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Dutchess County Resource Recovery Task Force Report

Dutchess County Pyrolysis Program

July 1980

Prepared For:

U.S. Department of Energy
Assistant Secretary Conservation
and Solar Energy
Office of Buildings and Community Systems

Under Contract No. FG01-78CS20094

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Dutchess County Resource Recovery Task Force Report

Dutchess County Pyrolysis Program

July 1980

Prepared For:
U.S. Department of Energy
Assistant Secretary Conservation
and Solar Energy
Office of Buildings and Community Systems
Washington, D.C. 20585

Prepared By:
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Armonk, New York 10504
Under Contract No. FG01-78CS20094

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ABSTRACT

Dutchess County initiated development of a long-range master plan for Solid Waste Management in 1971. The plan included development of a resource recovery facility to service the municipalities in the County population center. Based on early recommendations, a pyrolysis facility employing Purox technology was to be implemented. A feasibility study, paid for by County funds was completed in 1975. The study provided siting recommendations, estimation of available waste, and preliminary facility design. Because of various considerations, the project was not developed.

Under the Department of Energy grant, the County reassessed the feasibility of a resource recovery facility, with emphasis on confirming previous conclusions supporting the Purox technology, waste availability, energy recovery and sale and siting of the plant. The conclusions reached in the new study were:

- o A resource recovery facility is feasible for the County,
- o Sufficient waste for such a facility is available and subject to control,
- o While Purox technology was feasible it is not the most appropriate available technology for the County,
- o That mass burning with steam recovery is the most appropriate technology,
- o That resource recovery while presently more expensive than landfilling, represents the only cost effective, energy efficient and environmentally sound way to handle the solid waste problem in the County.

ACKNOWLEDGEMENT

This report was prepared by the Dutchess County Resource Recovery Task Force under the general direction of L. Pettison, County Executive. Members of the Task Force were M. P. Amodeo - Commissioner of Finance, G. Bosaz, Jr. - Project Coordinator, P. Hackett - Comptroller, J. Hill - Public Health Administrator, M. Murphy - Assistant to County Executive, J. Spratt - Commissioner of Public Works, C. R. Velzy Associates - Project Engineers, and S. J. Wing - County Attorney.

Work performed by C. R. Velzy Associates included subcontracted work performed by Converse Ward Davis Dixon - Geotechnical Consultants, P. L. Geiringer and Associates - Electrical Consultants, Resource Recovery Services, Inc. - Materials Handling Consultants, Union Carbide Corporation/Linde Division/Solid Waste Systems - Pyrolysis System Consultant and Zamory Engineering - Structural Consultants.

Special thanks are extended to the following for cooperation, review and assistance: U.S. Department of Energy - Argonne National Laboratory, Energy and Environmental Systems Division, U.S. Department of Energy - Community Technology Systems Branch, U.S. Environmental Protection Agency - Industrial Extractive Processes Division, New York State Department of Environmental Conservation - Division of Solid Waste Management/Bureau of Resource Recovery, New York State Department of Environmental Conservation - Region #3, CSI Resource Systems, Inc., Central Hudson Gas & Electric Corporation and International Business Machines Corporation - Energy & Environmental Management.

July 23, 1979

The Honorable Lucille P. Pattison
County Executive
County of Dutchess
County Office Building
22 Market Street
Poughkeepsie, New York 12601

Re: Dutchess County Pyrolysis Project
D.O.E. Grant No. EM-78-G-01-5143
N.Y.S. DEC Bond Act Project No. 3-MSWRR-002-Q

Dear Mrs. Pattison:

We are pleased to submit this Summary Report and accompanying project concept definition drawings which are our response to Task II of the Department of Energy Grant and our Consulting Agreement with Dutchess County dated October 20, 1979.

The report summarizes our findings and makes recommendations related to plant size, potential markets for recovered material and energy, plant site, possibility of sludge disposal, plant design features and costs, and overall economic viability of the project.

The assistance provided by you and other County Officials has been most helpful and appreciated. We look forward to further work on this project as it progresses.

Very truly yours,

Roger S. Hecklinger, P.E.
Principal

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REPORT OF THE DUTCHESS COUNTY
RESOURCE RECOVERY TASK FORCE

INTRODUCTION

In 1978, Dutchess County received a grant from the United States Department of Energy relating to the development of a resource recovery system for the County. The three major objectives of the program were:

To recover energy intensive materials, primarily ferrous metals, from the waste.

To recover energy from the waste in the form of a medium BTU fuel gas or other energy form useful in the area.....

To effect a dramatic reduction in the quantity of solids which must be disposed of in a landfill.

In order to obtain those objectives, the project was divided into specific tasks. Task I involved project management planning including the assembling of a project team and the development of a decision/milestone plan for implementation of the project. Task II involved the confirmation of the conceptual design of a Union Carbide Purox pyrolysis facility as performed by R. Martin Bodner Associates in 1975 and 1976. The study was to concentrate specifically on siting of the facility, verification of waste quantities available for processing, and net processing costs based on current projected revenues versus facility construction and operating costs. Based upon the updated conceptual design, the County was then to develop revised project economics which would be utilized as a decision mechanism regarding completion of the remaining tasks of the grant. Those tasks were to culminate

in the final design of the project. The Department of Energy provided 100% funding for the project, in the amount of \$459,000.00 for Tasks I and II, and an additional \$1,050,000.00 for the balance of the project.

Task I was carried out in late 1978 and early 1979. The project team as formed consists of the Project Coordinator, Commissioner of Public Works, County Attorney, Commissioner of Finance, Comptroller, Assistant to the County Executive, Public Health Administrator and Charles R. Velzy Associates, Engineers, whose services were retained in the Fall of 1978 by agreement with then County Executive Benson to perform engineering services called for by Tasks I and II. Velzy Associates, in turn, sub-contracted the portion of the engineering work that related specifically to the Purox facility to the developer, Union Carbide.

The report was developed by engineering consultants with comments from the project team over the first six months of 1979. The final summary report was submitted on July 23, 1979.

The report was then critiqued by the project team, and was disseminated to the public. Presentations of the report were made to the Dutchess County Legislature and public meetings were held on the report for the purpose of advising the constituency. The report was submitted to the United States Environmental Protection Agency, the Department of Energy and the New York State Department of Environmental Conservation which, pursuant to the authority of the New York State Environmental Quality Bond Act of 1972, had appropriated for this project the maximum sum of \$13,449,000.00

or 50% of the eligible project cost, whichever was lower.

All agencies responded with written comments and questions with regard to the report. Answers to the comments and questions were solicited from Velzy Associates. This dialogue is attached to the final summary report as Exhibits "C" through "H".

After the receipt of the report and the ensuing discussion, it became evident that a limitation in the work authorized by the Department of Energy grant was the lack of a comparative analysis of available technologies. Therefore, utilizing appropriated County funds, Velzy Associates was authorized to implement a second study to consider the availability of alternate technologies and to compare those technologies to the proposed pyrolysis facility.

That report was received on November 21, 1979 and was in turn reviewed by the Task Force. It is annexed hereto as Exhibit "J-1". Comments on this report were formulated by the Project Coordinator and additional information on modular incineration, cost estimates and a project timetable were received, reviewed and commented upon by the project team. These additional documents are annexed hereto as Exhibits "J-2" through "J-4".

A significant development in the project proceedings occurred when Union Carbide indicated orally and then confirmed in writing that the company would not be interested in operating or being responsible for the operation of the Purox facility. The final summary report was based upon the earlier statements of the company to the contrary. Another significant occurrence during

the course of the project was that the Commissioner of Environmental Conservation of the State of New York gave his written assurance that the Environmental Quality Bond Act funds would be available to Dutchess County for the purpose of developing an acceptable resource recovery project utilizing an alternate technology.

All appropriate information has been generated, received and reviewed by the Task Force in connection with Task II of this project. It is the intent of the Task Force in presenting this consideration of the various reports to do the following:

1. Make a formal recommendation on whether to proceed with the development of a pyrolysis resource recovery facility based upon the Union Carbide Purox technology.
2. Make a recommendation on the prospect of proceeding with a resource recovery project utilizing an alternative technology.
3. Make certain related recommendations concerning the development and implementation of a long-range solid waste management-resource recovery plan for Dutchess County.

SUMMARY OF CONCLUSIONS

For the reasons set forth below, the Dutchess County Resource Recovery Task Force recommends as follows:

1. That the County not proceed with the single-system development of the pyrolysis resource recovery facility based upon the Union Carbide Purox technology.
2. That the County proceed with the development of a resource recovery facility utilizing mass burning technology with steam recovery with IBM Corporation (Poughkeepsie) as the recovered energy user.

3. That the County develop a long-range resource recovery-solid waste management plan for the County which would include, as an integral part, a mass burning facility with steam recovery.

DISCUSSION

Recommendation No. 1 - That the County not proceed with the single-system development of the pyrolysis resource recovery facility based upon the Union Carbide Purox process.

The purpose of the first Velzy report was to study the feasibility of the application of the Purox pyrolysis technology to the Dutchess County solid waste management problem. Indeed, the thrust of the County's efforts in developing a resource recovery project have focused on the Purox technology since 1972. In an early report, then Solid Waste Commissioner Carlton Laird deduced that the only viable customer for recovered energy was Central Hudson Gas & Electric Corporation. Unfortunately, the plants of Central Hudson which would utilize the recovered fuel are not in Dutchess County, but are situated in Orange County and separated by the expanse of the Hudson River. Therefore, it would be necessary to convey the recovered gas to the other side of the Hudson. Laird concluded that the only possible fuel that would be acceptable to Central Hudson would be a gas, such as the by-product of the Purox process. He further concluded that it would be essential to pipe the gas over or under the Hudson River to the Danskammer facility of Central Hudson. He found no economically viable user of the Purox gas or recovered steam or other refuse derived fuel or energy in Dutchess County. The only other

alternative for the County was to build a generating station along side the resource recovery facility and produce its own electricity. This idea has been abandoned because of the high initial cost, requirement for highly skilled operators and reduced total energy conversion efficiency.

Therefore, Laird's conclusion was that the Purox process would be the only feasible technology for Dutchess County, and thus developed the County's one-system approach to the problem. Indeed, the application for the State EQBA funds and the ensuing contract with the State specifically mention the development of a Purox pyrolysis system. The contract with Velzy Associates specifically mentions the development of the Purox project, and the grant from the Department of Energy also emphasizes the development of the Purox pyrolysis facility. Based upon the results of the Velzy study, in particular Chapters 7 and 8, and the results of the second study, considering alternative technologies, we conclude that the one-system approach utilizing the Purox technology is not the most appropriate way for the County to proceed.

Specifically, the single technology approach to system procurement is restrictive, in that it excludes many other processes from consideration. The second Velzy study has shown that steam generation in mass burning units such as water wall incineration and modular incineration are viable technologies for the County.

Based upon the Velzy study and the comparison of the Purox

system to other alternatives on the issue of economics, it is clear that the pyrolysis system is potentially a more expensive system.

Also, alternative technologies that are less expensive and appropriate to satisfy the County's needs have been developed and operated on a commercial scale. This is not the technological status of the Purox process offered to the County. The County's development of a Purox system would be the first commercial project built in the United States. Thus, the risks, both known and unknown, to the success of the Purox system are greater when compared to other systems that have been developed commercially.

The last consideration pertains to the change in the corporate direction of the Union Carbide Corporation. Previously, Union Carbide had indicated its willingness to negotiate a contract with the County for operation of the pyrolysis plant. This was deemed to be most valuable to the County because of the lack of general expertise to handle such a new and complicated process, and because it indicated the willingness of Union Carbide Corporation to stand behind their technology and see that its performance guarantees were, in fact, carried out. Furthermore, it meant that the County would have one less party to take issue with should problems develop at the plant.

After the first Velzy report was submitted, Union Carbide indicated at first orally, and then confirmed in writing, that they were not in a position to operate the plant, nor were they in a position to be responsible for obtaining a third-party

contractor to handle the operation of the plant. This change in corporate position created grave doubts at the County in Union Carbide's commitment to this project and their product. It seriously affected the County's position insofar as the liability issue was concerned. In subsequent meetings, Union Carbide officials reconfirmed their faith in their product. However, it was clear that the corporation would not operate, nor be responsible for the operation of the facility. Union Carbide did offer to seek out a responsible third party which through agreement with Union Carbide would be able to provide the County with a "full service" contract for the project, i.e. constructing and operating the plant. Union Carbide indicated that they would attempt to develop this alternative within the time period set by the County for decision on the project. That time period has passed and Union Carbide has not entered into an arrangement with a full service contractor. The project must proceed.

The conclusion reached above does not necessarily mean that Union Carbide be excluded entirely from consideration. However, major changes in their approach to this project would have to be made in order for them to be considered as an alternative as the County proceeds to implement Recommendation No. 2.

Recommendation No. 2 - That the County proceed with the development of a resource recovery facility utilizing mass burning technology with steam recovery with IBM Corporation (Poughkeepsie) as the recovered energy user.

In accordance with the second Velzy report, as amended, the

technology of mass burning with steam recovery appears to be the most economically feasible resource recovery alternative for the County. It is difficult to establish a definite tip fee for the project at this time. However, the projected minimum tip fee of \$15.57 set forth in Exhibit "J-3" is as reliable as possible. It represents the start-up of the project in 1984 and was established after considerable review and discussion, taking into account the projected 1979 project costs set forth in Exhibits "J-1" and "J-2" and the effect of various inflationary factors. The projected tip fee for the mass burning system, while only an estimate, is encouraging and further development of the system is warranted.

In considering this alternative, the County is dealing with a technology that is more advanced in development than the Purox pyrolysis system. Systems using mass burning technology have been developed and operated on a commercial scale in this country. There are several systems suppliers available.

While the per ton tip fee cost of this alternative still appears to be higher than the present cost of landfilling, it is projected that this cost would not be prohibitive when compared with other alternatives available to the municipalities of the core area of the Towns of Hyde Park, Pleasant Valley, LaGrange, Wappinger, and the City and Town of Poughkeepsie, and the Village of Wappingers Falls. Each of those municipalities will be required to transport their refuse great distances to landfills if no other waste disposal alternative is found. Of course, comparison of resource recovery with landfilling should not be made solely on the basis of

cost. Resource recovery provides a more environmentally sound method of disposing of solid waste. It frees more land area for other, more beneficial usage. It provides an alternate source of energy and thus aides in reducing our dependance on fossil fuels. A compelling case can be made for incurring somewhat higher costs in order to accomplish desireable ends.

The original Velzy report, in Chapter 3, considered the availability of waste quantities. It found that approximately 458 tons per day would be available to the resource recovery facility at the time of its start-up. This conclusion should be modified in light of developments in the southern part of Dutchess County where the Village and Town of Fishkill and the Town of East Fishkill are in the process of developing a landfill site with a projected ten to fifteen year capacity. Thus, it would appear that a less costly relatively short-term alternative for the disposal of solid waste is available to those municipalities. Furthermore, the City of Beacon, which has a municipal collection system under contract to a private carter, appears to have a more economical solution to the solid waste problem. That contractor trucks the solid waste collected in Beacon to the Orange County landfill. Because of Beacon's location, disposal at the Orange County landfill may not be economically prohibitive.

However, long-term, cost-effective alternatives do not seem to be available to the other municipalities of the "core area" cited above. By the time the resource recovery facility is in operation,

those municipalities may have no other disposal alternative available to them. While further analysis of the waste quantities is required, it is projected that sufficient waste is available if the core area municipalities agree to participate in the project.

Another consideration is that the facility must be sized so as to be responsive to IBM's energy requirements. Exact size of the facility will be determined as IBM's needs and the quantity of available waste are analyzed. Obviously, it would not be wise to build a system which produced a great quantity of excess steam.

Of course, based upon future developments, the facility at the IBM plant could be expanded, or other resource recovery facilities or disposal alternatives developed at other locations in the County. This would be accomplished pursuant to a comprehensive solid waste management and resource recovery plan to be developed by the County.

Recommendation No. 3 - That the County develop a long-range resource recovery-solid waste management plan for the County which would include, as an integral part, a mass burning facility with steam recovery.

If this project is to proceed successfully, the County needs a qualified individual whose primary function would be to oversee its development. Therefore, we recommend that the Solid Waste Commissioner's post be filled as soon as possible. Of course, the County Task Force would continue to provide support services to the project. Furthermore, the Task Force recommends that funds be appropriated in the Dutchess County budget to provide for the retention of specialized project consultants who would be

responsible for assisting the County in organizing the project, developing procurement alternatives, and preparing the necessary environmental impact statements.

Another function of the Solid Waste Commissioner would be to fulfill the mandate set forth in the Dutchess County Administrative Code to prepare and present a long-range solid waste management-resource recovery plan. It is the opinion of the Task Force that the development of the resource recovery facility at the IBM Poughkeepsie site is only the first step in the County's response to solid waste management problems. In the future, municipalities which have current solutions to their solid waste management problems will be facing the same dilemma the core area is confronted with today.

IMPLEMENTATION

In order to carry out the general recommendations of this report, the County must take certain immediate steps so that the proposed resource recovery facility can be operational by 1984. These steps relate to the critical requirements for such a project: (a) a sufficient and controlled waste stream; (b) a recovered energy customer and (c) a facility that is strategically located, reliable, and efficient.

(a) The County must establish communications with the municipalities of the core area to insure their support of the project. Control of the waste stream is a vital component of the project and inter-municipal contracts providing for such control should be negotiated as soon as possible. Discussions with

private carters servicing the citizens of the municipalities also must be held. Support for this project by local governments and carters is essential to its success.

(b) The County must enter into discussions with IBM Corporation to insure their participation in the project and to determine the extent of recovered energy that the corporation would require. A contractual arrangement covering IBM's participation and requirements is essential.

(c) The first step regarding this aspect of the project is to confirm continued availability and levels of funding from the New York State Department of Environmental Conservation and the United States Department of Energy. Without the moneys previously granted, the development of a resource recovery facility is not economically feasible. This report recommends significant change in project direction. Therefore, previous statements of the funding agencies that they would participate in an acceptable alternative project must be reviewed with the agencies and hopefully reduced to agreement.

The next step is a reassessment of the organization to carry out the project. Then, site requisition and development of procurement alternatives must be initiated. Further refinement of project cost must be undertaken.

After confirmation of state and federal funding is achieved, local funding must be authorized to the extent required.

CONCLUSION

This report concludes the Task Force's work on Task II of the Dutchess County Resource Recovery project. If the County Executive

and the County Legislature affirm the recommendations in this report, then a concerted effort to implement the project will be commenced.

COUNTY OF DUTCHESS
Poughkeepsie, N. Y.

DUTCHESS COUNTY PYROLYSIS PROJECT

DEPT. OF ENERGY GRANT
NO. EM-78-G-01-5143

NYS DEC
SOLID WASTE MANAGEMENT PROJECT
BOND ACT PROJECT
NO. 3-MSWRR-002-Q

FINAL SUMMARY REPORT
JULY, 1979

EXECUTIVE SUMMARY

This summary report was developed as Task II in the design of the Dutchess County Pyrolysis Project - DOE Grant No. EM-78-G-01-5143, utilizing the PUROX System developed by the Union Carbide Corp. Task II is an updating and reconfirmation of the recommendations of the conceptual design performed by R. Martin Bodner Associates in 1975 and 1976, concentrating specifically on siting the facility, tonnage of waste available for processing, and net process costs based on current projected revenues versus facility construction and operating costs.

Population

Population projections for Dutchess County were re-examined and revised through the year 2000. The projected population in the year 2000 of 330,520 is somewhat less than previous projections and reflects a declining birth rate.

Refuse Generation

Refuse collection data from throughout the County was reviewed. Projections were made for all municipalities through the year 2000 by extrapolating current data. The total generation forecast for the County of 690 tons per day in the year 2000 is somewhat less than that of previous projections. The low population density in many parts of the County reconfirmed the recommendation that a pyrolysis project should be designed to serve the "core area". The core area is defined as the seven towns, two incorporated villages and two cities in

the southwestern quadrant of the County. The total generation forecast for the core area in the year 2000 is 554 tons per day.

Plant Size

The recommended plant size for the core area should initially be 400 tons per day with the potential for expansion to 600 tons per day. Two processing lines should initially be included in the plant to provide suitable redundancy. Thus, the plant size is somewhat smaller than previously recommended.

Energy and Materials Recovery

The reduced plant size makes it feasible to develop a customer for the PUROX fuel on the Dutchess County side of the Hudson River. The IBM Poughkeepsie plant is suitably located with a reasonable match of energy requirements to the energy production from a 400 ton per day plant. The steam generators at the IBM Poughkeepsie plant could easily be converted to fire PUROX gas. On the other hand, if IBM were required to convert to coal firing to comply with the Dept. of Energy mandates, the existing boilers could not be converted at a reasonable cost and major capital expenses would be required. Therefore, IBM is recommended as the logical candidate to purchase the PUROX gas. Extensive negotiations will be required before a contract between the County and IBM could be consummated. The Arlington sewage treatment plant is also a likely candidate to use some of the PUROX fuel produced at the plant.

An attractive site for the PUROX facility was identified on property presently owned by New York Trap Rock Corp. This property is adjacent to the Arlington sewage treatment plant and within one-half mile of the boiler house at the IBM industrial complex in Poughkeepsie. This site is recommended for the PUROX facility.

Markets for materials recovered from waste were explored in detail. There does not appear to be a viable market for metals, glass, or aluminum at this time. The residue slag material from the PUROX process does appear to have a modest market value.

Sewage Sludge

The PUROX facility would be capable of handling sludge generated by the three existing and one proposed sewage treatment plant in the County. The economic evaluation does not take credit for income for processing sludge nor does it include the cost of sludge feeding equipment. The necessary feeding equipment will be included in the final facility design if it appears to be economically justified.

Conceptual Design

The conceptual plant design as described in the report and displayed on the accompanying drawings evolved over a nine month period. The conceptual design differs markedly from the design presented in the Bodner Reports. Changes resulted from a re-evaluation of design concept by Union Carbide and by

experience gained elsewhere, in actual plant operation, where refuse is processed for resource recovery.

A basic design criterion is utilization of PUROX fuel gas on site to reduce utility costs. This will enhance the match between energy produced by the PUROX facility and energy required by the IBM plant. Energy is used on site to destruct contaminated wastewater, drive the compressor in the cryogenic oxygen separator and to provide in-plant heat. This minimizes wastewater handling problems and electric power requirements which had been a major concern in previous designs. The PUROX converter is now designed to generate gas at sufficient pressure so that gas can be delivered to the customer without further pressurizing.

Another major shift in concept has been to design the front end processing train to operate on a continuous basis utilizing trommels and shear type shredders to replace high energy, high maintenance hammermill type shredders and to eliminate the need to store refuse in both the raw and processed states.

Construction materials and techniques are commensurate with durability and equipment life requirements implied by the 30-year term for bond amortization.

The plant includes a transfer station. Material collected in excess of plant capacity will be removed to a landfill.

Project Costs

The cost estimate takes advantage of the N.Y.S. Department of Environmental Conservation Agreement with the County for Grant Aid under the Environmental Quality Bond Act of 1972. It also takes advantage of remaining funds in the Department of Energy Grant for plant design.

Union Carbide Corp. is interested in entering into a contract to assume responsibility for operation of the entire facility; and it is recommended that this be pursued. Operation under such an arrangement concentrates responsibility for proper system operation with the system supplier, a proper objective at this time.

Facility construction and operating costs are tabulated on the Summary Table. All costs are based on summer 1979 prices using financial arrangements developed by other members of the project team. A tipping fee of \$16.00 per ton is recommended as sufficient to support plant operations and low enough to attract a full supply of refuse.

SUMMARY TABLE
DUTCHESS COUNTY PYROLYSIS PROJECT
PUROX FACILITY

REFUSE RECEIVED	145,000 tons per year
REFUSE PROCESSED	125,000 tons per year

CAPITAL COSTS	TOTAL	GRANT AID	REMAINDER
Land Acquisition	\$ 80,000		\$ 80,000
Construction Costs	24,235,000	\$12,117,000	12,118,000
Modifications at Fuel Users Plant	80,000		80,000
Mobile Equipment	300,000	150,000	150,000

TECHNICAL SERVICES

Engineering	2,110,000	1,580,000	530,000
Bond Issuance	625,000		625,000
Interest During Construction			1,315,000

TOTAL			\$14,898,000
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ANNUAL COST OF AMORTIZATION			\$ 1,270,000
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OPERATING COSTS

Operating Contract			1,200,000
Maintenance			502,000
Utilities & Miscellaneous Supplies			547,000
Landfill Tipping Fee			126,000
Depreciation of Mobile Equipment			75,000

REVENUES

Tipping Fee			2,320,000
Fuel			1,468,000
Slag			68,000

NET OPERATING SURPLUS			\$ 136,000
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Recommendations

In summary, the recommendations generated by this report are:

- The plant should serve the core area.
- The plant should be sized for 400 tons per day.
- The recommended site is a portion of the property owned by New York Trap Rock adjacent to the Arlington sewage treatment plant.
- The IBM industrial complex in Poughkeepsie is a logical customer for the fuel gas with the Arlington sewage treatment plant a logical secondary customer.
- A contract should be negotiated with Union Carbide Corp. to operate the PUROX facility.
- At 1979 cost levels, a tipping fee of \$16.00 per ton should be sufficient to finance ongoing plant operation while providing an opportunity to attract the necessary refuse to the plant.

Overall Economic Viability

Economic viability of this project is dependent on a number of factors other than facility design and operation.

These include:

- Utilization of the grant funds allocated by the U.S. Department of Energy and the N.Y.S. Department of Environmental Conservation in accord with existing agreements
- Control of the waste stream to attain capacity operation of the facility. (This is, in a large part, contingent on propitious enforcement of applicable codes, rules and regulations governing landfill siting and operation.)
- Realization of the financial terms, conditions and costs enumerated in the Report
- Successful negotiation of a long term contract to furnish fuel gas to the IBM Poughkeepsie plant. (This is, in a large part, contingent on U.S. Department of Energy acceptance of the fuel gas as the main fuel for the plant thereby relieving IBM of the cost of conversion to coal as the main fuel.)

1. PURPOSE AND SCOPE

The purpose of this study is to develop a design and cost estimate for a resource recovery facility for Dutchess County. Dutchess County is presently served by many small landfills. Most of these landfills are municipally owned and have short service lives. Table 1-1 shows the status of Dutchess County landfills. Conformance with state sanitary landfill codes and the limited availability of land are raising the cost of landfilling. This project has been undertaken to alleviate the problem of limited solid waste disposal facilities to serve the urbanized areas of the County by constructing a resource recovery facility utilizing Union Carbide's PUROX process. The urbanized areas are referred to as the "core area", and are the more densely populated municipalities, comprising the southwestern quarter of the County. Outlying rural areas will not contribute to the PUROX facility due to the high cost of transporting refuse into the core area. Figure 1-1 shows the relative locations of the County and core area. The overall project, which is partially funded by grant monies from the U.S. Department of Energy, would result in the production of documents suitable for the taking of public bids.

The scope of work for this phase of the overall project includes verification of solid waste quantities, verification of markets, site investigations, determination of sludge quantities and characteristics, conceptual plant design, and cost estimates. The basic scope involves investigations, designs, updating and confirming and/or modifying the recommendations of

TABLE 1-1
STATUS OF DUTCHESS COUNTY LANDFILLS

<u>FACILITY</u>	<u>TOTAL LAND AREA</u>	<u>CAPACITY</u>	<u>SITE LIFE</u>	<u>PERMIT STATUS</u>	<u>PROPERTY OWNER</u>
(T) Poughkeepsie (Dutchess Sanitation Co.)	9.5A	140 T/day	6 years	Pending	Dutchess Sanitation Services
(T) Milan	10A	138 CY/week	7.7 years	Pending	(T) Milan
(V) Tivoli	3A	10 T/day	10 years	Pending	(V) Tivoli
(T) LaGrange Baird State Park	5A	Unknown	Unknown	Pending	New York State
(C) Beacon	10A	--	--	Pending	Leased to (C) Beacon
(T) Beekman	13.6A	8 T/day	5.5 years	Pending	(T) Beekman
(T) Clinton	0.95A	30 T/week	16 months	Pending	(T) Clinton
(T) Dover	5 ¹ A	15 T/day	1-3 yrs.	Pending	Leased to (T) Dover
(T) East Fishkill	7.07A	2200 T/Mo.	16 months	Pending	Leased to (T) E. Fishkill
(T) Fishkill	7.89A	2400 CY/Mo.	6 months	Pending	Leased to (T) Fishkill
(T) Amenia (Harlem Valley Landfill Corp.)	10+A	80T/day	3 years	Pending	Harlem Valley Landfill Corp.
(T) Hyde Park	10A	40 T/day	3 months	Pending	(T) Hyde Park

TABLE 1-1 (cont.)
STATUS OF DUTCHESS COUNTY LANDFILLS

<u>FACILITY</u>	<u>TOTAL LAND AREA</u>	<u>CAPACITY</u>	<u>SITE LIFE</u>	<u>PERMIT STATUS</u>	<u>PROPERTY OWNER</u>
(T) Pine Plains	-	-	-	-	-
(T) Rhinebeck	10A	500 CY/week	3 years	Pending	(T) Rhinebeck
(T) Stanford	8A	7 T/day	3.5 years	Pending	(T) Stanford
(T) Unionvale	7A	4 T/day	6 years	Pending	(T) Unionvale
(T) Washington	40+A	60-70 T/week	200+ yrs.	Pending	(T) Washington
(T) Milan (Wilcox Park)	-	-	-	-	-
(T) Northeast	30A	41 cy/day	10 years	Pending	(T) Northeast

LOCATION MAP

the 1975 and 1976 reports prepared for Dutchess County by R. Martin Bodner Associates (Bodner Reports).

2. POPULATION

Population projections were made based on data obtained from the Dutchess County Planning Board and confirmed with appropriate county personnel. Future solid waste generation and collection rates were estimated based on current data and population projections for the year 2000.

Population projections have been revised in recent years to account for the declining birth rate. Table 2-1 summarizes County population projections from the various sources listed. Estimates used in the 1970 Statewide Comprehensive Solid Waste Plan, the 1972 Comprehensive Solid Waste Study, and the 1976 Preliminary Engineering Report (same estimates as the 1972 study) are no longer considered accurate by the Dutchess County Department of Planning. Therefore, the Department of Planning has revised its estimates, and now projects a 1990 population of 304,000. The design year for this project is 2000, so further projections must be made. The Tri-State Regional Planning Commission projects 330,000 as the year 2000 population for the County, but does not break down the total by municipality. The New York State Economic Development Board projects a total County population of 328,400 for the year 2000 but also does not break down the estimate by municipality. The New York State Department of Environmental Conservation breaks this total down by municipality for use in its 208 Study. The results, however, are not totally consistent with estimates made by the Dutchess County Department of Planning.

The Department of Planning estimates are based on probable growth and capture rates by the individual

TABLE 2-1

POPULATION PROJECTIONS
FROM VARIOUS SOURCES

Source	1965	1970	1975	1980	1985	1990	1995	2000
NYSHD-1970 (1)	210,456	240,197	275,174		370,260		504,367	
Trautman 1972 (2)		222,295	250,000	280,000	310,000	339,200		
NYSEDB 1978 (3)		222,295	232,913	246,206	263,828	283,070	303,138	321,676
NYSDEC 1978 (4)		222,295	233,100	247,900	268,800	291,300	311,100	328,400
Tri-State RPC 1976 (5)								330,000
DCPD-1977 (6)		222,295	238,623	258,000	280,000	304,000		
CRVA (7)		222,295	238,623	258,000	280,000	304,000		330,520

- (1) "A Statewide Comprehensive Solid Waste Management Study", R.F. Weston, 1970
- (2) "Comprehensive Solid Waste Study" Dutchess County, W.R. Trautman, 1972
- (3) New York State Economic Development Board, 1978
- (4) New York State Department of Environmental Conservation, 1978, based on 1976 estimate of Ref. (3) above
- (5) Tri-State Regional Planning Commission, 1976
- (6) Dutchess County Planning Dept., 1977
- (7) Charles R Velzy Associates, 1978, based on Ref. (6) above

municipalities, so their estimate is most useful for this project. The estimates should also concur with those of other planning agencies. If the same percentage increase in population from 1985 to 1990 were to occur from 1990 to 2000, the resulting county population would be about 330,000, in close agreement with two other sources. The County Department of Planning percentage increase from 1985 to 1990 in each municipality was assumed to occur from 1990 to 2000 to arrive at population estimates by municipality. Table 2-2 lists the population projections by municipality which will be used for this study. These estimates have been reviewed and approved by the County Department of Planning. Table 2-2 also shows the population of the core area.

Population densities of the municipalities were used to confirm solid waste generation rates for this study. Table 2-3 shows the 1975 populations, municipality areas, and population densities which were used to verify current waste generation rates. The 1975 populations were used for all analyses concerned with existing conditions. Most of the data used was from 1974 to 1977. Population estimates are revised periodically to reflect changes in local demographic parameters. Since the population values are estimates, any revisions to correlate the exact population with actual dates of data would be unjustifiable.

TABLE 2-2

POPULATION PROJECTION BY MUNICIPALITY

<u>CITIES</u>	<u>1970(1)</u>	<u>1975(1)</u>	<u>1980(1)</u>	<u>1985(1)</u>	<u>1990(1)</u>	<u>2000(2)</u>
Beacon (c)	13,255	13,316	13,460	13,665	14,010	14,365
Poughkeepsie (c)	32,029	33,624	35,085	36,850	39,235	41,775
<u>TOWNS(3)</u>						
Amenia	7,842	7,077	6,955	6,915	6,960	7,005
Beekman	5,701	7,074	7,165	7,980	8,965	10,070
Clinton	2,604	2,909	3,055	3,305	3,585	3,890
Dover	8,475	7,427	7,410	7,475	7,655	7,840
East Fishkill (c)	11,092	13,320	16,005	18,675	21,335	24,375
Fishkill (c)	11,022	12,154	14,130	16,185	18,290	20,670
Hyde Park (c)	16,910	19,480	21,035	22,790	24,980	27,380
LaGrange (c)	10,902	12,053	14,130	16,240	18,415	20,880
Milan	1,322	1,453	1,580	1,710	1,915	2,145
Northeast	1,688	1,896	1,965	2,070	2,160	2,255
Pawling	2,850	3,359	3,675	3,975	4,410	4,895
Pine Plains	1,792	2,013	2,040	2,130	2,310	2,505
Pleasant Valley(c)	6,021	6,562	6,980	7,505	8,175	8,905
Poughkeepsie (c)	39,961	40,259	42,615	45,465	47,980	50,635
Red Hook	5,129	5,957	6,620	7,310	8,145	9,075
Rhinebeck	3,322	3,576	3,880	4,170	4,590	5,050
Stanford	2,479	2,859	3,185	3,530	3,950	4,420
Unionvale	1,702	2,010	2,250	2,465	2,735	3,035
Wappinger (c)	17,559	21,008	25,225	29,540	33,340	37,630
Washington	2,672	2,712	2,945	3,190	3,495	3,830
<u>VILLAGES</u>						
Fishkill (c)	913	1,515	1,555	1,625	1,735	1,850
Millbrook	1,735	1,717	1,680	1,710	1,735	1,760
Millerton	1,042	1,020	1,035	1,035	1,065	1,095
Pawling	1,914	1,894	1,940	1,990	2,100	2,215
Red Hook	1,680	1,665	1,655	1,625	1,670	1,715
Rhinebeck	2,336	2,686	2,765	2,855	2,950	3,050
Tivoli	739	758	755	755	760	770
Wappingers Falls(c)	5,607	5,270	5,225	5,265	5,350	5,435
TOTALS	222,295	238,623	258,000	280,000	304,000	330,520
Core Area Total (c)	165,271	178,561	195,445	213,805	232,845	253,900

(1) Dutchess County Department of Planning 1977 revision of 1975 estimates

(2) Charles R Velzy Assoc. estimate

(3) Town figures exclude population of incorporated villages

(c) Core Area Municipality

TABLE 2-3

1975 POPULATION, MUNICIPALITY AREA AND POPULATION DENSITY

Cities	1975 Population	Municipality area (square miles)	1975 Population Density (persons/sq.mi.)
Beacon(c)	13,316	4.87	2734
Poughkeepsie (c)	33,624	4.78	7034
Towns			
Amenia	7,077	41.40	171
Beekman	7,074	30.00	236
Clinton	2,909	37.60	77
Dover	7,427	51.60	144
East Fishkill (c)	13,320	53.10	251
Fishkill (c)	12,154	30.10	404
Hyde Park (c)	19,480	37.40	521
LaGrange (c)	12,053	40.80	295
Milan	1,453	36.00	40
Northeast	1,896	42.90	44
Pawling	3,359	47.10	71
Pine Plains	2,013	29.80	68
Pleasant Valley (c)	6,562	32.20	204
Poughkeepsie (c)	40,259	31.90	1262
Red Hook	5,957	38.90	153
Rhinebeck	3,576	34.90	102
Stanford	2,859	50.10	57
Unionvale	2,010	38.10	53
Wappinger (c)	21,008	26.10	805
Washington	2,712	59.60	46
Villages			
Fishkill (c)	1,515	0.39	3885
Millbrook	1,717	1.87	918
Millerton	1,020	1.02	1000
Pawling	1,894	1.00	1894
Red Hook	1,665	1.00	1665
Rhinebeck	2,686	1.00	2686
Tivoli	758	1.42	534
Wappingers Falls (c)	5,270	0.94	5606
County Total	238,623	807.89	295
Core Area Total (c)	178,561	262.58	680

(c) Core Area Municipality

3. DETERMINATION OF WASTE QUANTITIES

3.1 Methodology

The 1970 "New York Statewide Comprehensive Solid Waste Management Study" (Weston), 1972 "Comprehensive Solid Waste Study - Dutchess County" (Trautman), 1975 "Dutchess County Pyrolysis Siting Study" (Bodner), and 1976 "Dutchess County Pyrolysis Program Preliminary Engineering" (Bodner) were reviewed, and solid waste generation rates were abstracted to be verified. A survey of 98 industries (10 or more employees), 44 institutions, and four sewage treatment plants (one proposed) was conducted to establish solid waste contributions from those sources. Residential waste quantities were verified by site investigations of transfer stations and interviews with persons involved in solid waste collection and disposal in the County. Commercial waste quantities were estimated from records from the Beacon Incinerator/Landfill.

