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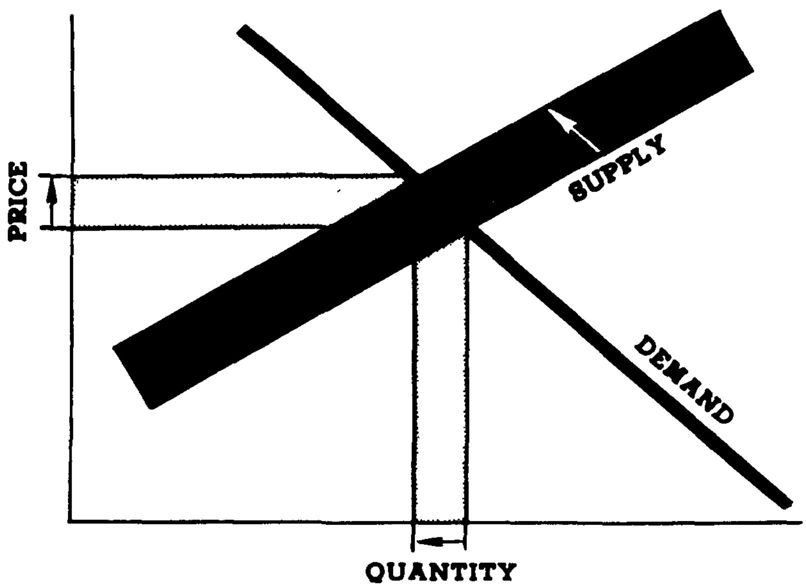
ECONOMIC ANALYSIS OF PROPOSED EFFLUENT GUIDELINES

Cane Sugar Refining Industry



U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Planning and Evaluation
Washington, D.C. 20460

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ECONOMIC IMPACT OF
COSTS OF PROPOSED EFFLUENT LIMITATION GUIDELINES
FOR THE CANE SUGAR REFINING SEGMENT OF THE
SUGAR PROCESSING INDUSTRY

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PREFACE

The attached document is a contractor's study prepared for the Office of Planning and Evaluation of the Environmental Protection Agency ("EPA"). The purpose of the study is to analyze the economic impact which could result from the application of alternative effluent limitation guidelines and standards of performance to be established under sections 304(b) and 306 of the Federal Water Pollution Control Act, as amended.

The study supplements the technical study ("EPA Development Document") supporting the issuance of proposed regulations under sections 304(b) and 306. The Development Document surveys existing and potential waste treatment control methods and technology within particular industrial source categories and supports promulgation of certain effluent limitation guidelines and standards of performance based upon an analysis of the feasibility of these guidelines and standards in accordance with the requirements of sections 304(b) and 306 of the Act. Presented in the Development Document are the investment and operating costs associated with various alternative control and treatment technologies. The attached document supplements this analysis by estimating the broader economic effects which might result from the required application of various control methods and technologies. This study investigates the effect of alternative approaches in terms of product price increases, effects upon employment and the continued viability of affected plants, effects upon foreign trade and other competitive effects.

The study has been prepared with the supervision and review of the Office of Planning and Evaluation of EPA. This report was submitted in fulfillment of Contract No. 68-01-1533, Task Order No. 5 by Development Planning and Research Associates, Inc. Work was completed as of October, 1973

This report is being released and circulated at approximately the same time as publication in the Federal Register of a notice of proposed rule making under sections 304(b) and 306 of the Act for the subject point source category. The study has not been reviewed by EPA and is not an official EPA publication. The study will be considered along with the information contained in the Development Document and any comments received by EPA on either document before or during proposed rule making proceedings necessary to establish final regulations. Prior to final promulgation of regulations, the accompanying study shall have standing in any EPA proceeding or court proceeding only to the extent that it represents the views of the contractor who studied the subject industry. It cannot be cited, referenced, or represented in any respect in any such proceeding as a statement of EPA's views regarding the subject industry.

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I. INDUSTRY SEGMENTS

For identification, this study deals with one of the three functions in the production of sugar from cane defined by industry code as follows:

SIC 2062 Sugar Cane Refining

The other functions, that of cane growing and harvesting and sugar cane milling (SIC 2061), have no direct bearing on the currently proposed water pollution, but through their indirect activity, they will be referred to in several places.

A. Types of Firms

The firms that own and control the cane sugar industry vary from the very small individual mill or refinery to the giants of U.S. Industry. By and large, large U.S. companies dominate cane sugar refining and have a position in cane milling and growing but no one company has more than 20 percent of a given segment.

1. Size of Firms

Table I-1 lists the 20 large firms that have the dominant position in the cane sugar industry. Amstar, by virtue of its five cane sugar refineries, and its ownership of Spreckels, a beet sugar company based in California, has the dominant position in sugar. Spreckels' capacity in beet sugar is about 12 percent of the U.S. beet capacity and this subsidiary also has acquired a wet corn milling company and are therefore in all phases of the sweetner industry.

Beyond the 20 large companies that have 77 percent of the refinery capacity and 34 percent of the sugar cane milling capacity, there are 60 companies of various sizes and types that process the rest of that which is considered domestic cane sugar production. These companies are grouped in specific areas as seen in Tables I-2 and I-3. The companies operating refineries are shown in Table I-4.

2. Level of Integration

From Table I-1 it can be seen that there is integration of companies within larger firms and there is a vertical integration in sugar cane production including growing, harvesting and cane milling. Some integration extends into refining also.

Table I-1. Dominant cane sugar firms and relation to industry

Firms	Estimated Net Worth ($million)	Other Sweeteners: Corn	Other Sweeteners: Beet	Cane Grower	Cane Sugar Mills: No.	Cane Sugar Mills: TPD	Cane Sugar Mills: Pct.	Cane Sugar Refineries: No.	Cane Sugar Refineries: TPD	Cane Sugar Refineries: Pct.
1. Amstar	175	X	X					5	11,050	
2. C & H	NA							2	3,690	
3. Borden, Inc.	725							3	2,190	
4. Su Crest Corp.	20							2	1,670	
5. Archer Daniels Midland	124							1	700	
6. CPC International	510	X						1	1,800	
7. United Brands	494							1	1,200	
8. Savannah Foods	32							2	2,550	
9. Imperial Sugar	NA							1	1,500	
10. Zapata-Narness	NA			X	4	14,400		1	660	
11. U. S. Sugar Co.	55			X	2	18,500				
12. Gulf & Western Foods	673			X	1	8,000				
13. Southdown Lands	132			X	3	10,700				
14. Jim Walters Co.	345			X	1	4,000				
15. Alexander Baldwin Ltd.	143			X	4	13,100				
16. Arnfac	210			X	6	17,250				
17. C. Brewer & Co.	90			X	8	17,300				
18. Theo H. Davis	NA			X	3	7,000				
19. Castle & Cooke Inc.	224			X	2	7,000				
20. Pepsico	440							1	800	
Sub-Total					34	117,250	34	20	27,810	77
Other Companies - U. S.					35	159,185	45	4	5,060	16
Other Companies - Puerto Rican					16	71,500	21	5	1,820	7
Total Domestic Cane Sugar Industry					85	347,935	100	29	34,690	100

Table I-2. Raw sugar mill companies by geographical area and number of mills

Location	Number of Owners	Number of Companies	Number of Mills
Louisiana	38	38	43
Puerto Rico	12	16	16
Hawaii	6	22	26
Florida	8	8	9
Total	64	84	94

Table I-3. Cane sugar refinery companies by geographical area and number of refineries

Location	Number of Owners	Number of Companies	Number of Refineries
Louisiana	6	[illegible]	[illegible]
Puerto Rico	5	5	5
Hawaii	[illegible]	[illegible]	[illegible]
Florida	3	3	3
West Coast	1	1	1
East Coast	8	8	10
Texas	1	1	1
Midwest	2	2	2
Total	19 1/	27	29

1/ Total doesn't add due to multiregional operations owners.

Table I-4. Ownership of domestic refineries

Percent of Industry Capacity	Company	Location
32.9	Amstar Corporation	Brooklyn, N.Y.
		Boston, Mass.
		Baltimore, Md.
		New Orleans, La.
		Philadelphia, Pa.
11.6	California & Hawaiian Sugar Co.	Crockett, Calif.
		Aiea, Hawaii
6.3	Borden Inc.	
	North American Sugar Industries Inc.	
	Colonial Sugars Co.	Gramercy, La.
	Florida Sugar Refinery, Inc.	Belle Glade, Fla.
	Industrial Sugars, Inc.	St. Louis, Mo.
7.4	Savannah Foods & Industries, Inc.	Savannah, Ga.
	Everglades Sugar Refinery Inc.	Clewiston, Fla.
1.3	Glades County Sugar Grower Coop Assn.	Moore Haven, Fla.
4.9	Godchaux - Henderson Sugar Co.	Reserve, La.
4.3	Imperial Sugar Co.	Sugarland, Tex.
5.8	National Sugar Refining Co.	Philadelphia, Pa.
2.3	PepsiCo Inc.	Long Island City, N.Y.

continued--

Table I-4. (continued)

Percent of Industry Capacity	Company	Location
3.5	United Brands Revere Sugar Refinery	Charlestown, Mass.
2.0	Jim Walter Company The South Coast Corporation	Mathews, La.
5.2	CPC International Refined Syrups and Sugars, Inc.	Yonkers, N.Y.
1.9	Zapata - Norness Southdown, Inc.	Houma, La.
4.8	SuCrest Corporation	Brooklyn, N.Y. Chicago, Ill.
2.0	Archer Daniels Midland Supreme Sugar Refinery	Supreme, La.
5.2	Refineries of Puerto Rico (5)	Puerto Rico

The cane sugar industry is characterized by a vertical integration which is far different from the structure than found in the beet sugar industry. In the beet sugar industry, until this past year, the sugar companies were separate from the growers and have bargained through growers' associations for the price and supply of beets. With the advent of coop ownership of beet sugar factories, the picture has somewhat changed since the beet grower has an interest in the processing operation.

In cane sugar, the growing of cane and cane sugar milling facilities demonstrates a high degree of integration through direct ownership or cooperative organization. Each of the four geographical areas has its own characteristic as to how integration has developed over the years.

Reference to Tables I-5 and I-6 will indicate that Puerto Rico is essentially an integrated operation inasmuch as the mills' refineries are either outright owned by the Puerto Rican Commonwealth or subsidized by this governmental body. Although there are many small farms, the growers are closely tied to the mills that they are supplying.

In Hawaii, essentially five companies own the 19 mills expected to be operating in 1973, and, with the exception of 500 cane growers that have varying degrees of tie-in with the mills, the cane land is owned by the processing mill companies. In turn, all of these companies and processors own the refinery operations of C&H in Hawaii and on the mainland near San Francisco. All of the marketing of sugar is done through this organization.

Florida has only one mill that is vertically integrated from growing to refining, but this accounts for seven percent of the Florida raw sugar production. All of the other mills are land owners and, therefore, there is integration of the grower and the mill covering the 130 farms in Florida and 90 percent of the state's raw sugar production.

Louisiana has the only area of extensive independent ownership of both cane farm and milling operations. Figures are not available to give a definite acreage, but it is estimated that half of the production in Louisiana is that of independent growers and independently owned mills. Seven of the mills owned by three companies are vertically integrated into the three operations of the cane sugar industry.

Table I-5. Cane sugar processing integration relationship, grower-mill integration, 1971 production

	Louisiana		Florida		Hawaii		Puerto Rico		Total	
	Production	Pct	Production	Pct	Production	Pct	Production	Pct	Production	Pct
Total Cane (000 acres)	301	34	194	22	232 1/	26	153	18	880	100
Total Cane (000 tons)	7,974	25	6,388	20	10,685	34	6,437	21	31,484	100
No. of Farms	1,513		130		528		4,202		6,373	
Total Raw Sugar (000 tons)	571	20	635	23	1,229	45	324	12	2,759	100
Total Mills	43		8		19		16		86	
<u>Grower-Mill Integration</u>										
Co-op Mills	8		3		0		0		11	
Administration Cane (000 tons)	2,536	86	2,127	99	0		0		4,663	92
Independent Cane (000 tons)	417	14	11	1	0		0		428	8
Total Cane	2,953		2,138		0		0		5,091	
Corporation Mills	35		5		19		0		59	
Administration Cane (000 tons)	1,663	33	3,630	85	10,151	95	0		15,444	77
Independent Cane (000 tons)	3,358	67	620	15	534	5	0		4,512	23
Total Cane (000 tons)	5,021		4,250		10,685		0		19,956	
Government Mills	0		0		0		16		16	
Administration Cane (000 tons)	0		0		0		6,437		6,437	100
Independent Cane (000 tons)	0		0		0		0		0	0
Total Cane (000 tons)	0		0		0		6,437		6,437	
Total Administration Cane (000 tons)	4,199	53	5,757	90	10,151	95	6,437	100	26,544	84
Total Independent Cane (000 tons)	3,775	47	631	10	534	5	0	0	4,940	16
Total Cane (000 tons)	7,974		6,388		10,685		6,437		31,484	

1/ Total cane acreage - only 1/2 harvested each year due to 22-24 month crop maturity.

Sources: <u>Hawaiian Sugar Planter's Association Sugar Manual</u>, 1973
<u>Gilmore Sugar Manual</u> 1971
USDA -ASCS various data
Puerto Rico Land Administration Data

Table I-6. Cane sugar processing integration relationship, mill-refinery integration, 1971 production

	Louisiana		Florida		Hawaii		Puerto Rico		Total	
	Production	Pct	Production	Pct	Production	Pct	Production	Pct	Production	Pct
Total Cane (000 acres)	301	34	194	22	232[1/]	26	153	18	880	100
Total Cane (000 tons)	7,974	25	6,388	20	10,685	34	6,437	21	31,484	100
No. of Farms	1,513		130		528		4,202		6,373	
Total Raw Sugar (000 tons)	571	20	635	23	1,229	45	324	12	2,759	100
Total Mills	43		8		19		16		86	
Mill-Refinery Integration										
Integrated Mill	8		1		19		16		44	
Raw Sugar (000 tons)	124	22	46	7	1,229	100	324	100	1,723	62
Non Integrated Mill	35		7		0		0		42	
Raw Sugar (000 tons)	447	78	589	93	0	0	0		1,036	38
Total Raw Sugar	571		635		1,229		324		2,759	

1/ Total cane acreage - only 1/2 harvested each year due to 22-24 month crop maturity.

Sources: Hawaiian Sugar Planter's Assn. Sugar Manual, 1972.
Gilmore Sugar Manual 1971
USDA-ASCS Various data
Puerto Rico Land Administration Data

3. Number of Plants

The three parts of the cane sugar industry are composed of:

6,373 Cane farms or plantations
85 Cane mills
29 Refineries

The previous tables, I-5 and I-6, have given some of the statistics of integration between farms, mills and refineries. Inasmuch as the mills are in the middle of the chain, it would be well to summarize the degree of integration from this standpoint. Table I-5 shows that 84 percent of the sugar cane goes to a mill. Table I-7 shows that 23 percent of the refined cane sugar end-product comes from a mill integrated with the refinery.

4. Products

The cane sugar refining industry is essentially a one product industry -- refined cane sugar. Cane sugar does take on many forms and variations but the product is still cane sugar -- chemically sucrose. Some sugar is produced in liquid form without being crystalized, but the percent is very small. [1/] Crystalline sugar is produced in varying degrees of color, fineness and concentrations. Still other combinations include packaging in bulk, in 100 pound bags, or in the myriad of consumer packets. Repeating, the most common product is crystallized white cane sugar priced and sold in 100 pound bag.

The mills produce three by-products -- bagasse, molasses, and an intermediate product, raw sugar. Bagasse, the pulp from the cane, comparable to some extent with beet pulp from beet sugar, is most frequently used as fuel in the milling process. In boilers designed to handle bagasse it is burned for energy with natural gas or fuel oil. Surpluses are sold for animal feeds and some bagasse ends up in the building material known as celotex. Revenue figures from all mills show almost insignificant income from bagasse sales.

Molasses is the important by-product; its prime use is as an animal feed supplement. A small percentage becomes edible molasses for a variety of food flavorings, colorings and syrups. About 3.6 percent of the returns to a milling operation comes from molasses.

1/ Liquid sugar is common, but most often comes from putting crystalline sugar into liquid form after the refining process.

Table I-7. Refinery-mill integration by company and relationship to total industry

Refineries integrated	Capacity	No. of Refineries	Percent of Capacity
C & H	3,690	2	10.6
Glades County Coop.	460	1	1.3
South Coast	700	1	2.0
Southdown	660	1	1.9
Supreme	700	1	2.0
Puerto Rico	1,820	5	5.2
Integrated Refinery Total	8,030	11	23.0
Non Integrated Total	26,660	18	77.0
Total - All Refineries	34,690	29	100.0

Summarizing, the product that shall be most discussed in this report is refined cane sugar from the intermediate product raw sugar.

5. Level of Diversification

Referring again to Table I-1, it can be seen that the large companies listed are recognized as diversified firms. Cane sugar processing with few exceptions, is a small part of the business for the 20 large companies. The notable exception is Amstar which has approximately 60 percent of its inventory in some form of cane sugar and, presumably, its sales and assets assume a similar proportion.

The other companies by and large are smaller and primarily derive their sales from cane sugar production and processing.

B. Types of Plants

Essentially, there are three types of plants in the cane sugar industry -- farms or plantations, mills and refineries. The first and second types, the farm or plantation, and cane mills, will not be directly considered in this study. The remaining plants or refineries are distinct and readily identifiable by name, size, location and output.

1. Size

Refineries are industrial plants that operate on a year around basis as contrasted with the mills that have a seasonal operation which coincides with the cane harvest. The tonnage figures in Table I-8 are raw sugar tons which is approximately 97 percent pure sugar.

As can be anticipated, the larger refineries are in the large population centers and the nine refineries that have a capacity of over 1,500 tons per day account for 58 percent of the total U.S. refining capacity.

With the exception of three plants, all of the refineries are over 50 years old and have been well maintained and kept up-to-date. For this reason there is no significant difference in refineries based on age except as will be noted under the following section.

