground (recumbent cane) and continue to grow forming a thick, tangled mat of

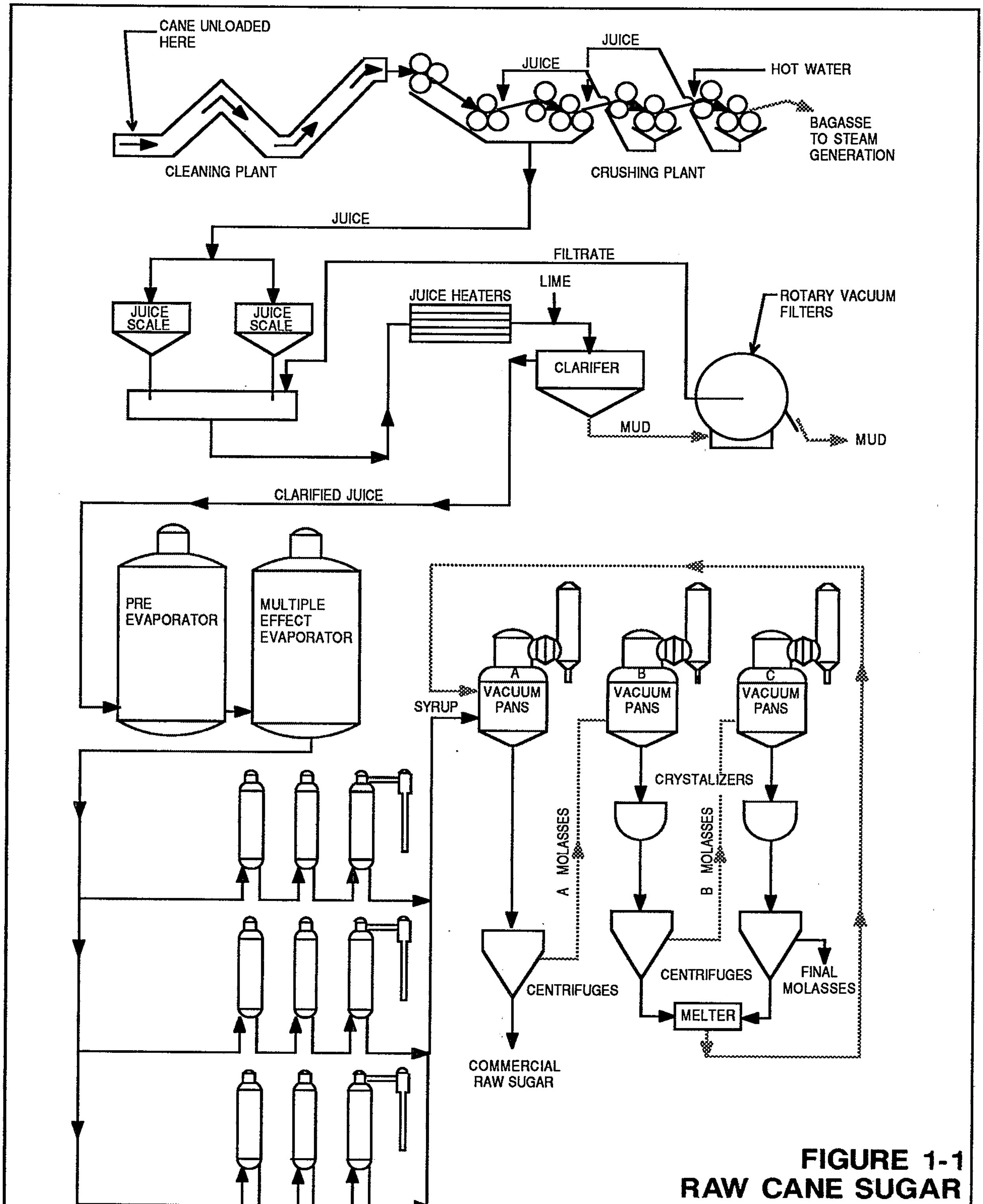


FIGURE 1-1
RAW CANE SUGAR PROCESS SCHEMATIC

vegetation not easily harvested by conventional mechanical methods. As a result, most Hawaiian growers harvest sugarcane with specially designed machines called push-rakes and in some cases with V-cutters. (A more detailed discussion of harvesting equipment is presented in Section 5.5.)

The second factor specific to the Hilo-Hamakua coast on the island of Hawaii is that this area is characterized by steeper slopes and heavier annual rainfall than other Hawaiian sugarcane lands. Figure 1-2 shows an example of the slope of cultivated land along the Hilo-Hamakua coast. One hundred to two hundred inches of rain per year are common along the Hilo-Hamakua coast (Figure 1-3). These conditions result in the entrainment of considerable amounts of soil and rock during sugarcane harvesting which is conducted essentially year-round and 24 hours per day regardless of weather conditions. This entrained material is removed at the sugar mills and is the major contribution to raw wastewater suspended solids loads. Figure 1-4 shows sugarcane and entrained soil as it enters the cane cleaning plant at a sugar mill. The location of the Hilo-Hamakua mills at the edge of the plantations and close to the sea creates wastewater disposal problems more severe than at other Hawaiian mills.

1.5.2 Profile of Hilo-Hamakua Coast Mills

In 1920 an estimated 11 raw sugar mills were operating along the Hilo-Hamakua coast.(3) By 1960 this number had dropped to eight. Changing economic conditions and the imposition of Best Practicable Treatment effluent limitations guidelines in 1975 resulted in closure and/or consolidation of most of these remaining mills. Today, only two remain: the mill at Haina, operated by Hamakua Sugar Company, Inc., and the mill at Pepeekeo, operated by Hilo Coast Processing Company.

<u>1.5.2.1 Hamakua Sugar Company, Inc.</u> Hamakua Sugar Company, Inc., is a for-profit firm owned by Francis S. Morgan and his family. The company comprises the lands of seven smaller plantations established between 1877 and 1898, which were consolidated over the years. The last two plantations, Honokaa Sugar Company and Laupahoehoe Sugar Company were merged in 1979. The company cultivates and harvests approximately 33,000 acres of sugarcane (Figure 1-5). About one-half of the land is owned by HSC; the remainder is leased. The Haina mill is one of the state's largest and most modern producers of raw sugar. The mill produced 133,430 tons of raw sugar in 1988, and 100,015 tons in 1987. Production capacity is estimated to be 160,000 tons per year. HSC also produced 34,000 tons of molasses in 1988.(5)(2)

F.S. Morgan bought HSC from Theo H. Davies and Co., Ltd. in 1984 with financing from the Federal Land Bank (FLB) ($60 million), a federally chartered lending institution designed to help farmers, and from Theo H. Davies and Co., Ltd. ($20 million). Morgan had been president of the HSC subsidiary of Theo H. Davies and Co., Ltd. Without Morgan's offer, the fate of HSC was uncertain. When Morgan bought HSC, it had two factories, one at Ookala and one at Haina. In 1987 he closed the factory at Ookala and consolidated operations at the Haina plant to achieve economies of scale. He has made large capital expenditures to modernize the Haina factory and to handle the cane that was once processed at two mills, and has built a fertilizer mixing plant to reduce fertilizer costs. He has replaced top executives and managers, restructured

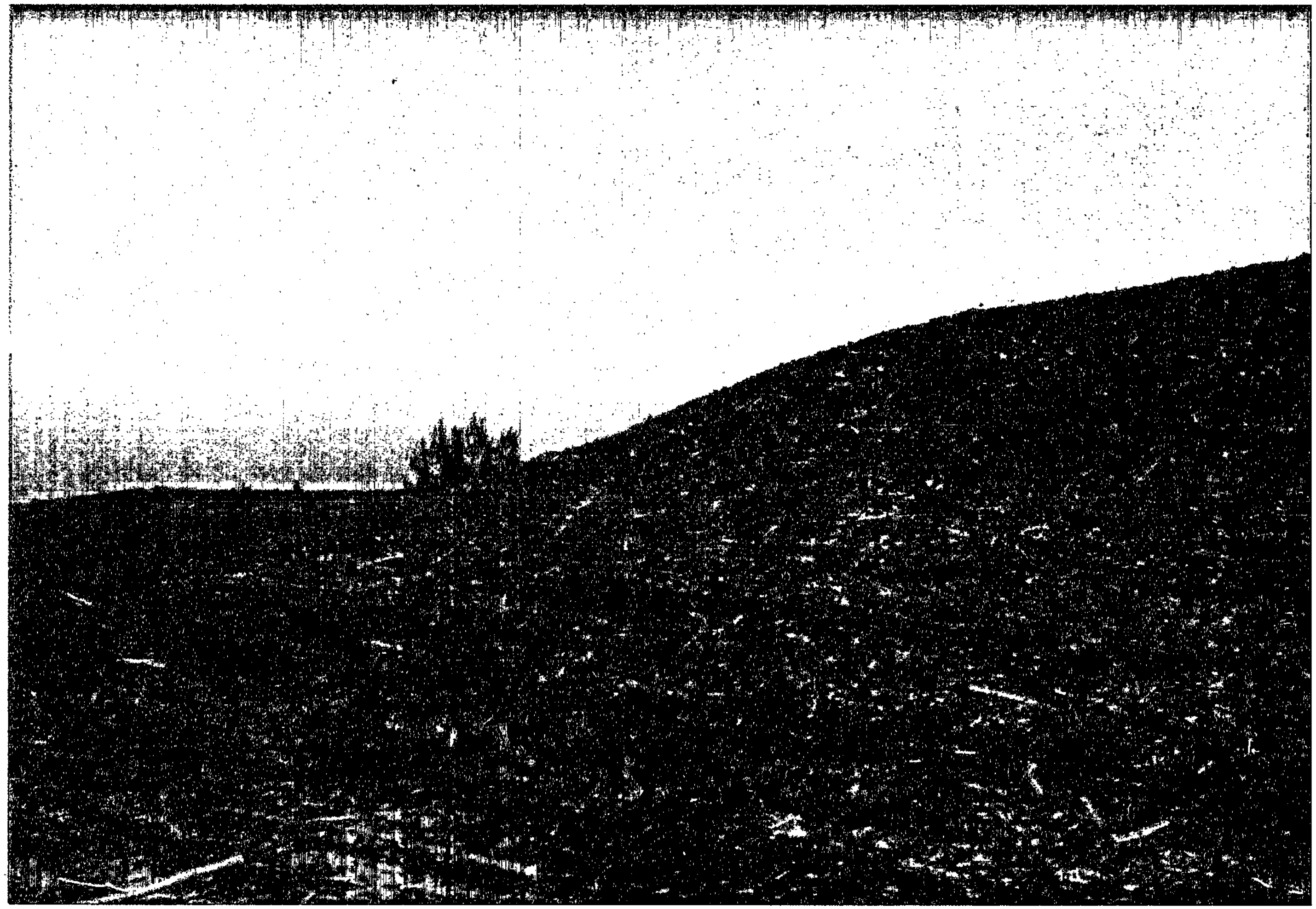
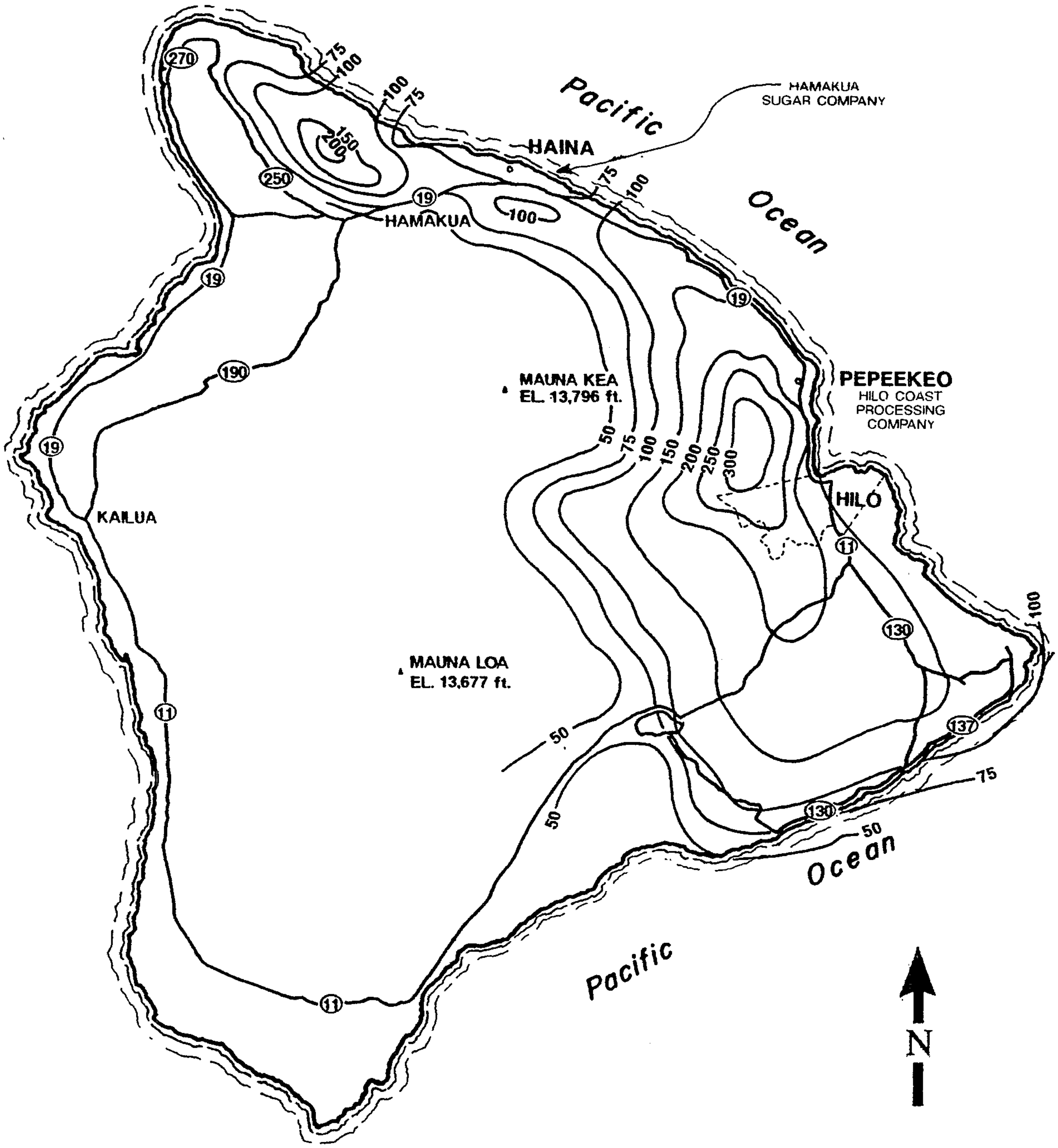


FIGURE 1-2
EXAMPLE OF CULTIVATED LAND SLOPE
ALONG THE HILO - HAMAKUA COAST



(SOURCE: HAWAII WATER AUTHORITY. WATER RESOURCES IN HAWAII. HONOLULU: STATE OF HAWAII, 1959)

0 10 20 MILES

FIGURE 1-3
MEDIAN ANNUAL RAINFALL ALONG THE HILO-HAMAKUA COAST

FIGURE 1-4
SUGARCANE AND ENTRAINED SOIL
ENTERING THE CANE CLEANING PLANT

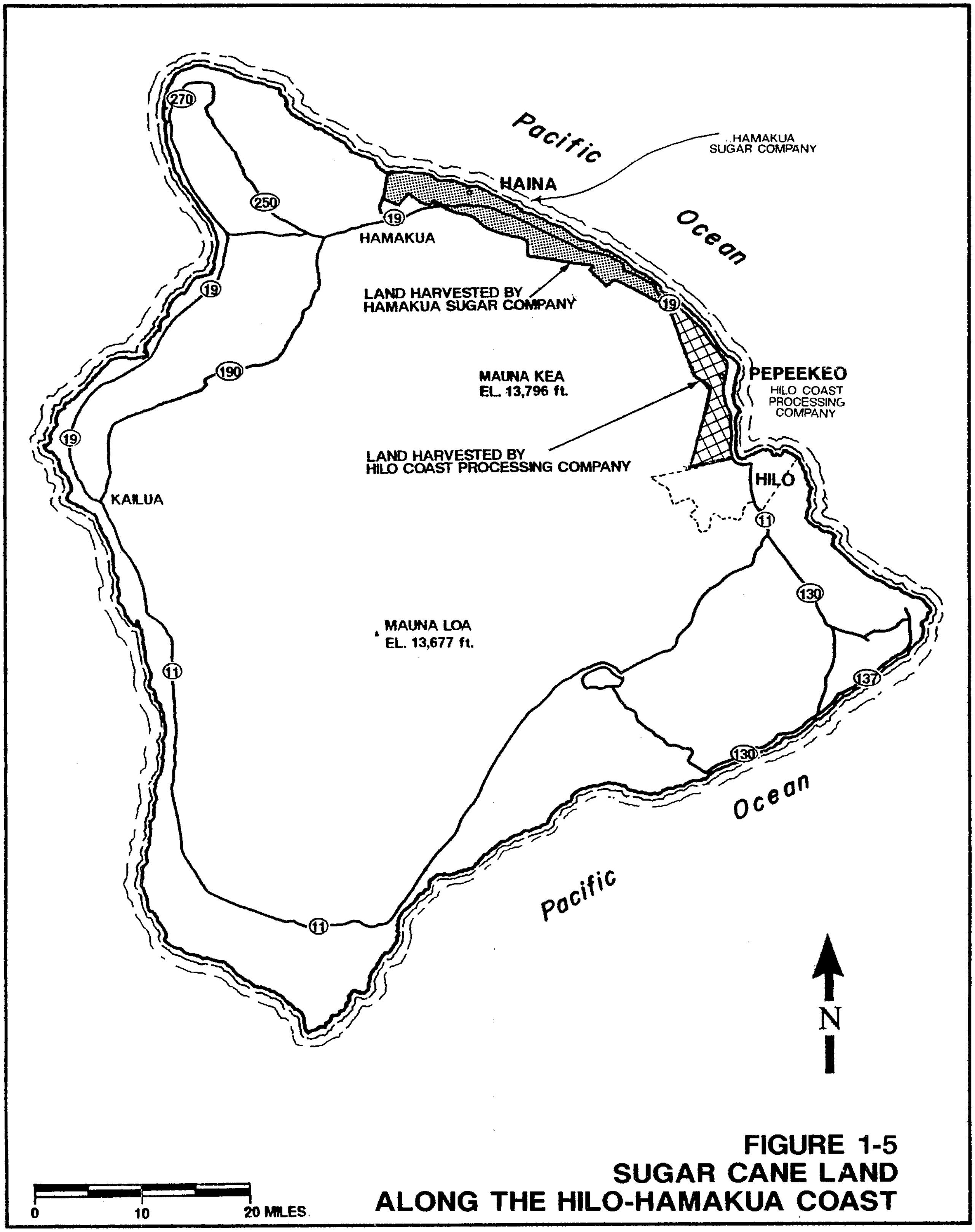


FIGURE 1-5
SUGAR CANE LAND
ALONG THE HILO-HAMAKUA COAST

the organization before and after the management changes, and instituted cost-cutting programs including layoffs and salary cuts.

In October of 1986, the company expanded to include a feedlot and beef processing plant called Big Island Meat. Bad weather, disappointing yields, large capital expenditures, low sugar returns, and losses for Big Island Meat all contributed to losses for the company and a severe cash shortage in 1987. As a result of these factors, HSC was in default under certain covenants of a revolving credit agreement, and failed to make interest and principal payments on the FLB loan, now $50 million. Under the loan provisions, the FLB and another lender (the Production Credit Association) called in both loans, shifting the entire loan balances from long-term to short-term liabilities. Since then, HSC has made their principal and loan payments on time and the loan balances have shifted back to long-term liabilities. The company continued to lose money, and in 1988 received an emergency loan from the State of Hawaii for $10 million. Morgan described the current interest cost as "unsupportable" and identified it as the most significant contributing factor in the company's critical cash position. Substantial reduction of water pollution controls represent one measure to cut costs and increase the chances of mill survival. In 1988, HSC lost $12.0 million; about $10 million of that loss was from the sugar operations.

Electricity sales are an additional important revenue source for HSC. About 72 percent of electricity produced by HSC is sold to Hawaii Electric Light Company (HELCO); the remainder is used in the HSC mill, offices, garages, and at Big Island Meat.(5) A new power contract establishing a 10-megawatt capacity payment and an annual export of 60 million kwhr adds to revenues.

<u>1.5.2.2 Hilo Coast Processing Company</u>. The Pepeekeo mill, formerly owned by C. Brewer and Co., LTD. is now owned by Hilo Coast Processing Company, a nonprofit agricultural cooperative that harvests and processes all cane grown on approximately 17,000 acres by its two members, Mauna Kea Agribusiness Company, Inc. (MKA), which is owned by C. Brewer and Co., LTD., and United Cane Planters Cooperative (UCPC) (see Figure 1-5). The mill produced 72,873 tons of raw sugar in 1988, down from 80,783 tons in 1987 when it accounted for 8 percent of the raw sugar produced in the State.(2)(6) HCPC also produced 19,000 tons of molasses in 1988.

HCPC formed and began operations at the beginning of 1972 with four factories: Hakalau and Pepeekeo (both owned by MKA), Papaikou, and Wainaku. One of the mills closed in 1975 and the other two closed in 1976 when HCPC consolidated all processing at the Pepeekeo Mill. Pepeekeo is the only one of the original four now in operation. UCPC contributed $1.2 million to the formation of the cooperative, borrowed from the State at 5 percent interest and no payback date. The UCPC agreement with the State requires UCPC to pay back $32 per acre harvested. UCPC originally consisted of 415 growers; today the number is 48, due to low returns received by the growers. With the attrition, MKA must pick up the acreage. Today, MKA accounts for about 90 percent of total sugar production at the Pepeekeo mill and, by virtue of the attrition of independent growers, is also a member of the UCPC.

Members of HCPC retain title to their respective shares of raw sugar and molasses until delivered to C&H Sugar. HCPC accepts payments for members, and allocates costs to members based on their patronage. Costs are adjusted to the tax basis so HCPC has no taxable income, were revenues to exceed costs. In the last several years HCPC's largest grower, MKA, has lost $3 to $5 million annually.

In 1988, HCPC sold 123 million kwhr of electricity to HELCO under a 20 megawatt demand contract. HCPC is now requesting an $8.5 million loan from the State of Hawaii so that it may own rather than lease the electric power plant. With the loan and an improved harvest, MKA may break even in 1989.

1.6 DISCHARGE OF TREATED CANE WASHWATERS

Both HSC and HCPC operate wastewater treatment systems that remove more than 95 percent of the TSS from the water used to clean raw sugarcane. Mill data indicate, however, that in spite of relatively good removal efficiencies, eachmill discharged approximately 12 tons per day of TSS to the Pacific Ocean in 1988. The effluent suspended solids concentrations averaged about 300 mg/ at HSC and 700 mg/ at HCPC. The discharges create turbid plumes that are typically visible for a distance of a mile or more from the discharge points. When effluent suspended solids concentrations are high and sea conditions are calm, the plumes become very muddy, highly colored, and highly visible (Figures 1-6 and 1-7, and 1-8).

In its proposal to EPA, HSC has asked for permission to stop operation of its primary clarifiers and remove only leafy trash and coarse grit (material retained on 0.25 inch screen) from sugarcane washwater. HCPC has asked for permission to cease all treatment of its sugarcane washwater.

The Hawaii DOH, to which EPA has delegated authority for issuance of NPDES permits, has established a rectangular zone of mixing extending 2 miles East, 1 mile West, and 1 mile seaward from the discharge point at HSC and a semicircular zone of mixing with a 1-mile radius originating at the discharge point for HCPC. The mixing zones provide areas in the immediate vicinity of the discharge points to allow for mixing and dilution; acute toxicity is not allowed within the mixing zones. The mills are not permitted to cause a violation of receiving water quality standards outside of the mixing zones. In addition, the discharges must meet the State of Hawaii's narrative water quality criterion and federal water quality standards.

The narrative criteria specify that all waters shall be free of substances attributable to domestic, industrial, or other controllable sources of pollutants, including:

- materials that will settle to form objectionable sludge or bottom deposits
- substances in amounts sufficient to produce taste or odor in the water, or detectable off flavor in the flesh of fish, or in amounts

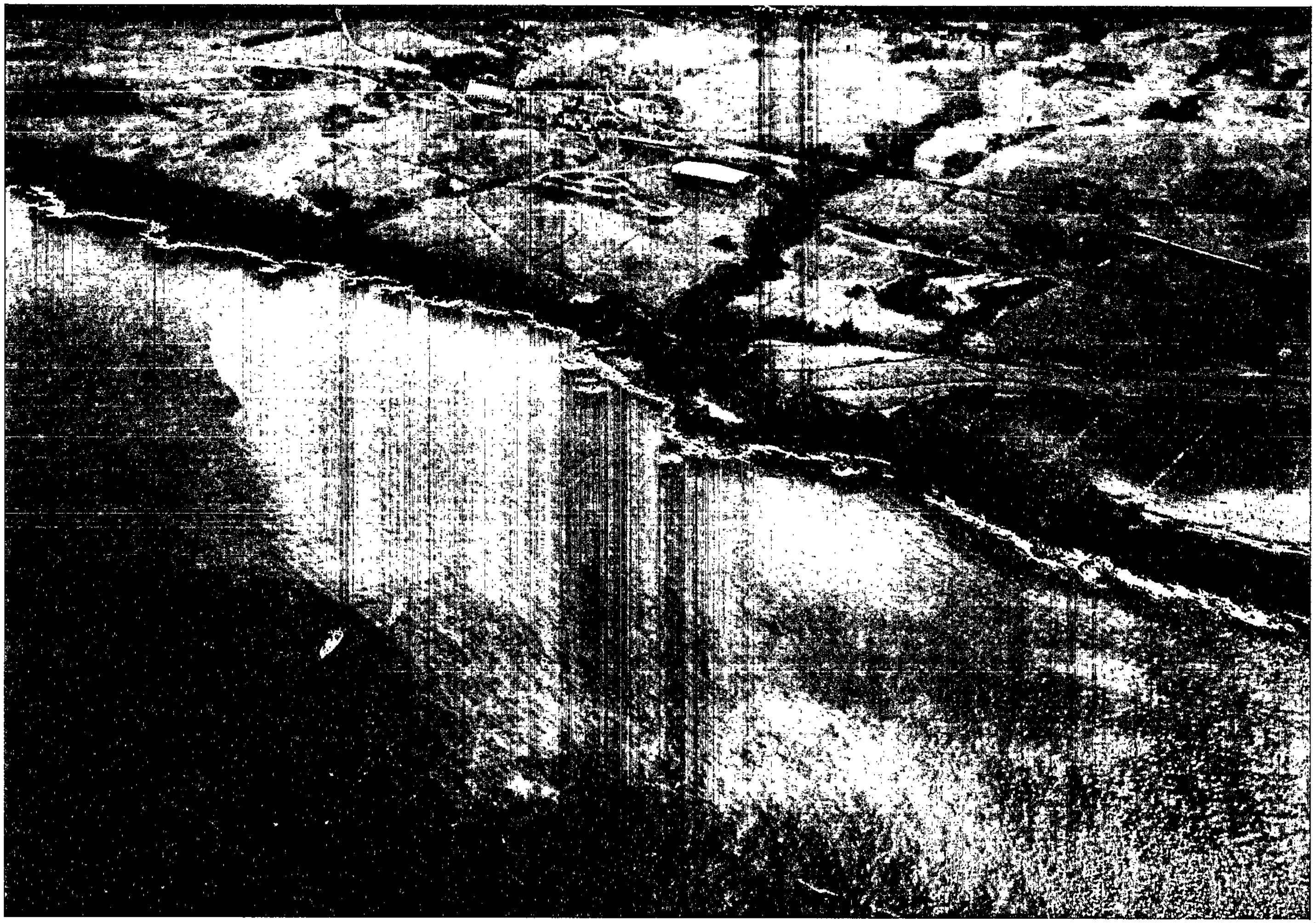


FIGURE 1-6
AERIAL VIEW OF DISCHARGE PLUME AT
HAMAKUA SUGAR COMPANY

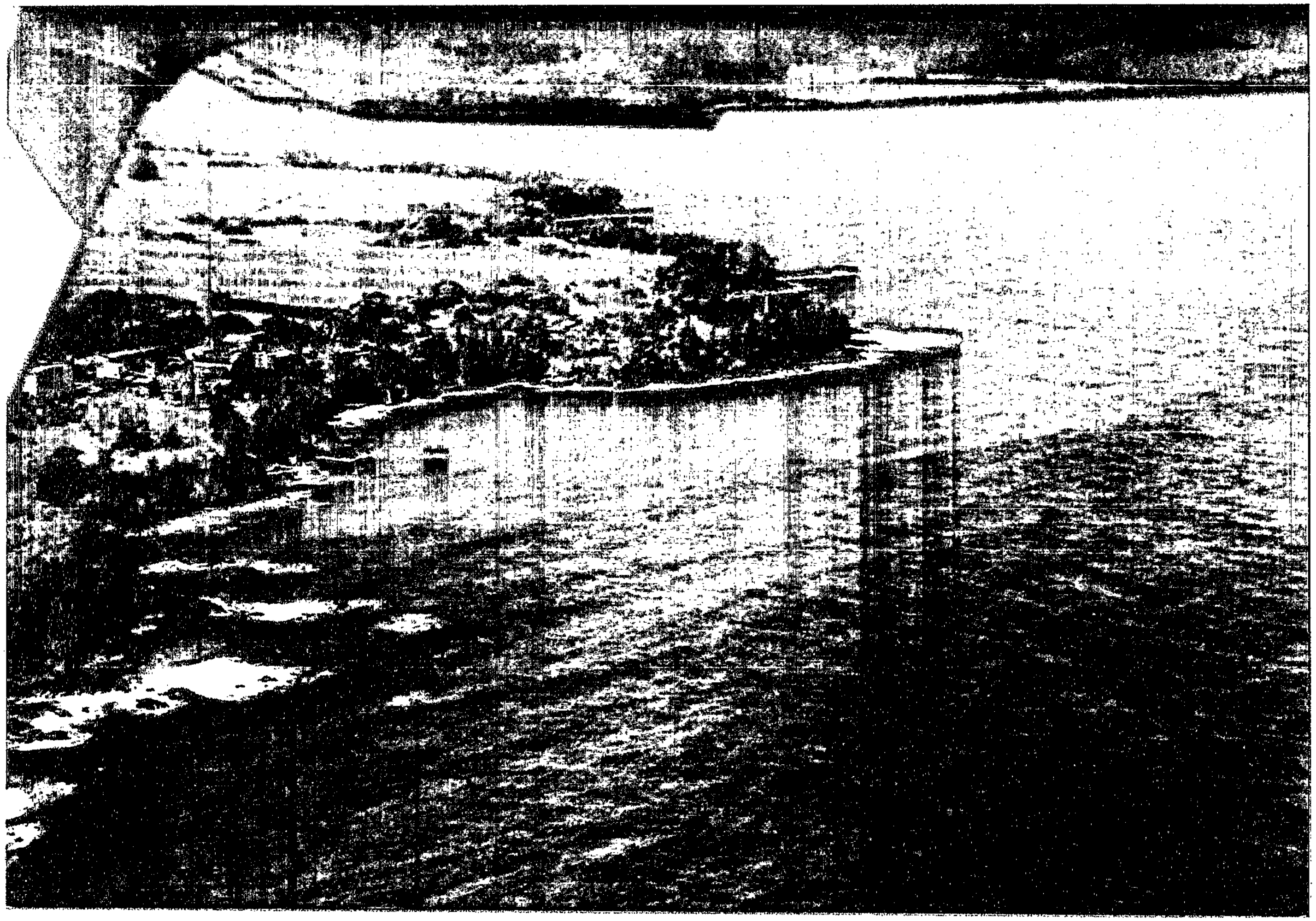


FIGURE 1-7
AERIAL VIEW OF DISCHARGE PLUME AT
HILO COAST PROCESSING COMPANY

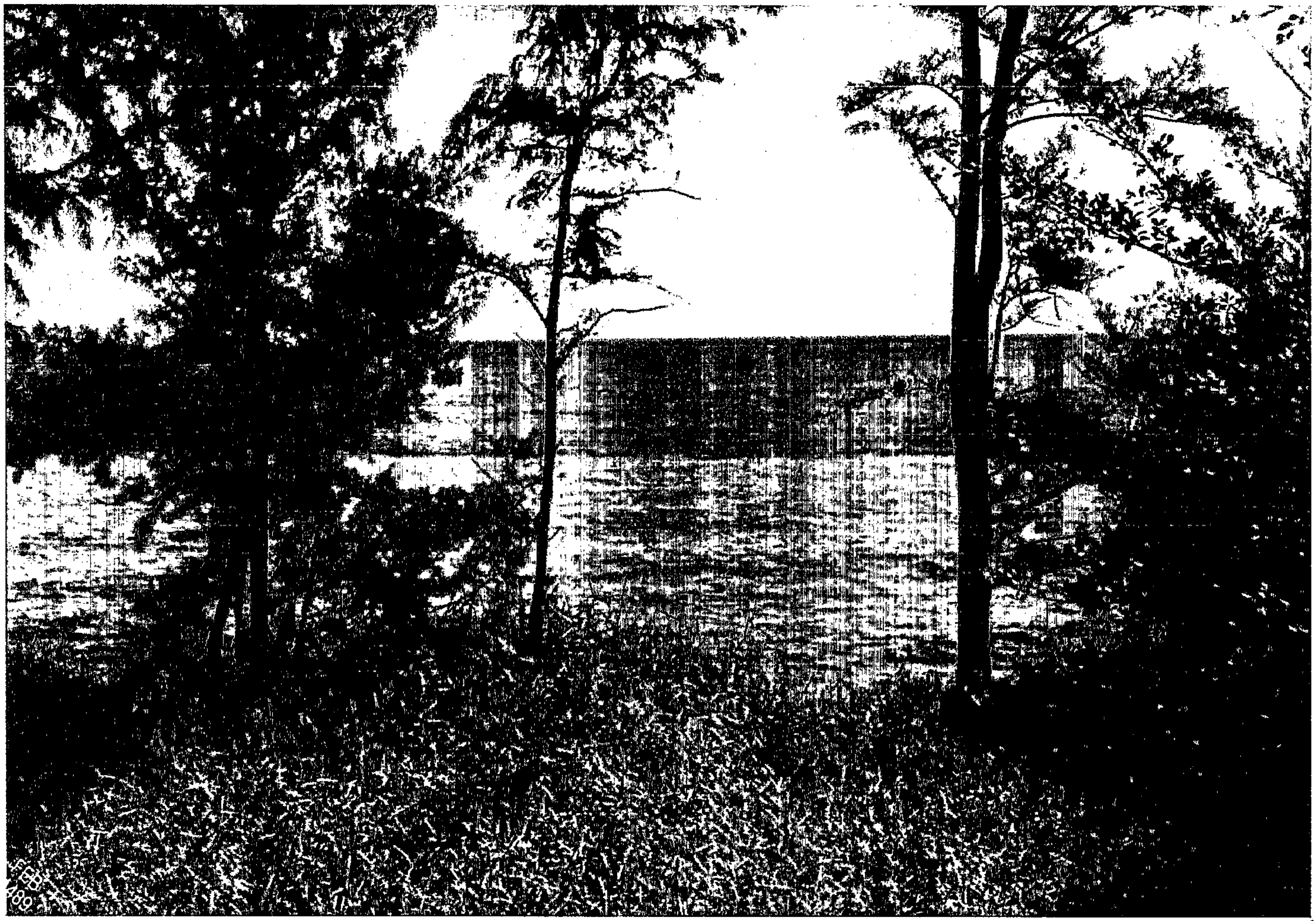


FIGURE 1-8
SHORE VIEW OF DISCHARGE PLUME AT
HILO COAST PROCESSING COMPANY

sufficient to produce objectionable color, turbidity, or other conditions in the receiving waters

- high temperatures; biocides; pathogenic organisms; toxic, radioactive, corrosive, and other deleterious substances at levels or in combination sufficient to be toxic or harmful to human, animal, plant, or aquatic life, or in amounts sufficient to interfere with any beneficial use of the water

The mixing zone policy (see Section 8 of this report for additional details and citations) within the WQS specifies that no zone of mixing shall be established unless the application and the supporting information clearly show that the discharge or proposed discharge does not violate the basic standards applicable to all waters, will not unreasonably interfere with any actual or probable use of the water areas for which it is classified, and has received the best degree of treatment or control. The Hawaii mixing zone policy further specifies that any zone of mixing may be renewed from time to time provided that the renewed zone of mixing is not for a mass emissions greater than that of the immediately preceding zone of mixing.

Federal regulations require that existing uses of the receiving waters and waters adjacent to mixing zones be maintained, regardless of the designated uses. EPA guidance on mixing zones, similar to Hawaii WQS, requires that narrative "free from" water quality criteria be met within mixing zones, and that mixing zones be "limited to an area or volume as small as practicable that will not interfere with the established community of aquatic life in the segment."

Each mill's wastewater discharge must at all times comply with the discharge limitations (based on Subpart F regulations) and conditions of its NPDES permit.

REFERENCES

1. Letter from Rebecca W. Hamner, U.S. EPA, to Francis Morgan, Theo Davies Hamakua Sugar Company, September 23, 1983.

2. Hawaiian Sugar Planters Association. 1988. Hawaiian Sugar Manual.

3. Personal Communication between Rick Klemm, Hawaiian Sugar Planters Association, and Stanley W. Reed, E.C. Jordan Co., Portland, ME. June 19, 1989.

4. Kahane, Joyce D. and Jean Kadooka Mardfin. 1987. The Sugar Industry in Hawaii: An Action Plan. Report No. 9, p. 48. Honolulu, Hawaii: Legislative Reference Bureau.

5. Hamakua Sugar Company. 1989. Submittal to USEPA.

6. Hilo Coast Processing Company. 1989. Submittal to USEPA.

2.0 ENVIRONMENTAL EFFECTS

2.1 MARINE ENVIRONMENTAL EFFECTS

EPA Office of Water Regulations and Standards (OWRS) conducted a marine environmental effects study of the wastewater discharges from HSC and HCPC in February 1989. The study's purpose was to evaluate the present impacts of the wash water discharges from HSC and HCPC on the ocean receiving waters and marine life, especially benthic biota. Of particular interest was the extent of impacted areas relative to the currently permitted mixing zones, compliance with Hawaii numerical water quality standards (including toxicity standards to be proposed according to DOH staff recommendations) and EPA marine water quality criteria for selected pollutants (Table 2-1), and impact on corals. Conditions in an area not directly affected by mill discharges were also of interest.

2.1.1 Historical Studies

Though many studies have been completed on the effects of sedimentation on coral-reef communities (1), few relate to the effects of sugar mill derived sediments in general, much less the effects of Hawaii mills. Pertinent reports which served as background material for this study include the following:

- Report on Hawaiian Sugar Factory Waste Receiving Water Study (2)
- Hawaiian Sugar Industrial Waste Study (3)
- Some Ecological Effects of Discharged Sugar Mill Wastes on Marine Life Along the Hamakua Coast, Hawaii (4)
- Environmental Impact of Thermal Loading and Biological Oxygen Demand of Sugar Mill Wastes off the Eastern Coast of Hawaii (5)
- Hamakua Coast Sugar Mills Revisited: Environmental Impact Analysis in 1983 (6)
- Hamakua Coast Sugar Mill Ocean Discharges: Before and After EPA Compliance (7)

There also have been a number of studies in Hilo Bay and the nearby continental shelf area, some of which have extended to as far north as the Pepeekeo mill site.(8)(9)(10)(11)(12)(13)(14)(15) In addition, there have been some site-specific reclamation studies of sugar mill solids disposed on land.(16) Concern for bacterial contamination in Hilo Bay has prompted several studies, one of which is ongoing.(17)

TABLE 2-1

SUMMARY OF MARINE WATER QUALITY STANDARDS AND CRITERIA

Parameter	Standards/Criteria: Hawaii Current*
Classicals	
Ammonia (as N)	3.5/8.5/15 ug/l
Nitrate & Nitrite	5/14/25 ug/l
Phosphorus, Total	20/40/60 ug/l
Turbidity	0.5/1.25/2 NTU
Dissolved Oxygen	> 75 %sat

Parameter	Hawaii Proposed*** Marine Acute ug/l	Hawaii Proposed*** Marine Chronic ug/l	Hawaii Proposed*** Human Health** ug/l	EPA Marine Acute ug/l	EPA Marine Chronic ug/l	EPA Human Health** ug/l
Metals						
Antimony			45000			45000
Arsenic	69	36		69	36	0.0175
Beryllium						0.117
Cadmium	43			43	9.3	
Chromium (hex)	1100	50		1100	50	
Copper				2.9	2.9	
Lead	140			140	5.6	
Manganese						100
Mercury	2.1			2.1	0.025	0.146
Nickel	75			75	8.3	100
Selenium	410	54		300	71	
Silver				2.3		
Thallium	2130		48			48
Zinc				95	86	

Herbicides	Lowest Reported Toxicity Values		
Diuron			308
2,4,D	2.59E+05	12950	1958
Picloram			37700
Atrazine			1940
Ametryn			2000
Dalapon	4.8E+06	240000	7.54E+05
Benomyl			41400
Glyphosate			5.4E+07

NOTES: *Geometric mean/Not to exceed 10% of time/Not to exceed 2% of time.
**Water quality criterion for protection of human health, based upon fish consumption only.
***Hawaii DOH staff recommendation for toxic criteria to be proposed.

To the extent possible, these reports served as input into the present investigation. However, with the exception of the Grigg reports, there is little information regarding the current benthic and water column conditions in coastal waters near either of the two mills. The only exceptions are the limited number of surface water sample analyses done by the mills as required in their NPDES permits. Another limited data set is available on STORET. Generally the data are out of date (most were collected in the 1970s), and there is no indication as to whether the samples were taken in or outside of the discharge plume. Also, the direction of prevailing currents at the time of the sampling is not specified. Therefore these data were not used.

2.1.2 Study Design

To document impacts within and beyond the mixing zone boundaries, EPA formulated a data collection program to quantify the physical and chemical characteristics of the water column, and the characteristics of the coral communities up and down coast from the mill discharge points. Corals were selected as an impact indicator because of their sensitivity to sedimentation and because changes in coral community characteristics (species type and number, percent cover, and diversity) represent a long-term integrated effect, independent of short-term mill operating conditions.

In addition to data collection at and near the mill discharge points, two reference sites also were studied. An ocean site located between the Waipio and Waimanu Valleys, was chosen as a reference site because of its large distance from any sugar mill, and absence of any sugarcane agricultural operations in either of the two drainage basins. It was considered a relatively pristine area from the standpoint of either anthropogenic or direct stream runoff impacts. The Kolekole Stream mouth also was selected as a reference site because of its proximity to the HCPC mill (though well beyond the authorized mixing zone), because it is the location of an earlier investigation of sugar mill impacts, and because the drainage area is well within the sugarcane harvesting area. Figure 2-1 shows the relative location of the four marine environmental study areas.