3.2 Data Collection

Waste generation is generally presented in the form of pounds of waste per capita per day (lb/cap/day) and includes contributions from:

- residences
- commercial establishments
- industries
- demolition and construction
- institutions
- street and highway maintenance
- trees and brush

Table 3-1 shows estimates of typical per capita solid waste generation by each of these categories as reported in the 1972 "Comprehensive Solid Wastes Study - Dutchess County" (Trautman). As shown in this table, the per capita generation rate can vary greatly.

Demolition and construction wastes will not be processed at the PUROX facility. This type of material decreases the overall BTU value of the waste entering the facility, since a high proportion is noncombustible, and detracts from optimum plant operation. Also, the energy required to reduce the size of these wastes to an acceptable level for the PUROX converter is high when compared to the energy produced from pyrolysis of these wastes. These wastes will be landfilled, and it will remain the responsibility of the contractor to find a landfill which will accept the waste.

Street and highway maintenance waste which is collected by municipalities would also be excluded from the PUROX facility. These wastes are relatively inert, and, for the most part, are presently landfilled at municipally-owned sites. Municipalities would probably continue this practice to avoid paying the tipping fee to the County for use of the PUROX facility.

Tree and brush wastes are seasonal in nature, and will be accepted at the PUROX facility when they are of residential origin. Yard waste, or brush, can usually be pyrolyzed directly with other solid waste. Trees require shredding or other preparation prior to being fed to the converter. They may therefore be excluded from the facility if excessive preparation

TABLE 3-1

SOLID WASTE GENERATION BY CATEGORY *

Type of Waste	Range Pounds per Capita (1)	Median per Day (1)	Median Percent	Region II 1968 EST. USPHS (2)
Residential	2.1 to 2.9	2.4	39.35	2.6
Commercial	0.4 to 3.2	1.2	19.67	.9
Industrial	0.2 to 1.4	0.4	6.56	2.6
Demolition & Construction	0.1 to 1.7	0.7	11.47	.6
Institutional	0.1 to 0.2	0.1	1.64	.1
Street Sweepings	0.1 to 0.8	0.3	4.92	.3
Trees & Brush	0.2 to 0.4	0.3	4.92	.1
Other	0.3 to 0.9	0.7	11.47	.3
TOTAL	3.5 to 11.5	6.1	100.0	7.5

(1) Information on Solid Waste Generation, New York State Department of Environmental Conservation, 1970

(2) Preliminary Data Analysis - 1968 National Survey of Community Solid Waste Practices - U.S. Public Health Service - 1968

* Comprehensive Waste Study, Dutchess County, New York, William R. Trautman Associates, 1972

is necessary, and could be landfilled inexpensively without cover since they are not a troublesome putrescible waste. The amount of tree and brush waste delivered to the plant would probably be small and is not expected to affect plant sizing. Most of these wastes could alternatively be disposed of in a municipally-owned landfill with no adverse environmental impact.

Residential, commercial, industrial, and institutional wastes will be contributors to the PUROX facility on a regular basis. An accurate generation rate for Dutchess County is needed for proper facility design. Data from municipalities, industries, institutions, sewage treatment plants, and landfills were collected and analyzed, and compared with estimates made by the NYSDEC. After verification of present quantities, future quantities were projected based on anticipated growth.

Municipalities in Dutchess County are generally served by landfills, most of which do not have any formalized methods for determining the amount of refuse handled or the population served. Many of these landfills are small and have short service lives. Some do not have permits for operation. The status of Dutchess County landfills was previously shown in Table 1-1. There are only two facilities in Dutchess County equipped with scales to weigh the refuse to facilitate billing. These are the Amenia landfill and the Beacon Incinerator/Landfill.

The Amenia landfill is privately owned and serves the City of Poughkeepsie, the Towns of Pleasant Valley, Amenia, and Pawling, and the Village of Pawling. A flat fee of \$9.00 per ton is charged for disposal. Records were obtained from the

various contributory municipalities, showing the monthly amount of refuse disposed of and the collection practices employed by the municipalities to arrive at an accurate residential per capita generation rate.

The Beacon Incinerator/Landfill serves all residential, industrial and commercial establishments within the City boundaries. Accurate records of the hauler and pounds of refuse taken to the incinerator and landfill were maintained and recorded on a daily and weekly basis. Records from 1974 through 1977 were obtained from the City and evaluated for type and amount of waste generated and weekly and seasonal variation in refuse quantities.

Non-residential waste quantities were estimated from responses to questionnaires sent to industries, institutions and sewage treatment plants in the County. All data was evaluated and compared with theoretical waste generation rates described in the New York State Comprehensive Solid Waste Plan. The results were then extrapolated to account for facilities that did not respond to the questionnaire. Commercial wastes were estimated from data collected at the Beacon Incinerator/Landfill and from the amount of local commercial zoning. Based on these procedures, estimates were made for current total waste generation for the County. Projections for future generation in the year 2000 were also made.

3.3 Residential Solid Waste Component

3.3.1 Poughkeepsie. Personnel from the City of Poughkeepsie Department of Public Works were interviewed to determine the refuse collection quantities and practices for the City. Refuse is collected by City vehicles and transported either directly or through its transfer station to Amenia, where it is weighed. The amount of refuse deposited by the City in the Amenia landfill is shown in Table 3-2.

Records from September, 1977 to October, 1978 show a range of 1.91 to 3.04 and an average of 2.55 pounds per capita per day was collected in the City. The municipal collection service includes all of the residential waste, plus some small commercial businesses (including stores in the downtown mall) and a few large businesses. The amount of waste contributed by these commercial establishments, while believed to be small, cannot be separated from the total. Thus, the value of 2.55 lb/cap/day is not representative of residential waste alone and cannot be used as a data point in developing a curve for the residential component. There is no organized recycling program in the City of Poughkeepsie, so the amount generated is equal to the amount collected.

3.3.2 Pawling. The Town and Village of Pawling utilize the Amenia landfill via their transfer station. A site investigation and interviews with transfer station and other town personnel were held to obtain information regarding the method and amount of waste collected. The village is served by

TABLE 3-2

RESIDENTIAL SOLID WASTE COLLECTION

CITY OF POUGHKEEPSIE

DATE	TONNAGE ⁽¹⁾	POUNDS PER DAY	LB/CAP/DAY ⁽²⁾
Sep. 77	1245	83000	2.47
Oct. 77	1232	79484	2.36
Nov. 77	1181	78733	2.34
Dec. 77	1139	73484	2.19
Jan. 78	1135	73226	2.18
Feb. 78	898	64143	1.91
Mar. 78	1226	79097	2.35
Apr. 78	1443	96200	2.86
May 78	1551	100065	2.98
Jun. 78	1535	102333	3.04
Jul. 78	1385	89355	2.66
Aug. 78	1562	100774	3.00
Sep. 78			
Oct. 78	1432	92387	2.75
TOTAL	16964		
Average	1305	85560	2.55

(1) Tonnage represents residential and small business pickups.
No waste from Town of Poughkeepsie. No recycling.

(2) Population = 33624

a municipal collection service, while the town has private haulers, who are charged for the use of the transfer station. There is no charge for residents who live in the town and wish to deliver their refuse to the transfer station; however, they are required to separate glass, metal, brush, tires and newspapers from their waste. Other residents who utilize a carting service are encouraged to recycle. The transfer station accepts only residential waste. Carters who collect commercial and industrial wastes are not permitted to use the transfer station. The waste is hauled to Amenia where it is weighed and landfilled. Data obtained for a 21 month period from February, 1977, through October, 1978, is shown in Table 3-3. The data shows a range of 1.32 to 2.17, and an average of 1.84 lb/cap/day is collected.

Transfer station personnel estimate that about one ton per week of glass, one and one-half tons per week of metal and one ton per week of newspaper are recycled. This amounts to 0.19 lb/cap/day which is removed from the waste stream. About 200 yards of brush are burned every three weeks. Tires are stockpiled, since the landfill is not permitted by the state to bury them.

In Pawling, the amount collected is less than the amount generated, due to recycling. This is a good indication of what may continue to occur in the smaller towns when a regional resource recovery facility is built. The collection rate may be lower than the generation rate, and fewer tons of refuse will reach the solid waste facility. Towns encourage source separation because it lowers transfer costs (fewer trips) and

TABLE 3-3

RESIDENTIAL SOLID WASTE COLLECTION

TOWN AND VILLAGE OF PAWLING

DATE	TONNAGE ⁽¹⁾	POUNDS PER DAY	LB/CAP/DAY ⁽²⁾
Feb. 77	108.9	7779	1.48
Mar. 77	148.2	9561	1.82
Apr. 77	104.3	6953	1.32
May 77	131.7	8497	1.62
June 77	151.7	10113	1.93
Jul. 77	141.3	9116	1.74
Aug. 77	124.7	8045	1.53
Sep. 77	161.3	10753	2.05
Oct. 77	167.0	10774	2.05
Nov. 77	159.0	10600	2.02
Dec. 77	127.7	8239	1.57
Jan. 78	144.2	9303	1.77
Feb. 78	128.3	9164	1.74
Mar. 78	133.1	8587	1.63
Apr. 78	138.0	9200	1.75
May 78	176.9	11413	2.17
Jun. 78	160.7	10713	2.04
Jul. 78	173.5	11194	2.13
Aug. 78	174.8	11277	2.15
Sep. 78	161.4	10760	2.05
Oct. 78	163.8	10568	2.01
TOTAL	3080.5		
Average	146.7	9648	1.84

(1) Tonnage represents residential waste only. Recycling:

Glass: 1 ton/week
 Paper: 1 ton/week
 Metal: 1.5 ton/week
 3.5 ton/week, or 1000 lb/day

This amounts to 0.19 lb/cap/day for total generation rate =
 2.03 lb/cap/day

(2) Population: Town = 3359, Village = 1894, Total = 5253

tipping fees (fewer tons). Thus, according to the records available, the residential generation rate for Pawling is 2.03 lb/cap/day, but the collection rate is only 1.84 lb/cap/day. The residential generation rate will be used to develop the curve for the residential waste component.

3.3.3 Pleasant Valley. The Town of Pleasant Valley owns and operates a transfer station and hauls its waste to Amenia where it is weighed and landfilled. A site investigation and discussions with town personnel were held to obtain data on refuse quantities and collection practices. The town provides no refuse collection service, so the transfer station is used by private carters and residents. Each must pay to use the transfer station (based on \$2.00 per cubic yard).

From March, 1977, to October, 1978, Pleasant Valley spent a total of \$27,166.90 for refuse disposal. Of this amount, \$3,000 was spent during one month for charges other than disposal at Amenia. Thus, \$24,166.90 was charged as a tipping fee at the Amenia landfill. At \$9.00 per ton, this indicates that 2,685 tons of waste was handled by the Pleasant Valley transfer station. This amounts to a collection rate of 1.44 lb/cap/day. The transfer station operator estimated that 18 tons of newspaper are recycled every 3 months (72 tons per year), 28 tons of metal were recently collected, representing a one year accumulation, and glass (no estimate since recycling was only recently started) are recycled. This amounts to 0.08 lb/cap/day, or a total generation rate of 1.52 lb/cap/day. The generation rate at Pleasant Valley may not be a true

representation of the residential component. Some waste generated in the town may be going by direct haul to the Amenia landfill, since individuals and haulers are charged to use the station. Thus, this data point cannot be used directly for estimating the residential solid waste component.

3.3.4 Amenia. The Town of Amenia utilizes the Amenia landfill by direct haul. There is no accurate method for billing, since residents use private carters or bring their waste directly to the landfill and individual cars are not weighed. The town negotiates a lump sum price to be paid to the landfill on an annual basis. In 1977, the amount was \$22,800 and in 1978 it was \$24,000. The landfill normally charges \$9.00 per ton of waste. Assuming the negotiated fee is representative of the tonnage, this averages 2,600 tons per year, which amounts to a collection rate of 2.01 lb/cap/day. This value was used to develop the residential waste component curve, since it is representative of the entire town's residential component only.

3.3.5 Beacon. Until recently, the City of Beacon operated both a landfill and an incinerator. The landfill was used only for trash, and all other refuse was fed to the incinerator. In August, 1978, the incinerator was closed, and that portion of refuse is now hauled to the Goshen landfill. The city provided municipal collection for only private residences while the incinerator was operating. It did not provide service to about 1000 residents who live in large, privately-owned apartments, whose refuse was collected by a private hauler. The weight

records that were kept for the years 1974 through 1977 were analyzed for residential wastes. The residential component had an average generation rate of 1.98 lb/cap/day with a range of 1.52 to 2.93 during that period. There are no organized recycling programs, so this represents the residential generation and collection rate.

3.3.6 Summary. The residential component of the solid waste stream appears to be fairly consistent regardless of the size of the municipality. Table 3-4 and Figure 3-1 summarize the results which can be approximated by the equation:

$$R(R) = -0.08 \log D + 2.22,$$

where:

$R(R)$ = Residential generation rate, in lb/cap/day

D = Population Density in persons/square mile.

This can be approximated to $R(R) = 2.0$ for all cases, since there should be little difference in residential waste generation with different population densities. Thus, 2.0 lb/cap/day will be used to represent the generation rate of the residential component of refuse for all municipalities. Towns outside the core area, which may eventually be contributory to the facility, would probably use a transfer station to transport refuse to the plant. A value of 1.9 lb/cap/day will be used to represent the lower collection rate due to the probability of recycling at the transfer stations or by paper drives, etc. In Pawling, residents who have private haulers are encouraged to recycle, and all residents who deliver their waste to the transfer station are required by the town to separate and

TABLE 3-4

SUMMARY OF RESIDENTIAL WASTE GENERATION AND COLLECTION DATA

Municipality	Generation Rate lb/cap/day	Salvage Rate lb/cap/day	Collection Rate lb/cap/day	Comments
Poughkeepsie City	2.55	0.00	2.55	Not representative - high due to collection of some commercial waste
Pawling Town and Village	2.03	0.19	1.84	Residential waste only
Pleasant Valley Town	1.52	0.08	1.44	Not representative - low due to direct haul to landfill by some
Amenia Town	2.01	0.00	2.01	Estimated by annual fee charged by landfill
Beacon City	1.98	0.00	1.98	Residential waste only

RESIDENTIAL WASTE GENERATION RATE vs POPULATION DENSITY

FIGURE 3-1

recycle newspaper, glass, and metal. This accounts for the high recycle rate when compared to Pleasant Valley, which has a voluntary recycling program. Therefore, 0.1 lb/cap/day appears to be a reasonable rate of recycle for municipalities outside the core area.

3.4 Industrial Solid Waste Component

The amount of industrial solid waste generated in Dutchess County can be approximated by two methods. The first estimate is based on the waste generation of similar industries. This is done by using typical waste production rates as determined by the New York State Comprehensive Solid Waste Plan and reported by Standard Industrial Classification (SIC) Codes. The rate for each major SIC group, representing similar industries, is reported in terms of tons per employee per year (T/emp/yr). The second method of estimating the industrial waste contribution is to survey the industries in Dutchess County and determine the actual waste generation. Both methods were used for this study.

Questionnaires were sent to 98 manufacturing industries (those reporting ten or more employees) of the 209 total industries in the County as reported in the 1974 Dutchess County Data Book. Forty-five industries responded, representing 46 percent of the number of industries surveyed, and 78 percent of the total industrial employment (30,600 persons) in the County.

Results from the industrial survey are shown on Table 3-5a. This data was compared with generation rates developed by New York State. The New York State data is representative of a

TABLE 3-5a

ACTUAL INDUSTRIAL WASTE GENERATION AND COLLECTION BY SIC CODE

(Industries Responding to Industrial Survey)

SIC CODE	TYPE OF INDUSTRY	Number of Industries	Number of Employees	Actual Generation Rate T/emp/yr	Actual Amount Generated lb/day	Actual Amount Salvaged lb/day	Actual Amount Collected lb/day
203	Preserved Foods	1	147	15.28	12,343	0	12,343
20	Food Processing	1	9	0.87	43	0	43
22	Textile Mill Prods.	1	60	1.52	500	0	500
23	Apparel	1	8	0.57	25	0	25
24	Wood Products	3	81	1.44	640	311	329
25	Furniture	0	0	0	0	0	0
26	Paper & allied prods.	0	0	0	0	0	0
27	Printing & Publishing	3	1,167	0.64	4,111	0	4,111
28	Chemical & allied Prod.	2	11	0.55	33	0	33
29	Petroleum	1	820	0.29	1,300	229	1,071
30	Rubber & Plastic	2	345	2.90	5,490	0	5,490
31	Leather	0	0	0	0	0	0
32	Stone, clay	2	168	1.94	1,786	1,429	357
33	Primary metals	0	0	0	0	0	0
34	Fabricated Metals	4	200	2.49	2,727	2,441	286
35	Non-electric machinery	10	12,552	0.53	36,162	17,429	18,733
36	Electrical Machinery	3	8,008	0.56	24,729	4,715	20,014
37	Transportation Equip.	0	0	0	0	0	0
38	Prof. & Scient. Inst.	2	237	1.43	1,857	0	1,857
39	Misc. Manufacturing	0	0	0	0	0	0
TOTAL		36 ⁽¹⁾	23,813	31.01	91,746	26,554	65,192

(1) Nine additional industries responded with insufficient data pertaining to their waste quantities and are not included in this tabulation

much larger number of data points, while the industrial survey results are more indicative of local conditions in Dutchess County. Both sources of information are important in arriving at estimates for industries which did not respond to the survey. Generation rates from both information sources were considered in arriving at the generation rate of industries in Dutchess County which were too small or did not respond.

Data from the New York State Industrial Directory was used to distribute the results over an additional 79 industries, and is shown in Table 3-5b. Table 3-5c is the sum of Tables 3-5a and 3-5b, and combines actual and estimated waste quantities for 115 industries, representing 94 percent of the total county employment. The amount of recycling as reported by surveyed industries was taken into account in determining the collection rate.

The results of Table 3-5c were extrapolated to represent the current total employment in Dutchess County to account for the many small industries which were not surveyed. A further breakdown of industries into municipalities and conversion to equivalent lb/cap/day generation and collection rates representing total employment is shown in Table 3-6. The average industrial generation rate for the County is 0.60 lb/cap/day, while the core area is slightly higher, at 0.66 lb/cap/day.

The results of the industrial survey also show that, as a rule, industries recycle their waste wherever feasible to reduce disposal cost and produce additional revenues. The amount of waste salvaged and net amount collected are therefore also shown

TABLE 3-5b

ESTIMATED INDUSTRIAL WASTE GENERATION AND COLLECTION BY SIC CODE

(Industries Reported in Industrial Directory,
Which did not Respond to Industrial Survey)

SIC CODE	TYPE OF INDUSTRY	Number of Industries	Number of Employees	Estimated Generation Rate T/emp/yr	Estimated Amount Generated lb/day	Estimated Amount Salvaged lb/day	Estimated Amount Collected lb/day
203	Preserved Foods	1	20	12.90	1,417	0	1,417
20	Food Processing	5	127	5.80	4,047	0	4,047
22	Textile Mill Prods.	6	813	0.50	2,234	0	2,234
23	Apparel	7	451	0.31	768	0	768
24	Wood Products	2	24	3.00	395	197	198
25	Furniture	1	170	0.52	486	0	486
26	Paper & allied prods.	3	455	2.00	5,000	0	5,000
27	Printing & Publishing	8	316	0.49	850	0	850
28	Chemical & allied prod.	2	19	0.63	66	0	66
29	Petroleum	2	47	14.80	3,822	764	3,058
30	Rubber & Plastic	2	388	2.60	5,543	0	5,543
31	Leather	1	2	0.17	2	0	2
32	Stone, clay	8	393	2.40	5,182	0	5,182
33	Primary metals	1	9	24.00	1,188	594	594
34	Fabricated Metals	9	330	1.70	3,082	1,542	1,540
35	Non-electric machinery	4	266	1.00	1,461	731	730
36	Electrical Machinery	7	902	1.70	8,425	0	8,425
37	Transportation Equip.	1	13	1.30	93	0	93
38	Prof. & Scient. Inst.	3	64	1.00	352	0	352
39	Misc. Manufacturing	6	62	0.14	35	0	35
TOTAL		79	4,871	76.96	44,448	3,828	40,620

TABLE 3-5c

TOTAL INDUSTRIAL WASTE GENERATION AND COLLECTION BY SIC CODE

(All Industries Reported in Industrial Directory)

SIC CODE	TYPE OF INDUSTRY	Number of Industries	Number of Employees	Total Amount Generated lb/day	Total Amount Salvaged lb/day	Total Amount Collected lb/day
203	Preserved Foods	2	167	13,760	0	13,760
20	Food Processing	6	136	4,090	0	4,090
22	Textile Mill Prods.	7	873	2,734	0	2,734
23	Apparel	8	459	793	0	793
24	Wood Products	5	105	1,035	508	527
25	Furniture	1	170	486	0	486
26	Paper & allied prods.	3	455	5,000	0	5,000
27	Printing & Publishing	11	1,483	4,961	0	4,961
28	Chemical & allied prod.	4	30	99	0	99
29	Petroleum	3	867	5,122	993	4,129
30	Rubber & Plastic	4	733	11,033	0	11,033
31	Leather	1	2	2	0	2
32	Stone, clay	10	561	6,968	1,429	5,539
33	Primary metals	1	9	1,188	594	594
34	Fabricated Metals	13	530	5,809	3,983	1,826
35	Non-electric machinery	14	12,818	37,623	18,160	19,463
36	Electric Machinery	10	8,910	33,154	4,715	28,439
37	Transportation Equip.	1	13	93	0	93
38	Prof. & Scient. Inst.	5	301	2,209	0	2,209
39	Misc. Manufacturing	6	62	35	0	35
TOTAL		115	28,684	136,194	30,382	105,812

TABLE 3-6

INDUSTRIAL WASTE GENERATION BY MUNICIPALITY

	1975 Pop.	Density Persons per sq. mi.	Generation Rate lb/cap/day	Amount of Waste Generated lb/day	Amount of Waste Salvaged lb/day	Amount of Waste Collected lb/day
CITIES						
Beacon(c)	13,316	2,734	1.35	17,900	1,300	16,600
Poughkeepsie(c)*	73,883	2,014	0.84	61,800	23,700	38,100
TOWNS						
Amenia	7,077	171	0.07	500	0	500
Beekman	7,074	236	0.0	0	0	0
Clinton	2,909	77	0.21	600	100	500
Dover	7,427	144	0.29	2,200	0	2,200
East Fishkill(c)	13,320	251	2.35	31,300	6,400	24,900
Fishkill(c)	-	-	-	-	-	-
Hyde Park(c)	19,480	521	0.03	600	100	500
LaGrange(c)	12,053	295	0.0	0	0	0
Milan	1,453	40	0.0	0	0	0
Northeast	1,896	44	0.0	0	0	0
Pawling	-	-	-	-	-	-
Pine Plains	2,013	68	0.0	0	0	0
Pleasant Valley(c)	6,562	204	0.39	2,600	0	2,600
Poughkeepsie(c)	-	-	-	-	-	-
Red Hook	-	-	-	-	-	-
Rhinebeck	-	-	-	-	-	-
Stanford	2,859	57	0.0	0	0	0
Unionvale	2,010	53	0.0	0	0	0
Wappinger(c)	21,008	805	0.0	0	0	0
Washington	2,712	46	0.0	0	0	0
VILLAGES						
Fishkill(c)*	13,669	448	0.03	400	0	400
Millbrook	1,717	918	0.24	400	0	400
Millerton	1,020	1,000	1.51	1,500	0	1,500
Pawling*	5,253	109	1.13	6,000	0	6,000
Red Hook*	7,622	191	1.74	13,300	0	13,300
Rhinebeck*	6,262	174	0.21	1,300	600	700
Tivoli	758	534	0.54	400	0	400
Wappingers Falls(c)	5,270	5,606	0.60	3,200	100	3,100
COUNTY TOTAL	238,623	-	0.60	144,000	32,300	111,700
Core Area Total(c)	178,561	-	0.66	117,800	31,600	86,200

*Includes Town of same name
(c) Core area municipality

Note: Values adjusted for full employment

on Tables 3-5a,b,c, and 3-6. The amount generated represents the industrial solid waste component, while the net amount collected is used for the industrial contribution to the solid waste facility. The net industrial solid waste collected amounts to 0.47 lb/cap/day for the County and 0.48 lb/cap/day for the core area.

Some questionnaires were verified by contacting the haulers who collect the refuse from selected industries. The amounts that were reported on the questionnaires by the industries were in close agreement with estimates made by the haulers.

Figure 3-2 is a graph showing the industrial generation rate vs. log population density. A mathematical approximation utilizing a least square fit through the data points results in the equation:

$$R(I) = 0.39 \log D - 0.48$$

where:

$R(I)$ = industrial generation rate, in lb/cap/day

D = population density, persons/square mile

Fifty percent of the industrial waste generated in Dutchess County is from four sources. Schatz Federal Bearing, Inc. (bearing manufacturer) produces 11,700 lb/day. However, it recycles 9,400 lb/day as ferrous metals. Orchard Hill Farms (frozen foods) generates 12,300 lb/day none of which is recycled. The two IBM facilities (Poughkeepsie and East Fishkill) produce data processing equipment and generate 22,900 and 24,700 lb/day of refuse respectively. Of the total amount, 11,900 lb/day is recycled, most of which is paper. The two IBM

INDUSTRIAL WASTE GENERATION RATE vs POPULATION DENSITY

55

FIGURE 3-2

facilities produce 33 percent of the County's total industrial waste stream and account for 60 percent of the total manufacturing employment in the County. These four industries account for the unusually high amount of industrial refuse generated in Poughkeepsie, Red Hook, and East Fishkill.

3.5 Commercial Solid Waste Component

Commercial solid waste generation rates are perhaps the most difficult to estimate. Waste quantities and characteristics vary widely with the different types of businesses. The large number and variety of commercial establishments make it unfeasible to obtain a representative sample for all types of activities with respect to refuse quantities and characteristics.

Operating records from the Beacon Incinerator/Landfill from the years 1974 through 1977 were obtained and analyzed. The residential, industrial, and institutional components of the refuse were subtracted from the total refuse delivered to the incinerator/landfill. The remaining portion is considered to be attributable to commercial refuse. Over the four year period, an average of 23,500 lb/day or 1.77 lb/cap/day was collected and disposed of at the incinerator/landfill. Beacon is the only municipality which has reliable data which can be easily broken down into its components.

The curve for the commercial component is expected to be similar in nature to that for the industrial component. Since commercial establishments rely on residents for business, there will be an increase in generation rate with increasing

population density. By the same token, sparsely populated areas will not be capable of supporting commercial establishments so the commercial component will drop to near zero. Table 3-7 is developed from information taken from the 1974 Dutchess County Data Book, and shows the distribution of commercial property in the County by municipality and the percentage of the municipality's area which is commercially zoned. Most towns, with the exception of Poughkeepsie, have significantly less than one percent of their area dedicated to commercial zoning, while all cities and villages have significantly more than one percent. Also, all core area municipalities have about one percent of their land zoned commercially, while those outside the core area have less than 0.2 percent of their overall land zoned commercially.

A best fit curve through the data points was developed by applying the method of least squares to the data. The resulting curve shows that in Dutchess County, municipalities with population densities under 100 persons per square mile have essentially no commercially zoned land, and so generate no commercial waste.

The Town Clerks from nine towns with population densities under 100 persons per square mile were contacted to determine the number and type of commercial establishments within the town limits to confirm the mathematical analysis. The results ranged from no commercial establishments in Pine Plains to ten in the Town of Clinton. Most towns showed one to three gas stations, a supermarket or deli, and another small business, such as a bank. The other towns contacted were Milan, Northeast, Pawling,

TABLE 3-7
DISTRIBUTION OF COMMERCIAL PROPERTY BY MUNICIPALITY

	Total Municipality Acreage	Commercially Zoned Acreage	Percentage of Commercially Zoned Land	Density Persons per Square Mile
CITIES				
Beacon(c)	3,100	220	7.09	2734
Poughkeepsie(c)	3,100	222	7.16	7034
TOWNS				
Amenia	26,500	51	0.19	171
Beekman	19,200	36	0.19	236
Clinton	24,100	28	0.12	77
Dover	33,000	61	0.18	144
East Fishkill(c)	34,000	86	0.25	251
Fishkill(c)	19,300	48	0.25	404
Hyde Park(c)	23,900	203	0.85	521
LaGrange(c)	26,100	74	0.28	295
Milan	23,000	15	0.07	40
Northeast	27,500	14	0.05	44
Pawling	30,100	43	0.14	71
Pine Plains	19,100	35	0.18	68
Pleasant Valley(c)	20,600	110	0.53	204
Poughkeepsie(c)	20,400	570	2.79	1262
Red Hook	24,900	21	0.08	153
Rhinebeck	22,300	20	0.09	102
Stanford	32,100	33	0.10	57
Unionvale	24,400	9	0.04	53
Wappinger(c)	16,700	89	0.53	805
Washington	38,100	82	0.21	46
VILLAGES				
Fishkill(c)	300	48	16.00	3885
Millbrook	1,200	27	2.25	918
Millerton	700	30	4.28	1000
Pawling	600	24	4.00	1894
Red Hook	600	48	8.00	1665
Rhinebeck	600	43	7.16	2686
Tivoli	900	35	3.88	534
Wappingers Falls(c)	600	35	5.83	5606
COUNTY TOTAL	517,000	2,360	0.46	295
Core Area Total(c)	168,100	1,705	1.01	680

(c) Core Area Municipality

Stanford, Unionvale, Rhinebeck and Washington. The Town Clerks generally commented that almost all commercial activity was in the incorporated villages within the towns.

A curve of commercial waste generation (and collection) was drawn by combining this information with that obtained from Beacon. Figure 3-3 shows a graph of per capita commercial generation rate vs. population density. This curve can be approximated by the equation $R(C) = 1.23 \log D - 2.46$. No recycling is expected to occur among commercial establishments, and the amount of refuse collected is equal to the amount generated.

3.6 Institutional Solid Waste

Institutional wastes usually account for a small percentage of the overall solid waste quantities. Dutchess County, however, has several large institutions which generate an unusually high proportion of the total County wastes. Questionnaires were sent to 44 institutions, of which 27 responded. The 27 which responded account for 87 percent of the total number of institutional beds in the County. Twenty-one of the returned questionnaires contained an estimate of the amount of solid waste generated. Table 3-8a summarizes the responses to the survey. The results of the survey were adjusted based on similar institution types for those which did not respond. Table 3-8b estimates refuse from institutions which did not respond to the questionnaire. Table 3-8c combines the results of Tables 3-8a and 3-8b by type of institution and shows the total institutional solid waste collection rate for the County.

COMMERCIAL WASTE GENERATION RATE
VS
POPULATION DENSITY

FIGURE 3-3

TABLE 3-8a

ACTUAL INSTITUTIONAL WASTE GENERATION BY INSTITUTION TYPE

(Institutions Responding to Survey)

Institution Type	Number of Institutions	Number of Occupied Beds	Generation Rate lb/bed/day	Amount Generated lb/day	Amount Incinerated lb/day	Amount Collected lb/day
Adult Homes	7	759	7.52	5,710	3,611	2,099
Children Homes	2	197	2.03	400	0	400
Correctional	2	3,030	6.60	20,000	0	20,000
Educational	2	3,050	4.75	14,500	0	14,500
Medical	5	1,089	8.72	9,491	1	9,490
Psychiatric	3	2,840	15.02	42,670	0	42,670
TOTAL	21 ⁽¹⁾	10,965		92,771	3,612	89,159

(1) Six additional institutions responded with insufficient data pertaining to their waste quantities and are not included in this tabulation

TABLE 3-8b

ESTIMATED INSTITUTIONAL WASTE GENERATION BY INSTITUTION TYPE
(Institutions Not Responding to Survey)

Institution Type	Number of Institutions	Number of Occupied Beds	Generation Rate lb/bed/day	Amount Generated lb/day	Amount Incinerated lb/day	Amount Collected lb/day
Adult Homes	13	1,020	7.5	7,650	0	7,650
Children Homes	4	218	2.0	436	0	436
Correctional	0	0	0.0	0	0	0
Educational	0	0	0.0	0	0	0
Medical	4	445	3.0	1,335	0	1,335
Psychiatric	2	2,854	15.0	42,810	0	42,810
TOTAL	23	4,537		52,231	0	51,231

TABLE 3-8c

TOTAL INSTITUTIONAL WASTE GENERATION BY INSTITUTION TYPE

(All Institutions)

Institution Type	Number of Institutions	Number of Occupied Beds	Amount Generated lb/day	Amount Incinerated lb/day	Amount Collected lb/day
Adult Homes	20	1,779	13,360	3,611	9,749
Children Homes	6	415	836	0	836
Correctional	2	3,030	20,000	0	20,000
Educational	2	3,050	14,500	0	14,500
Medical	9	1,534	10,826	1	10,825
Psychiatric	5	5,694	85,480	0	85,480
TOTAL (1)	44	15,502	145,002	3,612	141,390

(1) Equivalent collection rate = $\frac{141,390 \text{ lb.}}{238,623} = 0.59 \text{ lb/cap/day for County}$

The amount of waste contributed by institutions is considered to be in addition to the total generated by residential, industrial and commercial establishments and will be added to the total waste from the municipality in which it is generated. Table 3-9 shows the generation for each municipality. An equivalent collection rate of 0.59 lb/cap/day in the County, and 0.45 lb/cap/day in the core area results from the data. The institutional waste survey showed that no recycling was practiced at the institutions, and that the amount collected is the same as the amount generated, except for a small amount which is incinerated on site.

Fifty-six percent of the institutional waste collected in the County is from four sources. The two correctional facilities, Green Haven State Security Prison and the Fishkill Correctional Facility account for a total of 20,000 lb/day of waste. Two psychiatric facilities, the Hudson River Psychiatric Center in Poughkeepsie and the Wassaic Development Center in Amenia generate 58,500 lb/day of refuse. The institutions and commercial haulers who collect the waste were contacted to verify the amounts, since they are high in comparison to other institutions. These four facilities have a capacity in terms of average number of beds occupied of 6,819 of the 15,502 total in the County, or 44 percent.