Table I-8. **United States cane sugar refinery** companies, location and capacity

No.	Company Name	Refinery Location	Capacity	Total Daily Capacity
Liquid refineries			(TPD)	(Pct.)
1	SuCrest	Chicago, Illinois	850	
2	Pepsico	Long Island City, N. Y.	800	
3	Industrial	St. Louis, Missouri	300	
4	Florida Sugar	Belle Glade, Florida	390	
5	Ponce Candy	Ponce, Puerto Rico	100	
			2,440	7
Rural: Small crystalline refineries - 700 tons/day or less				
1	Glades Co. Cooperative	Moore Haven, Florida	460	
2	C & H	Aiea, Hawaii	190	
3	Puerto Rico Land Administration	Guanica, Puerto Rico	220	
4	Puerto Rico Land Administration	Humacao, Puerto Rico	400	
5	Everglades	Clewiston, Florida	350	
6	Southdown	Houma, Louisiana	660	
7	Puerto Rico Land Administration	Mercedita, Puerto Rico	600	
8	Puerto Rico Land Administration	Igualdad, Puerto Rico	700	
			3,580	10
Large crystalline refineries - over 700 tons/day				
1	J. Aron	Supreme, Louisiana	700	
2	Colonial	Gramercy, Louisiana	1,500	
3	South Coast	Mathews, Louisiana	700	
4	Godchaux	Reserve, Louisiana	1,700	
			4,600	13

(continued)

Table I-8. (Continued)

No.	Company Name	Refinery Location	Capacity (TPD)	Total Daily Capacity (Pct.)
Urban: Crystalline refineries				
1	Amstar	Baltimore, Maryland	2,600	
	"	Brooklyn, New York	2,100	
	"	Chalmette, Louisiana	3,250	
	"	Philadelphia, Pennsylvania	2,100	
	"	Boston, Massachusetts	1,000	
2	Imperial	Sugarland, Texas	1,500	
3	CPC	Yonkers, New York	1,800	
4	National	Philadelphia, Pennsylvania	2,000	
5	Savannah	Port Wentworth, Georgia	2,200	
6	Revere	Charlestown, Massachusetts	1,200	
7	SuCrest	Brooklyn, New York	820	
8	C & H	Crockett, California	3,500	
			24,070	70
U. S. Total companies (24)		Total Daily Capacity	34,690	100

2. Locations

Referring to Table I-8 and Figure I-1, the locations of refineries point to two of their essential requirements: deep water ports for shipping of raw sugar, domestic and imported, and close proximity to population centers and markets.

Raw sugar is not considered a food product and therefore can be shipped by bulk in cargo ships with a variety of cargo capabilities. Refined sugar, on the other hand, is a food and its transport is at a much higher rate because of the sanitary requirements as well as its higher value.

Sugar refineries have had dockside locations for many years as mentioned in the previous section on age. These areas are highly industralized now and for that reason additional land which may be needed for water pollution control may be difficult and expensive to obtain adjacent to the refinery.

This may not be true of new plants and rural plants (Table I-8). The Chicago and St. Louis refineries are not deep water port locations although Chicago is an international port. Raw sugar to St. Louis is shipped by barge up the Mississippi. Both ports do qualify for lower cost transport by water and serve large market areas.

3. Level of Technology and Efficiency

The cane producing and harvesting part of the industry is essentially agricultural and uses large amounts of relatively unskilled labor. Mechanization of the harvesting and loading operations are increasing but the equipment is not sophisticated.

Refining is more capital intensive than milling. This is seen by the fact that less than 12,000 men refine all domestic and import raw sugar as compared to 15,000 employees for milling which produces only one-third the amount of raw sugar the refineries process. The plants are industrial in nature and located in industrial areas as contrasted to the agriculturally-oriented mills.

From Table I-9 the break-down of plants according to technology is shown:

- 14 Crystalline refineries
- 5 Liquid sugar refineries
- 2 Liquid-crystalline refineries
- 8 Refineries operating with mills

Seventy-four percent of the industry capacity is the normal standardized crystalline refinery discussed below.

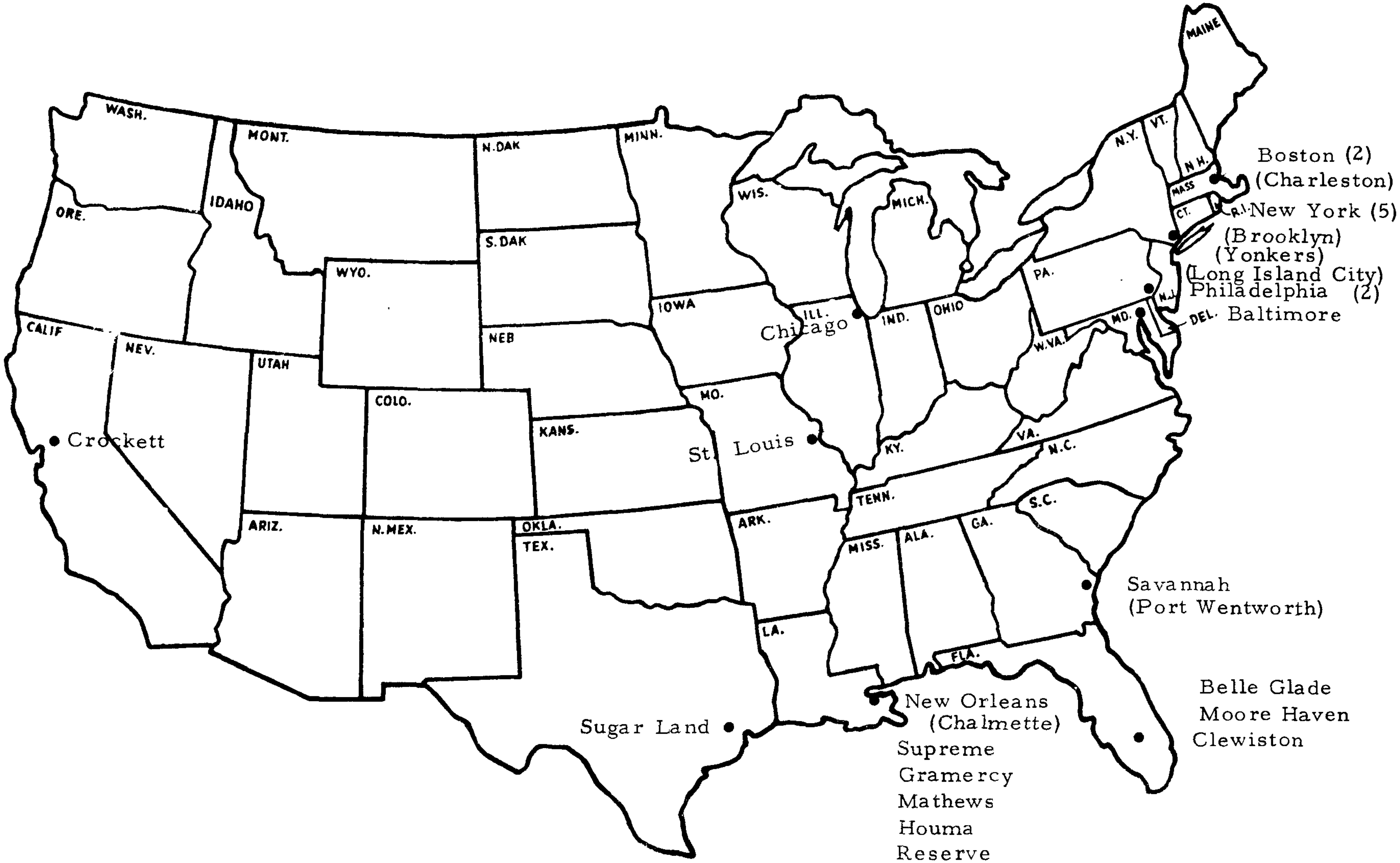

Figure I-1. Location of mainland cane sugar refineries.

Table I-9. Cane sugar refineries by type and capacity

Refinery - Type and Company	Location	Percent of total domestic capacity
Crystalline Refineries		
1. Amstar	Baltimore, Md.	
2. Amstar	Boston, Mass.	
3. Amstar	Brooklyn, N. Y.	
4. Amstar	Chalmette, La.	
5. Amstar	Philadelphia, Penn.	
6. California & Hawaiian	Crockett, Calif.	
7. California & Hawaiian	Aiea, Hawaii	
8. Colonial (Borden)	Gramercy, La.	
9. Everglade (Savannah Foods)	Clewiston, Fla.	
10. Godchaux	Reserve, La.	
11. Imperial	Sugarland, Texas	
12. National	Philadelphia, Penn.	
13. Revere	Charlestown, Mass.	
14. Savannah Foods	Port Wentworth, Ga.	74
Liquid Sugar Refineries		
1. Florida Sugar (Borden)	Belle Glade, Fla.	
2. Industrial (Borden)	St. Louis, Mo.	
3. Pepsico	Long Island, N. Y.	
4. SuCrest	Chicago, Ill.	7
5. Ponce Candy	Puerto Rica	
Liquid-Crystalline Refineries		
1. CPC	Yonkers, N. Y.	
2. SuCrest	Brooklyn, N. Y.	8
Refineries Operating with Sugar Factories		
1. Glades County	Moorehaven, Fla	
2. Guanica	Ensenada, P. R.	
3. Iqualdad	Mayaquez, P. R.	
4. J. Aron & Company	Supreme, La.	
5. Mercedita	Ponce, P. R.	
6. Roig	Yubacoa, P. R.	
7. South Coast	Mathews, La.	
8. Southdown	Houma, La.	11

The raw material for cane sugar refining is the raw, crystalline sugar produced by the cane sugar factories. Raw sugar crystals contain a film of molasses, the thickness of which varies with the purity of the sugar and in which the non-sucrose components are concentrated.

The raw sugar processed by the American refineries may be domestic or foreign but from a refining process viewpoint, there is little difference in raw sugar related to its source other than the amount of impurities present.

A cane sugar refinery receives raw sugar in bulk form by truck, rail, barge, and/or ship, and stores it for periods up to several months in large warehouses.

Affination and Melting [1/]--The first step in the refining process is mingling, or placing the raw crystals into a syrup solution. The magma is fed into centrifugals, which separate the syrup and molasses from the sugar. Hot water is then added to provide a washing action. The washed sugar is discharged into a melter which also contains about one-half of the sugar's weight in water.

Clarification (Defecation)-- The screened melt liquor still contains fine suspended and colloidal matter which are removed in clarification. Clarification may involve coagulation and floatation clarifiers or pressure filtration.

Decolorization--After affination and clarification the sugar liquor still contains impurities and color that require physical adsorption for removel. Most large crystalline refineries use fixed bed bone char cisterns (also called filters).

Sugar liquor passes in parallel through each cistern in a downward direction and undergoes adsorption of the color bodies and ions. From 90 to 99 percent of color is removed, with the higher percentage removal occurring at the beginning of the cycle.

Powdered activated carbon is used for decolorization in small refineries and in liquid sugar production. Regeneration of powdered carbon is difficult and it is normally discarded after one or two cycles. However, in 1972 one company announced the successful and economical regeneration of powdered activated carbon.

1/ Process description adapted from Development Document for Effluent Limitations Guidelines. Environmental Protection Agency.

Evaporation--No matter what method of decolorization is used, the final steps of recrystallizing and granulating are essentially the same in all refineries. The first step in recrystallization may be concentration of the decolorized sugar liquor and sweet waters in continuous type evaporators. Since the liquors in a refinery are kept as highly concentrated as possible, refinery pans are relatively small compared with the evaporators in a raw sugar factory.

Crystallization--After concentration in evaporators, the sugar liquor and sweet waters are crystallized in single effect, batch type evaporators called vacuum pans. Several pans are used exclusively for commercial granulated sugar and the resulting syrups are boiled in other pans.

Finishing--The dryer or granulator is usually a horizontal, rotating drum 1.5 to 2.4 meters (five to eight feet) in diameter and 7.6 to 11 meters (25 to 35 feet) long which receives steam heated air along with the sugar crystals. It may consist of one drum or more in parallel. The granulators remove most of the one percent moisture still remaining in the sugar after centrifugation, reducing the moisture content to 0.02 percent or less. In addition, the dryers serve to separate the crystals from one another. After drying, the sugar goes to coolers. Coolers are similar drums, but without the heating elements.

Any lumps remaining in the sugar are then removed by fine screening. Screening also accomplishes crystal size grading.

Other Variations--Four plants representing seven percent of total capacity are liquid sugar refineries. The initial refining steps of affination, decolorization, and even evaporation in a liquid sugar refinery are essentially the same as in a granulated sugar refinery. The primary difference occurs in the fact liquid sugar refineries do not recrystallize their primary product and therefore do not use vacuum pans for this purpose. The result is the need for considerably less condenser water and process steam.

Two plants operate both liquid and crystalline refineries and eight are directly integrated with the cane mills. These latter plants refine the raw sugar directly in much the same manner of the beet sugar plants without the crystallization and remelt steps.

C. Number of Plants and Employment by Segment

In the entire U.S. cane sugar industry, there was estimated to be a total of 92,140 employees in 1970. This estimate was made up of:

Subsegment	Number of Employees
Farm	64,900
Mill	15,000
Refinery	12,240
Total	92,140

As stated, employment in the sugar refineries is low and the industry is characterized as capital intensive rather than labor intensive. In 1968 the total employment in refinery operations was estimated at 13,049. Since that time, due to improved efficiency and productivity (estimated at 1-2 percent per year), 1972 total employment was 12,240. Table I-10 shows estimated number of employees in each area based on the current productivity of 237 employees per 1,000 tons per day refinery capacity.

D. Relationship of Segments to Total Industry

Subsequent financial profiles and impact analyses will depend upon the use of model plants to represent the various segments and subsegments of the cane sugar industry. The rationale for use of model plants is largely dictated by the paucity of financial data. The model plants, developed to represent the various segments by size, geography and type, are shown in Table I-11.

Table I-10. Cane sugar refinery employment by cities in 1970

Location	Number employed
New Orleans	2,280
New York	2,541
San Francisco	1,646
Philadelphia	1,223
Baltimore	797
Boston	982
Savannah	572
Sugar Land	495
Chicago	215
Clewiston	32
Puerto Rico	940
Sub-total	11,723
Other locations	517
Total	12,240

Source: U. S. Cane Sugar Refiners Association, Washington, D. C., by Robert R. Nathan, Assoc., Inc.

Table I-11. Relationship of segment models to industry for cane sugar refinery segments

Type	Location	Model		Industry			
		Size	Capacity	No. of plants	Average capacity	Total capacity	
			(TPD)		(TPD)	(TPD)	(Pct)
Liquid	Urban	--	500	5	585	2,340	7
Crystalline	Rural	Small	400	8	409	3,680	11
		Large	1,200	4	1,150	4,600	13
	Urban	Large	2,000	12	2,005	24,070	69
Total				29	1,037	34,690	100

II. FINANCIAL PROFILE

A. Plants by Segment

Because the cane sugar industry is subject to a considerable amount of government control and allotments, marketing and regulations under the Sugar Act, there is a lot of financial data on cane production and milling which is available through the Department of Agriculture and the Sugar Division of the Agricultural Stabilization and Conservation Service.

Unfortunately, the USDA cost studies exclude the cane sugar refining segment and therefore subsequent financial data was constructed from previous material in an earlier study entitled "Initial Analysis of Economic Impact of Water Pollution Control Costs Upon U.S. Cane Sugar Industry," by ERS of USDA. In addition, other figures were obtained from the U.S. Cane Sugar Refineries Association and from a partial economic study which was done for that association by Robert R. Nathan and Associates of Washington, D. C. Finally, in addition to bringing this basic material of 1968 up to 1972, a complete reconstruction was made and all of these data were then checked with a number of industry sources representing various sizes and locations of sugar cane refineries.

1. Annual Profit

Table II-1 contains sales and earnings shown in model form for the two types, liquid and crystalline, and the five sizes of cane sugar refineries. These data were constructed from a number of sources and while none of the models are a real refinery, the overall effect does represent the industry.

Table II-2 are actual figures of industry totals submitted to the Cost of Living Council. For example, the industry-wide profit for 1972 of $20 million is close to the $25,000,000 industry profit that a weighted total of the five model plants would show. The former figure represents 91 percent of industry and the latter figure is 100 percent.

Table II-1 . Cane sugar refinery models - sales, costs, production and cash flow

		Crystalline			
		Small rural		Large rural	
	Liquid	PR[1/]	Other[2/]		Urban
Capacity (TPD)	500	400	400	1,200	2,000
Operating days	250	250	250	250	250
Production - raw value					
Millions hundredweight	2.500	2.000	2.000	6.000	10.000
Production refined[3/]					
Millions hundredweight	2.336	1.869	1.869	5.607	9.346
	--------------------$1,000--------------------				
Sales	28,032	22,335	22,335	67,508	118,881
Raw sugar	22,659	16,896	16,896	50,968	85,329
Other costs	4,571	5,430	4,571	14,407	29,550
Interest	194	270	270	564	325
Depreciation	140	168	168	561	1,402
Total costs	27,564	22,764	21,905	66,500	117,106
Net profit before tax	468	(429)	430	1,008	1,775
Net profit after tax	243	(429)	224	524	923
After tax cash proceeds[4/]	484	9	533	1,378	2,754

1/ Includes four Puerto Rican refineries based on very incomplete data.

2/ Includes four Mainland small refineries.

3/ Raw value divided by 1.07 for refined value.

4/ Revenue less expenses other than interest, less depreciation and taxes, plus depreciation.

Table II- 2. Profit levels of sugar refineries, 1971-1973

Time Period	Number of Companies	Percent of Total Industry Capacity	Net Profit Before Taxes for Period 1/	Change From 71-72	Change From 71-73	Net Profit Before Tax per 100 lbs. Refined Sugar
		%	$	%	%	$
1971	12	91	41,611,437			.313
1972	12	91	20,239,769 2/	-51.4		.152
1st Quarter '71	12	91	10,194,362			.3[illegible]0
1st Quarter '72	12	91	2,954,662	-71.0		.100
1st Quarter '73	12	91	2,433,078 3/		-76.1	.080
2nd Quarter '71	11	89	13,974,305			.428
2nd Quarter '72	11	89	8,472,760	-39.0		.258
2nd Quarter '73	11	89	2,469,634 2/		-82.3	.077

Source: U. S. Cane Sugar Refineries Assn., Washington, D. C. based on survey and data filed with Cost of Living Council, 1973.