The following study activities were conducted at the stations near each mill, and in the reference area between the Waipio and Waimanu Valleys, and at the mouth of Kolekole Stream:

- o coral transects were conducted within and beyond the assigned mixing zone boundaries, and at reference stations

- o water column dissolved oxygen, pH, temperature, conductivity and turbidity were measured within and beyond the mixing zone boundaries and at reference stations to determine compliance with Hawaii water quality standards

- o receiving water samples were collected at selected stations within the mixing zone boundaries and beyond, and at reference stations, for analysis at approved laboratories under contract with EPA to determine compliance with Hawaii water quality standards and EPA water quality criteria

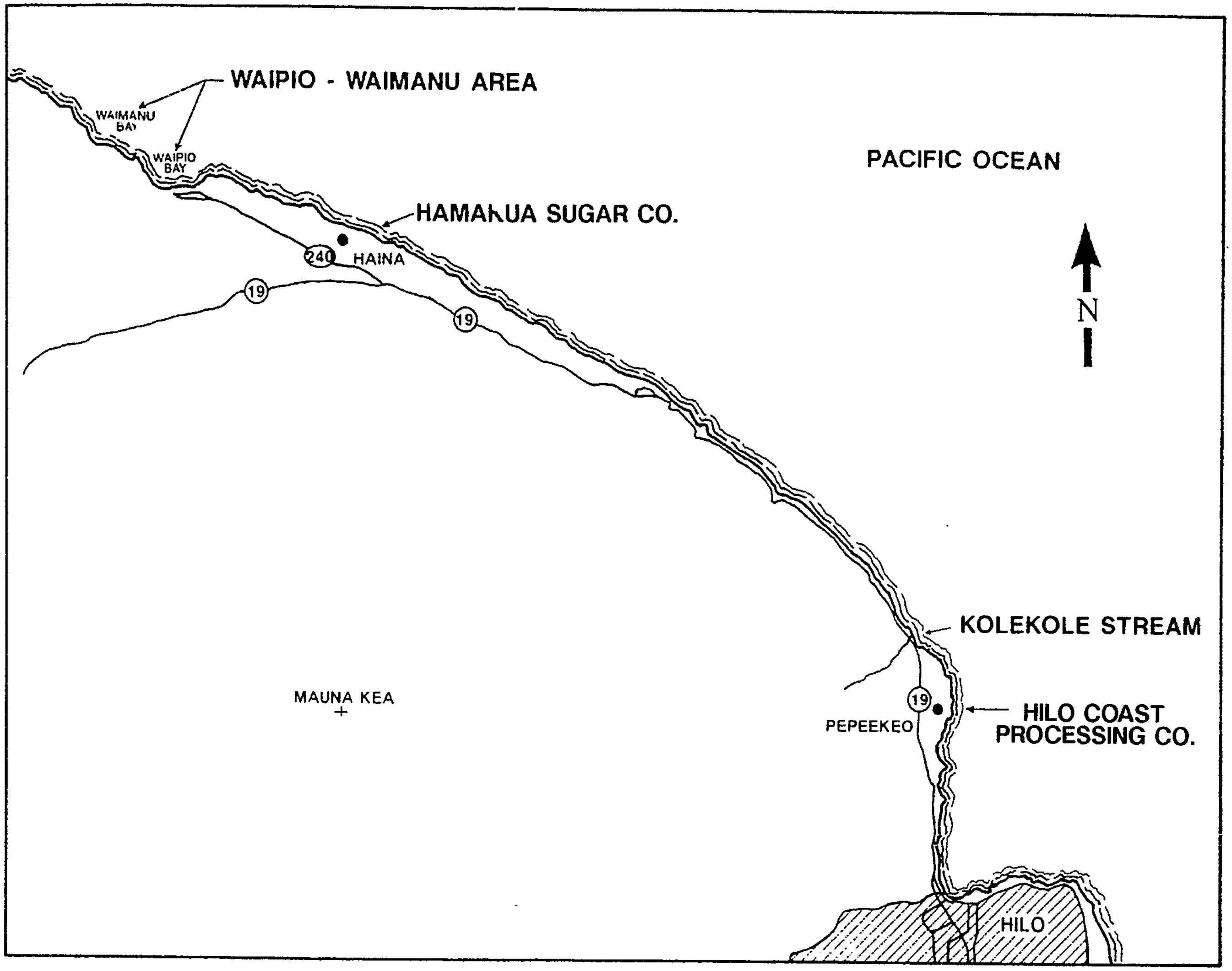


FIGURE 2-1
MARINE ENVIRONMENTAL STUDY SITE LOCATIONS

- composite mill effluent samples were collected at both mills during the field survey period, and analyzed for the same parameters as receiving water samples

- aerial photographic surveys were conducted of the plumes during the field sampling period

- Secchi disc depths (an indication of water clarity) were recorded at each water sample collection station

- a remotely operated vehicle (ROV) was used to document bottom conditions along transects from the 60-foot depth out to 400-500 feet, or the 1 mile offshore mixing zone boundary

- ancillary sediment samples were collected for visual examination to supplement diver information, and to archive for future analyses, if warranted

- a limited number of current measurements were performed to gain insight into circulation patterns during the study period

All of the environmental impact study activities noted above, except for the effluent sampling and aerial photographic surveys, were conducted from the U.S. Coast Guard Cutter CAPE CROSS based at Hilo, Hawaii. Sugar mill effluent samples were collected by mill personnel and provided to EPA and supporting contractor personnel. Aerial photographic surveys were conducted in part by a local aerial survey company at Hilo, Hawaii, and also in part by EPA and supporting contractor personnel.

2.1.3 Coral Impacts

2.1.3.1 Coral Transects. A series of diver transects to define coral conditions were conducted on February 8, 9, 13, and 14, 1989. The transect lines were located at regular intervals from each mill discharge point, at the Waipio-Wiamanu reference site, and at the mouth of Kolekole Stream (Figures 2-2 through 2-5). Several additional transects were completed between these locations to better define any apparent transition region. In addition, a ROV was used to complete a series of transects perpendicular to the shore and extending from the 60 ft depth location to approximately one mile offshore, the authorized boundaries of the mixing zones. Along each transect coral species type and number, percent coral coverage, and species diversity were determined at the depth of maximum coverage.

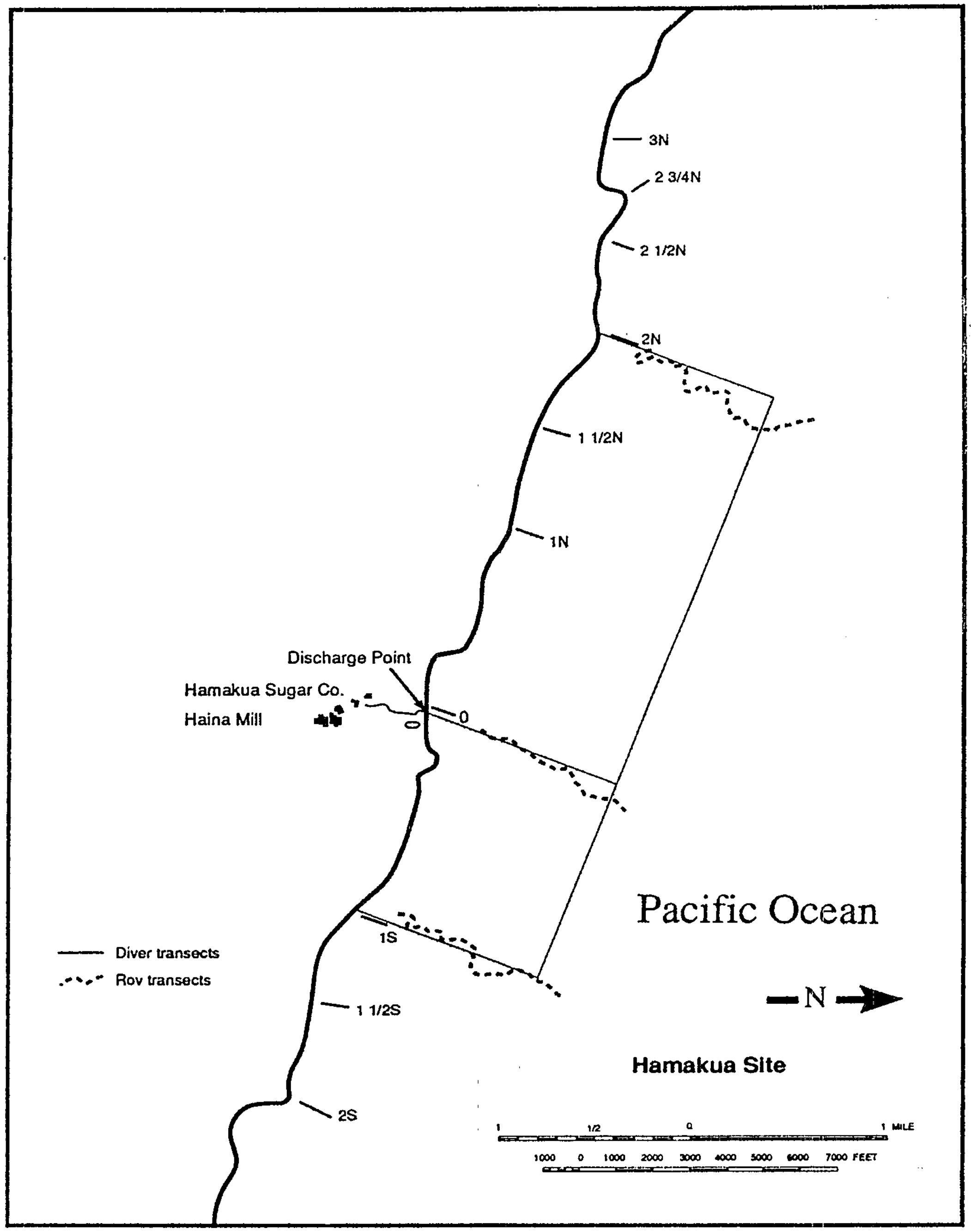


FIGURE 2-2
DIVER AND ROV TRANSECT LOCATIONS AT THE HSC DISCHARGE SITE

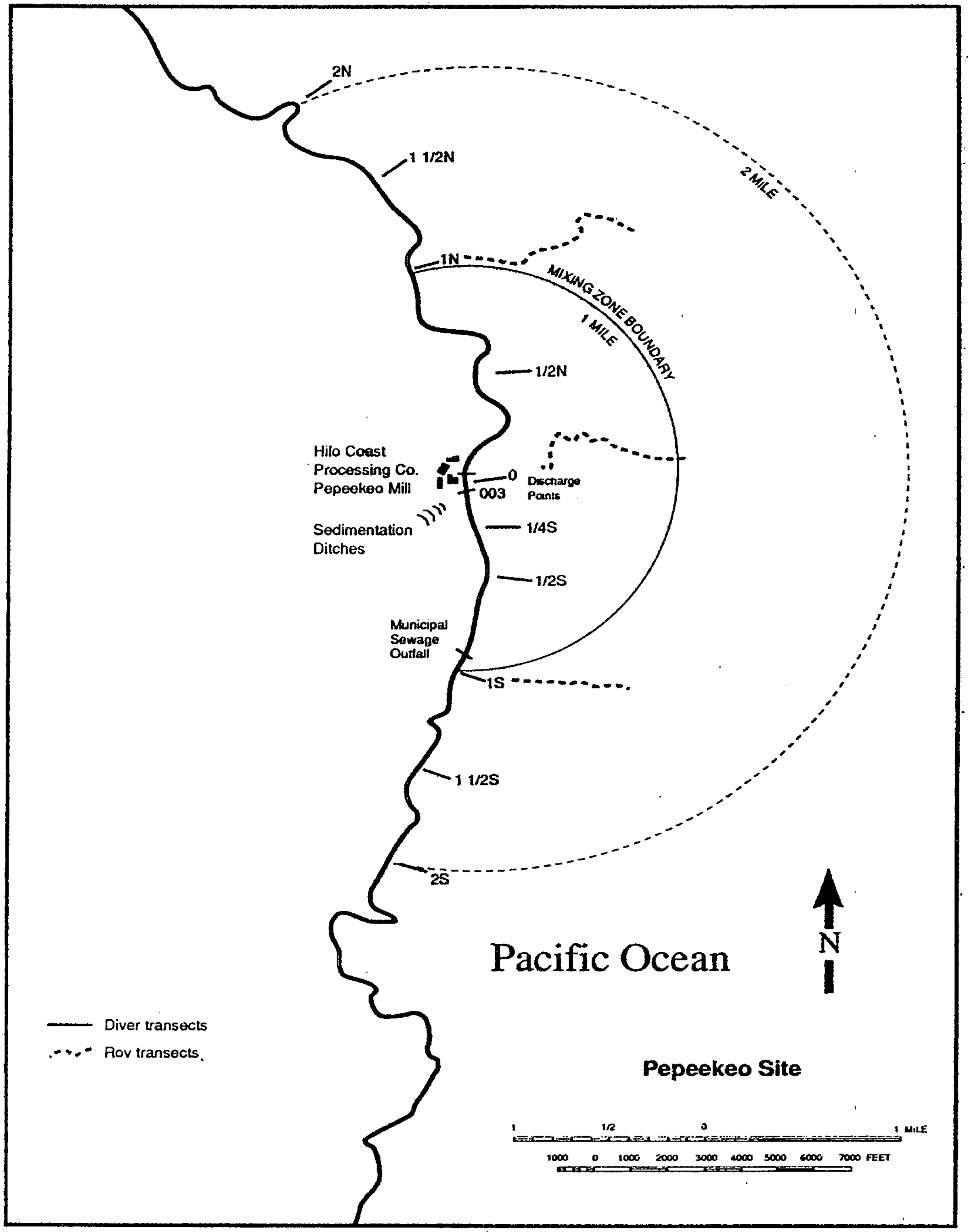


FIGURE 2-3
DIVER AND ROV TRANSECT LOCATIONS AT THE HCPC DISCHARGE SITE

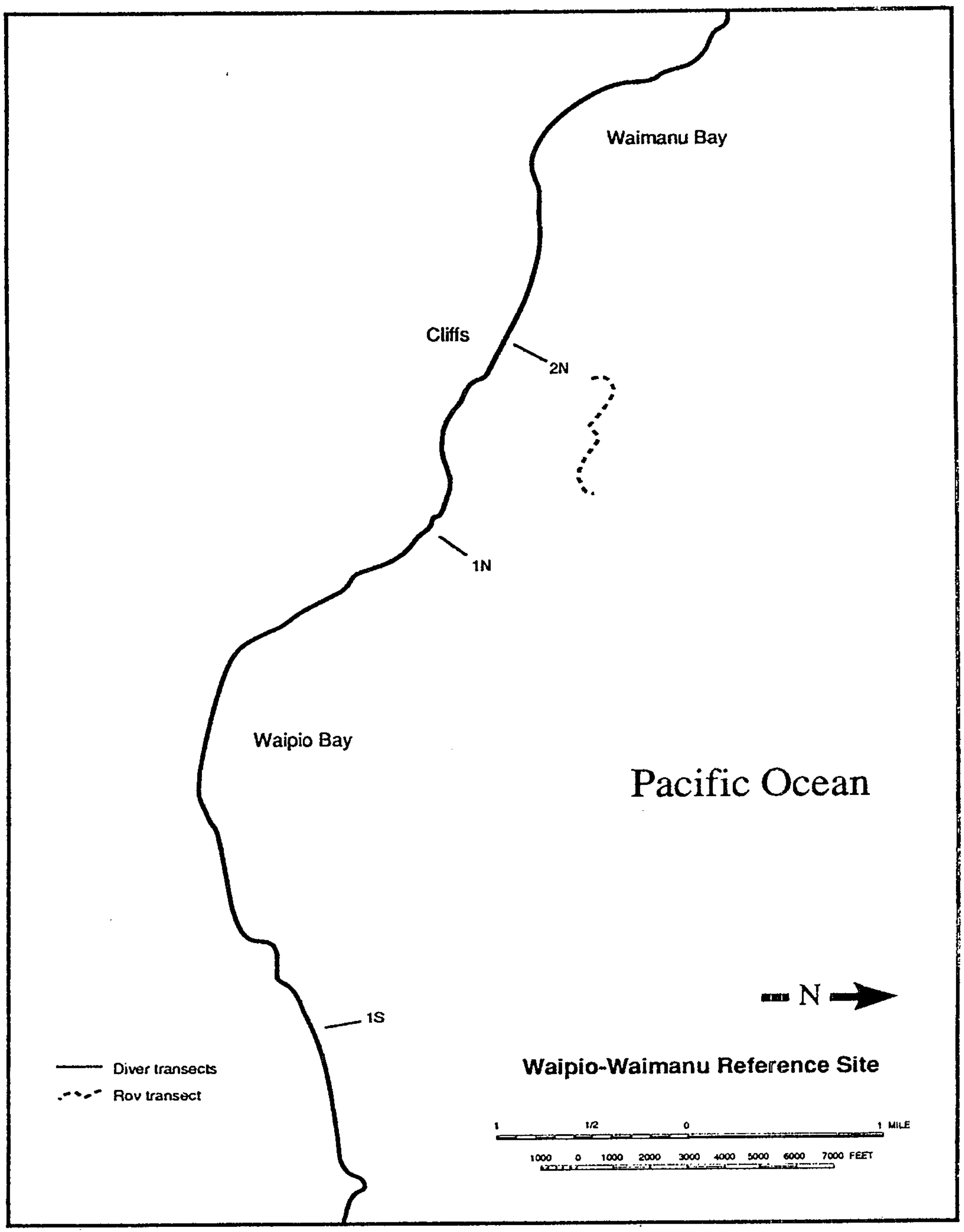


FIGURE 2-4
DIVER AND ROV TRANSECT LOCATIONS IN THE WAIPIO-WAIMANU AREA

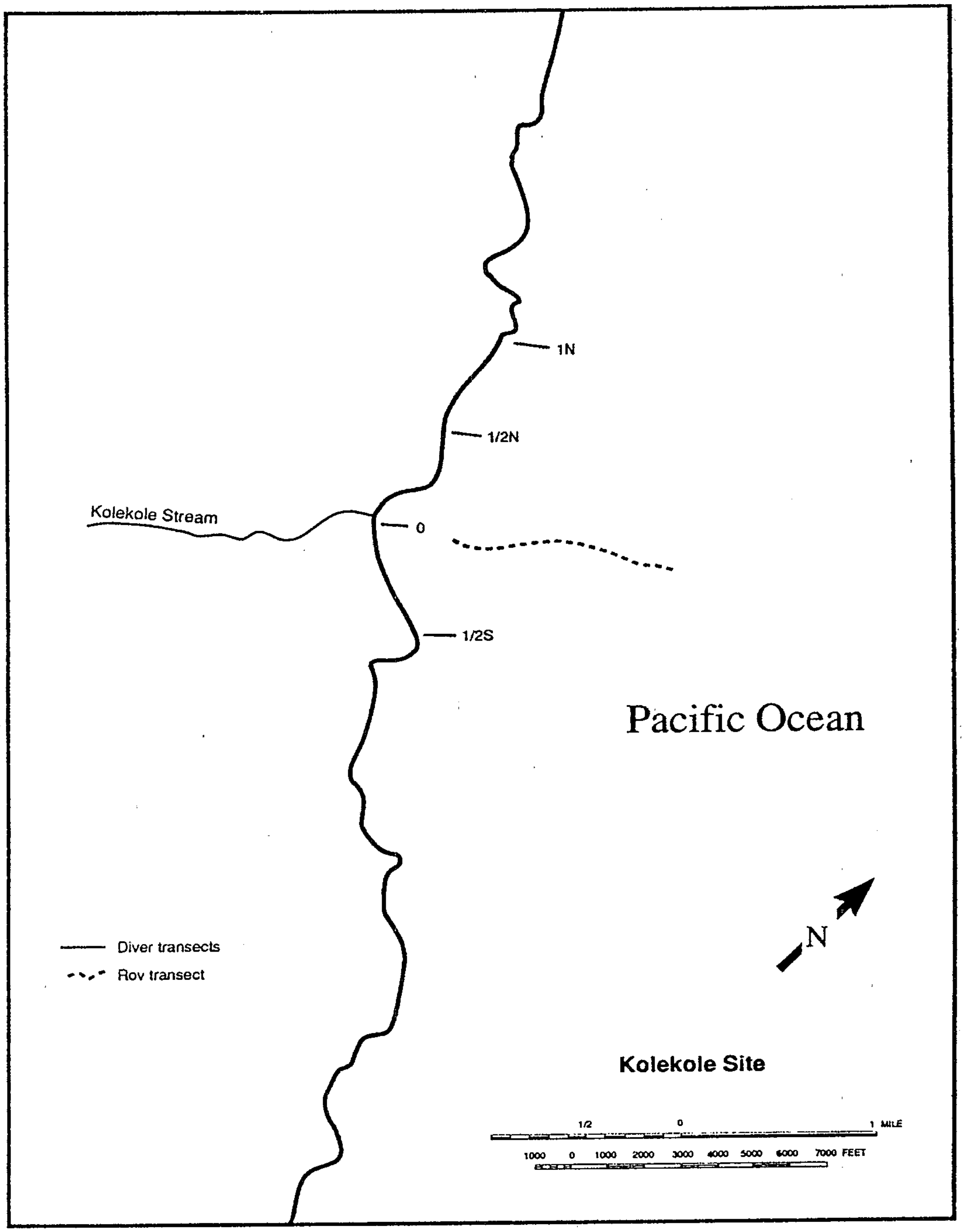


FIGURE 2-5
DIVER AND ROV TRANSECT LOCATIONS AT THE KOLEKOLE STREAM SITE

2.1.3.2 General Physiography. Except at the mill discharges and stream mouths, all survey stations were relatively homogeneous in overall structure. (18) The nearshore area, extending to approximately the 60- to 80-foot depth, is primarily composed of basaltic rocks and boulders, the largest on the order of 10 feet in diameter. At several stations, large flat-topped blocks of basalt extend up to 25 feet from the sea floor. All rock surfaces are covered with a ubiquitous layer of fine sediment bound in an algal turf. Though deposition was observed at all stations, sediment layers are thicker near the mill discharges. Living coral communities are consistently more abundant on the tops of boulders, probably due to lower scour in this region compared to the sides. Channels and pockets between the boulders are filled with a coarse black sand. Near the mill discharges, fine-grained brown mud deposits (to an undetermined depth) completely cover the bottom, except on boulder surfaces extending well above the bottom which remain exposed due to wave-action scour. Coral communities are completely eliminated due to sediment burial and virtual elimination of light. Isolated cane debris was observed on sand pockets in several locations.

2.1.3.3 HSC Discharge Area. The number of coral species observed in the HSC area representing background conditions was eight with Porites lobata the predominant species. Species counts were zero off the mill discharge point, and rose to between four and five at the one mile mark, and to eight beyond the one mile mark (Figure 2-6). In this same region, species cover diversity (H'c) ranged from zero off the mill discharge point to 1.25 (Figure 2-7).

Immediately off the HSC discharge, the percent coral cover is zero and remains substantially reduced at the one mile north mark (Figure 2-8, and photograph in Figure 2-9). The percent of coral cover at stations located near the mixing zone boundaries is within the range observed at stations located outside the mixing zone (16 to 42 percent).(18) Even the coral cover at the 1.5 mile north station (24 percent) is within this range, suggesting that the influence of the HSC discharge on coral cover is within a zone somewhat less than 1 mile wide to the south of the discharge and somewhat less than 1.5 miles to the north of the discharge. However, some bleached corals indicating sublethal effects were observed on the 2-mile north transect (photograph in Figure 2-10). The 40-percent cover recorded at 2.75 miles north (photograph in Figure 2-11) and 3.0 miles south is considered a peak value for wave exposed coastlines. Tests for significant differences between transect means indicate a patchy distribution of coral cover. The observed vacillation in coral cover may be due to differential exposure to breaking waves and surge, or stream discharges upcoast and downcoast from the station origin.

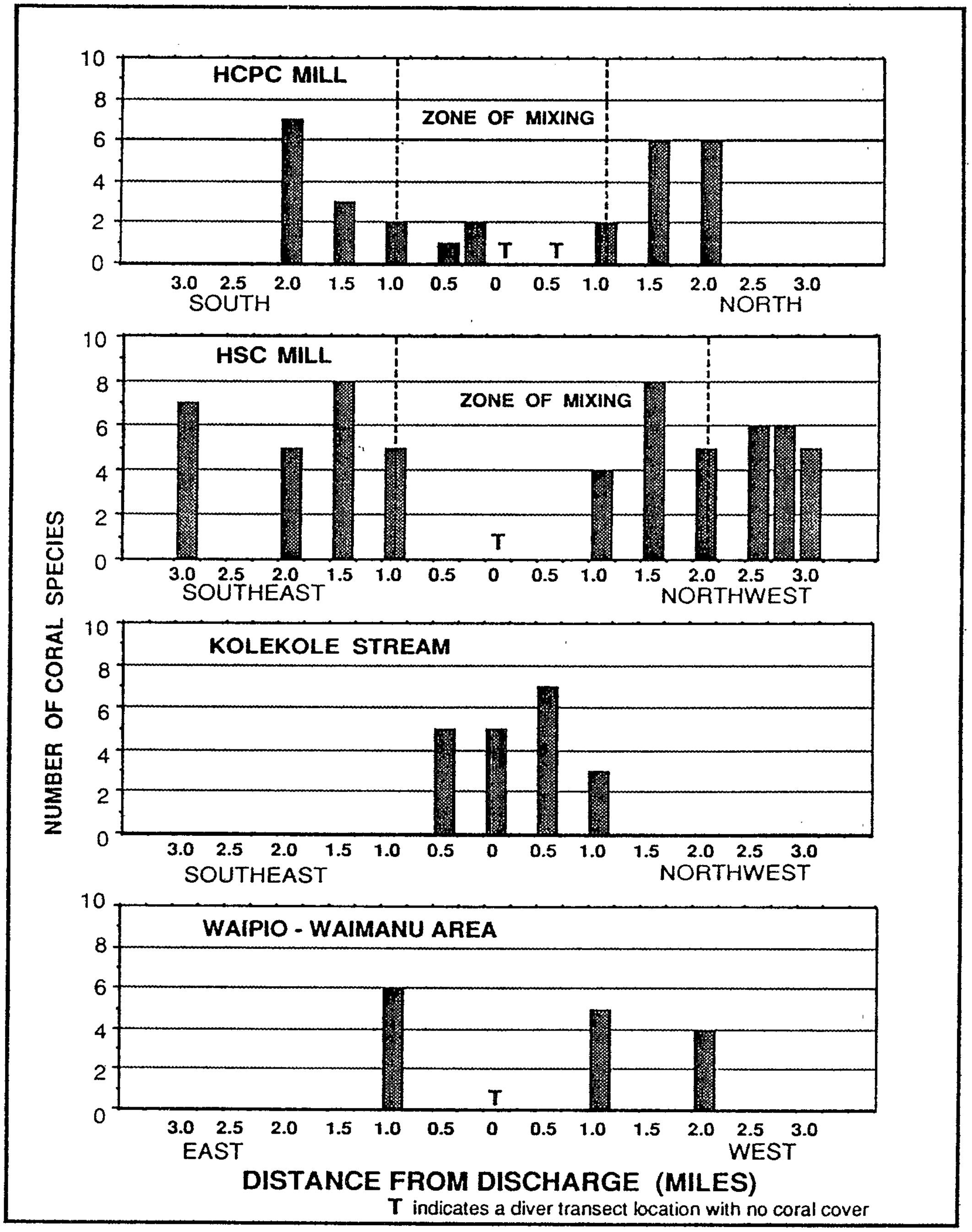


FIGURE 2-6
HISTOGRAMS SHOWING THE NUMBER OF CORAL SPECIES ON EACH PHOTO-QUADRAT TRANSECT

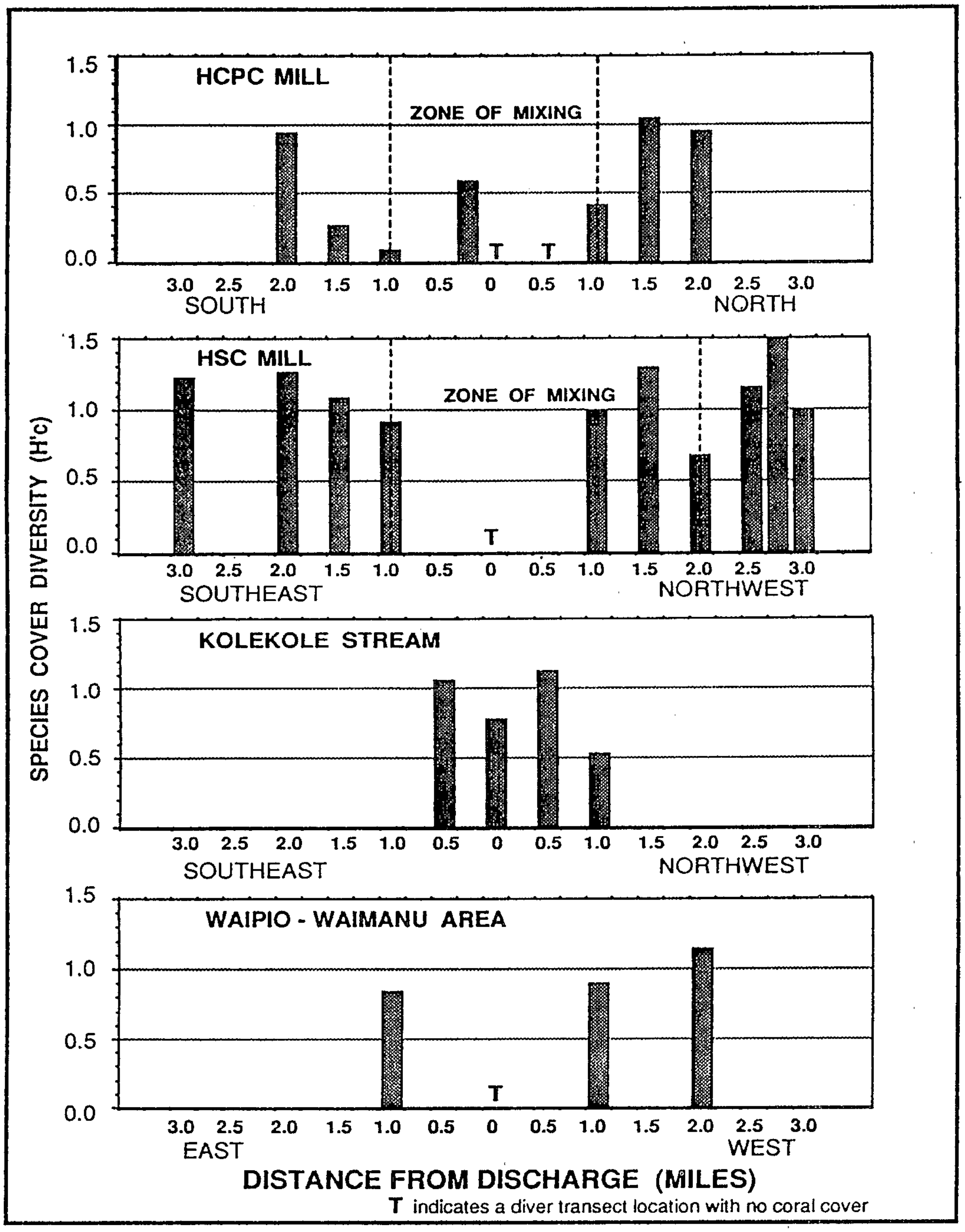


FIGURE 2-7
HISTOGRAMS SHOWING THE CORAL SPECIES COVER DIVERSITY (H'c) ON EACH PHOTO-QUADRAT TRANSECT

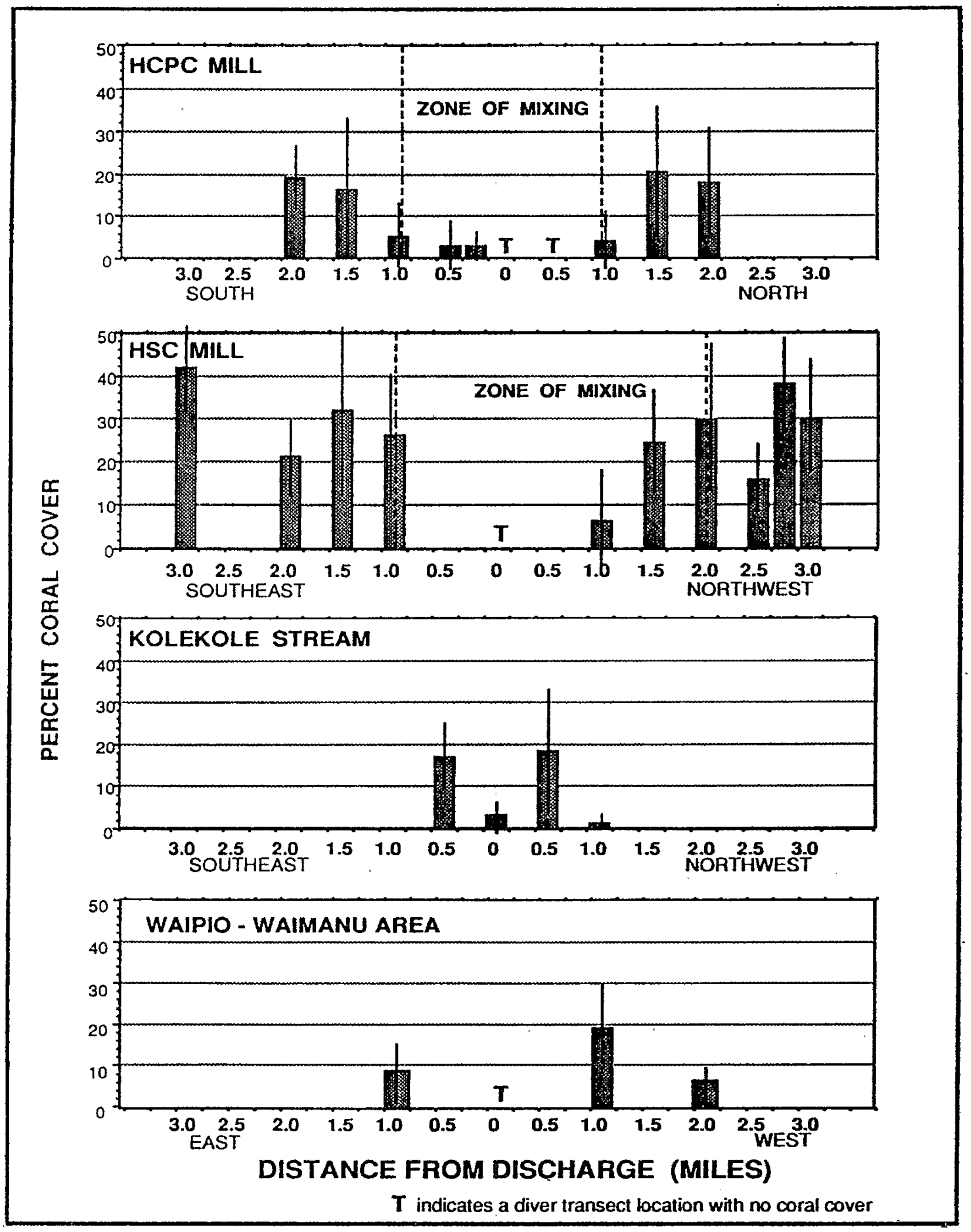


FIGURE 2-8
HISTOGRAMS SHOWING THE MEAN AND STANDARD DEVIATION OF PERCENT CORAL COVER ON EACH PHOTO-QUADRAT TRANSECT

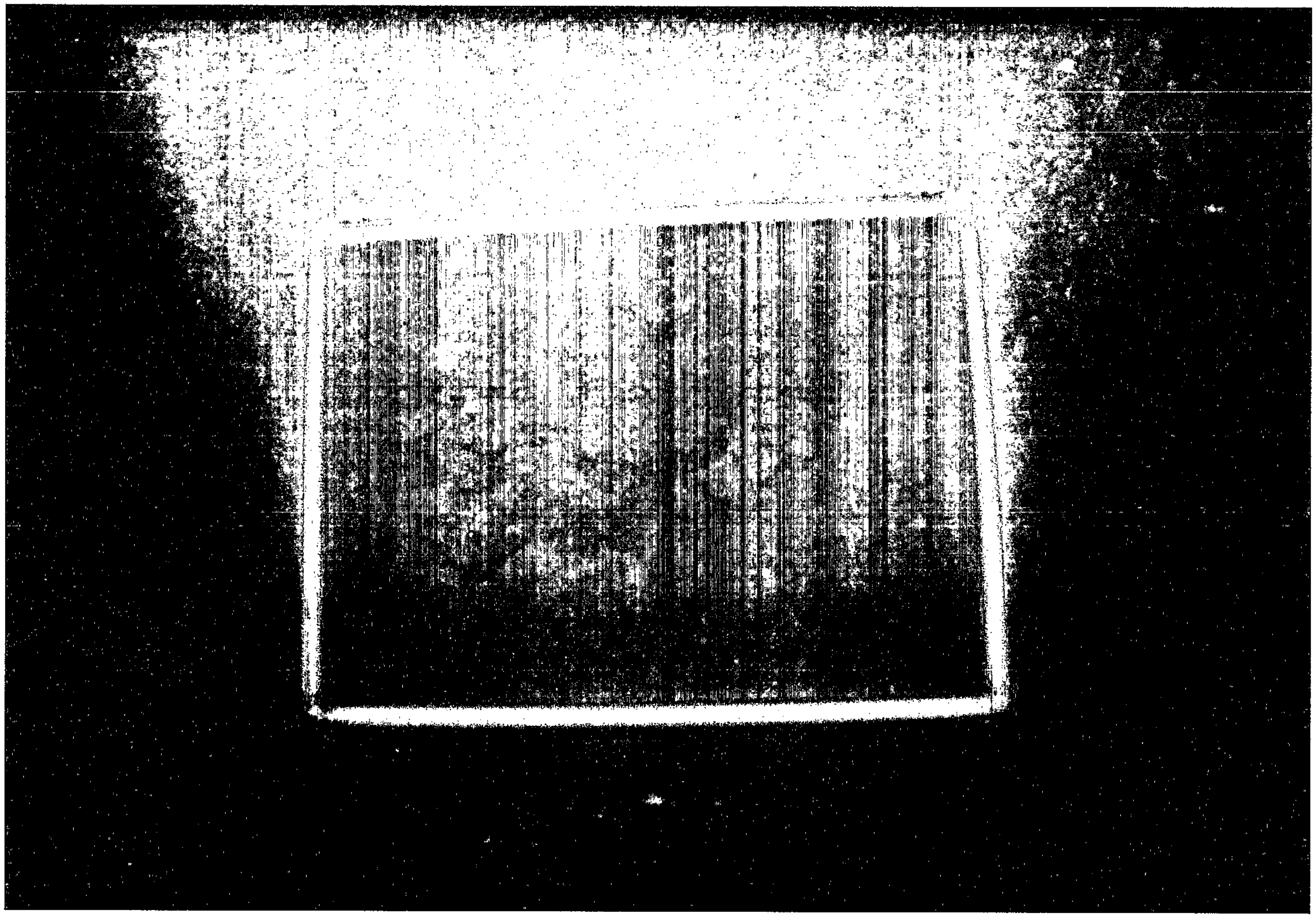


FIGURE 2-9
LIMITED CORAL COVER OBSERVED 1 MILE
NORTH OF HSC DISCHARGE

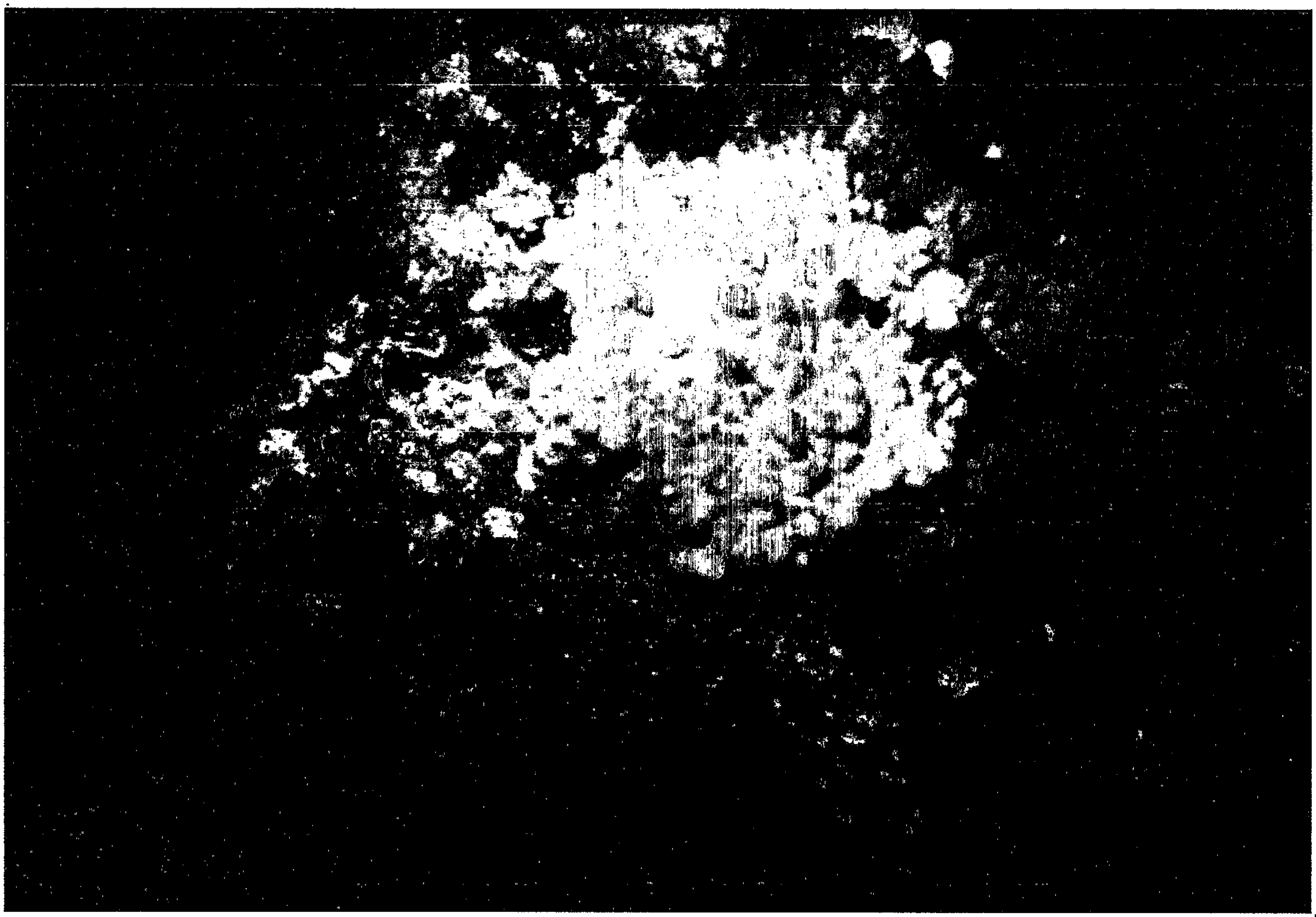


FIGURE 2-10
BLEACHED CORALS INDICATING SUBLETHAL EFFECTS
2 MILES NORTH OF HSC DISCHARGE

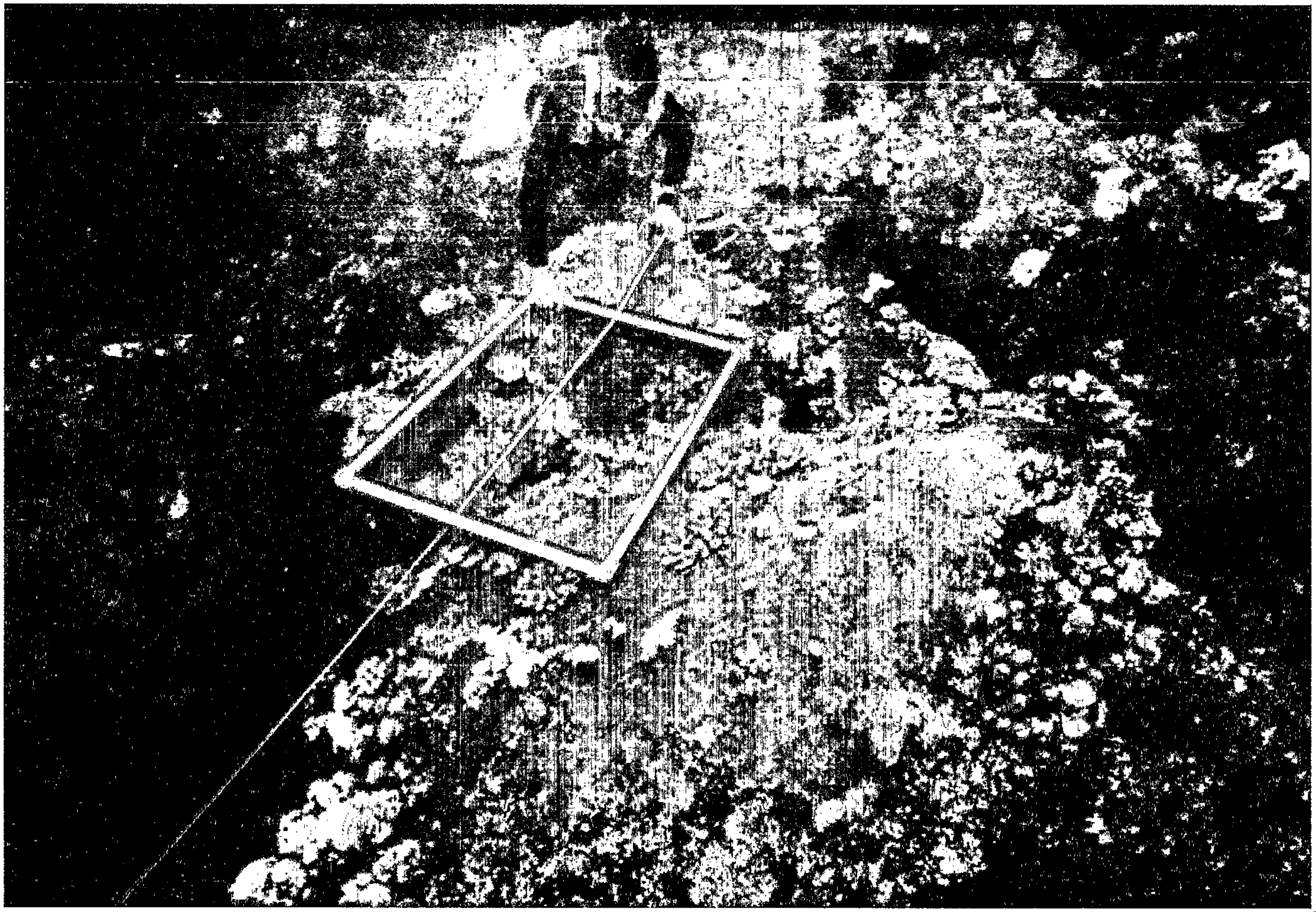


FIGURE 2-11
BACKGROUND CORAL COVER OBSERVED 2.75 MILES
NORTH OF HSC DISCHARGE

2.1.3.4 HCPC Discharge Area. Seven species of coral representing background conditions were observed in the HCPC discharge area. Species number is zero near the mill discharge and at 0.5 miles north, and remains low (2) within the 2-mile width of the mixing zone, with *Porites lobata* representing 90 percent of the cover. Several *P. lobata* colonies on transects within the mixing zone displayed a distinct bleached appearance, indicating loss of photosynthetic pigment due to stressed conditions. Background species counts were six to seven at 1.5 miles and 2.0 miles north and at 2.0 miles south of the discharge (see Figure 2-6). Species diversity was lowest within the two mile width of the mixing zone, ranging from zero (near the mill discharge) to 0.6. Beyond this area, species diversity was lowest at 1.5 miles south (0.26), otherwise ranging from 0.94 to 1.05 beyond the mixing zone boundary (see Figure 2-7).