3.7 Summary of Present Waste Generation and Collection

Generation rates for the residential component were obtained from actual tonnages from several municipalities. Generation rates for the industrial component were obtained by

TABLE 3-9

INSTITUTIONAL WASTE GENERATION BY MUNICIPALITY

	1975 Pop.	No. of Insts.	Inst. Collection Rate lb/cap/day	Amount of Waste Generated lb/day	Amount of Waste Incinerated lb/day	Amount of Waste Collected lb/day
CITIES						
Beacon(c)	13,316	8	1.43	19,000	0	19,000
Poughkeepsie(c)*	73,883	16	0.70	51,600	0	51,600
TOWNS						
Amenia	7,077	1	4.64	32,800	0	32,800
Beekman	7,074	0	0.0	0	0	0
Clinton	2,909	0	0.0	0	0	0
Dover	7,427	2	3.41	25,300	0	25,300
East Fishkill(c)	13,320	1	0.43	5,700	0	5,700
Fishkill(c)	-	-	-	-	-	-
Hyde Park(c)	19,480	3	0.19	-	0	3,600
LaGrange(c)	12,053	0	0.0	0	0	0
Milan	1,453	0	0.0	0	0	0
Northeast	1,896	0	0.0	0	0	0
Pawling	-	-	-	-	-	-
Pine Plains	2,013	0	0.0	0	0	0
Pleasant Valley(c)	6,562	0	0.0	0	0	0
Poughkeepsie(c)	-	-	-	-	-	-
Red Hook	-	-	-	-	-	-
Rhinebeck	-	-	-	-	-	-
Stanford	2,859	0	0.0	0	0	0
Unionvale	2,010	0	0.0	0	0	0
Wappinger(c)	21,008	0	0.0	0	0	0
Washington	2,712	0	0.0	0	0	0
VILLAGES						
Fishkill(c)*	13,669	1	0.01	100	0	100
Millbrook	1,717	4	0.37	1,000	400	600
Millerton	1,020	0	0.0	0	0	0
Pawling*	5,253	1	0.17	900	0	900
Red Hook*	7,622	1	0.03	200	0	200
Rhinebeck*	6,262	5	0.17	4,300	3,200	1,100
Tivoli	758	0	0.0	0	0	0
Wappingers Falls(c)	5,270	1	0.09	500	0	500
COUNTY TOTAL	238,623	44	11.64	141,400	3,600	141,400
Core Area Total(c)	178,561	30	2.85	76,900	0	80,500

*Includes Town of Same Name

(c) Core Area Municipality

an industrial survey and, where data was missing, estimates were based on results of the survey and previous studies done by New York State. The amount of commercial wastes collected was obtained from information from the Beacon Incinerator/Landfill and local zoning of commercial parcels in Dutchess County municipalities.

A rate of $R(R) = 2.0 \text{ lb/cap/day}$ for the residential component has been developed previously in Section 3.3. The industrial and commercial components have been estimated by least squares fit of existing data at $R(I) = 0.39 \log D - 0.48$ and $R(C) = 1.23 \log D - 2.46$ respectively. The total residential, industrial and commercial components are therefore represented by $R(R + I + C) = 1.62 \log D - 0.94$.

Waste generation rate studies were done for New York State and the results summarized in the 1970 Statewide Comprehensive Solid Waste Plan (Weston). Those studies resulted in a non-linear approximation of per capita waste collection versus population density, expressed as:

$$R(T) = 1.54 \log D - 0.68,$$

where:

$R(T)$ = Total solid waste collection rate in lb/cap/day

D = Population density in persons/square mile.

This relationship is generally used for more urbanized areas than are found in Dutchess County. The relationship was applied to Poughkeepsie and Beacon for the statewide study while the rest of Dutchess County was considered as a "County remainder" and one factor was applied for all other towns and villages.

The mathematical relationship of total waste generation rate versus population density as developed by New York State is shown graphically on Figure 3-4. The total residential, industrial, and commercial components as developed from data collected in Dutchess County is also shown on Figure 3-4. The two curves agree closely, and refuse generation rates developed from Dutchess County data concur with those developed from a larger number of data points encompassing all of New York State.

Residential and industrial collection rates are, in some cases, lower than the generation rates to account for reduced waste quantities due to recycling. Municipalities outside the core area are estimated to recycle 0.1 lb/cap/day, while core area municipalities are not expected to recycle any residential waste. Generalizations concerning recycling of industrial wastes cannot be made, due to the variety of wastes generated. Industrial recycling is estimated based on the results of the industrial survey. No recycling is assumed for commercial waste. Institutional wastes are not included in the development of the above mentioned curve, and are added to the waste from the towns in which they are located.

Table 3-10 summarizes present waste collection rates and quantities for all municipalities in Dutchess County. The overall collection rate is 4.11 lb/cap/day, which accounts for 490 tons per day (seven day basis) of refuse. The collection rate in the core area is slightly higher, at 4.25 lb/cap/day, resulting in 379 tons per day of refuse.

TOTAL WASTE GENERATION RATE
VS
POPULATION DENSITY

FIGURE 3-4

TABLE 3-10

SUMMARY OF PRESENT WASTE COLLECTION

	Residential Collection lb/day	Industrial Collection lb/day	Commercial Collection lb/day	Institutional Collection lb/day	Total Collection lb/day
CITIES					
Beacon(c)	26,600	16,600	23,500	19,000	85,700
Poughkeepsie(c)	67,200	38,100	76,400	51,600	233,300
TOWNS					
Amenia	13,400	500	2,000	32,800	48,700
Beekman	13,400	0	3,200	0	16,600
Clinton	5,500	500	0	0	6,000
Dover	14,100	2,200	1,400	25,300	43,000
East Fishkill(c)	26,600	24,900	6,500	5,700	63,700
Fishkill(c)	24,300	(1)	9,100	(1)	33,400
Hyde Park(c)	39,000	500	17,200	3,600	60,300
LaGrange(c)	24,100	0	7,000	0	31,100
Milan	2,800	0	0	0	2,800
Northeast	3,600	0	0	0	3,600
Pawling	6,400	(1)	0	(1)	6,400
Pine Plains	3,800	0	0	0	3,800
Pleasant Valley(c)	13,100	2,600	2,500	0	18,200
Poughkeepsie(c)	80,500	(1)	54,500	(1)	135,000
Red Hook	11,300	(1)	1,400	(1)	12,700
Rhinebeck	6,800	(1)	0	(1)	6,800
Stanford	5,400	0	0	0	5,400
Unionvale	3,800	0	0	0	3,800
Wappinger(c)	42,000	0	23,400	0	65,400
Washington	5,200	0	0	0	5,200
VILLAGES					
Fishkill(c)	3,000	400	3,000	100	6,500
Millbrook	3,300	400	2,000	600	6,300
Millerton	1,900	1,500	1,300	0	4,700
Pawling	3,600	6,000	3,000	900	13,500
Red Hook	3,200	13,300	2,500	200	19,200
Rhinebeck	5,100	700	4,700	1,100	11,600
Tivoli	1,400	400	700	0	2,500
Wappingers Falls(c)	10,500	3,100	11,300	500	25,400
COUNTY TOTAL	470,900	111,700	256,600	141,400	980,600
Core Area Total(c)	356,900	86,200	234,400	80,500	758,000

(1) Included in city or village of same name

(c) Core area municipality

3.8 Future Solid Waste Generation and Collection

Increases in solid waste generation for the year 2000 will come from increased population and industrial and commercial activity. A slight increase in the generation rate will be effected by increased population densities of most municipalities, as shown previously in Figure 3-4. Changes in packaging materials, passage of returnable bottle legislation, and changes in lifestyle could also cause a change in the generation rate. The 1972 Trautman report used an increase in the generation rate of 1-1/2 percent per year, based on data estimated for other cities. Table 3-11 shows the year 2000 populations, total waste collection rates and quantities which would result from each of the above two cases. Both cases assume that industrial and commercial wastes will have a similar distribution as currently exists and the same percentage of recycling will occur. This table shows what is projected to be collected in the County in the future, and is not related to the amount which will be delivered to the PUROX facility. The amount delivered to the plant would depend on the County's control method to assure that sufficient refuse would be available to operate the plant.

The County collection rate will be 4.17 lb/cap/day, resulting in 690 tons per day being collected if there is no increase in the generation rate. The core area per capita collection rate would be higher, at 4.37 lb/cap/day which represents 554 tons per day.

Considering a 1-1/2-percent increase in the generation rate, the overall collection rate for the County would be 5.62

TABLE 3-11

PROJECTED WASTE COLLECTION - YEAR 2000

		No increase in Generation Rate		1-1/2 percent per year increase in Generation Rate	
	2000 Pop.	Collection Rate lb/cap/day	Total Collected lb/day	Collection Rate lb/cap/day	Total Collected lb/day
CITIES					
Beacon(c)	14,365	6.51	94,000	8.77	126,000
Poughkeepsie(c)*	41,775	7.14	298,000	9.61	402,000
TOWNS					
Amenia	7,005	6.86	48,000	9.24	65,000
Beekman	10,070	2.55	26,000	3.43	35,000
Clinton	3,890	2.12	8,000	2.86	11,000
Dover	7,840	5.88	46,000	7.91	62,000
East Fishkill(c)	24,375	5.47	133,000	7.37	180,000
Fishkill(c)	20,670	3.06	63,000	4.12	85,000
Hyde Park (c)	27,380	3.31	91,000	4.46	122,000
LaGrange(c)	20,880	2.91	61,000	3.92	82,000
Milan	2,145	2.06	4,000	2.78	6,000
Northeast	2,255	2.03	5,000	2.73	6,000
Pawling	4,895	2.08	10,000	2.80	14,000
Pine Plains	2,505	2.03	5,000	2.74	7,000
Pleasant Valley(c)	8,905	2.99	27,000	4.02	36,000
Poughkeepsie(c)	50,635	3.49	177,000	4.69	238,000
Red Hook	9,075	2.38	22,000	3.20	29,000
Rhinebeck	5,050	2.21	11,000	2.98	15,000
Stanford	4,420	2.07	9,000	2.78	12,000
Unionvale	3,035	2.06	6,000	2.78	8,000
Wappinger(c)	37,630	3.45	130,000	4.65	175,000
Washington	3,830	2.05	8,000	2.76	11,000
VILLAGES					
Fishkill(c)*	1,850	4.41	8,000	5.95	11,000
Millbrook	1,760	3.69	6,000	4.96	9,000
Millerton	1,095	4.67	5,000	6.29	7,000
Pawling*	2,215	7.31	16,000	9.84	22,000
Red Hook*	1,715	11.59	20,000	15.61	27,000
Rhinebeck*	3,050	4.40	13,000	5.93	18,000
Tivoli	770	3.31	3,000	4.46	3,000
Wappingers Falls(c)	5,435	4.84	26,000	6.52	35,000
COUNTY TOTAL	330,520	4.17	1,379,000	5.62	1,859,000
Core Area Total(c)	253,900	4.37	1,108,000	5.89	1,492,000

*Includes industrial and institutional components from Town of same name
(c) Core area municipality

lb/cap/day, or 930 tons per day. The core area would be higher, at 5.89 lb/cap/day, resulting in 746 tons per day.

In the year 2000, at least 554 tons per day should be available at the plant, assuming there was no increase in solid waste generation rate and only the core area was contributory to the plant. An upper limit of 930 tons per day could be delivered to the plant if, by the year 2000, all of Dutchess County were using the facility and a 1-1/2 percent per year increase in the per capita generation rate actually did occur.

The PUROX facility will include design considerations such that, with suitable expansion and additional facilities, any of the amounts of refuse collected in the core area can be handled. The facility will be designed with two 200-ton per day process trains, with ample room set aside for a third unit which could be added if necessary in the future. The two trains would be capable of handling the refuse collected in the core area with sufficient plant capacity to handle daily, weekly, monthly, or seasonal variations in refuse quantities. A third train could be constructed if required to handle increased refuse deliveries. The decision of whether to build the third process train could be delayed with no adverse impact on operation until several years after the initial construction is complete.

Table 3-12 and Figure 3-5 show the projected core area refuse collection from 1975 to 2000. The actual amount of refuse handled by the facility during the interim years from 1980 to 2000 will help in determining the need for an additional process train.

TABLE 3-12

PROJECTED CORE AREA REFUSE COLLECTION: 1975 to 2000

Refuse Collection Quantities in lb/day⁽¹⁾

Core Area Municipality	1975	1980	1985	1990	2000
Beacon C.	85,700	87,000	88,000	91,000	94,000
Poughkeepsie C.	233,300	245,000	259,000	278,000	298,000
East Fishkill T.	63,700	80,000	96,000	113,000	133,000
Fishkill T.	33,400	40,000	47,000	55,000	63,000
Hyde Park T.	60,300	66,000	73,000	81,000	91,000
LaGrange T.	31,100	38,000	45,000	52,000	61,000
Pleasant Valley T.	18,200	20,000	22,000	24,000	27,000
Poughkeepsie T.	135,000	144,000	156,000	166,000	177,000
Wappinger T.	65,400	81,000	98,000	113,000	130,000
Fishkill V.	6,500	7,000	7,000	8,000	8,000
Wappingers Falls V.	25,400	25,000	25,000	26,000	26,000
TOTAL	758,000	833,000	916,000	1,007,000	1,108,000

(1) Based on no increase in refuse generation rate.

FIGURE 3-5

PROJECTED CORE AREA REFUSE COLLECTION

3.9 Variations in Refuse Quantities

Day-to-day, week-to-week, and season-to-season variations in refuse quantities occur at all solid waste processing facilities. Day-to-day variations are most extreme, but least important to PUROX design. The processing plant will be designed to have ample storage to even out daily variations over a one-week period. Peak seasonal variations should not be critical to daily operations. The peak season is fairly predictable, based on the records at the Beacon Incinerator/Landfill, so its impact on plant operations could be minimized by advanced planning.

Weekly variations will be most critical to plant design. Storage capacity will be designed such that there will be sufficient front end storage and a backup landfill available so normal operations can proceed uninterrupted when the peak week occurs.

Data was obtained from the Beacon Incinerator/Landfill for the four-year period, 1974 through 1977, to determine the variation in waste quantity during the year. Figure 3-6 is a graph of weekly tons of waste collected vs. time, over an annual period. The weekly tons of waste represent an average of four years' data. The average over the four-year period is 245 tons per week, with a range of 178 tons per week (-67 tons per week, or -27 percent) occurring during the week before Christmas, to 285 tons per week (+40 tons per week, or +16 percent) occurring in mid-April. The lowest value recorded over the four-year period was 151 tons per week (-94 tons per week, or -38 percent), and occurred during Thanksgiving week of 1977. The

CITY OF BEACON
VARIATION IN MUNICIPAL REFUSE COLLECTION
THROUGHOUT THE YEAR
AVERAGE VALUES 1974-1977

FIGURE 3-6

highest recorded value over the period analyzed was 350 tons per week (+105 tons per week, or +43 percent), and occurred during late March, 1976.

The average lowest season occurs from mid-November to mid-February. An average of 221 tons of refuse per week (-24 tons per week, or -10 percent) is collected during this period. The average highest season occurs from mid-March to mid-June, when an average of 262 tons of refuse per week (+17 tons per week, or +7 percent) is collected.

From the four years' data, the peak week is confirmed as being most critical for design. An increase of 43 percent over the average was recorded during one week of the four-year period. This is a worst case due to the tremendous increase in refuse and the unpredictable nature of the peak week occurrence. An increase of only seven percent above average conditions for the more predictable peak season would not be a critical design parameter.

3.10 Refuse Composition

The composition of refuse from any municipality varies throughout the year depending on factors such as the specific source of solid waste, day of the week, season of the year and specific weather conditions. The time available for completion of this project does not permit sampling of solid waste over a broad range of such varied conditions. Data has been drawn from the experiences at refuse processing facilities in the U.S. and from other studies to establish a refuse composition for design purposes for the Dutchess County project. The major variable in

refuse composition is moisture content. A less critical variable is non-combustible material content. The remaining material, which is the combustible material, is largely cellulosic in nature. Minor constituents such as fats, waxes, oil, and plastics tend to raise the higher heating value of the moisture and non-combustible free material to something more than the higher heating value of cellulose alone. Drawing on the extensive data taken at the City of St. Louis, Ames, Iowa and elsewhere, the moisture and non-combustible-free higher heating value is estimated at 9,400 BTU's per pound. Table 3-13 shows the parameters used for the purposes of nominal plant sizing and design. Table 3-14 shows a typical composition of municipal solid waste.

Solid waste comprises many materials which, prior to being discarded, have a relatively high value if recycled. Newspaper, scrap iron and steel cans, aluminum, and glass have been source separated and recycled. Once they become mixed with other refuse, they are contaminated and their value decreases. The technology of removing these materials is also limited in some cases.

Source separated newspaper is worth about the same amount as the energy produced by pyrolysis of the newspaper. Once newspaper is discarded and contaminated by other refuse, its recycle value drops significantly, but the value of the gas produced by pyrolysis remains the same. Therefore, newspaper recycling at the plant site is not practical or economical for this type of facility.

TABLE 3-13

REFUSE COMPOSITION DESIGN PARAMETERS

Parameter	As Received	Dry Basis	Moisture and Non-Combust. Free
Moisture, Percent	27	-	-
Combustibles, Percent	50	69	100
Non-Combustibles, Percent	23	31	-
Higher Heating Value, BTU/LB	4,700	6,500	9,400

TABLE 3-14

TYPICAL COMPOSITION OF MUNICIPAL SOLID WASTE

<u>Component</u>	<u>Percent Weight- Wet Basis</u>
Paper	44.0
Glass	9.0
Ferrous Metals	7.0
Aluminum	0.4
Other Non-Ferrous Metals	0.2
Textiles	2.0
Rubber and Leather	1.4
Plastics	2.0
Wood	2.5
Food Waste	14.0
Yard Waste	13.0
Miscellaneous	<u>4.5</u>
TOTAL	100.0

Ferrous metals make up about seven percent of "as received" refuse. Scrap iron and steel cans have a relatively high resale value if source separated. The value drops with increasing contamination from refuse, and the final market value depends on the degree of contamination. Some resource recovery facilities in this country have found it cost-effective to remove ferrous metals from the waste stream, even though the product is contaminated. Magnetic separation of ferrous metals is necessary to satisfy the PUROX process requirement of a maximum allowable ferrous content of five percent. The degree to which the metal is processed will be determined by a cost-effectiveness analysis and the results of the marketing study. These details will be discussed further in Section 6.2.

Aluminum, mostly in the form of beverage cans, usually comprises less than 0.5 percent of the waste stream. Clean source separated aluminum is a valuable resource. Once contaminated with refuse, however, the value decreases to a fraction of its clean value. The technology for aluminum recovery has had only marginal success. Once removed, the aluminum-rich stream must go through several additional cleaning steps. The result is a product that has a much lower value than source separated aluminum. If sufficiently large amounts of aluminum are available in the raw waste stream, aluminum recovery may become cost-effective.

Four major beverage bottlers who supply Dutchess County (and other areas) were contacted to determine whether the amount of aluminum in the waste stream could justify consideration of aluminum recovery. Three use only steel cans; one uses about 80

percent steel, and 20 percent aluminum. Their general comments indicated that aluminum was more expensive, harder to work with and less structurally sound. One had reverted back to steel cans after trying aluminum cans. Thus, the trend in Dutchess County and elsewhere has recently been away from the use of aluminum cans, and the percentage of aluminum in the waste stream is decreasing. Also, the high value of clean, source-separated aluminum has caused individuals to remove cans from the waste stream.

Glass comprises approximately nine percent of the waste stream. Glass must be extremely clean and should be color-sorted to maximize revenues from recycling. This can be best accomplished by source separation. There is limited experience with glass recovery from mixed refuse. As a rule, only color-sorted glass has a reasonable value, however, the color sorting process is an expensive, power intensive, and not yet proven process. The PUROX process requires that the glass (or silicon) content be above three percent to control slagging in the converter. If glass recovery eventually becomes cost-effective and is added to the plant, about 70 percent of the glass could be removed without adversely affecting the slagging operation. In a similar manner, returnable container beverage legislation, if adopted, would have to remove 70 percent of the glass before adversely affecting the PUROX process. If this were to occur, some slag or sand could be recycled to the converter to make up the difference in the amount of glass needed for slagging. The net effect on the plant of a returnable bottle bill being enacted would be

positive, since all of the glass is not needed by the process, and removal of the glass would increase the heating value of the as-received refuse, resulting in more BTU's of product gas per ton of refuse. Since glass is an abrasive material, removal of some of the glass would also result in decreased wear on refuse handling and processing equipment, and reduce operating and maintenance costs.

4. Sewage Sludge Quantities and Characteristics

There exist three major secondary sewage treatment plants in Dutchess County. The Beacon Plant (average flow = 3.2 mgd, design flow = 6.0 mgd) has vacuum filtration and multiple hearth sludge incineration. The Arlington Plant (average flow = 2.8 mgd, design flow = 4.0 mgd) has vacuum filtration and fluidized bed incineration. The Poughkeepsie plant (average flow = 3.5 mgd, design flow = 8.0 mgd) has low pressure oxidation, centrifuges, and land disposal at the Amenia landfill. There is one proposed treatment plant (Tri-Municipal) which was scheduled to be placed under construction in September 1979, and be on line in 1982, however, unexpected delays have altered the time schedule somewhat.

Representatives of these plants were contacted for data pertaining to sludge quantities, characteristics, and treatment. Table 4-1 summarizes the results of the survey. Beacon, Arlington, and Poughkeepsie dewater sludge to 14, 19, and 35 percent solids, respectively. A total of about 6 dry tons per day or 29 wet tons of sludge per day (weighted average) will be produced from the four plants when the pyrolysis plant goes on line. Since all four plants have, or plan to have, sludge disposal systems, the pyrolysis facility could not be guaranteed the sludge from the treatment plants unless there would be an overall cost savings associated with co-disposal. Thus, although 29 wet tons of sludge per day is produced, it may not be handled on a regular basis at the pyrolysis plant. Some of the sludge could possibly be delivered to the pyrolysis facility

TABLE 4-1

SLUDGE SURVEY RESULTS

	BEACON	ARLINGTON	POUGHKEEPSIE	TRI-MUNICIPAL * (Proposed)
Present Average flow, mgd	3.2	2.8	3.5	
Design average flow, mgd	6.0	4.0	8.0	
Population served	17,000	23,000	30-40,000	
Type of treatment	Secondary	Secondary	Secondary	
Sludge Process train (1)	T,C,V,A,M	T,C,V,F	T,O,T,C,Ce,L	
Raw Sludge Generation:				
Grit	2cf/d	50 cy/mo	-	
Primary	-	88,000 gpd	-	
Secondary	1,268 lb/d	26,000 gpd	-	
Grease, skimmings	-	-	-	
Septage	75,000 gal/yr.	0	-	
Total	-	-	3500-5000 lb/d	
Raw Sludge characteristics:				
Percent solids	-	4.6	3-6	
Percent volatile solids	-	66	50-70	
Percent inert solids	-	34	30-50	
Stabilized sludge characteristics:				
Percent solids	-	4.6	11-19	
Percent volatile solids	86	79	45-60	
Percent inert solids	14	21	40-55	
Percent chemicals	0	0	0	
Sludge to disposal:				
Dry lb/day	1,268	6,709	3500-5000 lb/d	
Percent solids	13.9	18.7	30-40	
Type	Digested		Zimpro	
(1) T Thickening				
C Conditioning				
V Vacuum Filtration				
M Multiple Hearth Incineration				
A Aerobic Digestion				
F Fluidized Bed Incineration				
O Low Pressure Oxidation				
Ce Centrifuges				
L Landfill Disposal				

*No response to questionnaire

during emergency situations at the wastewater treatment plants when sludge disposal facilities are inoperative.

During this phase of the design, facilities will be investigated for receipt and handling of sludge to facilitate unloading and insure complete mixing with solid waste prior to pyrolysis. Costs will also be developed for this sludge handling option so a decision can be made with respect to the cost-effectiveness of this option.

5. SITE INVESTIGATIONS

5.1 Introduction

Six potential sites were evaluated in the 1975 "Dutchess County Pyrolysis Siting Study" (Bodner) report. Based on the findings of that study, the preliminary market investigations, and recent developments, four potential sites or areas were evaluated for the proposed PUROX facility. These are:

1. Arlington site
2. Trap Rock site
3. Beacon Landfill site
4. Area opposite Danskammer Point

The relative location of the four potential sites or areas in the County is shown on Figure 5-1. Each site was visited by Dutchess County and CRVA personnel to determine the feasibility of the location for the PUROX facility and to observe local conditions. Traffic, topographic, economic, environmental, and aesthetic aspects of the sites were evaluated.

5.1.1 Environmental. Some environmental aspects of the PUROX facility will be the same regardless of the selected site. Potential sources of noise, odors, air emissions, dust and water pollution common to all potential sites will be controlled by incorporating proper control equipment and facilities into the plant design. Any machinery generating potentially objectionable noise levels will be soundproofed as necessary to reduce noise to acceptable levels inside the plant and at the

FIGURE 5-1

LOCATION OF FOUR POTENTIAL SITES

site boundary. Dust control equipment will be included as part of the design.

The fuel gas produced by the PUROX facility will be combusted at the market or at the PUROX facility. The fuel is similar to natural gas, with approximately one-third the BTU content, and is low in sulfur. It may be used as a replacement fuel or a supplementary fuel. Air pollution from combustion of the gas is expected to be well below acceptable levels. Tests for particulate matter on the PUROX pilot facility at South Charleston, West Virginia showed emissions of 0.008 grains per standard cubic foot (SCF), adjusted to 12 percent carbon dioxide. This value is one-tenth of the emissions allowed in the Federal standards. Since pure oxygen is used in the combustion zone of the converter, oxides of nitrogen are low in concentration when the gas is combusted. If coal or oil is replaced in part or in total by the PUROX gas, a net decrease in air emissions will result from the cleaner burning characteristics of the PUROX gas.

The PUROX process also produces a liquid waste which has a high organic loading and must be treated. Wastewater treatment will be considered as part of the facility design. The wastewater can be discharged to a municipal wastewater treatment plant, however, pretreatment may be required at the PUROX facility. A treatment plant at the PUROX facility could be designed to produce an effluent which will meet all state and Federal discharge limitations if no treatment plant is nearby. In either case, the impact to the receiving waters would be minimal. Wastewater could also be incinerated using a portion

of the PUROX gas. The organics present in the wastewater would therefore be utilized in the combustion process, and the heat generated could be recovered in a waste heat boiler.

Any other environmental impacts would be associated with the specific sites, and are discussed under the respective sections.

5.1.2 Soils. The firm of Converse Ward Davis Dixon (CWDD) was retained by CRVA for preliminary geotechnical evaluation and recommendations regarding subsoil conditions and foundation requirements. All information contained in the sections entitled "Soils" and conclusions pertaining to geotechnical aspects of the sites were extracted from the CWDD report entitled "Preliminary Geotechnical Study, Proposed Pyrolysis Program, Dutchess County, New York", dated February 2, 1979. A complete copy of that report is included as Appendix A. The configuration of the sites as shown in that report are slightly different than the ones described herein. The sites as noted in the CWDD report show the approximate area of the soils survey.

5.1.3 General Construction Needs. Many construction aspects of the PUROX facility will be the same regardless of the selected site. Items common to construction on any of the sites include:

- Receiving and handling equipment

- Front end processing equipment

- Conveyors

- PUROX converters and related equipment

- Oxygen generating equipment

Truck scales

Mechanical equipment layout

Electrical power substation

Building superstructure size

The number and size of these items will be the same, so costs associated with these items will not vary with the potential sites.

Site-specific construction needs will be evaluated for each location. Items which require specific investigations for each potential site include:

Foundations

Grading

Storm water discharge

Access roads

Overall plant layout

Product gas pipeline

Wastewater treatment

Utility needs

Foundation requirements will be based on subsurface soil conditions, as determined by CWDD. Grading, access roads, storm water drainage, and plant layout will vary based on the existing contours of the site and proximity to the main road. The product gas pipeline will have a varying diameter, construction material, and length, depending on the market. An underground pipeline (of varying lengths) would be required if IBM or the Fishkill Correctional Facility is the market. A river crossing, whether under the water or over the Newburgh-Beacon Bridge, will be needed if Central Hudson is the market. The amount of gas to

be sold to the market will determine the pipe diameter.

The wastewater treatment method will be determined by the proximity to a wastewater treatment plant and the amount of gas which can be sold. The utility needs will be determined by the utilities which are available at each site. Potable water and natural gas may not be at the site, and may have to be brought in. An alternative to using natural gas would be the use of propane. Process water may be obtained from the local water supply (if available and cost-effective) or by constructing a pumping station at the Hudson River and treating the water to the desired quality.

These site-specific needs will be discussed under each respective section.

5.2 Arlington Site

The IBM site which was evaluated in the 1975 Bodner Report consisted of two potential parcels of land near the IBM industrial complex in Poughkeepsie. IBM has since added a building and parking lot, and has relocated the access road such that one parcel, which was 3.8 acres, was decreased to about one acre. The other parcel was 9.7 acres, and was the preferred site according to the Bodner Report.

In 1978, the area of the parcels was redistributed to 7.9 and 3.0 acres. Also, IBM presently has plans for developing the two parcels for their own use. Thus, neither of the sites investigated in the 1975 Bodner Report is available.

A parcel of land near the IBM site, which consists of 86 acres, is available for the PUROX facility. This proposed site

is shown as parcel number 710950 on the Town of Poughkeepsie Tax Map Number 6059-02. It was not evaluated in either Bodner Report. This site is adjacent to the Arlington sewage treatment plant, and is referred to as the Arlington site. This site consists of about 11.7 acres, and would be sufficient for the PUROX facility.

5.2.1 Location Analysis. The site fronts on Sand Dock Road, off IBM Road (or Rudco Road), to the west of and less than one mile from Route 9 in the Town of Poughkeepsie. Figures 5-1 and 5-2 show the site. It is in the western center of the core area, south of Poughkeepsie, and is easily accessible to the entire core area by direct haul. This site is presently owned by New York Trap Rock, and is zoned "Recreation-Club", according to the Town zoning map. The parcel and surrounding parcels of land on the east and south are presently vacant. The Arlington sewage treatment plant, which abuts the northern boundary of the site, is less than 1/4 mile south of IBM Road and the IBM industrial complex. It is expected that the PUROX facility will fit in well with existing uses of the land. The land would require rezoning if selected for the site.

Highway accessibility to the site is excellent. Route 9 has a cloverleaf access on Spackenkill Road and a traffic light on IBM Road, both of which are within one mile of the site. Neither access road passes through any residential areas. A potential problem of traffic congestion may exist during hours when IBM employees are going to and from work. This potential problem would probably be minimal since trucks would be bringing

ARLINGTON SITE LOCATION

refuse to the facility primarily during off-peak traffic hours. Details of the traffic analysis are in Section 7.2.3.

5.2.2 Environmental. The Arlington site is generally level, at an elevation of about 70 feet. It is far enough from Route 9 and residences so it will not create any aesthetic problems. Trees will shelter the site from both visual and noise impacts in the immediate area. There exists an excellent natural barrier from residential areas across Sand Dock Road. There, the land rises to an elevation of about 110 feet, then slopes downward, to the residential area. The elevated section is owned by Trap Rock, and will provide a permanent barrier for noise and visual aesthetics from residences.

Wildlife in the area is limited due to the isolation of the site from heavily wooded areas. The heavily developed north-south corridor of Route 9 (east of the site), the Hudson River (west of the site), IBM (to the North) and Trap Rock (to the south) separate the site from other wooded areas. Wildlife which inhabits the area is limited to small animals and various birds.

Construction of the PUROX facility will result in short-term primary environmental impacts associated with similar construction projects. Noise, traffic, erosion and dust problems can be minimized by using mitigating measures during construction. These impacts are temporary and the area will return to normal when construction ends.

Secondary, or long-term environmental impacts are more critical to the project. Once completed, there will be an

increase in truck traffic delivering refuse to the plant. This impact would be minimized by the proximity of the plant to Route 9, which can handle the increased traffic flow which will occur during off-peak hours. Refuse deliveries to the plant would be limited to daytime hours. Any disruption to the local wildlife would be limited to the plant site only.

5.2.3 Soils. The site attains its highest elevation in the eastern central portion, sloping down to the north and south from this central area. There is a saddle in the center of the site, connecting with another topographic high on the western side of the site. Slopes on the western side exceed 40 percent (near the railroad cut), and range from nearly horizontal to about 7.5 percent on the rest of the site.

Based on field reconnaissance, logs of test borings for the existing Arlington sewage treatment plant, and air photo data, the soil conditions are anticipated to be as follows:

1. A thin layer of dense glacial till is present at the surface. The thickness of the glacial till is expected to vary from a few inches to no more than about ten feet. Borings for the existing sewage treatment plant show the till to be no more than about four to five feet deep at that location.
2. Recently, fill was placed over a relatively small area, directly south of the existing sewage treatment plant. The fill appears to be of limited thickness.
3. Bedrock comprising gray shale exists near or at shallow depths below the surface. Bedrock exposures are quite frequent and generally control the topography. The rock

exposures are steeply tilted, and dip to the southeast. Visual observation of the exposed rock surfaces shows that the near-surface material consists of relatively soft slate with frequent thin bedding planes.

Because of the rugged topography of the site, cutting and filling will be required to level the site for development. Blasting will be required for rock removal, and suitable materials will have to be imported from off-site for use in controlled structural fills to achieve final grades.

For the soil conditions encountered, shallow foundations could be used for support of the structure and equipment. The foundations could be supported on rock and/or glacial till and controlled structural fill. However, the dynamic loads that would be generated by some equipment make it desirable to support the foundations for this equipment on rock to minimize the overall effects of the vibrations on the facility. Floor slabs could be supported on grade in the glacial till and/or controlled structural fill. Allowable bearing pressures for the foundation design would be as follows:

1. Controlled Structural Fill - 6.0 KSF (kips per square foot)
2. Glacial Till - 6.0 KSF
3. Rock - 16.0 to 24.0 KSF

The site appears to drain quite readily and there is no evidence of springs or ponding of water on the site. Therefore, control of groundwater during and after construction would not be expected to present any problems.

5.2.4 Site-Specific Construction Requirements. A shallow depth to bedrock exists at the Arlington site. Shallow foundations could be supported on rock or glacial till, and floor slabs could be constructed on grade. The proximity of rock to the surface, however, becomes a disadvantage for grading. Rock excavation for relatively deep cuts is expected to be costly. The relatively level site is amenable to truck travel and overall site layout. Storm water would be drained to a common point on the western side of the plant and discharged to the Hudson River.

The access road would be Sand Dock Road, which dead ends several hundred feet past the site. Sand Dock Road is a narrow road from the Arlington sewage treatment plant on the north to the end of the site on the south, and would require improvement. The entire road from the PUROX facility to IBM Road would be widened to accommodate two - direction traffic consisting primarily of refuse trucks. Only minor amounts of regrading would be needed for the entire length of the road.

The railroad cut on the western portion of the site results in an escarpment for much of the length of the property. This limits the amount of usable land and affects plant layout.

The product gas market at the Arlington site, could be either IBM or Central Hudson. If IBM is the market, a short gas pipeline (about one-half mile) would be needed. If Central Hudson is the market, a pipeline would be constructed under the Hudson River (approximately 3000 feet) and along the river bank to Danskammer Point (about 6 miles).

Although the Arlington sewage treatment plant is on the adjacent parcel of land, PUROX wastewater treatment would probably be effected by incineration and would therefore not require a large diameter sewer pipeline between the two plants. The sewer would be for domestic wastewater and small amounts of process wastewater.

Potable water is available from the town approximately 3000 feet from the site, and a water line would have to be extended to the plant. A small water line from IBM provides potable water to the Arlington sewage treatment plant. It may be possible to obtain permission to tap into that line, provided the water demand is compatible with the amount available. Process water would be obtained from the Hudson River via a pumping station to be installed as part of the PUROX facility. The pumping station could be located on the same land parcel as the PUROX facility. Natural gas is available several thousand feet away, and a pipe would have to be extended to the plant. As an alternate, propane gas could be used as an auxiliary energy source. Electrical power is available at the intersection of Sand Dock Road and IBM Road. Power lines would be extended from the utility's power substation to the plant's substation.

5.3 Trap Rock Site

The Trap Rock site was selected for the PUROX facility in the 1976 "Dutchess County Pyrolysis Program Preliminary Engineering" (Bodner) report. New York Trap Rock owns over 1,000 contiguous acres of land in the Town of Poughkeepsie.

This potential site consists of approximately 15 acres in the southern portion of that property, noted as parcel number 800100 on the Town of Poughkeepsie Tax Map Number 6059-04.

5.3.1 Location Analysis. This site is in the Town of Poughkeepsie, about 2 miles west of Route 9, as shown on Figures 5-1 and 5-3. It is part of the Trap Rock property, and access to the plant would be either through Trap Rock's existing private road or on a new road which would have to be constructed. Truck traffic would probably be routed along Sheafe Road (a medium-duty road) to the Trap Rock access road and into the plant site. The land is zoned "Industrial", according to the Town zoning map. Gravel is presently being quarried on the Trap Rock property. However, the potential site is on a wooded hillside which has not been quarried.