1/ Consolidated data for industry.

2/ Includes 3 companies that operated at net loss.

3/ Includes 5 companies that operated at net loss.

Actual industry profits for this time period show a dramatic decline over the '71 to '73 years and indicates that there are companies experiencing losses.

In the model plants the only segment to show a loss was the small rural refineries which included essentially the four refineries from Puerto Rico.

Other than the refineries operating in Puerto Rico, there appears to be no segment by virtue of its size or location that shows loss. Rather, as will be shown later, the profitability of refineries and of their companies seems to be a function of management and the philosophy of management that has been pursued over the years.

Table II-3 showing the returns on sales and the returns on investment, however, indicates an industry with very low returns and taken as a whole, one that is not financially healthy and vigorous.

2. Annual Cash Flows

Estimated annual cash flows (after tax earnings plus depreciation) is displayed in Tables II-1 and II-3. Positive cash flows were obtained for all configurations except the small rural Puerto Rican group. In the other four groups cash flows are similar and there appears to be no significant difference for each of the four segments that do show a positive cash flow.

3. Market (Salvage) Value of Assets

Data appearing in an earlier economic study [1/] showed total asset values based on hundredweights of sugar produced. However, the data which was 1968 data, did seem to have a large margin of error. Therefore, in this analysis, the figures are based on interviews with knowledgeable industry people representing a broad section of the refineries themselves and are based on 1972 figures.

1/ "Initial Analysis of the Economic Impact of Water Pollution Control Costs Upon the U.S. Cane Sugar Industry." USDA - ERS, Bruce J. Walter and Peter M. Emerson.

Table II-3. Cane sugar refinery models - cash flow, ROI, ROS

	Liquid	Crystalline			
		Small rural		Large	
		PR	Other	rural	Urban
Net profit before tax($000)	468	(429)	431	1,008	1,775
Net profit after tax($000)	243	(429)	224	524	923
After tax cash proceeds ($000)	484	9	533	1,378	2,754
Total investment[1/] ($000)	9,750	13,500	13,500	28,200	41,250
ROI before tax (percent)	4.8	(3.2)	3.2	3.6	4.3
ROS before tax (percent)	1.7	(1.9)	1.9	1.5	1.5
ROI after tax (percent)	2.5	(3.2)	1.7	1.9	2.2
ROS after tax (percent	0.9	(1.9)	1.0	0.8	0.8
Cash flow (percent on investment)	5.0	0.1	3.9	4.9	6.7

1/ Estimated book value.

Estimated Model Plant Investment

The data shown here in Table II-4 are projected to be the book values for various model plants based on 1972 figures. Liquid refineries have somewhat less of an investment than the crystalline refineries due to a simplified process and a practice which is quite common in liquid refineries - that of using higher value raw sugar. The refining process is not faced with the removal of as large a percentage of impurities as is necessary in most crystalline refineries that operate with the world sugar. Even though these basic plants are 50 years old, the machinery and equipment and its value is current due to modernization and continual replacement. The land values are based on original purchase prices and, therefore, are book values as compared to replacement values which probably would be higher. From these data, it appears as a rule of thumb that the depreciable assets or equipment represent approximately one-third of the total investment in the operation.

Salvage Values

In looking at salvage values as well as investment values, the individual plants were considered on their own merits rather than being part of a multi-plant company. Inasmuch as only one company operates five refineries, the rest basically operate one refinery and it was felt that the individual unit should be considered. Under multi-plant operations in the refinery business, however, the working capital is combined for the company rather than operated for individual mills and might show a somewhat different arrangement for salvage value than has been indicated here.

In estimating salvage values in Table II-4, the rationale used was that net working capital is considered a current asset and therefore fully recoverable. Depreciable assets, building and equipment, are shown to be recoverable at approximately 10 percent of the book value. For land, it is felt that book values represent market value in a very conservative appraisal.

Table II-4. Cane sugar refineries investment[1] and salvage values

	Liquid			Small Rural			Large Rural			Large Urban		
	Investment 2/	Percent	Salvage 2/	Investment 2/	Percent	Salvage 2/	Investment 2/	Percent	Salvage 2/	Investment 2/	Percent	Salvage 2/
Working capital	2.50	100	2.50	3.50	100	3.50	8.00	100	8.00	12.00	100	12.00
Depreciable assets	3.50	10	.35	5.50	10	.55	10.00	10	1.00	15.00	10	1.50
Land	.50	100	.50	.50	100	.50	.80	100	.80	1.50	100	1.50
Debt	3.25			4.50			9.40			13.75		
Total investment	9.75			14.00			28.20			42.25		
Total salvage			3.35			4.55			9.80			15.00

1/ Estimated book value.

2/ Millions of dollars.

4. Cost Structure

In Table II-5, the budgets of cost for the five segments of model plants are extremely consolidated to show just basic elements. The sales are income figures that are somewhat representative of the published whole-sale price of refined sugar quoted in various markets. Below are listed the 1972 average wholesale prices per hundredweight of refined sugar.

Northeast	$13.09
Chicago and West	12.00
Gulf	12.14
Southeast	12.74
Pacific	11.65
Average U.S.	12.29

While average sale prices to the distributor reflect these wholesale prices, they vary from them due to discounts and various trade allowances. Because the northeast market traditionally carries the highest wholesale price, the urban refineries show the highest returns as they are primarily located in this market.

The raw sugar price in the cost budgets bears a consistent relationship to New York spot prices which depends on location of the refinery and the source of the raws. 1972 quoted raw sugar prices are shown below:

Raw Cane Spot-Price-World	$8.53
Raw Cane Spot-Price-Domestic	9.09

The liquid sugar plants traditionally buy a higher purity or higher polarity domestic sugar than do the crystalline sugar refineries. Since the liquid refineries normally pay a premium for their raw sugar, Table II-5 shows the highest raw sugar price at $9.70 per hundredweight for three plants.

All other refinery costs vary from a low of $2.04 for the liquid plants to a high of $3.25 for the urban plants. The urban plants reflect higher labor and other costs of the urban area in total and the liquid plants indicate less costly processing, less investment and, therefore, less cost to produce liquid sugar. The small rural plants of the crystalline refineries have a higher cost than the other rural plants, due largely to the higher costs associated with Puerto Rico.

Table II-5. Refinery cost by model size - 1972

		Crystalline			
		Small rural			
	Liquid	PR 1/	Other 2/	Large rural	Large urban
	-------------	Per hundred weight	refined sugar	--------------	
Returns	$12.00	$11.95	$11.95	$12.04	$12.72
Raw sugar	9.70	9.04	9.04	9.09	9.13
Other costs	2.04	3.05	2.59	2.67	3.25
Depreciation	.06	.09	.09	.10	.15
Total costs	11.80	12.18	11.72	11.86	12.53
Net profit	.20	-(.23)	.23	.18	.19

1/ Includes four Puerto Rican refineries.

2/ Includes four domestic mainland refineries.

Depreciation costs vary from $.06 per hundred weight for the liquid refineries to $.15 for the urban refineries. This is from 4.28 percent to 10.0 percent based on the net asset value.

In estimating income taxes for all model plants, a straight 48 percent tax rate was used on earnings. No carry forward or back provisions were assumed in the case of losses.

Summing up the cost structure, it can be said that raw sugar costs, i.e., raw material, are the major costs and that equipment and investment are significant factors. The industry is characterized as capital intensive rather than labor intensive.

B. Distribution of Financial Data

As shown in the preceding discussion of the financial profile of the cane sugar industry, little variance in financial parameters of location and plant size was found.

Table I-11 shows that the model refineries do closely resemble the industry quite accurately but in neither case, the model plants nor the real plants, does size or location make a significant difference in profit or returns.

C. Ability to Finance New Investment

The ability of a firm to finance new investment for pollution abatement is a function of several critical financial and economic factors. In general terms, new capital must come from one or more of the following sources: (1) funds borrowed from outside sources; (2) equity capital through the sale of common or preferred stock; (3) internally generated funds--retained earnings and the stream of funds attributed to depreciation of fixed assets.

For each of the three major sources of new investment, the most critical set of factors is the financial condition of the individual firm. For debt financing, the firm's credit rating, earnings record over a period of years, stability of earnings, existing debt-equity ratio and the lenders' confidence in management will be major considerations. New equity funds through the sale of securities will depend upon the firm's future earnings as anticipated by investors, which in turn will reflect past earnings records. The firm's record, compared to others in its own industry and to firms in other similar industries, will be a major determinant of the ease with which new equity capital can be acquired. In the comparisons, the investor will probably look at the trend of earnings for the past five or so years.

Internally generated funds depend upon the margin of profitability and the cash flow from operations. Also, in publicly held corporations, stockholders must be willing to forego dividends in order to make earnings available for reinvestment.

The condition of the firm's industry and the general economy are also major considerations in attracting new capital. The industry will be compared to other similar industries (i.e., other processing industries) in terms of net profits on sales and on net worth, supply-demand relationships, trends in production and consumption, the state of technology, impact of government regulation, foreign trade and other significant variables. Declining or depressed industries are not good prospects for attracting new capital. At the same time, the overall condition of the domestic and international economy can influence capital markets. A firm is more likely to attract new capital during a boom period than during a recession. On the other hand, the cost of new capital will usually be higher during an expansionary period. Furthermore, the money markets play a determining role in new financing; example, the 1973 year has been viewed as especially difficult for new equity issues.

As was seen in Table I-11, there appears to be no significant difference in the earning ability of a cane sugar refinery based on size or location. Except for Puerto Rico which is a special situation and involves companies that are not competing in the open investment dollar market, all earnings records depend on management.

There are only limited financial data available for companies which operate cane sugar refineries. Table II-6 presents selected data on four companies, three of which are primarily sugar companies. The fourth company, Southdown, a producer of both raw sugar and refined sugar, is a widely diversified company whose operating data are not at all representative of the cane sugar refining industry. Although Southdown is included in the table, it will be ignored in the analysis which follows.

Profit margins (income before interest and federal income taxes as a percent of sales) have averaged in recent years 7.0 percent for Savannah, 6.9 percent for Amstar and 3.4 percent for Sucrest. Net income as a percent of sales has averaged 2.5 for Savannah, 2.3 for Amstar and 0.9 for Sucrest.

Net income as a percent of net worth has been estimated for Savannah as 13.1 (for two years, 1970-71), for Amstar as 8.5 (5-year average, 1968-72) and for Sucrest as 5.7 (5-year average, 1968-72).

Depreciation has averaged three to four percent of gross property values for these three companies, producing an average cash flow as a percent of sales of 4.1 percent for Amstar and Savannah and 1.9 percent for Sucrest.

These three companies appear sufficiently profitable to be able to finance new investment. Sucrest has a very low profit margin and earns only about one percent on sales and five to six percent on equity. Its profitability is well below average for manufacturing in general. At the same time, Sucrest has laid out from $1.4 to $3.1 million annually for capital expenditures from 1968 through 1972.

The long-term debt situation shows that the three companies have from 20 to 30 percent of gross property in fixed debt; Savannah has a 1972 debt/equity ratio of 98.3 percent compared to 44.7 percent for Amstar and Sucrest. Although Sucrest is highly leveraged, the three companies show no evidence to indicate that there would be barriers to borrowing for pollution abatement capital expenditures.

Table II-6. Financial ratios for selected cane sugar refining companies, 1968 - 1972

Year	Amstar	Savannah Foods	Southdown	Sucrest
		Profit Margin (%)		
1968	6.6	N.A.	6.4	3.2
1969	5.9	N.A.	19.2	3.0
1970	7.3	7.3	12.6	3.7
1971	8.0	6.7	13.7	4.1
1972	6.5	N.A.	15.2	3.1
Av.	6.9	7.0	13.4	3.4
		Net Income to Sales (%)		
1968	2.1	N.A.	22.2	1.0
1969	1.6	N.A.	24.6	0.8
1970	2.5	2.9	8.7	1.0
1971	3.1	2.5	9.1	1.1
1972	2.4	2.0 1/	10.6	0.6
Av.	2.3	2.5	15.0	0.9
		Depreciation to Gross Property (%)		
1968	3.3	N.A.	3.4	4.1
1969	1.7	N.A.	0.6	4.3
1970	3.5	3.4	3.9	4.3
1971	3.4	3.5	4.3	4.2
1972	3.4	N.A.	3.5	4.2
Av.	3.1	3.5	3.1	4.2
		Cash Flow to Sales (%)		
1968	3.9	N.A.	18.0	2.1
1969	3.6	N.A.	19.1	1.9
1970	4.3	4.2	8.5	2.0
1971	4.6	3.9	9.4	2.1
1972	4.0	N.A.	9.9	1.6
Av.	4.1	4.1	13.0	1.9

Table II-6. (continued)

Year	Amstar	Savannah Foods	Southdown	Sucrest
		Net Income to Net Worth (%)		
1968	7.4 2/	13.6 2/	14.8 2/	4.8 2/
1969	7.0 2/	14.1 2/	N.A.	4.6 2/
1970	9.3 2/	13.8 2/	N.A.	6.6 2/
1971	13.6	12.2	N.A.	7.7
1972	9.7	N.A.	N.A.	4.6
Av.	9.4	13.4	14.8	5.7
		Long-term Debt to Gross Property (%)		
1968	28.0	N.A.	N.A.	41.5
1969	27.2	N.A.	26.7	36.9
1970	25.3	31.4	50.2	33.7
1971	22.8	28.9	54.9	31.0
1972	21.0	N.A.	60.3	27.8
Av.	24.9	49.0	48.0	34.2

1/ 9 months

2/ From Report of the Federal Trade Commission on Rates of Returns in Selected Manufacturing Industries, Federal Trade Commission, 1961-1970, p. 35.

Source: Standard and Poor's Stock Market Reports.

With respect to the industry's overall ability to fund new investment for pollution control, the limited data available indicate that some cane sugar refineries may encounter difficulty, based on recent levels of profitability. While other factors may influence the decision concerning new investment in these small refineries, the low return on investment suggests strongly that these resources could be more profitable elsewhere.

It should be noted that these financial analyses have not included Puerto Rican refineries. The picture is complicated by the fact that the Commonwealth of Puerto Rico owns or leases the company's properties.

III. PRICING

Cane sugar processors are only one component of the sugar industry, which in turn is a member of the sweetener sector of the U. S. food system. Sugar (sucrose) can be either beet sugar or cane sugar with cane sugar accounting for more of the domestic market (see Figure III-1).

Refined beet sugar and cane sugar compete as perfect substitutes in the wholesale market. Through a quota system the government regulates the production and importation of sugar so as to stabilize and maintain prices at specified levels. Refined sugar is marketed by refiners and processors under a system of base point pricing. It will be shown that the structure of the sugar industry and government policy provides possible limitations on the sugar processors ability to shift the cost of additional pollution abatement to the consumers in the long run.

A. Price Determination

1. Demand

All but a small fraction of domestic sugar consumption is for human food. U. S. per capita sugar consumption (Table III-1) has been fairly stable since the 1930's, ranging between 90 and 100 pounds. Recent increases above 100 pounds are attributed to the Food and Drug Administration restrictions on the use of cyclamates. Sugar and corn sweeteners (corn syrup and dextrose) are known as nutritive sweeteners while cyclamates and saccharine are called noncaloric sweeteners. About two-thirds of all sugar is consumed in industrial uses, especially by food processing industries. Only one-fourth is purchased for home use--kitchen and table. The remainder is used in restaurant and institutional meal preparation.

Industrial uses for sugar are mainly in food processing with minor other industrial uses (Table III-2). The beverage industry is the largest user of sugar and has made little use of corn sweeteners as a substitute for sugar. The beverage industry is also the highest user of noncaloric sweeteners. Baking, the next largest user, has dropped its use of sugar from

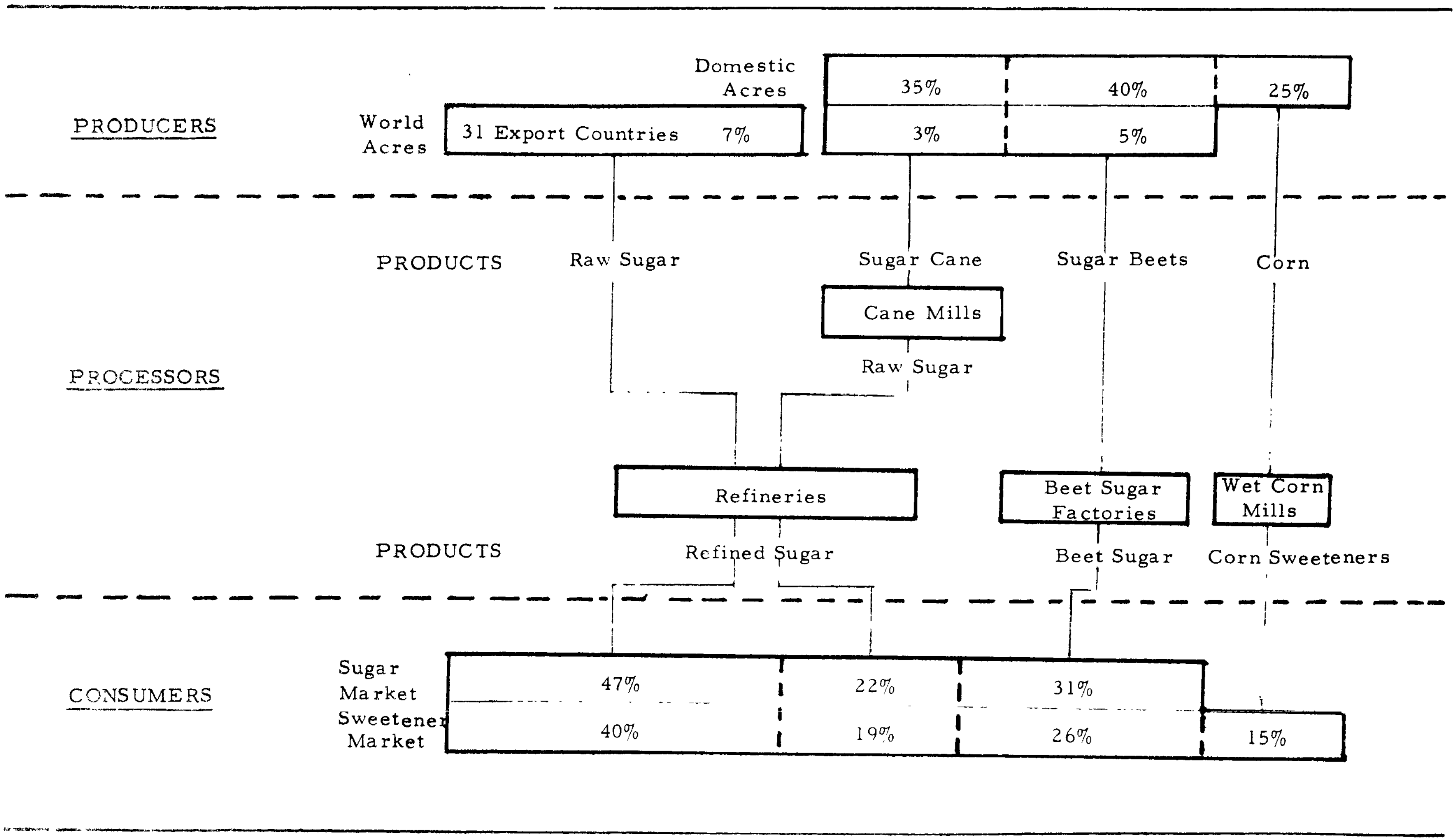

Figure III-1. Structure of the domestic sweetener industry.