Immediately off the HCPC discharge point, the percent coral coverage is zero (see Figure 2-8 and the photograph in Figure 2-12). The zone of coral elimination extends up to 1 mile north and up to 0.25 miles south. The elimination mechanism appears to be burial by sediment and virtual elimination of light. The coral cover at HCPC is also substantially lower out to the mixing zone boundary in both the north and south directions compared to beyond the boundaries (see Figure 2-8). The photograph in Figure 2-13 shows the limited coral coverage at one mile north. At the 1.5-mile and 2.0-mile stations in the north and south directions, coral cover is relatively constant (16 to 20 percent) indicating background conditions (photograph in Figure 2-14). All stations beyond the 1 mile range do not differ significantly with each other. With one exception, all stations within 1 mile of the discharge differ significantly ($p < 0.01$) with all stations beyond 1 mile. At the southern boundary of the mixing zone, the 1-mile and 1.5-mile transects differ significantly at the 0.01 level, while at the northern boundary, the corresponding stations differ at the 0.001 level.

2.1.3.5 Waipio-Waimanu Area. Four coral species were observed at the reference area located 2 miles north of Waipio Valley, off cliffs in a non-agricultural area. Except immediately off the Waipio Stream mouth where there were no corals, transect species counts ranged from 4 to 6 (see Figure 2-6), and cover diversity was from 0.84 to 1.15 (see Figure 2-7). Coral coverage is relatively low for a remote area, ranging from 9 percent to 19 percent (see Figure 2-8). This may not be due to stream discharges (i.e., low amounts of sediment deposits and high water clarity). A probable cause is the increased stress due to breaking waves from the long period swells emanating from north Pacific storms.(18)

2.1.3.6 Kolekole Stream Discharge Area. Seven coral species were identified within 1 mile of the stream mouth, with *Porites lobata* again being predominant (see Figure 2-6). Species diversity ranged from 0.77 to 1.33 (see Figure 2-7). Coral cover off the stream mouth is low (3 percent) (photograph in Figure 2-15), but reaches a background level of 17 to 18 percent by the 0.5-mile range upcoast and downcoast (see Figure 2-8 and see the photograph in Figure 2-16). The lowest value of coral cover (1 percent) at 1.5 miles north may be a

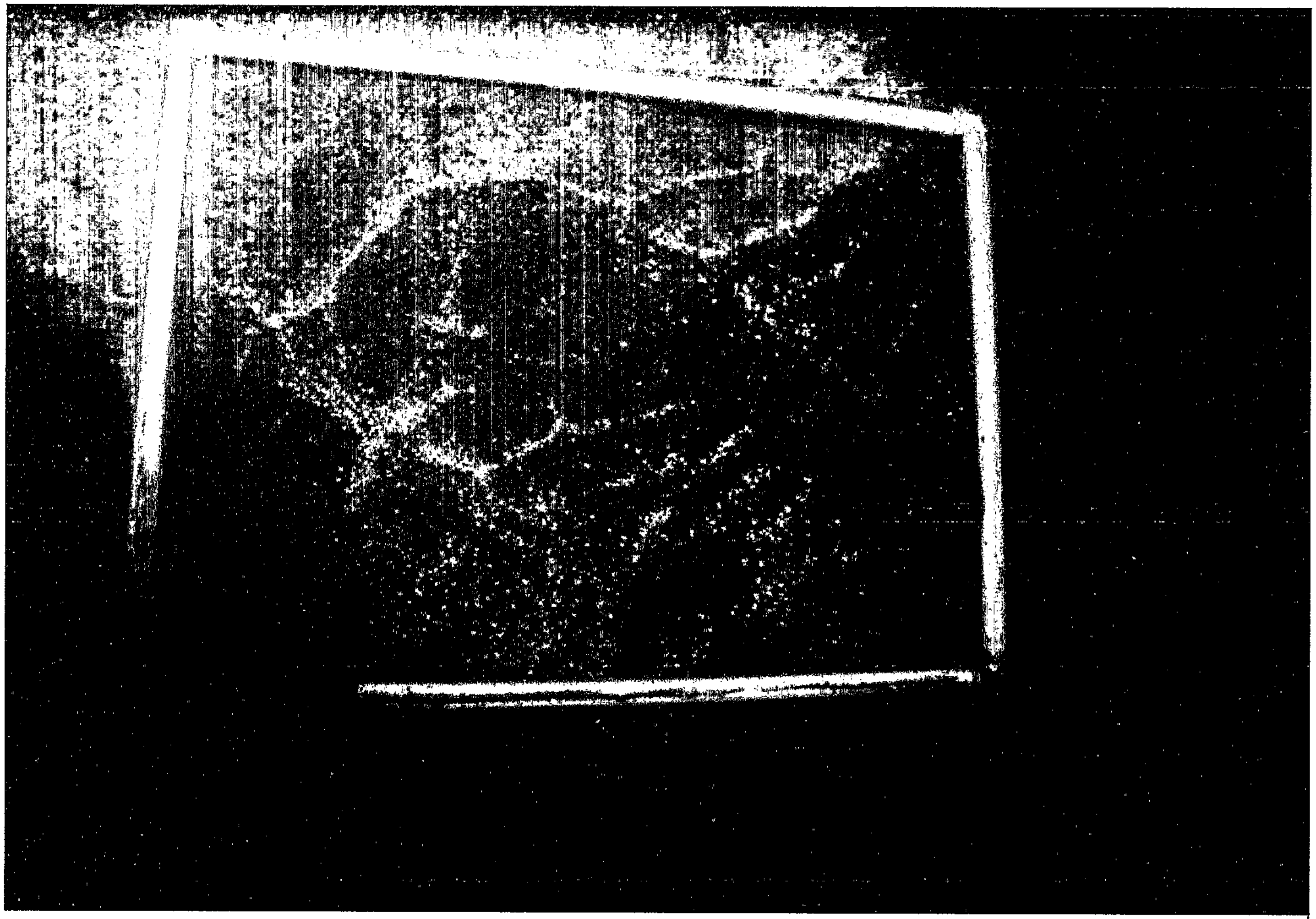


FIGURE 2-12
COMPLETE CORAL ELIMINATION OBSERVED NEAR HCPC DISCHARGE

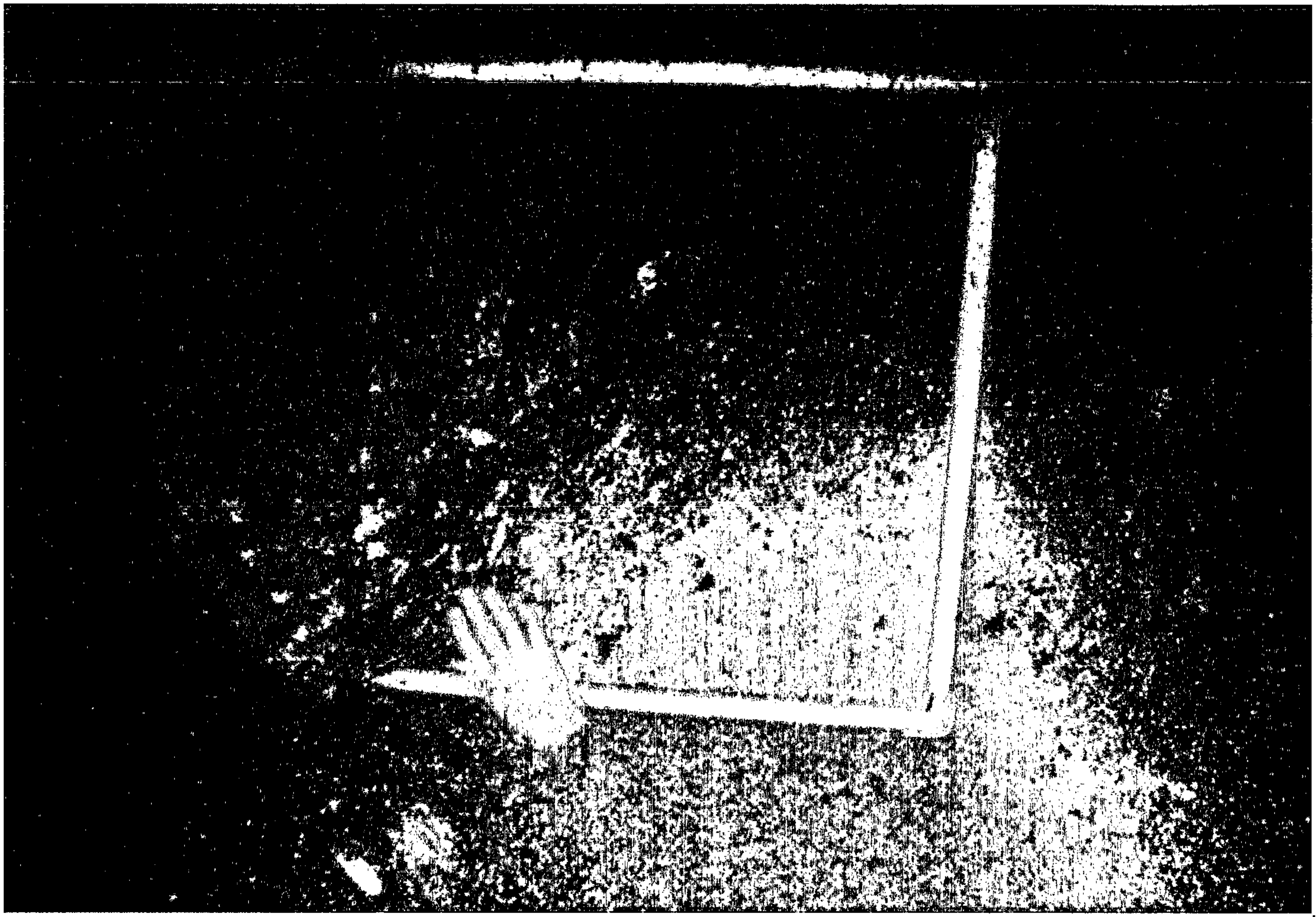


FIGURE 2-13
LIMITED CORAL COVER OBSERVED 1 MILE
NORTH OF HCPC DISCHARGE

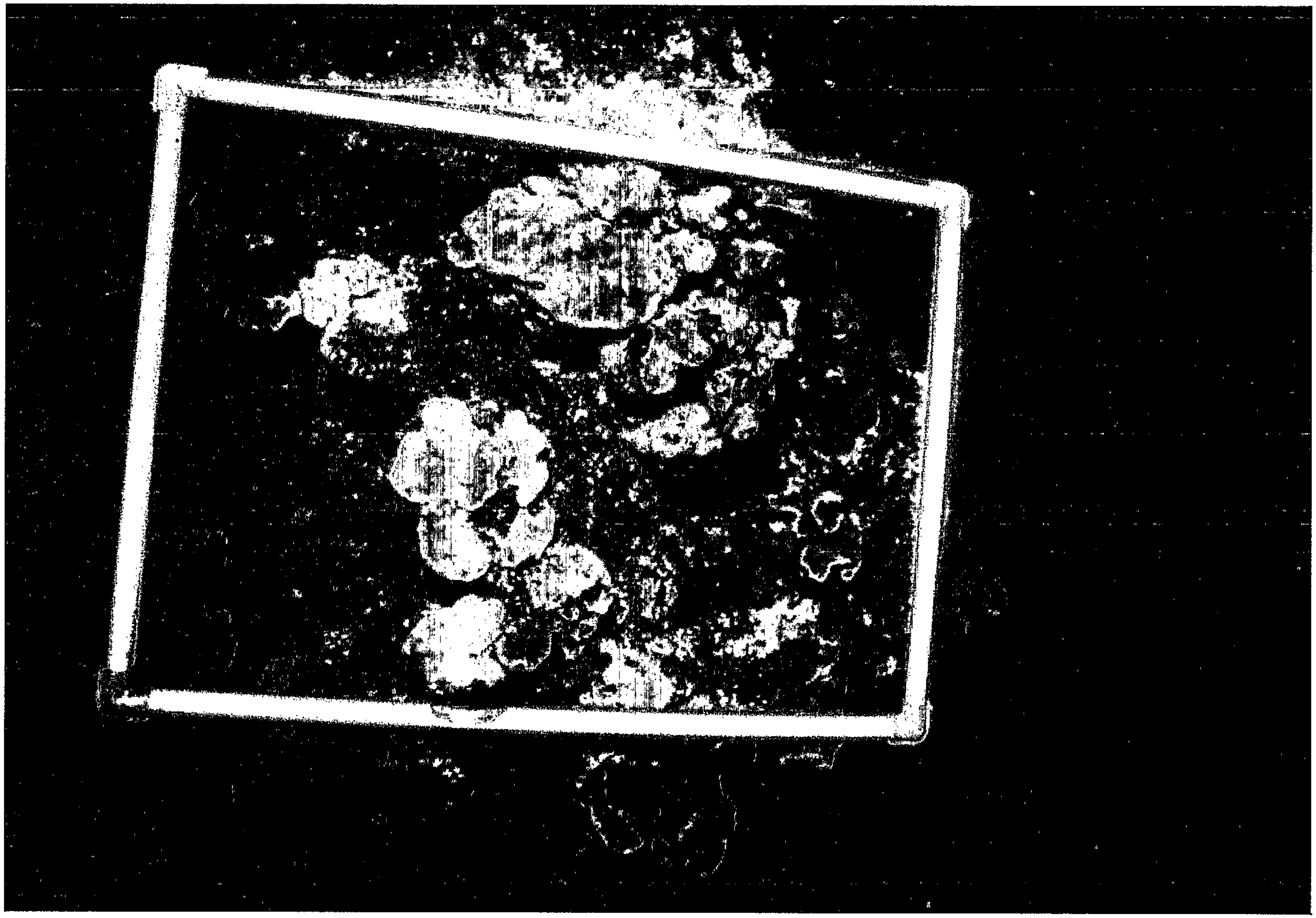


FIGURE 2-14
BACKGROUND CORAL COVER OBSERVED 1.5 MILES NORTH OF HCPC DISCHARGE

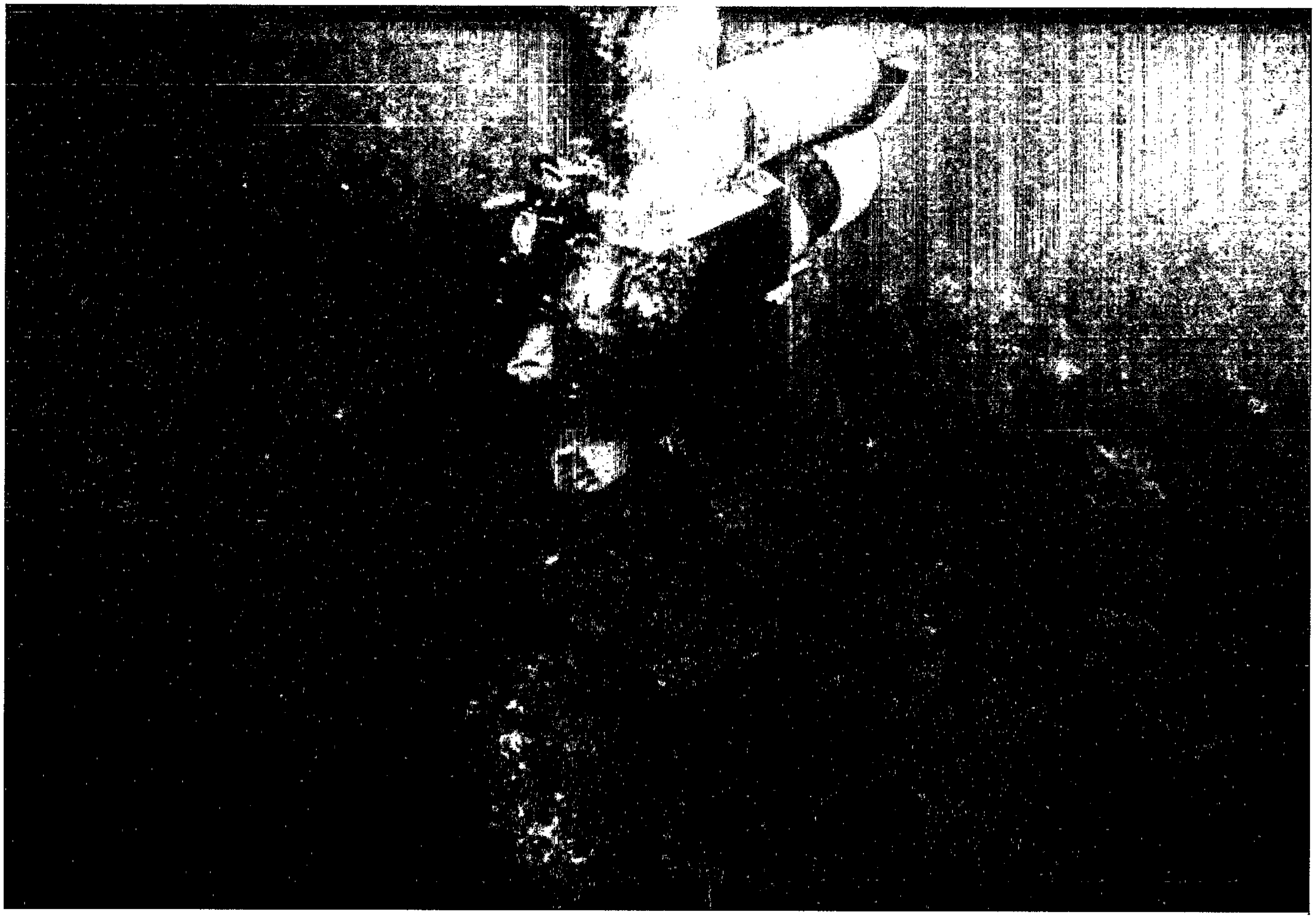


FIGURE 2-15
CORAL COVER OBSERVED AT KOLEKOLE
STREAM MOUTH

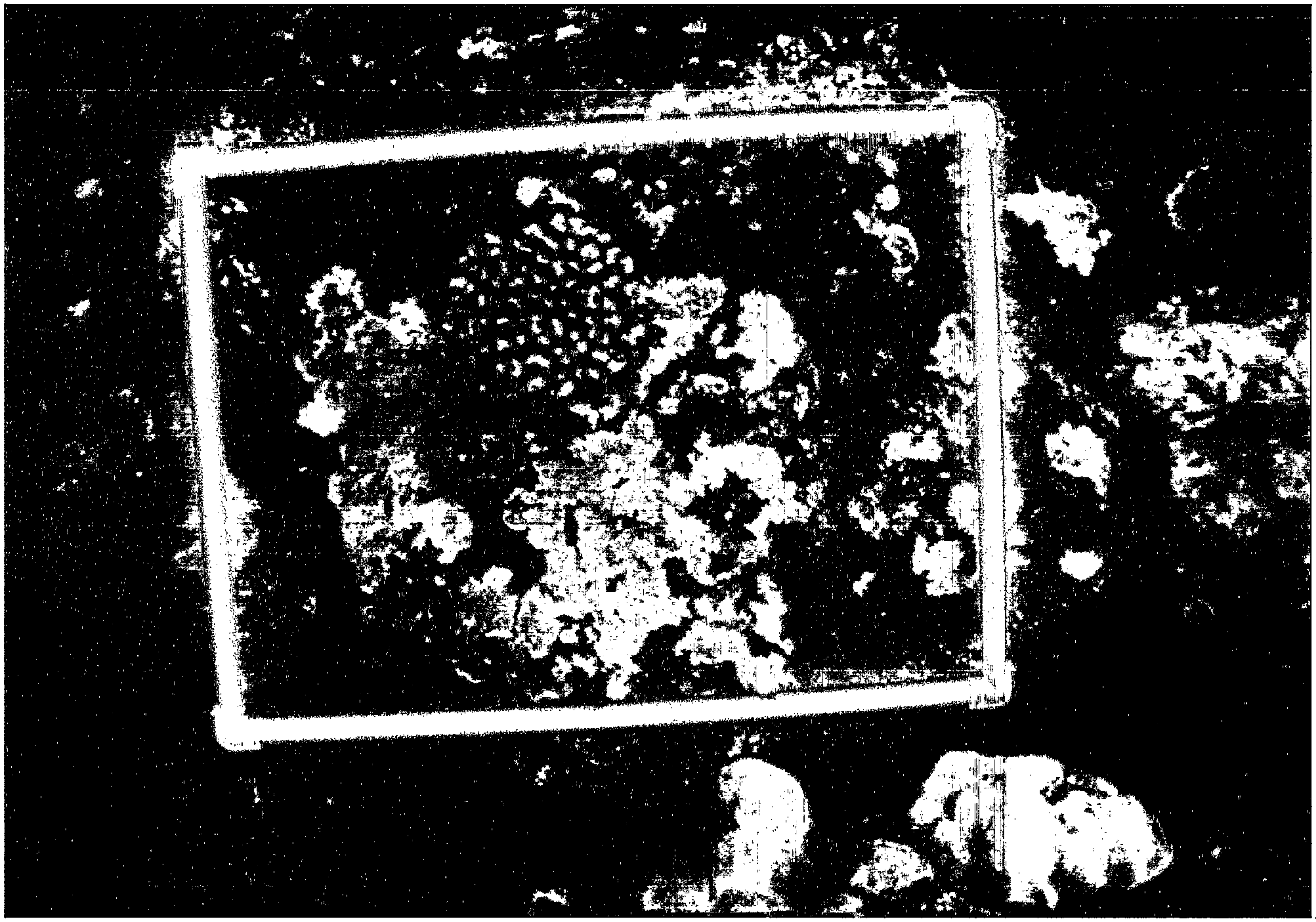


FIGURE 2-16
BACKGROUND CORAL COVER OBSERVED 0.5 MILE
NORTH OF KOLEKOLE STREAM MOUTH

result of the Hakalau Stream discharge, or of equal or greater probability, the result of mud discharges by the Hakalau sugar mill prior to its closing in 1975 (Section 1.5.2.2). Exclusive of the coral elimination zone at HCPC, the magnitude of impact (less than 5 percent cover) is similar at HCPC, and Kolekole but the zone of influence is much smaller. At Kolekole depressed coral cover occurs over somewhat less than 1 mile, while at HCPC this depressed coverage extends somewhat less than 3 miles.

<u>2.1.3.7 Coral Impact Summary</u>. The following overall conclusions can be drawn from analysis of the coral transect data:

- Coral reef assemblages off the northeast coast of the island of Hawaii are characterized by coral communities growing on basaltic boulders and platforms. Background percent coral cover is approximately 20 percent in the area of the HCPC discharge and 30 percent in the area of the HSC discharge.

- None of the coral species encountered are considered rare, unique to the area, or commercially valuable.

- Sugar mill wastewater discharges cause environmental changes sufficient to totally eliminate corals in a restricted zone directly off the mill discharge points. The mortality mechanism appears to be sediment burial and virtual elimination of light. Near the HCPC discharge, this elimination zone extends up to 0.25 mile south, and up to one mile north, which is the mixing zone boundary. The width of the elimination zone (seaward) was not determined in the area of the HSC discharge. However, coral coverage was zero at the discharge and could extend out somewhat less than 1 mile to the north and south.

- Sugar mill wastewater discharges cause sufficient environmental change to alter coral community structure within and (at least in one case) beyond the presently authorized zones of mixing. The impacted zone adjacent to the HCPC discharge extends between 1.0 mile (mixing zone boundary) and 1.5 mile in both the upcoast and downcoast directions. The impacted zone adjacent to the HSC discharge extends between 1.0 and 1.5 miles upcoast and may extend to somewhat less than 1.0 mile downcoast.

- Within the zones of impact, coral cover, number of species, and species cover diversity are substantially lower than background values. Within the zones of mixing, the sub-lethal effect of bleaching was observed on some coral communities.

- The Kolekole Stream discharge appears to cause coral cover to be depressed within an area extending 0.5 mile upcoast and downcoast from the mouth of the stream relative to areas with no stream influence, but does not appear to cause total decimation as was observed at the mill sites.

- Coral community parameters at 0.5 miles beyond the upcoast and downcoast zone of mixing boundaries at HCPC are similar to those at stations 0.5 miles from the mouth of Kolekole Stream.

- At the HSC upcoast and downcoast mixing zone boundaries, coral community parameters are well within the range of values at distant stations. This indicates that the mill discharge is not adversely affecting community structure beyond this zone.

- The Waipio-Waimanu reference site proved sufficiently different from mill discharge sites and the Kolekole Stream site to prevent direct comparisons in terms of impacts (i.e., the coral impacts due to a high-energy environment versus sedimentation and light blockage).

- Mill discharge impact areas are substantially larger, more severe, and different in character than natural stream discharge areas.

2.1.4 Water Column Impacts

2.1.4.1 Field Activities. Water column studies were conducted between February 5 and 19, 1989. Study tasks included taking measurements from a surface vessel using a profiling instrument and an onboard computer for data recording.

Eleven discrete water samples were collected in near-surface and mid-depth locations at each mill site, three were collected at the Waipio-Waimanu site, and four were collected at the Kolekole Stream mouth. Composite effluent samples were also collected by mill staff during the field sampling period. All samples were analyzed for 11 conventional parameters and 34 metals, and all except the off-stream samples were analyzed for eight herbicides (Table 2-2). Dissolved oxygen, pH, temperature, conductivity, turbidities, and water clarity were measured in the water column.

2.1.4.2 Visible Characteristics. Water column characteristics varied significantly between diver transect stations. Directly off the mill discharges, water clarity was greatly reduced by suspended material. Near the bottom at the 60-foot depth, for example, visibility was essentially zero at both mill sites. Suspended material of terrigeneous origin, consisting primarily of leaf litter, was observed off the Waipio and Kolekole stream sites by the divers. The turbid wastewater plumes were highly visible from the air and from the surface of the ocean, and were seen extending beyond the mixing zone boundaries at HCPC during the period of the field survey. On the days of sampling at HSC, the plume was significantly reduced compared to its size on earlier occasions (i.e., compared to historic aerial photos and as observed on a preparatory trip in December 1988).

TABLE 2-2

METHOD OF RECEIVING WATER AND EFFLUENT SAMPLE ANALYSIS

Pollutant or Pollutant Characteristic	Analytical Method
Classical Pollutants	
Ammonia Nitrogen (as N)	EPA 350.1
Total Kjeldahl Nitrogen (TKN)	EPA 351.2
Nitrite & Nitrite Nitrogen (NO_2 & NO_3)	EPA 353.2
Total Phosphorus (TP)	EPA 365.2
Ortho-Phosphorus (OPO_4)	EPA 365.2
Total Organic Carbon (TOC)	EPA 415.1
Biochemical Oxygen Demand (BOD-5)	EPA 405.1
Chemical Oxygen Demand (COD)	EPA 410.1,.2,.3,.4
Total Suspended Solids (TSS)	EPA 160.2
Fecal Coliform Bacteria	EPA 600/8-78-017
Hexavalent Chromium (Cr^{+})	EPA 218.5
Elements	
Aluminum	200.7 (Q,ICP)
Antimony	204.2 (Q,GF)
Arsenic	206.2 (Q,GF)
Barium	200.7 (Q,ICP)
Beryllium	200.7 (Q,ICP)
Boron	200.7 (Q,ICP)
Cadmium	200.7 (Q,ICP)
Calcium	200.7 (Q,ICP)
Chromium	200.7 (Q,ICP)
Chromium (hex)	SM 312B
Cobalt	200.7 (Q,ICP)
Copper	200.7 (Q,ICP)
Iron	200.7 (Q,ICP)
Lead	200.7 (Q,ICP)
Lithium	200.7 (S,ICP)
Magnesium	200.7 (Q,ICP)
Manganese	200.7 (Q,ICP)
Mercury	245.1 (Q,CV)
Molybdenum	200.7 (Q,ICP)
Nickel	200.7 (Q,ICP)
Osmium	200.7 (S,ICP)
Potassium	200.7 (S,ICP)
Selenium	270.2 (Q,GF)
Silicon	200.7 (S,ICP)
Silver	200.7 (Q,ICP)
Sodium	200.7 (Q,ICP)
Strontium	200.7 (S,ICP)
Sulfur	200.7 (S,ICP)
Thallium	279.2 (Q,GF)
Tin	200.7 (Q,ICP)

TABLE 2-2
(continued)

Pollutant or Pollutant Characteristic	Analytical Method
Elements (continued)	
Titanium	200.7 (Q,ICP)
Vanadium	200.7 (Q,ICP)
Yttrium	200.7 (Q,ICP)
Zinc	200.7 (Q,ICP)
Pesticides	
Ametryn	EPA 619 (GC)
Atrazine	EPA 619 (GC)
2,4-D	EPA 615 (GC)
Dalapon	EPA 615 (GC)
Diuron	EPA 615 (GC)
Picloram	EPA 615 (GC)
Benomyl	EPA 631 (HPLC/UV)
Glyphosate	EPA 140 & 631 (HPLC/UV) & Pesticide Analytical Manual, Vol. II (1986); Pesticide Reg. Sec. 180.221; J. Agric. Food Chem. 1986, 34, 955-960.

NOTES:

1	Q	quantitative determination
2	ICP	inductively coupled plasma emission spectrometry
3	GF	graphite furnace
4	SM	Standard Method
5	S	semi-quantitative determination
6	CV	cold vapor
7	GC	gas chromatography
8	HLPC/UV	high pressure liquid chromatography/utlraviolet detection

2.1.4.3 HSC Discharge Area. Hawaii open coastal water quality standards were not exceeded at or beyond the mixing zone. Within the mixing zone, only turbidity and NO_2+NO_3 values numerically exceeded any standard value. Turbidities of 25 NTU and 17 NTU (i.e., 12.5 and 8.5 times the maximum standard of 2 NTU, not to be exceeded more than 2 percent of the time) occurred at stations immediately off the discharge point and 0.25 miles directly offshore (Figure 2-17). At other sampling locations within the mixing zone, turbidities were below the 0.5 NTU minimum criterion. NO_2+NO_3 values at these same two stations and one at 0.75 mile northeast were approximately double the maximum level of 25 ug/l to be exceeded no more than 2 percent of the time. At the remaining stations within the mixing zone, NO_2+NO_3 values were at or below the 10 ug/l level, which numerically exceeds the 5 ug/l criteria for the geometric mean maximum. However, single sample data preclude a compliance determination with this criterion.

EPA metals criteria that were exceeded within the mixing zone boundary include mercury, copper, lead, and arsenic. The reported mercury concentration of 3.7 ug/l at 0.75 miles from the discharge point exceeds the marine acute criterion by a factor of 1.8 times, and the human health fish consumption criterion by a factor of 25, and the EPA marine chronic criterion by a factor of 148. It also exceeds the Hawaii proposed marine acute criterion by a factor of 1.8; however, this mercury value may be an anomaly. Surface sample copper values exceeded the acute and chronic criterion by the following factors: six times at 0.5 miles northwest, seven times at 2 miles northwest, six times at 0.5 miles southeast, and three times at one mile southeast. Lead, at approximately 10 times the marine chronic criterion, occurred in a surface sample at one mile east. Arsenic was detected at 1,200 times the 0.0175 ug/l human health fish consumption criterion in a surface sample immediately off the discharge and in a mid-depth sample at 2 miles northwest.

For beryllium, nickel, and silver at all sampling locations, and arsenic, copper, lead, and mercury at other than the above locations, compliance cannot be determined because the detection limits were above the respective EPA criteria. All herbicide concentrations were below detection limits and below the lowest reported toxicity values used in the absence of EPA criteria to project water quality impacts.(19) Therefore,there are no potential impacts from herbicides.

2.1.4.4 HCPC Discharge Area. No violations of Hawaii open coastal water quality standards (for ammonia-nitrogen, nitrate plus nitrite nitrogen, total phosphorus, turbidity, pH, dissolved oxygen, or temperature) were observed at or beyond the mixing zone boundary. Excluding an anomalous 220 mg/l NO_2+NO_3 result (possible sample contamination), the only exceedances within the mixing zone of state regulated criteria for which there are data were NO_2+NO_3 at greater than two times the allowable maximum level (25 ug/l) and turbidity at 47 times the allowable maximum level (2 NTU), both of which occurred just off the discharge point (Figure 2-18). A total phosphorus concentration of 20 ug/l was measured at two mixing zone sites and one site

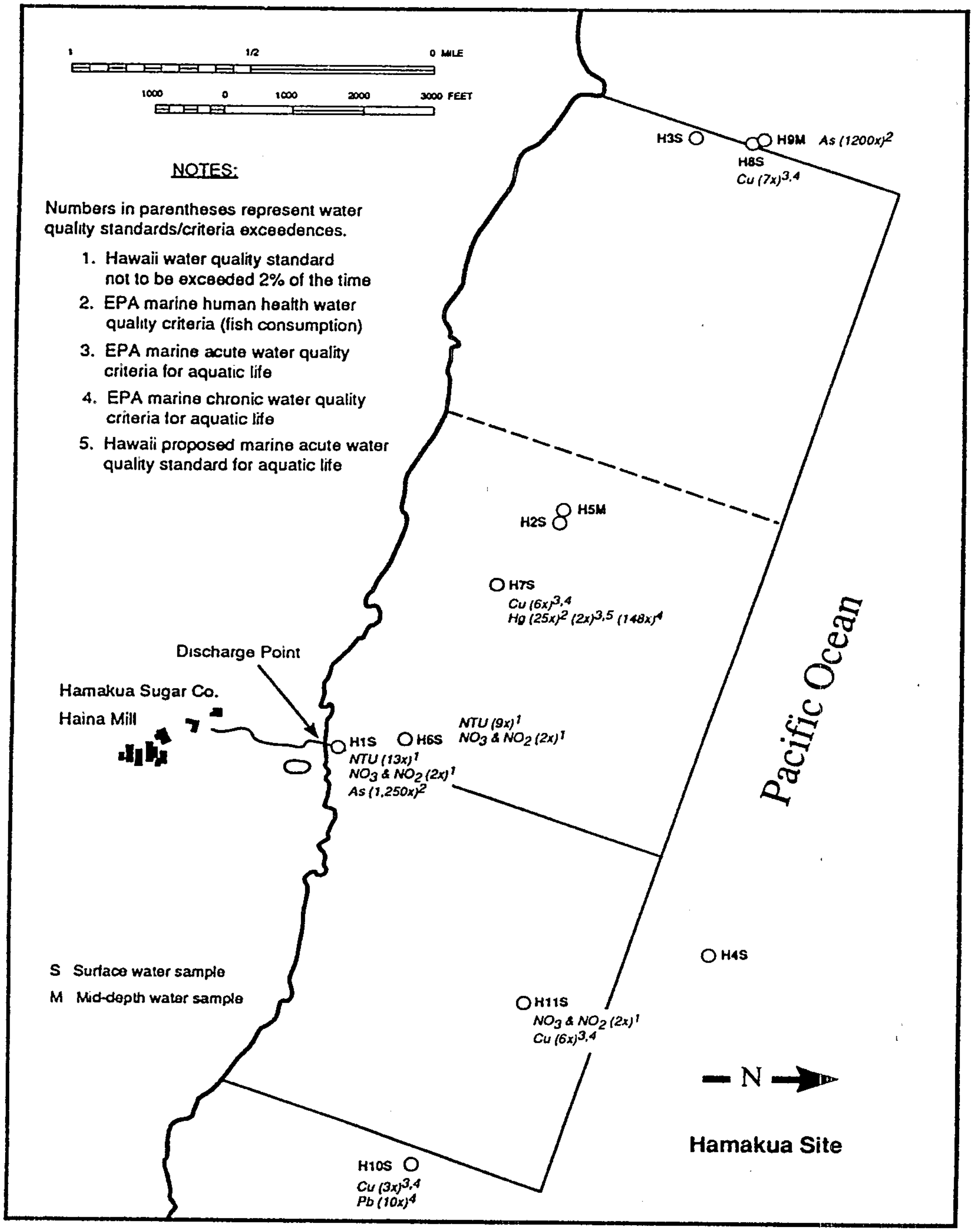


FIGURE 2-17
LOCATIONS OF EXCEEDENCES OF WATER QUALITY STANDARDS OR CRITERIA NEAR HSC DISCHARGE SITE

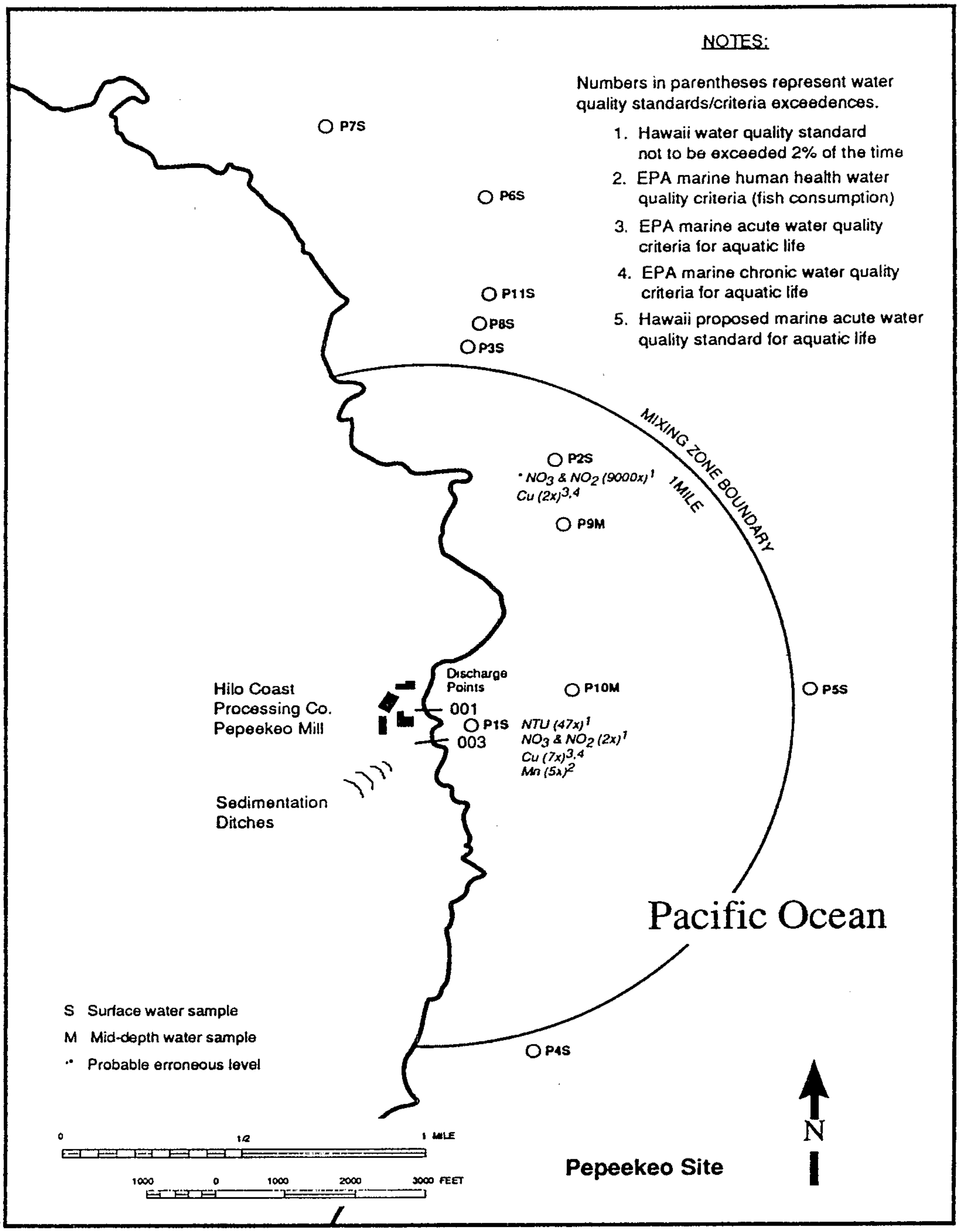


FIGURE 2-18
LOCATIONS OF EXCEEDENCES OF WATER QUALITY STANDARDS OR CRITERIA NEAR HCPC DISCHARGE SITE

beyond the mixing zone. However, single sample analytical results preclude determination of compliance with the 20 ug/l Hawaii standard (based on geometric means). Because detection limits for ammonia nitrogen, total phosphorus, and NO_2+NO_3 were higher than one or more of the Hawaii standards, potential exceedances of these criteria at stations other than cited above cannot be excluded. Samples were not analyzed for total nitrogen or chlorophyll a.