Highway accessibility to the site is fair. The roads that would be used by refuse trucks to get from Route 9 to the plant are presently heavily travelled by large trucks carrying stone from the quarry. Refuse truck traffic would be compatible with existing road usage. Only a few residences would be passed in travelling from Route 9 to the potential site.

The site is approximately midway between the Cities of Beacon and Poughkeepsie, in the western part of the County. It is easily accessible to all core area municipalities by direct haul. A disadvantage to this site is that it is completely surrounded by Trap Rock property. All accesses, including pipelines to the river for water, or to the market for gas,

TRAP ROCK SITE LOCATION

would require extensive easements from New York Trap Rock Corporation.

5.3.2 Environmental. The Trap Rock site slopes upward fairly uniformly from west to east at about a 15 percent slope. Elevations range from about 60 feet to 200 feet. The site is wooded, and is surrounded on the north and west by an active gravel quarry. A wooded hillside continues to rise to an elevation of about 250 feet near Sheafe Road, where the nearest residences are located to the east. The site therefore has an excellent natural barrier to shield the residential area from activity at the facility.

Wildlife is limited to small animals and birds due to isolation of the site. Route 9 to the east, the Hudson River to the west, and the Trap Rock quarry to the north of the site restrict the migration of animals through the area and lower the habitability of the site.

Short-term primary environmental impacts of construction will be comparable to those associated with similar construction projects. Noise, traffic, erosion and dust problems can be reduced by using mitigating measures during construction. The impacts are temporary, and will end when construction is complete.

The main secondary environmental impact will be the increased truck traffic along Sheafe Road and Route 9. Refuse vehicles should not have a severe impact since the roads are already heavily travelled by trucks going to and from the Trap Rock quarry.

5.3.3 Soils. The eastern portion of the site exists in its natural state and slopes downward to the west. The western portion of the site consists of an old sedimentation pond which was associated with the quarry to the north. The pond has been filled to approximate elevation 60.

Based on field reconnaissance, logs of borings, and air photo data, the soil conditions are anticipated to be as follows:

1. The old sedimentation pond has been filled with loose sediments from the quarry operation over a period of many years. The pond had probably been previously mined for sand and/or rock, and the loose sediments in the pond may be as much as 100 to 125 feet deep, based on observations in the quarries still in operation.

2. Dense glacial till is present at the surface in the eastern portion of the site. The glacial till is typically on the order of eight to ten feet deep, but is as much as 18 feet deep in the southern portion of the site. The till is expected to consist of a heterogeneous mixture of sand, gravel and boulders with varying percentages of silt and clayey silt.

3. Bedrock consisting of shale underlies the glacial till, and probably the sediments in the old pond.

There is an electrical transmission line crossing along the eastern portion of the site. The area available for development is west of the right-of-way for the transmission line. From a geotechnical engineering standpoint, two different methods of site development would have to be considered for the site, as follows:

1. Immediately west of transmission right-of-way: This includes a narrow strip (about 450 feet wide), still in its natural state, sloping downward to the west at about 15 percent. Dense glacial till is at the surface to depths on the order of 10 to 20 feet, with shale and possibly dolomite (bedrock) below the till. However, there are indications of relatively shallow rock at the higher elevations. Significant cuts into the hillside would be required to develop this area and a substantial amount of blasting for the rock excavation would be necessary. Rock cuts as deep as 30 feet may be required to develop a building site about 300 feet wide, based on a final site grade of elevation 70. Side slopes on the order of 1:3 (horizontal:vertical) would be required for the rock, and about 2:1 for the overlying glacial till.

2. Sedimentation Pond: The loose sediments in the pond have no presumptive bearing value, and deep foundations (piles) would be required to support structures and equipment in this area. The depth to the bottom of the loose sediments would have to be confirmed with borings.

Spread footings bearing in the natural materials could be used to support building and equipment foundations in the area immediately west of the right-of-way of the transmission line, with all floor slabs supported on grade. The allowable bearing values for footings are as follows:

Glacial Till - 6.0 KSF

Bedrock - 24.0 KSF

Piles driven to rock with design capacities up to 240 kips could be used to support the facility (foundations and

floors) in the pond area. Borings would be necessary to determine the depth of the loose sediments in the ponds. However, based on observations in the rock quarries still in operation, it is likely that the unsuitable materials in the pond could be as deep as 100 to 125 feet.

Foundation construction costs will be relatively high for this site. An economic comparison of the cost of site development and foundation construction for the two separate and distinct subsurface conditions would have to be made after borings in the pond are completed.

There is evidence of some channelized stream flow across the site, which may be the result of springs. Therefore, some flow through the joints where excavations are made into the rock can be anticipated. The flow should not be significant, and perimeter and/or underdrains would be provided to intercept and remove the water by gravity drainage.

5.3.4 Site-specific Construction Requirements. Significant cuts into the hillside are required for a building of the size anticipated according to the soils analysis. Spread footings could be used on the hillside, while piles are required for construction over the sedimentation pond. Foundation construction would be difficult and costly for this site. Regrading the site to provide access to all equipment would also be difficult on the hillside, due to the 15 percent slope. The site would be terraced similarly to that proposed in the Bodner Report. Storm water would be collected and discharged to the Hudson River.

Access to the plant from Route 9 would be on Spring Road to Sheafe Road, both medium duty, two-lane roads. From Sheafe Road, access would be along the privately owned Trap Rock access road. A right-of-way would be needed for the County to use this road.

The overall plant layout would probably be different from the other sites to minimize rock excavation. The terracing could make vehicular access to various parts of the plant difficult.

The product gas market at the Trap Rock site could be either IBM or Central Hudson. The IBM gas pipeline would be about three miles long. The Central Hudson pipeline would require a 4000-foot river crossing and four-mile land crossing. Wastewater incineration would probably be the preferred method of disposal, since no sewage treatment plant is nearby.

Potable water facilities are available approximately one mile from the Trap Rock site, and a pipeline would be extended to the plant. Process water would be obtained from the Hudson River via a pumping station to be installed as part of the PUROX facility. This would require a small parcel of land adjacent to the river, and an easement approximately 2000 feet in length through Trap Rock property to the plant. Natural gas is not available. A line would have to be extended to the plant, or propane could be used for an auxiliary energy source. Electrical power could be made available on the site, and would be connected to the plant's substation.

5.4 Beacon Landfill Site

This site was not evaluated in either the 1975 or 1976 Bodner Report. It consists of two parcels totalling 16.6 acres. The potential site is noted as parcel number 660374 (6.5 acres) and parcel number 679329 (10.1 acres) on the City of Beacon Tax Map Number 5954-15. Figures 5-1 and 5-4 show the potential site. Both parcels have been and are currently used as a landfill. Until recently, refuse was incinerated in the adjacent Beacon Incinerator, while commercial and industrial trash, and special wastes, such as demolition waste, trees and brush, and other non-putrescible materials were landfilled. The Beacon Incinerator is now inoperative, so all putrescible refuse is transported to the Orange County landfill in Goshen. The Beacon Landfill still accepts trash.

5.4.1 Location Analysis. The site is at the terminus of the City access road to the landfill. There is no thru traffic on the access road. The Beacon wastewater treatment plant and the presently inoperative incinerator are adjacent to the landfill. The potential site is zoned "light industrial", according to the City zoning map. The municipal use of the adjacent property makes the PUROX facility compatible with the present land use. Property adjacent to the eastern side, however, is residential. This could cause environmental, aesthetic, and public acceptance problems.

The site is in the southwesternmost section of the County. Access from the southern core area can be accomplished

BEACON LANDFILL SITE LOCATION

easily by direct haul, while northern core area municipalities may require transfer stations.

Highway accessibility to the site is poor. Route 9D is the nearest main highway, about one mile to the northeast of the site, through a residential area. Trucks coming from the north could use Route 9D, a two-lane road which passes through several residential areas. An alternative is the less direct Route 9, a four-lane highway which meets Route 84 about five miles east of Route 9D. In either case, several miles of roads passing through heavily populated residential areas must be used. Refuse trucks presently use this route to arrive at the landfill. However, there would be a significant increase in truck traffic through the City of Beacon if this site is selected. This could cause localized traffic problems.

5.4.2 Environmental. The Beacon Landfill site is generally level, at an elevation of about 40 feet. A residential area abuts the site on the eastern boundary. The western and southern property boundary is adjacent to the north-south MTA railroad property along the Hudson River and a Conrail Corp. spur along Fishkill Creek. The Beacon wastewater treatment plant abuts the site on the north. Possible adverse visual and noise impacts on the neighboring residential area are of great concern with respect to this proposed site.

There is presently little wildlife in the site area. The Hudson River and Fishkill Creek on the west and south, and the proximity of developed areas to the north and east form natural barriers to wildlife migration. Since the parcel is used for a

landfill, there is little ground cover to provide shelter for wildlife.

5.4.3 Soils. The site slopes downward to the west at an average slope of about ten percent. The western portion is fairly flat, having been substantially altered in recent times by the placement of fill materials. Aerial photos dated April, 1967 show that lakes covered about 60 percent of the site before the existing landfill was placed. The site has been filled to approximately 20 feet above the level of the adjacent sewage treatment facility.

Based on field reconnaissance, logs of borings, and air photo data, the soil conditions are anticipated to be as follows:

1. Sanitary landfill materials are below the surface, in the range of 20 or more feet deep. Older fills comprising bricks, cinders, etc., also may be present below the sanitary landfill.
2. Varved clays and silts are below the landfill, with the bottom of the stratum extending to about 60 to 100 feet below the surface. The materials are potentially compressible and would be unsuitable to support the foundation loads.
3. Glacial till, which is an excellent stratum to support deep foundations, is below the varved clay.
4. Bedrock comprising shale is below the glacial till.

The significant depth of the existing sanitary landfill and underlying miscellaneous fill precludes the excavation and replacement of these materials with a controlled structural fill to support the facility on shallow foundations. Therefore, deep

foundations (piles) bearing in the competent underlying strata will be required to support the building and equipment loads.

The piles for foundation and floor support will have to be founded in the dense glacial till and/or the underlying bedrock. Design capacities of up to 120 kips would be appropriate for piles founded in the glacial till, and up to 240 kips for piles founded on rock. The existing fill will consolidate and settle with time, resulting in negative skin friction and "downdrag" on the piles. The net capacities for design will have to be reduced to account for the "downdrag". The pile types which could be considered for the project would include: concrete-filled pipe or shell piles, steel H-piles and pre-cast concrete piles. The potential corrosivity of the materials in the landfill may cause extensive and costly corrosion protection methods to be required for pipe and steel H-piles.

Groundwater at the site would be controlled by the level in the adjacent Hudson River. Since the site has been filled to levels substantially higher than the river, groundwater control should not be a significant factor for the proposed development and construction.

The sanitary landfill is expected to generate combustible gases and, therefore, a gas collection and positive venting system is required below all equipment foundations and floor slabs.

5.4.4 Site-specific Construction Requirements. Special foundations using corrosion-resistant piles are needed due to

the material in the landfill. The entire plant would rest on these piles. Gas venting equipment will also be needed under the buildings due to the combustible gases generated in the landfill. Final grading of the area could be easily accomplished due to the level nature of the land. Storm water would be collected and discharged to the Hudson River.

The access road is in good condition, since it already serves the incinerator and sewage treatment plant. The last few hundred feet should be regraded and paved, however, to handle increased truck traffic.

The plant would require no special layout, since the land is larger than the other sites and is flat. Sufficient area should be left on the east to allow for a large buffer zone to isolate the plant from the residences.

The product gas market at the Beacon Landfill site could be the Fishkill Correctional Facility or Central Hudson. A gas pipeline approximately three miles long to the power plant of the Correctional Facility would be needed. Approximately six miles of land pipeline to the Danskammer Power Plant, with a one mile span crossing on the Newburgh-Beacon Bridge would be required if Central Hudson purchases the gas.

Potable water, power and natural gas are available nearby, and service would have to be extended to the site. Propane gas could be used as an auxiliary energy source. Process water is available from the Hudson River via a pumping station which would be included as part of the facility design.

5.5 Area Opposite Danskammer Point

Two potential areas opposite Danskammer Point were evaluated in the 1975 Siting Study. These are the New Hamburg Site and the Chelsea Site.

The New Hamburg Site was described in that report as being a four-acre parcel along the Hudson River. The conclusions of the Bodner Report were that (1) refuse trucks moving along the narrow residential streets in New Hamburg would create hazardous and undesirable conditions; (2) the access roads are not adequate; (3) the surrounding land is residential and recreational; (4) construction would be difficult and expensive (due to a steeply rising bluff); and (5) the pyrolysis plant would have an adverse impact on the environment peculiar to the particular area.

Personnel from Dutchess County and CRVA visited the site, and were in agreement that the conclusions of the Bodner Report were accurate, and that the adverse impacts well outweighed the benefits which could be derived from using the site. The site was therefore eliminated from further study.

The precise location and size of the Chelsea Site were not discussed in the 1975 Siting Study. The site was reported to have generally favorable characteristics for construction of the PUROX facility. The disadvantage of truck traffic on narrow local streets could have been avoided by construction of a new access road.

Personnel from Dutchess County and CRVA visited the area of the Chelsea site. The precise location was not apparent, and no specific suitable site could be identified in the immediate

vicinity of Chelsea. The area between New Hamburg and Chelsea was also visited, and no specific suitable site could be found across from the Danskammer Plant. The terrain of that area consists of steeply rising hills with poor access from the main roads. Despite the advantage of the proximity of a year round potential user of energy, the area was not considered to be suitable for construction of a PUROX facility, and was not evaluated further.

5.6 Gas Consumption of Potential Markets

Three markets have been identified as potential consumers of gas produced by the Dutchess County PUROX facility. These include Central Hudson Gas & Electric Corporation's Danskammer Point Generating Station, the Fishkill Correctional Facility in Beacon, and the IBM industrial complex in Poughkeepsie. An analysis of the compatibility of the potential gas markets with the output of the plant must be done prior to recommending a site. Recent data was collected from the three potential gas customers regarding energy use during the year. This data was evaluated and compared with the anticipated output of the PUROX facility.

The PUROX facility is expected to produce about 100 million BTU's per hour (MBTU/hr) of salable energy when both converters are operating at full capacity. When one unit is operating, half of that amount could be sold. Two units will operate 75 percent of the time, and one unit will operate 25 percent of the time on an annual average basis. Most of the down time is for scheduled maintenance, and can be performed

when the energy demand is low. The potential markets have expressed some concerns associated with purchasing the gas. These concerns are addressed in Section 6.1.

5.6.1 Central Hudson Gas & Electric Corp. Central Hudson owns and operates the Danskammer Point Generating Station on the western side of the Hudson River, across from New Hamburg. This could be the product gas market from any of the three potential sites. Central Hudson has indicated that it is willing to purchase all of the gas produced by the PUROX facility for use in its Danskammer plant to produce electricity. The amount of energy consumed at the Danskammer plant is well in excess of that which will be produced by the PUROX facility. There will be no problem with compatibility of gas production and usage if Central Hudson purchases the gas. One hundred percent of the gas produced by the facility is assumed to be salable to Central Hudson.

5.6.2 Fishkill Correctional Facility. The Fishkill Correctional Facility comprises the northeastern corner of the City of Beacon and the adjacent land in the Town of Fishkill. Data pertaining to oil consumption was obtained from the facility for the period July, 1978 through February, 1979.

The average energy use during the three winter months is approximately equal to the average supply from the PUROX facility. The average use drops to about 20 percent of the potential supply during the summer months. Assuming a linear change between summer and winter demands, the maximum usage by

the Fishkill Correctional Facility would be about 60 percent of the annual energy output from the PUROX facility. The actual use would be less, depending on scheduled and unscheduled down times at the PUROX facility, refuse delivery rate, weather severity during the winter months, and daily fluctuations in energy demand.

It is not desirable, from an economic or environmental standpoint, to produce such a large quantity of gas with a projected beneficial use of fifty percent of the output. The Fishkill Correctional Facility's gas usage is not compatible with the gas production from the PUROX facility. The Fishkill Correctional Facility will not be considered further as a viable primary gas market. Central Hudson's Danskammer Power Plant will be the market if the Beacon Landfill site is selected for construction of the PUROX facility.

5.6.3 IBM Corp. The IBM industrial complex is about one-half mile north of the Arlington site and 2-1/2 miles from the Trap Rock site in the Town of Poughkeepsie. IBM uses steam for heat in the winter, and steam or electrical power to drive air conditioning compressors during the summer months. Energy for steam production is provided by No. 2 fuel oil or natural gas. IBM is planning to install a waste paper incinerator, which will reduce their purchased fuel requirements somewhat.

Table 5-1 shows IBM's energy requirements for 1978, the energy produced by the PUROX facility, and the estimated amount of pyrolysis gas which could be used by the IBM plant. The theoretical PUROX gas usage amounts to approximately 95 percent

TABLE 5-1
IBM POUGHKEEPSIE PLANT
ENERGY REQUIREMENT - 1978

(in million Btu's)

	<u>IBM Plant Requirements</u>	<u>Energy Equivalent of Steam From Paper Incineration</u>	<u>Energy Produced Pyrolysis Plant</u>	<u>Pyrolysis Energy Useable at IBM Plant</u>
January	65,000	2,000	65,000	58,000
February	62,500	2,000	59,000	55,000
March	57,500	2,000	61,500	55,000
April	45,000	2,000	59,500	42,500
May	40,000	2,000	54,000	37,500
June	72,000 (42,500)*	2,000	63,000	62,000
July	74,500 (37,500)*	2,000	65,000	64,000
August	74,000 (32,500)*	2,000	65,000	64,000
September	32,500	2,000	52,500	31,000
October	40,000	2,000	54,000	37,500
November	50,000	2,000	59,500	45,000
December	70,000	2,000	65,000	60,000
TOTAL	683,000 (112,500)*	24,000	723,000	611,500
Summer Peak	221,000	6,000	193,000	190,000
Remainder	462,000	18,000	530,000	421,500

Pyrolysis Plant Utilization Rate $\frac{611,500}{723,000} = 0.85$

IBM Plant Pyrolysis Gas Utilization $\frac{611,500}{683,500} = 0.90$

Theoretical Gas Utilization $\frac{683,500}{723,000} = 0.95$

*Actual Fossil Fuel Usage

of IBM's annual plant requirements. The actual usage is projected to be closer to 90 percent. This lower value represents 85 percent of the total gas produced by the plant, and will be used to project plant economics. It is desirable to sell the total amount of gas produced by the facility. An economic analysis indicates that it is more desirable to construct a short pipeline to IBM and sell less than the total amount produced, rather than a long pipeline to the Danskammer Power Plant and sell all of the gas. Additional smaller markets for the product gas will be evaluated if IBM becomes the market for the gas and it is found that excess gas is flared on a regular basis.

5.7 Site Selection

Table 5-2 summarizes existing conditions at the three potential sites. The Beacon Landfill site shows no advantages that the other sites do not have. The disadvantages of the proximity of residences, poor access, distance to market and poor geotechnical conditions requiring expensive foundations make the site undesirable for the PUROX facility.

The Arlington and Trap Rock sites are comparable in many respects. They are both on property owned by New York Trap Rock. The Arlington site is in the northern part, while the Trap Rock site is two miles to the south, in the southern part of the property. Both are screened from view of residences and are compatible with adjacent land use, although the Arlington site would require rezoning. Both could pipe the product gas either to IBM or across the Hudson River to the Danskammer Power

TABLE 5-2

SUMMARY OF SITE CONDITIONS

<u>LOCATION:</u>	<u>ARLINGTON</u>	<u>TRAP ROCK</u>	<u>BEACON</u>
In core area	Central	Central	Southern
Distance to Main Highway	1 Mile	2 Miles	2 Miles
Distance to Potential Fuel Markets	1/2 to 7 Miles	2-1/2 to 4 Miles	7 Miles
Size of Parcel	11.7 Acres	10-15 Acres	16.6 Acres
<u>LAND USE COMPATIBILITY:</u>			
Present Parcel Zoning	Recreat Club	Industrial	Light Industrial
Surrounding Zoning	Quarry/Indus.	Industrial	Residential/Indus.
Nearest Residences	2000 ft.	1000 ft.	Adjacent
General Aesthetics	Excellent	Excellent	Fair
<u>AVAILABLE FACILITIES:</u>			
Access Road	Excellent	Fair	Fair
Potable Water	Nearby	Nearby	On-Site
Process Water	Hudson River	Hudson River	Hudson River
Power	Nearby	On-site	On-site
Wastewater Treatment Plant	Adjacent	2 Miles	Adjacent
<u>GEOTECHNICAL:</u>			
Topography	Fairly level	15% Slope	Fairly level
Soils	Till-5 ft.	Till-10 ft.	Landfill, clay 80 ft.
Subsurface Conditions	Gray Shale	Shale	Shale
Groundwater/Runoff	None	Springs	None
Foundation Requirements	Footings on rock, slab on grade	Spread Footings Slab on Grade	Piles

Plant. The Arlington site would be heavily favored, should IBM be the market for the energy. The gas pipeline would be approximately two miles shorter at the proposed Arlington site. Also, the access road is better and the main highway closer with the Arlington site.

The Arlington site is also more level and construction would be easier than on the Trap Rock site. The Arlington site would appear to be most favorable for the planned construction from a geotechnical engineering standpoint. Shallow foundations could be used to support the buildings and equipment, and the floor slabs could be supported on grade. Moreover, the relatively shallow depths to bedrock would simplify the design and reduce construction costs of the foundation for equipment imposing dynamic loads. Additional investigations, including field explorations and laboratory testing, will be required to define accurately the soil conditions when the detailed facility design begins.

The Arlington site is by far the best of these sites for the PUROX facility, and is recommended for the plant location.

6. END PRODUCTS

All refuse processing facilities result in both desired and undesired end products which must be disposed of. Desired end products are those which have a value and may be marketed to produce revenues. Undesired end products usually have little or no value, and may require special handling, thus incurring additional costs for disposal. The PUROX facility, when operating under normal conditions, will produce six end products. These include: product gas, ferrous metal, slag, wastewater, gaseous nitrogen, and solid waste. Figure 6-1 shows a mass balance of the proposed PUROX facility based on one ton of raw solid waste delivered to the plant. Table 6-1 describes the specification of refuse that is to be delivered to the PUROX converter feeder. That specification identifies the physical properties of preprocessed refuse which are pertinent to its suitability for use in the PUROX converters. Certain constraints are placed upon these physical properties, where appropriate, to assure reliable long-term operation in accordance with the existing design goals of the process. All end products, whether produced continuously or intermittantly, and whether used or discarded, are shown. The origin, quantity, characteristics, and ultimate disposal method for each of these end products are discussed in the following sections.

6.1 Product Gas

Pyrolytic reactions which occur in the converter of the PUROX system cause the gasification of the organic portion of

FIGURE 6-1

STEADY-STATE MASS BALANCE
(One ton input basis)

TABLE 6-1

PUROX SYSTEM REFUSE SPECIFICATION (1)

<u>SIZE:</u>	The refuse shall have a nominal 10 inch size (98 percent by weight equal to or less than 10 inches maximum dimension and less than 1 percent larger than 14 inches maximum dimension).
<u>MIXING:</u>	The refuse shall be well mixed.
<u>BULK DENSITY:</u>	The refuse shall have an average bulk density of not less than 3.0 pounds per cubic foot over any two hour period.
<u>COMPOSITION:</u>	<p>(Percentages based on weight)</p> <ul style="list-style-type: none">a. Water content shall not be less than 10 percent nor greater than 35 percent over any two hour period.b. Ferrous metal content shall not exceed 5 percent.c. Glass content shall not be less than 3 percent nor greater than 20 percent over any two hour period.d. The minimum higher heating value (HHV) shall be 3750 BTU/lb.
<u>PROHIBITED MATERIAL:</u>	<ul style="list-style-type: none">a. Material which could present a health hazard is not acceptable.b. Explosives or confined materials with high explosive potential are not acceptable, including ammunition.

(1) Data obtained from Union Carbide Corporation

municipal refuse. The resulting gaseous mixture is high in carbon monoxide, carbon dioxide, and hydrogen, and can be used as a medium BTU fuel gas.

The gas mixture, as it leaves the converter, contains water vapor, oil mist formed by the condensation of high-boiling organics, and fly ash. The oil mist and fly ash solids are removed by a gas cleaning system and recycled. After cleaning, the product gas is passed through a condenser. The resultant dry gas is a clean-burning fuel, comparable to natural gas in combustion characteristics. The heating value of the gas is approximately 370 BTU per standard cubic foot. This recovered gas can be used effectively as a fuel in existing steam generating equipment or other fuel-consuming operations, usually without downrating the generating capability or making extensive and costly modifications. The gas is low in sulfur and contains only about one-tenth the amount of fly ash allowable under federal air quality standards. Table 6-2 shows the dry fuel gas characteristics as reported by Union Carbide Corporation, based on extensive test work at South Charleston.

Approximately 6.6 million BTU could be available in the product gas from processing one ton of raw refuse containing an average heating value of 4,700 BTU per pound, or 9.4 million BTU per ton. Nearly 18,000 cubic feet of gas at 370 BTU per cubic foot could be produced by one ton of raw refuse. The plant could produce over seven million cubic feet of gas, the energy equivalent of over 400 barrels of No. 2 fuel oil, per day, when it is operating at its design capacity of 400 tons per day.

TABLE 6-2

PUROX FUEL GAS CHARACTERISTICS (1)

<u>GAS ANALYSIS AT 60°F, 1 atm.</u>	<u>PERCENT VOLUME</u>	
	<u>TYPICAL</u>	<u>RANGE</u>
H ₂	23.6	21-23
CO	38.3	29-42
CO ₂	23.6	20-34
CH ₄	5.9	4-7
C ₂ H ₂	0.7	0.2-1.5
C ₂ H ₄	2.06	1-3
C ₂ H ₆	0.3	0.1-0.5
C ₃ H ₆	0.3	0.02-0.7
C ₃ H ₈	0.2	0.1-0.6
C ₄	0.5	0.1-0.8
C ₅	0.4	0.1-0.6
C ₆ H ₆	0.3	0.1-0.6
C ₇ H ₈	0.1	0.05-0.15
C ₆ ⁺	0.2	0.1-0.7
N ₂	1.0	0-1.5
Ar	0.5	0-0.5
O ₂	0.1	0-0.2
H ₂ S	0.05	.02-.06
CH ₃ OH	0.1	0.05-0.15
ORGANIC VAPORS*	0.15	0.1-0.4
H ₂ O	1.64	1-2

(1) Data obtained from Union Carbide Corp.

* Higher alcohols, aldehydes, ketones, organic acids

Sale of the product gas to a public utility or institution or to a private corporation will result in differing advantages and disadvantages to the users. The advantage common to all users is the source of a competitively priced fuel that can replace oil, gas, or coal. The PUROX gas, being low in particulates and sulfur, results in lower emissions of particulate and sulfur compounds, making federal and state air quality emission standards easier to meet if coal or oil is replaced. The potential beneficial publicity for becoming involved with resource recovery and energy conservation may also be attractive to the gas user. The disadvantage common to all users is the risk of process problems and process unknowns, since no commercial PUROX installations presently exist. While these risks appear to be minimal due to the extensive large scale demonstration and development work carried out by UCC, it is true that long term operating data relating to reliability and variations in the heating value of the gas from a full scale plant does not exist. Other advantages and disadvantages are specific to the user.

6.1.1 Central Hudson Gas & Electric Corp. Of the two potential major markets, Central Hudson has the least amount of risk associated with accepting the gas. It is in the business of selling energy, and has offered to purchase the fuel for 95 percent of the value of the lowest cost available form of energy during a monthly period. Central Hudson is therefore guaranteed that the cost for PUROX gas is less than any other source available at a given time.

There is also a minimal incentive for Central Hudson, since their rates are regulated, and any savings incurred by burning PUROX gas would be passed along to all its customers in several counties. This would appear at first to be an additional economic benefit for those people living in Dutchess County. However, revenues for the PUROX facility would be lower due to the energy cost savings by Central Hudson. The decreased revenues would result in a higher tipping fee for those using the PUROX facility. The higher fee would be paid by those residents of the core area of Dutchess County. In short, any savings incurred by core area residents in lower electric rates would be more than offset by the increased tipping fee for refuse disposal.

There is an excellent load match between this proposed plant and the utility, since the amount of energy consumed by Central Hudson is well in excess of that produced by the PUROX facility. All available PUROX gas could be combusted at Central Hudson. PUROX facility shutdowns would have a minimal effect on Central Hudson's operation, since Central Hudson has alternate energy sources available at all times.

In summary, Central Hudson has expressed a positive interest in purchasing the PUROX gas. The incentive for them is primarily energy conservation through resource recovery, resulting in better public relations.

6.1.2 IBM Corp. Considering capital and operating costs, a PUROX facility at the Arlington site that generates gas for the IBM industrial complex in Poughkeepsie is the most

cost-effective means of utilizing energy from solid waste in Dutchess County. There are a number of considerations that must be addressed before a contractual relationship between the PUROX facility and IBM can be consummated.

IBM believes it will be required by Department of Energy (DOE) regulations to reduce its present oil and natural gas usage at the Poughkeepsie complex and convert to coal firing. This will entail considerable capital expense for new boiler equipment, coal receiving and handling equipment, and ash handling and disposal equipment. The same goal of reducing oil and natural gas consumption without the major capital expenditures to IBM can be accomplished by purchasing PUROX gas. Preliminary discussions with the DOE indicate that a long term contract for using PUROX gas might be considered to be reasonable grounds for relieving IBM of the requirement to convert to coal. This possibility will be explored as the project proceeds.

A disincentive for IBM to use PUROX gas is that the PUROX facility would be the major source of fuel energy for the IBM industrial complex, and IBM would be the major customer of the PUROX facility. Problems in availability or reliability of the PUROX gas would have a profound impact on energy usage and operations at IBM. This is a concern that can be overcome only by demonstrating that the PUROX facility contains sufficient redundancy and time-tested equipment to be reasonably certain that fuel interruptions will be infrequent and of short duration.

IBM recognizes that, as private industry dealing with a local government or authority, it must pay the full and true value of the energy purchased. Any contractual agreement must be clearly stated so that IBM can not be perceived to have any "windfall" advantages at the expense of local residents. An extensive public awareness and public participation program must therefore be implemented for this project to proceed with IBM as the customer.

IBM is concerned that PUROX gas could adversely affect the life and maintenance cost of the existing boilers and that toxic materials could appear in their boiler stacks. Test data to date do not bear out a cause for concern. However, appropriate contractual guarantees and insurance provisions would be included in any contract between the PUROX facility and IBM.

IBM is concerned about the impact of the refuse vehicle traffic on automobile traffic in and around the IBM complex. A traffic count was made and the results are discussed in Section 7.2.3. Truck traffic can be largely limited to the off-peak hours between the morning and evening rush hours to the IBM plant.

6.2 Ferrous Metal

Ferrous metal accounts for about seven percent by weight of incoming raw refuse. The PUROX facility will include primary magnetic separation of ferrous metals as part of the design. Some magnetic separation is required to meet the UCC refuse specification as shown in Table 6-1.

Questionnaires were sent to 14 dealers who purchase recovered ferrous metals, to obtain product specifications and anticipated purchase prices. A summary of the ferrous metal marketing survey is given in Table 6-3. Three firms responded to the questionnaire. Follow-up telephone calls and mailings to those who did not respond resulted in one additional response. Two responses were from detinning plants, neither of which had equipment installed in the area, and could not be considered viable markets at this time. Two responses were from local scrap dealers. A meeting was held with the scrap dealers to discuss the quality and quantity of the material that could be expected to be produced. The dealers indicated that the material would not be marketable, and thus declined to offer a suggested purchase price. The discouraging results of the marketing survey indicate that the ferrous metal is not salable at this time. If the PUROX converter can not process the ferrous component of the refuse stream, ferrous metals will be removed from the waste stream by the magnet and landfilled. A processing area is allocated for additional equipment, so that the metal can be cleaned and sold if an economically attractive market should develop in the future.

6.3 Slag

The temperature generated in the hearth of the PUROX reactor is sufficiently high to melt and fuse most noncombustible materials. The molten material continuously overflows from the hearth into a water quench tank where it forms a hard, sterile granular slag. The slag represents two to

TABLE 6-3

FERROUS METAL MARKETING SURVEY RESULTS

NAME OF FIRM (Responding to Questionnaire)	Min. Percent Fe	Condition of Material	Density (Lb/CF)	Min Amt. (TPD)	Max Amt. (TPD)	Revenue/Comments
MRI Corp. Clark, N.J.	90	loose	30 (max)	-	-	\$11.60/No. 2 Bundle (1), (2)
Wisconsin Metal & Chemical Corp Milwaukee, Wis.	95	loose	20-24	15	-	No price offered, (2)
Beacon Salvage Co. Beacon, N.Y.	-	baled	-	-	-	No price offered, (2)
Charles Effron & Son Poughkeepsie, N.Y.	-	-	-	-	-	Not marketable

Firms Not Responding to Questionnaire

Aaron's Scrap Metal Poughkeepsie, N.Y.	Kingston Recycling, Inc. Kingston, N.Y.	Al's Scrap Iron & Metal Peekskill, N.Y.
B & L Salvage Beacon, N.Y.	P & D Surplus Kingston, N.Y.	B. Millens Sons (3) Kingston, N.Y.
Bridge City Scrap Metals Poughkeepsie, N.Y.	Saturn Scrap Metal, Inc. Poughkeepsie, N.Y.	
Consolidated Iron & Metal Co. Inc. Newburgh, N.Y.	Vulcan Materials Co. Sanduski, Ohio	

- (1) FOB PUROX facility
 (2) Processing Equipment for Recovered Ferrous Metals Presently Not Installed
 (3) Affiliated with Charles Effron & Son

three percent of the volume and 15 to 20 percent of the weight of incoming refuse, depending upon the amount of noncombustible material in the raw refuse.

As shown on Figure 6-1, it is estimated that an average of 366 pounds of slag would be produced per ton of raw refuse. Thus, when the plant is operating at 400 tons per day, approximately 73 tons per day of slag will be produced.

Table 6-4 shows an analysis of the PUROX slag as reported by Union Carbide Corporation. The slag is primarily a product of the glass in the refuse fused with minor quantities of metals and ash from the combustible components.

Nine questionnaires were sent to industries which might be interested in purchasing the slag. Four responses were received. Three were interested in purchasing all of the slag produced by the plant. Commitments to purchase the slag ranged from sixty cents per ton (picked up) to three dollars per ton (delivered). The results of the survey are shown in Table 6-5. Those indicating that they would pick up the slag required several months' storage at the PUROX facility. If delivered, a minimal slag pile would be needed at the PUROX facility. However, open body dump trucks would have to be purchased and a driver would be needed full time. The increased revenues from delivering the material would appear to offset the additional capital and operating costs incurred. The slag will be sold subject to competitive bids when the facility is being constructed. However, the net income will be minimal.

TABLE 6-4

PUROX SYSTEM RESIDUE (Slag) ANALYSES(1)

Major Components - Weight Percent, Expressed as Oxide

	<u>Typical</u>	<u>Range</u>
Silicon	59.7	57-62
Aluminum	10.5	9-13
Calcium	10.3	9-12
Sodium	8.0	7-10
Iron	6.2	1-8
Magnesium	2.2	1-4
Potassium	1.0	
Phosphorus	0.8	
Titanium	0.6	
Manganese	0.3	
	<u>99.6</u>	

Trace Compounds - Parts per Million

	<u>Range</u>
Barium	1000-3000
Copper	500-3000
Zirconium	300-1000
Strontium	200-400
Chromium	100-400
Lead	50-300
Tin	50-300
Nickel	50-250
Vanadium	25-80
Cobalt	15-40
Silver	5-30
Molybdenum	10
Antimony	3-10
Beryllium	5
Sulfur	1000-3000
Chlorine	5000-10,000
Zinc	50-250

(1) Data obtained from Union Carbide Corp.