Table III-1. Trends in per capita distribution of nutritive sweeteners and the share that each sweetener represents of the total distribution, 1956-71

Calendar year	Nutritive sweeteners	Sugar	Corn sirup	Dextrose	Percent of total nutritive sweeteners: Sugar	Corn sirup	Dextrose
	Pounds per capita refined				Percent		
1956	110.8	98.7	8.3	3.7	89.1	7.5	3.4
1957	106.4	94.6	8.2	3.6	88.9	7.7	3.4
1958	109.8	96.9	8.7	4.1	88.3	8.0	3.7
1959	109.9	96.4	9.1	4.3	87.7	8.2	3.9
1960	110.9	97.5	9.3	4.1	87.9	8.4	3.7
1961	111.6	97.7	9.7	4.2	87.5	8.7	3.8
1962	113.1	98.0	10.7	4.4	86.6	9.5	3.9
1963	113.7	97.6	11.1	5.0	85.8	9.8	4.4
1964	113.3	96.2	12.2	4.9	84.9	10.8	4.3
1965	113.6	96.6	12.2	4.8	84.9	10.8	4.3
1966	115.3	98.1	12.5	4.7	85.1	10.9	4.0
1967	114.5	97.2	12.6	4.6	84.9	11.0	4.1
1968	117.7	100.2	12.8	4.7	85.1	10.9	4.0
1969	118.1	100.3	13.0	4.8	84.9	11.0	[illegible]
1970	121.0	102.5	13.1	5.4	84.7	10.8	4.5
1971	122.3	102.9	13.7	5.7	84.1	11.2	4.7
1956-67 trend	+.61	+.04	+.46	+.11	-.44	+.37	+.08
1968-71 trend	+1.67	+1.03	+.28	+.36	-.32	+.07	+.25
1956-71 trend	+.84	+.34	+.39	+.11	-.34	+.28	+.06

Source: USDA, ASCS, Sugar Reports.

Table III-2. Sugar deliveries, by type of sugar and by type of product or business of buyer, calendar year 1971. 1/

Product or business of buyer	Beet	Cane	Imported direct consumption	Total all sugar	Liquid sugar included in totals: Beet	Liquid sugar included in totals: Cane
	Hunderedweights 2/					
Industrial						
Bakery, cereal and allied products	9,847,388	17,115,774	161,348	27,124,510	292,403	2,377,746
Confectionery and related products	6,653,051	14,236,521	156,920	21,046,492	167,552	3,269,348
Ice cream and dairy products	4,074,342	7,001,147	49,445	11,124,934	2,150,928	4,783,993
Beverages	11,926,601	35,310,248	50,103	47,286,952	5,831,266	22,768,934
Canned, bottled, frozen foods, jams, jellies and preserves	9,458,478	11,004,504	111,587	20,574,569	3,564,693	5,325,399
Multiple and all other food uses	4,003,454	5,855,962	58,025	9,917,441	269,138	1,585,445
Non-food products	282,605	1,537,700	40,276	1,860,581	54,002	581,339
Sub-total	46,245,919	92,061,856	627,704	138,935,479	12,329,982	40,692,204
Non-industrial						
Hotels, restaurants, institutions	98,375	1,455,605	33,566	1,587,546	12,868	100,862
Wholesale grocers, jobbers, sugar dealers	12,522,604	30,132,194	542,662	43,197,460	345,371	311,983
Retail grocers, chain stores, super markets	4,799,114	21,031,042	750,163	26,580,319	116,833	227,642
All other deliveries, including deliveries to Government agencies	591,438	1,309,258	2,588	1,903,284	100,841	81,350
Sub-total	18,011,531	53,928,099	1,328,979	73,268,609	575,913	721,837
Total deliveries	64,257,450	145,989,955	1,956,683	212,204,088	12,905,895	41,414,041
Included in totals:						
Deliveries in consumer-size packages (less than 50 lbs)	9,591,717	41,954,005	652,985	52,198,707		
Deliveries in bulk (unpackaged)	25,318,587	34,622,624	144,527	60,085,738		

1/ Represents approximately 100.0 percent of deliveries by primary distributors in continental United States.
2/ Reported as produced or imported and delivered except liquid sugar which is on a sugar solids content basis.

Source: USDA-ASCS, Sugar Reports, No. 238 (March, 1972), p. 14.

80 percent of total nutritive sweeteners in 1956 to less than 74 percent in 1972. Sugar's share of confectionary demand for nutritive sweeteners has been more stable, declining from 70 percent in 1956 to 68 percent in 1972. Although sugar's share of canning demand has fallen from 87 percent in 1956 to 82 percent in 1972, its share has risen since hitting a low in 1967. During the period from 1956 to 1972 the price of corn sweeteners has fallen relative to sugar and new production techniques have improved the quality of corn syrup.

As shown above, some substitution among sweeteners exists. Noncaloric sweeteners are used to meet the demands of those consumers seeking to limit sugar intake. Some substitution of noncaloric sweeteners for sugar is associated with relative price changes. However, for noncaloric sweeteners quality considerations appear to be more important. Corn sweeteners are sugar's major price competitor. Technical improvements in corn syrup manufacture have produced a range of syrups of different qualities. Thus, corn syrup is better able to meet the different specifications of users. A limiting factor is the degree of corn syrup's sweetness which is less than sugar. However, research in improving "corn syrup's sweetness" is promising.

Japan's recent development of processes for the production of high levulose and high fructose corn syrups show great promise and may have a significant impact on the U. S. sweetener market in the future. These syrups, produced by partial isomerisation of dextrose (corn sugar) into levulose, are said to be comparable to sucrose (cane and beet sugar) in sweetening power and unlike other corn syrups can be used as complete substitutes for sucrose. Thus an improved product and lower relative prices have made corn syrup a stronger competitor of sugar.

The substitution of corn syrup is a gradual process and the market reacts to long-run changes in prices. Substitution of corn syrups may require changes in manufacturing techniques and alter the quality of the final product. Firms making the substitution must invest in new techniques and develop promotional programs to "educate" the consumer to prefer the new product. Such difficulties mean that the food processor will shift from one source to another slowly and when the processor can justify the change for a long period. In some instances, the level of use of corn syrup is restricted by the Food and Drug Administration. In other cases, corn syrup may not be an acceptable substitute thus limiting the extent of substitutibility.

A price war beginning in December 1971 among the corn syrup producers dropped the equivalent cost ratio of corn syrup to sugar from 70 percent to 36 percent. Even now as corn syrup prices come up to 7.25 cents per pound in New York as of April, 1973, this price is still only 55 percent of the equivalent sugar price in the Northeast (Table III-3).

Table III-3. Wholesale prices of sugar, corn syrup, and dextrose.

Year	Refined sugar Northeast	Dextrose N.Y.	Corn Syrup N.Y.	Dextrose relative to sugar	Corn syrup relative to sugar
	cents per pound, dry basis				
1956	8.77	7.91	8.90	90	101
1957	9.15	8.32	9.17	91	100
1958	9.27	8.33	9.18	90	99
1959	9.33	8.13	9.10	87	98
1960	9.43	8.13	9.12	86	97
1961	9.40	8.10	9.00	86	96
1962	9.60	8.04	8.73	84	91
1963	11.94	9.10	9.19	76	77
1964	10.68	8.85	8.36	83	78
1965	10.22	8.70	8.27	85	81
1966	10.36	8.87	8.34	86	81
1967	10.62	9.49	8.40	86	79
1968	10.84	9.49	7.85	86	72
1969	11.44	9.96	8.01	85	68
1970	11.97	10.20	8.45	85	
1971	12.48	10.71	8.77	86	70
1972	13.09	10.07	5.78	77	44
1973 (April)	13.31	10.65	7.25	80	55

Source: Sugar Reports, USDA-ASCS, selected issues.

Production of corn syrup is up and production facilities are fully utilized. A new entry into corn syrup production is Amstar, a cane sugar producer of "Domino" sugar and an owner of Spreckels beet sugar division.

Demand and Price Elasticity

Estimates of price elasticity and cross elasticity of demand for sugar in industrial uses do not exist. However, price consciousness appears to increase as the cost of sugar increases in proportion to total food costs. Thus substitution seems to be occurring. The gradual adjustments indicate that demand is much more price elastic in the long run as time for adjustment is increased.

Household use accounts for about one quarter of total consumption. Sugar is a minor item in the household budget. Households do not appear to make substitution for sugar when the price changes. Estimates of price elasticity of demand for household use of sugar confirm this inelasticity with estimates ranging from -0.16 to -0.24. [1/] Likewise, income has little influence with income elasticity estimates ranging from .03 to 0.15. [1/] The corn syrup price cross elasticity is also small at 0.05. [1/] Thus households will make little change in sugar consumption in response to changes in prices or incomes.

2. Government Sugar Policy [2/]

The U. S. sugar industry has been protected and regulated by the Federal Government since 1789. A quota system of control was initiated in 1934 and has been amended and extended periodically since then. The current legislation governing the industry is the Sugar Act of 1948 as amended in 1971. This legislation became effective January 1, 1972 and extended the Act through December 31, 1974.

1/ Thomas H. Bates and Andrew Schmitz, "A Spatial Equilibrium Analysis of the World Sugar Economy," Giannini Foundation Monograph No. 24, Univ. of Calif., Berkeley, 1969, and P. S. George and G. A. King, "Consumer Demand for Food Commodities in the U.S. with Projections for 1980," Giannini Foundation, Monograph No. 26, Univ. of Calif., Berkeley, 1971.

2/ Adapted from "Initial Analysis of the Economic Impact of Water Pollution Control Costs upon the U.S. Cane Sugar Industry," Bruce J. Walter and Peter M. Emerson, ERS, USDA. (1973)

The principal provisions of the U. S. Sugar Act are (a) limitation of the total supply of sugar available to U. S. consumers, (b) Government subsidy payments to U. S. sugar cane and sugar beet growers, (c) an excise tax on all sugar marketed within the U. S., and (d) a tariff on sugar imports.

Under the supply limitation provision of the Sugar Act, the Secretary of Agriculture each year (a) determines the quantity of sugar needed to meet the requirements of domestic consumers and to attain the price objective specified in the Sugar Act, (b) divides, by means of quotas, this total supply requirement among specified domestic and foreign production areas, (c) assigns, when necessary for orderly production, "proportionate shares" of each domestic production area quota to individual farms within that production area, and (d) imposes, when necessary for orderly marketing, a refined sugar "marketing allotment" upon each refining and importing firm. (See Table III-4 for the 1970, 1971, and 1972 quotas assigned to each domestic production area and foreign country.) Through these strong supply limitation powers granted by the Sugar Act, the Secretary of Agriculture is able to control the price of raw sugar.

<u>The price objective</u> specified in the Sugar Act is to maintain the same ratio between (a) the price of raw sugar, as registered in the New York market, and (b) the average of (i) the parity index (the index of prices paid by all farmers for commodities and services, including interest, taxes, and farm wages, 1967 = 100) and (ii) the wholesale price index (1967 = 100) as the ratio that existed during the period September 1, 1970, through August 31, 1971. The Secretary of Agriculture is required to make appropriate adjustments in his determination of national consumption requirements whenever the average price of raw sugar varies from the objective by 4 percent or more for 7 consecutive days (3 percent or more during November, December, January and February).

<u>Sugar marketing</u> is controlled under the provisions of the U. S. Sugar Act and numerous changes in the law since 1934 have permitted significant increases in the output of domestically produced raw sugar. Even larger increases have been granted to domestic refiners. Over time, the increases granted to each of the domestic sugarcane producing areas have been markedly different. This has affected the degree of modernization and the average size of the mills producing raw sugar in each area although little effect on sugar refineries.

The Sugar Act provides for subsidy payments to U. S. sugarcane and sugar beet growers. These payments are made only to growers who meet the following conditions:

a. That the grower has not marketed cane or beets in excess of the proportionate share for the farm, as determined by the Secretary of Agriculture;

b. That no child labor (except family members) has been employed on the farm;

Table III-4. U.S. Sugar quotas: 1970, 1971 and 1972 basic and adjusted quotas by domestic production area and foreign country

Production area	1970 Basic Quota	1970 Adjusted Quota 1/	1971 Basic Quota	1971 Adjusted Quota 1/	1972 Basic Quota	1972 Adjusted Quota 1/
	(short tons, raw value)		(short tons, raw value)		(short tons, raw value)	
Domestic						
Domestic beet	3,597,000	3,597,000	3,454,000	3,406,333	3,692,000	3,400,000
Mainland cane	1,308,000	1,308,000	1,256,000	1,256,000	1,643,000	1,643,000
Hawaii	1,145,486	1,145,486	1,110,000	1,110,000	1,218,238	1,218,238
Puerto Rico	1,140,000	360,000	1,140,000	150,000	855,000	175,000
Virgin Islands	15,000	--	15,000	--	--	--
Total domestic	7,205,486	6,410,486	6,975,000	5,922,333	7,408,238	6,436,238
Foreign						
Total Foreign	4,394,514	5,189,514	4,325,000	5,377,667	4,391,762	5,363,762
Grand Total	11,600,000	11,600,000	11,300,000	11,300,000	11,800,000	11,800,000

1/ Adjustments reflect (a) changes in total U.S. sugar requirements, (b) withheld quotas, and (c) deficits and deficit prorations.

Source: USDA-ASCS, Sugar Reports, No. 243 (August 1972), pp. 22-24.

c. That all employed labor has been paid in full at not less than the minimum wage determined by the Secretary;

d. That growers who are also processors have paid other growers for purchased cane or beets at prices not less than those set by the Secretary.

Subsidy payments provide a powerful financial incentive for growers to observe the conditions imposed by the Sugar Act. If a grower fails to meet these conditions--i.e., if he attempts to market beets or cane in excess of his assigned proportionate share--his payments are reduced or withheld entirely. Thus, subsidy payments are the principal legal device for obtaining compliance by domestic growers, just as import licenses are the means for obtaining compliance for foreign suppliers.

Conditional payments are made at the basic rate of 80 cents per 100 pounds of sugar recoverable from the cane or beets grown on farms producing less than 350 tons of sugar, raw value. The rate declines by stages to 30 cents per 100 pounds for all sugar in excess of 30,000 tons produced on a farm. In addition, growers may receive payments for abandoned acreage at the rate of one-third the normal yield for the farm; payments may also be received for crop deficiencies caused by drought, flood, storm, freezing, disease, or insects which result in yields below 80 percent of normal. Generally, the payments for abandonment and deficiency are much smaller than the conditional payments made for sugar cane and sugar beets which are harvested and marketed. The 1970 and 1946-69 average return to sugar cane growers, including government payments, are presented in Table III-5 by production area and revenue source.

An excise tax is levied on sugar at the rate of 50 cents per 100 pounds, raw value. This tax is collected on all sugar marketed in the United States regardless of source. Receipts from the tax in recent years have averaged more than $100 million per year, but payments to sugar cane and sugar beet growers have averaged about 15 percent less than the tax. Thus, the U. S. sugar program generates revenue which is deposited in the general funds of the U. S. treasury. However, it should be noted that the subsidy payments made under the Sugar Act and the sugar excise tax are legally separate. Thus, either one could be amended or repealed without affecting the other.

The equitable distribution of the benefits which the Sugar Act created was provided in addition to controlling the supply of sugar, imposing a tax on sugar sales and subsidizing sugar cane and sugar beet growers. For

Table III-5. Sugarcane growers' returns by production area and source, 1970 and 1946-69 average.