EPA aquatic life acute and chronic water quality criteria and human health water quality criteria (fish consumption) were not exceeded at any stations beyond the mixing zone. Within the mixing zone, however, criteria for copper and manganese were exceeded. Directly off the discharge point, copper in a surface water sample was seven times the acute and chronic marine criteria (2.9 ug/l), and manganese was five times the human health criterion for fish consumption (100 ug/l). Copper also occurred at two times the marine acute and chronic criteria in a surface sample at 0.75 miles north of the discharge. For arsenic, beryllium, copper, (at other than the above stations) lead, mercury, nickel, and silver, compliance can not be determined because detection limits were above respective EPA criteria. All herbicide concentrations were below detection limits, and below the lowest reported toxicity values used in the absence of EPA criteria to project water quality impacts.(19) Therefore, there are no potential impacts from herbicides.

2.1.4.5 Waipio-Waimanu Area. There were no exceedances of the Hawaii marine water quality standards in the surface and mid-depth samples collected in the remote area between the Waipio Valley and the Waimanu Valley (Figure 2-19). Detection limits for ammonia nitrogen and NO_2+NO_3 were numerically higher than their respective 10 percent nonexceedance criteria. This fact, and the lack of multiple samples, preclude a definitive statement regarding compliance on these two parameters. Lead in a surface water sample was the only metal exceeding the EPA criterion (73 ug/l compared to 5.6 ug/l chronic). As indicated above, high detection limits prevent a compliance determination for several other metals. Herbicide results are all below detection limits, which in turn were less than the lowest reported toxicity values.(19) Again, there are no potential impacts.

2.1.4.6 Kolekole Stream Discharge Area. The Hawaii water quality criteria for NO_2+NO_3 were exceeded near the mouth of Kolekole Stream at one mid-depth station (40 ug/l measured versus a maximum criterion of 25 ug/l 98 percent of the time) (Figure 2-20). A total phosphorus value of 20 ug/l was recorded for one surface sample. However, a single sample precludes a determination of compliance with the 20 ug/l maximum geometric mean value. The only metal to exceed the criterion was copper in a surface sample off the stream mouth, registering 8 ug/l compared to the 2.9 ug/l marine acute and chronic criteria. As indicated above, the high detection limits on seven metals preclude a conclusive statement regarding compliance with these criteria at any station. All herbicide concentrations were below detection limits, and below the lowest

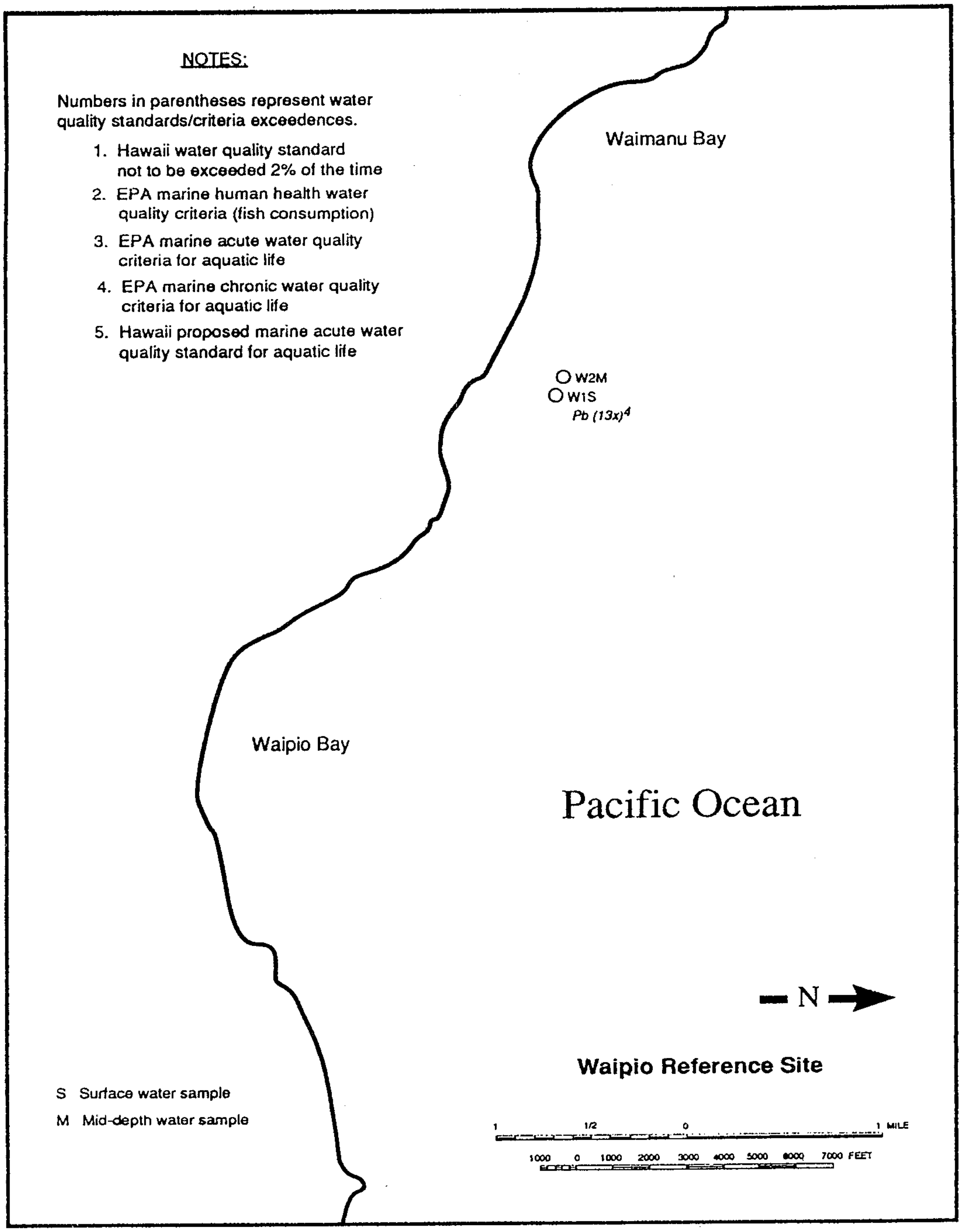


FIGURE 2-19
WATER SAMPLING LOCATIONS IN THE WAIPIO-WAIMANU AREA

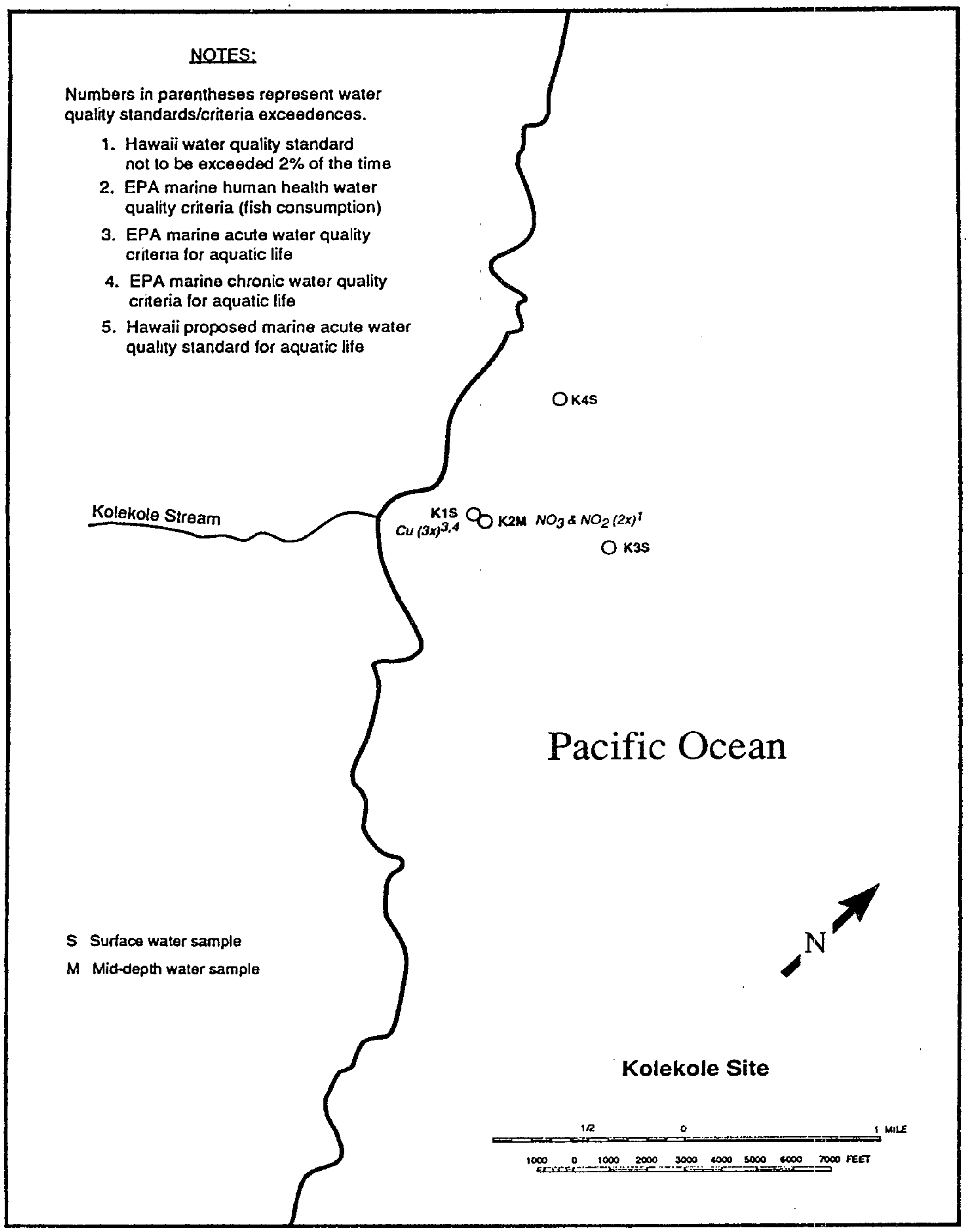


FIGURE 2-20
WATER SAMPLING LOCATIONS AT THE KOLEKOLE STREAM SITE

reported toxicity values used in the absence of EPA criteria to project water quality impacts.(19) Therefore, there are no potential impacts from herbicides.

<u>2.1.4.7 Summary of Water Column Impacts</u>. The major conclusions of the assessment of water column impacts are summarized below.

- Beyond the present Hawaii mixing zone boundaries at HCPC and HSC, no Hawaii water quality standards or EPA water quality criteria violations were detected for the parameters measured.

- Within the mixing zones at both mills, levels of two classical parameters (turbidity and NO_2+NO_3 at both mills) and several metals (copper, mercury, lead, and arsenic at HSC, and copper and manganese at HCPC) were found to be above Hawaii standards and EPA criteria. The exceedances of acute criteria for copper and mercury are of concern because EPA's mixing zone policy is that acute effects (lethality) are not permitted within mixing zones.

- Herbicides were not detected above the lowest reported toxicity values used to project water quality impacts.

- Water column impacts from natural stream discharges were much smaller than impacts from mill discharges. At the Waipio reference site, only one of the measured parameters (lead) at one location was above EPA criteria. At the Kolekole Stream site, only one conventional parameter (NO_2+NO_3) and one metal (copper) were above Hawaii and EPA standards respectively. Both of these latter exceedances were at the same sample station near the mouth of Kolekole Stream.

2.1.5 Discharge Area Bathymetry

Bathymetric contours were constructed to evaluate deposition of sediment off the mill discharge points. Bathymetry information was also compared to fathometer records reported by Grigg.(16) Although contours were developed for the HSC and HCPC sites (Figure 2-21 and 2-22), insufficient data prevented contouring for the Kolekole Stream site or for the Waipio-Waimanu area.

At HCPC, the profiles off the discharge point and at 1.0 mile to the north are very similar, and indicate a much more shallow contour in the onshore-offshore direction than at 1 mile south. In view of the upcoast trend in bottom impacts and the usual upcoast direction of the plume, the profiles appear to verify sediment accumulation in this direction. Immediately offshore of the Kolekole Stream mouth, the bathymetry is very similar to that near the discharge (one mile to the north). However, in deeper waters (over 100 ft) farther from shore (3,000 ft), the profile is shallower. At HSC, a progressive deepening of the profiles occurs going along the coast from one mile southeast of the discharge to 2 miles northwest of the discharge.

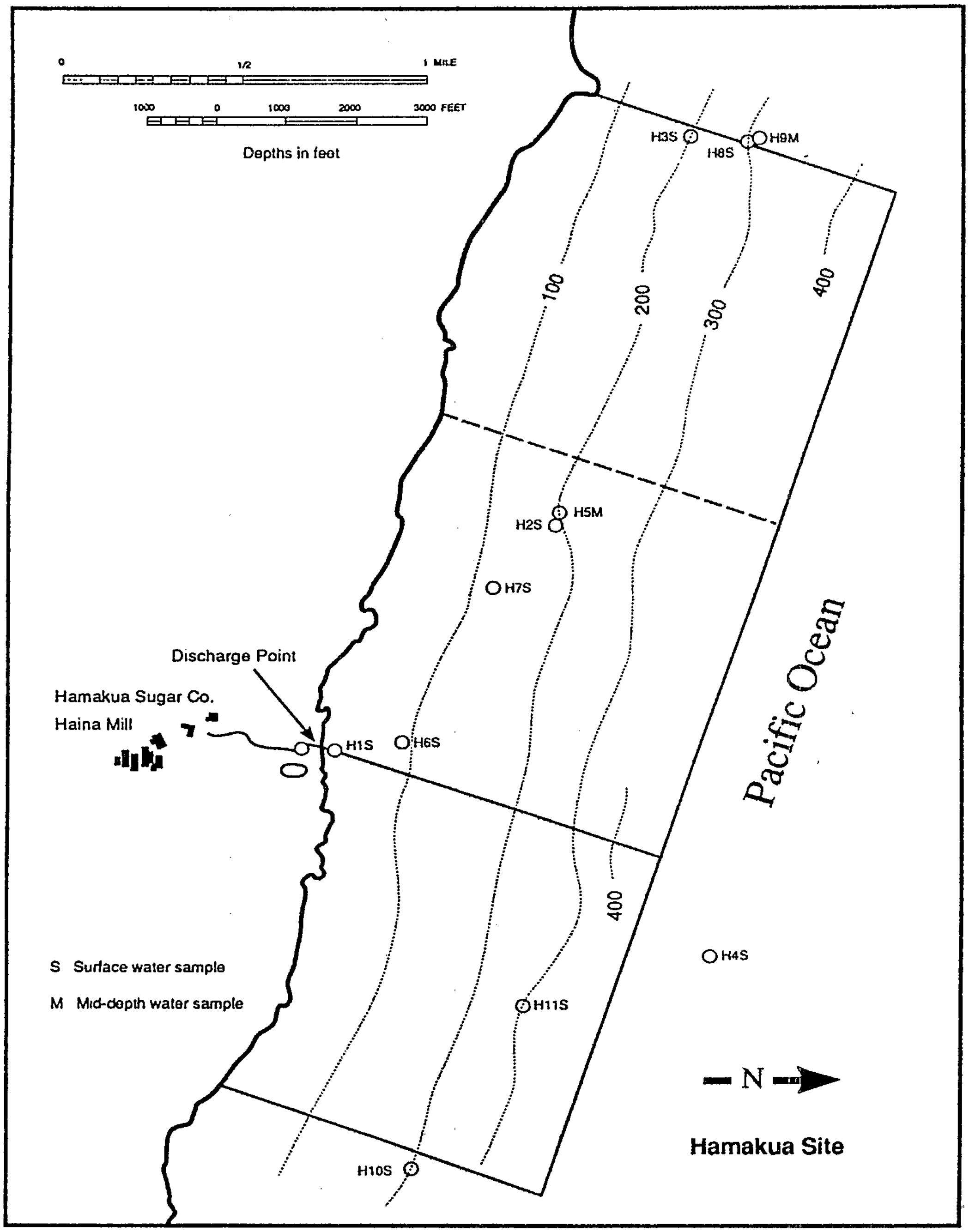


FIGURE 2-21
BATHYMETRY AT THE HSC DISCHARGE SITE

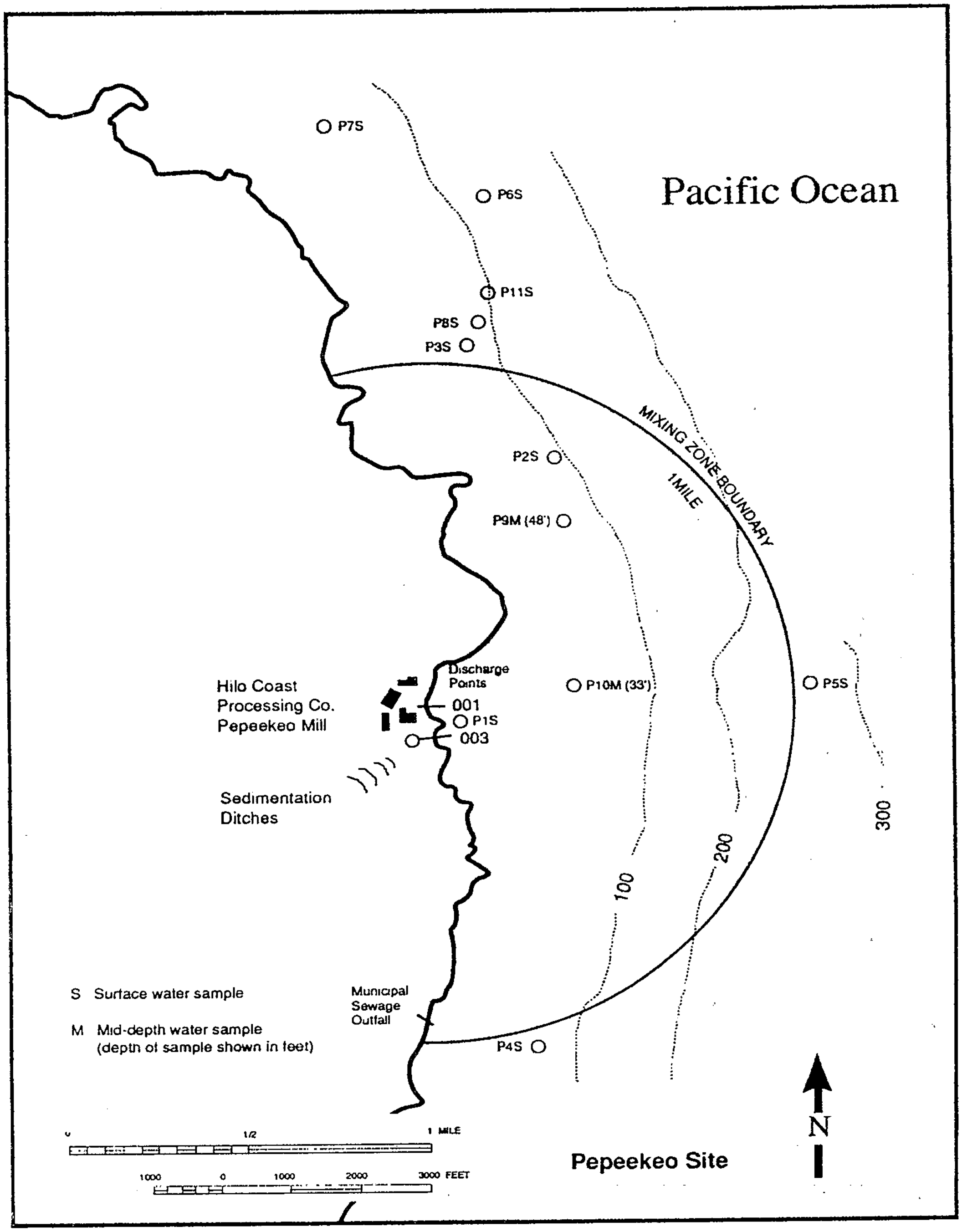


FIGURE 2-22
BATHYMETRY AT THE HCPC DISCHARGE SITE

2.1.6 Mill Discharges During Field Observation and Sample Collection Period

To judge whether observations of receiving water turbidity and plume extent made during the period of the field program were representative of typical discharge conditions, EPA obtained production and waste discharge data from the mills and analyzed wastewater composite samples collected by mill personnel at each facility. Table 2-3 summarizes the analytical results for the mill wastewater samples. Tables 2-4 and 2-5 compare the discharge of suspended solids during the study period with 1988 averages for HSC and HCPC, respectively.

Review of the data in Table 2-4 indicates that processing levels at HSC averaged 15.4 million pounds of gross cane per day from February 7 through 18, a level 2.1 million pounds above the average for February 1988. Flows during the 12-day period averaged 11.6 mgd, or about 10 percent above the February 1988 average. It is notable, however, that on the second day of ocean sampling (February 15), the mill processed only 7.8 million pounds of gross cane. Discharge flows were intermittent on the 14th and 15th, and data to estimate a daily total flow were not available.

Plant records indicate significant periods of plant shutdown on February 14 and 15. The mill experienced intermittent shutdowns from approximately midnight on February 13, up until the ocean sampling began at 10:30 a.m. on February 14. At 11:30 a.m., the mill shut down completely, remaining nonoperational until 5:45 p.m., about 25 minutes after completion of ocean sampling for the day. The mill again shut down at 9:30 p.m. on February 14 and remained down until 10:15 a.m. on February 15. Thereafter, the mill operated for approximately 5 hours, with the exception of a thirty minute period near mid-day on the 15th. Ocean sampling commenced at 2:30 p.m. and continued until 7:30 p.m. The mill shut down at 3:00 p.m. and remained down until 7:45 p.m., about 15 minutes after completion of field sampling. Thereafter, operation was more or less continuous for the next 7 hours.

The level of TSS in the effluent sample for February 14 was 2,180 mg/l. This is much higher than the average discharge level from the mill, whose records indicate effluent TSS concentrations exceeded 1,000 mg/l only five times, and 2,000 mg/l (2,460 mg/l) only once during the three-year period of 1986, 1987, and 1988.

In summary, plant operating records indicate that, during a large portion of the field sampling period, the Hamakua mill was not operating. Since there is no significant lag period between discharge to the plant and to the ocean (compared to the multiple-hour lag at Pepeekeo due to the settling channels), it appears that the plume and resultant water quality conditions during this period were atypical, requiring qualification of any findings based on water column data collected during this period. Figure 2-23 shows the plume during the survey, and Figure 1-6 shows the plume during a preparatory visit in December 1988 when operations were more typical.

TABLE 2-3

RESULTS OF EFFLUENT SAMPLE ANALYSIS

Pollutant or Pollutant Characteristic	Units	Hamakua Sugar Company	Hilo Coast Processing Company
Classical Pollutants			
Biochemical Oxygen Demand	mg/l	520	2,970
Total Suspended Solids	mg/l	2,180	2,200
Fecal Coliform Bacteria	MPN/100 ml	1,600	170
Chemical Oxygen Demand	mg/l	950	3,300
Total Organic Carbon	mg/l	260	771
Total Kjeldahl Nitrogen	mg/l	7.0	49
Ammonia Nitrogen (as N)	mg/l	0.01U	0.21
Nitrate + Nitrite Nitrogen	mg/l	0.05	0.06
Total Phosphorus	mg/l	0.28	0.10
Ortho-Phosphate	mg/l	0.01U	0.01U
Hexavalent Chromium	mg/l	0.04U	0.04U
Turbidity	NTU	450-925	no data
Elements			
Antimony	ug/l	4.0U	4.0U
Arsenic	ug/l	8.6	12.9
Beryllium	ug/l	1.0U	2.0U
Cadmium	ug/l	19.0	76.0
Chromium(tot.)	ug/l	302	1,560
Copper	ug/l	150	219
Lead	ug/l	65.0	115
Mercury	ug/l	0.50	1.00U
Nickel	ug/l	37.0	148
Selenium	ug/l	3.9	30.0U
Silver	ug/l	7.0	7.0U
Thallium	ug/l	2.8	2.0U
Zinc	ug/l	150	287
Aluminum	ug/l	118,000	239,000
Barium	ug/l	100	71.0
Boron	ug/l	101	104
Calcium	ug/l	13,000	28,300
Cobalt	ug/l	42.0	201
Iron	ug/l	162,000	478,000
Magnesium	ug/l	8,560	26,400
Manganese	ug/l	2,220	8,490
Molybdenum	ug/l	10.0U	10.0U
Sodium	ug/l	6,790	54,800
Tin	ug/l	30.0U	69.0
Titanium	ug/l	21,200	53,200
Vanadium	ug/l	393	1,310
Yttrium	ug/l	42.0	45.0
Iodine*	ug/l	6,200	6,800

TABLE 2-3
(continued)

Pollutant or Pollutant Characteristic	Units	Hamakua Sugar Company	Hilo Coast Processing Company
Elements (continued)			
Osmium*	ug/l	ND	700
Phosphorus*	ug/l	6,800	7,700
Potassium*	ug/l	2,100	5,800
Silicon*	ug/l	22,900	21,400
Strontium*	ug/l	100	400
Sulfur*	ug/l	12,400	15,600
Zirconium*	ug/l	ND	200
Pesticides			
Diuron	ug/l	<100U	25J
2,4-D	ug/l	<25U	1J
Picloram	ug/l	<25U	<25U
Atrazine	ug/l	<2.00	<2.00
Ametryn	ug/l	<2.00	<2.00
Dalapon	ug/l	<10	<10
Benomyl	ug/l	<10	<10
Glyphosate	ug/l	<10	<10

* - Results of semiquantitative screening analysis.

U - Undetected at the detection limit. Value given is detection limit. Detection limits may vary between samples due to sample size limitations and/or matrix problems.

J - Quantitation below range of curve.

ND - Not detected.

TABLE 2-4

HAMAKUA SUGAR COMPANY WASTEWATER FLOWS AND MASS EMISSION RATES

	Gross Cane Harvested (10^6 lb/day)	Flow Rate (MGD)	Total Suspended Solids (mg/l)	Approx. Mass Loading (lb/day)
1988 Data*				
January	16.0	10.4	276	23,909
February	13.3	10.4	223	19,357
March	12.3	10.4	253	21,965
April	N/O	N/O	N/O	N/O
May	10.8	8.3	400	26,031
June	13.8	10.4	542	46,599
July	14.6	10.2	251	21,358
August	16.6	8.7	237	16,675
September	14.0	9.5	216	17,180
October	15.8	9.1	299	22,680
November	13.2	10.3	301	25,757
December	12.4	8.8	210	19,673
Annual Average	13.9	9.5	286	23,531
February 1989 Data				
2/7	14.6	N/A		
2/8	14.9	12.1		
2/9	10.9	11.7		
2/10	14.5	12.0		
2/11	18.8	10.3		
2/12	18.9	13.0		
2/13	20.2	13.2		
2/14**	12.8	N/A	2,180***	
2/15**	7.8	N/A	2,180***	
2/16	14.1	12.8		
2/17	13.0	13.2		
2/18	17.4	13.4		

* Values are averages of all available data
** Ocean sampling periods: 1030-1720 hours on 2/14/89 and 1430-1930 hours on 2/15/89
*** Reported value is for a single composite collected between approximately 0600 and 1800 hours on 2/14/89 and on 2/15/89
N/A is not available
N/O is not operating

TABLE 2-5

HILO COAST PROCESSING COMPANY WASTEWATER FLOWS AND MASS EMISSION RATES

	Gross Cane Harvested (10^6 lb/day)	Flow Rate at .003 (MGD)	Total Suspended Solids (mg/l)	Approx. Mass Loading (lb/day)
1988 Data*				
January	17.0	4.2	438	15,323
February	15.3	4.1	522	17,647
March	17.3	4.2	1,157	39,222
April	15.0	4.5	565	21,121
May	N/O	N/O	N/O	N/O
June	14.9	3.9	347	11,533
July	16.9	3.9	846	26,880
August	16.9	3.9	1,233	40,638
September	16.6	3.3	535	18,309
October	14.0	3.5	767	22,497
November	11.6	3.4	678	19,951
December	11.3	4.2	545	19,090
Annual Average	15.3	3.9	721	23,152
February 1989 Data				
2/7	12.3	2.7		
2/8	15.8	3.2		
2/9	17.6	3.2		
2/10	16.7	3.2		
2/11	16.3	2.9		
2/12	17.6	3.2		
2/13	16.8	3.1		
2/14	16.4	3.2		
2/15	16.8	4.2		
2/16	19.1	2.9		
2/17**	16.4	2.2	2,200	40,394
2/18**	N/O	0.9		
2/22	17.9	4.2***	2,335***	81,850

* Values are averages of all available data

** Ocean sampling periods: 0900-1800 hours on 2/17/89 and 0900-1200 hours on 2/18/89

*** These values are reportedly higher because the last settling pond (polishing pond) was being cleaned

N/O is not operating

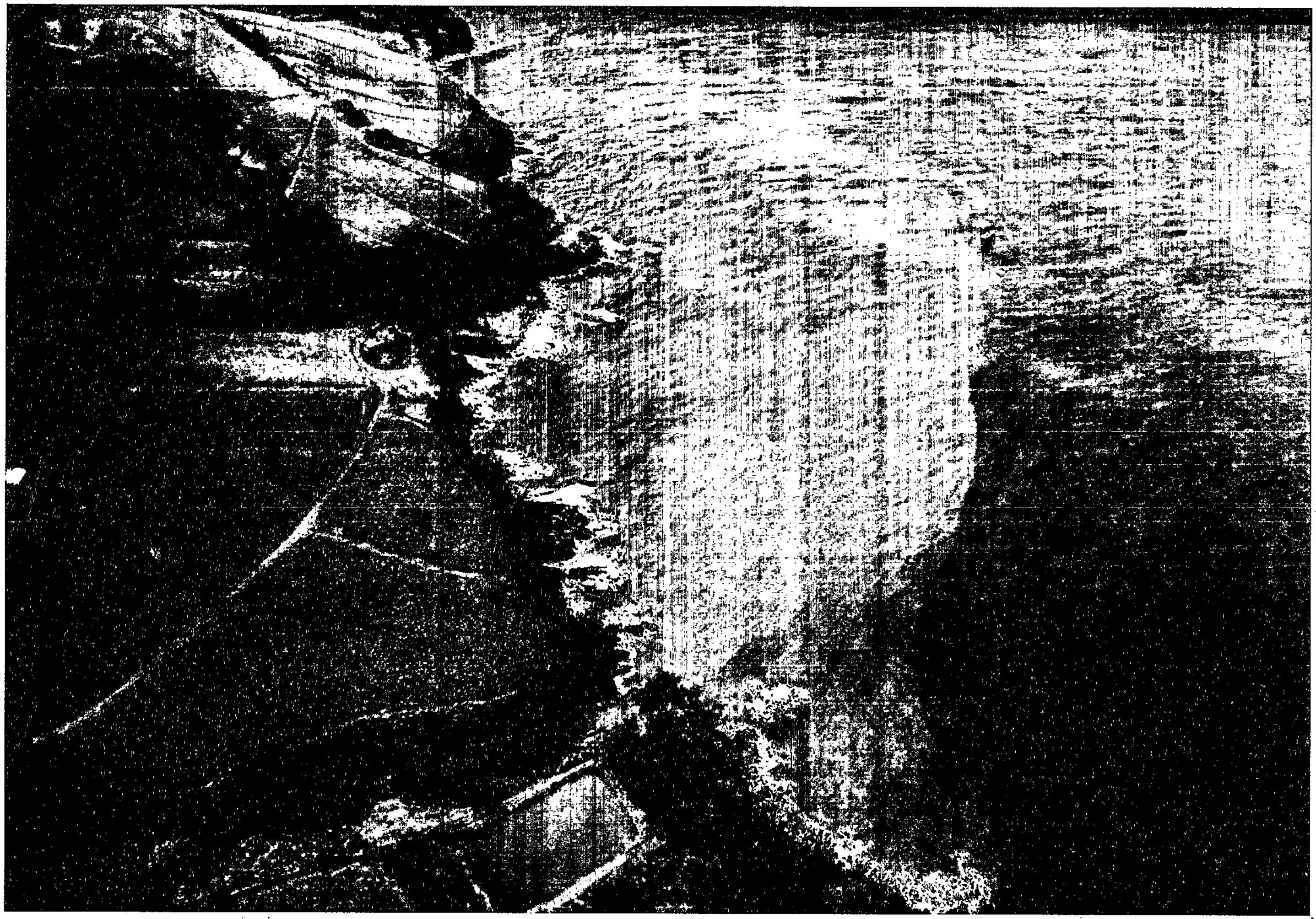


FIGURE 2-23
AERIAL VIEW OF HSC DISCHARGE PLUME DURING FIELD SURVEY

Review of the data in Table 2-5 indicates that processing levels at HCPC averaged 16.6 million pounds of gross cane per day between February 7 and 22 (exclusive of February 18), 1.3 million pounds per day higher than the average processing level in February of 1988, but still less than the averages for five months in 1988. The average processing level for 1988 was 15.3 million pounds per day. Flow from discharge 003, the settling pond effluent, ranged from 2.2 to 4.2 MGD, and averaged 3.2 MGD, (excluding when the plant was shutdown and the reported flow was 0.9 MGD). The prior day, when field sampling commenced, the flow was 2.2 MGD. For the 2,200mg/l, TSS concentration measured on February 17, the corresponding mass emission rate is 40,394 lb/day or 2.5 pounds TSS per 1,000 pounds of gross cane processed. The mass emission on February 22 was 81,850 pounds or 4.6 pounds per 1,000 pounds of gross cane processed.

These data suggest that on the first day of the field survey, February 17, the mass emission rate was approximately double the average rate for the prior year and the average rate for the same month in 1988. Figure 2-24 shows the discharge plume during the survey. Mill records indicate, however, that a discharge in excess of 40,000 pounds per day occurred eight times in 1987, and six times in 1988. Lack of a suspended solids reading for the discharge on the February 18 prevents calculating a mass loading for the second day of the survey. However, the flow is known to have been low at 0.9 MGD. Discussions with the mill Environmental Coordinator indicate that the mill shut down the morning of February 18, with a gradual tapering off of the 003 flow due to drainage of the settling ponds (which apparently takes approximately six hours).(20) For this reason, field sampling ended by noon of that day.

2.1.7 ALTERED DISCHARGE IMPACTS

The following paragraphs address the changes in discharge impacts that might be expected if wastewater treatment was reduced or eliminated at the two mills.

<u>2.1.7.1 Mass Loading Increases</u>. Based on mass balance information submitted by the mills and 1988 processing levels, EPA estimates the total suspended solids discharged to the ocean would increase from approximately 13 tons/day to 656 tons/day at HSC, an increase of about 50 times. (The actual average discharge in 1989 was 11.8 tons per day.) The estimate of 656 tons/day is equal to the estimated current discharge plus the solids removed from the wastewater by the primary clarifiers and one-half the solids removed by the trash and grit separators minus the solids contained in boiler ash. (This estimate is discussed further in Section 5.3 of this report.) At HCPC, mass balance information indicates the increase would be from approximately 7 tons/day to 479 tons/day, an increase of about 70 times. (The actual average discharge in 1988 was 11.8 tons per day, the same as at HSC.) This amount is equal to the estimated current discharge plus the solids removed from the wastewater, minus the solids contained in filter cake and boiler ash. The affected ocean areas would increase as a result of such significant loading increases, however, the extent of the increases cannot be specified without further information on the particle size distribution of the untreated

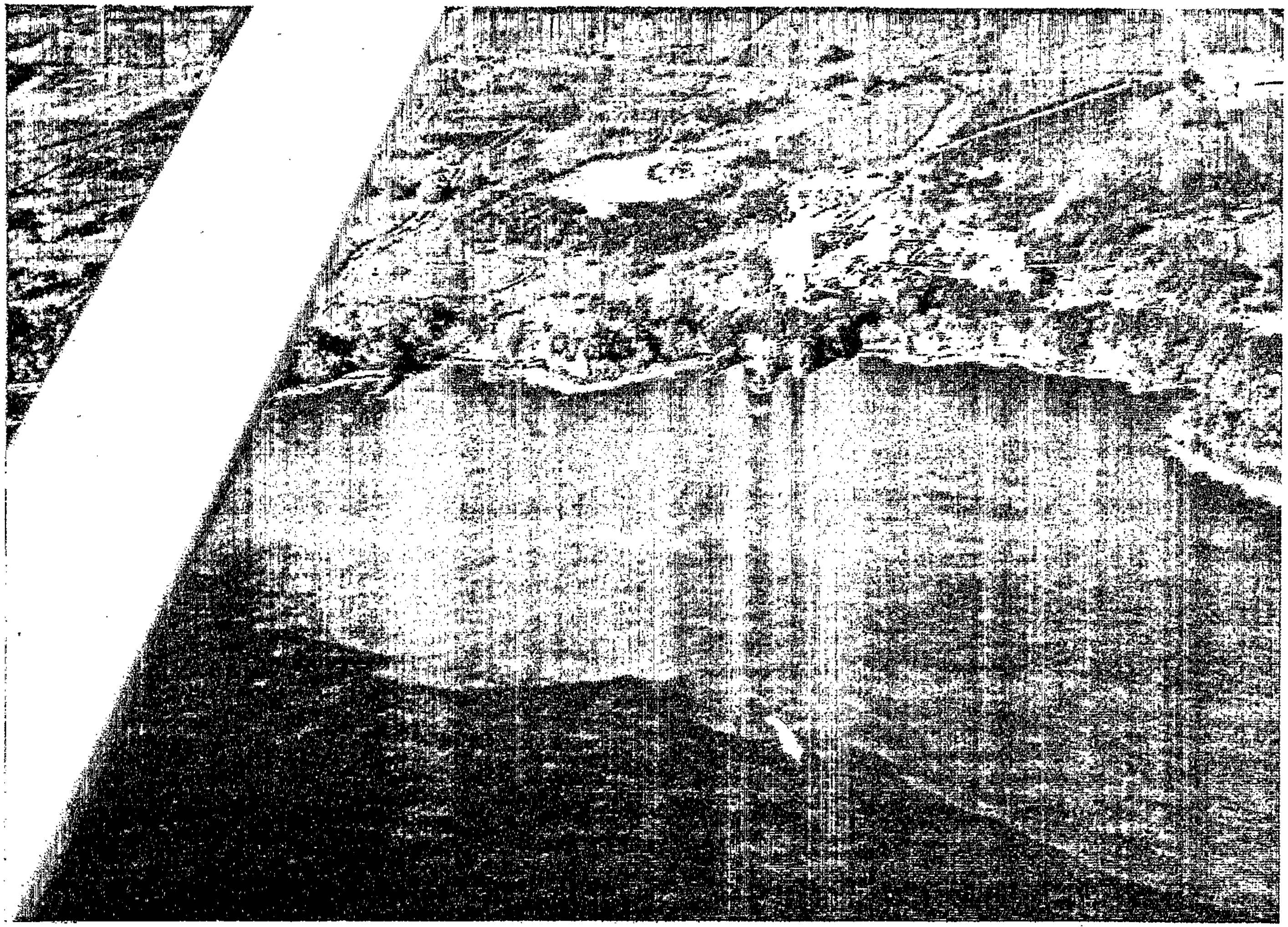


FIGURE 2-24
AERIAL VIEW OF HCPC DISCHARGE PLUME DURING FIELD SURVEY

effluents, the nature of flocculation and settling of particulates in an ocean environment, and projections regarding resuspension and coastal transport or movement to deeper areas offshore under the influence of the waves and tidal currents.

2.1.7.2 Effluent Characterization. The particle size distribution of the proposed discharges (with no treatment) from the two mills would shift significantly to the more coarse material, since this component would no longer be removed by passage through the settling channels at HCPC, or be removed by the primary clarifiers at HSC. To predict the fate of these particulate fractions requires information on the settling characteristics of the effluent under shear conditions experienced when injected into the dynamic coastal environment (i.e., static water column settling tests are inadequate). To obtain this information requires that typical (untreated) samples be subjected to settling tests in which the saline receiving water is in motion to simulate actual conditions under which flocculation and settling will occur. The settling rates for each particle size class can then be used with computer models to predict the distances traveled before reaching the sea bottom.

2.1.7.3 Particulate Fate Predictions. The fate of particulates in the ocean is a function of the settling characteristics of the material, and the nature of both the seasonal and episodic events that control where the material will settle initially, when it will resuspend, and where it will move over a long period of time. Several models are available to predict where particulates will settle, ranging from a simple screening model (21), to more comprehensive models, like DECAL (22). These models have been used extensively to predict the initial depositional patterns near ocean outfalls from municipal wastewater treatment facilities. In addition, a model has been developed recently to predict the extent of resuspension, transport, and redeposition of material already on the bottom, under the influence of waves and tidal currents.(23) Though devised to define movement of dredged material from coastal disposal sites, the model could be adapted to predict the transport of sugar mill effluent particulates. Although a significant buildup of the coarser sediment would likely occur near the discharge points, this material will ultimately be spread out over a much larger area due to the influence of strong bottom currents generated by the waves and swell along this coastline.

The optimal approach to predicting the extent of a sediment deposition impact zone is to measure the characteristics of the effluent as indicated above, and to define the circulation patterns in the receiving waters. The latter requires that density and currents be known during representative periods in order to construct expected temporal patterns (e.g., annual). If further field measurements cannot be made, then the models can be run for a range of assumed currents (e.g., upcoast, downcoast and offshore) and water column density structures.

2.1.7.4 Zone of Mixing Impacts. The currently permitted mixing zone for HSC covers 3.0 square miles and the one for HCPC 1.6 square miles. These mixing zones are one to three orders of magnitude larger than the mixing zones for seven industrial dischargers (Section 403[c] of the CWA), and four municipal discharges (Section 301[h] of the CWA) all in Hawaii with comparable or substantially larger flows. Table 2-6 compares the mixing zone areas for these discharges.

This study has shown that at HCPC, significant impacts on corals have occurred out to at least 1 mile either side of the discharge point (mixing zone boundary). At HSC, the coral impacts appear to be confined within the two mile upcoast mixing zone boundary (though bleached corals, indicating sub-lethal effects, were evident at this location), and within the one mile downcoast boundary. However, if the mass emission rate is increased as proposed by the mills, the areas of impact are expected to increase.