TABLE 6-5

SLAG MARKETING SURVEY RESULTS

Name of Firm	Resp. to Quest.	Picked up at PUROX Facility				Delivered to Market			
		Min. Amt. TPD	Max. Amt. TPD	Revenue \$/ton	Min. Storage	Min. Amt. TPD	Max. Amt. TPD	Revenue \$/ton	Min Storage(1)
Package Pavement Co., Inc. (Red Wing Properties, Inc.) Stormville, N.Y.	Yes	20	100	\$0.60	60 days	-	-	-	-
Department of Public Works Dutchess County	Yes	All	-	\$1.00	6 mo.	All	-	\$3.00	-
Lone Star Minerals Highland, Ind.	Yes	All	-	-	-	All	-	\$2.50-\$3.00	-
New York Trap Rock Corp. (3) New Hamburg, N.Y.	No								
Dutchess Quarry & Supply Co. Inc. Pleasant Valley, N.Y.	No								
Poughkeepsie Asphalt, Inc. Poughkeepsie, N.Y.	No								
Spoor-Lasher Co., Inc. Poughkeepsie, N.Y.	No								
Amenia Sand & Gravel Inc. Amenia, N.Y.	No								
Custom Concrete Co. (2) New Paltz, N.Y.	Yes								

- (1) A minimum storage of one week is allowed for design purposes
 (2) Slag not needed in their business
 (3) Subsidiary of Lone Star Minerals

6.4 Wastewater

Moisture contained in raw refuse vaporizes in the converter and exits with the product fuel gas. The amount of water vapor in the gas is equal to the moisture entering in the raw refuse plus water vapor formed in the pyrolysis process. The fuel gas is processed in a gas cleaning system prior to transmission to market. After the particulates are removed by electrostatic precipitation, the gas is cooled to 100 degrees Fahrenheit in a condenser to reduce water vapor in the product gas. Between 60 and 100 gallons of wastewater (depending on the moisture in the incoming refuse) can be expected to be removed per ton of raw refuse.

Table 6-6 shows the characteristics of untreated PUROX wastewater. It is a high strength waste containing dissolved organics and has a high oxygen demand resulting from soluble 5-day biochemical oxygen demand (BOD).

The high BOD in the PUROX wastewater makes the stream difficult to treat. Domestic sewage usually contains between 200 and 300 milligrams per liter (mg/L) BOD, while the PUROX wastewater contains a maximum of 52,000 mg/L.

At 400 TPD, the PUROX facility will generate a wastewater flow of about 40,000 gallons per day. The Arlington treatment plant, which is designed for 4 mgd, is currently receiving about 2.8 mgd. The PUROX waste stream would add 0.04 mgd to the present flow at the Arlington sewage treatment plant if discharged directly to the sanitary sewer. This flow is not significant, and falls well within the hydraulic design constraints of the plant.

TABLE 6-6

CHARACTERISTICS OF UNTREATED PUROX WASTEWATER⁽¹⁾

Flow rate, gal/ton refuse (max)	100
Temperature, degrees F	100
pH (min)	3.7
COD, mg/l (max)	77,000
BOD ₅ , mg/l (max)	52,000
Suspended Solids, mg/l	50
Oil and Grease, mg/l	1000 - 80,000
Metals, mg/l (max)	
Antimony	0.08
Cadmium	0.01 - 0.3
Chromium	0.04
Copper	0.03
Iron	2
Manganese	20
Mercury	0.01
Nickel	1
Lead	2.2 - 60
Silicon	2
Tin	0.08
Zinc	3.1 - 60
Organics, percent by weight	
Methanol	1.1
Ethanol	0.5
Acetone	0.5
Methyl Ethyl Ketone	0.1
Acetic Acid	0.8
Propionic Acid	0.4
Butyric Acid	0.1
Furfural	0.5
Phenol	0.1
Benzene	0.06
Other	<u>0.38</u>
Total (max)	4.54

(1) Data obtained from Union Carbide Corporation

The organic loading of an activated sludge treatment plant is critical to maintain a proper balance of food and microorganisms in the treatment process. The Arlington sewage treatment plant is designed to treat 4 mgd of domestic sewage at 240 mg/L BOD. This amounts to an organic design loading of 8,000 pounds per day of BOD. The PUROX waste stream consists of 40,000 gallons per day at 52,000 mg/L BOD, or 17,350 pounds per day of BOD. Therefore, although the flow is low, the organic loading is more than double the capacity of the Arlington sewage treatment plant.

There are several alternate methods by which the wastewater can be handled. It can be treated on site to a degree such that it could be discharged to the Hudson River, or partially treated and discharged to a sanitary sewer for further treatment at a sewage treatment plant. An alternative to treating the organic-laden wastewater is to combust it with PUROX fuel gas.

Meetings with the operators of the Arlington sewage treatment plant have included discussions concerning alternate methods of wastewater treatment. As a result of those meetings and economic analyses of the various alternatives, wastewater incineration using excess PUROX gas has been found to be more economical than the other treatment methods considered.

6.5 Nitrogen

The PUROX facility utilizes oxygen to maintain high temperatures in the hearth and control the pyrolysis reactions

which take place within the converter. The source of oxygen is an on-site conventional cryogenic air separator.

About 0.2 tons of oxygen is needed per ton of refuse input to the converter. For present refuse quantities, a generation capability of 80 tons of oxygen per day is required. A by-product of the cryogenic oxygen separation process is a low quality gaseous nitrogen. About 3.7 tons of nitrogen will be produced per ton of oxygen, or about 270 tons per day. The cold nitrogen created by the process is used in heat exchangers to cool incoming air to the cryogenic separator. During this process, nitrogen is warmed to near ambient temperature. Some gaseous nitrogen is used for instrument systems within the PUROX facility. Cold, dry nitrogen is used periodically to remove condensed, frozen water and carbon dioxide from the tubes carrying cold air in the cryogenic oxygen generator. Nitrogen is also purged through the tuyeres of the PUROX converter when the unit is being shut down. For the most part, however, nitrogen is not extensively used in the PUROX facility, and generally will be vented to the atmosphere.

Several industries in Dutchess County which might utilize nitrogen in their processes were contacted to investigate the possibility of selling the waste nitrogen gas. In all cases, the firms used small quantities (relative to that produced by the PUROX facility) and required high purity nitrogen. They generally expressed a need for 99.9 to 99.999 percent purity, while the waste nitrogen from the plant is on the order of 97 percent purity. Waste nitrogen from cryogenic oxygen plants is generally vented to the atmosphere due to its low purity and lack of salability.

6.6 Solid Waste

Solid waste will be generated at the facility as an end product requiring final disposal under the following conditions:

1. in the form of bulky items and white goods;
2. when the facility is not operating at rated capacity due to a scheduled or unscheduled shutdown;
3. when the amount of refuse delivered to the plant is in excess of the design peak; or,
4. when the average tonnage exceeds 400 tons per day.

Bulky items and white goods should not be delivered to the plant on a regular basis. These types of refuse were not included in the refuse collection quantities, therefore, they will not affect the anticipated amount of refuse which would be processed. They will be removed from the plant and hauled to the landfill, or recycled, without going through any part of the processing train.

The facility is designed to handle 400 tons per day of refuse on an annual average basis. Scheduled maintenance on each converter train should require 30 days per year, and down time due to unscheduled maintenance on the entire plant should not exceed an additional 25 days per year. This amounts to a converter system on-stream time of about 85 percent.

The plant will be designed with front end storage of raw refuse which will be capable of handling most peaks by storing refuse in the receiving pits until the peak subsides, then feeding the refuse through the system. The overall plant availability of 85 percent will result in a refuse processing

capability of 340 tons per day on an annual average basis. Solid waste collected in the core area in excess of an annual average of 340 TPD will require alternate disposal or landfilling.

7. CONCEPTUAL DESIGN

The equipment described for the Dutchess County PUROX facility is the culmination of a nine month conceptual design evaluation. The design began with a review of the equipment described in the Bodner Reports and evolved as data was collected and evaluated, operating personnel were interviewed and specific equipment inspected and reviewed.

A complete set of conceptual design drawings accompanies this report. Table 7-1 is a list of drawing titles comprising the conceptual design. The equipment descriptions contained herein are for the major components of the facility as shown on the conceptual design drawings. The specific sizes and dimensions given represent the optimal design developed to date. Design improvements would be considered and adopted as final plans and specifications are developed.

7.1 Process Descriptions

Generalized process descriptions for the front end and PUROX equipment are given in Sections 7.1.1 and 7.1.2, respectively. Details of the front end and PUROX equipment, including sizes, capacities, motor horsepowers, etc., are included in Sections 7.3 and 7.4, respectively.

7.1.1 Front End. Thirteen equipment arrangements were evaluated during development of the final recommended front end processing train. Alternate systems that were evaluated include floor dump vs. pit and crane; storage of raw vs. processed refuse; hammermill vs. shear (with and without trommel); and

TABLE 7-1

CONCEPTUAL DESIGN DRAWINGS

<u>DWG. NO.</u>	<u>TITLE</u>
1.	Title Sheet
2.	Index Sheet & Location Plans
3.	Site Plan
4.	Outside Piping Plan
5.	400 TPD Refuse Processing Facility Architectural Elevations - South & East
6.	400 TPD Refuse Processing Facility Architectural Elevations - North & West
7.	400 TPD Refuse Processing Facility Plan - Mechanical
8.	400 TPD Refuse Processing Facility Longitudinal Section
9.	Refuse Processing Building Cross Section
10.	Refuse Processing Building Cross Sections
11.	Refuse Processing Building Typical Wall Sections
12.	Refuse Processing Building Floor Plan - Structural
13.	Refuse Processing Building Roof Framing Plan - Structural
14.	Refuse Processing Building Roof Plan Mechanical
15.	Process Water Pumping Station Architectural Elevations

TABLE 7-1 (cont.)

CONCEPTUAL DESIGN DRAWINGS

<u>DWG. NO.</u>	<u>TITLE</u>
16.	Process Water Pumping Station Plans & Sections
17.	Scale Pit Plans & Sections
18.	Cooling Tower & Pumping Station Plans & Sections
19.	Cooling Tower & Pumping Station Plan & Architectural Elevations
20.	Emergency Generator Building Plan, Section & Architectural Elevations
21.	Miscellaneous Details
22.	400 TPD PUROX System Processing Area Equipment Arrangement
23.	400 TPD PUROX System Process Piping, Plan
24.	400 TPD PUROX System Process Piping, Elevations
25.	400 TPD PUROX System Process Piping, Elevations
26.	200 TPD PUROX System Module Simplified Instrumentation and Control Diagram
27.	200 TPD PUROX System Module Simplified Heat and Material Balance
28.	80 TPD Cryogenic Oxygen Separator Equipment Arrangement, Plan
29.	80 TPD Cryogenic Oxygen Separator Equipment Arrangement, Elevations
30.	80 TPD Cryogenic Oxygen Separator Instrumentation and Control Diagram

TABLE 7-1 (cont.)

CONCEPTUAL DESIGN DRAWINGS

<u>DWG. NO.</u>	<u>TITLE</u>
31.	80 TPD Cryogenic Oxygen Separator Instrumentation and Control Diagram
32.	80 TPD Cryogenic Oxygen Separator Heat and Material Balance
33.	Electrical - Site Plan
34.	Electrical - One Line Diagram
35.	Electrical - Plant Primary Service Profile
36.	Electrical - Refuse Processing Building Motor Control Center
37.	Electrical - Cooling Tower & Pumping Station One Line Diagram
38.	Electrical - Plant Layout
39.	Electrical - Control Room, Cooling Tower & Pumping Station Layout
40.	Electrical - Refuse Processing Building Roof, Fans Layout
41.	Electrical - 200 TPD PUROX System Module One Line Diagram
42.	Electrical - 400 TPD PUROX System Routing, Plan
43.	Electrical - 80 TPD Cryogenic Oxygen Separator One Line Diagram

various equipment layouts. Figure 7-1 shows a simplified front end process diagram of the selected system.

Refuse trucks would approach the plant from the north, on Sand Dock Road. The trucks would pass over a scale upon entering the site, where the net weight would be calculated and stored in a computer to facilitate billing. The weighmaster would direct the trucks to a specific tipping station in the receiving area. The trucks would enter the building and proceed to the appropriate tipping station, where the driver could back the truck up to the pit and dump. The weighmaster could direct the driver to pass over the scale before he leaves the site if the tare weight of the truck is desired.

Refuse would be stored in the pit until the crane removes it for further processing. Sufficient storage capacity is provided to allow uninterrupted processing during periods of reduced refuse delivery or when refuse is not being delivered. Only one of the two cranes would operate at a time, allowing the flexibility of conducting crane maintenance without interrupting total plant operations. The crane would normally feed the two trommel infeed conveyors. These conveyors transport refuse from the receiving area to the trommels, located in the processing area. The crane could also feed the hopper leading to the stationary refuse compactor, where refuse would be compacted into trailers and hauled to the landfill, when necessary.

The trommel, a rotating cylindrical screen, classifies refuse by size. So-called "lifters" on the interior of the trommel give a tumbling action to the refuse. This motion breaks open plastic bags and facilitates size separation. The

SIMPLIFIED FRONT END PROCESS

"unders", or refuse which falls through the holes in the trommel shell, are collected on the trommel unders conveyor. This conveyor runs longitudinally under the trommel and discharges onto the sized refuse conveyor. The "overs", large size objects which pass through the trommel, require additional size reduction prior to further processing. The overs are discharged into a hopper which leads to a shear-type shredder, where they are size-reduced.

The shear shredder is a relatively low speed, low energy shredder, as compared to the hammermills that have been used in most refuse size reduction systems to date. Trommel overs would be reduced in size to approximately three inches. The sheared material would fall onto the sized refuse conveyor along with the trommel unders.

The sized refuse conveyor is an inclined belt conveyor which discharges onto a short, nonmagnetic vibrating feeder. The vibrating feeder spreads and levels the refuse to a relatively uniform depth, and passes the material under the magnetic separator. Here, ferrous metals are removed by a rotating drum separator and discharged onto the ferrous metal conveyor. Non-ferrous materials fall into a bifurcated chute.

The ferrous metal conveyor collects the recovered ferrous metal from both processing trains and transports it to a ferrous metal processing room. This room is reserved for future ferrous metal processing, if market economics should dictate. No equipment would be installed in this room during this phase of construction unless a viable market is identified. Recovered ferrous metals would be discharged to a stationary refuse

compactor and hauled to a landfill until a market is established.

The bifurcated chute permits flexibility such that each front-end processing train could feed either or both converters. The bifurcated chute would normally discharge directly onto the converter feed conveyor that is in-line with the sized refuse conveyor. The bifurcated chute could be switched to discharge onto a reversing conveyor, where refuse would be transported to the other converter feed conveyor if desired. The reversing conveyor could alternate direction to supply both converter feed conveyors using one front-end processing train. The converter feed conveyors transport the prepared refuse to the PUROX processing equipment.

7.1.2 PUROX. Union Carbide Corp. began developing the PUROX System in 1968. The process was tested in a five-TPD pilot plant and a 200-TPD demonstration unit in South Charleston, West Virginia. Early marketing efforts for full-sized systems pointed out the desirability of conducting further engineering development directed at reducing both the capital and operating costs of the PUROX System. This engineering program, completed in early 1979, resulted in improvements which have been incorporated into the PUROX System design for the Dutchess County project.

The PUROX process converts pre-sized mixed municipal refuse into a clean-burning fuel gas and an inert granular residue. Figure 7-2 shows schematically the simplified PUROX process.

SIMPLIFIED PUROX PROCESS

Sized refuse is delivered from the front end system on the converter feed conveyor. The conveyor is inclined to transport refuse to the converter feed elevation. Burden height on the conveyor is evened by a rotating drum leveler, which tumbles excess material back to the feed end of the conveyor. The conveyor speed, and thereby the rate at which material is delivered to the converter, is varied according to the operating rate of the system. A detector to sense the bed depth within the converter maintains the solids level within a specified range by adjusting the feed conveyor speed. The average rate at which gasification occurs is determined by the input oxygen rate.

The converter feed conveyor discharges into the hopper of the refuse feeder. The feeder is a hydraulically-driven dual ram device which compresses the refuse into cylindrical pellets. A gas seal is effected by the string of compressed pellets in the two tubes which feed the converter.

The converter is a vertical shaft furnace with an ellipsoid-shaped hearth section at the bottom. The converter is pressurized to permit delivery of its gasified fuel product to a user without further compression.

The pelletized refuse feed forms a porous packed bed within the converter. The bed descends as material is gasified from below. The rate at which oxygen is introduced to the hearth determines the rate of gasification. The refuse feed rate is in turn set to match the rate at which material is gasified.

The solids descend through the shaft in countercurrent contact with hot rising gases which are generated below. The gases cool as they dry and preheat incoming refuse.

The solids are exposed to higher temperatures as they descend. The organic content of the refuse begins to decompose chemically, or pyrolyze, in the presence of a hot reducing atmosphere. The pyrolysis reactions yield gases (carbon monoxide, carbon dioxide, hydrogen, steam, methane and other light hydrocarbons), heavier organic vapors which form tars and oils at ambient temperature, and a solid char. Some heavy organic vapors undergo further thermal breakdown, forming light gases. Some fluid components exit in small droplets with the rising gas stream.

The char and nonvolatile inorganic materials descend to the hearth of the converter. The char is composed primarily of fixed carbon and ash. Within the hearth, the char is contacted with oxygen gas, which is fed directly to that section through blow pipes, or tuyeres. The carbon is oxidized to carbon monoxide and carbon dioxide. This combustion reaction occurs at about 3000 F, and provides the heat which drives the conversion process. The presence of a large inventory of combustible solid fuel assures that all the oxygen will be consumed within the hearth section.

The remaining char ash, glass, metal, and some oxidized metal, are melted to form a slag pool at the bottom of the hearth. A slag tap continuously withdraws slag from the hearth. Slag is maintained in a molten state within the tap by combustion of a small amount of recycled gas in a torch. The

molten slag is solidified into a granular material by quenching in water. This residue is removed through pressure-sealed lock hoppers, and conveyed to a storage area, where it is later removed as a product.

The product gas stream formed in the converter rises to the top of the converter where it is collected and transported to the gas cleaning system. It is composed mostly of gases (carbon monoxide, carbon dioxide, hydrogen, and hydrocarbons), moisture, organic vapors, and a small amount of entrained particulate. An in-line aqueous spray reduces the gas temperature. The heavier organic vapors are condensed into entrained liquid particulate.

The gas then passes through a Venturi-type scrubber which frees it of most of the entrained solid and tar particulate. The excess liquid in the system, together with the tars and particulates, is withdrawn from the gas cleaning system and is transported to the wastewater treatment system.

The gas stream is further cleaned in an electrostatic precipitator (ESP). The ESP has been proven to be efficient at removing fine particulates from the gas. These particulates are collected and recycled to the converter feeder. A portion of the gas is removed at this point and diverted to fuel the wastewater treatment system.

The gas is then cooled in a heat exchanger to condense most of the remaining water vapor. The gas is now suitable for export as a clean-burning fuel product. Excess gas which cannot be marketed will be combusted on site in a ground flare.

Parallel wire mesh tube filters, which are periodically backwashed to yield a more concentrated slurry, remove particulates from the process wastewater. The slurry is combined with tars and oils collected in the ESP and returned to the converter feeder. The filtered wastewater is combined with the condensate from the final stage of gas cooling. The oil and aqueous phases are separated gravimetrically, and the decanted oil is returned to the converter feeder.

The aqueous phase is contaminated with byproducts of pyrolysis, and cannot be disposed of directly to a sewer system. A fraction of the product gas is used as fuel to incinerate this process wastewater. The wastewater is atomized into the hot zone of a fuel gas combustion chamber. A waste heat boiler is used to recover heat in the form of steam. The flue gases are vented to the atmosphere through a stack. The steam produced in this process is used to drive the compressors of the cryogenic oxygen separator and to provide steam for other in-plant uses.

7.2 Site Work

7.2.1 Land Acquisition. As noted in Section 5.2, the proposed site is 11.74 acres of parcel number 710950, (86 acres in area) on the Town of Poughkeepsie Tax Map Number 6059-02. Figure 7-3 shows the site boundaries and adjacent land use. The land is owned by New York Trap Rock Corporation (Trap Rock). Trap Rock has suggested that the land should be obtained by condemnation procedures.

FIGURE 7-3

The Milestone Plan estimates the time for land acquisition to take between two and five months to complete. Condemnation proceedings should begin immediately following approval of permits by the regulatory agencies regarding construction of the facility. Details of the appraised value of the property are in Section 8.1.

7.2.2 Easements. Three easements are required for the facility. The plant fronts on a town road which would be taken over by the County. No easement is therefore needed to obtain access to the plant.

An easement is needed for the two pipes which must cross under the railroad tracks to access the Hudson River. One pipe supplies process and fire protection water to the process water pumping station. The other pipe is a drainage pipe to return storm water to the Hudson River. Both pipes cross under the tracks at the same point.

The procedure to obtain a railroad easement necessitates complete design of the facilities which cross the tracks. The facilities must be in accordance with Conrail Specifications. The final plans are then submitted to Conrail. Upon finding that the final plans meet their specifications, Conrail would arrange an agreement for the owner of the facilities to sign, and grant the easement. This part of the project would be completed during final facility design.

Two easements are required for the product gas pipeline running from the process water pumping station at the PUROX facility across the Arlington sewage treatment plant property

and onto IBM property. The two easements would be acquired from the Town of Poughkeepsie and IBM.

7.2.3 Traffic Analysis. Minimal impact of truck traffic on the surrounding area is critical to public acceptance of the project. Data collected from the Beacon Incinerator was used together with this firm's experience, to project the number, time of arrival, and type of truck which could be expected to deliver refuse to the PUROX facility.

An analysis of 1978 data shows similar distributions of the arrival times of trucks regardless of the time of year. Although the number of trucks varies with the seasonal and weekly refuse variations, the percentage which arrived during specific hours of the day remained about the same. Table 7-2 shows the results of the traffic analysis, including the delivery hours and percentage of trucks arriving during those times. The data shows a double peak in delivery times, in mid-morning and early afternoon, which is typical for municipal refuse deliveries. A further analysis of the Beacon data shows that municipal packer trucks delivered about 6 tons per trip, private packer trucks delivered about 8 tons per trip, and other smaller vehicles delivered about 0.5 tons per trip, under average conditions.

The initial operating stage (458 TPD in the year 1985) would have about 102 trucks per day deliver refuse on Monday through Friday and 41 trucks on Saturday. Based on projected future conditions (554 tons per day in the year 2000), approximately 124 trucks per day on Monday through Friday, and

TABLE 7-2
TRAFFIC ANALYSIS

DELIVERY HOURS	PERCENTAGE OF TRUCKS	FUTURE CONDITIONS(1) 124 TRUCKS/DAY BASIS		INITIAL CONDITIONS(2) 102 TRUCKS/DAY BASIS	
		TRUCKS PER HOUR	MINUTES BETWEEN TRUCKS	TRUCKS PER HOUR	MINUTES BETWEEN TRUCKS
Before 7	1	1	48.4	1	58.3
7 to 8	8	10	6.0	8	7.3
8 to 9	13	16	3.7	13	4.5
9 to 10	19	23	2.5	20	3.1
10 to 11	12	15	4.0	12	4.9
11 to 12	8	10	6.0	8	7.3
12 to 1	7	9	6.9	7	8.3
1 to 2	15	19	3.2	16	3.9
2 to 3	11	14	4.4	11	5.3
3 to 4	5	6	9.7	5	11.7
After 4	1	1	48.4	1	58.3
Average		11.3	13.0	9.3	15.7

(1) For year 2000, plant operating at 554 TPD,
Deliveries = 124 Trucks per day Monday through Friday
47 trucks per day Saturday

(2) For year 1985, plant operating at 458 TPD,
Deliveries = 102 trucks per day Monday through Friday
41 Trucks per day Saturday

47 trucks on Saturday could be expected to deliver refuse to the plant. This assumes municipal collection service for residential waste in the City of Poughkeepsie only. Residential collection in all other municipalities, all commercial establishments, and for 90 percent of industrial and institutional wastes is assumed to be by private hauler. The remaining ten percent of industrial and institutional waste would be delivered by other smaller trucks. This breakdown is similar to that which is presently occurring in the core area, and is expected to continue to occur. The results, for average conditions for the years 1985 and 2000 are also shown in Table 7-2.

IBM has identified its peak traffic hours as between 7 and 9 in the morning, and 4 and 6 in the evening. Table 7-2 shows that 26 trucks could be expected to deliver refuse between the hours of 7 and 9 AM, or about one truck every five minutes in the year 2000. In 1985, 21 trucks, or one every six minutes, could be expected to deliver refuse to the plant. Truck traffic would be essentially over by 4 PM. The heaviest concentration of the deliveries would come between 9 to 10 AM and 1 to 3 PM, when about 20 trucks per hour, or 3 minutes between trucks would occur in both cases.

The Engineering Division of the Dutchess County Department of Public Works conducted a traffic study for the roads immediately adjacent to the proposed site. A complete copy of the Dutchess County traffic study is included in Appendix B. All the traffic counts on County Routes 48 (Rudco Road) and 76 (Spackenkill Road) were taken in 1978, and those on

U.S. Route 9 in 1977. Each of the 26 counts listed an average of a five-day continuous period on an hourly basis from 7 AM to 6 PM. There was no differentiation between automobiles and trucks or buses, however, the percentage of trucks and buses on the County roads is normally low. The peak hours are obvious and are influenced by IBM-related traffic. The data was analyzed by taking the total traffic count for the 11-hour period and determining the percentage of total cars passing a counter for each hourly period. The data was used to evaluate the effect of refuse trucks on traffic patterns.

The IBM access roads, such as Rudco Road, are most sensitive to rush hour traffic. Typically, fifty percent of the total cars using Rudco road travel toward IBM in the two-hour morning rush hour period (7 AM to 9 AM), and leave IBM in the two-hour evening rush hour period (4 PM to 6 PM). Opposing traffic during the same two-hour periods is typically five percent, showing an obvious relationship to IBM working hours. Another smaller peak occurs around the lunch hour. About 15 percent of the total traffic leaves between 11 AM and noon, and returns between noon and 1 PM. These roads carry about five percent of the total daily traffic during the remainder of the day. Between 2000 and 4000 cars use Rudco Road daily during the 11-hour period covered by the traffic survey, depending on the relative locations of the traffic counters and the parking lot entrances.

The weekday traffic counts show that Route 9 is less affected by rush hour commuter traffic, and is heavily travelled throughout the day. A minimum of six percent of the total

traffic flow per hour occurred during mid morning, and a maximum of 15 percent during the 7 AM to 8 AM rush hour. The remainder of the day showed a fairly uniform traffic flow pattern of between eight and ten percent of the total traffic per hour. This range is small when compared to that on Rudco Road, which is heavily influenced by commuter traffic. About 14,000 cars travel Route 9 in each direction during the 11-hour weekday period covered by the traffic survey.

Trucks delivering refuse to the plant would have a minimal overall effect on the traffic patterns in the area. Most refuse trucks would approach Rudco Road from Route 9, which has a fairly uniform traffic distribution during the day. Between 7 and 9 AM, an average of 26 trucks could be expected to deliver refuse to the plant. The refuse trucks would not have a significant impact on the traffic patterns, when compared to more than a thousand cars that use Rudco Road for access to IBM during the same period. The peak refuse deliveries occur between 9 and 10 AM and 1 and 3 PM, and correspond to times of low commuter traffic along these roads. Actions could be taken at the PUROX facility to alleviate any problems relating to conflicting traffic patterns, to encourage the arrival of refuse trucks during non-peak hours. In addition, improvements are now being made to Route 9 to alleviate traffic congestion. Route 9 is being widened to four lanes along its entire route from Poughkeepsie to its intersection with Interstate Route 84. When completed, traffic flow should improve, and the PUROX facility would have even less impact on traffic than presently projected based on the existing condition of the highway.

7.2.4 Access Roads. The existing access road (Sand Dock Road) is owned by the Town of Poughkeepsie. The section from Rudco Road to the Arlington sewage treatment plant entrance is paved. This section will be widened to 22 feet and repaved to meet the County road specifications for commercial/industrial roads to handle the increased traffic.

The next 700 feet, which makes up most of the property length, has a blacktopped pavement 10 to 12 feet wide. The last 100 feet (to the end of the property) is an eight- to ten-foot wide dirt road. The dirt road continues for about 400 feet past the property boundary. The entire length of the access road along the property will be widened to 22 feet to accommodate refuse trucks in a two-way traffic pattern. The road will be realigned to a straighter orientation along the property line. The road will consist of 12 inches of gravel base and six inches of asphalt for the final surface. This construction meets the County road specifications for commercial/industrial roads. The maximum slope in front of the plant will be six percent.

Major access roads within the facility boundaries are 22 feet wide, and are laid out for one way traffic flow through the plant. A counterclockwise traffic pattern is designed into the facility layout to minimize traffic congestion and lower the risk of accidents caused by crossing paths of refuse vehicles. The major internal access roads are of similar construction to the final design specifications of Sand Dock Road. Minor, intermittently used access roads, including those within the

PUROX processing area and the process water pumping station access road, vary in width from ten to twenty feet, and are constructed with a porous pavement. A total of approximately 3000 feet of internal access roads is provided throughout the plant.

7.2.5 Personnel and Visitor Parking. A lot providing 13 parking spaces for administrative personnel and visitors is adjacent to the administration wing. A second lot, providing 20 spaces for other plant employee parking is in the rear of the building near the PUROX processing area.

7.2.6 Final Grading and Drainage. Final grading of the site provides gently sloping areas toward the rear of the building, to a point near the escarpment to the railroad right-of-way. The perimeter of the site is maintained in its original wooded condition where possible, to provide a buffer zone for nearby properties. Gently sloping areas are grassed. Retaining walls are provided to avoid using steep slopes on the property. Retaining walls may not be necessary in cut areas if the underlying rock can be used to support the surrounding soils. The PUROX processing area and the cryogenic oxygen separator area are level and graded with a gravel topping.

Catch basins along Sand Dock Road, internal access roads, parking lots, and paved areas, as well as roof drains collect storm water. Swales collect runoff from other areas. All stormwater is transported through 12-inch corrugated metal pipes with paved inverts to the rear of the plant, then down the

embankment toward the process water pumping station. From there, a 24-inch diameter corrugated metal pipe transports storm water under the railroad tracks, in the same easement as the process water pumping station influent pipe, to a discharge point to the Hudson River.

7.2.7 Architecture. The exterior of the main processing building, process water pumping station, and emergency generator building consist of steel and translucent wall panels. The steel panels are galvanized, with final color bonded to the surface and are of corrugated construction on the outside. The inside panel is smooth galvanized steel. Panels enclosing heated areas have 1-1/2 inches of insulation between the interior and exterior walls, while those enclosing unheated areas are not insulated.

The translucent panels are three inches thick and provide light into the tipping floor. These panels are installed on the front of the receiving area only. The administration wing is brick and block masonry construction.

7.3 Front End Processing Equipment

7.3.1 Scale. The scale is outside the main processing building, adjacent to the receiving area entrance. This scale would weigh all refuse trucks entering the plant to dump. It would also be used to determine the tare weight of trucks as required, and to weigh trucks removing materials from the plant.

The scale has a 60-ton capacity, with a 60-foot long by 10-foot wide platform. It has a fully electronic weighing system with digital readout in 20-pound increments. The scale has a mechanical backup system, which enables trucks to be weighed if the electronic system becomes inoperative.

Regular users would be issued a special ID card for the truck, containing, in addition to other information, the tare weight of the truck. The computer would subtract the tare weight from the total weight to determine the net weight of the refuse. Credit transactions would be billed automatically by the computer, while cash transactions would be handled by the weighmaster and documented by the computer.

7.3.2 Receiving Area. The receiving area is the enclosed area where refuse trucks maneuver to dump into the pits. It consists of an eight-inch concrete slab on grade, over six inches of gravel, 335 feet long by 85 feet wide. The area within 15 feet of the pits is armored with one-inch deep steel grid, to protect against wear. Four overhead motorized steel roll-up doors, each 16 feet wide by 18 feet high with two-horsepower motors provide access. The receiving area is designed such that it can handle the truck traffic generated if the plant is expanded to 600 TPD.

Each pit has eight 12-foot wide tipping stations. Under normal conditions, each truck entering the tipping area would be able to proceed to an empty tipping station. Columns separating the tipping stations are protected by ten-foot high concrete and steel plate armored piers, to protect the building from structural damage if a column is accidentally hit by a refuse

truck. The edge of each pit is protected by a steel armored curb, to prevent trucks from accidentally backing into the pits. The curbs contain "broom slots" to facilitate floor cleaning.

The roof is supported by seven-foot deep trusses to provide a tipping floor with no supporting columns. The bottom chord of the truss is 19 feet above the tipping floor. This is adequate to provide clearance during tipping for all anticipated refuse trucks.

7.3.3 Pit and Crane. The pit size was determined by the desired storage capacity. Sufficient capacity to maintain normal operations through a three-day weekend was desired, to minimize converter shutdown and startup due to a lack of refuse, and to maximize revenues from gas sales.

Two pits, each 105 feet long, 30 feet wide, and 25 feet deep are capable of handling 600 TPD of refuse delivered in 4-1/2 days. The pits could therefore handle the refuse load if the plant is expanded to 600 TPD, without being enlarged. This size pit also allows for a minimum number of trips to the landfill, since the pits act as surge bins for weekly variations in refuse deliveries.

The pits are open on the side facing the receiving area. A block wall isolates the entire receiving and pit area from the processing area. This separates the noise and dust in the pit area from the remainder of the building. It would also isolate a fire in either area.

Each pit slopes toward the inside, where a drain and sump pit allow for the collection and removal of free water. The

pits have steel rail armoring along the sides and bottom to protect against wear from bulky refuse and the grapple.

The trommel infeed conveyors are between the pits. The conveyor floor is elevated 11 feet above the tipping floor, and is 36 feet above the bottom of the pits. The conveyors are fed through hoppers which rise five feet above the conveyor. Access from the tipping floor to the processing area floor is provided by a concrete stairway under the trommel infeed conveyors. Access to the infeed conveyors is provided from the processing area through a door leading from the grating platforms around the trommels.

A four-foot high wall surrounds the trommel infeed conveyor area to protect against accidents. Refuse that spills onto the floor in the conveyor area can be swept back into the pits through broom slots in the walls.

Two overhead cranes service the pits and feed refuse to the trommel infeed conveyors. One crane would be used while the other would act as a standby. The second crane could also be used to remove bulky items, mix the refuse, or feed the stationary compactor. Each crane has a five-ton capacity with a three-cubic-yard grapple. Each has a 30-foot span across the pit. A 28-foot crane rest area is provided on the outside end of each pit, where the cranes would be parked while not in use and while being serviced. Both cranes are capable of removing refuse from either pit, and feeding either trommel infeed conveyor or the stationary compactor. A three-foot distance is allowed between the crane rest area and the stationary compactor

on one side so that one crane could feed the compactor while the other crane is in the rest area.

The bottom of the roof truss over the pits is 44 feet above the tipping floor. A two-foot clearance is allowed between the top of the trolley and the bottom chord of the truss. When completely elevated, the grapple has a five-foot clearance above the trommel infeed conveyor hoppers.

The closing and holding hoist motors are 50 horsepower each, capable of lifting at 280 feet per minute; the trolley motor is 15 horsepower, capable of moving at 150 feet per minute, and the bridge motor is 40 horsepower, capable of moving at 375 feet per minute. The crane is specified for the most severe duty service to maximize crane availability and minimize required maintenance.

The crane operator would be in a cab on the crane, facing the receiving area. This provides ease of material handling and a good view of the pit area where refuse is being removed. This cab orientation allows the operator a clear view of truck dumping operations and crane grapple working areas. The cabs are heated and air conditioned, with soundproofing and dustproofing equipment installed for operator safety and comfort.

7.3.4 Trommel. A trommel screen is a rotating perforated cylinder which is used to classify refuse by size. The purpose of the trommel is to separate material that is already small enough to be processed, or "unders" from material that requires size reduction, called "overs". The unders typically contain

most of the glass and metals, which cause rapid deterioration to mechanical processing equipment such as shredders. Shredder loading rate and wear are reduced by removing these abrasive materials. The overs would be size reduced, so the entire waste stream would meet the PUROX refuse specification.

Two ten-foot diameter by 38-foot long trommels with six-inch holes classify refuse by size. The units are inclined at a five-degree angle to the horizontal. Short angular metal sections called "lifters" are positioned inside the trommel to assist in inducing both a tumbling action and forward motion to the entering refuse to break open bags and ensure a high screening efficiency. The first five feet and the last seven feet of the trommel are without holes or "blind" sections. Lifters within the inlet blind section tend to break open plastic refuse bags and align long materials along the axis of the trommel. The alignment reduces the possibility that long, narrow materials, such as two-by-fours, "spear" through the holes with the unders. The final blind section tends to realign the material, minimize discharge problems and make dust control easier to accomplish.