Production Area	Basis of Payment 1/: Raw sugar (per pound)	Basis of Payment 1/: Molasses (per gallon)	Processor Payments: Per ton of sugarcane produced for sugar: Sugar	Processor Payments: Per ton of sugarcane produced for sugar: Molasses	Processor Payments: Total 2/	Sugar Act Payments: Per ton of sugarcane produced for sugar: Sugar	Sugar Act Payments: Per ton of sugarcane produced for sugar: Abandonment and deficiency	Sugar Act Payments: Total	Total Payments: Per ton of sugarcane produced for sugar	Total Payments: Total
	Cents	Cents	Dollars per ton		1,000 Dollars	Dollars per ton		1,000 Dollars	Dollars per ton	1,000 Dollars
Louisiana										
1946-69 avg.	6.50	14.73	7.13	.29	43,813	1.24	.03	7,319	8.68	51,133
1970	8.19	13.08	9.09	.24	64,629	1.25	.01	8,692	10.59	73,321
Florida										
1946-69 avg.	6.45	14.98	7.86	.28	23,473	.89	.02	2,540	9.05	26,001
1970	8.37	14.15	11.67	.27	67,712	1.08	3/	6,121	13.02	73,833
Hawaii										
1946-69 avg.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1970										
Puerto Rico										
1946-69 avg.	5.93	11.26	7.92	.35	78,434	1.44	.02	4/15,045	9.73	93,898
1970	7.32	11.63	7.18	.59	45,773	1.08	0	6,341	8.85	52,114

1/ Seasons' average prices based on selected periods of varying length.
2/ Seasons' average prices including molasses payment paid by processors to growers multiplied by sugarcane production.
3/ Less than 0.5 cents.
4/ Includes Commodity Credit Corporation payments for 1945-46.

Source: <u>The Gilmore Louisiana-Florida-Hawaii Sugar Manual</u>, 1971.
USDA-ASCS, Sugar Reports, various issues.

example, most small-scale sugar cane growers have no investment in the mill to which they sell their cane and usually have little freedom in selecting a mill. In most cases, only one or two mills are located near enough to a given farm to permit the economical transportation of cane. In order to protect such growers, the USDA annually determines a minimum price for sugar cane grown in each of the four domestic production areas. This price is established by a formula related to the quality of the sugar cane and the market price of raw sugar for a specified period. For most independent growers in most years, this minumum price is the actual price received. The independent grower's ability to influence the price of sugar cane largely depends, therefore, upon the arguments and evidence which he can present to the Sugar Act administrators who set the minimum prices.

Imported sugar is sold at the same level of prices paid for domestically produced sugar. Sugar prices in the United States generally have been much higher than those prevailing in the world market (Table III-6). During the past two decades, world prices have exceeded the U. S. price only in 1950-51, 1957 1/, 1963-64, and 1972. 1/ High U. S. sugar prices make this country a very desirable market for sugar exporting nations, especially those which do not have other preferred markets such as the United Kingdom or France. The value of the U. S. sugar market to an exporting nation is also affected by the importance of sugar exports to that nation's economy and the share of its sugar exports which can be sold in the United States. In addition to being the dominant factor in determining domestic sugar prices, the U. S. sugar program is, at times, also an important factor influencing world sugar prices. Each time that world sugar prices have risen sharply, U. S. prices have also risen, but more moderately. When world prices have increased, the Secretary of Agriculture has increased the U. S. sugar consumption requirement so as to make more sugar available to consumers here. In 1950, the increase was from 7.5 million to 8.7 million tons; in 1957, from 8.8 million to 9.3 million tons; in 1963, from 9.8 million to 10.4 million tons; and in 1972 from 11.2 million to 11.8 million tons. In each case, the increased supply of sugar for U. S. consumers moderated the price rise here but, by decreasing supplies available for other importing countries, caused world prices to rise even further than expected. Since the United States is by far the world's largest importer of sugar--taking 20 to 25 percent of the total in world trade--unexpected changes in the volume of this country's imports have an appreciable effect on all other sugar importing and exporting countries.

Although U. S. sugar prices since the end of World War II have usually been maintained above the world market level, it does not follow that U. S. prices would have declined to the world level if quotas had not

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1/ Exceeded U.S. prices in some months but not for year average.

Table III-6. Raw sugar prices in New York and the world market, 1948-72

Year	Raw sugar in New York	World sugar 1/	Difference: New York over world
	Cents per pound		
1948	5.54	5.13	0.41
1949	5.81	5.03	0.78
1950	5.93	5.82	0.11
1951	6.06	6.66	-0.60
1952	6.26	5.08	1.18
1953	6.29	4.27	2.02
1954	6.09	4.14	1.95
1955	5.95	4.19	1.76
1956	6.09	4.47	1.62
1957	6.24	6.10	0.14
1958	6.27	4.36	1.19
1959	6.24	3.86	2.38
1960	6.30	4.09	2.21
1961	6.30	3.85	2.45
1962	6.45	3.87	2.58
1963	8.18	9.41	-1.21
1964	6.90	6.79	0.11
1965	6.75	3.07	3.68
1966	6.99	2.81	4.18
1967	7.28	2.95	4.33
1968	7.52	2.96	4.56
1969	7.75	4.37	3.38
1970	8.07	4.88	3.19
1971	8.52	5.65	2.87
1972	9.09	8.53	0.56

1/ Adjusted to the New York delivery base.

Source: USDA-ASCS, Sugar Reports.

existed and import duties were unchanged. Without quotas, U. S. prices would have declined and those in the world market would have risen until they balanced at some intermediate level. No estimates of changes in U. S. and world prices, based on various assumptions regarding changes in quotas and tax policies, are available.

The U. S. sugar program has both benefited the domestic sugar industry and increased the average price paid by sugar users. The disadvantage to consumers of higher sugar prices has been partially offset by the benefit of extreme price stability relative to the prices of other agricultural products.

The Secretary of Agriculture also must adjust quotas for domestic areas. For example, should the effluent limitation guideline costs close mills and production is abandoned, the Secretary of Agriculture is required by law to distribute these acreages to other domestic quota areas first and then to import quotas. The Secretary is directed to set quotas for the coming year such that the price objective for raw sugar as defined in the law is satisfied. If abandoned production was not reallocated, there would be a short run shortage of sugar forcing wholesale prices up causing refiners to bid up the price of raw sugar, and thus causing divergence away from the price objective.

3. Base Point Pricing

Base point pricing developed because large refineries found it economical to locate close to ports of entry or adjacent to major population centers. This gave them ready access to off-shore sugar from which the bulk of refined cane sugar is manufactured. Because these refineries became the major sellers in their respective areas, they established base point pricing. Eight points of origin are used in this base point pricing. Within a region the price at any point is the origin sugar price plus the freight cost from base point to the buyer's location. The principal seller in a region sets the price so as to maximize his profit in the region. All sellers of sugar compete to sell their excess sugar in the Chicago market. The Chicago market has been used because many food processors are located there and because the nation's rail system tends to come together at Chicago. Thus the result of base point pricing is a lower price in Chicago as can be seen in Table III-7. Obviously, the wholesale market for sugar is not one of perfect competition.

Table III-7. Wholesale prices for refined sugar, March 1973.

Location	100 lb. bag	bulk
	cents per lb.	
Northeast	13.31	12.70
Midcentral	12.85	12.25
Western Ohio-Lower Michigan	12.20	12.05
Southeast	12.95	12.45
Gulf	12.40	12.05
Chicago - West	11.75	11.55
Intermountain North	12.05	11.80
Pacific Coast	11.85	11.70

Source: Sugar Reports, USDA-ASCS (April, 1973).

4. Supplies

In the total supply of sugar for the U.S., imports play a major role. Forty-five percent of this total supply is imported, 26 percent of the total comes from domestic sugar cane, and 29 percent from domestic sugar beets.

B. Expected Price Impacts

Since the demand for sugar for household use is relatively inelastic, we doubt that a price increase would alter the consumption patterns significantly. Although price elasticities for industrial uses or cross elasticities with other sweeteners, such as beet sugar, corn sweeteners and synthetics, are not known with certainty, this market representing about two-thirds of sugar use appears to be price conscious and with the indirect government price controls oriented toward price stability, it is doubtful that significant price increases can be achieved in the long run by the cane sugar industry to offset investment in non-productive pollution control equipment.

The price situation is further compounded by the role of sugar imports, which represent about 45 percent of total sugar consumption. Also influencing expected price impacts will be the response of the beet sugar industry to pollution controls. However, it should be noted that in an analysis of the impacts on the beet sugar industry [1/] it was concluded that imposition of water pollution controls would not significantly increase prices due to the large amount of in-place control currently being achieved.

The ability of the industry to pass along cost increases will ultimately depend on government sugar policy. Supply curtailment in the cane mill segment could mean price increases to refiners and consumers, if quotas are not adjusted accordingly and world sugar prices remain at present levels. Any significant curtailment of U. S. domestic cane production could mean that the exceptionally strong world sugar prices will continue, since U. S. actions tend to impact the world price, as pointed up above in the discussion of government sugar policy. At the present stage of analysis, we suspect that much of the projected price effect will depend on the impact on cane mill production.

1/ Economic Impact of Costs of Proposed Effluent Limitation Guidelines for the Beet Sugar Industry, Draft Report, Development Planning and Research Associates, Inc., (1973).

IV. ECONOMIC IMPACT ANALYSIS METHODOLOGY

The following economic impact analysis utilizes the basic industry information developed in Chapters I-III plus the pollution abatement technology and costs provided by Environmental Protection Agency. The impacts examined include:

- Price effects
- Financial effects
- Production effects
- Employment effects
- Community effects
- Other effects

Due to the crucial nature of potential plant shutdowns (financial and production effects) to the other impacts, a disproportionate amount of time will be devoted to the financial and plant closure analysis.

In general, the approach taken in the impact analysis is the same as that normally done for any feasibility capital budgeting study of new investments. In the simplest of terms, it is the problem of deciding whether a commitment of time or money to a project is worthwhile in terms of the expected benefits derived. This decision process is complicated by the fact that benefits will accrue over a period of time and that in practice the analyst is not sufficiently clairvoyant nor physically able to reflect all of the required information, which by definition must deal with projections of the future, in the cost and benefit analysis. In the face of imperfect and incomplete information and time constraints, the industry segments were reduced to money relationships insofar as possible and the key non-quantifiable factors were incorporated into the analytical thought process to modify the quantified data. The latter process is particularly important in view of the use of model plants in the financial analysis. In practice, actual plants will deviate from the model and these variances will be considered in interpreting financial results based on model plants.

A. Fundamental Methodology

Much of the underlying analysis regarding price, financial, and production effects is common to each kind of impact. Consequently, this case methodology is described here as a unit with the specific impact interpretations being discussed under the appropriate headings following this section.

The core analysis for this inquiry was based upon synthesizing physical and financial characteristics of the various industry segments through model or representative plants. The estimated cash flows for these model plants are summarized in Chapter II. The primary factors involved in assessing the financial and production impact of pollution control are profitability changes, which are a function of the cost of pollution control and the ability to pass along these costs in higher prices. Admittedly, in reality, closure decisions are seldom made on a set of well defined common economic rules, but also include a wide range of personal values, external forces such as the ability to obtain financing or consideration of production unit as an integrated part of a larger cost center where total profit center must be considered.

Such circumstances include but are not limited to the following factors:

1. There is a lack of knowledge on the part of the owner-operator concerning the actual financial condition of the operation due to faulty or inadequate accounting systems or procedures. This is especially likely to occur among small, independent operators who do not have effective cost accounting systems.

2. Plant and equipment are old and fully depreciated and the owner has no intention of replacing or modernizing them. He can continue in production as long as he can cover labor and materials costs and/or until the equipment deteriorates to an irrepairable and inoperative condition.

3. Opportunitites for changes in the ownership structure of the plants (or firms) exist through the acquisition of the plants by grower cooperatives where the principal incentive is that of maintaining sugar cane acreages in situations where grower returns from sugar cane production are substantially above returns from alternative cropping opportunities. In this situation, which presently exists in the cane sugar industry, growers may elect to form producer-processor cooperatives and acquire ownership of processing plants which they would continue to operate at levels of return generally unattractive to private owners.

4. Personal values and goals associated with business ownership that override or ameliorate rational economic rules is a complex of factors commonly referred to as a value of psychic income.

5. The plant is a part of a larger integrated entity and it either uses raw materials being produced profitably in another of the firm's operating units wherein an assured market is critical or, alternatively, it supplies raw materials to another of the firm's operations wherein the source of supply is critical. When the profitability of the second operation offsets the losses in the first plant, the unprofitable operation may continue indefinitely because the total enterprise is profitable.

6. The owner-operator expects that losses are temporary and that adverse conditions will dissipate in the future. His ability to absorb short-term losses depends upon his access to funds, through credit or personal resources not presently utilized in this particular operation.

7. There are very low (approaching zero) opportunity costs for the fixed assets and for the owner-operator's managerial skills and/or labor. As long as the operator can meet labor and materials costs, he will continue to operate. He may even operate with gross revenues below variable costs until he has exhausted his working capital and credit.

8. The value of the land on which the plant is located is appreciating at a rate sufficient to offset short-term losses, funds are available to meet operating needs and opportunity costs of the owner-operator's managerial skills are low.

The above factors, which may be at variance with common economic decision rules, are generally associated with proprietorships and closely held enterprises rather than publicly held corporations.

While the above factors are present in and relevant to business decisions, it is argued that common economic rules are sufficiently universal. To provide an useful and reliable insight into potential business responses to new investment decisions, as represented by required investment in pollution control facilities, economic analysis will be used as the core analytical procedure. Given the pricing conditions, the impact on profitability (and possible closure) can be determined by simply computing the ROI (or any other profitability measure) under conditions of the new price and incremental investment in pollution control. The primary consequence of profitability changes is the impact on the plant in terms of a plant shutdown rather than making the required investment to meet pollution control requirements.

In the most fundamental case, a plant will be closed when variable expenses (Vc) are greater than revenues (R), since by closing the plant losses can be avoided. However, in practice, plants continue to operate where apparently $Vc > R$. Reasons for this include:

- lack of cost accounting detail to determine when $Vc > R$.
- opportunity cost of labor or some other resource is less than market values. This would be particularly prevalent in proprietorships where the owner considers his labor as fixed.
- other personal and external financial factors.
- expectations that revenues will shortly increase to cover variable expenses.

A more probable situation is the case where $Vc < R$ but revenues are less than variable costs plus cash overhead expenses (TCc) which are fixed in the short run. In this situation a plant would continue to operate as long as contributions are being made toward covering a portion of these fixed cash overhead expenses. The firm cannot operate indefinitely under this condition, but the length of this period is uncertain. Basic to this strategy of continuing operations is the firm's expectation that revenues will increase to cover cash outlays. Factors involved in this type of closure decision include:

- extent of capital resources. If the owner has other business interests or debt sources that will supply capital input, the plant will continue.
- lack of cost accounting detail or procedures to know that $TCc > R$, particularly in multiplant business situations.
- labor or other resources may be considered fixed and the opportunity cost for these items is less than market value.

Identification of plants where $TCc > R$ but $Vc < R$ leads to an estimate of plants that should be closed over some period of time if revenues do not increase. However, the timing of such closures is difficult to predict.

The next level of analysis, where $TCc < R$, involves estimating the earnings before and after investment in pollution abatement. So long as TCc R it seems likely that investment in pollution control will be made and plant operations continued so long as the capitalized value of earnings (CV), at the firms (industry) cost of capital, is greater than the scrap or salvage value (S) of the sunk plant investment. If S > CV, the firm could realize S in cash and reinvest and be financially better off. This presumes reinvesting at least at the firms (industry) cost of capital.

Computation of CV involves discounting the future earnings flow to present worth through the general discounting function:

$$V = \sum_{n=1}^{t} A_n (1+i)^{-n}$$

where

V	=	present value
A_n	=	a future value in n^{th} year
i	=	discount rate as target ROI rate
n	=	number of conversion products, i.e., 1 year, 2 years, etc.
t	=	terminal number (or year)

It should be noted that a more common measure of rate of return is the book rate, which measures the after-tax profits as a ratio of invested capital, net worth, or sales. These ratios should not be viewed as a different estimate of profitability as opposed to DCF (discounted cash flow) measures but rather as an entirely different profitability concept. The reader is cautioned not to directly compare the DCF rates with book rates. Although both measures will be reported in the analyses, the book rate is reported for informational purposes only.

The two primary types of DCF measures of profitability are used. One is called the internal rate of return or yield and is the computed discount rate (yield) which produces a zero present value of the cash flow. The yield is the highest rate of interest the investor could pay if all funds were borrowed and the loan was returned from cash proceeds of the investment. The second DCF measure is the net present value concept. Rather than solve for the yield, a discount rate equivalent to the firms cost of capital is used. Independent investments with net present values of above zero are accepted; those below zero are rejected. The concept of comparing capitalized earnings with the sunk investment value is a variation of the net present value method.

The data input requirements for book and DCF measures are derived, to a large extent, from the same basic information although the final inputs are handled differently for each.

1. Benefits

For purposes of this analysis, benefits for the book analysis have been called after-tax income and for the DCF analysis after-tax cash proceeds. The computation of each is shown below:

$$\text{After tax income} = (1 - T) \times (R - E - I - D)$$

$$\text{After tax cash proceeds} = (1 - T) \times (R - E - D) + D$$

where

T = tax rate

R = revenues

E = expenses other than depreciation and interest

I = = interest expense

D = depreciation charges

Interest in the cash proceeds computation is omitted since it is reflected in the discount rate, which is the after-tax cost of capital, and will be described below. Depreciation is included in the DCF measure only in terms of its tax effect and is then added back so that a cash flow over time is obtained.

A tax rate of 48 percent was used throughout the analysis. Accelerated depreciation methods, investment credits, and carry forward and carry back provisions were not used due to their complexity and special limitations. It is recognized that in some instances the effective tax rate may be lower for single plant but, with the dominance of multiplant firms, the industry's tax rate will be close to the 48 percent rate.

Revenue, expenses, interest and depreciation charges used were those discussed in Chapter II. Chapter V discusses the cost of pollution control facilities. These items were assumed to be constant over the period of analysis.

2. Investment

Investment is normally thought of as outlays for fixed assets and working capital. However, in evaluating closure of an on-going plant where the basic investment is sunk, the value of that investment must be analyzed in terms of its liquidation or salvage value, that is its opportunity cost or shadow price. 1/ For purposes of this analysis, sunk investment was taken as the sum of equipment salvage value plus land at book value plus the value of the net working capital (current assets less current liabilities) tied up by the plant (see Chapter II for values). This same amount was taken as a negative investment in the terminal year. Replacement investment for plant maintenance was taken as equal to annual depreciation, which corresponds to operating policies of some managements and serves as a good decision rule for replacement in an on-going business.