The determination of how large the increase would be cannot be made with any certainty using the data at hand, which simply document the extent of existing impacts. To project the distances beyond which the long-term deposition rate is below some limit deemed acceptable to local coral will require simulation of particulate fate as described above. Unfortunately, there are no known data sets from other sugar mill or high-sediment discharges to similar receiving environments available to make such a projection at this time.

2.2 NONPOINT SOURCE EFFECTS

In the report Hawaii's Assessment of Nonpoint Source Pollution Water Quality Problems, DOH identifies agricultural activities as Hawaii's most pervasive nonpoint source pollution problem.(24) The nonpoint source environmental effect of greatest concern associated with the activities of HSC and HCPC is soil erosion during the period of time that the fields are open following harvesting. Although the companies replant harvested areas as quickly as possible, several months elapse before plant foliage and roots develop sufficiently to prevent soil erosion during heavy rains. After several months of growth, sugarcane is very effective in preventing soil erosion.

Both the Sierra Club Legal Defense Fund (25) and the U.S. Fish and Wildlife Service (USFW) (26) have expressed concern that soil erosion may have a detrimental effect on the life cycles of native diadromous fish. Four species of goby fishes, a nerited mollusk, and two species of shrimp ascend Hamakua Coast streams to complete growth and reproduce after larval development as marine zooplankton. The shrimp, mollusk, and one of the fishes are the basis of a seasonal recreation and commercial fishery. Another one of the fishes, the o'opu alamo'o (Lentipes concolor) is listed as a category 1 candidate endangered species by USFW under the Endangered Species Act.

The USFW states that this species inhabits a number of Hamakua Coast streams, but is far more abundant in streams draining undisturbed watersheds. USFW believes that non-point source sedimentation from sugarcane fields has reduced the habitat for these species. This impact, combined with the degradation of nearshore water quality and larval habitat by mill wastewaters, is thought by USFW to have a cumulative detrimental impact on the population biology. Although graduate student research has described the life histories and

TABLE 2-6

COMPARISON OF HAWAIIAN MIXING ZONE AREAS

Facility and Permit Number	Plant Flow (MGD)	Mixing Zone Dimensions (ft)	Mixing Zone Area (sq. mi)
Mixing Zones Established for Industrial Facilities pursuant to 403(c)			
Sugar Mill Discharges			
Pepeekeo Mill Hawaii NPDES No. HI000191*	3.9	1 mile radius (semi-circular)	1.57
Hamakua Mill Hawaii NPDES No. HI0000256*	9.0	3 miles x 1 mile	3.0
Other Industrial Discharges			
Navy Public Works Center Oahu NPDES No. HI0110086* (domestic & industrial)	7.5	Irregular shape	0.950 (est.)
Chevron USA, Inc. Oahu NPDES No. HI0000329* (refinery)	4.9	20x2000 (est.)	0.001 (est.)
Gasco, Inc. Oahu NPDES No. HI0000035* (cooling water)	1.44	2,000x200 (est.)	0.011 (est.)
Hawaii Electric Co., Inc. Oahu NPDES No. HI0000027* (cooling & non-toxic waste)	257.125	N/A	N/A
Hawaii Electric Light Co., Inc. Hawaii NPDES No. 0000264* (cooling water)	28.0	220x450 (est.)	0.004 (est.)
Citizens Utilities Co. Kauai NPDES No. HI0000353* (cooling water)	11.0	300 ft radius (seim-circular)	0.005

TABLE 2-6
(continued)

Facility and Permit Number	Plant Flow (MGD)	Mixing Zone Dimensions (ft)	Mixing Zone Area (sq. mi)
Other Industrial Discharges (con't.)			
Hawaiian Electric Co. Oahu NPDES No. HI0000019 (cooling water)	861.0	7,000x7,000	1.757
Hawaiian Electric Co., Inc. Oahu NPDES No. HI0000604* (cooling water)	558.0	N/A	N/A
Maui Electric Company Maui NPDES No. HI0000094* (cooling & industrial)	55.0	3,000x500, plus 1,000 radius (semi-circular) (est.)	0.107 (est.)
Marine Culture Enterprises Hawaii NPDES No. HI0021059 (process water)	33.6	5,500x2,500	0.493
Mixing Zones for POTWs established pursuant to 301(h)			
Kaneohe/Kailua Oahu NPDES No. HI0020150**	14.3	1,960x1,000	0.070
Sand Island Oahu NPDES No. HI0020117*	82.0	4,800x1,500	0.258
Honouliuli WWTP Oahu NPDES No. HI0020877***	25.0	3,700x2,000	0.265
Wailua STP Kauai NPDES No. HI0020257*	1.5	3,000x3,000	0.323

Notes:
* Administratively extended
** Issued
*** Application pending

population biology of the o'opu alamo'o, the research has not focused on the effects of nonpoint source pollution. Thus the specific effects of sugarcane cultivation and processing are not known.

The report Hawaii's Nonpoint Source Water Pollution Management Program identifies 56 Best Management Practices (BMPs) used in Hawaii to control nonpoint source water pollution (27). The list of BMPs includes several that are specific to sugarcane cultivation. These are controlled tillage, crop cover on a field rotation basis, and diversion. Each is described briefly in the following paragraphs.

Controlled Tillage. Controlled tillage is the practice of breaking up the soil only in the row where crops are planted. Interrow areas are left untilled. Because interrow areas are not disturbed, less erosion occurs. The practice also reduces power and operating costs associated with crop production.

Crop Cover in a Rotation Bases. This practice involves planting and harvesting sugarcane in field blocks to avoid long open field areas that would be susceptible to erosion.

Diversions. Diversions are channels constructed across the slope with a supporting ridge or berm on the lower side. This practice is used to divert surface runoff from areas where it is in excess to areas where it can be disposed of in a nonerosive manner.

To help address the problem of excessive soil erosion from all farm land, not just that in Hawaii, Congress set a maximum soil loss target of 5"T" in the 1985 Agriculture Bill.(28) The value T is the soil tolerance and is equivalent to the soil replacement/formation rate. Typical soil tolerances along the Hilo-Hamakua coast are four to five tons per acre per year. The Soil Conservation Service (SCS) considers all the land cultivated by HSC to be highly erodable land and estimates that portions of it could lose as much as 30 tons of soil per acre per year. In contrast, the land harvested by HCPC is less erodable and less soil loss is expected. An important point to remember is that these soil loss values may represent the loss from only a small part of a field where conditions are most conductive to erosion, and that average soil loss for the entire field may be considerably less. In addition, soil washed from steep areas may settle on less steep areas and not directly reach a surface stream, except after resuspension and transport during subsequent rainfall runoff events.

Both HSC and HCPC are working with SCS to construct berms and drainage diversions across cultivated slopes to reduce soil loss. According to SCS, HCPC stands a good chance of meeting 5T per acre by the 1995 target date. SCS indicated that HSC may have difficulty in meeting the 5T target in spite of considerable on-going effort.

If HSC and HCPC were to stop processing sugarcane, the biennial harvesting of cane and opening of the land would stop, as would associated erosion. Some of the land might be converted to macadamia nut orchards and other agricultural use; however, most would likely lie fallow. Once a new ground cover (weeds, grasses, volunteer sugarcane) becomes established, erosion would be reduced. This could be a two-edged sword, however, since the new ground cover might not be as effective as sugarcane at soil retention.

2.3 NONWATER QUALITY ENVIRONMENTAL EFFECTS

2.3.1 Air Quality

Both HSC and HCPC have entered into long-term contracts to sell excess electricity to HELCO. The arrangement is mutually beneficial, in that it provides economic benefits to the mills and electricity to HELCO which needs additional capacity to accommodate island growth. If either or both mills stopped processing sugarcane, their source of bagasse would disappear, and oil (HSC and HCPC) or coal (HCPC) would have to be burned to generate the electricity to comply with their contracts with HELCO. This would lead to increased sulfur dioxide (SO_2) emissions. EPA estimates that fuel oil consumption would increase 2.7 times above projected 1989 levels at HSC. Sulfur dioxide emissions would also increase 2.7 times from approximately 350 tons per year to 950 tons per year. At HCPC, EPA estimates oil consumption would increase to 2.1 times the 1988 levels. Sulfur dioxide levels would increase from approximately 780 tons per year to 1,620 tons per year. If HCPC used coal similar to that used in the past, SO_2 emissions would decrease from 780 tons per year to 670 tons per year.

Particulate emissions now attributable to burning bagasse would be substantially reduced, if the mills switched to fuel oil. Switching to coal would result in particulate emission levels similar to those from burning bagasse. Section 4.0 of this report provides additional information on fuel and energy consumption at the mills.

The increase in SO_2 emissions from increased fuel oil use would potentially lead to air quality degradation in the immediate downwind areas of the mills. However, the projected emission levels from the mills would be only about 0.3 to 0.5 percent of the discharge from Kilauea. Since the summer 1986, the volcano has discharged an estimated 1,500 to 2,200 tons per day of SO_2 from locations near its summit and along the East rift. These SO_2 emissions are 200-300 times the projected increases in SO_2 emissions from the mills.(29)

Cessation of preharvest burning would decrease the particulate emissions associated with sugarcane culture.

The Hawaii Department of Health did not have any reports that compared current emission levels and impacts associated with exclusive fossil fuel use.

2.3.2 Solids Disposal

The major solid waste streams from the mills requiring disposal are 1) soil and rock transported with the cane, and 2) leafy trash transported with the cane. Bagasse, the fibrous residue remaining after juice is extracted from sugarcane, was once considered a waste material and discharged with soil-laden wastewaters to the Pacific Ocean. Bagasse is now considered a valuable fuel for steam and electricity generation. HCPC tries to process all leafy trash to produce additional bagasse for use as fuel, and HSC is planning to implement this procedure. Mass balance information indicates that in 1988 HSC disposed of 2,013 dry tons per day of soil, rock, leafy trash, and bagasse, while HCPC disposed of 1,208 dry tons per day. At HSC about 670 tons per day of bagasse were burned, and 13 tons per day of soil and other solids were discharged to the ocean, leaving 1,330 tons per day of solids, primarily soil and rock, for land disposal. At HCPC about 580 tons per day of bagasse were burned and 7 tons of soil and other solids were discharged, leaving 621 tons per day of soil and rock for land disposal.

HSC disposes of rock, grit, and leafy trash in company landfills, and spreads recovered soil on fallow fields. HCPC also disposes of rock and soil at a company landfill. Because HCPC attempts to mill all leafy trash and subsequently burn it, HCPC does not dispose of much leafy trash.

Because these solid waste streams are disposed of on mill land, they do not impact local or community solid waste disposal facilities. Thus, no impact on local or community facilities is anticipated if the mills closed. However, improper disposal practices could contribute to nonpoint source pollution.

2.3.3 Land Use

HSC and HCPC together cultivate over 51,000 acres of sugarcane along the Hilo-Hamakua coast (see Figure 1-3). This is the predominant land use along the Hilo-Hamakua coast. Other uses include macadamia nut orchards and residential/community use. No major towns exist between Hilo and Hamakua, and no other major industrial/commerical activities occur. Largely because of its current dedication to sugarcane, frequent rainfall, steep coastal cliffs, and lack of beaches, this area has not experienced resort development similar to that on the west side of the island and on other islands in the archipelago. The State of Hawaii has been supportive of maintaining this land-based economy and agricultural life style, and the Hilo-Hamakua coast has been zoned for agricultural use.

Over time, alternative crops may replace sugarcane on some acreage along the Hilo-Hamakua coast, if HSC and HCPC stop processing sugarcane. However, it is unlikely that other crops would be grown on the large number of acres currently devoted to cane production.

Several thousand acres are already devoted to macadamia nut orchards; however, the seven year lag between planting and initial harvesting, and the developmental nature of the macadamia nut market, make it likely that increases in macadamia nut production will evolve slowly.

For Hilo-Hamakua coast land to remain in agriculture, producers must also overcome numerous marketing problems. Even if crops were found that could be grown successfully on all of the sugarcane acreage, producers would probably have difficulty marketing these crops. Alternative crops would have to be suitable for export, would have to be relatively inexpensive to transport overseas, and would have to command a high enough price to offset Hawaii's higher production and marketing costs.(30)

In the past, when Hawaiian sugar mills have closed, other types of agricultural operations have been unsuccessful at replacing sugarcane. Eventually, large portions of the cane land have returned to scrub and brush. Some studies have suggested that most of the land in Hawaii that is currently in cane production would not remain in agricultural uses if sugar were no longer produced.(31)

In return for reduced taxes, both HSC and HCPC have agreed to keep cane land in agricultural uses through 1994. Even if no such agreement existed, it is unlikely that significant portions of this acreage would be developed in the near future, since the climate and topography make most parts of the Hilo-Hamakua coast undesirable for either tourism or residential development. It would be difficult to attract tourists to this area because of its excessive rainfall and rocky coast. Tourists may visit the Hilo-Hamakua coast briefly, but prefer to stay on the other side of the island where the climate is more favorable.

Some residential development may take place, however, after 1994, assuming there are no further legal restrictions on land use. If any development were to take place, it would most likely occur close to the city of Hilo, a local population center, or perhaps in Hamakua, since this area receives somewhat less rainfall than other parts of the coast, and is closer to the tourist industry on the western side of the island.

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3.0 PUBLIC HEALTH EFFECTS

This chapter discusses the potential public health effects associated with the Hawaiian cane sugar industry. The discussion is limited to the potential effects on the general public and does not include any determination of the potential effects on workers employed in the industry. The potential for public health effects is based on the estimated population of the study area, pollutants, and likely routes of exposure. Exposure routes considered include recreational contact, fish consumption, drinking water exposure, and exposure resulting from sugarcane pesticide applications and preharvest burning.

The study area of concern is the sugarcane producing Hilo-Hamakua coast on the island of Hawaii. The Hilo-Hamakua coast is currently zoned for agricultural use. There are no indications that this classification will change in the near future, according to discussions with individuals in the Office of State Planning, and Hawaii County Planning Department.(1)(2) The coastal population of this area was estimated from records available from the Hawaii County Department of Water Supply. The County Department of Water Supply serves an estimated population of 17,000 people on the Hilo-Hamakua coast (nearly the entire population) and 25,000 people in the city of Hilo. These estimates were based on the number of households served by the water department and an estimated three people/household.(3) Because there are no plans to change the land use classification in the area, the population is expected to be fairly stable with slight increases projected in the western portion.

3.1 POTENTIAL HEALTH EFFECTS ASSOCIATED WITH CONTACT RECREATION

The Hilo-Hamakua coast area is characterized by steep, rocky cliffs that limit the accessibility of the area for recreational activities. Figure 3-1 shows the location of public beaches along the Hilo-Hamakua coast. One public beach, Honolii Beach, is located approximately 6 miles south of HCPC and is easily accessible to the public.(4) According to Hawaii's Visitors' Bureau, surfers from Hilo (approximately 50 people on a good day) use this beach.

According to DOH, Honolii Stream near Honolii Beach is a popular area for picnicking and for limited fishing and swimming. Other streams along the coast are more isolated and remote, and are used mainly by the local residents for limited fishing and swimming.(5)

Two other beaches, Waipio Valley Beach and Laupahoehoe, are also on the Hilo-Hamakua coast. However, these areas have limited access. The Waipio Beach is accessible only by four-wheel drive vehicles. Both beaches are used primarily for swimming.(4)

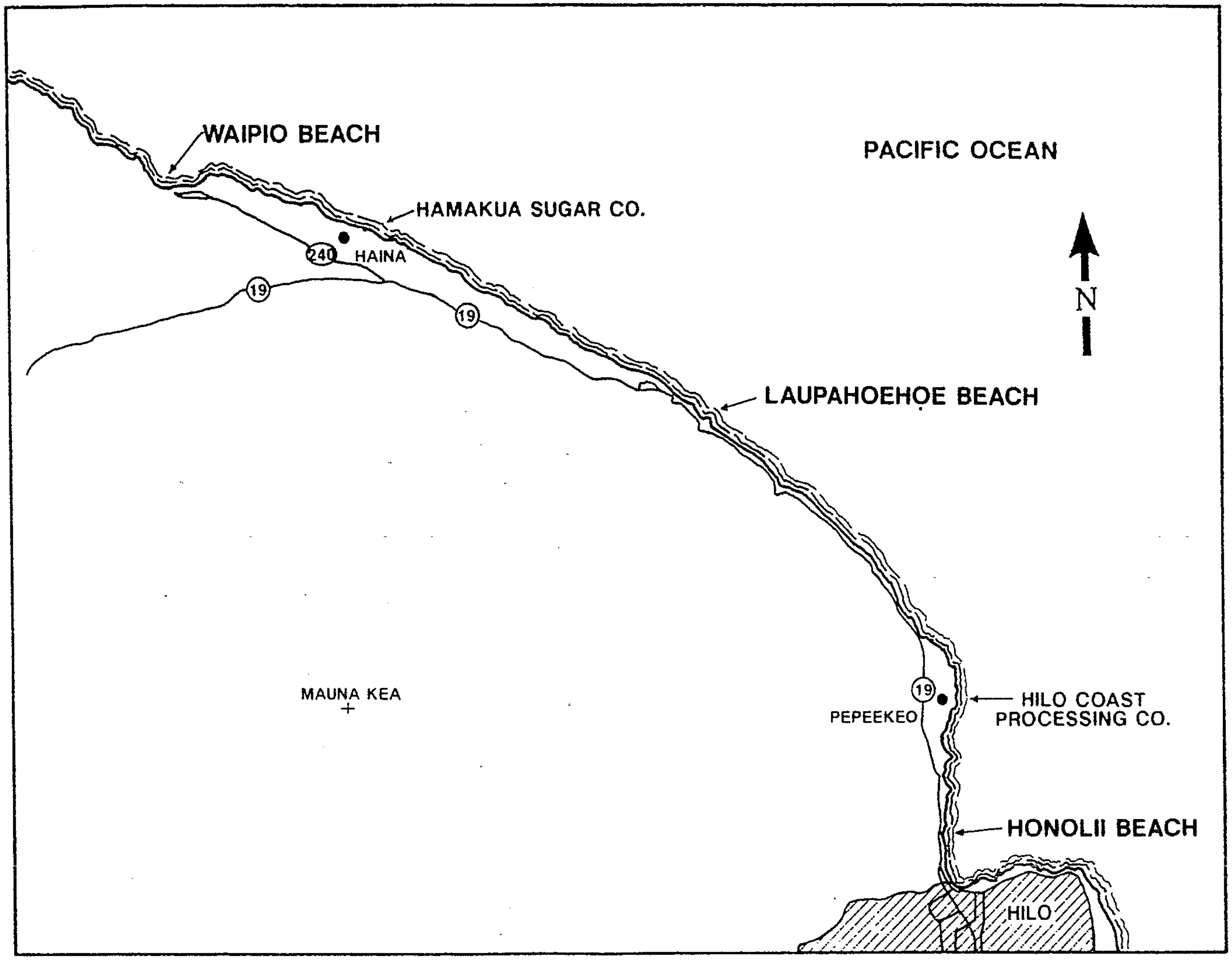

FIGURE 3-1
PUBLIC BEACHES ALONG THE HILO-HAMAKUA COAST

A seasonally occurring contact dermatitis known as "swimmer's itch" occurs at Honolii Beach. However, the same swimmer's itch also occurs at other beaches not associated with the cane sugar industry on the island of Hawaii and on other islands. Although swimmer's itch is not fully understood, it seems to be linked to excessive nutrients and changes in salinity which increase algae growth. Direct contact with certain types of algae produce the dermatitis.(5)

Swimmer's itch has also been linked to contact with the larval stage of parasitic worms (i.e., schistosomes). The intermediate hosts for these parasites are fresh or salt water mollusks (e.g., snails). It is possible that the discharges from the mills may influence the growth of these mollusks because of the high nutrient levels; however, there is no evidence to indicate the presence of parasites in mollusks in the waters in the discharge area. While it is possible that the sugarcane industry may be responsible for increases in nutrients in the water at this beach, DOH believes it is more plausible that naturally occurring stream discharges (laden with nutrients) are responsible.(5) Thus, based on available information, there does not appear to be any significant health effects associated with recreational activity in the waters near the two cane sugar mills.

3.2 POTENTIAL HEALTH EFFECTS FROM RECREATIONAL FISHING

3.2.1 Water Quality Concerns

No information is currently available to estimate the number of fishermen in the area, the frequency of fishing, or the catch size. Individuals in the Hawaii Department of Land and Natural Resources, Division of Aquatic Resources, have reported that there is limited commercial and recreational fishing along the Hilo-Hamakua coast.(6)(7) They added that many fish and many fishermen stay out of the discharge area because of the high turbidity of the water.

One sampling point in the EPA National Bioaccumulation Study(8) is located near the mouth of Honolii Stream. No dioxins were detected in fish tissue samples from this location. Most of the other compounds analyzed for were not detected. Several compounds were detected at very low levels at or near the detection limit; however, none of the levels exceeded FDA Action/Tolerance Levels.(9)

No information was found regarding the occurrence of any contamination of fish in the area. According to the National Marine Fisheries Service (NMFS), no public health advisories, fish bans, or warnings on fish consumption have been issued for the northeast coast of Hawaii between Hilo Bay and the Kohala Forest Reserve.(10) A spokesman for NMFS said that some recreational fishermen fish the areas off the discharge points, which are attractive to certain fish species, including the moi (a bottom-feeder highly prized by the fishermen). Contacts at the Hawaii Department of Land and Natural Resources, and DOH, were not aware of any restrictions on fish consumption along the Hilo-Hamakua coast.(6,11)

The Section 305(b) Report on Water Quality provides information on results of monitoring studies in Hilo Bay (which is outside the area of influence of the HSC and HCPC discharges). This report shows that pesticides and metals have been detected in sediments and that pesticides have been found in fish. However, the levels are below the EPA allowable limits and are not thought to pose significant health risks.(12)

The results of EPA's Study sampling program (discussed in Section 2.1 of this report) showed that there was a potential for health effects resulting from fish consumption. EPA human health (fish consumption) criteria were exceeded at three and one surface water sampling stations, near the HSC and HCPC mills, respectively. Near the HSC mill, the criteria for arsenic and mercury were exceeded; near the HCPC mill, the criterion for manganese was exceeded. Since fishing occurs in the discharge area and zone of mixing, there is some level of public health concern for individuals consuming fish from these areas.

An additional potential public health concern exists based on data collected from sites other than the sampling stations mentioned above for arsenic and mercury, and at all sampling stations for beryllium, at both mills. The detection limits for these pollutants exceeded the EPA human health (fish consumption) criteria; thus the potential for exceedances could not be determined from the available data.

3.2.2 Ciguatera Poisoning

Several deaths have resulted in Hawaii from eating the viscera of fish contaminated with ciguatera toxin. The toxin(s) is produced by a microscopic marine organism, a dinoflagellate called Gambierdiscus toxicus, which grows on the surface of marine algae. Herbivorous fish eat the algae and bioaccumulate the toxin. Fish further up the food chain concentrate the toxin further and become toxic. The toxin is concentrated up to 100 times in the fish viscera (i.e., roe, liver, entrails).

The symptoms of ciguatera poisoning include general weakness, diarrhea, muscle pain, reversal of temperature sensation, nausea, and vomiting. These symptoms vary greatly among individuals, usually occur within 3 to 5 hours, and may last for weeks or months. The fish seem to be unaffected by ciguatoxin(13).

Ciguatera poisoning is thought to have been unknown to early Hawaiian fishermen.(13) Until recently most cases involved fish from other areas of the Pacific, such as Johnson or Midway Island. Today in Hawaii, ciguatera poisoning, although not a well-understood natural occurrence, is a serious problem for recreational fishermen and the fishing industry. Many highly esteemed fish species (e.g., jack, amber jack, surgeoa fish, wrasse, and other reef fish) have been responsible for cases of ciguatera poisoning. While, none of the cases have been reported on the Hilo-Hamakua coast, the potential for their occurence does exist.(14)

3.3 POTENTIAL PESTICIDE EXPOSURE ROUTES

The general public can be exposed to pesticides by the inhalation route during aerial applications of herbicides and growth regulators (i.e., ripening agents), and during preharvest burning of cane fields. In addition, potential exists for exposure due to ingestion of contaminated drinking water.

3.3.1 Pesticides Used by HSC and HCPC

The pesticides used by HSC and HCPC during 1987 and 1988 are listed in Table 3-1. The majority of the pesticides (70 percent) are herbicides; growth regulators account for 10 percent, fungicides account for 10 percent, and the remaining 10 percent are rodenticides.

Diuron, dalapon, atrazine, and 2,4-D accounted for 95 percent of the total amount of pesticides used by HCPC in 1988; and diuron, atrazine, dalapon, and ametryn accounted for over 90 percent of the total used by HSC in 1987.

These herbicides are applied by aerial or ground application for the first four to eight months of cane growth (three applications) or until the cane dominates the weeds.(16) In 1988, dalapon was withdrawn from the market by the manufacturer. Restrictions on the use of atrazine are also being considered by its manufacturers, EPA, and DOH.(15)

Two growth regulators (glyphosate and ethephon) are used as ripening agents prior to harvest. The growth regulators are applied by aerial application.(16)

3.3.2 Application Procedures

Both herbicides and growth regulators are applied by aerial application. Herbicides are also applied by ground methods. Spray drift from aerial application of pesticides is confined for the most part to the cane fields. However, there is a slight potential for spray drift reaching a residential location.(17) No problems or complaints associated with aerial application of pesticides on sugarcane are on file with the Hawaii Department of Agriculture which is the lead agency for pesticide-related problems and complaints in Hawaii.(18)

TABLE 3-1

PESTICIDES USED BY HAMAKUA SUGAR COMPANY AND HILO COAST PROCESSING COMPANY

Herbicides	Growth Regulators	Fungicides	Rodenticides
Ametryn	Glyphosate	Benomyl	Zinc Phosphide
Atrazine	Ethephon	Propiconazole	Warfarin
Diuron			
Dalapon			
2,4-D			
Glyphosate			
Hexazinone			
Asulam			
Terbacil			
Picloram			
Simazine			
Trifluoro-2			
Sulfometuron			
Trifluralin			

3.3.3 Potential Exposure from Drinking Water

Almost all of the residents along the Hilo-Hamakua coast get their drinking water from water districts of the Hawaii County Department of Water Supply.(3) The population served along this coastal zone is approximately 17,000 people. The sources of water serving the area are springs and wells. The Hawaii County Department of Water Supply also serves approximately 25,000 people in Hilo. The water sources for Hilo include five wells, springs, and surface water intakes. The surface water intakes are on the Kahoamato and Lauiole tributaries of the Wailuku River.

According to DOH, none of the public water systems have ever violated federal drinking water standards.(19) According to the Department of Agriculture(20), the National Pesticide Survey contains three monitoring wells in Hawaii; none of these, however, are in the Hilo-Hamakua coast area.

3.3.4 Potential Exposure to Airborne Emissions from Preharvest Burns

Sugarcane fields are burned just prior to harvest to reduce the amount of leafy trash that enters the processing plants and to increase juice quality. Ten to 70 acres are typically burned each day for each mill; the burn usually takes 20 to 30 minutes. The typical smoke plume for preharvest burns, also known as "black Hawaiian snow," dissipates in approximately one hour (Figure 3-2). The smoke plumes occasionally drift into residential areas. Residential complaints arising from the visual and odiferous characteristics of the smoke have prompted the cane industry to control field burnings to avoid affecting nearby residents.(16)

Preharvest burns are regulated by DOH under Hawaii Administrative Rules, Chapter 11-60, sub-chapter 2. The regulations permit burning under favorable weather conditions and also allow DOH to determine "no-burn" days.

EPA conducted a study in 1987 to determine products of incomplete combustion (PICs), herbicide residues, and dioxins in the preharvest fire smoke plumes.(21) The study was designed to determine the presence or absence of contaminants at the source (i.e., burn site), not in the emissions in the drifting smoke plume. Approximately 20 PICs were identified at the source and no dioxins were detected. Three herbicides, atrazine, ametrym, and diuron were detected in ambient air samples; no herbicides were detected in particulate samples. Interestingly, atrazine and ametrym were detected in the field blanks but not in the laboratory blanks. Therefore, atrazine and ametrym were present in the ambient background air at the sugarcane site prior to burning. Diuron and ametrym concentrations were significantly higher during sugarcane burning than background levels. The report concluded that there were insufficient data to draw conclusions on potential health risks associated with burning sugarcane fields. The HSPA was highly critical of the EPA study design and was planning to conduct their own study.(16)

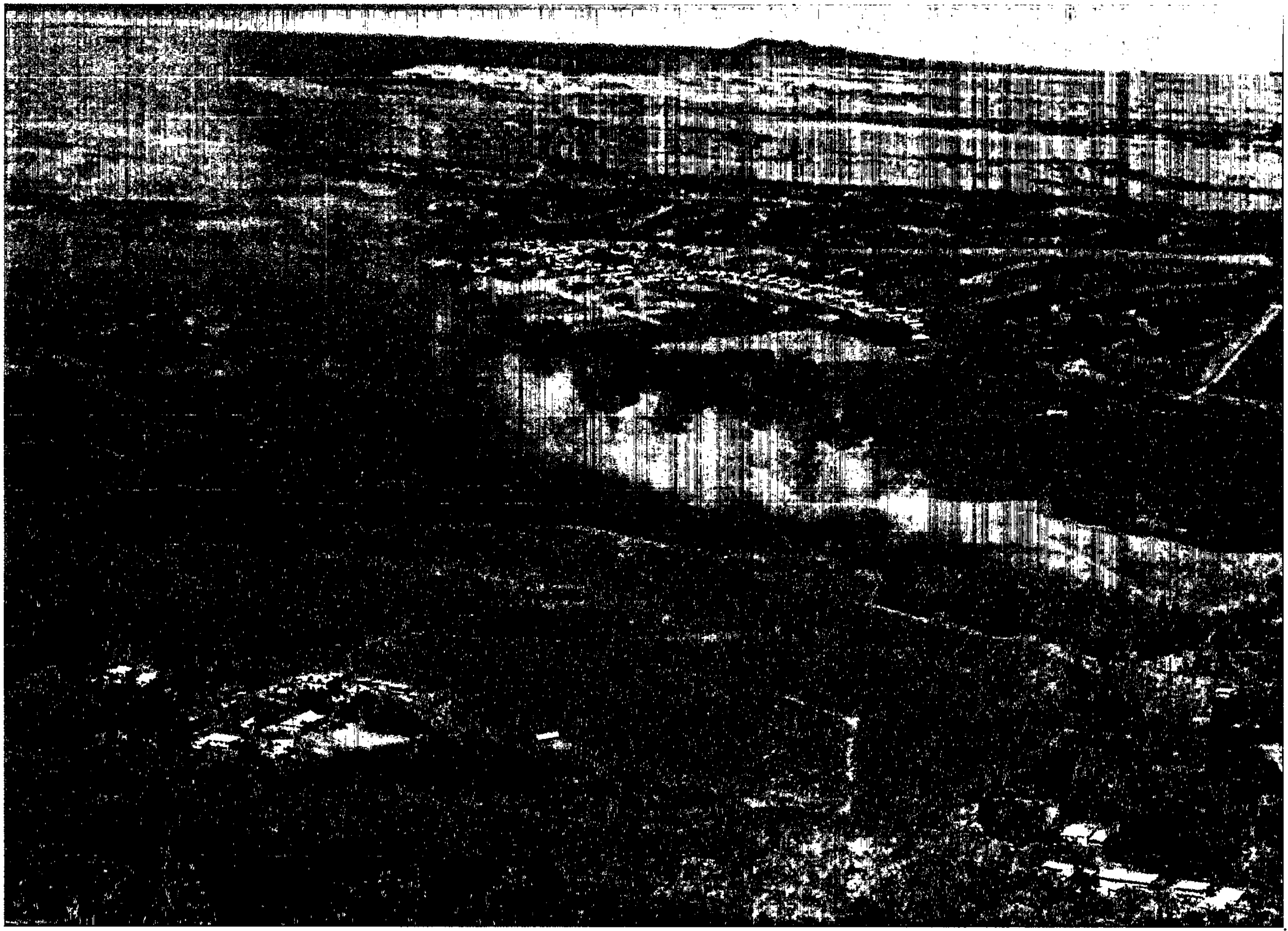

FIGURE 3-2
SMOKE PLUME FROM PREHARVEST BURN

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4.0 ENERGY REQUIREMENTS

4.1 EXISTING SUGAR MILLS AND TREATMENT SYSTEMS

Both HSC and HCPC burn bagasse, the fibrous material remaining after juice is extracted from sugarcane, to generate steam and electricity for mill use, and sell excess electricity to HELCO for distribution throughout the island of Hawaii. HSC has a contract to supply 10 megawatts of power to HELCO on demand, and HCPC has a contract to supply 20 megawatts on demand. The peak power demand on Hawaii during 1988 was 126.3 megawatts, thus HELCO can require HSC to supply approximately 8 percent of peak island demand and HCPC to supply approximately 16 percent of peak island demand.

The boilers used by the sugar mills to burn bagasse can also burn fuel oil (HSC and HCPC) or coal (HCPC). During periods when the mills are shut down for maintenance, and occasionally when there are interruptions in the supply of sugarcane, bagasse is not available for fuel. At these times, the mills substitute fuel oil or coal in the boilers.

Information submitted by HSC indicates that, in addition to process steam, HSC generated a total of 85.5 million kilowatt hours (kwhr) of electricity in 1988. Of this amount, 61 million kwhr (approximately 9 percent of total island demand in 1988) were sold to HELCO, the remainder was used on-site or at Big Island Meat. About 1.7 million kwhrs were used for wastewater treatment. Although HSC burned about 92,000 barrels of oil in 1988 in addition to bagasse, recent equipment modifications have improved system performance, and oil consumption is expected to be 53,000 barrels in 1989.

At HCPC approximately 154.4 million kwhrs of electricity were generated in 1988. HCPC sold 122.9 million kwhrs (approximately 18 percent of total island demand in 1988) to HELCO, and used the remainder (an estimated 3.3 million kwhrs) for wastewater treatment. In addition to bagasse, approximately 135,000 barrels of oil and as well as 20,000 tons of coal were burned at HCPC in 1988. Coal use is not anticipated, however, in 1989.

4.2 ENERGY REQUIREMENTS AT REDUCED LEVEL OF TREATMENT

If HSC eliminated the operation of the grit separator, clarifiers, and vacuum filters as proposed, a 60 percent (or 1 million kwhr/yr) reduction in wastewater treatment energy use is projected at 1988 processing levels. This represents a potential annual savings of about 2,400 barrels of Number 6 oil or 4.4 percent of current estimated oil use at an estimated heat rate of 15,000 BTUs per kwhr.

At HCPC, discontinuance of use of the settling ponds would eliminate essentially all the electricity use associated with wastewater treatment (i.e., wastewater pumping) for a potential annual savings of 7,800 barrels of Number 6 oil or about 5.6 percent of current estimated oil use at an estimated heat rate of 15,000 BTUs per kwhr.

4.3 IMPACT OF MILL CLOSURE ON ISLAND POWER SUPPLIES

If the mills were to close, the supply of bagasse would disappear, and the mills would need to burn fossil fuel to generate electricity for sale to HELCO. At HSC, approximately 144,000 barrels of oil would be needed to produce 61.0 million kwhrs of electricity, or approximately 1.7 times 1988 consumption and 2.7 times projected 1989 consumption. At HCPC, approximately 290,000 barrels of oil would be needed to produce 122.9 million kwhrs electricity, or approximately 2.1 times the 1988 use. HCPC can also burn coal in its boilers. Approximately 71,000 tons of coal would be needed to produce 122.9 million kwhrs of electricity. Therefore, even if the mills were to close, they could continue to fulfill their power contracts with HELCO, and island power supplies would not be impacted.

5.0 EVALUATION OF CONTROL TECHNOLOGIES

5.1 EVALUATION OF CURRENT HARVESTING TECHNIQUES

Up until the late 1940s, some Hawaiian sugarcane was harvested by hand and transported to the mills by mules, flumes, aerial trams, and railways. This approach to harvesting did not result in the entrainment of large amounts of soil that had to be removed at the mills. However, before World War II, increased labor costs had induced some growers to begin switching to mechanical harvesting methods (mainly push-rakes). The mechanical methods successfully reduced labor costs, but resulted in the entrainment of soil that had to be removed at the mill which increased costs. Both HSC and HCPC and their predecessor companies have tried several mechanical harvesting approaches in an effort to achieve the best balance between operating costs and a reduction in the amount of soil that is entrained with the cane.

In the HSC area, initial efforts focused on the development of cutter-transport long cane harvesters for use in especially wet areas. The cutter-transports cut standing cane, put it into unloadable bins, shuttled it to the edge of the field, and deposited it there in windrows. While these machines worked well, they did not eliminate the cut-cane to ground contact that resulted in soil entrainment. This fact, and the inefficiency of the shuttle operation, led HSC to attempt the development of an improved harvester.

Working with other growers, HSC experimented with development of a combination chopper harvester and dry cleaner. This machine was to harvest standing cane, cut it into 18 inch lengths, field clean it with an air stream, and shuttle it in an unloadable hopper to a truck loading area at the edge of the field. The cane was then offloaded onto the ground, loaded into trucks, and transported to the mill. Despite a major reduction in ground contact, the cane still required wet cleaning at the mill. The dry cleaning machinery was retired after only a brief full-scale trial.

Efforts to develop an improved chopper harvester continued, however. Because chopper harvesters from other parts of the world could not handle heavy Hawaiian cane, HSC had an Australian company custom build a prototype harvester, but it turned out to be too heavy. HSC then built a machine of their own design. This machine worked sufficiently well in field trials that HSC had several made. The harvester discharged chopped cane into buggies that placed the cane into bins on trailers. Trucks would return from the mill and drop off trailers with empty bins, and pickup trailers with full bins. However, under adverse conditions the trucks had difficulty backing up to the trailers, and consequently, the mill could not be kept supplied. Furthermore, sugar yields were not as high as anticipated.

Following the efforts to develop a chopper harvester, HSC attempted to reactivate their old long-cane harvesters, but found that they were no longer serviceable. The company used push-rake harvesters for a short time, while reinvesting in long-cane harvesting equipment. Although cutter-transports brought in less mud than push-rakes, subsequent analysis showed that use of push-rakes recovered 1 ton more sugar per acre than use of cutters. Moreover, push-rakes were much cheaper to buy and maintain. This prompted scrapping of the long-cane harvesting equipment, and reintroduction of push-rakes.

HSC now relies exclusively on push-rake harvesters to harvest sugarcane. A push-rake harvester consists of a D-6 Caterpillar tractor or similar tracted vehicle on which the bulldozer blade has been replaced with a special rake-like device (Figure 5-1). Each rake is about eight feet wide and has several equally spaced teeth extending forward like fingers. To use the push-rake the operator lowers it until the teeth are parallel to and just above the ground surface and then drives forward into the standing cane. The teeth lift recumbent cane off the ground and the frame of the push-rake breaks the cane stalk off at ground level or pulls the root ball or "stool" out of the ground. The frame also prevents the cane from falling in front of the tractor. The operator uses the push-rake to push the cane into parallel windrows about 50 to 100 feet apart. Relatively lightweight spring-tooth rakes called "liliko" rakes mounted on the rear of the tractors gather pieces of cane missed by the push-rake (Figure 5-2). Large hydraulic grapples or "grabs" then load the harvested cane into chain bottom trailers for transport to the mill for processing (Figure 5-3).

When used carefully, during dry conditions, and on gentle slopes, push-rakes do not entrain a large amount of soil. However, as conditions become more adverse, more and more soil is gathered into the windrows with the cane. Figure 5-4 shows a windrow with a considerable amount of entrained soil. Much of this soil will be picked up by the grapples, loaded into the haul trucks, and transported to the mill. In addition, the liliko rakes tend to incorporate a large amount of soil with the cane that they gather. The grabs load this soil into the trailers along with the cane. Use of push-rakes is the standard way of harvesting Hawaiian sugar cane.

Although the land harvested by HCPC is less steep than the land harvested by HSC, it typically receives more rainfall, and the fields are wet and muddy much more of the time. Because of the muddy conditions, harvesting at HCPC has evolved differently than at HSC. Underlying this difference was the decision of HCPC predecessors not to drive their haul trucks onto the fields as HSC and other Hawaiian growers do, but only on a network of roads constructed between the fields.

HCPC relies primarily on V-cutters to cut sugarcane and on tracked vehicles to shuttle it to the field edge for pick-up and transport to the mill.