Twenty to 40 percent of the entering refuse should not pass through the holes in the trommel shell, and would require size reduction. The actual amount would depend on the type of refuse, moisture content, and seasonal variations. These overs are discharged into a hopper positioned over the shear shredder.

Each trommel could handle about 20 TPH, with short-term peak loads in excess of 30 TPH. Screening efficiency decreases at higher throughput rates. Each trommel is equipped with two

40-horsepower motors and a hood to control dust and odors. The trommels are fabricated of 3/4-inch steel plate.

The overall building height in the trommel area is 42 feet. The trommel rotates on wheels supported by structural steel, with the discharge end about 20 feet above the floor. A minimum of six feet of clearance is provided from the top of the trommel cover to the roof. The trommels and all associated pieces of each front-end processing train are spaced 30 feet apart on centers. Grating walkways provide access to the trommels and associated equipment.

7.3.5 Shear Shredder. Two shear-type shredders, one for each trommel, are provided to size-reduce the overs from the trommels. Material is introduced into the shear by a steel chute positioned at the discharge end of the trommels. The chute is 11 feet wide (across the length of the discharge end of the trommel) and extends nine feet out from the trommel. The hopper sides are sloped steeply to inhibit bridging. The chute is 13 feet high, and is of sufficient volume to act as a surge bin for the shear shredder.

This type of shear has advantages over conventional hammermills in that it could reduce the size of many problem materials such as rubber, wires, bedding materials, tires, and carpeting. A shear shredder slices, rather than hammers the material, to accomplish the same result with lower power input. It also reduces the potential of explosions, which are a particular concern with hammermill shredders. The shear has a

low noise level, dust level, horsepower, and maintenance requirements when compared to conventional hammermills.

The shear is a hydraulically-driven, high torque, low horsepower shredder with cutting teeth mounted on two counter-rotating shafts. The hydraulic control system is designed to stop rotation when the cutters reach a preset (field adjustable) pressure limit. When this occurs, the cutters reverse for an adjustable number of revolutions to prevent jamming and to realign the material in the cutting area. They then reverse again after the hard-to-shred material has been repositioned. This anti-jamming feature reduces strain on the shredder and also reduces the possibility of self-destruction.

Each shear has a 72- by 46-inch feed opening, and is capable of handling up to 20 tons per hour. Each has two 175-horsepower electric motors to operate the hydraulic system. The cutter shaft speed would be about 60 revolutions per minute.

The shears would reduce the overs to a nominal three-inch size. The size-reduced overs are recombined with trommel unders on the sized refuse conveyor for further processing. A clearance of 30 inches is provided between the structural steel support for the shear and the sized refuse conveyor. The shear discharge is 12 feet above the floor elevation. Access to the chute and shear is provided by grating walkways. The hydraulic power pack is water cooled to maintain proper operating temperatures.

7.3.6 Ferrous Metal Recovery Equipment. Magnetic separation equipment is installed to remove ferrous metals from refuse

prior to pyrolysis. The sized refuse conveyor discharges onto an eight-foot long, 72-inch wide vibrating feeder to spread and level the material prior to magnetic separation. The vibrating feeders are constructed of nonmagnetic steel, and are operated by five-horsepower motors. Nonmagnetic material from the vibrating feeder discharges through a bifurcated chute onto the converter feed conveyors.

The magnet is a rotating drum, four feet in diameter and seven feet long. The magnet is suspended below the roof by cables connected to the roof beams. The centerline of the magnet is 21 feet above the floor and is mounted such that the distance between the circumference of the drum and the edge of the vibrating feeder is adjustable from ten to 16 inches. The building is 33 feet high in this area. The magnet requires 6 kW of power, including AC/DC converter. Magnetic materials are picked up by the magnet and discharged onto the ferrous metal conveyor. This conveyor serves both magnetic separators and delivers the ferrous scrap outside the main processing area. The magnet and feeder mechanism are served by grating walkways. Space is provided for additional processing equipment to be installed, when it could be economically justified.

7.3.7 Stationary Refuse Compactor. The stationary refuse compactor would be used for refuse that cannot be processed through the PUROX facility and must be landfilled. It will be on the north end of the receiving area between the pit and the crane rest area. Either crane could serve the refuse compactor from either pit.

The floor elevation around the compactor is the same as that of the tipping floor. A four-foot high hopper with a ten-foot square top opening is provided as a feed to the compactor. The hopper has sloping sides which narrow to a six-foot square opening that discharges into the compacting hopper. The hopper has a nine-cubic-yard capacity. A hydraulic ram, operated by a 60-horsepower motor, compacts and forces the refuse into a transfer trailer.

The transfer trailer area is behind the pits, and is 16 feet below the elevation of the tipping floor. This provides convenient access, since the elevation is comparable to that in the remainder of the processing area. A trailer would always be parked to receive material from the compactor, and a standby trailer would be nearby. When one is removed for transport to the landfill, the other would be put in its place.

7.3.8 Conveyors and Appurtenances. The following conveyors transport refuse through the various front end processing stages:

- Trommel infeed conveyor
- Trommel unders conveyor
- Sized refuse conveyor
- Reversing conveyor
- Ferrous metal conveyor.

The front-end conveying equipment ends at the converter feed conveyor, which transports refuse from the front end into the PUROX feeder. That conveyor is part of the PUROX equipment, and is discussed in Section 7.4.1.

The trommel infeed conveyor accepts unsorted refuse from the crane and transports it to the trommel feed chute. The conveyor is a horizontal apron-type, 28 feet long, 84 inches wide, and is powered by a 7-1/2-horsepower variable speed motor. It would be capable of transporting refuse at rates up to 500 TPD. The conveyor has hopper sides to prevent refuse spillage when the crane dumps. The trommel feed chute at the discharge of the trommel infeed conveyor slopes downward at a 45-degree angle. The chute is six feet wide, seven feet long, and five feet high with a curved bottom to align material along the axis of the trommel.

The trommel unders conveyor is a 33-foot long, 36-inch wide belt conveyor which declines 20 degrees from the horizontal. It is driven by a five-horsepower motor, travels at 200 feet per minute and is capable of handling unders at rates up to 400 TPD. Side hoppers will direct refuse falling through the trommel onto the conveyor. The conveyor discharges onto the sized refuse conveyor.

The sized refuse conveyor is a 67-foot long, 72-inch wide belt conveyor, powered by a ten-horsepower motor. It is inclined 20 degrees from the horizontal. Trommel unders are discharged onto the feed end of the conveyor, and sheared overs are discharged about 11 feet in from the feed end. This belt travels at 100 feet per minute and handles sized refuse at rates up to 500 TPD. It delivers the combined sized refuse stream to the vibrating feeder of the magnetic separator. Ample area along this conveyor, between the shear and the magnetic separator, is provided for processing equipment which may be

desired in the future. This area can also be used for hand-picking stations, where recyclable materials can be sorted for resale.

One reversing conveyor provides the capability of feeding either or both converters from one front-end processing train. It is a horizontal belt-type conveyor, 26 feet long, 72 inches wide, and is driven by a 7-1/2-horsepower motor. This conveyor travels at 100 feet per minute, and handles 500 TPD of refuse. It is fed by either bifurcated chute and discharges to either of the converter feed conveyors. The reversing conveyor would be used when one front-end processing train is not operating and both PUROX converters are in service.

The ferrous metal conveyor collects the material separated by both magnets, and conveys it outside the main processing area. The belt is a horizontal trough-type, 90 feet long, 24 inches wide, and driven by a three-horsepower motor. It travels 50 feet per minute and handles up to 50 TPD.

One bifurcated chute is on each process train to divert the refuse to either converter. Nonferrous material which falls from the vibrating feeder discharges into a 60- by 86-inch opening at the top of the bifurcated chute. The chute has two parallel diverting plates, hinged at the top, to feed either the dedicated converter directly, or the reversing conveyor to feed the other converter. The feed chutes are inclined 60 degrees from the horizontal. The top of the hopper is 18 feet above the floor. The floor in the area of the bifurcated chute and magnetic separator is elevated five feet above the remainder of

the processing area. This area is elevated to reduce costs and shorten the converter feed conveyor.

Gratings surround all major pieces of equipment to provide access to elevated machinery areas. All gratings are three feet wide and have a 42-inch high railing around them. The long sized refuse conveyor is inclined at 20 degrees from the horizontal. Access for this conveyor is by an inclined grating with a nonskid surface. The platform is 30 inches wide and is also protected by the 42-inch high railings.

A two-ton monorail is above the center of the shears. The monorail is 70 feet long, and could be used for shear maintenance and to remove items that cannot be sheared. The monorail is supported from the roof truss.

7.4 Converter Processing Equipment

The PUROX facility consists of two independent front- and back-end processing trains. The front end trains are designed such that they could feed either or both converter processing trains. Each converter processing train operates independently of the other train until the fuel gas and slag products come together in common collection systems.

7.4.1 Refuse Feeding System. The refuse feeding system receives sized refuse from the front-end trains and delivers it to the refuse converter. The converter feed conveyor and leveler receives and conveys the material uniformly to the converter feed elevation. The loading end of the conveyor has side walls forming a hopper which could be batch-loaded with

volumes of up to 300 cubic feet. This permits feeding both converters when one front-end processing train is operating.

The converter feed conveyor is a heavy duty steel pan apron type driven by a ten-horsepower motor. It is 32 inches wide and approximately 75 feet long. The first 27 feet are level and inside the main processing building. As the conveyor leaves the building, it inclines upward at a 45-degree angle. The portion of the conveyor that is outside the building is covered. The leveler is a three-foot diameter rotating drum, mounted at an adjustable distance above the conveyor, about 45 feet from the feed end. The leveler rotates counter-current to the direction of the conveyor, causing an even burden depth along the length and width of the conveyor. Excess material tumbles back along the conveyor toward the receiving hopper, tending to fill any gaps. This assures a uniform delivery of material to the refuse feeder. The delivery rate is automatically adjusted by the variable speed conveyor. The leveler is driven by a one-horsepower motor.

The refuse feeder is a hydraulically-driven double ram compactor which forms sized refuse into pellets and moves them into the converter. Material is discharged from the refuse conveyor into a feed chute. A hydraulically-operated vane directs and partially compacts the refuse alternately toward either of two forming tubes. Two rams, acting in tandem, push the refuse into the tube, compacting the material into approximately 10-inch diameter cylindrical pellets. The length of the pellets vary, depending on the feed rate and the type of material being fed, from several inches to in excess of a foot.

The pellets are compacted and pushed further along the tube during subsequent ram strokes, until they reach the end of a trough extending into the converter. A string of pellets within the forming tubes provides a seal against gases flowing out of the converter. The pellets are discharged into the center of the vertical shaft.

The vane and ram are driven by a refuse feeder power pack consisting of hydraulic pumps, valves, an oil storage reservoir, and associated equipment, mounted on a skid. The power pack is operated by three electric motors totalling 87.5 horsepower.

7.4.2 Refuse Converter. The refuse converter is a vertical shaft furnace consisting of the shaft, hearth, and slag tap shroud. Its overall height is approximately 40 feet. In the converter, the combustible components of refuse are gasified, while the noncombustible fraction is slagged to an inert residue. Liquids vaporize and exit with the product gas. The converter operates at about 56.7 psia pressure.

The converter shaft is a refractory-lined, vertical cylindrical vessel, with truncated conical heads on both ends. It is supported from a ring welded around the circumference near the bottom of the cylindrical section. The ring is set onto a steel support structure and concrete foundation. The shaft has a nine-foot outside diameter.

Refuse pellets are fed into the shaft through the side, at a point near the top of the cylindrical section. They form a porous bed of solids within the shaft, and are dried and pyrolyzed as the bed descends. The resulting gases are

withdrawn through pipes connected to the upper head. The solids bed is partially supported by the sharply converging walls of the lower cone. As the pellets at the bottom decompose, char and noncombustible solids feed through an opening into the hearth.

The hearth is a refractory-lined, ellipsoid-shaped vessel. It is attached to the shaft by a flanged connection. The largest dimension of the hearth is the horizontal diameter of seven feet. Its upper and lower sections are also joined by a flange.

Oxygen is fed into the hearth through 16 tuyeres penetrating the steel shell and refractory lining. These are arranged in a circular pattern around the upper section of the hearth. The char feeds downward from the shaft and is partially combusted within the hearth. The combustion reactions generate 3000 F temperature gases which, after giving up some heat to the noncombustibles, rise into the shaft. The residual ash, glass and metals form a molten slag pool in the bottom of the hearth. A slag tap is mounted through the wall on one side of the lower half of the hearth.

The slag tap shroud connects the hearth to the quench tank, sealing the outside of the tap from the atmosphere. The connection is made with an expansion bellows, since the converter and quench tank have separate supports. There is a continuous flow of slag from the tap. Three torches, mounted in the upper section of the shroud, maintain fluidity as the slag is tapped. The torches are fueled by a small fraction of the PUROX product gas, which is burned with oxygen to give a high

flame temperature. Sight glasses in the shroud wall provide a view of the tap. The steel shells of the hearth and slag tap shroud, slag tap, tuyeres, torches and sight ports are water cooled.

The refractory lining of the hearth is expected to require replacement about once a year. A hearth transfer car, which moves on tracks beneath the hearth, is provided to facilitate removal of the hearth for maintenance. The transfer car is not motorized, and serves only to remove the hearth from under the converters to a point where a movable crane could pick up the hearth and transport it to the maintenance area. There, the refractory lining can be replaced. One spare hearth is provided for the converters to minimize downtime. This allows both converters to be in service while the relining is done.

7.4.3 Gas Cleaning. The gas scrubbing system is the initial step in cleaning the converter offgas. It removes most of the large particulates and cools the stream from 500 F to about 200 F. It consists of three stages in which the gas contacts a recirculated aqueous stream.

The offgas desuperheater consists of 12 water spray nozzles installed in the gas line from the converter. The sprays cool the gas rapidly by vaporization of 70 gpm of water and prevents accumulation of material inside the pipe. Because of the piping arrangement, water from this step cannot flow back into the converter. The partially cooled gas, aqueous liquid and particulates flow together into the Venturi scrubber through a ten-inch pipe.

The Venturi scrubber is a high energy gas-liquid contacting device. It utilizes some of the available pressure of the gas to atomize additional scrub liquid as it is introduced with the gas into a single throat-like nozzle. The atomized liquid captures most of the entrained solid and tar particulates from the gas. The scrubber has a maximum diameter of about 2.5 feet and is about 8.5 feet high. The system is protected from overpressurization by the scrubber bursting disc, which vents to the atmosphere if the set pressure is exceeded.

The outlet stream from the Venturi scrubber goes through a flanged connection to the cyclone separator/cooler. This is a cylindrical vessel about four feet in diameter and 18 feet high. The bottom section causes a cyclonic separation of most of the scrub liquid from the gas. Direct contact with cooler scrub liquid in a trayed section above this further cools the gas and condenses more of its moisture. Finally, liquid mist is separated from the gas stream, and the gas is sent to the electrostatic precipitator. All of the liquid is withdrawn from the bottom of the cyclone separator/cooler.

The pressure of the aqueous stream is increased by the scrubber slurry pump and most of the stream is recirculated to the three stages of gas contacting. Heat picked up in the scrubbing system is rejected to cooling water in the scrubber recycle cooler, a spiral tube-type heat exchanger, prior to recirculation to the trayed cooler.

Condensation from the converter offgas results in an excess of liquid in the scrubbing system. This excess liquid is withdrawn for treatment and disposal. The level of contaminants

builds up in the scrubber loop until equilibrium is reached, and the amount withdrawn with the excess liquid stream is equivalent to that which has been removed from the gas. Under steady-state conditions, about 10 gpm of excess liquid is removed for treatment.

The gas stream leaving the cyclone separator/cooler has been cleansed of most of its entrained particulate. It is next treated in an electrostatic precipitator (ESP) to remove submicron particulates. The unit consists of the ESP and supporting components which transform line voltage alternating current into a high voltage direct current supply.

The electrostatic precipitator is a cylindrical pressure vessel about 5.5 feet in diameter and 18 feet high, with vertically mounted tubes. An electrode rod is suspended in the center of each tube. The rods are connected to a high tension support frame in the top section of the precipitator, and have weights at the bottom to hold them in place. The gas to be cleaned flows upward through the tubes. An electrostatic field is set up, imparting a charge to the particulate being carried by the gas. The particulate, consisting mostly of liquid, is collected on the inside surface of the electrically grounded tube. It flows down the surface of the tubes and drips to the sump of the vessel where it is later withdrawn by a pump. The top head of the vessel serves as a manifold for the clean gas, which is sent on to the condenser. The ESP bursting disc in the top head protects against over pressurizing the vessel. It vents to the ground flare if the set pressure is exceeded.

The high tension support frame is hung on insulators in compartments on opposite sides at the top of the vessel to remain separated from the grounded structure of the ESP. Product gas taken downstream from the final condenser is recycled to the compartments to keep the insulators dry, since the process gas at this point is saturated with moisture. The recycled gas stream is pressurized by a fuel gas recycle compressor and superheated to 145 F by a steam-operated recycle fuel gas heater. Since the purge gas rejoins the clean gas stream leaving the ESP, no fuel is consumed in the process. The recycle compressor also serves as the means for supplying fuel gas to the torches in the slag tap shroud.

The fuel gas condenser is a shell and tube heat exchanger where the product gas is cooled to near ambient temperature. Heat is rejected to plant cooling water and most of the remaining moisture in the gas is condensed. The condenser contains a separator which removes condensate for disposal. The remaining gas is discharged to the product gas header, where it could be transported to the market or burned on site. The product gas header is an eight-inch pipe.

7.4.4 Residue Handling. The residue handling system consists of equipment to solidify the slag tapped from the converter and remove it from the pressurized converter quench tank. The molten slag solidifies as it pours into the water in the quench tank. Heat given up by the slag is removed from the tank by drawing off 130 gpm of hot water through a quench tank cooling pump. The hot water is circulated through the quench tank

cooler, a spiral tube heat exchanger, where the heat is rejected to plant cooling water. The quench tank temperature is maintained at about 180 F. The cooled water is returned to the quench tank.

Pusher blades move the slag horizontally across the floor of the quench tank, causing it to fall into either of two lock hoppers. The lock hoppers each employ two knife gate valves to transfer the residue to atmospheric pressure without any gas leakage from the pressurized converter. The upper valve starts in the open position with the lower valve closed. After slag is pushed into the lock hopper, the upper valve closes. When the top valve closes, pressure between the valves is equalized with the atmosphere, and the bottom valve opens long enough to dump the slag. When the bottom valve recloses, the hopper is refilled with water, displacing air from the lock hopper, and the cycle can be repeated. The pusher blades and knife gate valves operate on a timed cycle, and are hydraulically driven from the quench tank power pack, consisting of two five-horsepower motors.

The slag skip car is installed in a pit beneath the lock hoppers. When the bottom valve of a lock hopper opens, the slag drops into a skip car, which carries the material out of the pit. The water which drains from the skip cars is collected in a sump and returned to the 20-gpm quench tank recirculation pump. Each car is driven by a five-horsepower motor.

The residue from both converters is dumped by the associated skip cars onto a common slag conveyor. This is a covered elastomer belt conveyor, which transfers the material

to a stockpile, where it is later removed as a product. The slag conveyor is 60 inches wide and about 200 feet long.

7.4.5 Process Wastewater. The process wastewater handling system collects the liquid streams from the gas scrubbing system, the ESP and the condenser and sends them to the wastewater treatment system. The liquid stream from the scrubbing system is a thin slurry containing solid particulate. The particulate filter consists of three parallel wire mesh tube filters which strain most of the solids out of the liquid stream. The solids build up on the filters, resulting in an increased pressure drop. The particulate filter backwash pump is employed when a set pressure is reached, to reverse the flow through one of the filters. The resulting concentrated slurry is combined with the tars and oils removed during gas cleaning in the recycle hold tank/mixer. The oil and particulate recycle pump returns this material to the converter feed conveyor, where it is mixed into the refuse pellets for disposal within the converter. The tank holds the mixture during periods when the refuse feeding system is not operating.

The strained liquid from the particulate filter and the liquid from the fuel gas condenser are aqueous streams containing some immiscible organics. These streams are combined in the oil/aqueous phase separator, a baffled tank having a capacity of about 400 gallons. Here, a quiescent zone allows the aqueous and oil phases to separate gravimetrically. The lighter oil phase is decanted and transported by the oil phase pump to the recycle hold tank, where it is combined with the ESP

bottoms and particulate slurry, then returned to the converter. The aqueous phase, containing soluble organic contaminants (alcohols, aldehydes, ketones, and organic acids), is sent by the wastewater pump to the wastewater disposal system.

The wastewater disposal system consists of a combustion chamber equipped with a special burner, combustion air supply equipment, and waste heat recovery equipment. It combusts partially cleaned fuel gas to vaporize the condensate stream and thermally destruct organic contaminants. The gas which is used for incineration is split off from the product stream ahead of the final cooling and condensing stages to avoid a need to revaporize its water content. A waste heat boiler recovers energy as steam for use in the facility.

The combustion chamber is an insulated horizontal cylindrical vessel. Within the chamber, a temperature in excess of 1800 F and a residence time of at least one second insure destruction of the organics in the wastewater stream. A dual fuel waste burner is mounted on one end of the combustion chamber. This burner is capable of burning either partially cleaned product gas or No. 2 fuel oil. A wastewater atomization system, which injects the wastewater into the combustion chamber as a fine mist, is integral to the burner.

Heat contained in the flue gas exiting the combustion chamber is recovered in the waste heat boiler and air preheater. The waste heat boiler consists of a water-tube boiler and convective superheater to provide steam for use within the facility. A counterflow air preheater preheats the combustion air by extracting additional low level heat from the flue gas.

leaving the waste heat boiler. Combustion air is provided to the air preheater and waste burner by the combustion air blower.

The combustion products are vented to the atmosphere at a temperature of 380 F through the flue gas stack. A single free standing stack is shared by the two processing trains. A single auxiliary boiler, capable of burning either product gas or No. 2 fuel oil, is provided so the plant will maintain 100 percent of its steam generating capacity when either of the waste heat boilers are not operating.

7.5 Gas Utilization Equipment

7.5.1 Quality Control and Metering. Quality control and metering is accomplished at the market end of the pipeline. The gas customer has a metering station which would measure and record the flow (through an orifice), density (gravitometer), temperature, pressure, and specific heating value (calorimeter). The data would be integrated in accordance with procedures adapted from American Gas Association Standards, to determine the quantity of energy delivered. The gas customer could cease accepting fuel, independent of any action on the part of the PUROX facility, if the fuel quality were to fall below required standards. An alarm at the PUROX facility would indicate a low BTU value in the gas.

7.5.2 Delivery. The product gas is delivered to IBM through an eight-inch diameter steel pipe. The gas pipe is installed above the ground leading to the process water pumping station. A

drain is installed at the low point in the pipe near the process water pumping station to assure removal of condensate from the gas. From there, the pipeline travels northward across the Arlington sewage treatment plant property near the railroad right-of-way, and onto IBM property. The pipe enters the boiler house, which contains the quality control and metering devices.

A blowoff or relief valve is not needed along the length of the pipe. A pressure controller on the product gas header at the PUROX facility functions to prevent overdrawing from the conversion system or to vent excess gas to the flare. The pressure controller works automatically to regulate the flow of gas to the appropriate destination.

The Arlington treatment plant could either utilize PUROX gas in its existing sludge incinerator or send sludge to the PUROX facility for destruction in the converters. Economics will dictate the procedure used.

7.5.3 In-Plant Uses. The PUROX fuel gas is used within the plant in internal PUROX recycle streams, incinerating wastewater, and producing steam for in-plant use. Internal recycle streams provide process control for the PUROX equipment. Recycled fuel gas is combusted in the slag tap to maintain slag fluidity. It is also used in the ESP to prevent condensation of water. The gas recycled to the ESP is not combusted and exits with the product gas.

A portion of the fuel gas is withdrawn from the gas stream and combusted in the wastewater incinerator. The gas is removed prior to the condenser to avoid revaporizing the water

contained in the gas. A waste heat boiler in each wastewater incinerator recovers energy in the form of steam for use on site. The steam is used to drive the compressor in the cryogenic oxygen separator and at reduced pressure for process control, plant heating and steam tracing.

Excess and subquality gas produced by the facility is combusted on site in a ground flare in an environmentally acceptable manner.

7.5.4 Modifications Required at IBM Boiler House. There are five boilers at the IBM boiler house, each sized to produce 45,000 pounds of 150 psig steam per hour. Three boilers were manufactured by Combustion Engineering, Inc. Each operates with balanced draft and is fired by two combination oil and gas burners. The remaining two boilers were manufactured by the Babcock and Wilcox Company. Each is pressurized and fired by one combination oil and gas burner. The draft equipment on all five boilers should permit load capacities with PUROX fuel gas as high as that obtained with the present fossil fuels. Although space conditions are tight, all five boilers should be capable of being retrofitted with fuel gas trains to accommodate the PUROX fuel gas utilizing the existing burner throats. No other modifications to the boilers should be required.

The PUROX facility produces enough gas at normal full load to carry two-thirds load on any two of the five existing boilers. All boilers that are planned to remain operational should be equipped to burn PUROX fuel gas. The characteristics of the PUROX fuel gas are such that there should be no corrosion

or erosion of any parts of the boiler or ancillary equipment at a greater rate than if fired with oil alone.

7.5.5 Ground Flare. If the supply of product gas is more than that which can be utilized by the customer, or if quality is not up to specifications, the excess is diverted to the ground flare, where it is burned on site. The ground flare employs post-mixed burner heads equipped with turbulence inducers, which are connected by a manifold to distributor piping. The ground flare is supplied with a propane gas pilot. The burners are mounted within a refractory-lined nine-foot square flue, which extends 14 feet high to enclose the flame. Combustion air is supplied by natural draft through openings below the flue. The lower section of the ground flare is enclosed by a four-foot-high acoustical fence.

7.6 Utility Requirements

The PUROX facility requires connections to external utilities to supply the various needs of the plant. Oxygen, potable and process water, domestic wastewater, auxiliary energy, and electricity would be brought into or out of the plant site.

7.6.1 Cryogenic Oxygen Separator. The PUROX facility requires about 80 tons of oxygen per day. The most economical supply form for this amount of oxygen is an on-site cryogenic air separation plant. Some liquid oxygen would be stored on site for periods when the cryogenic separator is inoperative. The

oxygen plant operation is semi-automatic, requiring infrequent attention by plant operators.

In the cryogenic plant, ambient air is first filtered, then it is compressed and cooled. The cooled air passes to a surge tank where demisters remove entrained water. The air is delivered to the "cold box" which contains the insulated cryogenic equipment.

In the cold box, the air is cooled in reversing heat exchangers countercurrent to outgoing cold product oxygen and cold waste nitrogen. The moisture and carbon dioxide in the air condense and freeze in the heat exchanger passages during the cooling, causing the air to be dried and cleaned. The air and waste nitrogen passes are interchanged periodically to prevent the eventual plugging of these passages. A gas phase adsorption trap removes the remaining carbon dioxide and hydrocarbons prior to delivery to the distillation columns, where the final oxygen separation is made.

The upper column recovers most of the oxygen available in the incoming air. A small fraction of oxygen escapes with the waste nitrogen. Product oxygen gas is withdrawn from the top of the reboiler-condenser and warmed to ambient temperature in the reversing heat exchanger. Waste nitrogen removes contaminants from the reversing heat exchanger as it is warmed to ambient temperature. Part of this stream is dried and compressed for use as a purge gas for the PUROX process.

Refrigeration is supplied by expanding high pressure purified air through a turbo-expander and exhausting the subcooled air to the low pressure column.

Liquid oxygen from the oxygen production unit could be transferred to an 11,000 gallon storage tank which will serve as a back-up oxygen supply in the event of a plant outage. Facilities for transferring liquid oxygen and nitrogen from a transport vehicle are also included. For assistance in start-up, liquid oxygen can be transferred from the storage tank into the cold box.

The liquid oxygen system would go into operation automatically to insure a continuous supply of oxygen to the process if additional oxygen is required above the production capability of the oxygen generating unit or if the oxygen generating unit is down. Liquid oxygen from the storage tank is delivered to a vaporizer where the liquid oxygen is converted to a gas and warmed to ambient temperature.

Clean, dry air to operate the instruments, valves and controllers is normally provided through the heat exchanger section of the cold box. Backup instrument gas for the air separation plant is provided by the liquid nitrogen storage system.

7.6.2 Potable Water. Approximately five gallons per minute of potable water on an average basis is required to supply the needs of the facility. Potable water would be used for drinking, showers, lavatories, quench tank and boiler feed makeup water for the PUROX process and for general washdown. The demand rate of 50 gpm is available to the plant. All other plant functions would be supplied with nonpotable process water.

Sufficient potable water is available at the Arlington sewage treatment plant via a four-inch line owned by IBM. IBM officials have indicated that they would be willing to discuss arrangements for utilizing that line to serve both the Arlington plant and the PUROX facility.

A two-inch potable water line is installed along Sand Dock Road to connect with the four-inch line from IBM. This is sufficient to satisfy the needs of the PUROX facility without adversely affecting the water requirements at the Arlington sewage treatment plant.

7.6.3 Process Water. Process water is used for fire protection, cooling tower makeup, and process control. All process water is supplied from the Hudson River through the process water pumping station, as described in Section 7.6.4.

Fire protection requires a peak supply of 1660 gpm. This water would be used only when an emergency from a fire arises. Untreated Hudson River water is suitable for this purpose.

Cooling tower makeup requires a maximum flow of 170 gpm. A description of the cooling tower is in Section 7.6.5. Cooling tower makeup water must be partially treated to remove suspended and dissolved solids. This is accomplished by a package treatment plant installed near the cooling tower pumps. The package treatment plant incorporates pretreatment, chemical feed, and filtration in one unit.

7.6.4 Process Water Pumping Station. A process water pumping station provides water for makeup water for the cooling tower

and standby water for fire protection. It is in the northwest corner of the site, adjacent to the railroad right-of-way, about 200 feet from the Hudson River. The floor of the pumping station is about two feet above the extreme high water level of the Hudson River, to avoid flooding.

A reinforced concrete pipe provides water from the Hudson River. A bar screen over the intake pipe prevents fish and other large materials from entering the pipe. The invert of the flared intake is six feet below the extreme low water level of the Hudson River. This assures a continuous water supply to the pumps. The intake pipe is supported above the river bed by concrete piers.

A section of the intake pipe must be jacked under the railroad tracks, while the remainder would be installed in open excavation. The intake pipe is installed with no slope.

A bar screen with a hand-operated trash rake provides a second mechanism to remove relatively large particles which might pass the external bar screen. A mechanical traveling screen provides continuous removal of smaller particles from the process water.

After passing through the screening devices, the water enters the wet well. Two fire pumps and two process water pumps are installed at this time, with space allowed for a future third process water pump.

Each of the fire pumps is driven by a 100-horsepower motor and is capable of pumping 1000 gpm at 265 feet discharge head. One would be operational, with the other acting as a standby. The pumps discharge to an eight-inch pipe.

Each process water pump is driven by a 20-horsepower motor, and is capable of pumping 170 gpm at 120 feet discharge head. One would operate, with the other acting as a standby. Ample room is allowed in the wet well to install a third process pump when the plant is expanded. The pumps discharge into a common four-inch pipe.

A two-ton hand-operated hoist is provided above the pumps. The hoist could be used to remove pumps or motors for maintenance or repair. Access to the building is through a pair of extended height Dutch-type doors, with the lower sections used for normal access and the upper sections used for access by the hoist.

The building has one ventilating fan and one electric unit heater. The building exterior is similar in appearance to the main processing building.

7.6.5 Cooling Tower. The PUROX facility requires 6000 gpm of water at 85 F for cooling and temperature control of the various processes. The quality of water should be noncorrosive and biologically inactive, however it need not be potable water. A once-through cooling system would require large pumps on the Hudson River with auxiliary power for use during power outages. Interfacing with regulatory agencies and permits for a thermal discharge into the Hudson River would also be required. A cooling tower which cools and recirculates the water would lower the water needs to that lost by evaporation and drift from the tower. Makeup water amounting to approximately 170 gpm is required for the cooling tower.

The cooling tower is capable of cooling 6000 gpm of water from 105 to 85 F, based on a 78-degree wet bulb temperature. A double flow, three-cell induced draft wooden framed tower will be erected on site. The overall tower dimensions are 73 feet long, 29 feet wide and 18 feet high. Each cell has a cast aluminum induced draft fan driven by a 60-horsepower motor. The tower would be erected to the northwest of the main processing building. Sufficient cool water is available in the tower to cool down the facility, should power failure occur, so auxiliary power is not needed for the makeup water pumps during power outages. Standby power is needed only to pump cool water from the tower to the PUROX units. Two 3000-gpm pumps with a third standby pump are provided. Each is driven by a 100 horsepower motor and discharges at 100 foot head.

7.6.6 Domestic Wastewater. Only domestic wastewater would be transported for treatment off site. (All other wastewater would be treated at the PUROX facility.) About 2000 gpd would be discharged to the sanitary sewer. This is equal to the amount of potable water used at the plant for the showers and lavatories. It is collected and discharged through an eight-inch diameter pipe to the inlet manhole at the Arlington sewage treatment plant. The pipe has cleanout connections every 300 feet.

7.6.7 Auxiliary Energy. Auxiliary energy is provided by propane gas and No. 2 fuel oil. Propane gas amounting to 40 standard cubic feet per hour (SCFH) at 10 psig is needed

continuously as a pilot for the flares. The torches for the converter tuyeres require 800 SCFH at 55 psig for converter startup prior to product gas production.

The propane system consists of two 1000-gallon tanks, a vaporizer which produces 75 psi gas, and two regulators to reduce the pressure to 55 and 10 psig as needed by the process. This equipment is opposite the employee parking lot on the south side of the property.

No. 2 fuel oil is required for wastewater incinerator startup, steam heat during the winter when PUROX gas is not available, mobile equipment fuel, and in the emergency generator during power outages. Incinerator startup is intermittent and requires about 200 gph at 110 psig. An oil pump provides the necessary pressure for the incinerator fuel.

About 5000 gallons of fuel oil per week is needed to heat the building under the most severe winter conditions. Oil would be used only when the converters are inoperative. The fuel would also power the mobile equipment. The front-end loaders use 10.7 gph, and the transfer tractor and open body dump trucks each use 19.3 gph. One front-end loader would be used during one shift, seven days per week. The transfer tractor and one open body dump truck would be used one shift, five days per week. Total weekly fuel consumption of the mobile equipment is therefore about 2100 gallons. The standby emergency generator would be used only during power outages. It consumes about 29 gallons of fuel oil per hour.

The oil storage tank provides a four week supply of oil during the peak demand period. This assumes that if oil is used

for heating, the converters are inoperative, and so other plant uses of oil are reduced. A 20,000-gallon storage tank would supply the plant needs under these conditions. The tank is behind the main processing building near the emergency generator building. Pumps for fueling the mobile equipment are also in this area.

7.6.8 Electrical Power. Electrical power is supplied to the plant by one Central Hudson 13.2 kilovolt (KV) overhead line stepped down to the plant voltage at two locations:

1. The main processing area, and
2. The cooling tower.

The riser is protected at each location by pole-mounted power fuses. Underground direct burial cables connect the step down transformers to the overhead line.

7.7 Building Areas

7.7.1 Administration Wing. The Administration wing is annexed to the northeast corner of the receiving area. The wing extends about 42 feet by 36 feet outside the main processing building. The scalehouse is incorporated as part of this wing.

The main entrance from the outside is through double glass doors leading to an entrance lobby. From there, a door leads to the administrative offices. Access from the outside on the north side of the plant is also provided into the main corridor. The main corridor leads to all areas within the administration wing.

The administrative offices consist of a 9-foot by five-foot reception area, separated from the clerical area by a counter. The clerical area is a 13-foot square, and has access to the superintendent's office, the file room, and the main corridor. The superintendent's office is 16 feet by 22 feet. The file room is six feet by eight feet. Details of the weighmaster area are discussed in Section 7.7.2.

Access to a men's room and women's locker room is from the main corridor. Access to a trucker's toilet is from within the tipping floor area.

7.7.2 Weighmaster Area. The scale is 15 feet from the plant entrance, and two feet from the rear of the administration wing. It is more practical to include the weighmaster area as part of the administration wing rather than to construct a separate scalehouse. Toilet facilities, heat, utilities, etc. become common to one area and reduce overall costs.