Investment in pollution control facilities was taken as the estimates provided by EPA and shown in Chapter V. Only incremental values were used to reflect in-place facilities. The value of the land involved was taken as a negative investment in the terminal year.

The above discussion refers primarily to the DCF analysis. Investment used in estimating book rates was taken as invested capital--book value of assets plus net working capital. In the case of new investment, its book rate was estimated as 50 percent of the original value.

3. Cost of Capital - After Tax

Return on invested capital is a fundamental notion in U. S. business. It provides both a measure of actual performance of a firm as well as expected performance. In this latter case, it is also called the cost of capital. The cost of capital is defined as the weighted average of the cost of each type of capital (equities and interest bearing liabilities) employed by the firm. There is no methodology that yields the precise cost of capital, but it can be approximated within reasonable bounds.

The cost of equities was estimated by two methods -- the dividend yield method and the earnings stock price (E/P ratio) method. Both are simplifications of the more complex DCF methodology. The dividend method is:

1/ This should not be confused with a simple buy-sell situation which merely involves a transfer of ownership from one firm to another. In this instance, the opportunity cost (shadow price) of the investment may take on a different value.

$$k = \frac{D}{P} + g$$

where

k = cost of capital
D = dividend yield
P = stock price
g = growth

and the E/P method is simply

$$k = E/P$$

where k = cost of capital
E = earnings
P = stock price

and is a further simplication of the first. The latter assumes future earnings as a level, perpetual stream.

The after tax cost of debt capital was estimated by using reported interest costs as a percent of total debt and multiplying by .52-- assuming a 48 percent tax rate. These values were weighted by the respective equity to total asset and total liabilities[1/] to total asset ratios.

The average cost of capital for the sugar refining industry was estimated using the equity and debt data from Chapter II as follows:

Dividend Yield Plus Growth

Capital	Weight	Cost	Growth	Cost
Equity	.66	.046	.04	.057
Debt	.34	.033	--	.011
Average Cost of Capital				.068

E/P

Capital	Weight	Cost	Growth	Cost
Equity	.66	.112	--	.074
Debt	.34	.033	--	.011
Average Cost of Capital				.085

1/ It is recognized that liabilities contain non-interest bearing liabilities, but their weight is believed to be an adequate estimate of the weight of debt since such liabilities are usually insignificant.

As shown in the above computations, the estimated after-tax cost is 6.8 to 8.5 percent. The subsequent analysis was based on 6.5 and 7.5 percent, since it was felt that this was representative of the industry. However, the above 6.8 to 8.5 percent were estimated from only four firms. The lower estimate presumes a four percent growth factor which is roughly equal to inflation expectations.

4. Construction of the Cash Flow

A twenty-two period cash flow was used in this analysis and was constructed as follows:

1. Sunk investment (salvage market value of fixed assets plus net working capital) taken in year t_o.

2. After tax cash proceeds taken for years t_1 to t_{20}.

3. Annual replacement investment equal to annual current depreciation taken for years t_1 to t_{20}.

4. Terminal value equal to sunk investment taken in year t_{21}.

5. Incremental pollution control investment taken in year t_o for 1977 standards and year t_6 for 1983 standards.

6. Incremental pollution expenses taken for years t_1 to t_{20} for 1977 standards and years t_7 to t_{20} for 1983 standards, if additive to the 1977 standards.

7. No replacement investment taken on incremental pollution investment on the assumption of a 20 year life.

8. No terminal value of pollution facilities was taken in year t_{21}. Often land would be taken, but because it represents such a small quantity, the value was ignored.

B. Price Effects

At the outset, it must be recognized that price effects and production effects are intertwined with one effect having an impact upon the other. In fact, the very basis of price analysis is the premise that prices and supplies (production) are functionally related variables which are simultaneously resolved.

Solution of this requires knowledge of demand growth, price elasticities, supply elasticities, the degree to which regional markets exist, the degree of dominance experienced by large firms in the industry, market concentration exhibited by both the industry's suppliers of inputs and purchasers of outputs, organization and coördination within the industry, relationship of domestic output with the world market, existence and nature of complementary goods, cyclical trends in the industry, current utilization of capacity and, exogenous influences upon price determination (e.g., governmental regulation).

In view of the complexity and diversity of factors involved in determination of the market price, a purely quantitative approach to the problem of price effects is not feasible. Hence, the simultaneous considerations suggested above will be made. The judgment factor will be heavily employed in determining the supply response to a price change and alternative price changes to be employed.

As a guide to the analysis of price effects, the estimated price required to leave the model plant segment as well off as it is today will be computed. The required price increase at the firm level will be evaluated in light of the relationship of the model plant to the industry and the understanding of the competitive position of the industry. The required price increase can be readily computed using the DCF analysis described above, but dealing only with the incremental pollution investment and cash proceeds.

Application of the above DCF procedure to these costs will yield the present value of pollution control costs (i.e., investment plus operating cost less tax savings). If this is known, the price increase required to pay for pollution control can readily be calculated by the formula

$$X = \frac{(PVP)(100)}{(1-T)(PVR)}$$

where:

X = required percentage increase in price

PVP = present value of pollution control costs

PVR = present value of gross revenue starting in the year pollution control is imposed

T = tax rate

Note that this formula implies that incremental profits resulting from the price increase will be taxed at a rate of 48 percent.

C. Financial Effects

In Chapter II, the financial characteristics of model plants were presented. These data will serve as the base point for the analysis of financial effects of pollution control. The primary focus of analysis will be upon profitability in the industry and the ability of the firms to secure external capital. Hence, it is obvious that this portion of the analysis cannot be divorced from production effects since profit levels and the ability to finance pollution abatement facilities will have a direct influence on supply responses -- utilization of capacity and plant closures.

The measures of profitability utilized will include after-tax book rate of return on invested capital and cash flow (after-tax profit plus depreciation). After-tax profit as a percent of sales will also be reported to assist in comparing financial data with standard industrial measures.

In addition to these factors, two additional measures of economic profitability will also be examined: (1) capitalized value of earnings and (2) present values estimated by the procedures described in Section A above. Both of these measures will be calculated on pre- and post-pollution control bases.

Given these financial measurements, the ability of the industry to finance the required pollution control expenditures will be reexamined in light of the financial results and the information shown in Chapter II. This ability will vary from one industry subsector to another due to different financial structures, profitability, and abatement requirements. Hence, capital availability and cost will probably have to be examined on a model plant by model plant basis.

D. Production Effects

Potential production effects include reductions of capacity utilization rates, plant closures and stagnation of industry growth. It is anticipated that reductions in capacity utilization will be estimated via qualitative techniques given the analysts' knowledge of the industry. The same is true for assessing the extent to which plant closures may be offset by increases in capacity utilization on the part of plants remaining in operation. Data limitations and time constraints are expected to require that the impact of pollution control standards upon future growth of the industry also be estimated via qualitative methods.

The remaining effect, plant closures, is very difficult to measure realistically as discussed above in Section A. As a starting point in the plant closure analysis, a shutdown model will be employed to indicate which model plants should be closed, the marginal operations and the sound operations. These conclusions will be based upon the decision rule that a plant will be closed when the net present value of the cash flow is less than zero.

It is recognized that the use of models to represent an industry is imperfect and that not all of the relevant values or factors can be included in the models. Hence, in this industry, the appropriate model plant results will be equated with each cane sugar plant and the variances to the model plant parameters will be subjectively evaluated to arrive at an estimate of the probability of closure. In Chapter VI a list of the 6 model parameters are shown against which each plant in the industry was compared.

The above analysis will be done under a "without pollution" control condition and a "with pollution" control condition. The former (and including historical trends) will establish a baseline against which total closures after pollution control will be compared, to arrive at an estimate of closures due to pollution control.

E. Employment Effects

Given the production effects of estimated production curtailments, plant closings and changes in industry growth, a major consideration arises in the implications of these factors upon employment in the industry. The employment effects stemming from each of these production impacts will be estimated. To the extent possible, the major employee classifications involved will be examined with respect to the potential for re-employment.

F. Community Effects

The direct impacts of job losses upon a community are immediately apparent. However, in many cases, plant closures and cutbacks have a far greater impact than just the employment lost. Multiplier effects may result in even more unemployment. Badly needed taxes for vital community services may dwindle. Community pride and spirit may be dampened. However, in some cases, the negative community aspects of production effects may be very short-term in nature with the total impact barely visible from the viewpoint of the overall community. In a few cases, the closure of a plant may actually be viewed as a positive net community effect (e.g., a small plant with a high effluent load in an area with a labor shortage). These impact factors will be qualitively analyzed as appropriate.

G. Other Effects

Other impacts such as direct balance of payments effects will also be included in the analysis. This analysis too, will involve qualitative judgments.

V. POLLUTION CONTROL REQUIREMENTS AND COSTS

Water pollution control standards, technology and costs used in this analysis were provided by the Environmental Protection Agency. The conclusions of this report are based on those costs. During the preparation of this report, a number of changes were introduced by EPA but it is believed by the contractor that the cost figures and investment amounts shown in the analytical portion of this report are current. Several factors, however, have been spelled out in the limits to this analysis which bear specifically on the information and cost as provided by EPA. Further, it should be noted that the information shown below refers specifically to cane sugar refineries. Sugar cane milling costs and impacts are not shown and are not to be considered at this time.

A. Alternative Effluent Control Levels

General levels of pollution control for the cane sugar refinery industry, both the liquid sugar segment and the crystalline sugar segment are set forth below. Each of these levels indicate an effluent discharge and the loadings for this discharge in BOD and Suspended Solids are shown in Table V-1.

1. Alternative A: No waste treatment or control. Essentially the effluent from this alternative is the raw effluent and there is neither treatment or cost involved with this alternative.

2. Alternative B: Elimination of discharge from filters. This alternative can be achieved by either impounding the mud resulting from slurrying the filter cake with water or by dry hauling the desweetened filter cake to land fill. B-1 assumes that the filter slurry is impounded and B-2 assumes dry disposal of the filter cake.

3. Alternative C: Inplant modifications to reduce entrainment of sucrose into condenser water. This alternative includes the installation of the demisters and external separators in order to reduce entrainment of sucrose in condenser water. In addition, refineries have good baffling and operation controls in the evaporators and vacuum pans as well as good vapor height.

Table V-1. Summary of waste loads from effluent treatment alternatives for cane sugar refineries

	Liquid		Crystalline	
	BOD	SS	BOD	SS
	----- kilograms per metric ton-----			
Alternative A	3.43	1.56	1.54	1
Alternative B-1	3.25	1.00	1.36	1.30
Alternative B-2	3.25	1.00	1.36	1.30
Alternative C	2.90	1.00	1.16	1.30
Alternative D	0.24	0.10	0.38	0.06
Alternative E-1	0.06	0.03	0.04	0.03
Alternative E-2	0.06	0.03	0.04	0.03

Source: Development Document for Effluent Limitations Guidelines and Standards of Performance; Cane Sugar Refining Segment of the Sugar Processing Industry, Environmental Protection Agency.

4. Alternative D: Biological treatment of process water. This alternative assumes the use of an activated sludge plant to treat process water in addition to the treatment under Alternative B and C. While there are presently no refineries which have their own biological treatment systems, the process waste water is highly bio-degradable and thus well suited for biological treatment in the opinion of the Development Document as furnished by EPA.

5. Alternative E: Recycle of condenser water and biological treatment of blowdown. This alternative includes, in addition to Alternative D, the recycle of condenser water followed by biological treatment of the blowdown in an activated sludge unit. The blowdown is to be approximately two percent of the total flow. Recycle of condenser water accomplishes two important things. One, it cools the water, thus removing the heat normally discharged and, (2) it concentrates the waste loadings into the smaller blowdown stream, making biological treatment of this waste stream feasible. Alternative E-1 assumes a cooling tower. Alternative E-2 assumes a spray pond. Furthermore, where the E technology is used in conjunction with Alternative D, a sand filter must also be added at the end of the line for removal of suspended solids.

Within the above context and water pollution abatement requirements under the Federal Water Pollution Control amendments for 1972, the following three categories of control were evaluated. Referring to Table V-2, the three levels of control are Best Practical Control Technology Currently Available, which is to be instituted by 1977, Best Available Technology Economically Achievable which is to be instituted by 1983, and the New Source Performance Standards which will be in effect for all new sources coming onstream by 1974. From the proposed guidelines for liquid and crystalline refineries in the Development Document, all refineries need to achieve Level D of the alternatives for Best Practical Control Technology Currently Available (BPT) by 1977 and Alternative E for Best Available Technology Economically Achievable (BAT) by 1983.

B. Current Level of Control

To identify current levels of control or inplace technologies refer to Table V-3, which is a listing of the methods of disposal of waste water at each refinery. This listing is from the EPA Development Document for Effluent Limitations Guidelines. Although specific refineries cannot be identified, refer to Table V-4 which indicates by Code Number, the type of refinery, its capacity, and its model classification.

Table V-2. Proposed effluent limitations guidelines

	BPT[1]		BAT[2]		NSPS[3]	
	BOD	SS	BOD	SS	BOD	SS
	------ kilograms per metric ton of melt------					
Monthly average						
Liquid	0.24	0.10	0.06	0.03	0.06	0.03
	(0.48)[4]	(0.20)	(0.12)	(0.06)	(0.12)	(0.06)
Crystalline	0.38	0.06	0.04	0.03	0.04	0.03
	(0.76)	(0.12)	(0.08)	(0.06)	(0.08)	(0.06)
Daily average						
Liquid	0.85	0.45	0.21	0.14	0.21	0.14
	(1.70)	(0.90)	(0.42)	(0.28)	(0.42)	(0.28)
Crystalline	1.14	0 24	0.12	0.12	0.12	0.12
	(2.28)	(0.48)	(0.24)	(0.24)	(0.24)	(0.24)

1/ Best practical control technology currently available - 1977.

2/ Best available technology economically achievable - 1983.

3/ New source performance standards.

4/ Bracket figures are pounds per ton.

Source: Development Document For Effluent Limitations Guidelines and Standards of Performance; Cane Sugar Refinery Segment of the Sugar Processing Industry, Environmental Protection Agency.

Table V-3. Summary of wastewater treatment and disposal techniques of United States' cane sugar refineries 1/

Refinery	Disposal of Wastewaters
C-1	All process wastewater to municipal sewers; condenser water to river.
C-2	All process wastewater to municipal sewers; condenser water to river.
C-3	All liquid wastes to river.
C-4	All process wastewater to municipal sewers; condenser water to river.
C-5	All process wastes to municipal sewers; condenser water to river.
C-6	All liquid wastes to river.
C-7	Primary settling of process wastes; all discharge to river.
C-8	All liquid wastes currently to river. Hook up to municipal system completed for process water and expected tobe operational before 1977.
C-9	Most process wastewater to municipal sewers; condenser water to river.
C-10	Most process wastewater to municipal sewers; condenser water to river.
C-11	Discharge into a swamp after traveling through a two and a half mile canal.
C-12	Total impoundment of wastewater resulting in no discharge to navigable waters.
C-13	Discharges into a swamp.
C-14	All process wastes to municipal sewers; recycle of condenser water through a cooling tower and discharge of blowdown to municipal sewers.

Table V-3. Summary of wastewater treatment and disposal techniques of United States' cane sugar refineries (continued)

Refinery	Disposal of Wastewaters
L-1	All liquid wastes to municipal sewers.
L-2	All liquid wastes to municipal sewer; condenser water to river.
L-3	All process wastewater to municipal sewer; condenser water to river.
L-4	Total impoundment of wastewaters resulting in no discharge to navigable waters.
L-5	Discharge of process water; cooling tower for condenser water
CL-1	All process wastewater to municipal sewers; condenser water to river.
CL-2	Most of process wastes to municipal sewers; condenser water to river.
CF-1	Closed system of canals and holding ponds resulting in no discharge to navigable waters.
CF-2	Total impoundment of acid/caustic wastes and filter cake slurry; impoundment with overflow of all other wastewaters.
CF-3	Condenser water passed through spray pond (partial recycle possible) before discharge; all process wastewaters discharged to impoundage.
CF-4	Condenser water impounded then discharged; all other waters impounded completely in ponds; cooling tower recently built.
CF-5	Partial impoundment.
CF-6	Partial reuse of wastewaters in raw sugar factory for cane washings during grinding season.
CF-7	Partial impoundment.
CF-8	Partial impoundment.

Source: Development Document for Effluent Limitations Guidelines and Standards of Performance; Cane Sugar Refinery Segment of the Sugar Processing Industry, Environmental Protection Agency.

Table V-4. Cane sugar refineries, code, capacity and classification

Code	Capacity ton/day	Type of Refinery	Classification 1/
C-1	2,600	Crystalline	4
C-2	2,100	"	4
C-3	3,250	"	4
C-4	2,100	"	4
C-5	1,000	"	4
C-6	190	"	2
C-7	3,500	"	4
C-8	1,500	"	4
C-9	2,000	"	4
C-10	1,200	"	4
C-11	1,500	"	3
C-12	350	"	2
C-13	1,700	"	3
C-14	2,200	"	4
L-1	300	Liquid	1
L-2	800	"	1
L-3	850	"	1
L-4	390	"	1
L-5	100	"	1
CL-1	1,800	Crystalline-Liquid	4
CL-2	820	"	4
CF-1	460	Ref.-Mill	2
CF-2	700	"	3
CF-3	660	"	2
CF-4	700	"	3
CF-5	220	"	2
CF-6	600	"	2
CF-7	400	"	2
CF-8	700	"	2

1/ Classification refers to model segment:
1 - Liquid
2 - Small rural crystalline
3 - Large rural crystalline
4 - Urban crystalline

Table V-5 indicates the type and extent of treatment at each specific refinery showing how the process water and the condenser water is currently handled. While it was not possible to translate each of the descriptions of how the discharge was handled into specific alternative levels of technology, a close, and we feel reasonable appraisal of the inplace technology was made. For each of the cane sugar refineries, a designation of the current status of inplace control is shown in Table V-5.