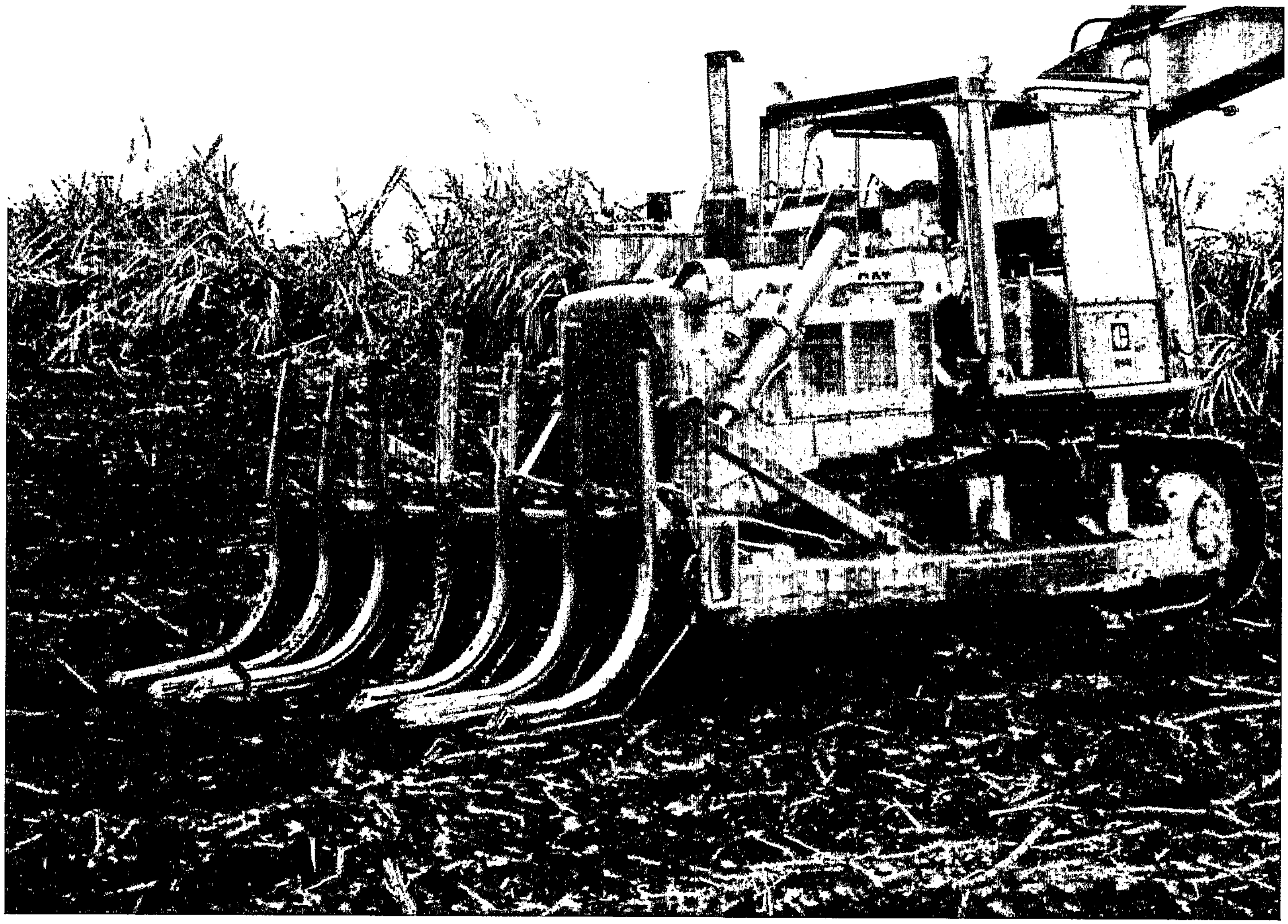


FIGURE 5-1
PUSH-RAKE USED TO HARVEST SUGARCANE

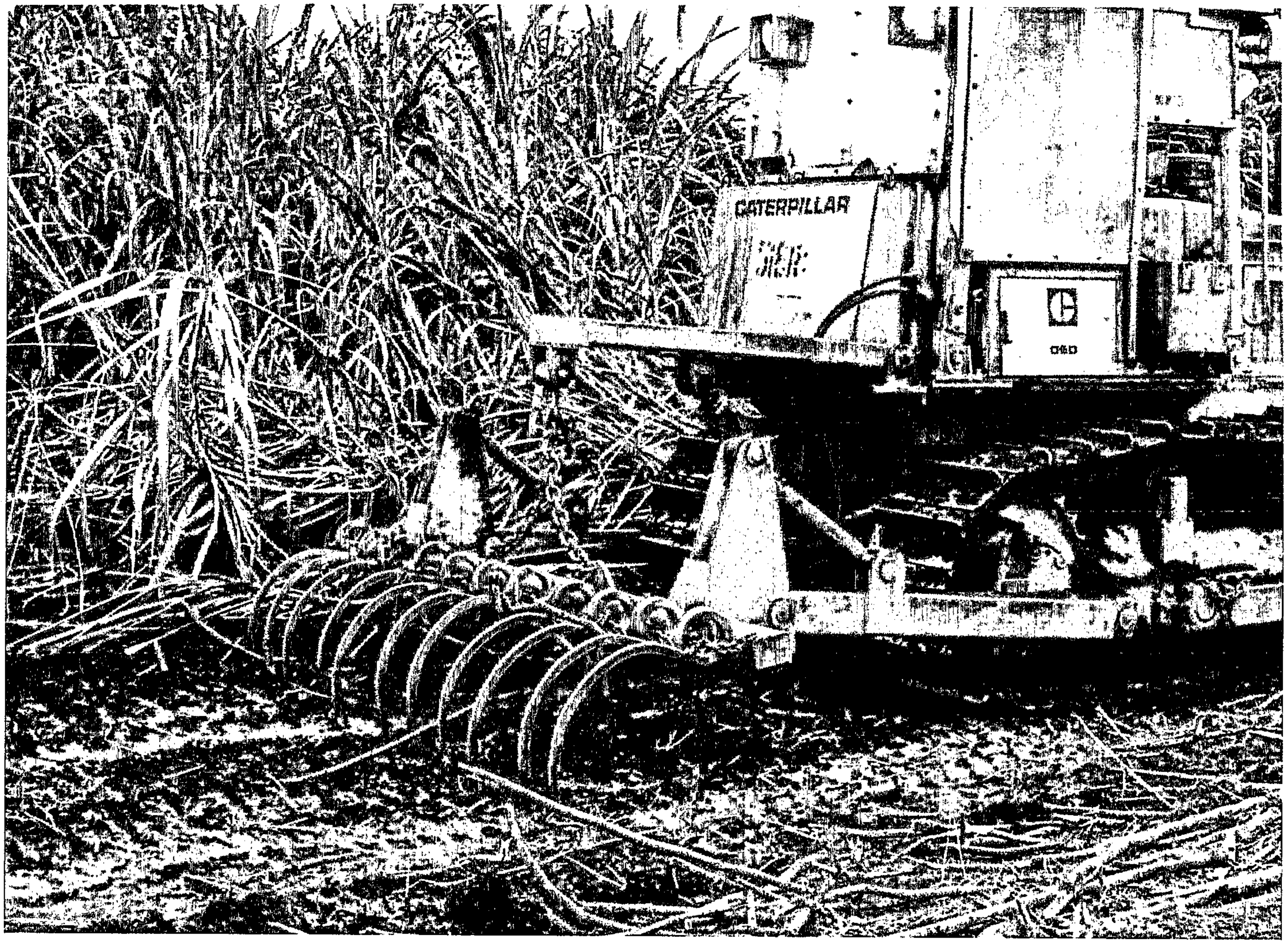


FIGURE 5-2
LILIKO RAKE USED TO GATHER SUGARCANE

FIGURE 5-3
HYDRAULIC GRAPPLE USED TO LOAD SUGARCANE

FIGURE 5-4
SOIL IN SUGARCANE WINDROW

A V-cutter harvester consists of a D-6 Caterpillar tractor or similar vehicle on which the bulldozer blade has been replaced with a heavy V-shaped blade about 8 feet wide and similar to a snow plow (Figure 5-5). To use the V-cutter the operator lowers the blade so that its lower edge is just above the ground and then drives forward into the standing cane. The V-shape of the blade creates small parallel windrows spaced six to eight feet apart. Two passes of the V-cutter, one in each direction, are usually needed. A rotary cutter mounted vertically just in front of the V-blade improves the performance of the V-cutter.

HCPC picks up the windrowed cane with pick-up cleaner transports (PUCTS) (Figure 5-6). These are large tracked vehicles equipped with an inclined pick-up conveyor on the front and a tiltable hopper on the rear that receives the cane from the pick-up conveyor. To use the PUCT the operator drives it forward so that the conveyor picks up the windrowed sugarcane. When the hopper becomes filled, the operator backs the machine to the field edge and dumps the hopper. He repeats this shuttle activity until all the cane is transferred to the field edge. A gap in the deck of the inclined conveyor allows some of the dirt that is picked up to fall back to the field. This reduces the amount of soil transported to the mill.

Hydraulic grapples or "grabs" load the cane deposited at the field edge into closed bottom bin trailers for transport to the mill.

In addition to the PUCTS, HCPC uses buggies and push-rakes during harvesting. A buggie consists of a tracked vehicle with a tiltable hopper on top which shuttles between an in-field hydraulic grab that loads it and the field edge where the cane is dropped and subsequently loaded into trailers (Figure 5-7). Push-rakes are used in areas that are too wet or steep for the V-cutters and PUCTs.

HCPC has tried several methods to reduce the amount of soil transported to the mill. These have included modification of the V-cutter, co-development of a dry cleaner pick-up, and roadside transfer conveyors. The current system has evolved based on these experiments.

HCPC constructed a cane dry cleaning pilot plant at the mill in the early 1970s. The system was designed to cut harvested cane into short lengths, pass it over a series of shaking drums, and blast it with an air stream to remove loosely adhering soil. The dry cleaned cane was then washed with cane juice to remove soil. Soil was subsequently removed from the juice during the syrup clarification process. In operation, the system was considered unsatisfactory from the beginning and was not implemented on a full scale basis. The cane could not be cleaned adequately without using washwater.

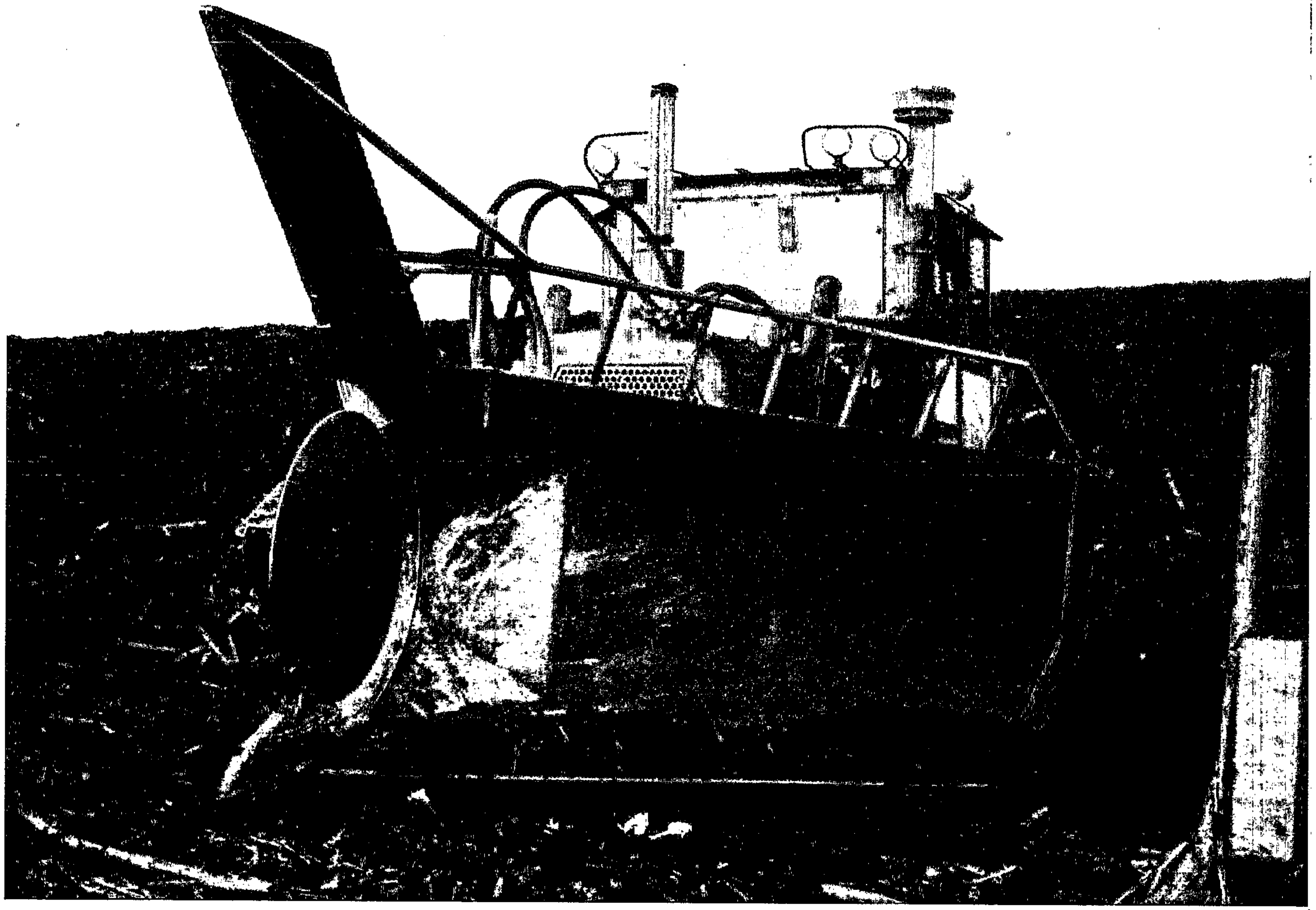


FIGURE 5-5
V-CUTTER USED TO HARVEST SUGARCANE

FIGURE 5-6
PICKUP CLEANER TRANSPORT

FIGURE 5-7
BUGGIE FOR SUGARCANE TRANSPORT

5.2 CURRENT TREATMENT SYSTEMS

The wastewater treatment system at HSC consists of a trash separator, a grit separator, two 60 ft diameter primary clarifiers, and two vacuum filters for dewatering clarifier underflow. Clarified effluent passes through a Parshall flume for flow measurement before discharge to an ephemeral stream. During periods when the vacuum filters cannot keep up with the settled mud from the clarifiers, the mud is diverted to three infiltration ponds for dewatering. The ponds are dredged when full, and the spoil is bulldozed into terraces adjacent to the ponds. Figure 5-8 presents a schematic of the wastewater treatment system at HSC.

The trash separator consists of an inclined chain and flight conveyor whose lower decking has 0.25 inch perforations. Raw wastewater flows onto the separator and water and solids smaller than 0.25 inch pass through the perforated plate to the grit separator. Material retained on the plate is moved up the conveyor to the end and dumped onto the ground. A bulldozer periodically pushes this material over the edge of an embankment.

The grit separator consists of a long narrow tank with an inclined bottom scraped by a chain and flight conveyor. Sand and grit settle to the bottom of this tank and are removed by the conveyor flights. Water overflows to the clarifiers.

The clarifiers are of conventional center feed-radial flow design. One has a side water depth of approximately 14 feet, while the other has a side water depth of only about 6 feet. The two clarifiers are operated in parallel, and because the deeper unit is less sensitive to fluctuations in loading than the shallow unit, the operator directs more flow to it than the shallow unit. A polymer to promote settling is added to the wastewater before entering the clarifiers. Effluent from the clarifiers is combined and measured in a Parshall flume before discharge to an ephemeral stream. It is about 0.25 miles from the discharge point to the ocean. During "normal" loading conditions, both units produce a low turbidity effluent that is only slightly opaque. A hydraulic surge from the cleaning plant can quickly upset the shallow unit, however, causing what appears to be essentially untreated water to be discharged. Figure 5-9 compares the clarifier discharge at HSC during normal operation, and during upset conditions observed during the plant visit.

A review of mill discharge data shows that if flow were split equally between the two clarifiers, the average hydraulic surface loading in 1988 would have been approximately 1,770 gallons per day per square foot of surface (gpd/ft^2). This is about twice the typical loading for primary clarifiers treating domestic wastewater. However, soil is much more dense then the typical solids in domestic waste and therefore a higher loading rate is permissible up to the point where unsatisfactory performance occurs. The available data indicate that the clarifiers generally do a good job of removing suspended solids.

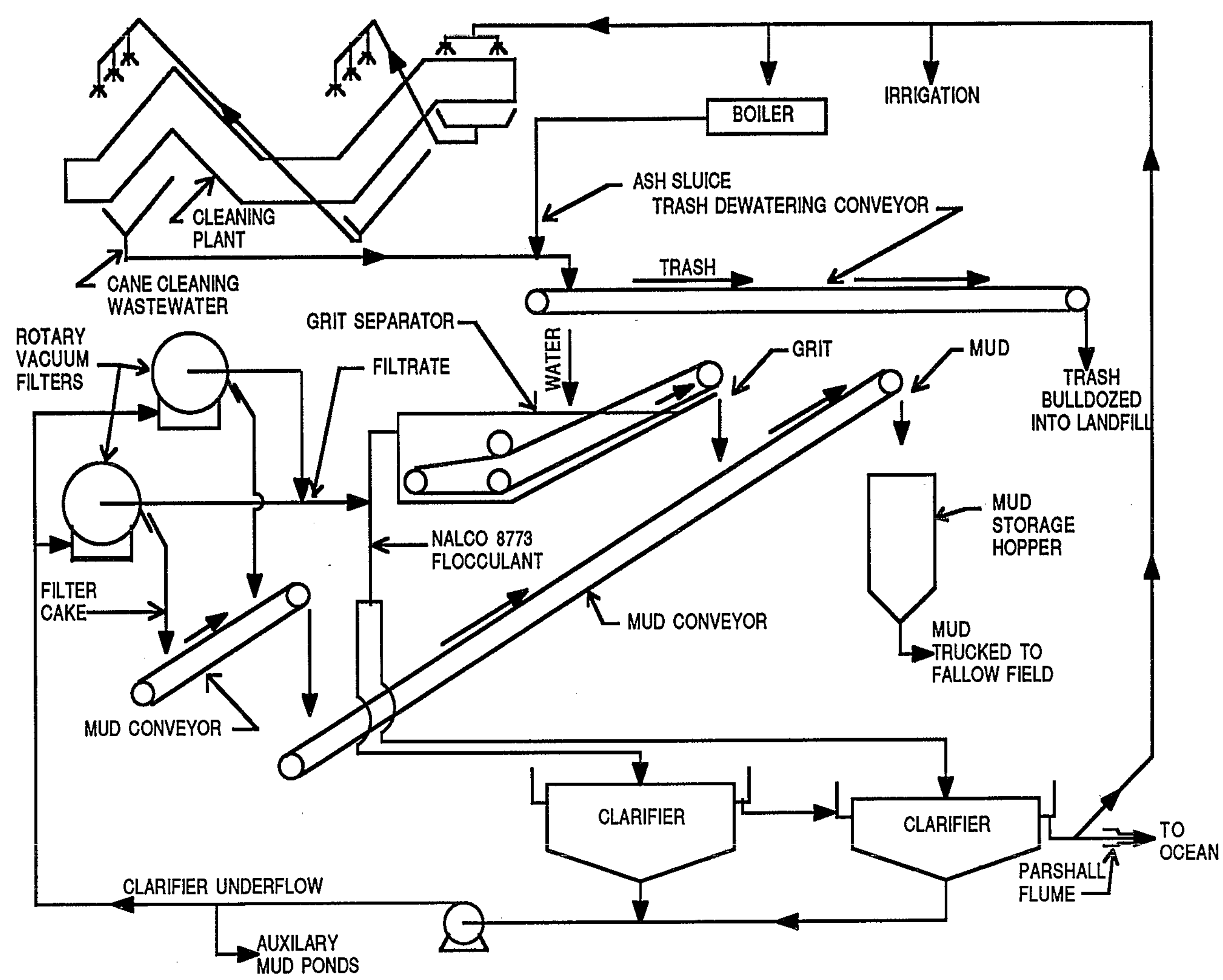
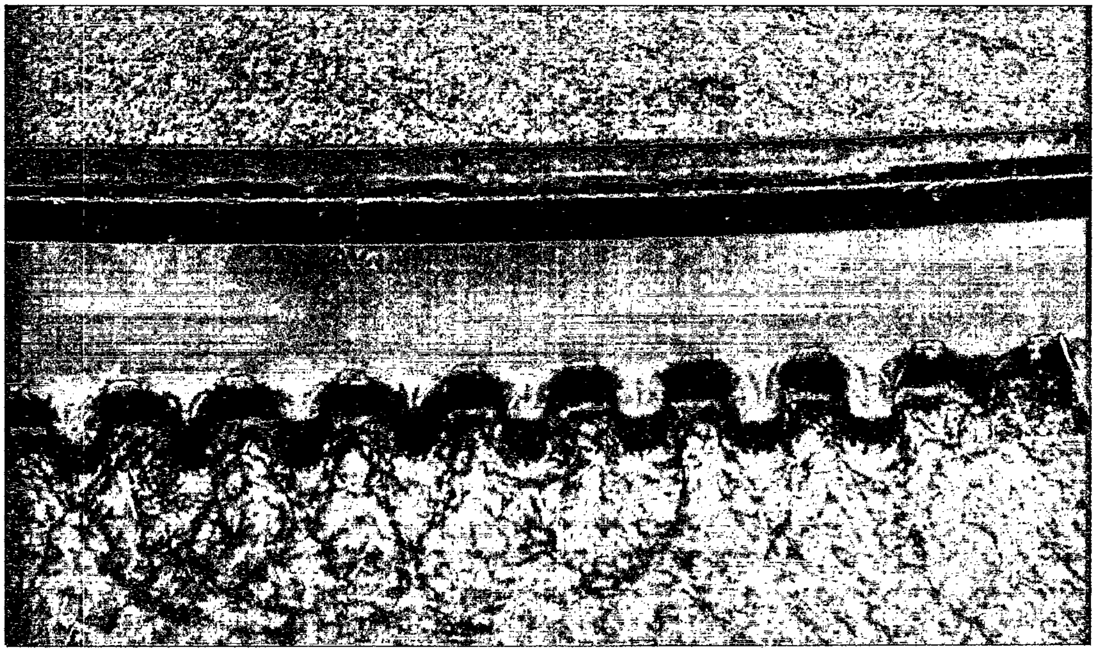


FIGURE 5-8
WASTEWATER TREATMENT SCHEMATIC FOR HSC



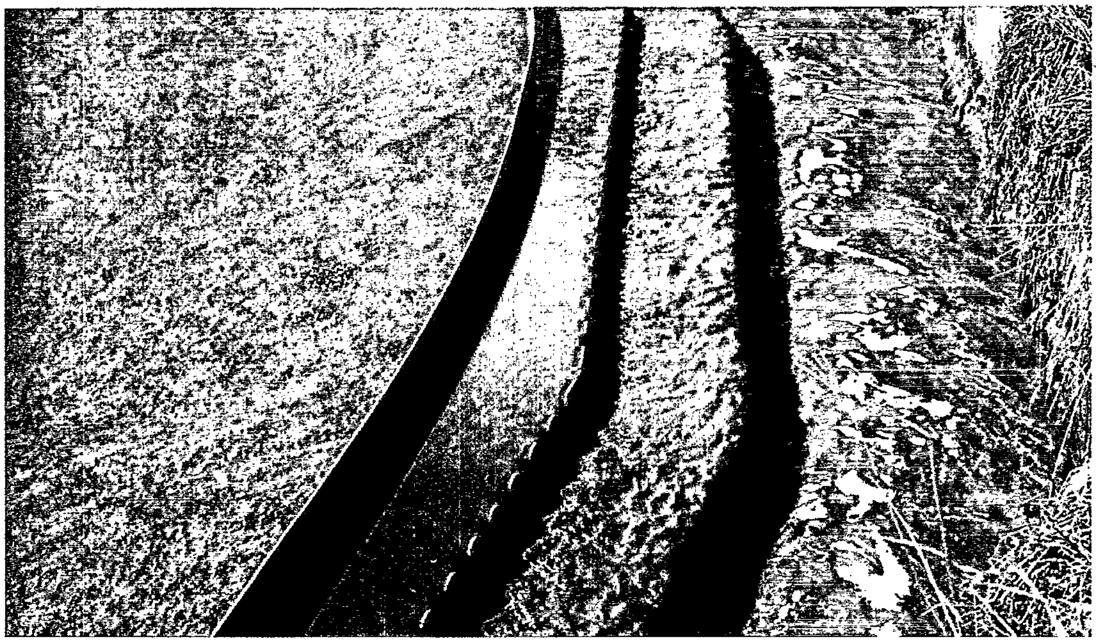


FIGURE 5-9
COMPARISON OF HSC CLARIFIER DISCHARGES DURING NORMAL AND UPSET CONDITIONS

Effluent concentrations are approximately 97 percent less than the influent and averaged 299 mg/l in 1988. Removals across the entire treatment system are approximately 98 percent. However, the fact that one unit is easily upset by unequalized flow surges from the cane cleaning process suggests that it is probably close to being overloaded. The effluent TSS concentration measure (2,180mg/l) during the environmental impact study may be more typical of concentrations during these periods of clarifier upset.

Wastewater flow measurement records (strip charts) were requested from and provided by HSC in order to attempt to identify the duration and volumes of wastewater surges from the cleaning plant, and thereby quantitatively determine the incidence of permit violations, if any. After extensive review, it was concluded that these records and available TSS data alone were not sufficient to quantify any violations that may be occurring.

The wastewater treatment system at HCPC consists of a collection sump, transfer pumps, and twenty two major earthen settling ponds (Figure 5-10). The collection sump receives cane cleaning wastewater, ash sluice water, and slurried mud from juice clarification. Three 300 h.p. pumps transfer this combined wastestream to the settling ponds approximately 0.75 miles away. The combined wastestream is dosed with about 3 mg/l of a Calgon cationic polymer before entering the settling ponds.

The settling ponds are each several hundred feet long and about 20 feet wide. Figure 5-11 shows a portion of the settling pond system at HCPC. The influent and effluent channels are arranged so that the ponds are grouped into three treatment units each with a minimum of five ponds operating in series. The ponds are dredged daily with three Caterpillar Model 235 excavators. Dredged spoil is placed at the edge of the ponds and allowed to drain for several days before being bulldozed into terraces downgradient of the ponds. The individual ponds are not taken out of service during dredging. The final overflow from the ponds passes through an H flume for flow measurement before discharge over the top of a nearly vertical embankment to the ocean (Outfall 003).

The treatment system works well, typically removing 96 to 99 percent of influent suspended solids and producing a effluent with an average of 721 mg/l of suspended solids in 1988. It would not be expected to be as easy to control this system, however, as the treatment system at HSC.

As is the case with the treatment system at HSC, the HCPC system also can be overloaded. Hydraulic surges can exceed the capacity of the transfer pumps and cause the sump to overflow. This results in the discharge of untreated wastewater to the ocean through Outfall 001 (photograph in Figure 5-12). Outfall 001 normally discharges barometric condenser cooling water and power house cooling water. HCPC representatives said that overflows may occur for a short while during periods of cleaning plant breakdowns (e.g., one or two times a day).

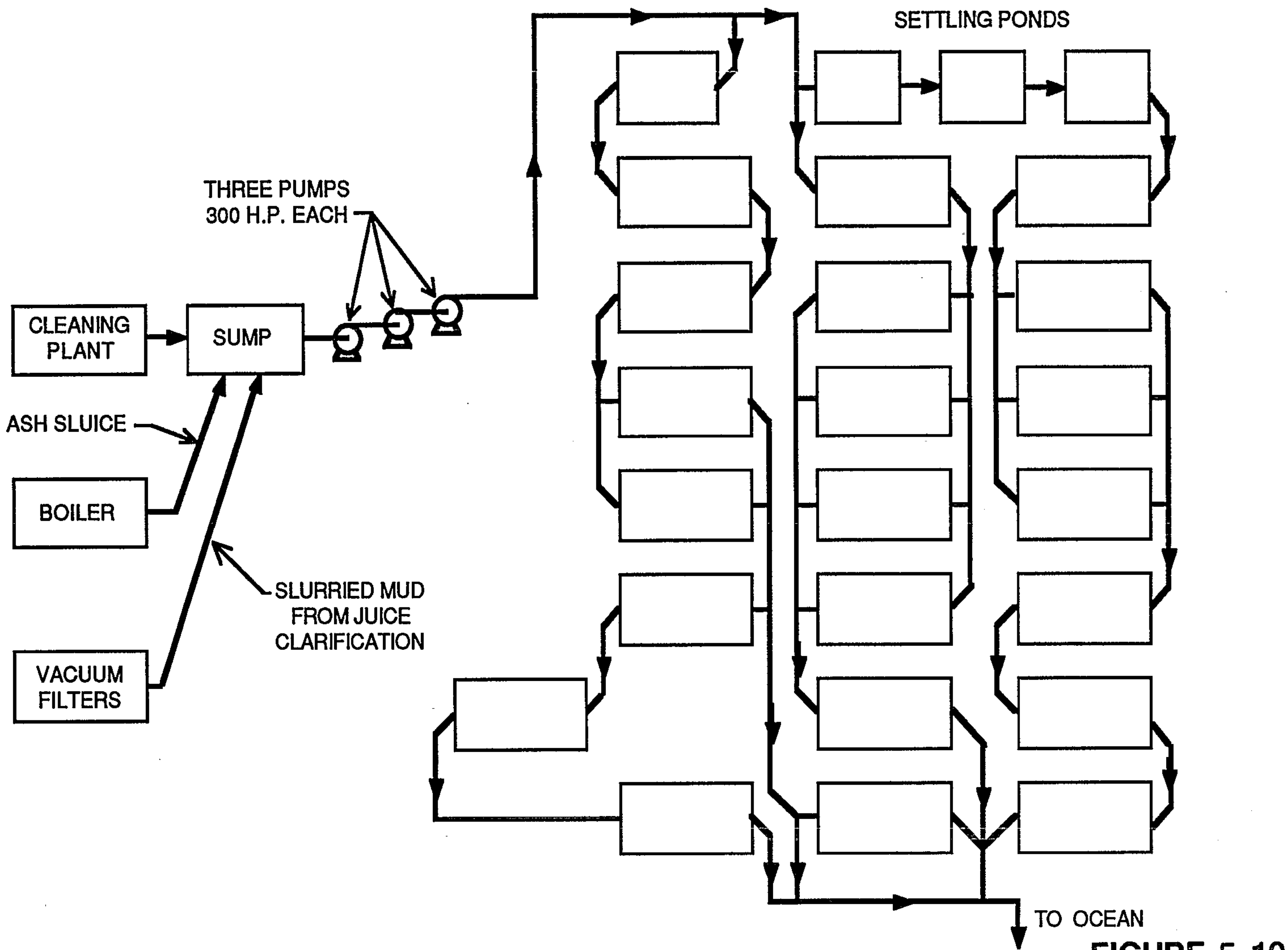


FIGURE 5-10
WASTEWATER TREATMENT SCHEMATIC FOR HCPC

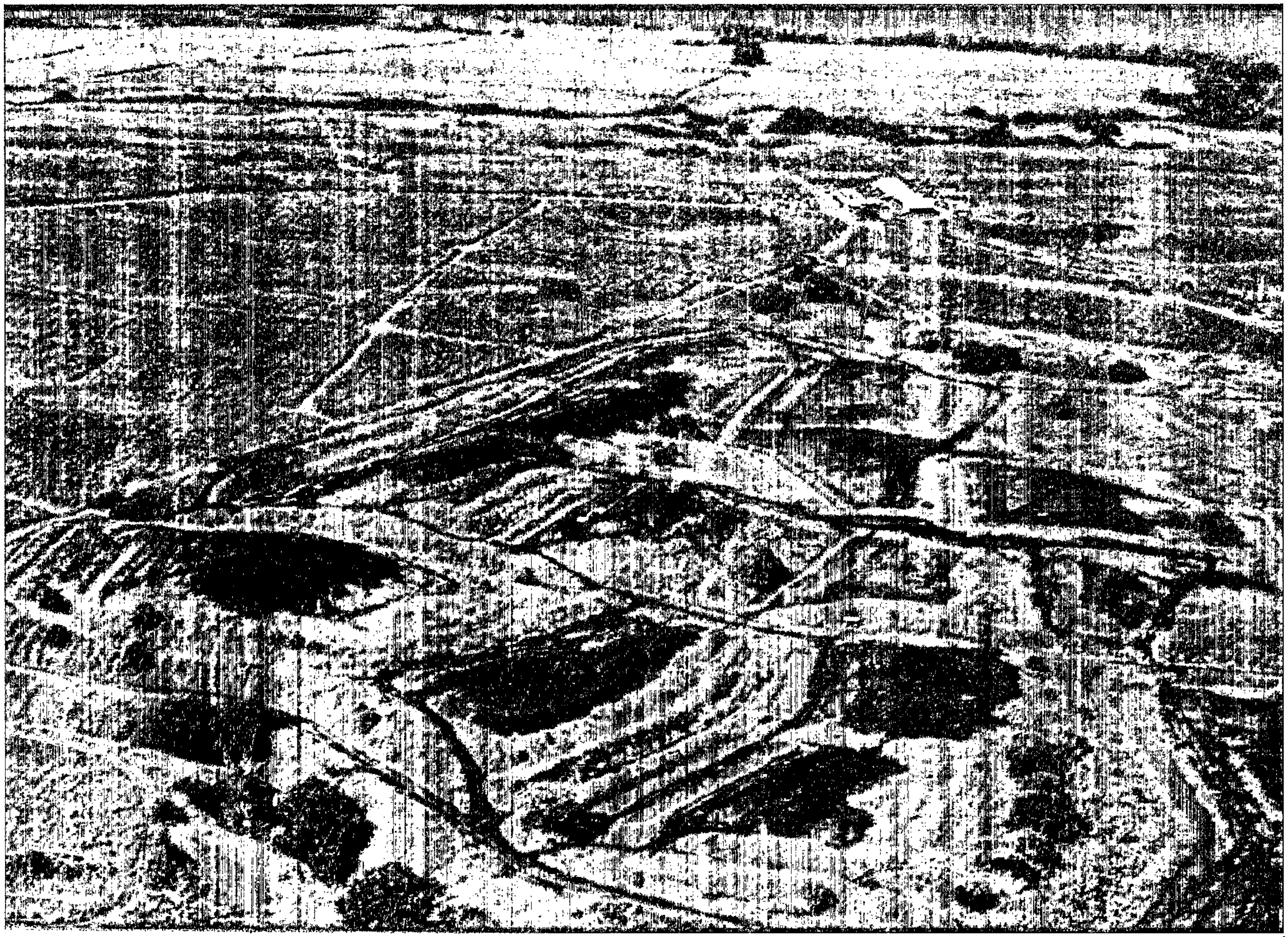


FIGURE 5-11
SETTLING POND SYSTEM AT HCPC

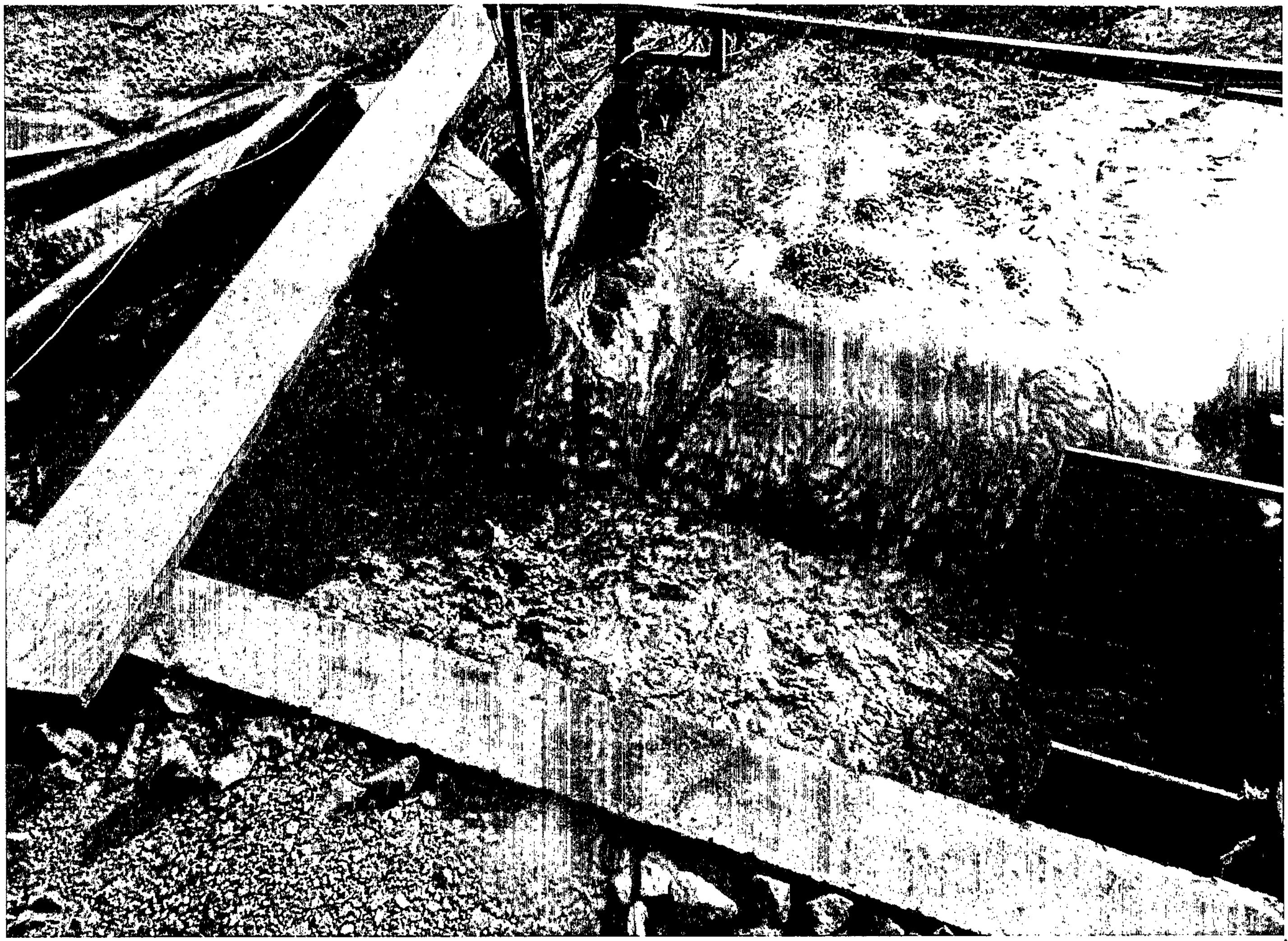


FIGURE 5-12
RAW WASTEWATER BYPASS AT HCPC

Water flow measurement records (i.e., strip charts) also were requested from and provided by HCPC in order to identify the duration and volumes of process wastewater bypasses occurring through Outfall 001, and thus the incidences of potential violations, if any. After extensive review, it was again concluded that these records and available TSS data alone were not sufficient to quantify any violations that may be occurring.

A second concern with the HCPC treatment system is that the water draining from dredged spoil is not contained. It can flow down the access roads between the ponds and into the ocean, thus contributing to the muddy appearance of the receiving water.

5.3 ESTIMATED SUSPENDED SOLIDS DISCHARGE AT REDUCED LEVEL OF TREATMENT

Based on mass balance information submitted by the mills and 1988 processing levels, EPA estimates that the TSS discharged to the ocean at the reduced level of treatment suggested by the mills would increase from about 13 tons per day to 656 tons per day at HSC. This amount is derived by adding the estimated current discharge to the solids removed from the wastewater by the primary clarifiers and one-half the solids removed by the trash and grit separators, and subtracting the solids contained in the boiler ash. Boiler ash is currently sluiced to the wastewater treatment facility and combined with cane washwater for treatment. Figure 5-13 presents a simple mass balance for soil and fiber only at HSC based on 1988 processing levels.

At HCPC, mass balance information indicates the discharge would increase from approximately 7 tons per day to 479 tons per day. This amount is derived by adding the estimated current discharge to the estimated solids removed from the wastewater and subtracting the solids contained in filter cake and boiler ash. HCPC currently sluices boiler ash and slurried filter cake from juice clarification to the wastewater sump for pumping to the settling ponds. According to HCPC's proposal, this practice would stop and the filter cake and ash would be handled separately. Figure 5-14 presents a simple mass balance for soil and fiber only at HCPC based on 1988 processing levels.

5.4 CANDIDATE TECHNOLOGIES TO REDUCE RAW WASTE LOADS

EPA believes the key to reducing raw waste loads at both mills is reducing cane to soil contact during the harvesting process. This in turn will reduce the amount of solids entrained with cut-cane, and the amount to be removed during the cane cleaning process. Mass balance information indicates that at HSC, soil and rock comprise approximately 50 percent (1,252 tons per day in 1988) of the solids, including sugar, trucked to the mill. At HCPC, approximately 33 percent (629 tons per day in 1988) of the solids are soil and rock.

To achieve the necessary reduction in cut cane to soil contact, the sugar industry will need to replace the existing push-rakes, V-cutters, and hydraulic grapples with a new generation of harvesting equipment that cuts the sugarcane and loads it directly into bins or hoppers. As discussed in Section 5.1, both mills tried development of this type of equipment in the past, but encountered problems that led to reliance on less complicated push-rakes and V-cutters.

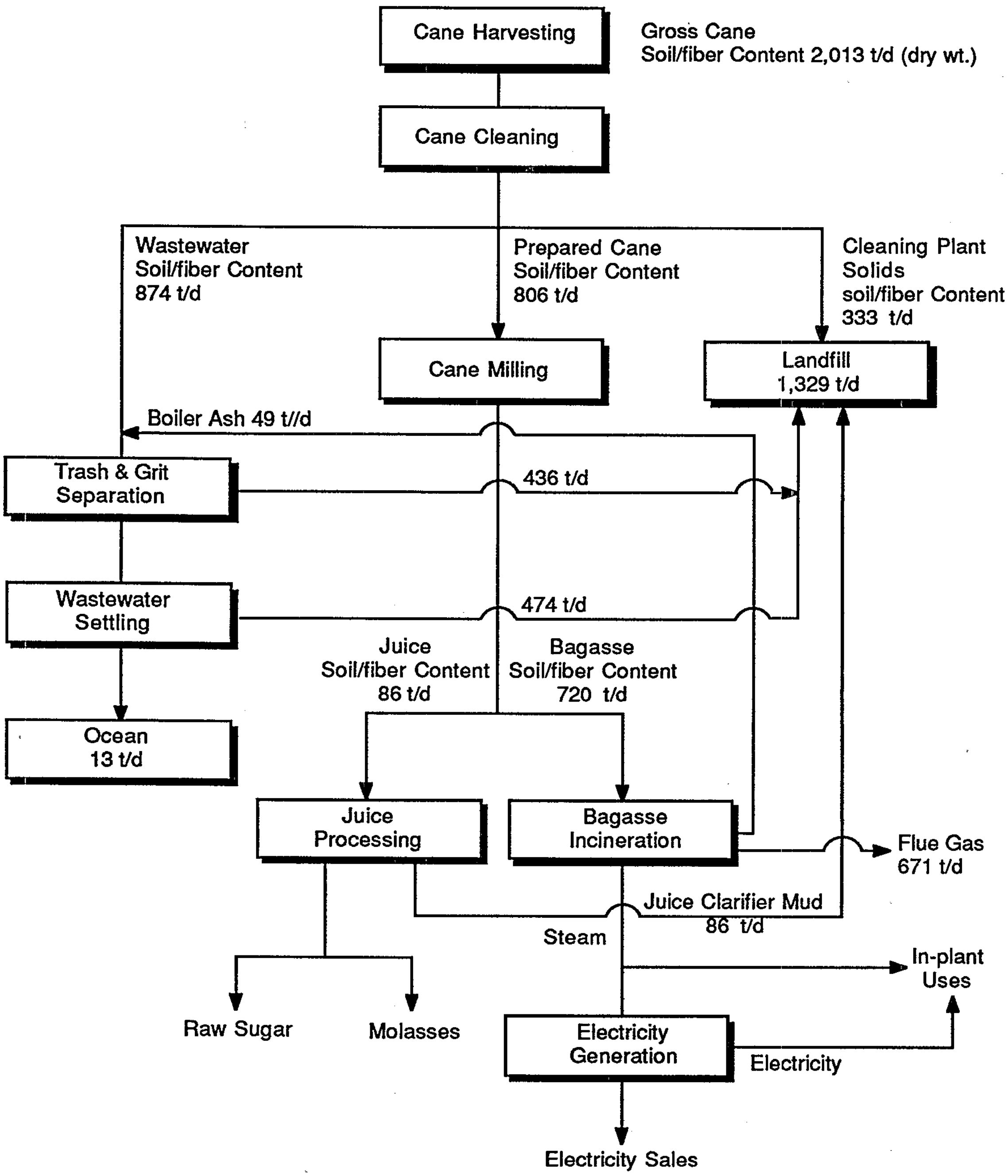


FIGURE 5-13
SOIL AND FIBER MASS BALANCE FOR HAMAKUA SUGAR COMPANY

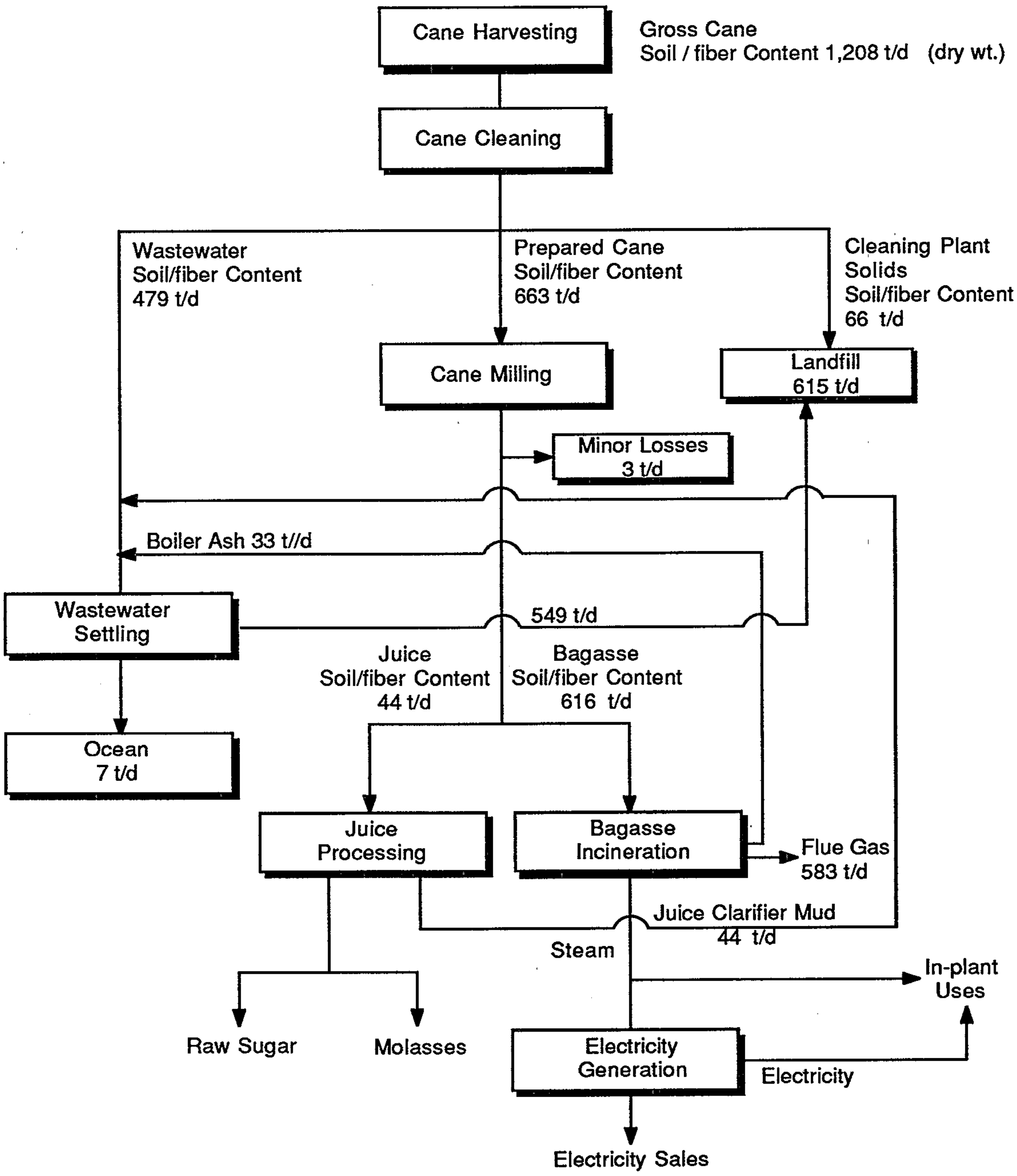


FIGURE 5-14
SOIL AND FIBER MASS BALANCE FOR HILO COAST PROCESSING COMPANY

Currently, the major obstacle to development of new harvesting equipment is the high cost of research and development, which could easily be several hundred thousand dollars to develop a new harvester. In addition, conversion to new harvesting equipment and methods would cost the mills millions of dollars. Neither mill is continuing, or has plans to resume, development of new harvesting equipment.