The weighmaster area is 13 feet by 12 feet and has access to the administration wing and the outside through the main corridor. This area contains all controls and equipment for scale operation. The area has windows on two sides to ensure visual contact with the scale, truck access areas, and the plant. All computer equipment for maintaining records and billings is in this area.

The weighmaster could receive payment or deliver receipts through a sliding glass window near the scale. The weighmaster area is raised two feet above the elevation of the remainder of the administration wing to facilitate transactions. The

weighmaster could have direct contact with the truck driver in the truck cab to exchange payments and receipts.

7.7.3 Motor Control Centers. All motor control centers throughout the plant are free-standing, NEMA Class II type B construction, NEMA 1 enclosure, 20 inches deep, 90 inches high. Draw out feeder unit types with suitable individual barriers are provided for easy removal and maintenance of any unit without the interruption of service or operation of any other unit. All motor starters are of the combination circuit breaker type and built in interchangeable modular combinations. Each combination magnetic starter is provided with a suitably sized 480/120 volt control transformer, three overload relays and the necessary selector switches, pushbuttons and indicating lights.

Starters for motors 100 horsepower and less are full voltage type. Motors larger than 100 horsepower are started by reduced voltage autotransformer type starters.

A 480-120/208V dry type transformer and a circuit breaker type lighting panelboard for lighting, receptacles and miscellaneous controls' power is housed in each motor control center. A continuous horizontal ground bus is provided throughout the entire length of each motor control center.

7.7.4 Electrical Substations. Two electrical substations are provided for the facility. The main processing area substation serves the refuse processing building, the PUROX area, and the cryogenic oxygen separator area. The substation consists of one 2,000 KVA transformer, 13.2 KV-480/277V. The transformer has a

primary load interrupter switch and is protected by power fuses. The secondary power from the transformer is connected through a 480V distribution switchboard in the control room.

The distribution switchboard is supplied with one 3000-ampere incoming circuit breaker. Three 1200-ampere frame circuit breakers supply power to the motor control centers for the processing area. One 400-ampere circuit breaker supplies power to distribution panel (DP-1), located adjacent to the administration area. One 1600-ampere circuit breaker supplies power to the PUROX System distribution panel. This distribution panel supplies power to the four motor control centers in the PUROX processing area and one motor control center in the cryogenic oxygen separator area. One motor control center is assigned to the refuse receiving area, the plant auxiliaries and the plant's common equipment. Two motor control centers serve the process lines (one per line). Three motor control centers are in the control room. A distribution panel on the refuse receiving area serves the administration building. Cables from the distribution switchboard to the motor control centers and from the motor control centers to the various equipment are carried on a cable tray system and further in metal conduits to the equipment.

The cooling tower substation is a 500 KVA pad-mounted transformer with high voltage current limiting loadbreak fuses in the transformer's primary compartment. Primary power is supplied to the transformer from the overhead line by underground direct burial cable. The secondary power is carried from the transformer to the motor control center through a

four-inch underground duct bank. The motor control center next to the south wall of the cooling tower is also supplied from the emergency generator. This double power feature secures a standby power source for the process cooling water pump through the automatic switch in the motor control center. This allows a safe plant shut down in case of loss of Central Hudson power. Cables are run in exposed metal conduits from the motor control center to the various equipment.

A feeder from the motor control center at the cooling tower supplies power to the process water pumping station.

7.7.5 Maintenance. A 43-foot by 49-foot maintenance area is provided adjacent to the processing area. The area has an overall clearance of 32 feet to the bottom of the roof beams. Two metal roll-up doors provide access to the outside. This area provides space for all plant maintenance, including replacing the refractory on the converter hearth. Front-end loaders could be stored in this area when not in use.

7.7.6 Mobile Equipment Storage. Mobile equipment comprises front-end loaders, transfer trailers and tractor and an open body truck. Front-end loaders and the transfer tractor could be housed inside the maintenance area when not in use. Transfer trailers for removing compacted refuse from the facility would be stored outside. One trailer would always be connected to the stationary refuse compactor so any refuse which should not be fed to the converter could be removed from the pit and stored prior to being transported to the landfill. The other trailer

would be stored outside in the vicinity of the stationary refuse compactor. The open body truck, used to haul slag to the market, would be stored outside on the paved slag storage area.

7.7.7 Employee Area. The employee area is enclosed within the main processing building and consists of a lunch room and men's locker room. The area is 44 feet long by 25 feet wide. The main control room is above this area.

The lunch room is 21 feet long by 15 feet wide. A kitchenette unit including stove, sink, cabinet, and counter space is provided.

The men's locker room consists of toilet facilities, showers, and lockers. The women's locker room is in the administration wing, and is discussed in Section 7.7.1.

7.7.8 Emergency Generator Building. The emergency generator building houses only the emergency generator. The building is behind the refuse processing building near the cooling tower.

The emergency generator is a 400-kW, diesel unit. It supplies standby power for the cooling tower pumping station and the fire pumps in the process water pumping station. The generator is skid mounted, complete with all controls and protection equipment. The emergency generator would start automatically upon loss of power on the motor control center's bus. The automatic transfer switch in the motor control center would open the transformer's side circuit breaker and close the

generator's side circuit breaker. This transfer would re-energize the motor control center's bus.

In case of total loss of Central Hudson's power, power would be supplied by the emergency generator to the process cooling water pumps and the fire pumps. The emergency generator capacity is adequate to start and run three 100 horsepower motors in addition to 15 kW auxiliary loads such as lighting, heating, etc.

7.8 Ancillary Equipment

7.8.1 Heating and Ventilating Systems. Areas where plant personnel work are heated. The main processing area is heated by steam unit heaters. Steam is provided by the waste heat boilers on the wastewater incinerators. The process water pumping station and cooling tower pumping station are heated with electric unit heaters. The control room and administration wing are heated and cooled by electric air conditioning units. The receiving area is not heated.

The main processing building, process water pumping station, and cooling tower pumping station are ventilated by exhaust roof fans. Air intake is from wall louvers or roof vents. The control room and administration wing are ventilated by the air conditioning units.

7.8.2 Odor and Dust Collection System. Odors are not expected to be a problem at the plant. Odors would be partially controlled by the dust control system. Equipment for further

odor control is not required.

Dust would be collected from conveyor transfer points and removed from the air stream by a bag filter. Dust hoods are installed where the trommel overs discharge into the shear shredder; above the trommel unders conveyor where it discharges onto the sized refuse conveyor; above the magnetic separator; and above the point where the bifurcated chute discharges onto the converter feed conveyor. The hoods are connected to a common main duct and transported to a bag-type dust collector.

The bag filter is 14 feet long, 9 feet wide, and 27 feet high. It contains about 3000 square feet of polypropylene media, with a capacity of 30,000 CFM (air to cloth ratio of 10:1). The dust collection hopper has a nine-inch diameter by ten-foot long screw conveyor powered by a one-horsepower motor, and a 12-inch rotary lock to discharge the dust. The system has a centrifugal fan that is suitable for handling an abrasive stream of air that contains dust particles. The fan is driven by a 75-horsepower motor. Dust removed from the filter is recycled to the converters.

7.8.3 Lighting. Plant illumination is provided by a combination of mercury, fluorescent and incandescent fixtures. High bay areas, such as the refuse receiving area and areas with ceilings 16-feet high or more, are illuminated by mercury fixtures. Low ceiling areas, offices, control room, and areas below platforms are illuminated by fluorescent fixtures. The type of fixture used in an area is according to the activity in the area. Industrial 15 percent upward light fixtures are

provided for the process area, cooling tower pumping station and the process water pumping station. Surface mounted and recessed fixtures are used in the offices and the administration building.

Outdoor and area lighting is provided by a variety of integral ballasted mercury vapor fixtures. Wall mounted fixtures are provided above all access doors. Flood lighting fixtures are installed on building roofs at appropriate locations to illuminate parking lots.

7.8.4 Front-End Loaders. Two four-wheel drive front-end loaders will be purchased for the PUROX facility. These would be used primarily for loading slag onto trucks, moving bulky items, removing snow, and, during emergency situations, loading refuse into the stationary compactor.

Each front-end loader is 145 horsepower and is equipped with a quick coupler-uncoupler for attachments. Each set of attachments includes a set of forks, a six-cubic yard refuse bucket, a dozer blade, and a 2-1/2-cubic-yard general purpose bucket. The tires are foam filled for long wear. The loaders could be stored in the maintenance area when not in use.

One 16-cubic yard dump truck is provided to remove slag. The truck is 240 horsepower and would be stored in the slag storage area when not in use.

7.8.5 Transfer Trailers and Tractor. Two 75-cubic-yard transfer trailers and one 290-horsepower tractor would transport refuse from the PUROX facility to the landfill when necessary.

Details of the amount of solid waste to be transported to the landfill are discussed in Sections 6.6 and 7.9.

The transfer trailers have overall dimensions of 39 feet long, 8 feet wide, and 13 feet high. The trailer is loaded by the stationary refuse compactor which is discussed in Section 7.3.7. A five-stage, hydraulically operated, telescopic cylinder exerting 85,000 pounds of force ejects refuse from the trailer. The cycle time for unloading is two minutes. Coupling hooks are used to mate the trailer with the refuse compactor.

7.8.6 Spare Parts. An inventory of spare parts would be maintained at the PUROX facility to minimize down time. The inventory includes most small replacable parts for conveyors and major pieces of equipment. Large replacable items such as motors or pumps would not be kept on hand. A spare hearth for the converter would be available to minimize down time during hearth relining, since the relining may take a few weeks. Tools needed to perform preventive maintenance and most small repairs would also be supplied. Spare parts and tools would be stored in the maintenance area.

7.8.7 Slag Storage. Slag is stored in an outdoor containment area near the PUROX processing area. The covered slag conveyor (see Section 7.4.4) delivers slag to the storage area and discharges into a hopper over the distributing conveyor. The distributing conveyor is a 35-foot long, 18-inch wide inclined conveyor which is pivoted at the feed end. This conveyor piles slag 10 feet high in a semicircular arc. The storage area is 75

feet by 80 feet, and is enclosed by a 10-foot high concrete wall to contain the slag. The entire area is paved, including the area to the access road to control product purity. Trucks would drive into the area, where slag would be loaded by a front-end loader. About one week's storage is provided in the pile, however, under emergency conditions, the front-end loader could move the slag to utilize additional space within the enclosure.

The pivoted section of the distributing conveyor is on an elevated platform, six feet above the storage area. The platform is semicircular, with a 15-foot radius. A travelling support structure with rubber tires for the conveyor is on the rim of the platform. The platform is provided to contain the slag and prevent it from spilling into the area of the support and pivot mechanisms.

7.8.8 Fire Control System. Automatic dry-type hydraulically-operated sprinkler systems are installed throughout the main processing building. Sprinkler heads have a 1/2-inch orifice and are fitted with fusible elements with a temperature rating of 165 F. The automatic sprinkler system is designed to meet all applicable codes and standards.

The hydraulic design depends on the specific needs of the areas. The following flow discharge densities are used for the conceptual design:

Offices	0.10 gpm/square foot
Employee area	0.10 gpm/square foot
Locker rooms	0.10 gpm/square foot
Tipping floor	0.15 gpm/square foot

Processing area	0.15 gpm/square foot
Shops	0.15 gpm/square foot
Pit area	0.20 gpm/square foot

Fire stations are provided in addition to the automatic sprinkler system, in several locations throughout the main processing building. Fire stations include hose cabinets with glass doors, hose rack, 100 feet of 2-1/2-inch hose, nozzle and valves.

Fire hydrants are outside the building to provide fire protection for areas remote from the plant. The hydrants are conveniently accessible to all areas where fire protection is needed.

7.8.9 Sludge Handling Equipment. The three sewage treatment plants in Dutchess County presently have sludge handling capabilities, as previously discussed in Section 4. The plants may or may not utilize the PUROX facility for sludge disposal, depending on the relative costs associated with the current sludge treatment method and the costs of delivery to the PUROX facility for disposal. Optional sludge handling equipment is planned for the PUROX facility. The equipment consists of a live bottom holding tank with a 25-ton capacity, cake breaker, positive displacement pump, and associated piping to feed sludge onto the converter feed conveyor. The equipment is in the ferrous metal handling area. It is not included in the cost estimate for the project, since it is optional. Installation would depend on demonstrated favorable economics.

7.9 Landfill Requirements

Section 6.6 discussed the origin of materials which are not expected to be handled by the PUROX facility. Planning for an overall solid waste processing facility includes the final disposition of all materials which would be collected. Additional handling, transportation, and disposal costs for materials not processed by the facility are included in the overall tipping fee. Details of the landfill disposal needs for the PUROX facility are contained in this section.

7.9.1 Materials to be Handled. Municipal solid waste from emergency processing plant downtime and bulky items would be handled by the landfill. Explosive, hazardous materials and liquid wastes would not be allowed at either the PUROX facility or the landfill. Any vehicles containing these materials would be turned away. It would be the responsibility of the carter to find a suitable disposal site for these materials.

Trees, brush, yard wastes (not ordinarily collected from residences by carters), street sweepings, and waste material from highway maintenance should not be delivered to the PUROX facility. These items are usually collected and disposed of by the municipalities in municipally-owned landfills.

The materials handled at the landfill would be of the same general nature as those handled at the PUROX facility, with the addition of bulky items. Also, it is presently planned that ferrous metal would be removed from the processing plant to be landfilled.

7.9.2 Location. Dutchess County has prepared a map outlining potential landfill sites in the County. The largest parcels are several hundred acres each. Most potential sites are in the Towns of Beekman and Unionvale. Between 50 and 150 acres of land would be required for landfilling for the 30-year design life of the PUROX facility. The wide range of acreage is due to the many variables involved with the final landfill design for Dutchess County. The area needed would depend on such factors as the area ultimately served by the County, (core area or entire County), control of refuse stream, enlargement of the PUROX facility, tipping fee, availability of alternate landfill areas, topography of selected landfill site, depth of landfill cells, and final grading and use of the landfill site.

An alternative to establishing a landfill in Dutchess County is to utilize the Orange County landfill in Goshen, New York. Several municipalities in Dutchess County are presently using that landfill. Orange County officials have indicated a willingness to discuss use of their landfill as a backup to the PUROX facility in the future.

The decision for the precise location of the County landfill lies with Dutchess County. For the purpose of this study, it is assumed that the Orange County landfill would be used. Using only State and County roads from the PUROX facility, a one-way haul distance of about 40 miles is anticipated. This haul distance is used to determine the travel time and cost of emergency transportation of normal solid waste, and the cost of hauling bulky waste and ferrous metals, from the PUROX facility to the landfill.

8. COST ANALYSIS

8.1 Land Acquisition

As previously discussed in Section 7.2.1, 11.74 acres of the New York Trap Rock property is required for the PUROX facility. Dutchess County retained the firm of L.T. Bookhout, Inc., a real estate consulting and appraising firm, to appraise the property. That firm used two methods to determine a value for the land. The first method, the direct sales comparison approach, yielded a value of between \$70,000 and \$76,000. The second valuation method, the residential land development technique, indicated a present market value range of \$68,000 to \$72,000. Appendix C contains a copy of that valuation. The Office of the Real Property Tax Service Agency of Dutchess County has appraised the property at \$82,200. An estimated land cost of \$80,000 is used for this study.

8.2 Construction Cost

Cost information for the construction of the PUROX facility has been compiled from several sources. Major equipment prices are based on manufacturers' cost submittals for fabrication, delivery, and installation at the site. Construction costs of a more general nature have been developed from recent bid costs for similar work, and from estimates by general contractors for specific work items. All costs are based on July, 1979 prices.

The overall construction cost for the PUROX facility is shown in Table 8-1. The ensuing sections (8.2.1 through 8.2.9)

TABLE 8-1

PROJECT CAPITAL COSTS

	GENERAL	WORK CATEGORY MECHANICAL	ELECTRICAL	TOTAL
Land Acquisition				80,000
Construction Costs				
Site Work	280,000			280,000
Refuse Processing Building	5,125,000	2,685,000	890,000	8,700,000
Purox Processing Area	610,000	10,070,000	460,000	11,140,000
Cryogenic Oxygen Separator	320,000	2,520,000	160,000	3,000,000
Cooling Tower	200,000	320,000	35,000	555,000
Process Water Pumping Station	195,000	75,000	25,000	295,000
Interconnecting Piping	90,000	175,000		265,000
Subtotal	6,820,000	15,845,000	1,570,000	24,235,000
Modifications at Fuel Users Plant				80,000
Mobile Equipment				300,000
Project Total				24,615,000

detail the items included in the construction costs for each aspect of the facility.

Each item is broken down into general construction, mechanical equipment, and electrical equipment. General construction costs include the following:

- Excavation and backfill
- Concrete foundations
- Subsurface concrete walls
- Superstructure steel framing
- Superstructure walls and roof
- Outside equipment foundations

Mechanical equipment for each part of the facility is itemized under the various subsections. Mechanical equipment costs include equipment fabrication and delivery to the PUROX site, support structures, installation and responsibility for start-up and shake-down. Costs for major equipment components are derived from manufacturer's submittals for the specific equipment as detailed in Section 7. Electrical equipment for each item includes the following:

- Switch gear
- Power distribution
- Motor control centers
- Lighting
- Emergency generator
- Communications
- Control circuits

8.2.1 Site Work. The site work components of construction include the following items:

Clearing and grubbing

Excavation and backfill (not part of buildings)

Drainage

Roads and other paved areas

Retaining walls

Fencing

Final grading and landscaping

8.2.2 Refuse Processing Building. The cost for the refuse processing building includes the general construction of the structure, electrical components associated with motor controls and the following mechanical equipment:

Scale and associated equipment

Cranes

Trommels

Shear shredders

Ferrous metal recovery equipment

Stationary refuse compactor

Conveying equipment

Heating and ventilating equipment

8.2.3 PUROX Processing Area. General construction in the PUROX processing area includes primarily equipment foundations and control room structures. Electrical equipment is limited to that specifically needed for the PUROX motor control centers and

associated equipment. Mechanical equipment includes the following:

- Refuse feeding system
- Converters and associated equipment
- Gas cleaning equipment
- Residue handling equipment
- Wastewater incinerators and waste heat boilers
- Gas quality control and metering equipment

8.2.4 Cryogenic Oxygen Separator. The construction cost for the oxygen plant includes general construction of equipment foundations, electrical components and motor control center, and the following mechanical equipment:

- Air filters, compressors, and pumps
- Heat exchangers
- Cold box
- Liquid oxygen and nitrogen storage tanks
- Associated piping

8.2.5 Cooling Tower. The general construction cost for the cooling tower includes the cooling tower foundation and the pumping station building. Mechanical equipment includes the following:

- Cooling tower
- Recirculation pumps
- Makeup water treatment system
- Associated piping

8.2.6 Process Water Pumping Station. General construction of the process water pumping station includes the building and Hudson River intake structure. Other piping is included in Section 8.2.7, Interconnecting Piping. Mechanical equipment includes:

- Screening equipment

- Process water pumps

- Fire pumps

8.2.7 Interconnecting Piping. Interconnecting piping comprises all piping except that used for drainage. Drainage is included in Section 8.2.1, Site Work. This section includes piping for:

- Process water

- Fire protection

- Sanitary wastewater

- Product gas to IBM

- Potable water

- Process steam

8.2.8 Modifications at Fuel User's Plant. The cost for modifications at the IBM boiler house will be borne by the PUROX facility. Associated costs include:

- Nozzle modifications

- Piping

- Interconnections with existing equipment

8.2.9 Mobile Equipment. The cost for mobile equipment includes the following:

Front end loaders and interchangeable attachments

Transfer trailers

Transfer tractor

Open body dump truck

8.3 Amortization of Capital Costs

State and U.S. Department of Energy grant funds are available to offset a major portion of the total capital costs for the project. N.Y.S. Department of Environmental Conservation Bond Act Project No. 3-MSWRR-002-Q, dated December 13, 1977 provides for grant funds for 50 percent of the project cost up to a grant amount of \$13,449,000. U.S. Department of Energy Grant No. EM-78-6-01-5143 provides for \$1,049,140., in addition to the amount already allocated, to develop the necessary plans and specifications for public bidding.

County officials have indicated that there will be no extraordinary legal costs for establishing an Authority or progressing with this project. Therefore, legal costs are not enumerated separately in determining amortization costs.

County officials have indicated that:

- the cost of bond issuance is estimated to be 4.2 percent of the bond issue
- interest during construction is estimated to be \$1,315,000
- Bond terms are to be 7.5 percent for 30 years

Bond issuance includes all legal fees associated with a bond issue plus the cost of an independent engineering evaluation and all other miscellaneous expenses such as engraving and printing.

Engineering costs to prepare plans and specifications for public bidding have been estimated. They include work by UCC as a subcontractor to CRVA. These cover engineering costs through Task V of U.S. Department of Energy Grant No. EM-78-6-01-5143 and assume that final design is an extension of this report with regard to site, plant size, and fuel usage. In addition, engineering costs have been estimated for the environmental assessment summary required by the terms of the agreement of N.Y.S. Department of Environmental Conservation Bond Act Project No. 3-MSWRR-002-Q. Engineering costs have been estimated for construction and start-up to include a resident engineer and an assistant for 130 weeks during the construction and start-up period. Based on the above, Table 8-2 tabulates the bond requirements and amortization rate.

The available grant funds have a major impact on the annual cost of amortization and on the overall economics of the PUROX facility. It should be understood that the size of this PUROX facility is somewhat smaller than the size the developer would normally consider to be economically attractive.

TABLE 8-2

ANNUAL AMORTIZATION COST

	TOTAL	AVAILABLE GRANT	REMAINDER
<u>Capital Costs</u>			
Land Acquisition	\$ 80,000		\$ 80,000
Purox Facility	24,235,000	\$12,117,000s	12,118,000
Modifications at Fuel Users Plant	80,000		80,000
Mobile Equipment	300,000	150,000s	150,000
Subtotal	\$24,695,000	\$12,267,000	\$12,428,000
<u>Technical Services</u>			
Engineering			
Tasks I & II	\$ 450,000		
Task IV Velzy	\$ 550,000	\$ 1,500,000f	
Task IV Union Carbide	950,000	250,000s	\$ 250,000
Task V	50,000		
Environmental Assessment	50,000	25,000s	25,000
Construction & Start Up	510,000	255,000s	255,000
Bond Issuance	625,000		625,000
Subtotal	\$ 3,185,000	\$ 2,030,000	\$ 1,155,000
<u>Interest During Construction</u>			\$ 1,315,000
Total			\$14,898,000
<u>Annual Cost of Amortization</u>			\$ 1,270,000

(s) N.Y.S. DEC Grant Funds
(f) U.S. D.O.E. Grant Funds

8.4 Annual Operating and Maintenance Costs

As described in Section 9, Union Carbide Corp. will be interested in operating the entire facility. The operating staff organization is displayed on Figure 8-1 and Table 8-3. The operating staff will be responsible for operation, preventive maintenance and minor repairs.

Major maintenance will be scheduled by the operating staff and will be accomplished by authorized representatives of equipment manufacturers where applicable or by other skilled contractors.

Union Carbide has suggested that accounts receivable and payable be handled by the Authority as a means of controlling and monitoring operations. The total number of transactions per month should not exceed 100; therefore this function could be handled on a part time basis by personnel on the County staff.

Costs for the following utilities have been estimated using current price schedules:

Electric

Fuel for vehicles and auxiliary fuel

Potable water

Liquid oxygen and nitrogen

Miscellaneous supplies

Necessary work to control the waste stream is assumed to be done by others on the project team to result in an average of 400 tons of refuse per calendar day received at the PUROX facility. This amounts to 145,000 tons per year. Of this, the PUROX facility will process 125,000 tons. The remainder, which includes the ferrous fraction removed during processing, must be

ORGANIZATION CHART

TABLE 8-3
OPERATING STAFF

<u>Administration</u>	<u>No. People</u>
Plant Superintendent	1
Administrative Assistant	1
<u>Operations</u>	
Shift Supervisor	5
Weighmaster/Relief Administrative Assistant	2
Crane Operator	4
Front End/Feeder Operator	4
Front End Day Operator	1
PUROX System Operator	5
Gas Cleaning Operator	5
Boiler/Cryo Day Operator	1
Laborer/Sweeper	2
<u>Maintenance</u>	
Mechanic/Electric Welder	4
<u>Truck Drivers</u>	
Slag Truck Driver	1
Ferrous/Refuse Truck Driver	<u>1</u>
TOTAL	37

disposed of in a landfill. The necessary transport vehicles, manpower, and fuel are covered in operating and utility costs. The tipping fee at the Orange County landfill is \$6.00 per ton at present.

The annual operating and maintenance costs are displayed on Table 8-4.

8.5 Annual Revenues

Revenues will be collected for the sale of product gas and slag. In addition, revenues will be collected in the form of a tipping fee to use the facility. A summary of revenues collected for the plant is shown in Table 8-4.

8.5.1 Fuel Gas. The amount of pyrolysis energy usable at the IBM plant has been shown previously in Table 5-1. IBM has offered to discuss purchasing the fuel gas for 100 percent of the value of alternate energy.

During the summer peak demand period (June 16 to September 15), electrical energy is used to replace fossil fuel to drive air conditioning equipment. The equivalent electrical energy value for 1979 was \$1.50 per million BTU's (MBTU). During the remainder of the year, oil is used as the boiler fuel. The 1979 value of oil is \$2.70 per MBTU. The value of PUROX fuel gas is calculated from Table 5-1 using the value of alternate fuel. During the summer peak demand period, 190,000 MBTU of electrical power would be replaced by fuel gas, at a value of \$1.50 per MBTU, or \$285,000. During the remainder of the year, 421,500 MBTU of oil would be replaced by fuel gas at a

TABLE 8-4

ANNUAL OPERATING COST & REVENUES

<u>AMORTIZATION</u> (30 years at 7½ percent)	\$1,270,000
--	-------------

OPERATING COSTS

Operating Contract	\$1,200,000
Maintenance	502,000
Utilities	
Electrical	387,000
Fuel	82,000
Water	2,000
Oxygen and nitrogen	24,000
Miscellaneous Supplies	52,000
Landfill Tipping Fee	126,000
Depreciation of Mobile Equipment	75,000
Sub Total	2,450,000

REVENUES

Tipping Fee (145,000 tons x \$16.00/ton)	2,320,000
Fuel	
IBM	1,423,000
Other	45,000
Slag	68,000
Sub Total	3,856,000

NET OPERATING SURPLUS	136,000
-----------------------	---------

value of \$2.70 per MBTU, or \$1,138,050. The total potential revenue from the sale of fuel gas is therefore \$1,423,050 per year.

It is of interest to note that Central Hudson Gas & Electric Corporation has indicated that the price they are currently able to pay for the fuel gas is \$1.99 per million BTU's. If all gas produced by the PUROX facility could be sold to Central Hudson, the income from gas sales would be 723,000 x \$1.99 or \$1,438,770. Of course, in order to transport gas to the Central Hudson, Danskammer Plant, capital and operating costs would increase significantly to cover the costs of additional gas drying, a longer pipeline, and gas compressors. The estimated additional capital cost for the pipeline (including one mile under the Hudson River), gas dryers, and gas compressors is \$3,600,000. The additional annual operating cost for electrical energy to drive the compressors (two 600-horsepower drive motors) is \$240,000.

8.5.2 Slag. Favorable responses were received from the slag marketing survey. Firms are willing to pick up slag at the facility for about \$1.00 per ton, or have it delivered for \$3.00 per ton. The PUROX facility includes provisions for the slag to be delivered, to avoid the need for a large storage pile. The revenues for slag sale are therefore estimated at \$3.00 per ton.

From the steady-state mass balance (Figure 6-1), 366 pounds of slag are produced per ton of refuse. On an annual

average basis, 125,000 tons of solid waste would be processed by the plant. This would produce about 22,700 tons of slag per year, for an annual plant revenue of \$68,000.

8.5.3 Tipping Fee. The major revenue to the PUROX facility will be the tipping fee. A fee of \$16.00 per ton of refuse received at this facility is recommended for this report as necessary to meet costs while providing for a modest operating surplus.

Possible alternate disposal facilities available for Dutchess County include transportation in 75 cubic yard transfer trailers to the Orange County landfill, and disposal in landfills in Dutchess County. Table 8-5 shows the cost for transportation to the Orange County landfill. This is the hauling cost for those that own and operate transfer facilities to transfer refuse from packer trucks to transport trucks. If transfer facilities have to be built, owning and operating costs of these transfer facilities are estimated at \$2.00 to \$4.00 per ton.

The Orange County landfill is used in this evaluation as it appears to be well operated with capacity to remain in service for many years. Other landfills might be developed and used in Dutchess County. However, this should not affect the economic evaluation radically. For example, use of the large landfill in Amenia would entail a sixty mile round trip but the tipping fee there at present is \$9.00 per ton, which more than offsets the lower transportation cost when compared to the Orange County landfill. New landfills, operated in accordance with the Code Rules and Regulations established by the N.Y.S.

TABLE 8-5

TRANSPORTATION COSTS
TO ORANGE COUNTY LANDFILL

Fuel & Oil	\$.26/mile	
Tires	.14	
Maintenance	.11	
Depreciation	<u>.80</u>	
Sub Total	\$1.31 x 80 miles =	\$105
Driver		<u>55</u> \$160/trip
At 16 tons/trip cost/ton is		\$10.00
Tip Fee		<u>6.00</u>
TOTAL cost per ton		\$16.00

Department of Environmental Conservation, can be expected to require tipping fees in excess of this amount.

An additional positive factor in the proposed PUROX facility is that the tipping fee, at \$16.00 per ton, should be fairly stable over the life of the plant while refuse transportation and landfill operating costs will, no doubt, escalate over these same years. Thus, from Table 8-4, it will be observed that amortization costs are fixed while over 50 percent of the operating costs, which will escalate, are offset by income from the sale of fuel. Income from the sale of fuel, based on present trends, will escalate more rapidly than operating costs. On the other hand, the major portion of the transportation/landfill alternate cost is operating cost which will escalate with time increasing the present differential in favor of the PUROX system.

9. OPERATING CONTRACT WARRANTIES

The cost of the operating contract includes the supervision and operating labor to operate the complete facility. As part of the contract, UCC will:

Weigh and receive refuse

Operate front-end processing system

Operate cryogenic oxygen separator

Operate PUROX System

Operate other on-site facilities including

hauling of surplus refuse to a landfill

located as indicated earlier in this Report

Perform regular preventive maintenance and

small repairs

Transmit billing information to the Authority

for processing

Arrange for contracted maintenance as required

The operating contract would include suitable liability insurance. Other operating costs, such as power, maintenance and repair will be paid by the Authority as part of the overall facility operating costs. The estimated cost of the operating contract is expressed in July, 1979 dollars and would be subject to change in future years by means of a mutually acceptable index.

Union Carbide Corp. will warrant the quality and quantity of the PUROX fuel gas, electric power consumption, and oxygen consumption. After the shakedown period of the PUROX System, UCC would conduct an acceptance test of approximately one

month's duration to demonstrate that the warranted items have been achieved. If the facility fails to pass the acceptance tests, UCC will, at its own expense, correct the PUROX System such that it passes the acceptance tests, or will pay a negotiated penalty if it is unable to correct the warranted items. The overall intent of the warranty document will be to assure that the County does not suffer a financial penalty if the PUROX System does not perform as warranted by UCC.

APPENDIX A

"Preliminary Geotechnical Study, Proposed
Pyrolysis Program, Dutchess County, New York"

REPORT OF PRELIMINARY
GEOTECHNICAL STUDY
PROPOSED PYROLYSIS PROGRAM
DUTCHESS COUNTY, NEW YORK

For

CHARLES R. VELZY ASSOCIATES, INC.

By

CONVERSE WARD DAVIS DIXON

2 February 1979

Project No. 78-8293-01

ConverseWardDavisDixon

Geotechnical Consultants

2 February 1979

Charles R. Velzy Associates, Inc.
355 Main Street
Armonk, New York 10504

Attention: Mr. Charles O. Velzy, P.E.

Report: Preliminary Geotechnical Study
Proposed Pyrolysis Program
Dutchess County, New York
(78-8293-01)

Gentlemen:

This report covers preliminary geotechnical investigations for three sites under consideration for locating the referenced project in Dutchess County, New York.

PROJECT DESCRIPTION

We understand that the proposed construction will be a facility to process refuse. The primary equipment may include conveyors, shredders, compactors, etc., and we anticipate that, in addition to their static loads, some of this equipment will impose dynamic loads on their foundations. It is tentatively estimated that the area to be developed would have plan dimensions on the order of 600 by 300 feet.

PURPOSE AND SCOPE

The purposes of this investigation are to characterize and evaluate subsurface physical conditions based on available data; and to provide preliminary recommendations on feasible methods of foundation design and construction, for each site under consideration, as influenced by subsurface physical conditions.

The scope of services performed was as follows:

1. Collected and reviewed available geologic and subsurface data for each site.
2. Obtained and studied stereoscopic pairs of aerial photographs of the sites.
3. Performed geologic field reconnaissances.
4. Visited the offices at the Arlington Sewage Treatment Plant and the Beacon Sewage Treatment Plant to review available construction records.
5. Completed a preliminary analysis of the available subsurface data, and evaluated the feasible foundation types.
6. Prepared this report containing our general conclusions.

EVALUATION AND CONCLUSIONS

SITE NO. 1

Location

The site is located south of the existing Arlington Sewage Treatment Plant in the Town of Poughkeepsie. The prominent adjacent site features are IBM Road to the north, Barnegat Road to the east and the Hudson River to the west; the site is indicated on Figure 1.

Site Conditions

Topography: The site attains its highest elevation in the eastern central portion, sloping down to the north and south from this central area. There is a saddle in the center of the site, connecting with another topographic high on the west side of the site. Slopes on the west side exceed 40% (near the railroad cut), and range from nearly horizontal to about 7.5% on the rest of the site.

Soils: Based on field reconnaissance, logs of test borings for the existing treatment plant, and air photo data, the soil conditions are anticipated to be as follows:

SCALE 1"=2000'

MAP SOURCE: BASE MAP WAS ADAPTED FROM U.S.G.S. MAP POUGHKEEPSIE, N.Y. QUADRANGLE, 7.5 MINUTE SERIES, 1957. (BASE MAP MAY NOT REFLECT RECENT CARTOGRAPHIC CHANGES)

SITE No.1 LOCATION MAP

PROPOSED PYROLYSIS PROGRAM
DUTCHESS COUNTY, NEW YORK
FOR CHARLES R. VELZY ASSOC.

Project No.

78-8293-01

Figure No.

1

1. A thin layer of dense glacial till is present at the surface. The thickness of the glacial till is expected to vary from a few inches to no more than about 10 feet; borings for the existing treatment plant show the till to be no more than about 4 to 5 feet deep at that location.
2. Recently placed fill over a relatively small area, directly south of the existing treatment plant; the fill appears to be of limited thickness.
3. Bedrock comprising gray shale exists near or at shallow depths below the surface; bedrock exposures are quite frequent and generally control the topography. The rock exposures are steeply tilted, and dip to the southeast; visual observation of the exposed rock surfaces shows that the near-surface material consists of relatively soft slate with frequent thin bedding planes.

Site Development

Because of the rugged topography of the site, cutting and filling will be required to level the site for development. Blasting will be required for rock removal, and suitable materials will have to be imported from off-site for use in controlled structural fills to achieve final grades.

Foundations

For the soil conditions encountered, shallow foundations could be used for support of the structure and equipment; the foundations could be supported on rock and/or glacial till and controlled structural fill. However, because of the dynamic loads that would be generated by equipment such as the shredders, it would be desirable to support the foundations for this equipment on rock to minimize the overall effects of the vibrations on the facility. Floor slabs could be supported on grade in the glacial till and/or controlled structural fill. Allowable bearing pressures for the design of the foundations would be as follows:

1. Controlled Structural Fill - 6.0 KSF
2. Glacial Till - 6.0 KSF
3. Rock - 16.0 to 24.0 KSF

Groundwater Control

The site appears to drain quite readily and there was no evidence of springs or ponding of water on the site. Therefore, control of groundwater during and after construction would not be expected to present any problems.

SITE NO. 2

Location

The site is located in Wappinger Falls. The prominent adjacent site features are Cobalt Lake to the north, Sheafe Road to the east and the Hudson River to the west; the site is shown on Figure 2.