From this table it can be seen that 16 plants currently either discharge their process water to a municipal system or have some other form of total treatment so that there is effectively no discharge of effluent from the process water to surface water bodies. By the same analysis, there are only five plants that have either treatment for their condenser water or discharge the condenser water to a municipal system. This would indicate that treatment for condenser water is a major consideration. Supportive of this position is the fact that there are 14 plants that discharge condenser water after making one pass through the condenser.

C. Water Pollution Abatement Costs

The costs of the various alternatives of treatment from B through E were furnished by the Environmental Protection Agency through Supplement A of The Development Document for Effluent Limitations Guidelines. Table V-6 shows a summary of these costs for both liquid and crystalline plants and shows the incremental investment and annual cost of operation involved for each level of treatment.

1. Investment

The figures on investment for each level of technology were used in total as received and the conclusions, as far as the impact of costs shown in the next chapter, follow from these estimates.

The assumption was made that B-1 or B-2 was in place for most refineries and therefore, the investments for the B-1 or B-2 technology was used only in evaluating one refinery in Table V-7. Similarly the need for Alternative C technology, involving various entrainment devices for the vacuum pans and the evaporators, was not clearly defined. The amount of investment for Alternative C appeared to be a small part of the total investment, however, when compared to the D and E levels, therefore the lack of specific knowledge was not considered serious.

Table V-5. Cane sugar refineries, water effluent discharge status

Code	Process Water: No Treatment	Process Water: Municipal system	Process Water: Partial Treatment	Process Water: Total Treatment	Condenser Water: Direct discharge to water bodies	Condenser Water: Municipal system	Condenser Water: Partial Treatment	Condenser Water: Cool and Recycle	Condenser Water: Total Treatment
C-1		X			X				
C-2		X			X				
C-3	X				X				
C-4		X			X				
C-5		X			X				
C-6	X				X				
C-7		1/	X		X				
C-8			X		X				
C-9		X2/			X				
C-10		X2/			X				
C-11			X3/				X		
C-12				X					X
C-13			X3/				X		
C-14		X				X			
L-1		X				X			
L-2		X			X				
L-3		X			X				
L-4				X					X
L-5	X							X	
CL-1		X			X				
CL-2		X 2/			X				

continued--

Table V-5. (continued)

Code	Process Water: No Treatment	Process Water: Municipal system	Process Water: Partial Treatment	Process Water: Total Treatment	Condenser Water: Direct discharge to water bodies	Condenser Water: Municipal system	Condenser Water: Partial Treatment	Condenser Water: Cool and Recycle	Condenser Water: Total Treatment
CF-1				X					X
CF-2				X			X		
CF-3				X			X		
CF-4				X			X		
CF-5			X				X		
CF-6			X				X		
CF-7			X				X		
CF-8			X				X		

1/ Expect to be on municipal hookup by the end of 1973.

2/ Most process water to a municipal system.

3/ Discharge to a swamp - not to a navigable river.

Table V-6. Cane sugar refinery water pollution control investment and annual costs 1/ by technologies

	A	B-1	B-2	C	D	E-1	E-1 3/	E-2	E-2 3/
	$1,000								
Liquid									
Investment	0	33.0	66.0	58.0	362.0	157.0	187.0	133.0	163.0
Annual cost 2/	0	6.2	39.5	23.6	145.9	18.4	20.0	15.5	17.1
Crystalline									
Small									
Investment	0	35.5	66.0	56.0	273.0	339.0	371.9	270.0	302.9
Annual cost 2/	0	5.8	39.5	20.3	127.6	46.4	48.0	40.6	42.1
Large									
Investment	0	71.0	66.0	79.0	712.0	709.0	766.0	584.0	640.0
Annual cost 2/	0	15.0	68.5	25.1	169.1	109.0	113.4	87.7	92.1

1/ All costs updated from 1971 to 1972 by use of 1.076 multiplier.

2/ Annual maintenance and operating cost less depreciation and interest.

3/ Includes cost of sand filter.

Source: Development Document for Effluent Limitations Guidelines and Standards of Performance; Cane Sugar Refining Segment of Sugar Processing Industry - Supplement A, Cost Analysis. Environmental Protection Agency

Table V-7. Cane sugar refineries estimated technology needs and costs to meet best practical control technology currently available

		B-1 1/		B-2 1/		C		D		Total	
Code	Capacity ton/day	Invest-ment	Annual Cost	Invest-ment	Annual Cost	Invest-ment	Annual Cost	Invest-ment	Annual Cost	Invest-ment	Annual Cost
		$000									
C-1	2,600										
C-2	2,100										
C-3	3,250	71	15.0					711	169.1	782	184.1
C-4	2,100										
C-5	1,000										
C-6	190					56	20.3	273	127.6	329	147.9
C-7	3,500					79	25.1	711	169.1	790	194.2
C-8	1,500										
C-9	2,000					79	25.1			79	25.1
C-10	1,200					79	25.1			79	25.1
C-11	1,500							711	169.1	711	169.1
C-12	350										
C-13	1,700							711	169.1	711	169.1
C-14	2,200										
L-1	300										
L-2	800					58	23.6			58	23.6
L-3	850					58	23.6			58	23.6
L-4	390										
L-5	100					58	23.6	362	145.9	420	169.5
CL-1	1,800										
CL-2	820					56	20.3			56	20.3

continued--

Table V-7 (continued)

Code	Capacity ton/day	B-1 [1/] Invest-ment	B-1 [1/] Annual Cost	B-2 [1/] Invest-ment	B-2 [1/] Annual Cost	C Invest-ment	C Annual Cost	D Invest-ment	D Annual Cost	Total Invest-ment	Total Annual Cost
	---$000---										
CF-1	460										
CF-2	700					56	20.3			56	20.3
CF-3	6 660					56	20.3			56	20.3
CF-4	700					56	20.3			56	20.3
CF-5	220					56	20.3	273	127.6	329	147.9
CF-6	600					56	20.3	273	127.6	329	147.9
CF-7	400					56	20.3	273	127.6	329	147.9
CF-8	700					56	20.3	273	127.6	329	147.9
Totals		71	15.0	0	0	915	328.8	4,571	1,460.3	5,557	1,804.1
No. of Refineries		1		0		15		10		18	

1/ Arbitrarily B-1 costs we assumed for rural and B-2 costs for urban refineries.

Table V-7 taken in total shows the various refineries that require investment and expense to meet the BPT level and Table V-8 shows what incremental investments and expenses need to be made by 1983 in order to achieve the BAT level of control.

2. Operating and Ownership Costs

In contrast with the beet sugar industry, for example, operating and maintenance costs are a significant part of the total costs of water pollution control equipment and practices as compared to the total cost of investment. As will be seen later, the amount of annual expense does have a significant impact on the refineries and the results of the discounted cash flow analysis. Annual depreciation charges of five percent were taken on equipment on the presumption that this equipment would have a 20-year life and no salvage value.

3. Estimated Costs

Based on the data which have been described above, it was possible to make a total cost estimate for each refinery. For the purposes of the impact analysis this cost information was then blended in with each model plant in order to measure the impact on a plant by plant basis. Overall on the industry wide basis for the BPT level of treatment, a total of $5,557,000 would need to be invested. For the BAT level, this investment is an additional $11,120,000.

These costs, as previously mentioned, assume that the levels of technology specified will produce the level of treatment required to meet the guidelines and, secondly, that the alternatives of treatment are properly costed so that these do, in fact, represent actual dollars to be spent by each refinery. Of the 29 refineries, 18 will be required to invest money by 1977 and a total of 22 will be investing in water pollution control by 1983.

Table V-8. Cane sugar refineries estimated technology needs and costs to meet best available technology economically achievable - 1972 data

Code	Capacity ton/day	E-1 [1/] Invest-ment	E-1 [1/] Annual Cost	E-2 [1/] Invest-ment	E-2 [1/] Annual Cost	Total Invest-ment	Total Annual Cost
		$000					
C-1	2,600	709	109.0			709	109.0
C-2	2,100	709	109.0			709	109.0
C-3	3,250	766	113.4			766	113.4
C-4	2,100	709	109.0			709	109.0
C-5	1,000	709	109.0			709	109.0
C-6	190			303	42.1	303	42.1
C-7	3,500	766	113.4			766	113.4
C-8	1,500	709	109.0			709	109.0
C-9	2,000	709	109.0			709	109.0
C-10	1,200	709	109.0			709	109.0
C-11	1,500			640	92.1	640	92.1
C-12	350					0	
C-13	1,700			640	92.1	640	92.1
C-14	2,200					0	
L-1	300					0	
L-2	800	157	18.4			157	18.4
L-3	850	157	18.4			157	18.4
L-4	390					0	
L-5	100	28	1.5 [2/]			28	1.5
CL-1	1,800	709	109.0			709	109.0
CL-2	820	339	46.4			339	46.4

continued--

Table V-8 (continued)

Code	Capacity ton/day	E-1 [1/] Invest-ment	E-1 [1/] Annual Cost	E-2 [1/] Invest-ment	E-2 [1/] Annual Cost	Total Invest-ment	Total Annual Cost
		$000					
CF-1	460					0	
CF-2	700			270	40.6	270	40.6
CF-3	660						
CF-4	700	170	23.2 [3/]			170	23.2
CF-5	220			303	42.1	303	42.1
CF-6	600			303	42.1	303	42.1
CF-7	400			303	42.1	303	42.1
CF-8	700			303	42.1	303	42.1
Totals		8,055	1,206.7	3,065	435.3	11,120	1,642.0
No. of Refineries		15		8		23	

1/ Arbitrarily E-1 costs were assumed for urban and E-2 costs for rural refineries.

2/ Has cooling tower - nneds only sand filtration.

3/ Has cooling tower with half capacity now. Therefore only one half cost of an additiona cooling tower is used.

VI. IMPACT ANALYSIS

The impacts considered in this analysis include the following:

Price effects
Financial effects
Production effects
Employment effects
Community effects
Balance of payments effects

A comprehensive and detailed analysis of each of the above was beyond the scope of this study. Consequently, efforts were allocated more to the financial and plant closure analysis with lesser effort on the other macro-economic impacts.

A. Price Effects

Estimated price increases necessary for the industry to maintain its current level of profitability are not large, although certain segments will require much hi her increases than others. Table VI-1 shows estimated price increases required to maintain estimated current profitability levels based on the model plant analysis. It shows the incremental increases involved in the BPT level, the BAT level, and the total of both, which would be required by 1983.

Except for the segment of refineries listed as small rural, all price increases needed are less than one percent. The liquid plants need the least price increase, only .14 of one percent. The small rural plants, and this is only some of the plants in this group, show a need for 2.07 percent increase while the large rural is .92 of one percent and the urban plants require .61 of one percent increase. Actually, five plants, which require no treatment costs whatsoever represent 11 percent of the total refinery capacity and would show in this table to need a zero price increase.

In the case of the sugar beet industry, a larger percent of the total industry was not required to spend money for water pollution control due to the fact that they were operating at zero discharge already. This percentage was approximately 30 percent. In the case of cane sugar, only 11 percent of the industry is currently meeting both the 1977 and 1983 guidelines. On the other hand, the need for price increases and the amount of price impact in cane sugar is about the same as the beet sugar industry.

Table VI-1. Percentage price increases needed to maintain profitability

Model	BPT		BAT		Total increase by '83	
	Min.	Max.	Min.	Max.	Min.	Max.
Liquid	0	0	0	.14	0	.14
Crystalline						
Small rural	0	1.74	0	.33	0	2.07
Large rural	0	.68	0	.24	0	.92
Urban	0	.44	.16	.16	.16	.61

Since the demand for sugar at the household level is relatively inelastic, we doubt that such price increases would alter this consumption pattern significantly. Although price elasticities for industrial users and cross elasticities with other sweeteners, such as beet sugar, corn sweeteners, and synthetics, are not known with certainty, there appears to be a possibility that sugar itself, both beet and cane, could become less competitive. Because of this price pressure, it may be that some companies will withdraw from specific markets in which they compete at a disadvantage and thus independently find ways and means of satisfying their own need for price increases. A recent example noted in the press was that of Holly Sugar, a beet sugar company announcing it was withdrawing from the Chicago market since they did not have enough sugar to compete in all markets and the Chicago market paid the lowest price.

However, under present legislation, sugar's ultimate competitive position will depend upon the Department of Agriculture's policy regarding such costs and how these are interpreted in relation to import quotas. Objectives of the Sugar Act, discussed in Chapter III, suggested that pollution control costs could receive some consideration, but again it needs to be pointed out that it is strictly at the option of the Secretary to act under broad powers rather than specific powers in the Act.

The Act in Section 205 entitled "Allotments of Quotas or Prorations" states that the Secretary of Agriculture shall make allotments to assure an orderly and adequate flow of sugar to prevent disorderly marketing or importation, and to maintain a continuous and stable supply of sugar so as to afford all interested persons an equitable opportunity to market sugar. It seems that, under this section, the Secretary could make adjustments in quotas to adjust for increased costs of pollution. However, in doing so, it is suspected that the Secretary would take into account the cost of impacts of pollution control in both the beet and cane sugar industries. In doing so the Secretary could be constrained to variances in the price of some three or four percent, as defined in Section 202 of the Act.

Thus, an important factor for price changes in response to the imposition of pollution controls appears to be the position which the Secretary chooses to take. It is of interest to note that some members of the sugar industry believe the Secretary is not taking full advantage of his powers to insure their welfare. However, some professionals who have studied the United States sugar policy have suggested that the benefits of a domestic sugar industry are considerably less than the cost of maintaining this industry and that policy be redirected in favor of increased imports. Given the current posture toward the removal of government agricultural controls, it seems that a ruling by the Secretary in favor of increased prices for the domestic sugar industry can not be automatically expected.

Satisfaction of one purpose could also be in conflict with another. In view of current pressures to keep food prices down, the provision of ample sugar supplies at reasonable prices might well receive greater weight than other purposes.

Current price ceilings due to wage and price controls have tended to hold down any normal price increases which might be expected in the entire sweetener industry. With the termination of such controls or allowable adjustments, there will probably be some movement of prices upward due to the depressed earnings of the entire sugar industry.

It is felt, however, that price increases specifically geared to water pollution control costs are not possible under the existing conditions of the Sugar Act and current government policy. For the rest of the analysis, therefore, it is assumed that there will be no price increase.

B. Financial Effects

Measurement of financial effects of water pollution control in the cane sugar refining industry requires knowledge of existing financial condition of the industry to serve as the base line projections of key financial indicators following pollution control implementation. These estimates were based on model plants described in Chapter II and the incremental costs by model plants as discussed in Chapter V.

1. Profitability

As shown in Chapter II, the cane sugar refinery industry is not highly profitable with after-tax returns on invested capital from zero to 2 1/2 percent. Thus any investment increase without profit increase will only compound low profitability.

Profitability effects for purposes of this analysis will be measured on a discounted cash flow procedure and in line with the conclusion of the previous section, no price increases were taken into account for this analysis.

Present values were computed using both a 6 1/2 percent and a 7 1/2 percent discount rate, which is the approximate after-tax cost of capital (equity and debt) in the cane sugar refinery industry as was shown in the computation in Chapter V. A higher rate would make these impacts more severe and a lower rate would reduce the impacts. In these terms, present value of cash flows, after adding pollution control costs, show a significant financial impact with either discount rate.

In order to apply the discounted cash flow procedure to the sugar refineries, certain steps have been taken. First of all the costs of various alternatives of water pollution control--both investment and annual operating costs--have been applied to specific model refineries. Discounted cash flows, assuming a 6.5 percent and a 7.5 percent rate after taxes, were computed for two cases--before (Base case) and after (BPT and BAT) were computed for pollution control.

The results of these runs are shown in Table VI-2. The specific costs for each level of treatment technology were taken from Table V-7 for BPT and V-8 for BAT. Water pollution control costs from these tables varied from zero to as much as $790,000 for the C-7 refinery for 1977 BPT guidelines. For the BAT 1983 proposed guidelines, the incremental costs varied from zero to $766,000.

It was the costs from Tables V-7 and V-8, added to the appropriate model base case that resulted in Table VI-2. Refineries that had zero costs show no impact. Refineries such as C-7 that needed Alternatives B, D and E-1 that show an impact by having the net present value of a targeted discounted cash flow of 6.5 percent drop from $3,949,000 before pollution control costs to a negative amount. This negative number indicates that the model plant, when impacted by costs of pollution control, refinery, cannot maintain a cash flow that will meet its or the industry's profit targets.

Approximately 30 percent of the total capacity of the industry does show some impact from the costs of these levels of control. The total impact on these plants will be discussed in the next section. Further examination of the data in Table VI-2 indicates that the cost required to institute treatment alternatives, E-1 or E-2, for condenser water has an impact on all refineries. From Table V-8 it can be seen that 23 of the 29 plants will have to make an investment in condenser cooling tower or spray pond, but probably more significant is the annual maintenance and operating costs that will be expended each year. Annual maintenance and operating costs over $100,000 per year are significant and markedly affect the current net values.

Table VI-2. Discounted cash flow for model refineries impacted with water pollution control costs from specific refineries

	Alternative Needed 1/	Base 6.5	Base 7.5	BPT 6.5	BPT 7.5	BAT 6.5	BAT 7.5	Percent of total production
		$000						
Liquid	C, E-1	1,345	892	1,037	604	815	402	4
Liquid	C	1,345	892	1,037	604	1,009	578	1
S.2/ Crystalline Rural	C, D, E-1	701	170	(1,258)	(1,666)	(1,724)	(2,095)	1
S. Crystalline Rural	C, E-1	701	170	421	(93)	(100)	(568)	2
S. Crystalline Rural	C, E-1 3/	701	170	421	(93)	421	(93)	2
L.2/ Crystalline Rural	C, E-2	1,849	681	1,569	418	1,132	20	2
L. Crystalline Rural	C, E-1	1,849	681	1,569	418	1,309	179	2
L. Crystalline Rural	D, E-2	1,849	681	(725)	(1,734)	(1,734)	(2,674)	9
L. Crystalline Urban	E-1	3,949	2,076	3,949	2,076	1,019	1,015	38
L. Crystalline Urban	C, D, E-1	3,949	2,076	2,786	(693)	(208)	(1,812)	22
Refineries requiring pollution control investment TOTAL								83
Refineries with no pollution control required								11
Refineries with negative cash flow, therefore not considered in this analysis								6

1/ Costs are for levels of technologies per Supplement A of Development Document Effluent Limitations Guidelines.