The Ezra C. Lundahl, Inc. company (Lundahl) of Logan, Utah and SIMCO of Weston, Connecticut approached the Hawaiian Sugar Planters Association (HSPA) in 1988 concerning modification of a Lundahl auger harvester to allow it to harvest sugarcane. As presently configured, the harvester is suitable for harvesting corn.

Lundahl and Simco envision a prototype harvesting system in which the harvester is mounted on a lightweight tracked vehicle and discharges chopped cane into a bin on a second vehicle moving alongside.(1) The chopped cane would then be moved to the field edge and transferred to an overroad vehicle. HSPA and an industry committee have voiced doubt that the equipment can be made to work economically on the wet ground, hilly terrain, and the mass of cane that must be handled.

The conversion to a new harvester such as the chopper-harvester might require a change in cane cultural practices. Growers currently plant cane on many slopes that are too steep, and in areas that are too wet for equipment such as the previous chopper-harvesters. If HSC and HCPC choose to maintain only new generation harvesting equipment, while abandoning existing push-rakes and V-cutters, the steepest and wettest areas might have to be taken out of cultivation.

Some Hawaiian growers are also experimenting with one year cane crops. One year old cane generally stands erect (soldier cane) rather than laying on the ground (recumbent cane). Soldier cane proves much easier to harvest mechanically, and equipment has been developed in other areas for its harvest. Direct transfer of the equipment to the Hilo-Hamakua coast presents problems, however, since this area is steeper and wetter than most sugarcane growing areas.

5.5 ALTERNATIVE OR INNOVATIVE TREATMENT TECHNOLOGIES

The clarifiers used by HSC and settling ponds used by HCPC represent two of the most basic, well proven, and inexpensive approaches available for removal of suspended solids from wastewater. These technologies are well suited and appropriate for treatment of cane washwater at the two mills. The cost effectiveness of these approaches is born out by the low estimated cost per pound of solids removed: $0.0020 at HSC in 1988 and $0.0039 at HCPC, also in 1988.

Other treatment technologies that might also be considered include centrifuges, fine screens, and filters. None of these, however, can be recommended over the existing treatment system without pilot testing and a detailed cost analysis. It is unlikely that any would be more cost-effective than the already installed systems. Centrifuges tend to be expensive to purchase and operate. Screens and filters would be subject to blinding from the large amount of silt and other fine grained material in the wastewater and might require wastewater settling as pretreatment.

The use of clarified wastewater for irrigation is an alternative to its discharge to the ocean. However, removal of suspended solids from the wastewater would likely be required to prevent plugging of pipelines and nozzles and to minimize equipment wear. Use of wastewater for irrigation, therefore, would not result in a reduction of costs. Other factors preventing the use of irrigation at HSC and HCPC are: 1) both mills are located at a substantially lower elevation than nearly all the sugarcane fields they harvest and are at the edge of the plantations, resulting in high costs to pump and distribute wastewater; and 2) although HSC irrigates some low elevation fields, (i.e., fields below Rt. 19), ample rainfall preempts the need for irrigation along most of the Hilo-Hamakua coast.

In 1980, the Hawaii Department of Agriculture commissioned a study of the feasibility of using cane washwater from HCPC to reclaim lava flows near Hilo for agricultural purposes.(2) A second, more detailed study was completed in 1982.(3) The second study concluded that it would be technically feasible and economically justifiable to pump sugarcane washwater from HCPC approximately 12 miles to a location south of General Lyman Field (Hilo Airport) to reclaim 2,600 acres of lava flows over a 20-year period. The reclaimed land would be the basis for an agricultural park administered by the State of Hawaii.

As proposed, the total capital cost of reclaiming the land, $19.2 million (1982 dollars) and annual operation and maintenance, $1.8 million (1984 dollars), would be shared by the State of Hawaii, Hawaii County, and HCPC. The 1982 report concluded that in order to ensure HCPC participation in the project, the company's costs could not be greater than current wastewater treatment costs, and in fact would need to be lower. The report recommended that HCPC's annual cost be limited to 75 percent of current O&M costs indexed to inflation. If HCPC's contribution was based on information submitted to EPA in 1988, the company's 1989 contribution would be (0.75) ($881,037) = $660,778. The 1989 savings to the company for participation would be $881,037-$660,778 = $220,259.

The report lists the following incentives to the State of Hawaii for participation in the project:

- excise taxes on the gross revenue from the agricultural park
- income taxes on increased farmers' incomes
- revenue from leasing of farm parcels
- revenue from sale of reclaimed topsoil
- increases in employment and land values, broadening of the state economic base, and other intangible benefits

The benefits to the County of Hawaii include the following:

- increased property taxes on agricultural parcels
- a lower cost for obtaining landfill cover soil

An additional possible benefit to the county discussed in the report was the avoided cost of a new sewage treatment plant. The Hilo Sewage Treatment Plant is a primary treatment facility that currently discharges chlorinated effluent to the ocean through a 4,500-foot outfall. The report suggests the option of mixing primary treated sewage effluent with the cane washwater from HCPC for disposal at the land reclamation area. The report concludes that although, on a preliminary basis, it appears the co-disposal option could be carried out with safety, further study would be required to determine if all administrative and environmental concerns can be satisfied.

The incentive to HCPC for participation would be reduced wastewater treatment costs.

EPA denied Hilo's application pursuant to section 301(h) of the CWA for a waiver to secondary treatment on August 31, 1987. The city is now under a Consent Order to upgrade to secondary treatment. Hilo plans to build a new wastewater treatment facility at a new site and use the existing discharge outfall. The move to a new site is necessary because the site of the current facility is in a tsunami inundation zone. These plans preempt a major incentive for the county to participate in the land reclamation project.

To EPA's knowledge no current efforts exist to implement the land reclamation project.

It should also be pointed out that the feasibility studies were based on recovery of approximately 1,100 to 1,200 tons per day of soil from cane washwaters, but the data obtained by EPA as part of this study indicate that only about one-half this amount was contained in cane washwater during each of the years 1986, 1987, and 1988. This fact could have an adverse impact on the economic feasibility of the project because of the additional amount of time that would be required to recover the lava flows.

HCPC presently sells a small portion of the soil dredged from its settling ponds to individuals and contractors in need of topsoil. This practice aids HCPC in disposal of spoil material, but does not provide an alternative to the discharge of sugarcane washwater, treated or not, to the ocean. Similarly, it may be economically practical for resort developers on the west coast of Hawaii to use treatment solids from HSC or HCPC for golf courses and landscaping, rather than stripping topsoil from agricultural land. Again, however, this would not eliminate the need for the mills to discharge sugarcane washwater.

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6.0 ECONOMIC IMPACT OF PROVIDING WASTEWATER TREATMENT

6.1 THE BASIS OF MILL VIABILITY

The economic and financial viability of the sugar mills owned by HSC and HCPC depends on the price they receive for sugar and the costs they incur to produce sugar. For these sugar mills to be economically viable, revenues must exceed costs of production. The sugar market has been affected by a long history of government intervention and the development of sugar substitutes. This section discusses both the sweetener and sugar markets, examines some determinants of U.S. sugar prices, presents alternative projections of U.S. sugar prices, and discusses the cost of sugar production at each mill.

6.1.1 Sweetener and Sugar Consumption Trends

Consumption of all sweeteners, including sugar, corn, and non-caloric sweeteners, has increased significantly during the past two decades. Within this overall consumption pattern for sweeteners, several changes are taking place that affect cane sugar producers such as HSC and HCPC.

Caloric sweeteners (including both sugar and corn sweeteners) have maintained the larger share of the U.S. sweetener market, even though the use of non-caloric sweeteners has been significant in recent years. In 1979, non-caloric sweeteners made up about 5 percent of the total sweetener market. In 1987, they made up over 13 percent of the market.

The caloric sweetener market has seen increased use of high fructose corn syrup (HFCS) since its development in the 1970's. Although HFCS does not have the same physical characteristics as sugar, it can be substituted directly for sugar in many uses. By 1985, corn sweeteners had a larger share of the U.S. caloric sweetener market than sugar. The largest market for HFCS is the beverage industry, where HFCS now accounts for over 95 percent of the caloric sweeteners used.(1)

Americans consume almost equal quantities of beet and cane sugar. Beet sugar producers now market beet sugar in parts of the country such as the Northeast, where in the past only cane sugar was sold.(1)

Historically, the United States has imported a significant portion of domestically consumed sugar. In the past decade, however, U.S. sugar producers have supplied an increasing proportion of the sugar consumed in this country, with imports declining steadily for the reasons discussed below.

6.1.2 U.S. Sugar Price System

The United States, like most other sugar-producing nations, has a long history of intervention in the market for sugar. In 1974, the U.S. House of Representatives voted to discontinue the U.S. Sugar Act, which had regulated domestic sugar production, imports, and prices for 40 years. Because 1974 was a time of world sugar shortages and record high prices, domestic price supports seemed unnecessary. Figure 6-1 shows that U.S. sugar prices entered a period of instability around 1974, with two "spikes," following a period of steady increases. Between 1974 and 1977 the U.S. government did not intervene in the sugar market. But from 1977 to the present (with the exception of the 1980-81 crop year when world sugar prices boomed) the U.S. government has supported the price of sugar.

The U.S. government maintains a target price or price floor for sugar through a system of quotas that regulate sugar imports, and a system of supports for domestic producers. Quotas raise the U.S. price above the competitive equilibrium by restricting the supply of sugar entering the country. Under the quota system, individual countries are assigned quantities of sugar that they may export to the United States at the U.S. price.(2) To maintain a market price above the target price, quotas have been reduced over time. In 1988, the price of sugar on the world market was about half of the U.S. price of 22 cents per pound.

HSC and HCPC can each sell all of the sugar they can produce at the market price for raw sugar. Even if there were no price support system, these companies could be reasonably viewed as price-takers since their production together makes up only 4.4 percent of total U.S. production and only 0.3 percent of world production.

Neither company sells raw sugar directly. They market it through their refining cooperative, C&H Sugar. After subtracting refining costs from sugar sales, C&H remits the difference to the producers. The members of C&H also receive a dividend. In 1988, C&H returned $42.7 million, or 16.02 cents per pound ($320 per ton) to HSC and $23.8 million or 16.35 cents ($327 per ton) to HCPC.

6.1.3 Sugar Price Projections

The future price of sugar will affect the economic viability of HSC and HCPC and their ability to pay for wastewater treatment. Sugar prices are the result of a complex set of economic and political factors that are beyond the scope of this analysis. However, some useful insights are possible.

Barry (3) indicates that experts have two types of theories on what determines sugar prices: structuralist and cyclicalist. Structuralists argue that improving sugar production and processing techniques, along with market penetration by corn and low-calorie sweeteners, are key factors affecting sugar prices. Structuralists contend that future sugar prices are likely to remain stable or fall. Cyclicalists believe sugar prices go through cycles with occasional spikes that occur when demand exceeds processing capacity. These spikes disappear as new processing capacity comes on-line and production catches up with demand.

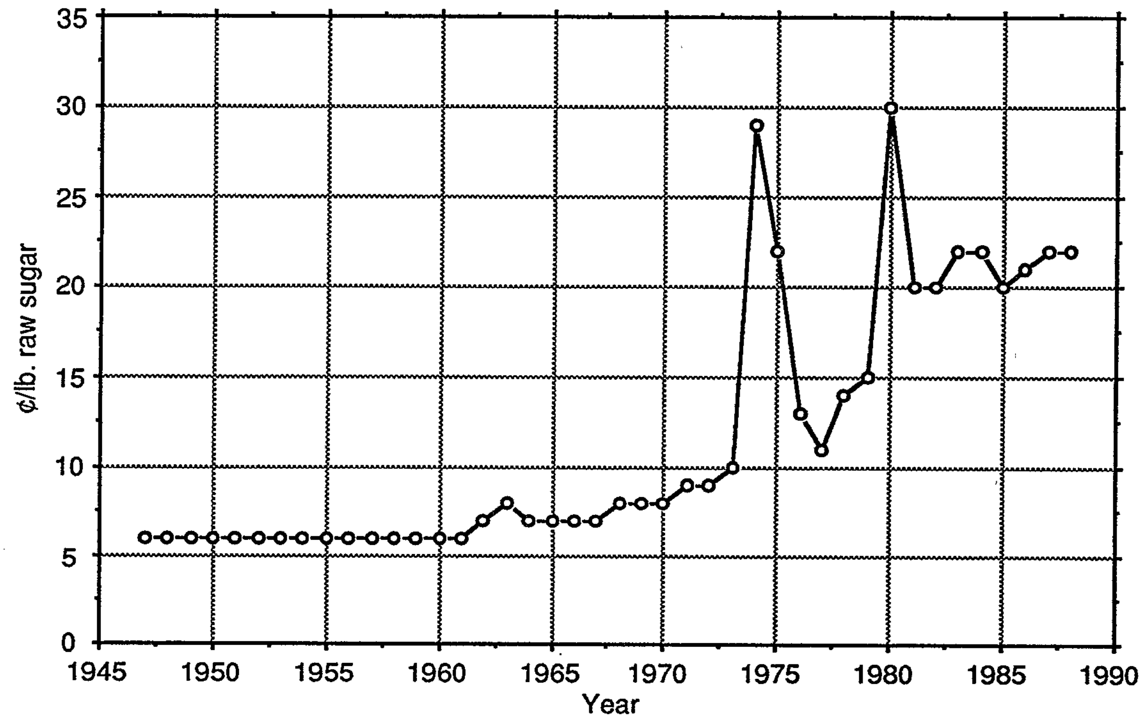

FIGURE 6-1
U.S. SUGAR NOMINAL PRICES, 1947-1988

For this study, a simple time-series forecasting technique is used to examine sugar price trends. Time-series forecasting does not attempt to model relationships between cause and effect. To a large extent, time-series forecasting treats the cause-effect system as a "black box" and simply tries to forecast, in this application, future sugar prices based solely on past sugar prices.

Annual U.S. sugar prices for the past 42 years (1947-1988) are presented in Figure 6-2, labeled as "nominal" or "actual" prices over the period. However, over this period the general price level of the U.S. economy changed--it increased. The inputs used to produce sugar--labor, capital, energy, materials--probably followed this general price movement. Several alternative measures of this trend are available. The most comprehensive measure is the GNP implicit price deflator. Showing sugar prices relative to all prices, the "real" price values in Figure 6-2 indicate that the relative price of sugar has fallen. A simple time-trend regression model shows the decline in prices over time to be statistically significant.

To project real future sugar prices using the time trend model, one must incorporate an assumption about the likelihood of spikes in the future. Because of the presence of 2 spikes in 15 years we are hesitant to ignore them; however, because these two spikes are the only ones present over 42 years, we are wary about giving them much weight. Three price projections are presented in Figure 6-3. The highest projection results from the assumption that spikes will occur on average every seven years, but at random intervals. The middle projection makes a similar assumption, but assumes a 41-year cycle. Finally, the low price projection assumes that the spikes of the last 20 years were an aberration and will not be repeated. Regardless of the assumption selected, continuation of current trends highlights the challenge facing all sugar producers, not only at HSC and HCPC, to improve productivity faster than the decline in the ratio of sugar to input prices.

6.1.4 Production Costs

EPA used cost and production data provided by HSC and HCPC, together with the production relationships presented in previous sections, to develop a simple fixed proportions sugar cost model for each company. The model provides a consistent structure for examining the costs of sugar production at both mills and a basis for making certain cost imputations for HCPC as described further below. The companies receive revenues from products other than sugar, especially molasses and electricity. In this cost model, these revenues are treated as offsets to variable production costs. The model provides only approximate cost relationships; detailed cost models were beyond the scope of this study.

The model defines six basic phases of the production process. These include fixed costs associated with sugar production and variable costs associated with harvesting the cane, delivering the cane from the fields to the factory, performing work associated with transforming the delivered cane into raw sugar,

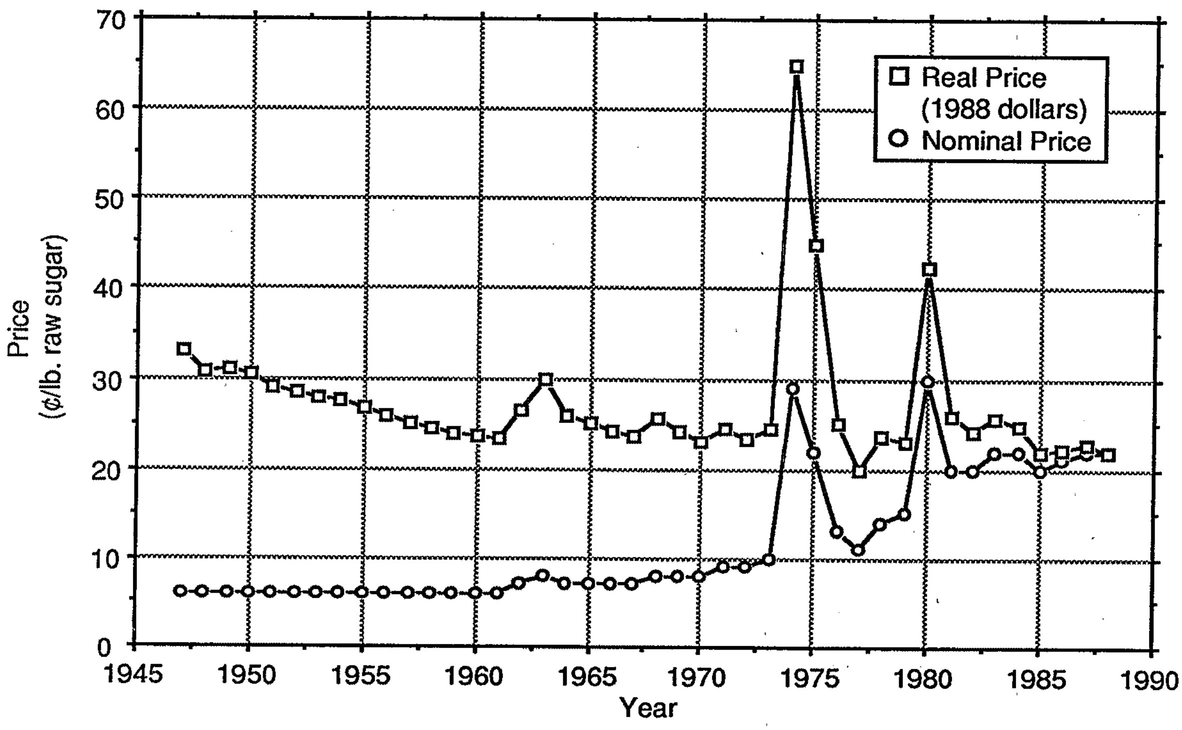

FIGURE 6-2
U.S. SUGAR NOMINAL AND REAL PRICES, 1947-1988

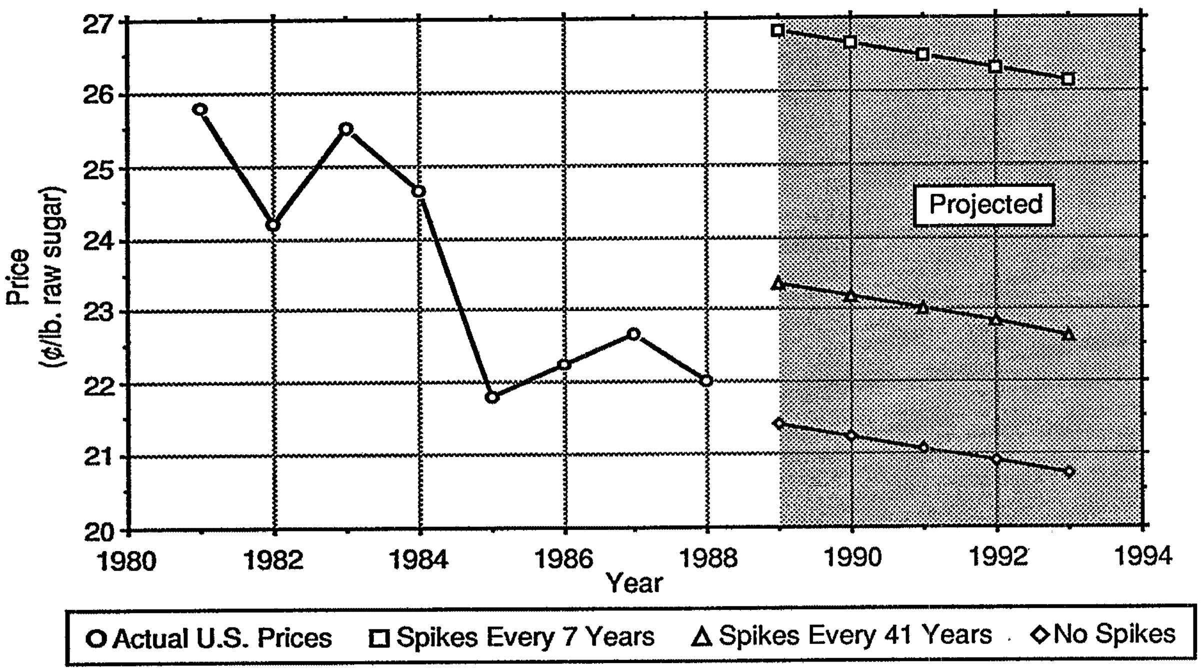

FIGURE 6-3
HISTORICAL AND PROJECTED U.S. SUGAR REAL PRICES, 1981-1993 (1988 DOLLARS)

treating the wastewater used in the factory processes, and transporting raw sugar to the refinery. Each of these six phases is broken down into similar cost components: land, labor, materials, insurance, taxes, and other. Previous expenditures for capital improvements are sunk costs and not part of the opportunity costs of current production. Hence, they are not included in the cost model. Depreciation allowances do, however, play an important role in determining companies' taxes and, hence, net earnings.

The model computes the total and per unit cost of sugar production at each mill. The data initially provided by HCPC did not include costs for planting and cultivation because the members, UCPC and MKA, perform these services. For this analysis, EPA imputed planting and cultivation cost for UCPC and MKA to make the total costs for HCPC more complete.

The costs of sugar production for HSC average an estimated 15.54 cents per pound ($310.80 per ton). Total costs for 1988 production of more than 133,000 tons raw sugar (net of revenues for non-sugar products) are $41.4 million. For HCPC, average costs are 16.14 cents per pounds ($323.81 per ton) annually. The total costs of production of HCPC are $23.5 million for about 73,000 tons of raw sugar.

Placing production costs in a broader context, based on studies by the U.S. Department of Agriculture, the cost of producing and processing cane sugar in Hawaii is slightly higher than the United States average. According to Hoff, Angelo, and Fry (4), from 1979-1985 the average cost of producing raw cane sugar in the United States was 3.42 cents per pound higher than the world average, placing the United States 40th among the 61 sugar-producing regions studied.

Cost estimates based on information submitted by the mills, adjusted to remove depreciation and interest expense, indicate the cost savings with reduced wastewater treatment would be $654,000 annually at HSC. This is equivalent to 0.25 cents per pound of raw sugar. For HCPC, the cost savings would be $724,000 annually or 0.50 cents per pound of raw sugar. Some of these cost parameters are summarized, along with other results, in Table 6-1 at the end of the section.

6.2 MILL ECONOMICS AND FINANCES WITH CURRENT WASTEWATER TREATMENT PRACTICES

6.2.1 The Operating Decision

HSC and HCPC contend that continued compliance with effluent guidelines places a significant burden on their businesses, which are already operating under poor economic conditions. These firms face two economic decisions under current effluent limitations guidelines: determining whether or not to keep their respective mills open and, if the mills remain open, setting the optimal production rates. The standard economic paradigm is that firms attempt to make decisions that maximize profits.

The economics of the mills impinge on the companies' finances--that is, on their sources and uses of funds. Just as the current physical characteristics of the mills, cane fields, transportation equipment, etc. reflect past decisions, the companies' current financial positions reflect past decisions. Thus each company has a current set of both physical assets and financial obligations based, in part, on decisions made in the past. The companies' financial positions with current and reduced wastewater treatment practices are also addressed below.

In the context of this analysis, profits may be interpreted as the surplus, if any, of revenues over production costs. The classical plant closure hypothesis is that firms will close plants when the surplus of revenues over costs falls below that required to yield a normal return on the value of the site, working capital, and the scrap value of the plant. These decisions are reviewed below for the two mills assuming current wastewater treatment practices.

Given a decision to operate, each mill will produce all the sugar possible given the constraints imposed by the cultivated acreage and the harvest and by its operating characteristics. However, the output rates for both the HSC and HCPC mills have fallen short of the sugar production rates that their respective companies believe are achievable. HSC's major constraints to improving productivity are the mill, mill yard, and cane transport; HCPC's is the total amount of cane harvested.

The difference between total revenues and total costs is the surplus provided by the mill. These surpluses are available to cover debt service or other obligations not associated with the production costs estimated above and to provide owners with a return on their investments in land and equipment. The surpluses for each company can be found by comparing revenues and costs. For the HSC mill the surplus of revenues over costs is about $1.3 million annually at 1988 rates. For the HCPC mill, when the cost for cane planting and cultivation incurred by its members is imputed, the surplus for HCPC and the members combined is about $0.3 million annually.

As shown earlier, the price of sugar has been very volatile over the last ten years. Changes in sugar prices will change the estimated surpluses. For example, a one-cent per pound change in sugar prices changes the annual HSC surplus by $2.7 million and HCPC surplus by $1.6 million. To the extent that 1988 prices are unrepresentative of the future, then the estimated surpluses are also incorrect measures of the future economic conditions of the two mills. However, as discussed earlier, projections of sugar prices are very problematic and, therefore, all analyses are performed using only the most recent data--the 1988 data.

The estimated 1988 surpluses can be placed into perspective by examining the returns to the owners of a major fixed factor--land. HSC owns 16,834 acres of cultivated land. The other half of the land cultivated by HSC is rented; lease payments are treated as a cost of production in this analysis. Thus, the current return per acre is $77 (i.e., $1.3 million/16,834 acres) annually.

For HCPC, MKA and UCPC together cultivate 16,908 acres making the return per acre $18 after imputing planting and harvesting costs. Assuming that these returns can be maintained into perpetuity, and that the cost of capital is 10 percent, the value of HSC land in sugar cultivation is $770 per acre; MKA/UCPC land is worth $180 per acre. This latter value appears to be unrealistically low. This may be due to the lack of cost data for UCPC and MKA. Regardless, the returns to land appear minimal for both companies.

6.2.2 The Mill Closure Decision

The standard closure decision model postulates that firms will close plants when price falls below average cost. Predictions of the future must be viewed cautiously, however. Even if the analyst could develop accurate predictions of these revenues and costs, the key question is the expectations of the owners and creditors of HSC and HCPC. Nonetheless, it is possible to highlight some important factors related to the mill closure decisions.

As long as the returns to land use are adequate and because both mills are generating a surplus, profit-maximizing behavior implies that both will remain open regardless of the actions of the Agency with regard to wastewater treatment practices. However, the value of these lands for uses other than sugarcane is not known. It surely varies across each plantation, based on soil quality, topography, proximity to highways, and so forth. Land values in the hundreds of dollars-per-acre as implied by the surpluses appear very low. One can only conjecture that unless the surpluses increase, as a result of price increases or cost decreases, the owners would have to seriously examine other land uses.

In addition, continuation of the long-term reduction in the ratio of the price of sugar to all other prices presents additional challenges to the land and mill owners. To avoid becoming uneconomic, the mills will need to improve productivity enough to continually stay ahead of the projected decline in the relative price of sugar. Both companies believe that they each have significant opportunities to make substantial productivity improvements.

These conclusions on mill closures are conjectural on a number of fronts. First, sugar prices may not follow any of the scenarios selected due to changes in market or government policies. Second, costs may change from their current values due to input price or productivity changes. Third, all costs and benefits of mill operation may not be captured in these values. Fourth, closures of mills on the island of Hawaii have, in the past, been accompanied by increased production at remaining mills, whereas closure of either the HSC or HCPC mills is very likely to be accompanied by removal of lands from sugar production. Even if only one mill closes, the two mills are probably too far apart for the remaining mill to pick up the other's production. Thus, the decision to close these mills would be more difficult than past mill closure decisions. Finally, both companies have agreements with the State of Hawaii to maintain the land in sugar production into the early 1990's.

6.2.3 Company Finances

The analysis above focused on the economic viability of the mills. Each is currently generating a surplus of revenues over costs, though the returns to land appear quite modest. Both companies have reason to believe that future productivity improvements will improve their current financial situations. The second issue is the viability of the companies. This is conditional on their ability to meet their legal liabilities at the company level. Thus, the mills could be viable, but the company could be unsuccessful if it were unable to meet its legal liabilities. In such cases companies may declare bankruptcy with a new owner taking over the operation of the physical assets. (i.e., plant, equipment, land).

Financial ratio analysis has been the traditional tool for assessing a firm's financial viability for many years. Single ratio analysis and multiple ratio analysis are the two methods most commonly used. Single ratio analysis has a distinct disadvantage compared to multiple ratio analysis, since the former can only independently examine a firm's liquidity, profitability, leverage, or activity.

Altman (5) first used multiple financial ratios in a model to predict future firm bankruptcy. He specified and estimated a multivariate discriminant function with five financial ratios known as the Altman multivariate "Z-score" model. The advantage of the Z-score model over traditional ratio analysis is its simultaneous consideration of liquidity, profitability, leverage, and activity.

The numerical Z-score values translated into qualitative probabilities of bankruptcy declaration are:

Z-score range	Bankruptcy probability
<1.23	likely
1.23-2.90	indeterminate
>2.90	unlikely

HSC's Z-score was -0.2, indicating "likely" bankruptcy. However, while HSC had some difficulty in meeting principal and interest payments in the past, these payments are now current. The bank has since approved HSC's debt-reduction program, and the creditors are willing to keep the Haina mill open.(6)

HCPC's financial status as of December 31, 1987, with a Z-score of 1.494, indicates some financial difficulty, but "indeterminate" bankruptcy probability. However, it is important to note that HCPC is cooperatively owned by UCPC and MKA. By virtue of grower attrition, MKA is also a member of UCPC. MKA is in turn owned by another firm, C. Brewer and Co. LTD., a Honolulu-based, diversified holding company with sales approaching $250 million annually. Consequently, HCPC represents only about 10 percent of C. Brewer and Co., LTD's sales. In addition, C. Brewer and Co., LTD operates a sugar mill, Ka'u Agribusiness, Inc., at Pahala, also on the island of Hawaii. Some port and other facilities are shared between HCPC and Ka'u. Thus any closure decision relative to HCPC is likely to be made in the context of the Pahala mill also. Although HCPC, according to Altman's Z-score model, appears in financial difficulty, an important consideration affecting the viability of HCPC is the willingness of C. Brewer and Co., LTD, to incur any of HCPC's losses.

6.3 MILL ECONOMICS AND FINANCIAL VIABILITY WITH REDUCED WASTEWATER TREATMENT PRACTICES

6.3.1 The Mill Closure Decision

Engineering cost estimates based on information submitted by the mills indicate that by operating under reduced wastewater treatment requirements, HSC and HCPC would save $654,000 and $724,000 annually, respectively. Treating all these costs as variable, the average variable cost for HSC would decrease by 0.25 cents per pound, and for HCPC by 0.50 cents per pound. Total operating costs would decrease 2 percent at HSC, 3 percent at HCPC.

It is unlikely that cost reductions of these magnitudes would significantly change the closure or operating decision at either mill. However, the surplus at both mills would increase by the costs avoided. These increases would be substantial in terms of their share of current surpluses. For HSC, the surplus would increase by $654,000 or 54 percent; for HCPC, the increase would be $724,000 or 241 percent. The return per acre at HSC would increase about $41 per acre. At HCPC the return per acre would increase about $43 per acre. Thus, while wastewater treatment costs are small on a share-of-all-costs basis, they significantly affect the surpluses and return per acre for both companies.

Even with reduced wastewater treatment costs, improvements in mill productivity are critical to the long-term viability of these mills. If HSC and HCPC are unable to continue improving productivity, revenues will eventually fall below costs, given the price trends described above, and the mills will close. HSC has already made large capital expenditures to modernize its mill, replaced top executives and managers, and restructured its organization in an effort to increase productivity and reduce costs. HCPC has also instituted management changes. These efforts, and others, must continue to maintain mill viability. Reductions in wastewater treatment costs would probably put off mill closure somewhat. Given the small shifts in the cost curves that reduced treatment would create, however, these changes in the timing of the mill closures are likely to be insignificant.

6.3.2 Company Finances

Reduced wastewater treatment requirements will slightly improve the financial picture of each company. To assess the impact, a pro forma 1987 financial statement was prepared for each company assuming the wastewater treatment savings presented above had been realized in 1987. The savings were entered in the 1987 income statements as reductions in costs of goods sold, and changes in "other" income statement items and balance sheet items were endogenously solved. New pro forma Z-scores were also computed.

The financial position of HSC improves only marginally with the $654,000 reduction in wastewater treatment costs. The Z-score increases still leave the company in the "likely" bankruptcy possibility range.

The financial position of HCPC also improves only marginally with the $724,000 reduction in wastewater treatment costs. The Z-score increases still leaves HCPC in the "indeterminate" bankruptcy range.

Table 6-1 summarizes the economic position of HSC and HCPC and their mills with current and reduced wastewater treatment practices.

6.4 EFFECTS OF MILL CLOSURES ON EMPLOYMENT AND INCOME

As described earlier, both mills, at present, appear to be only marginally viable. Reductions in wastewater treatment costs would increase the profitability of each mill fairly significantly, given the small surpluses estimated. However, because wastewater treatment costs are a small share of all costs, reductions in wastewater treatment costs are unlikely by themselves to have a significant impact on the viability of either mill. Nonetheless, when these mills close, regardless of the cause, there will be effects on employment and income in the local economy. These potential effects are discussed here.

A study by Hawaii's Legislative Reference Bureau (7) examined the impacts of sugar mill closures on employment. According to this study, supervisors, clerks, and skilled factory workers could transfer their skills with relative ease to jobs in other sectors of the economy. Most field workers, however, have little education and limited skills. These workers may be limited to other types of agricultural jobs, or to jobs as groundskeepers, maintenance workers, or housekeeping staff in the tourist industry. The transition from farming to work in the tourist industry would require a change in lifestyle that may be disruptive to some individuals and families, especially those who have worked for many years in the sugar industry.

Opportunities for employment in agriculture outside the sugar industry on the Hilo-Hamakua coast are limited. Some beef cattle and macadamia nuts are raised in this area, but these enterprises could not readily absorb the surplus farm labor that would be created by the sugar mills closing. Over time, alternative crops may replace sugar on some acreage on the Hilo-Hamakua coast, but in the

TABLE 6-1

SUMMARY OF THE ECONOMIC AND FINANCIAL EFFECTS OF WASTEWATER TREATMENT PRACTICES, 1988

	Hamakua Sugar Company		Hilo Coast Processing Company	
	With Current Wastewater Treatment	With Reduced Wastewater Treatment	With Current Wastewater Treatment	With Reduced Wastewater Treatment
Revenues				
¢/lb.	16.02	16.02	16.35	16.35
\$/yr.(10^6)	42.7	42.7	23.8	23.8
Operating Costs[1]				
¢/lb.	15.54	15.29	16.14	15.64
\$/yr.(10^6)	41.4	40.7	23.5	22.8
Surplus				
\$/yr.(10^6)	1.3	2.0	0.3	1.0
Wastewater Treatment Cost				
\$/yr. (10^6)	0.927	0.393	0.784	0.060
Share of Operating Cost (%)	2.2	1.0	3.3	0.3
Z Score	-0.200 (likely bankruptcy range)	-0.169 (likely bankruptcy range)	1.494 (indeterminate range)[2]	1.517 (indeterminate range)[2]

[1] Revenues from molasses, electricity, interest, tolling fees, C&H dividend, and other services are treated as an offset to costs

[2] Mauna Kea Agribusiness

near future it is unlikely that other crops would be grown on the 50,000 acres currently devoted to cane production. If unemployed sugar workers wished to find new jobs in agriculture, they would probably have to relocate. Workers from these mills would most likely have to move to obtain jobs in the tourist industry. It is at least a two-hour drive from where most sugar workers live to the hotels on the other side of the island.

Closure of these two mills would displace about 1,642 employees. It is unlikely, were these mills to close, that the closures would be unannounced. So workers would have fairly extended lead times to find new employment opportunities. Further, the companies would probably take land out of production over a three-year period, thus phasing out workers over a period of time rather than terminating all workers at once. Thus any effects of mill closures on the local labor markets should be attenuated somewhat.

If the sugar mills were to close, however, the effects on employment and income would not be felt just by people who work directly for that industry. The effects would be multiplied and felt throughout the local economy. According to Hitch (8), for every employee working full time in the sugar industry, 2.29 jobs outside the sugar industry would not exist without the sugar industry. Hitch also found that each dollar the sugar industry spends on payroll generates $1.72 of personal income in Hawaii. Using Hitch's employment multiplier of 2.29 and income multiplier of 1.72, EPA estimates that the closure of both mills would result in 3,760 lost jobs and almost $66 million in lost income. The total civilian labor force on the Island of Hawaii is approximately 41,000, based on 1980 Census data (9); the total civilian labor for the State is 435,780.

The actual effects on employment and income may be somewhat lower for a number of reasons. As was previously mentioned, some sugar mill employees, particularly those with managerial or technical skills, would probably have little or no difficulty finding new jobs. Also, 11 percent of employees are approaching retirement age and would be eligible to start receiving pensions. As dislocated workers find new jobs there would be similar positive multiplier effects on other jobs. There is no doubt, however, that the closing of these mills would have a substantial impact on the lifestyles of individuals and families involved, and on both employment and income in the local economy.

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7.0 COST AND EFFLUENT REDUCTION BENEFITS

7.1 COMPARING COSTS AND EFFLUENT REDUCTION BENEFITS

The methods used by HSC and HCPC to harvest sugar cane and process it into raw sugar result in the generation of large quantities of wastewater. Both companies are complying with existing effluent limitations guidelines based on BPT. One of the Task Force's objectives was to reevaluate the existing BPT regulations. In establishing BPT effluent limitations guidelines, EPA considers the total cost of applying the technology in relation to the effluent reduction benefits. Also, as presented in Section 1.2 of this report, the Senate colloquy preceding passage of the Appropriations Bill mandating this study, indicated that EPA's Task Force should consider the reasonableness of the relationship between the costs of reducing pollutant levels in effluent and the effluent reduction benefits derived.

For this evaluation of the Hilo-Hamakua mills, the relationship is expressed as the ratio of wastewater treatment cost to the pounds of TSS removed. This ratio or "unit cost" is calculated for the current level of control and for a reduced level of wastewater treatment.

7.2 COSTS AND EFFLUENT REDUCTION BENEFITS FOR BPT

The following sections present the current costs of wastewater treatment at HSC and HCPC, the amounts of TSS removed by wastewater treatment, and the relationship between costs and removals. Section 7.2.3 then compares the results for the Hilo-Hamakua coast subcategory to similar ratios EPA has calculated for other industries.

7.2.1 Effluent Reduction Benefits of BPT

For technical and economic reasons, HSC and HCPC, like other sugar growers in the State of Hawaii, use mechanical methods to harvest cane. Mechanical harvesting results in the entrainment of soil, rocks, and leafy trash along with the cane. To remove these materials, the cane is washed at the mill using large quantities of water. Based on mass balance data supplied by the mills and the analyses conducted by EPA, the Agency estimates that about 402,500 tons of this material, at 1988 rates, become entrained in the wastewater and are subject to BPT treatment. Figure 7-1 shows the production steps and annual soil and fiber mass balances for both mills combined.

Both companies currently treat the mill wastewater using similar processes, allowing the wastewater to stand so that most of the solids settle out. The solids are landfilled, and the remaining effluent is discharged to the Pacific Ocean. Settling results in the removal of about 99 percent of the TSS, about 397,000 tons annually at 1988 rates. The remaining 5,500 tons of TSS are discharged to the ocean in the wastewater.