2/ S = Small; L = Large

3/ Needs only sand filter.

2. Capital Availability Level

As discussed in Chapter II, the cane sugar refining industry as a whole appears to be hard pressed to attract new capital. Imposition of new capital requirements, particularly for non-productive assets, would appear to be a problem for the entire industry. However, as previously pointed out, this problem does not appear to be more significant for any particular segment of the industry but is going to depend upon a company by company analysis of its individual earnings. The health of an individual company and its ability to operate profitably, or at least to show performance ratings superior to other plants in the same group, rests with its current competence of management, its past management philosophies, and the degree of cost consciousness which management has been able to instill in its employees.

C. Production Effects

Of critical and fundamental interest is the production impact which the cost of pollution control may cause. This effect is shown graphically by looking at the results of discounted cash flows and estimating the potential plant closures due to the impact of costs of water pollution controls. As discussed in Chapter IV, the methodology used was to apply shutdown models to represent plants and to compare the appropriate model plant results with each of the firms in the cane sugar refining industry and thus draw inferences for each based on its relationship to the model.

1. Potential Plant Closures

Present values were computed at 6.5 and 7.5 percent after tax cost of capital for each of the models as shown in Table VI-2. Referring to Table VI-3, impact, as shown by the discounted cash flow analysis has been put into a table and evaluated on the basis of this impact along with many other possible closure factors. In this way a plant by plant analysis was made. In interpreting discounted cash flow columns in this table, we have shown L for low impact, M for moderate impact and H for high impact. In other words, those with an H could be considered highly likely to close if this matter of discounted cash flow were the only criteria to be measured. Were that the case, the values of discounted cash flows which are less than zero would indicate that the firms would be financially better off by liquidating the sunk investment and reinvesting the money where it would yield the industry's target return. However, as indicated, there are other factors to consider and it is a matter of judgment as to the parameters and the weight to be given to each parameter when making statements regarding potential plant closures.

Table VI-3. Factors considered in cane sugar refinery closure analysis

Code	Capacity TPD	Ownership type	Integrated with mill	Rural Urban	Winter climate	Market advantage	Discounted cash flow Base	BPT	BAT
C 1	2,600	Multiplant		U	Mod.	0	L	L	L
C 2	2,100	Multiplant		U	Severe	0	L	L	L
C 3	3,250	Multiplant		U	Mild	0	L	H	H
C 4	2,100	Multiplant		U	Mod.	0	L	L	L
C 5	1,000	Multiplant		U	Severe	0	L	L	L
C 6	190	Integrated	X	R	Mild	+	M	H	H
C 7	3,500	Integrated	X	U	Mild	-	L	H	H
C 8	1,500	Single		U	Mild	-	L	L	L
C 9	2,000	Single		U	Mod.	0	L	L	M
C 10	1,200	Single		U	Severe	0	L	L	M
C 11	1,500	Multiplant		R	Mild	-	M	H	H
C 12 [1]	350	Multiplant		R	Mild	-	M	M	M
C 13	1,700	Single		R	Mild	-	M	H	H
C 14 [1]	2,200	Multiplant		U	Mild	-	L	L	L
L 1 [1]	300	Multiplant		U	Severe	+	L	L	L
L 2	800	Single		U	Severe	+	L	L	L
L 3	850	Multiplant		U	Severe	+	L	L	L
L 4 [1]	390	Multiplant		R	Mild	-	L	L	L
L 5	100	Integrated	X	R	Mild	+	H	H	H
CL 1	1,800	Single		U	Severe	+	L	L	M
CL 2	820	Multiplant		U	Severe	+	L	L	M
CF 1 [1]	460	Integrated	X	R	Mild	-	M	M	M
CF 2	700	Integrated	X	R	Mild	-	L	L	M
CF 3	660	Integrated	X	R	Mild	-	M	M	M
CF 4	700	Integrated	X	R	Mild	-	L	L	L

continued.....

Table VI-3. Factors considered in cane sugar refinery closure analysis (continued)

Code	Capacity TPD	Ownership type	Integrated with mill	Rural Urban	Winter climate	Market advantage	Discounted cash flow Base	BPT	BAT
CF 5	220	Integrated	X	R	Mild	+	H	H	H
CF 6	600	Integrated	X	R	Mild	+	H	H	H
CF 7	400	Integrated	X	R	Mild	+	H	H	H
CF 8	700	Integrated	X	R	Mild	+	H	H	H

1/ Eleven percent of total refinery production now has no effluent discharge except to municipal sewage system.

In Table VI-3 the code for each plant is listed along with its capacity. In evaluating a specific plant, the capacity of the actual plant as compared to the capacity of the model does give some indication of its vulnerability to closing based on capacity. It is assumed that a plant that is larger than the model would be somewhat less impacted than a plant that was smaller than model. Two examples that were considered were C-3 and C-7. Both of these are ranked first-second in the industry as far as capacity is concerned and are substantially over the capacity of the urban model (2,000 tons per day). At the other end of the scale, there is the greater impact on the plant C-6 which has only a 190 tons per day capacity as compared to the small refinery model with 400 tons per day.

Ownership type was also considered in the plant analysis closure. For example, a single plant and a single company seems to be more vulnerable to closure than would be a plant which is integrated with a mill, since the combined operation would be considered when evaluating the plant in terms of closure. In a case of a multi-plant operation, the resources of a company that has severla plants are usually greater than a single plant and, thus, make it less vulnerable to closing. Also a case can be made for closing one plant of a multi-plant operation on the basis that production could be consolidated or transferred to another unit with expanding output.

As previously stated, those refineries that are integrated with a mill would seem to have a higher resistance to closing than those not integrated.

Whether a plant is a rural or a city refinery has its greatest significance in the area of costs and thus shows up in the DCF analysis. However, there seems to be no particular case where a plant in an urban area is more or less vulnerable than a plant in a rural area just on the basis of its location.

The winter climate is somewhat of a factor in the closure analysis because the major cost impact on all refineries is the treatment of the condenser water. Those plants which will be required to operate cooling towers or spray ponds have a particular problem where they are located in an area with severe winters as compared to those plants that are located in mild climates. Operating a cooling tower in freezing weather is hazardous and has a higher cost factor than operating one in year-round mild weather.

Another factor to consider is what we have termed "market advantage" on a plus, minus, or zero basis. Those plants that have some advantage in their market in that they are the only refinery in the area and don't have the cost competition of other refineries should have a higher price potential than the model plant would. For example, one plant which may be impacted from costs of water pollution control and penalized for its small size, nevertheless, does have a real advantage in its market compared with any other refinery located hundreds of miles away. By the same token, a refinery operating in Chicago would seem to have a market advantage, by virtue of its being located there rather than having to ship its sugar to this larger market. On the other side, those plants that are located away from the market and require absorption of freight and other costs seem to have a market disadvantage and thus are rated with a minus factor.

Referring now to the columns which deal with DCF analysis, we find that the refineries of Puerto Rico are shown to be highly impacted in the base case before pollution control money is spent and at the BPT and the BAT level as well. It has been difficult to evaluate these plants since we feel that the Commonwealth of Puerto Rico is subsidizing them and it is difficult to anticipate to what degree subsidization in the future will continue. On the other hand, faced with the costs of water pollution control, there may be a tendency to consolidate refineries in Puerto Rico. Thus, specific plants might be impacted to the point where they would be phased out or closed and their closure might be accelerated by the costs of water pollution control.

As previously indicated, most plants that are impacted at the BPT level would also be impacted at the BAT level in 1983. Finally, as marked, there are five refineries that in effect have zero discharge or at least need no cost expenditures for water pollution control. These plants represent about 11 percent of the total production of the industry.

When taking all of these factors into consideration, individual judgements can be made as to which plant may close or may not close. It is the opinion of the contractor that under the information submitted, evaluated and analyzed in this chapter, there is a high probability that three refineries may close due to the incremental cost of pollution control. An additional three refineries are moderately impacted and may close under these same conditions.

While these estimated plant closures of three to six are impacted by the combined BPT and BAT costs they are primarily impacted by BPT. Three to five plants are sufficiently impacted to close in 1977 even if there were no additional 1983 or BAT costs. Only one plant might remain in operation if there were no BAT costs.

Twenty-three of the 29 plants therefore, based on the information, costs, and other conditions previously stated, would, at this point, appear to have a low impact and a low likelihood of closure. Those plants that are highly impacted represent 10 percent of the number of plants (3) and 6 percent of productive capacity (2020 TPD). Plants which are moderately impacted represent another 10 percent of the plants (3) and an additional 6 percent of production (2090 TPD), and those plants least impacted represent 80 percent of the plants (23) and 88 percent of the production (30,580 TPD).

In looking into the production effects that are caused by events described above, it is seen that two to three plant closures are in Puerto Rico representing two percent of the production.

This 2 percent production can easily be absorbed by other Puerto Rican refineries as they have unused capacity.

The 10 percent balance of lost production is on the mainland U.S. There are no prospects for new refining construction due to low industry earnings and all refineries are operating at essentially total or full capacity.

It is speculated that the following events might therefore take place:

(a) Domestic raw sugar now going to a closed refinery would be diverted to another refinery and the import quota lowered by ten percent.

(b) The ten percent cane sugar loss might be made up by beet sugar if beet sugar production can be increased in the face of water pollution costs in that segment.

(c) Substitute sweetners might take over the ten percent loss as both caloric and no caloric sweetners are expanding their share of the sweetner market rapidly.

2. Sensitivity Analysis

As shown above, the impact of pollution control costs on potential plant closures is believed to be moderate. However, should pollution control costs differ from those used in the analysis, the expected impact would likely be changed. To gain an insight into the magnitude of such changes, an evaluation of Table VI-2 along with pollution control costs will form the basis of a sensitivity analysis.

As a point of reference, key data from Tables VI-2, V-7 and V-8 are displayed in Table VI-4 by refinery model. As can be seen, an additional investment of $156,800 and $18,400 O&M costs in pollution control in liquid refineries reduces the net present value by $200,000. For type 2 plants, a small investment of $56,000 and $20,300 O&M costs reduces NPV to below zero. In the case of the model No. 3 units (large rural), an investment of only $270,000 reduces NPV by $400,000. This suggests that an additional $100,000 to $150,000 investment and associated O&M costs would reduce NPV to zero, suggesting possible closure. A similar pattern exists for the model No. 4 plants (urban), although the absolute level of investment is greater.

These data could be plotted and additional indicative analyses performed in order to assess possible impacts of differing control lvels and costs.

The essential point is that imposition of more strict BPT and BAT standards, with presumably higher costs, could quickly lead to a much higher potential closure rate. The ultimate effect would, of course, depend on the magnitude of the additional costs. However, given typical cost-level of control relationships, one would conjecture that stricter standards in the cane sugar industry would dramatically increase the rate of potential closures in this industry.

D. Employment Effects

Cane sugar refineries do not employ large labor forces for the size of their output when measured in dollars or tons. The small refinery would employ as few as 32 full time people and the large refinery might employ seven or eight hundred people. Within this group there are both unskilled workers involved largely in handling sugar, loading and unloading, and operating materials and handling equipment. The technicians that are involved in actually operating the plant would be highly skilled and years of experience would be required on their part.

Table VI-4. Sensitivity of model net present values to effluent treatment costs

Type Refinery	Net Present Value Before Impact	Effluent Control Costs: Investment	Effluent Control Costs: Annual Operating Cost	Net Present Value After Impact
	------------------ $1,000	------------	------------	------------
1	892	0	0	892
1	892	156	18.4	690
2	170	0	0	170
2	170	56	20.3	(93)
2	170	670	203.6	(2,290)
2	- 1/	670	203.6	--
3	681	0	0	681
3	681	270	40.6	282
3	681	1,295	256.8	(2,615)
4	2,076	709	109	1,015
4	2,076	788	134.1	680
4	2,076	1,498	303.2	(1,752)

1/ This model has negative cash flow

E. Community Effects

Community effects due to closures are more difficult to assess. In the urban areas, the impact of sugar plants would be relatively small due to the fact that the employment and tax dollars lost would be the measure of the impact. The loss of value of raw material which is usually imported or shipped a long distance by a domestic industry would not be felt locally. In the case of rural plants where refinery is located in conjunction with a raw sugar cane mill, community effects would be greater. In these areas sugar is a prime industry and its effects would be felt throughout the area from the refinery to the mill to the sugar cane grower. The impact of closure as shown in "Production Effects" would indicate that 3 to 6 small communities might be affected.

F. Blance of Payments Effects

With the implementation of discharge controls, it has been shown that 6 to 12 percent of the cane sugar refinery capacity may be impacted sufficiently to close. Were this to happen, the refining of sugar could be shifted as discussed in "Production Effects" to:

(a) Other expanded cane sugar refineries
(b) Beet sugar production
(c) Importation of refined sugar

If (a) or (b) did not happen due to any number of factors such as the weather or lack of availability of other production facilities, then the increase in foreign imported refined sugar would adversely affect the balance of payments. This would be of particular concern at present since every effort is being made by government to improve the balance of payments.

At this time it is not known what effect the guidelines will have on beet sugar production although the construction of new beet sugar plants and resulting new production should offset the loss of production due to the closure of impacted plants. No new cane sugar refineries have been built for many years and it is doubtful if they will be now.

The possible expansion of the current refineries is the most likely event and, therefore the balance of payments effects should be minimal. One question not yet answered is the impact of pollution control costs on sugar cane mills. Should this segment be impacted and domestic raw sugar production lost, adjustments by the Secretary of Agriculture would undoubtedly take place to increase the flow of imported raw sugar. Such an event would create a balance of payment effect of adverse consequences.

VII. LIMITS TO ANALYSIS

A. General Accuracy

Data gathered were of secondary nature drawn from previously published reports, from private sources, contracted government studies and regularly reported government services. Personal interviews of key personnel of refinery and sugar cane milling companies and trade associations were conducted.

Throughout the study an effort was made to evaluate data and other information used and to update these materials, wherever possible. Data were reworked so as to make its presentation more clear in light of the purpose of this report and to the use that is intended.

As a result of the data and the step by step methodology by which the conclusions are drawn, this analysis represents a systematic evaluation of the impact of effluent limitation guidelines on the cane sugar refinery industry. However, it must be recognized that judgements based on this data are not absolute and the estimates represent the best relative conclusions given the limitations of time and budget.

B. Possible Range of Error

The instructions of the contract required that the contractor use the cost data provided by EPA under Supplement A of the Development Document. The following items indicate some of the range of error that is possible based on the use of the data supplied by EPA and the basic financial data.

Different data series and different sections of the analysis will have different possible ranges of error. Estimated error ranges as an order of magnitude are as follows:

		Error Range
1.	For number, location, capacity, and processes of plants	±0.2%
2.	Price information on products, materials and equipment	±10.0%

		Error Range
3.	Sunk investment	± 20.0%
4.	Plant operating costs	± 10.0%
5.	Land values	$1,000 - $100,000 acre
6.	Pollution	± 50.0%
7.	Plant closures	± 15.0%

C. New Technology

Two new technologies, not evaluated, which have potential impacts on waste water disposal are in the early stages of consideration or use by the industry. One is the condensation of sugar vapor by compression rather than by cooling in a condenser. This technology, not fully developed for application to cane sugar, is of interest, because it eliminates the need for large volumes of water for condenser cooling and, thus the entrainment of sugar in the cooling water.

The principle involves the use of a compressor for compressing the sugar vapor into liquid. Energy is required to accomplish this but a by-product of the process is that the heat generated in the compressing phase can be used as heat energy in the total sugar refining process.

"Dry cooling towers" which eliminate or reduce fog producing and air polluting tendencies are under development. Little data concerning them is known at this time except that both the investment cost and operating expense may run 3 times the figures of currently operating "wet cooling towers."

D. Critical Assumptions

A key assumption in the analysis concerns the action of the Department of Agriculture in response to maintaining the health of the sugar industry. The Secretary of Agriculture can act on certain conditions which include maintaining orderly marketing and supply processes. Further, under the broad terms of the Sugar Act, there are provisions to assure an equitable division of returns from sugar between beet and cane growers, farm workers and processors. However, it is unknown as to whether or how the Secretary would act in response to added costs to the processors arising from pollution control requirements.

Those refineries now on municipal hookups are dependent upon two assumptions: (a) that user charges for the future will be within predictable limits and be economically affordable by refineries; (b) that no forms of pre-treatment for refineries in the future will be required.

A final critical assumption lies in the reliability of the cost data and the contractor's ability to project by models these cost data. Care has been taken in working with these data but without access by the contractor to financial information of specific refineries, necessary assumption of costs have had to be made.

E. Remaining Questions

One question for cane sugar refineries concerns the impact on sugarcane mills. The mills' water pollution problem is more difficult by a factor of at least 2 than that of the cane sugar refiner. The ultimate impact on many refineries may depend on the impact of pollution controls on the mills. This is due to both the integrated ownership of mills and refineries and the location proximities of mills and refineries.

Further questions depend on costs, adequacy of treatment technology, and relations with municipal sewage systems alluded to in the previous section.

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15. Supplementary Notes

16. Abstracts

The cane sugar refining segment of the sugar industry (SIC 2062) is composed of 29 refineries operated by 20 companies. Most refineries, though over 50 years old, have been modernized and operate at full capacity refining raw sugar -- 32 percent of domestic sources and 68 percent imported. Two companies purchase 45 percent of the total capacity. Estimated after-tax return on sales are about one percent for all sizes of liquid and crystalline refineries. Prices are controlled indirectly under the Sugar Act by adjustments in the supply by the Secretary of Agriculture. There is price competition from other sweeteners.

Imposition of effluent limitations are not expected to raise prices. Potential refinery closures by 1977 due to the imposition of the effluent limitation guidelines are estimated to be from three to six refineries representing from six to twelve percent of total production. No additional closures by 1983 are expected.

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16. (continued)

Employment and community impacts appear to be small. The impact analysis is based on a number of assumptions and cost estimates which are identified in the report.