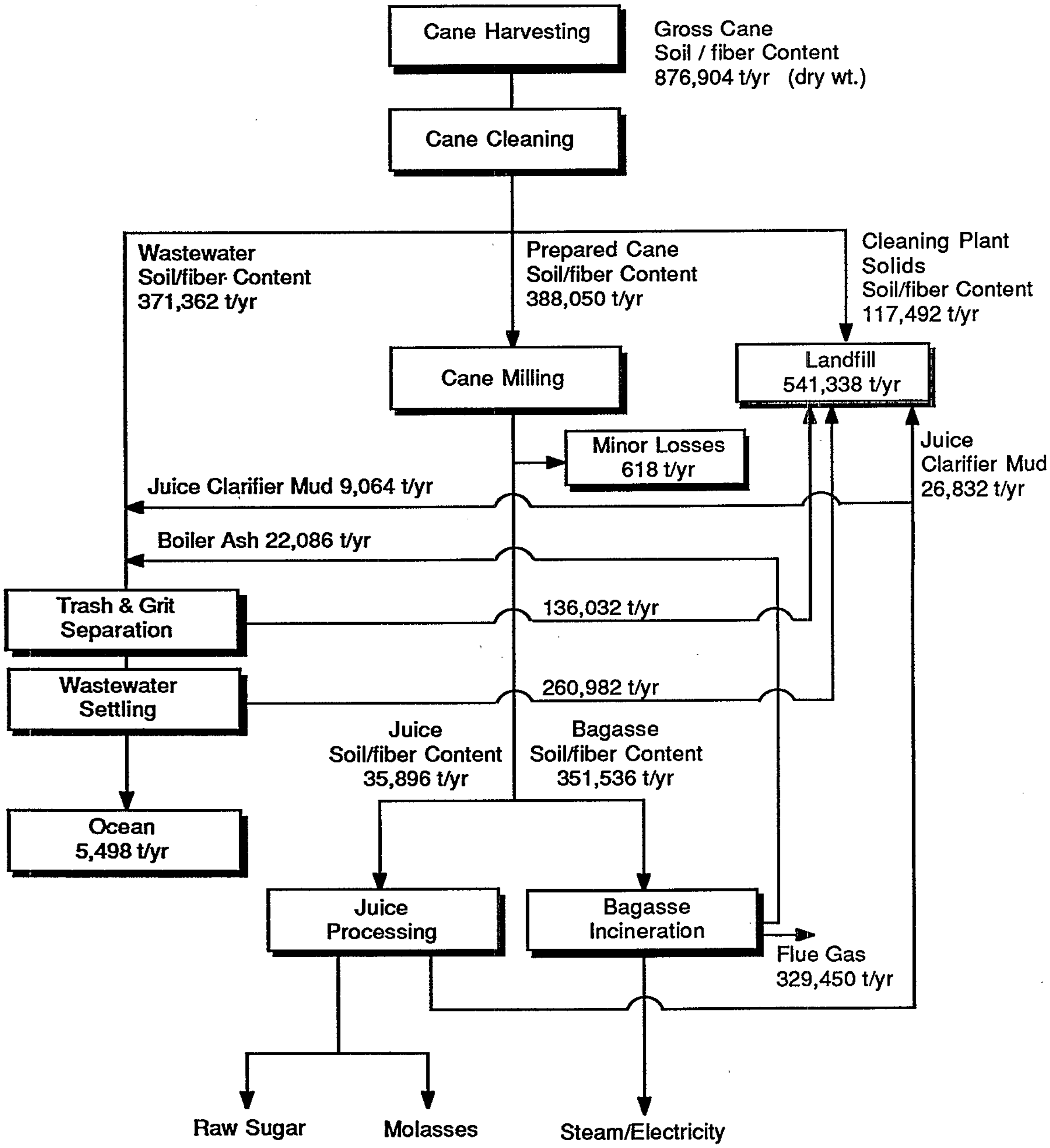

FIGURE 7-1
ANNUAL SOIL AND FIBER MASS BALANCE FOR HILO-HAMAKUA COAST SUGAR MILLS AT EXISTING LEVELS OF TREATMENT

7.2.2 Costs of BPT

Based on data provided by the mills and analyzed by EPA, the costs required to meet BPT for the two mills combined are $1.929 million annually at 1988 rates (see Tables 7-1 and 7-2). These costs include interest and depreciation expense of $217,280. These two cost components are fundamentally different from the other cost components of Tables 7-1 and 7-2 in that, were the mills to suspend all wastewater treatment, these costs would not be affected. Thus, the opportunity cost of BPT is $1.711 million annually. These costs are reflected in lower economic surpluses; they are not passed on to consumers in the form of higher prices.

7.2.3 Comparing BPT Costs and Benefits

As mentioned in Section 7.1, one measure EPA uses to evaluate the reasonableness of wastewater treatment costs is the cost per pound of pollutant (in this case, TSS) removed. For this industry subcategory, this cost is $0.0024 per pound using the data provided by the companies, and $0.0022 without depreciation and interest expense.

These costs can be compared to the unit costs incurred for effluent reductions in other industries where the effluent limitations are also primarily for the control of conventional pollutants. As shown in Table 7-3, the unit cost of control for the Hilo-Hamakua Coast subcategory is at least an order of magnitude less than the cost for sugar processors elsewhere and several orders of magnitude less than the costs for grain mills, pulp and paper mills, and the pharmaceutical manufacturing industries. This comparison suggests that the relationship of costs to effluent reductions for the Hilo-Hamakua Coast subcategory is reasonable.

7.3 COSTS AND EFFLUENT REDUCTION BENEFITS FOR REDUCED WASTEWATER TREATMENT

HSC and HCPC have requested a relaxation of their wastewater treatment requirements under BPT, arguing primarily that the effluent reduction benefits do not merit the costs incurred and the potential adverse effects of the costs on the viability of their companies. EPA estimated the cost savings and the additional discharges of TSS to the ocean assuming less stringent wastewater treatment, as proposed by the companies. This section presents the costs, TSS removals, and unit cost comparison for this reduced level of treatment.

7.3.1 Benefits of Reduced Wastewater Treatment

Figure 7-2 shows the production steps and annual soil and fiber mass balances for reduced wastewater treatment at both mills combined. With reduced wastewater treatment, EPA estimates that the removal efficiency for this subcategory would decrease to about 18 percent, increasing the TSS discharged to the ocean by nearly 298,000 tons annually at 1988 rates. This is an increase of 55 times the current materials loading.

TABLE 7-1

WASTEWATER TREATMENT COSTS AT
HAMAKUA SUGAR COMPANY IN 1988

Cost Category	Cost ($)
Labor	$ 410,950
Equipment	249,715
Maintenance Materials	33,311
Treatment Chemicals	83,890
Electricity	145,152
Laboratory Analyses	724
Interest	74,283
Depreciation	46,385
Outside Contractor Services	3,113
Total Operation and Maintenance Costs	1,047,523

TABLE 7-2

WASTEWATER TREATMENT COSTS AT
HILO COAST PROCESSING COMPANY IN 1988

Cost Category	Cost ($)
Labor	$ 158,019
Equipment	190,262
Maintenance Materials	52,138
Treatment Chemicals	29,020
Electricity	236,365
Laboratory Analyses	5,109
Insurance	3,172
Equipment Rental	76,616
Depreciation	96,612
Outside Contractor Services	35
Internal Mill Services	32,257
Freight and Other	1,432
Total Operation and Maintenance Costs	881,037

TABLE 7-3

COST PER POUND OF POLLUTANT REMOVED
FOR VARIOUS INDUSTRIES

Industry Category and Subcategory	Cost per Pound Removed* ($)
Sugar Processing	
Louisiana Raw Cane Sugar Processing	0.031
Puerto Rico Raw Cane Sugar Processing	0.027
Beet Sugar Processing	0.018
Crystalline Cane Sugar Refining (Large)	0.073
Liquid Cane Sugar Refining	0.182
Ferroalloy Manufacturing	
Covered Electric Furnaces	0.098
Slag Processing	0.036
Glass Manufacturing	
Plate Glass	0.222
Auto Glass Tempering	2.155
Auto Glass Laminating	0.073
Grain Mills	
Corn Dry Milling (Large)	0.206
Ready to Eat (Small)	0.807
Ready to Eat (Large)	0.327
Wheat Starch and Gluten	0.145
Pulp, Paper, and Paper Board Industry	
Nonintegrated Tissue Papers	0.476
Nonintegrated Lightweight Papers	0.573
Lightweight	0.515
Electrical	2.071
Nonintegrated-Filter and Nonwoven Papers	3.065
Nonintegrated Paperboard	0.599
Pharmaceutical Manufacturing	
Fermentation Products	0.487
Extraction Products	1.946
Chemical Synthesis Products	0.487
Mixing/Compounding and Formulation	1.946

* All values were derived from EPA Development Documents and are expressed as third quarter 1988 dollars.

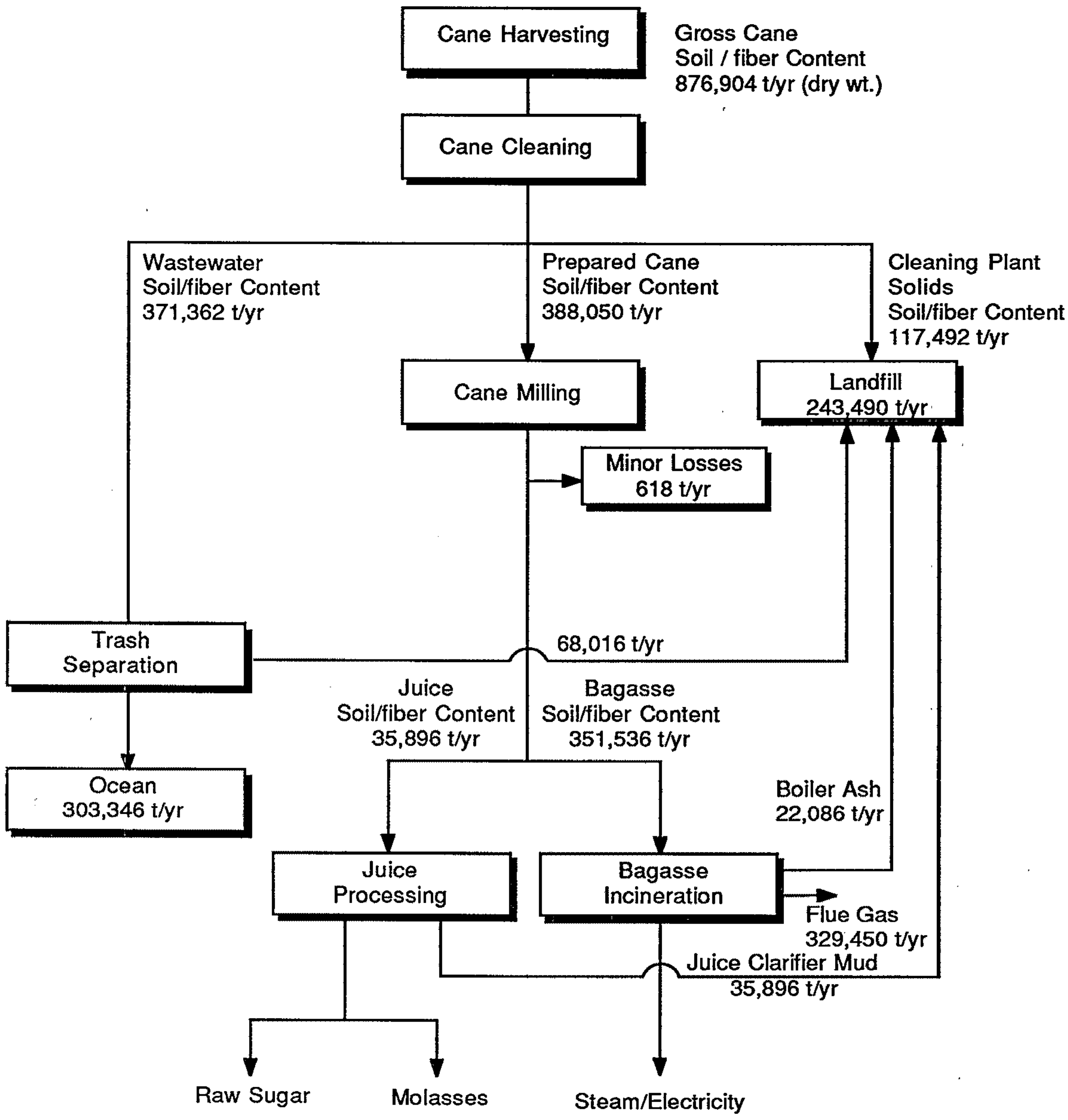

FIGURE 7-2
ANNUAL SOIL AND FIBER MASS BALANCE FOR HILO-HAMAKUA COAST SUGAR MILLS AT REDUCED LEVEL OF TREATMENT

7.3.2 Costs of Reduced Wastewater Treatment

With reduced wastewater treatment, the mills would save the costs of some of the land, labor, materials, and physical capital currently used to treat wastewater. However, all wastewater treatment costs incurred by the two mills would not be avoided as some treatment would still be undertaken. Tables 7-4 and 7-5 shows EPA's estimate, based on data provided by the mills, of the cost of reduced wastewater treatment.

The cost savings for the two mills combined with reduced wastewater treatment are $1.378 million annually at 1988 rates. The savings in these costs with reduced wastewater treatment would accrue to the owners and creditors of the two companies.

Costs of this magnitude are fairly small when expressed as a percentage of all operating costs for these mills. They are, however, a significant share of the economic surpluses generated by the mills.

The companies have argued that the costs of BPT threaten the economic viability of the mills. In 1988, the economic and financial condition of both companies was marginal. Without productivity improvements by the companies or increases in sugar prices, these companies may elect to close the mills, letting the land go fallow or returning it to other uses. Without reduced wastewater treatment and the attendant cost savings to the companies, the date of closure may be marginally accelerated. However, EPA does not believe it would be correct to attribute the closure of the mills and the associated impacts on workers and suppliers to BPT.

7.3.3 Benefit-Cost Comparison for Reduced Wastewater Treatment

Not reducing wastewater treatment requires the continued expenditure of $1.378 million annually at 1988 rates by the mills' owners and creditors. Not reducing the wastewater treatment requirements also provides certain water quality benefits, though no attempt was made to value those benefits. The benefit-cost comparison is thus limited to the unit cost of TSS removed.

The result for reduced wastewater treatment would be $0.0021 per pound of TSS removed. This value is approximately the same as the unit cost of BPT stated above; thus, it too compares favorably with BPT costs for other subcategories and industries.

7.4 SUMMARY OF COST AND EFFLUENT REDUCTION BENEFITS

Table 7-6 presents a summary of the cost and effluent reduction benefits for BPT and reduced levels of treatment. The difference between the two levels is also reported.

TABLE 7-4

ESTIMATED WASTEWATER TREATMENT COSTS AT
HAMAKUA SUGAR COMPANY AT REDUCED LEVEL OF TREATMENT

Cost Category	Cost ($)
Labor	$ 151,049
Equipment	111,435
Maintenance Materials	8,328
Treatment Chemicals	0
Electricity	21,773
Laboratory Analyses	724
Interest	74,283
Depreciation	46,385
Outside Contractor Services	0
Increased Ash Handling Costs	100,000
Total Operation and Maintenance Costs	513,977*

*The estimated cost savings to Hamakua Sugar Company at a reduced level of treatment are $653,546, which is calculated as follows: the costs of current BPT treatment are $1,047,523 (Table 7-1) minus $513,977, plus $120,000, which is an allowance for dredging of newly constructed mud settling ponds. This dredging cost will not be incurred if a reduced level of treatment is allowed.

TABLE 7-5

ESTIMATED WASTEWATER TREATMENT COSTS AT HILO COAST PROCESSING COMPANY AT REDUCED LEVEL OF TREATMENT

Cost Category	Cost ($)
Labor	$ 2,257
Equipment	903
Maintenance Materials	0
Treatment Chemicals	521
Electricity	0
Laboratory Analyses	0
Insurance	1,565
Equipment Rental	0
Depreciation	0
Outside Contractor Services	0
Internal Mill Services	0
Freight and Other	0
Increased Filter Cake and Ash Handling Costs	55,000
Total Operation and Maintenance Costs	60,246

TABLE 7-6

SUMMARY OF COST AND EFFLUENT REDUCTION BENEFITS

	BPT	Reduced Level of Treatment	Difference
Amount of TSS Treated (tons/yr)	405,512	371,362	31,150
TSS Removed by Treatment (tons/yr)	397,014	68,016	328,998
TSS Discharged to Ocean (tons/yr)	5,498	303,346	297,848
Wastewater Treatment Costs ($/yr, 10^6)	1.711	0.453	1.378
$/lb of TSS Removed ($)	.0022	.0033	.0021

8.0 PERMITTING AND WATER QUALITY STANDARDS ISSUES

8.1 COMPLIANCE WITH EXISTING EFFLUENT LIMITATION GUIDELINES

Review of discharge monitoring data supplied by HSC and HCPC indicates that both mills are able to meet BPT/BCT effluent limitations contained in their NPDES permits (based on gross cane) on a regular basis. HSC reported only one maximum day violation, and four monthly average violations during the years 1986, 1987, and 1988. During the same period HCPC did not report any discharges greater than the limitations of its permit. However, additional discharge permit violations may be occurring because of clarifier overloading and upsets at HSC, and cleaning plant breakdowns and wastewater by passes at HCPC. No records or reports of these potential violations were made. Tables 8-1 and 8-2 summarize the monthly average discharge data.

8.2 COMPLIANCE WITH EXISTING FEDERAL AND STATE WATER QUALITY STANDARDS AND OCEAN DISCHARGE CRITERIA

A detailed discussion of various water quality data which were collected from both water column sampling and coral evaluation (both within and outside of the existing mixing zones for both HSC and HCPC as well as both reference areas) was described in Section 2 of this report. Additional discussion of these data, and the mills' compliance with water quality standards, as well as section 403(c) ocean discharge criteria, follows. Achievement of water quality standards is a requirement of all NPDES permits.

8.2.1 Compliance With Water Quality Standards

8.2.1.1 Water Quality Standards and Their Implementation. Section 303 of the CWA contains provisions regarding State WQS and their implementation. 40 CFR Part 131 of EPA's regulations contains regulatory provisions regarding WQS, including general provisions, establishment of WQS, procedures for the review and revision of WQS and federally promulgated WQS. Hawaii's WQS are contained in the Hawaii Administrative Rules, Title 11, Chapter 54; the Hawaii WQS were originally adopted in 1974 and were revised in 1979, 1982, 1984 and 1988. EPA reviews State WQS and can require the State to make changes to its WQS to comply with the CWA. Federal WQS can be promulgated by EPA if a State's WQS do not comply with the Clean Water Act; there are no Federally promulgated WQS for Hawaii.

State WQS are implemented through NPDES permits. Under section 301(b)(1)(C) of the CWA, the NPDES permit must contain limitations necessary to assure compliance with State WQS. In the case of the NPDES permits for HSC and HCPC, the Hawaii Department of Health issued NPDES permits for both mills on March 1, 1985; the permits expire on February 28, 1990.

The receiving water at both mills (the Pacific Ocean) is classified in the Hawaii WQS as Class A Open Coastal Waters. The beneficial uses of the

TABLE 8-1

MONTHLY AVERAGE DISCHARGE SUMMARY
FOR HAMAKUA SUGAR COMPANY

Month	Pounds TSS Per 1,000 Pounds Gross Cane		
	1986	1987	1988
January	--	--	2.0
February	--	--	1.3
March	--	--	1.8
April	3.4	--	--
May	4.1	4.6	2.0
June	1.5	2.8	4.4
July	1.5	5.3	1.8
August	2.3	1.4	1.2
September	2.4	1.4	1.2
October	1.7	3.1	1.5
November	1.7	2.5	2.2
December	1.1	2.2	1.7

Note: BPT Limitation is 3.6 lbs TSS/1000lbs gross cane for maximum monthly average

-- indicates no data available

TABLE 8-2

MONTHLY AVERAGE DISCHARGE SUMMARY
FOR HILO COAST PROCESSING COMPANY

Month	Pounds TSS Per 1,000 Pounds Gross Cane		
	1986	1987	1988
January	0.6	1.7	0.9
February	0.5	1.7	1.1
March	0.8	0.5	2.2
April	0.1	1.0	1.6
May	1.5	--	--
June	0.4	1.3	0.8
July	1.1	0.9	1.5
August	1.4	2.4	2.3
September	0.8	1.5	1.1
October	0.6	2.0	1.6
November	1.1	1.6	1.8
December	1.6	1.4	1.6

Note: BPT Limitation is 3.6 lbs TSS/1000lbs gross cane for maximum monthly average

-- indicates no data available

receiving water are recreational (including fishing, swimming, bathing and other water-contact sports), aesthetic enjoyments, and the support and propagation of aquatic life.

In the Hawaii Administrative Rules, 11-54-04(a), the State has established basic water quality criteria applicable to all waters, including provisions that all waters shall be free of substances attributable to industrial pollution, including:

> (1) materials that will settle to form objectionable sludge or bottom deposits,
>
> ....
>
> (3) substances in amounts sufficient to produce taste or odor ... or in amounts sufficient to produce objectionable color, turbidity or other conditions in the receiving waters,
>
> (4) high temperatures; biocides; pathogenic organisms; toxic, radioactive, corrosive, or other deleterious substances at levels or in combination sufficient to be toxic or harmful to human, animal, plant or aquatic life, or in amounts sufficient to interfere with any beneficial use of the water,
>
> ....

In the Hawaii Administrative Rules, 11-54-06(b)(3), the State has established numeric criteria for open coastal waters for total nitrogen, ammonia nitrogen, nitrate + nitrite nitrogen, total phosphorus, chlorophyll a, and turbidity. In addition, as indicated previously, Hawaii intended to propose to establish marine water quality criteria for several metals.

In 11-54-09, Hawaii has also provided for the establishment of zones of mixing around outfalls to allow for the initial dilution and assimilation of waste discharges. Mixing zones are permissible provisions of State WQS, but as is the case with all State WQS, are subject to EPA approval. In addition, even though mixing zones are provided to allow for initial dilution of waste discharges, it is EPA's interpretation of WQS regulations that acute impacts (lethality) within the mixing zone are not allowed. As previously indicated, Hawaii has established interim mixing zones for both mills as described in Section 1.6 and as depicted in Figures 2-2 and 2-3. EPA approved these interim mixing zones for a period of one year on August 21, 1987.

Both permits contain narrative limitations (1) prohibiting the discharge of floating solids, visible foam, sugarcane trash and bagasse, filter cake, boiler ash, clinker, soot and rock; and (2) specifying that the discharge shall not cause objectionable odors at the surface of the receiving waters. These narrative limitations are based on basic water quality criteria contained in 11-54-04 and are applicable to all waters in Hawaii.

8.2.1.2 Benthic Impacts. As described in detail in section 2, there are significant impacts on coral caused by the existing discharge of sediments at both HSC and HCPC. The impacts include a decrease in the number of coral species, species diversity, and coral cover within the mixing zones at both mills. The impacts are most severe near the discharge outfalls of both HSC and HCPC, resulting in a complete or near complete elimination of coral and other benthos at some locations in the mixing zones. It is believed the impacts are due to burial of the coral and blockage of light by the sediment. The impacted zone at HCPC extends outside of the existing mixing zone. In addition, there are sub-lethal effects of bleaching of corals at some locations within the mixing zones. Therefore, a beneficial use of the receiving waters, support and propagation of aquatic life, is being impaired by the discharges and thus violate WQS within the mixing zones.

Evaluating the coral and other benthos at the Kolekole Stream reference area revealed a much less severe impact, that was different in character, and in a smaller area.

If the mills are allowed to increase the level of solids discharged to the Pacific Ocean, the severity of impacts to the coral and other benthos would be increased, as would the extent of the impacted areas.

8.2.1.3 Water Column Impacts. Numerous water column locations were sampled and analyzed primarily within but also outside of the existing mixing zones for both HSC and HCPC as well as both reference areas. The data were discussed in detail in Section 2.

In summary, there were no violations of current Hawaii numeric water quality criteria contained in 11-54-06 outside of the mixing zones of either mill. Based upon sampling data there were exceedances within the mixing zones at both mills of existing Hawaii numeric criteria, along with EPA criteria and Hawaii criteria to be proposed. In addition, in certain cases due to limited data, data were inconclusive as to the possibility of other exceedances within the mixing zones.

The pollutants for which exceedances are found are contained in Table 8-3.

The projected violations for nitrate + nitrite nitrogen and turbidity for both mills are within the mixing zones of the respective mills, and therefore, are not considered to be exceedances of the Hawaii numeric criteria contained in 11-54-06 which apply outside of the mixing zone.

In the case of HCPC, there also are exceedances of the EPA acute and chronic marine criteria for copper and the EPA human health marine criteria for manganese. Except for exceedances of the acute criteria for copper, these exceedances are not considered to be violations of WQS because they take place within the mixing zone. The violations of the acute copper criteria at HCPC were both directly off of and north of the outfall.

TABLE 8-3

WATER QUALITY CRITERIA EXCEEDANCES BASED ON SAMPLING DATA

Hamakua Sugar Company (Within the Mixing Zone)

Nitrate + nitrite nitrogen
Turbidity
Copper (EPA acute and chronic marine criteria)
Lead (EPA chronic marine criteria)
Arsenic (EPA human health marine criteria)
Mercury (EPA acute and chronic marine criteria, Hawaii proposed acute marine criteria, and EPA human health marine criteria)

Hilo Coast Processing Company (Within the Mixing Zone)

Nitrate + nitrite nitrogen
Turbidity
Copper (EPA acute and chronic marine criteria)
Manganese (EPA human health marine criteria)

Waipio-Waimanu Reference Site

Lead (EPA chronic marine criteria)

Kolekole Reference Stream

Nitrate + nitrite nitrogen
Copper (EPA acute and chronic marine criteria)

In the case of HSC, there are also projected to be exceedances of the EPA acute and chronic marine criteria for copper; the EPA chronic marine criteria for lead; the EPA human health marine criteria for arsenic; and the EPA acute and chronic marine criteria, the EPA human health marine criteria, and the Hawaii acute marine criteria for mercury. Except for the case of the exceedances of the acute criteria for copper and mercury, which are considered violations because they are violations of acute criteria within the mixing zone, these exceedances are not considered to be violations of WQS. The exceedances of the acute copper and mercury criteria occur in the various locations in the mixing zone.

The data indicate there are exceedances of the nitrate + nitrite nitrogen criteria and the EPA acute and chronic marine criteria for copper off of the location where Kolekole Stream enters the Pacific Ocean. The data also indicate exceedance of the EPA chronic marine criteria for lead at the Waipio-Waimanu reference site. The acute copper criteria exceedance at the Kolekole Stream site and at the mills may be attributable, at least in part, to naturally occuring heavy metals in the volcanic-based uncultivated soils and in the sugarcane plantation soils.

If the mills are allowed to increase the level of solids discharged to the Pacific Ocean, it is probable that additional and more severe exceedances of water quality criteria both within and outside of the existing mixing zone would occur.

8.2.2 Ocean Discharge Criteria

Section 403(a) of the CWA requires compliance with section 403(c) guidelines before an NPDES permit can be issued for a discharge to the territorial seas, contiguous zone, or the ocean. Section 403(c)(1) establishes criteria for the guidelines for determining the degradation of waters of the territorial seas, contiguous zone, and the oceans. Section 403(c)(2) indicates that an NPDES permit cannot be issued if there is insufficient information on a proposed discharge to make a reasonable judgment on compliance with the guidelines.

EPA has promulgated regulations for Ocean Discharge Criteria (ODC) under section 403 in 40 CFR Part 125, Subpart M. The regulations provide that the State Director may issue an NPDES permit after it is determined that the discharge will not cause unreasonable degradation to the marine environment after application of any necessary conditions (125.123(a)). The Director may not issue an NPDES permit if it is determined that the discharge will cause unreasonable degradation to the marine environment after application of any necessary conditions (125.123(b)). The Director may not issue an NPDES permit if there is insufficient information whether there will be unreasonable degradation, unless the Director decides the discharge will not cause irreparable harm during the period in which monitoring is undertaken, there are no reasonable alternatives to on-site disposal of the materials, and permit conditions are established as required by the regulations (125.123(c)). The regulations define "unreasonable degradation of the marine environment" in 124.121(e) as

(1) significant adverse changes in ecosystem diversity, productivity and stability of the biological community within the area of discharge and surrounding biological communities,

(2) threat to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms, or

(3) loss of esthetic, recreational, scientific or economic values which is unreasonable in relation to the benefit derived from the discharge.

In 125.122, the regulations provide ten criteria that are to be used in determining whether a discharge will cause unreasonable degradation of the marine environment.

EPA is currently drafting proposed revisions to its regulations implementing the ODC to implement a more focused and consistent national program of evaluating the effects of dischargers into marine waters. Specific criteria will be proposed to evaluate the ten ocean discharge factors. It is projected the regulations will be proposed in late 1990.

In the case of HSC and HCPC, the State made a determination that the discharges would not cause an unreasonable degradation of the marine environment, thereby allowing the issuance of the mills' NPDES permits. This determination was contained in the fact sheets for both NPDES permits which were subject to public notice. These permits were then issued on March 1, 1985.

8.3 VARIANCES FROM WATER QUALITY STANDARDS

States may, in limited situations, provide relief to specific dischargers from applicable water quality standards via either: (1) removing a designated use or establishing a subcategory of a designated use for a specific water body, or (2) adopting a variance policy and issuing temporary variances from standards for the specific dischargers. Each of these options requires changes to the State water quality standards regulation and is tightly controlled by the federal water quality standards regulation (40 CFR Part 131).

Removing designated uses and establishing subcategories of uses (i.e., use downgrades) are subject to the requirements of Section 131.10 of the water quality standards regulation. For use downgrades to be acceptable, <u>all</u> of the following tests must be satisfied:

- the action may not result in removal of an existing use, as defined at 40 CFR 131.3 (e);

- the action must ensure the attainment and maintenance of the water quality standards of downstream or adjacent waters;

- the action must be necessary because the standard will not be attained by implementing effluent limits required under Sections 301 (b) and 306 of the CWA and by implementing cost-effective and reasonable best management practices for nonpoint source control; and

- the action must be justifiable based on a use attainability analysis which demonstrates that attaining the use is not feasible based on one of the six factors established at 40 CFR 131.10(g).

Requirements pertaining to State variance policies have been described in the Water Quality Standards Handbook (p. 1-9) and a March 15, 1985 guidance memorandum from Edwin L. Johnson to the EPA Water Management Division Directors. Variance policies are optional components of State water quality standards but, where adopted, are subject to EPA approval (see 40 CFR 131.13). Variances from standards for specific dischargers are only permitted if the variance is included as part of the water quality standard, it is subjected to the same public review as other changes in water quality standards, and it is justifiable based on the same tests that are used to justify a use downgrade (outlined above).

In the case of these two Hawaii sugar mills, use downgrades or variances from water quality standards would not be acceptable under the federal water quality standards regulation because the action would result in further impairment of an existing use (i.e., the support and propagation of aquatic life including coral). In addition, it is possible that the action would cause violation of the water quality standards of adjacent waters.

As mentioned earlier, Hawaii and EPA would evaluate applications from HSC and HCPC to determine if increases in their respective mixing zones to accommodate such increases were appropriate. However, it is uncertain whether such increases in mixing zones for the mills would be approved in light of existing impacts.

8.4 ANTIBACKSLIDING

EPA has established regulations in 40 CFR 122.44(1), which generally prohibit the issuance of a permit with less stringent limitations than those in a previous permit, except in certain limited circumstances ("antibacksliding"). In the Water Quality Act of 1987, Congress enacted section 402(o) of the CWA and provided a statutory basis for the general prohibition against backsliding for several situations; these statutory provisions were generally similar to EPA's then existing regulatory provisions.

In 1978 the State of Hawaii Department of Health issued permits to the mills containing Best Professional Judgement (BPJ) technology-based limitations. The HSC permit contained BPJ TSS limitations based on 5.825 lb./1000 lb. net cane (monthly average) and 18.325 lb./1000 lb. net cane (daily maximum). The HCPC permit contained BPJ TSS limitations based on 6.881 lb./1000 lb. net cane (monthly average) and 28.131 lb./1000 lb. net cane (daily maximum). These effluent limitations are less stringent than current limitations issued by EPA in 1979, but substantially more stringent than the wastewater discharge levels being proposed by the mills. Assuming that EPA were to find that the current BPT effluent limitations are no longer appropriate (which has not occurred), then antibacksliding provisions would apply, unless one of the exceptions to the prohibition against backsliding are satisfied.

There are three general backsliding situations which are considered.

The first situation is the case where the permitting authority, in this case the State of Hawaii, has established BPJ technology-based limitations and an effluent guideline regulation is subsequently promulgated which would result in less stringent effluent limitations. This would be the situation if EPA were to subsequently revise the applicable effluent guidelines to allow for establishment of effluent limitations less stringent than those contained in the BPJ permits issued by Hawaii in 1978. This situation is specifically covered by the provisions in section 402(o) of the CWA and 40 CFR 122.44(l)(2) (54 FR 256, January 4, 1989). In this case, backsliding from the BPJ limitations to the less stringent guidelines-based limitations would be prohibited unless one of five listed exceptions is satisfied. EPA does not believe that any of the five exceptions are satisfied in this case. Therefore, even if the guidelines were made less stringent, technology-based limitations could not be established which would be any less stringent than those contained in the 1978 BPJ permits. In addition, any limitations must assure compliance with State WQS (CWA section 402(o)(3), and 40 CFR 122.44(l)(2)(ii)).

The second situation is the case where the permitting authority, in this case the State of Hawaii, has established BPJ technology-based limitations and a subsequent BPJ permit is issued. This would be the situation if EPA were to suspend the application of the applicable effluent limitations guidelines; Hawaii would then establish BPJ technology-based limitations. This situation is not covered by the provisions in section 402(o) of the CWA, but is covered by 40 CFR 122.44(l)(1). In this case, backsliding from the BPJ limitations established by the State to less stringent BPJ limitations would be prohibited unless one of the 17 listed causes for modification listed in 40 CFR 122.62(a) or one of the causes for modification or revocation and reissuance contained in 40 CFR 122.62(b) is satisfied. EPA does not believe that any of the causes for modification or revocation and reissuance applies to the mills. Therefore, even if the guidelines were suspended and Hawaii were to establish BPJ technology-based limitations, those BPJ technology-based limitations could not be established which would be any less stringent than those contained in the 1978 BPJ permits. In addition, as is the case with any permit, the permit must also contain limitations necessary to assure compliance with State WQS. 40 CFR 122.44(d).

The third situation is the case where the permitting authority has established water quality-based effluent limitations and the question arises whether less stringent water quality-based effluent limitations can be established. It is not believed that this situation is at issue in this matter. In any event, this situation is specifically covered by the provisions in section 402(o) of the CWA; EPA has not revised its regulations to deal with this situation.

In summary, antibacksliding regulations would prevent relaxation of the NPDES permit limitations for the mills to the mass loadings of TSS proposed by the mills.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 CONCLUSIONS

The Task Force has reached the following conclusions concerning the wastewater discharges from raw cane sugar mills on the Hilo-Hamakua coast of Hawaii:

1. The existing discharges cause substantial environmental impacts including elimination of coral and other benthic life in areas surrounding the discharge points at both mills, and significant reduction in coral and other benthos within the mixing zone at HSC, and within and beyond the mixing zone at HCPC. Therefore, a beneficial use of the receiving waters, support and propagation of aquatic life, is being impaired by the discharges and the discharges violate WQS within the mixing zones. Neither numeric Hawaiian water quality standards nor EPA water quality criteria are exceeded beyond the mixing zones.

   Within the mixing zones at both mills, the levels of two classical water quality parameters (NO_3+NO_2 and turbidity) and several metals (copper, mercury lead, and arsenic at HSC; and copper and manganese at HCPC) were found to exceed Hawaii standards and EPA criteria. The levels of copper and mercury exceeded EPA acute criteria. The acute criteria exceedances also violated federal water quality requirements and policy for mixing zones under section 403(c) of the CWA.

2. The impact of natural stream runoff on coastal waters is substantially smaller, less severe, and different in character from the impact of sugar mill discharges. Data are not available, however, for direct quantitative comparison. Sugarcane cultural practices cause soil erosion which contributes to nonpoint source discharges to both streams and coastal waters.

3. The receiving water (Pacific Ocean) is not a drinking water source and there are no beaches in the immediate area of the discharges, therefore these uses are not impaired by the existing discharges. However, the potential exists for ciguatera poisoning from human consumption of fish taken from the vicinity of the mills.

4. Discharge monitoring report (DMR) data indicate the mills (with a few exceptions at HSC) are in compliance with, and achieving better TSS removals than required by, BPT effluent limitations contained in the NPDES permits. However, discharge permit violations may be occurring because of clarifier overloading and upsets at HSC, and cleaning plant breakdowns and wastewater bypasses at HCPC, but are unrecorded and not reported.

5. EPA was not able to identify an alternative harvesting method that would result in fewer solids being entrained with sugarcane during harvesting. In addition, EPA could not identify a less costly and equally effective wastewater treatment/control method (other than reduced treatment, as proposed by the mills). Long-term research and development by the mills has the potential to improve harvesting methods and reduce soil loads to the mills, thus reducing treatment requirements and costs.

6. The ratios of costs to effluent reduction benefits for the two mills (0.2 to 0.4 cents per pound of TSS removed) for the existing BPT treatment systems at the mills are among the lowest of all BPT effluent limitations guidelines.

7. Both HSC and HCPC are in poorer economic condition than in 1979 when the existing BPT limitations were promulgated; however, mill closure due to the cost of BPT alone is not projected. Wastewater treatment costs are only a small portion of total operating costs (approximately 1 to 4 percent).

8. The estimated savings resulting from the proposed reductions in pollution control activities would make a short-term difference in the economic picture of both mills, but both mills may close in the foreseeable future even without BPT costs. Closing both mills would directly eliminate 1,642 jobs, with an unemployment effect of approximately 3,700 on the community.

9. The increased level of discharge proposed by the mills (up to 49 fold increase in TSS loadings for one mill and up to 70-fold increase in loadings for the other mill) would substantially increase the areas of impact on corals and other benthic life, extend those impacts beyond the existing mixing zones, and would increase the exceedances of water quality criteria. The increases in the areas of impacts would not necessarily be as great proportionally as the increase in TSS loading in the discharges. The currently permitted mixing zones are one to three orders of magnitude larger than the mixing zones for seven industrial and four municipal discharges in Hawaii with comparable or substantially larger flows. Any such increases would violate a broad array of Federal and State requirements.

10. NPDES permits for the mills based on Best Professional Judgement and issued in 1978 contained TSS limitations less stringent than current BPT. The antibacksliding provisions contained in existing NPDES regulations and section 402(o) of the CWA prevent relaxing TSS limitations to the levels proposed by the mills because those limitations would be less stringent than the 1978 BPJ limitations.

11. Closure of the mills would not mean a loss of electric power now provided to HELCO by the mills; HSC could use fuel oil and HCPC could use fuel oil or coal to operate their boilers. Sulfur dioxide air emissions from power generated solely by fuel oil would be two to three times the current emissions, while particulate emissions (now attributable to burning bagasse) would be substantially reduced. Burning coal would result in sulfur dioxide emissions levels similar to those from burning fuel oil. Particulate emission levels would be similar to those from burning bagasse.

12. Increased sulfur dioxide emissions could exacerbate acid rain problems downwind of the mills; however, the volcanic emissions of sulfur dioxide by Kilauea (and the East rift zone) are 200 to 300 times greater than the potential increased emissions from the mills and would have a substantially greater impact on regional air quality.

13. If the mills were to close, most of the 50,000 acres of sugarcane now in cultivation would probably become fallow. Alternative agricultural uses, such as macadamia nut groves, would only partially replace sugarcane. Major resort and/or residential development along the Hilo-Hamakua coast probably would be limited because of heavy rainfall.

9.2 RECOMMENDATIONS

The Task Force makes the following recommendations based on the information gathered during the study:

1. The proposed shutdown of wastewater treatment systems and resulting 50-70 fold increases in TSS discharges should not be allowed because:

   - existing sugar mill discharges cause almost complete elimination of coral and other benthic life, and exceedances of water quality criteria, including acute criteria, for certain pollutants (e.g., metals) within the mixing zones

   - proposed discharges would cause major increases, although not necessarily in direct proportion to increased solids loadings, in coverage of soil deposits, benthic (coral and other bottom organism) impacts, and would cause violation of a number of regulatory requirements

2. The existing BPT/BCT effluent limitations guidelines as applied in the current NPDES permits are still appropriate and should be retained because:

   - the cost of wastewater treatment, as in 1979 and 1983, is only a part of the current difficult economic circumstances; the mills may close within the foreseeable future even with relief;

   - the ratios of operating costs to effluent reduction benefits remain among the lowest (0.2-0.4 cents/lb of TSS removed) of all BPT effluent limitations guidelines;

   - no less costly and equally effective wastewater treatment or cane harvesting technologies were identified;

   - DMR data indicate the mills are achieving substantially better removals than required by BPT/BCT TSS effluent limitations, except during periods of upsets and bypasses

3. Antibacksliding rules apply and will not allow the proposed increases in discharges of TSS.

4. The engineering, economic, and environmental data gathered from this Task Force study are considered sufficient to make a sound determination regarding appropriate permit limitations for the mills.

10.0 ACKNOWLEDGEMENTS

The EPA Task Force staff representatives who participated in this study are as follows:

EPA Office of Water (OW)

1. Office of Water Enforcement and Permits (OWEP)
    - Permits Division
        - Gary Hudiburgh

2. Office of Water Regulations and Standards (OWRS)
    - Assessment and Watershed Protection Division (AWPD)
        - Alexandra Tarnay
    - Criteria and Standards Division (CSD)
        - David Moon
    - Analysis and Evaluation Division (AED)
        - Debra Nicoll
    - Industrial Technology Division (ITD)
        - Donald Anderson

3. Office of Marine and Estuarine Protection (OMEP)
    - Marine Operations Division (MOD)
        - Virginia Fox-Norse

EPA Office of Research and Development (ORD)

1. Risk Reduction Environmental Laboratory - Cincinnati
    - Water and Hazardous Waste Treatment Research Division
        - Kenneth Dostal

EPA Office of General Counsel (OGC)

1. Water Division
    - Margaret Silver

EPA Region IX - San Francisco

1. Water Management Division (WMD)
    - Permits Branch
        - Margaret Hooper
    - Wetlands, Oceans, and Estuaries Branch
        - Dr. Brian Melzian

2. Office of Regional Counsel (ORC)
    - Ann Nutt
    - Gail Cooper

State of Hawaii Department of Health

1. Environmental Health
   Dr. Bruce Anderson, Deputy Director
   Steve Chang

EPA Office of Policy, Planning, and Evaluation (OPPE)

1. Environmental Resource Economics Division (ERED)
   Mahesh Podar

The supporting contractor for the environmental field study was Tetra Tech, Inc., Lafayette, CA, (Contract No. 68-C8-0001) under the direction of Dr. William Muellenhoff. EPA direction for the environmental study was provided by Ms. Alexandra Tarnay. Ms. Virginia Fox-Norse and Mr. Paul Pan provided assistance in evaluating the ocean discharge and marine programs implications of this study, and the contracting mechanism for the study. Dr. Brian Melzian of EPA Region IX served to direct the field portion of that study. The expertise and extraordinary efforts of Dr. Meullenhoff and Dr. Melzian were instrumental in the planning and successful completion of this important study. The supporting contractor for the public health aspects of this study was Versar, Inc., Springfield, VA, (Contract No. 68-03-3339) under the direction of Mrs. Judy English.

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EPA
United States
Environmental Protection
Agency
(wh-552)
Washington, DC 20460