Site Conditions

Topography: The east portion of the site exists in its natural state and slopes downward to the west at about 10% to 15%, from about elevation 200 to elevation 60. The west portion of the site consists of an old sedimentation pond which was associated with the quarry to the north. The pond has been filled to approximate elevation 60.

Soils: Based on field reconnaissance, logs of borings, and air photo data, the soil conditions are anticipated to be as follows:

1. The old sedimentation pond has been filled with loose sediments from the quarry operation over a period of many years. We theorize that the pond had been previously mined for sand and/or rock, and that the loose sediments in the pond may be as much as 100 to 125 feet deep, based on our observations in the quarries still in operation.
2. Dense glacial till is present at the surface in the east portion of the site. Typically the glacial till is on the order of about 8 to 10 feet deep, but it was recorded to be as much as 18 feet deep in the south portion of the site. The till is expected to consist of a heterogeneous mixture of sand, gravel and boulders with varying percentages of silt and clayey silt.
3. Bedrock consisting of shale underlies the glacial till, and probably the sediments in the old pond.

SCALE: 1"=2000'

MAP SOURCE: BASE MAP WAS ADAPTED FROM U.S.G.S. MAP WAPPINGERS FALLS, N.Y. QUADRANGLE, 7.5 MINUTE SERIES, 1956. (BASE MAP MAY NOT REFLECT RECENT CARTOGRAPHIC CHANGES)

SITE No. 2 LOCATION MAP

PROPOSED PYROLYSIS PROGRAM
DUTCHESS COUNTY, NEW YORK
FOR CHARLES R. VELZY ASSOC.

Project No.

78-8293-01

Figure No.

2

Site Development

There is an existing electricity transmission line crossing along the eastern portion of the site. Tax maps furnished to us show that the property east of the transmission line is under private ownership; therefore, we assume that the area available for development will be west of the right-of-way for the transmission line. From a geotechnical engineering standpoint, two different methods of site development would have to be considered for the site, as follows:

1. Immediately west of transmission right-of-way: This includes a narrow strip (about 450 feet wide), still in its natural state, sloping downward to the west at about 15%. Dense glacial till is at the surface to depths on the order of 10 to 20 feet, with shale and possibly dolomite (bedrock) below the till; however, there are indications of relatively shallow rock at the higher elevations. In order to develop this area, significant cuts will be required into the hillside, and will necessitate a substantial amount of blasting for the rock excavation. Based on a final site grade of elevation 70, it is estimated that rock cuts as deep as 30 feet may be required to develop a building site about 300 feet wide. Side slopes on the order of 1:3 (horizontal:vertical) would be required for the rock, and about 2:1 for the overlying glacial till.
2. Sedimentation Pond: The loose sediments in the pond have no presumptive bearing value, and deep foundations (piles) would be required for support of structures and equipment in this area. The lateral extent of the pond is shown clearly on Figure 3. The depth to the bottom of the loose sediments would have to be confirmed with borings.

Foundations

Spread footings bearing in the natural materials could be used for support of building and equipment foundations in the area immediately west of the right-of-way for the transmission line, with all floor slabs supported on grade. The allowable bearing values for footings are as follows:

Glacial Till - 6.0 KSF

Bedrock - 24.0 KSF

SCALE 1"=500'

PHOTO SOURCE: BASE PHOTO WAS ADAPTED FROM AN AERIAL PHOTO BY LOCKWOOD, KESSLER & BARTLETT, INC., ONE AERIAL WAY, SYOSSET, L.I., N.Y. DATED 4-08-67, No. 7527, 1309 34-2651.

PROPOSED SITE

PROPOSED PYROLYSIS PROGRAM
DUTCHESS COUNTY, NEW YORK
FOR CHARLES R. VELZY ASSOC.

Project No.

78-8293-01

Figure No.

In the pond area, piles driven to rock with design capacities up to 240 kips could be used for support of the facility (foundations and floors). As previously indicated, borings will be necessary to determine the depth of the loose sediments in the ponds. However, based on our observation in the rock quarries still in operation, it is likely the unsuitable materials in the pond could be as deep as 100 to 125 feet.

Foundation construction costs will be relatively high for this site; an economic comparison of the cost of site development and foundation construction for the two separate and distinct subsurface conditions would have to be made after borings in the pond are completed.

Groundwater Control

There is evidence of some channelized stream flow across the site, which may be the result of springs. Therefore, we would anticipate some flow through the joints where excavations are made into the rock. The flow should not be too significant; perimeter and/or underdrains could be provided to intercept and remove the water by gravity drainage.

SITE NO. 3

Location

The site is located to the south of the existing Beacon Sewage Treatment Plant, in Beacon, New York. The prominent adjacent features are the New York, New Haven and Hartford Railroad to the south and west and the Hudson River on the west; the site is indicated on Figure 4.

Site Conditions

Topography: The site slopes downward to the west at an average slope of about 10%. The west portion is fairly flat, having been substantially altered in recent times by the placement of fill materials. Aerial photos dated April 1967 show that lakes covered about 60% of the site (see Figure 5) before the existing landfill was placed; presently the site has been filled to approximately 20 feet above the level of the adjacent sewer treatment facility.

Soils: Based on field reconnaissance, logs of borings, and air photo data, the soil conditions are anticipated to be as follows:

SCALE: 1"=2000'

MAP SOURCE: BASE MAP WAS ADAPTED FROM U.S.G.S. MAP WEST POINT, N.Y. QUADRANGLE, 7.5 MINUTE SERIES, 1957. (BASE MAP MAY NOT REFLECT RECENT CARTOGRAPHIC CHANGES)

SITE No.3 LOCATION MAP

PROPOSED PYROLYSIS PROGRAM
DUTCHESS COUNTY, NEW YORK
FOR CHARLES R. VELZY ASSOC.

Project No.

78-8293-01

Figure No.

4

SCALE: 1"=500'

PHOTO SOURCE: BASE PHOTO WAS ADAPTED FROM AN AERIAL PHOTO BY LOCKWOOD, KESSLER & BARTLETT, INC., ONE AERIAL WAY, SYOSSET, L.I., N.Y. DATED 4-04-67.

PROPOSED SITE

PROPOSED PYROLYSIS PROGRAM
DUTCHESS COUNTY, NEW YORK
FOR CHARLES R. VELZY ASSOC.

Project No.
78-8293-01

Figure No.

5

1-31-79 by JDC

Approved for publication

FORM NO. D56/78

1. Sanitary landfill materials below the surface, in the range of 20 or more feet deep. Older fills comprising bricks, cinders, etc., may also be present below the sanitary landfill.
2. Varved clays and silts below the landfill, with the bottom of the stratum extending to about 60 to 100 feet below the surface. The materials are potentially compressible and would be unsuitable for support of the foundation loads.
3. Glacial till which is an excellent stratum to support deep foundations is below the varved clay.
4. Bedrock comprising shale is below the glacial till.

Site Development

The significant depth of the existing sanitary landfill and underlying miscellaneous fill precludes the excavation and replacement of these materials with a controlled structural fill to support the facility on shallow foundations. Therefore, deep foundations (piles) bearing in the competent underlying strata will be required to support the building and equipment loads.

Foundations

The piles for foundation and floor support will have to be founded in the dense glacial till and/or the underlying bedrock. Design capacities of up to 120 kips would be appropriate for piles founded in the glacial till, and up to 240 kips for piles founded on rock. The existing fill will consolidate and settle with time, resulting in negative skin friction and "downdrag" on the piles; therefore, the net capacities for design will have to be reduced to account for the "downdrag". The pile types which could be considered for the project would include: concrete-filled pipe or shell piles, steel H-piles and pre-cast concrete piles; however, because of the potential corrosivity of the materials in the landfill, extensive and costly corrosion protection methods may be required for pipe and steel H-piles.

Groundwater Control

Groundwater at the site would be controlled by the level in the adjacent Hudson River. Since the site has been filled to levels substantially higher than the river, groundwater control should not be a significant factor for the proposed development and construction.

Gas Production

The sanitary landfill can be expected to generate combustible gases and, therefore, a gas collection and positive venting system would be required below all equipment foundations and floor slabs.

SITE SELECTION

From a geotechnical engineering standpoint, Site No. 1 would appear to be most favorable for the planned construction; shallow foundations could be used for support of the building and equipment with the floor slabs supported on grade. Moreover, the relatively shallow depths to bedrock at this site will simplify the design and reduce construction costs of the foundation for equipment imposing dynamic loads. Additional investigation, including field explorations and laboratory testing, will be required to accurately define the soil conditions when the site for the facility is selected.

Thank you for the opportunity of serving you on this project. If you have any questions, please call us.

Very truly yours,

CONVERSE WARD DAVIS DIXON

Joseph D. Chastanet
Joseph D. Chastanet, P.E.

RSW:JDC/jrs

Submitted: 5 copies

DUTCHESS COUNTY DEPARTMENT OF PUBLIC WORKS

Engineering Division

MEMORANDUM

To: Commissioner James Spratt, P.E.

From: P. N. Anagnos

Date: May 14, 1979

Re: Traffic counts near site of proposed pyrolysis plant.

Attached are tabulations and location maps of traffic counts on County and State roads in the vicinity of the proposed pyrolysis plant site adjacent to the existing Arlington Sewer Plant.

All of the counts on County Routes 48 and 76 were taken in 1978 and those on U.S. 9 in 1977. Each count listed is an average of a five day continuous period on an hourly basis. There is no differentiation between automobiles and trucks or buses - the percentage of trucks/buses on county roads is probably very low. The peak hours are obvious and are influenced primarily by IBM related traffic.

The first impression from information contained in your memorandum is that, with some control of operating hours at the plant, the general impact on existing traffic at off peak hours will be minimal.

Atts (2)

v

cc W. E. Bathrick

1979 MAY 15 PM 11:26

WEEKDAY TRAFFIC COUNTS

7 a.m. - 6 p.m.

<u>No. & Location</u>		<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
CR 78	(1) E & W	578	441	194	201	457	411	280	218	410	618	297
	(2) E	77	123	110	126	402	225	147	162	379	777	354
	W	548	331	106	104	109	267	159	94	100	45	30
	(3) E	91	131	133	107	591	258	167	192	555	1060	294
	W	802	528	209	110	107	270	208	132	95	76	42
	(4) E	98	148	137	140	571	258	181	156	645	1460	395
	W	1266	426	134	108	153	451	189	131	142	79	33
	(5) E	124	137	126	141	342	247	168	177	321	674	323
	W	639	358	102	102	130	292	164	118	93	78	75
	<hr/>											
CR 76	(6) E	198	256	181	177	448	294	230	215	583	947	362
	(7) W	540	188	115	117	169	246	176	204	232	174	185
	(8) W	94	32	28	38	70	93	54	73	68	70	93
	(9) E	110	188	198	265	526	429	391	432	471	682	590
	(10) W	366	85	60	88	118	149	105	154	224	93	65
	(11) W	125	113	119	98	94	106	95	101	108	109	112
	(12) E	159	185	164	318	612	371	184	344	705	832	453
	(13) W	513	287	62	52	58	167	87	67	103	53	42
	(14) W	1264	688	194	167	238	416	311	268	356	189	223
	(15) E	284	358	279	339	691	544	622	529	811	1471	1029
248	(16) E	60	98	110	87	129	136	128	150	176	162	214
	W	276	377	372	352	396	390	340	338	383	337	351

WEEKDAY TRAFFIC COUNTS- contd.

7 a.m. - 6 p.m.

CR 76	No. & Location		<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
	(17)	E W	346 1559	427 1124	331 621	419 586	812 617	528 837	628 725	666 667	993 743	1574 568	1240 594
<hr/>													
6 US	(18)	N & S	2170	1790	1420	1460	1670	1850	1720	1780	2010	2290	2150
	(19)	N S	1040 2020	1410 1310	1030 770	940 830	1140 950	1171 1250	1050 1150	1090 1120	1410 1370	1880 1360	1510 1340

[illegible]

DUTCHESS COUNTY DEPARTMENT OF PUBLIC WORKS TRAFFIC CONTROL SURVEY			
Project	Location		Notes
	CR 48 I.B.M. RD. (RUDCO RD)	P000-000004	
Interviewed by	JAMES SPRATT, P.E. Project Engineer of Dept. of P.W.	Date: 12-15-78	Sheet 1 of 2
Interviewed by	PETER M. MAGNAGORE Traffic Control Technician	Date: 1-8-1980	Sheet 2 of 2
		Sheet 1 of 1	Sheet 2 of 2

APPENDIX C

Property Appraisal by L.T. Bookhout, Inc.

May 30, 1979

Mr. Gregory Bosaz, Jr., P.E.
Project Coordinator
Dutchess County Department
of Solid Waste Management
22 Market Street
Poughkeepsie, New York 12601

Dear Mr. Bosaz:

REFERENCE: Pyrolysis Project Site
Sand Dock Road
Town of Poughkeepsie

In accordance with your request, I have made a preliminary study of the above referenced property as of May 2, 1979. This preliminary study consisted of:

- 1) physical inspection and inventory of the property,
- 2) research to determine highest and best use,
- 3) preliminary direct sales comparison approach,
- 4) preliminary land development approach,
- 5) correlation and final value range estimate,
- 6) research and report of any unusual legal, physical, locational or other factors affecting the subject site.

The physical inspection of the subject property revealed a rather rugged, rolling topography with a gradual descending grade from east to west. This grade becomes cliff-like at the western terminus overlooking the railroad tracks and Hudson River. The parcel has approximately 950 feet of frontage along the northwestern side of Sand Dock Road, which according to the Town of Poughkeepsie is a public thoroughfare. However, this road is only improved as far as the Town of Poughkeepsie sewer plant located just north of the subject property. From that point south, the road is a narrow, dirt right-of-way with occasional outcroppings of bluestone and other bedrock in its path. Approximately 85 percent of the parcel--that is, excluding the westernmost cliff region, is an undulating

Mr. Gregory Bosaz, Jr.
Page 2
May 30, 1979

plateau with what appears to be shallow soil to bedrock. There are numerous woodland pools and pockets of water scattered throughout the site, especially in the northeasternmost corner. The parcel is approximately 80 to 90 percent wooded with medium-growth trees and smaller saplings and some scattered brushland. There are also scattered pockets of cleared land.

The neighboring land on the southeast side of Sand Dock Road opposite the subject is unimproved woodland with a general rolling terrain. Across from the northern edge of the subject there is a 1-acre residential lot, which is also unimproved. Immediately north of the subject property is the Town of Poughkeepsie Arlington Sewage Treatment Plant and immediately north of this is the property of the I.B.M. Poughkeepsie facility.

The sewage treatment plant is located on an irregularly shaped parcel with narrow frontage on Sand Dock Road and the improvements to the parcel are located in a depression toward the center and the entire perimeter is enclosed with a 7-foot anchor fence. Along the southern line of the sewer plant property and the northern line of the subject property there are numerous trees, some of which are evergreens and provide a visual barrier of the plant itself.

The western terminus of the property overlooks the Hudson River with a commanding vantage point along its approximate 860 feet. At this point, the property is approximately 30 to 35 feet above the M.T.A. tracks.

Before the appraisal process for the subject property could commence, it was necessary first to determine its highest and best use. The definition of this concept is submitted as a part of this report in the Addenda. The first test to which the subject property must be put is that of its legal capabilities. It is currently zoned RC - Recreation/Conservation, which according to the Town of Poughkeepsie zoning ordinance adopted in 1974 has permissible uses for agricultural, golf courses or country clubs, private and social clubs of either the indoor or outdoor type, parks, playgrounds and temporary buildings for construction purposes. The subject parcel could comply with all setback and coverage requirements for any of the permitted uses under the RC zoning. Probably the most difficult requirement would be that of on-site parking, but because of the extensive frontage and adequate lot depth, this could also be met. Even with the physical problems of the site, it is the appraiser's opinion that it can be adapted to any of the uses stipulated under the RC zone. It is also felt that the site meets the criteria of appropriate use and feasibility of use, even though the market for recreational land is rather specialized and shallow.

The possibility of a zoning change to something other than RC was explored with officials of the Town of Poughkeepsie. Mr. Wilson Shook, the town planner, indicated that he would not recommend any change in zoning to any of

the commercial or industrial classifications. He feels that the site is not physically adapted to any of these uses and that because of its location on the river it enjoys the status of a unique environmental situation. However, this particular RC zone in which the subject is located is one of only three areas so designated in the Town of Poughkeepsie lying along the Hudson River. One is a very small tract upon which is located the Pirate Canoe Club, which predated the zoning ordinance. The other is a small parcel of land in the Hamlet of New Hamburg which extends into the river to the west of the M.T.A. tracks. All other lands along the east shore of the Hudson River in the Town of Poughkeepsie are zoned either industrial, multi-family, single-family residential or quarry. As the selection of this particular area to be zoned RC may be construed by the property owners involved to be confiscation of property without just compensation, and as these same owners might possibly bring suit against the Town, the possibility of a zoning change is relevant. Mr. Shook conceded that in the face of a court suit by a property owner in this area, the Town might grant a zoning change to R-20 or residential with 20,000 square foot lots.

The first valuation process, therefore, that was undertaken was a preliminary direct sales comparison approach. The rationale behind this method was to locate, research and inspect sales of properties comparable to the subject property, making necessary adjustments to the sale properties for quantitative and qualitative differences. This approach was used to test the hypothesis that the highest and best use is for development of a social or recreational facility. Sales were located in the Town of Poughkeepsie that were either in this RC type zoning district or in a flood plain or merely parcels that were purchased for the express purpose of recreation or conservation.

The second method of valuation used was the land development technique. In this method a hypothetical subdivision is designed and a yearly cash flow grid is constructed wherein all development costs are deducted from gross lot sales in that particular year, yielding a cash flow to the investor. These yearly cash flows are then discounted at the appropriate rate to arrive at a present worth of each. These discounted cash flows are then totaled, giving a present value of the entire parcel.

The first valuation method mentioned above--that is, the direct sales comparison approach utilizing sales of recreation and/or flood plain lands, yielded a range of value of \$70,000 to \$76,000.

The second valuation method, the residential land development technique, indicated a present market value range of the subject parcel of \$68,000 to \$72,000.

While the two value ranges are very close in terms of actual dollars in total and on a per acre basis, the method and hypothesis forecasting recreation and/or conservation use should be given the greatest weight. This use of the property can be effected immediately without any uncertainty of securing a change in zoning, which is the case under the residential land development theory. While, as mentioned before, the market for recreational property is very specialized and shallow, this method of valuation involves fewer assumptions and conditional situations. Besides the legal problem of effecting a zoning change for residential use, there is the question of market resistance for the proximity of the sewage plant. The proposed building lots would command a spectacular panoramic view of the Hudson River and at the same time are located in a centralized convenient area, but the stigma and the actual detrimental conditions of living next to the sewer plant may override the normal desirability of lots fronting on the river. At this point, we have found a mixed reaction from area brokers, builders and potential buyers for such a residential subdivision. An attempt was made in the calculation of gross sales from the lots in the land development technique to account for market resistance, especially to the lots nearest the plant, but this adjustment process was difficult and is more speculative in nature due to the lack of solid market evidence.

Therefore, stressing the direct sales comparison approach as developed in Method No. 1, we have estimated that the preliminary market value range of the subject property as of May 2, 1979 is \$65,000 to \$75,000.

The most relevant factors regarding this parcel which were uncovered in the preliminary study were:

- 1) necessity of effecting a zoning change from RC for any use other than social club, fraternal pavilion, playground or park,
- 2) development costs of improving Sand Dock Road to the subject site,
- 3) extension of sewer and water to the site,
- 4) probability of excavation difficulty at the site,
- 5) spectacular views of the Hudson River from the site,
- 6) close proximity to the Arlington Sewage Treatment Plant,
- 7) convenient location to employment centers, shopping, schools, etcetera.

It should be clearly understood that an appraisal has not been made of the above referenced property and that this letter does not constitute an appraisal

Mr. Gregory Bosaz, Jr.
Page 5
May 30, 1979

report, nor should it in anyway be construed as same. It should also be thoroughly understood that the range of value approximated herein is subject to adjustment upon completion of an appraisal.

If you have any questions after your review of this material, please do not hesitate to contact us. Thank you for the opportunity to serve you.

Very truly yours,

L. T. BOOKHOUT, INC.

A handwritten signature in dark ink, appearing to read "Leland T. Bookhout". The signature is written in a cursive, flowing style.

Leland T. Bookhout, M.A.I. - S.R.E.A.

LTB:km
Enclosure

PHOTOGRAPHS OF THE SUBJECT PROPERTY

Date Taken: May 2, 1979

Taken By: C. Richard Tobias

Looking southwest
along Sand Dock
Road

View of bluff at
western end of par-
cel above railroad
tracks

Looking northwest
across northern end
of parcel

PROPERTY PLAT

DEFINITION OF MARKET VALUE

The definition of market value is the highest price in terms of money which a property will bring in a competitive and open market under all conditions requisite to a fair sale, the buyer and seller, each acting prudently, knowledgeably and assuming the price is not affected by undue stimulus.

Implicit in this definition is the consummation of a sale as of a specified date and the passing of title from seller to buyer under conditions whereby:

1. Buyer and seller are typically motivated.
2. Both parties are well informed or well advised, and each acting in what he considers his own best interest.
3. A reasonable time is allowed for exposure in the open market.
4. Payment is made in cash or its equivalent.
5. Financing, if any, is on terms generally available in the community at the specified date and typical for the property type in its locale.
6. The price represents a normal consideration for the property sold unaffected by special financing amounts and/or terms, services, fees, costs or credits incurred in the transaction.

HIGHEST AND BEST USE

This principle of real estate valuation is defined as, "that reasonable and probable use that will support the highest present value, as defined, as of the effective date of the appraisal. Alternatively, that use, from among reasonably probable and legal alternative uses, found to be physically possible, appropriately supported, financially feasible, and which results in highest land value."¹

Certain criteria must be met in the economic analysis to distinguish highest and best use. These are:

1. Legal Use -	Is it permissible, therefore, possible?
2. Possible Use -	Is the site, or can it be, physically adapted?
3. Appropriate Use -	Are the necessary supporting facilities available; such as water, sewer, roads, supporting uses?
4. Feasible Use -	Does it appear to make economic or financial sense for the proposed use to be undertaken on the site at this time?

"Implied within these definitions is recognition of the contribution of that specific use to community environment or to community development goals in addition to wealth maximization of individual property owners."²

The most profitable use among the competing alternatives, after analyzing the impact upon the community environment, at the date of valuation, is the best estimate of the appraiser and represents the highest and best use of the property. This use is the result of careful analysis by the appraiser based upon the facts present.

1. Byrl N. Boyce, Editor, Real Estate Appraisal Terminology (Massachusetts: Ballinger Publishing Company, 1975), Pg. 107.

2. Ibid

REPORT OF THE DUTCHESS COUNTY RESOURCE RECOVERY TASK FORCE

APPENDIX D

REPRODUCTION OF CONCEPTUAL DESIGN

DRAWING NOS. 3, 7 & 27

- LEGEND**
- Existing Contours
 - - - New Contours
 - Existing Roadway
 - - - New Roadway & Paved Area
 - New Structure
 - Property Line
 - CB Catch Basin
 - OMH Manhole

DATUM REFERENCE - USGS

NO.	DATE	REVISION	BY	APP.
1				
2				
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DESIGN: J.B.G.
 SCALE: 1" = 50'
 DRAWN: J.B.G.
 JOB NO. 78-27-10
 CHECK: J.B.G.
 DATE: JULY 1978
 AUTHORIZED RETENTION OF ADDITION TO THIS DRAWING AND RELATED DOCUMENTS IS A VIOLATION OF SEC. 1224 OF THE N.Y.S. EDUCATION LAW.

CRVA CONSULTING ENGINEERS
 CHARLES R. VELZY ASSOCIATES, INC.
 MINEOLA, NY. ARMONK, NY. BABYLON, NY.

County of Dutchess
 Poughkeepsie, New York 12601

DUTCHESS COUNTY, NEW YORK
**DUTCHESS COUNTY
 PYROLYSIS PROJECT**

DEC GRANT
 NO. 3-MSWEE-008-Q

DOE GRANT
 NO. EM-78-G-01-0148

SITE PLAN

SHEET NO.

3

43

STREAM # (PLANT INPUT/OUTPUT)	PS-FED REFUSE	DIOXEN	SLAG	PRODUCT GAS	INCINERATOR FUEL GAS	WASTEWATER
1	15500	3450	3054	8164	2534	5138
2	888			888	733	65.8
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STREAM # (INTERNAL)	CONVERTER OFF GAS	SPRAY WATER	COOLER SPRAY WATER	SCRUBBER SLURRY	SCRUBBER SLURRY BLEND	FILTER BACKWASH	PARTICULATE SLURRY	FILTRATE	ESP BOTTOMS
ACFM	2400								
GPM		70	244	322.8	8.8	25	1.2	32.6	6.2
PSIA	500	213	350	213	213	170	170	210	200
PSIA	56.7	70	65	56	35	35	14.7	14.7	14.7

STREAM # (INTERNAL)	CONDENSATE	OIL PHASE	PARTICULATE & ORGANICS RECYCLE	SCRUBBER FUEL GAS	CLEARED FUEL GAS	COOLED FUEL GAS	TORCH RECYCLE GAS	ESP RECYCLE GAS	QUENCH TANK RECYCLE GAS	QUENCH TANK RECYCLE
ACFM				1300	3500	800	10	200		
GPM	3.8	2.1	2.5						130	20
PSIA	100	170	170	200	190	100	145	145	160	200
PSIA	14.7	14.7	14.7	52.7	52.7	52.7	69.7	52.7	56.7	56.7

HEAT EXCHANGER	CONVERTER COOLING	QUENCH TANK COOLING	SCRUBBER COOLING	CONDENSER COOLING	RECYCLE GAS HEATING
BTU #10 ⁶ /HR.	1.41	2.68	5.82	2.30	0.08

OTHER # STREAMS	COMBUSTION AIR	BOILER FEED WATER	H.P. STEAM	FLUE GAS	GROUND FLAME PILOT FUEL	BOILER CONTINUOUS BLENDING
1	15700	8995	7900	23472	2.3	395
2	200				0.14	
3	16.6					
4	227					
5	11.7	660	10.7	15.7	15.7	0.15
6	1.00	10.7	8.9	0	0.5	
7	0	0	0	0.05	0	
8	1.6	16.7	8.9	0.05	0.5	

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DUTCHESS COUNTY RESOURCE RECOVERY PROJECT

List of Exhibits

<u>No.</u>	<u>Description</u>	<u>Page</u>
B-1	Letter to Charles R. Velzy Associates, Inc., dated July 18, 1979, from the Department of Energy & Environmental Management of International Business Machines Corporation.	269
B-2	Letter to Dutchess County Department of Public Works, dated July 24, 1979, from Charles R. Velzy Associates, Inc. (re: B-1 above)	271
C-1	Letter to Dutchess County Dept. of Solid Waste Management, dated August 22, 1979, from Bureau of Resource Recovery Programs, Division of Solid Waste Management, New York State Department of Environmental Conservation.	272
C-2	Letter to Dutchess County Dept. of Solid Waste Management, dated August 31, 1979, from Charles R. Velzy Associates, Inc. (re: C-1 above)	276
C-3	Letter to Dutchess County Dept. of Solid Waste Management, dated September 27, 1979, from Charles R. Velzy Associates, Inc. (re: C-1 above)	279
C-4	Letter to Charles R. Velzy Associates, Inc., dated October 19, 1979, from New York State Department of Environmental Conservation, Region #3, (re: C-3 above)	287
D-1	Letter to Dutchess County Dept. of Solid Waste Management, dated August 29, 1979, from Division of Industrial Extractive Processes, United States Environmental Protection Agency.	288
D-2	Letter to Dutchess County Dept. of Solid Waste Management, dated September 10, 1979, from Charles R. Velzy Associates, Inc. (re: D-1 above)	291
E-1	Letter to Dutchess County Dept. of Solid Waste Management, dated October 2, 1979, from CSI Resource Systems, Inc.	294
E-2	Letter to Dutchess County Dept. of Solid Waste Management, dated November 6, 1979, from Charles R. Velzy Associates, Inc. (re: E-1 above)	296
E-3	DELETED	300
F-1	Letter with attachment to Dutchess County Executive, dated September 7, 1979, from Charles R. Velzy Associates, Inc.	302

List of Exhibits

<u>No.</u>	<u>Description</u>	<u>Page</u>
F-2	Letter to Solid Waste Systems, Union Carbide Corporation, dated September 26, 1979, from the County Attorney of Dutchess County (re: F-1 above)	305
F-3	Letter to Dutchess County Attorney, dated October 8, 1979, from Solid Waste Systems, Union Carbide Corporation.	307
F-4	Letter to Solid Waste Systems, Union Carbide Corporation, dated October 30, 1979, from the County Attorney of Dutchess County (re: F-3 above)	308
F-5	Letter to Solid Waste Systems, Union Carbide Corporation, dated January 4, 1980, from the Dutchess County Executive.	310
G-1	Letter to Dutchess County Dept. of Solid Waste Management, dated October 24, 1979, from Charles R. Velzy Associates, Inc.	311
H-1	Letter to Dutchess County Dept. of Solid Waste Management, dated November 1, 1979, from Community Technology Branch Office of Conservation and Solar Energy, U. S. Department of Energy.	315
H-2	Letter to Dutchess County Dept. of Public Works, dated December 7, 1979, from Charles R. Velzy Associates, Inc. (re: H-1 above)	319
I-1	Letter to Office of the Dutchess County Executive, dated August 28, 1979, from Division of Solid Waste Management, New York State Dept. of Environmental Conservation.	324
J-1	"Evaluation of Alternate Energy Sytems", dated November 1979, by Charles R. Velzy Associates, Inc.	325
J-2	"Revised Estimates of Alternate Energy Systems", by Dutchess County Dept. of Solid Waste Management, dated December 1979.	401
J-3	Letter with attachments to Dutchess County Attorney, dated January 2, 1980, from Charles R. Velzy Associates, Inc.	429
J-4	Letter to Charles R. Velzy Associates, Inc., dated January 21, 1980 from the Dutchess County Dept. of Solid Waste Management.	446
K-1	Updated Status Report of Solid Waste Management Facilities in Dutchess County, prepared by Dutchess County Dept. of Health.	448
K-2	Status of Solid Waste Management-Southern Dutchess and Northwestern Dutchess County, dated December 1979, prepared by Dutchess County Dept. of Health.	454

REPORT OF THE DUTCHESS COUNTY RESOURCE RECOVERY TASK FORCE

COMMENTARIES ON FINAL SUMMARY REPORT

July 18, 1979

Dept. 772
Bldg. 070
(914) 463-4424

Charles R. Velzy Associates, Inc.
Consulting Engineers
355 Main Street
Armonk, NY 10504

ATTN: Roger S. Hecklinger
SUBJECT: DUTCHESS COUNTY PYROLYSIS PROJECT

Dear Mr. Hecklinger:

As expressed in various communications with the County and its advisors, and as recently stated in Mr. A. W. Vandewinckel's memo to Thomas L. Connelly of November 28, 1978, we feel that a municipal recovery system would best serve the community if installed so that its output could be available and usable by the entire community. In that sense, Central Hudson Gas and Electric is a much better customer for pyrolysis gas than is IBM. That continues to be our position.

If Central Hudson Gas and Electric is not a viable customer, we would consider purchasing the fuel from a pyrolysis system or other resource recovery system under the following conditions:

We would require that the State and Federal Governments recognize pyrolysis as being our primary fuel and that they would exempt us from future requirements to convert to coal as a primary fuel.

We would need assurance of an alternate fuel supply such as oil or natural gas and we would reserve the right to switch over to that alternate fuel, should the pyrolysis gas, quantity or quality be deficient.

We would hold the County responsible for damage to our boilers due to corrosives or other damaging materials in the fuel.

We would hold the county responsible for any toxic materials in the fuels which would be discharged through our boiler stacks.

We would expect the cost to be competitive with our present fuels and would expect that future costs would be indexed to the cost of coal since we expect that that is the fuel in the future.

Very truly yours,

B. M. Hardy
Energy & Environmental Management

cc: Mr. J. A. Bitonti

July 24, 1979

Gregory Bosaz, Jr., P.E.
Project Coordinator
Dutchess County
Dept. Public Works
47 Cannon St.
Poughkeepsie, N.Y. 12601

Re: Dutchess County Pyrolysis Project
CRVA 78-27-1B

Dear Mr. Bosaz:

We are attaching a letter received from Mr. Hardy of IBM. Although the letter is dated July 18th it was not received in this office until July 24th.

The issues raised in Mr. Hardy's letter with one exception are, we believe, addressed in our report which was submitted to the County on July 23rd. The only issue raised that was not addressed is indexing the cost of Purox fuel used at the IBM facility to the cost of coal. While we believe that this is a reasonable issue, we do not believe that it would have a significant impact on the projected economics.

Should you have any other questions regarding Mr. Hardy's letter, please do not hesitate to call.

Very truly yours,

Roger S. Hecklinger
Principal

RSH:pp
Enc.

August 22, 1979

Mr. Gregory Bosaz, Jr., P.E.
Department of Solid Waste Management
22 Market Street
Poughkeepsie, NY 12601

Dear Greg:

Concerning the final report of the Dutchess County Pyrolysis Project dated July 1979, we have several questions and comments. Perhaps the County is aware of most, if not all, of these items, but they are listed primarily as concerns of this Department which we feel should be addressed.

The most important item noted from the report, is the possibility of reduced funding assistance due to the lack of a market for recovered ferrous metals. Under the Guidelines for Determination of Eligible Costs of Solid Waste Management Projects Pursuant to the E.Q.B.A. of 1972, (copy enclosed), Page 10, section B1, the State share of the cost of a Resource Recovery Project which produces a refuse-derived fuel without materials recovery is limited to forty-five (45) percent of the eligible cost of the project. Therefore, if no market exists for the ferrous metals, the level of funding assistance will be reduced to 45%.

The following items deal directly with the July 1979 report and preliminary plans:

1. There is a discrepancy between the number of tipping bays shown on the plans and the number stated on page 7-24 of the final summary report. On all plan sheets showing the tipping bays, five (5) twenty (20) feet wide bays are shown per pit. However on page 7-24, it is stated that eight (8) twelve (12) feet wide bays per pit will be used. If the eight (8) bays are to be used, the consultant should explain why and when this decision was made.
2. Concerning the receiving area, it is questionable whether there will be sufficient space for 75 cubic yard transfer trailers to maneuver. Also, it appears that a 75 cubic yard trailer with tractor will block the entrance or exit if one of the first few or last few tipping bays are used.
3. On page 7-5, the report states that the weighmaster is to direct the refuse trucks to a specific tipping station. However, from the weighmaster's present location, he cannot see the receiving area. Unless his location is switched with that of the women's locker room, he cannot determine which lanes are available, nor can he tell what is occurring in the receiving area.

4. On page 7-10, a detector senses bed depth in the converter and maintains the solids level within a specified range by adjusting the feed conveyor speed. It is anticipated that all other conveyors will be adjusted accordingly (automatically) to prevent refuse buildup at the base of the converter feed conveyor.
5. On page 7-25, the second paragraph of section 7.3.3 is confusing. What is the actual storage capacity of each pit?
6. On page 7-26, where will bulky items be stored upon removal from the pit and how will these items be disposed of?
7. On page 7-27, the crane operator faces the receiving area. He must also have a good view of the infeed conveyors and trommel openings. If not, he may not be able to detect "jam-ups" and will continue to feed refuse to the conveyor. This may be accomplished with a window in the rear of the crane operator's cab. Also, how does the crane operator know when to feed refuse to the conveyor or does he continuously feed refuse? How is a steady flow of refuse achieved this way?
8. On page 7-29, the opening size of the shredder hopper is not clearly stated. Also, the last paragraph indicated that use of the shear shredder reduces the potential of explosions. What provisions have been made to protect personnel and equipment should an explosion occur?
9. On page 7-32, will the stationary compactor hopper be constructed to withstand impacts caused by the grapple hitting it?
10. On page 7-39, the refractory lining of the hearth is expected to require replacement about once a year. What refractory materials is the hearth constructed of? Are the annual costs attributed to renting a crane to remove the hearths and then relining the hearths accounted for in the annual cost information? Also, from the plan sheets, it appears that the quench tank will interfere with removal of the hearth assembly. How do the transfer cars remove the hearths? What do these cars look like?
11. On page 7-43, the slag is discharged from the bottom of the quench tank into slag skip cars which bring the material up a forty-five (45) degree incline and deposit it onto a conveyor. The motor is a five (5) horsepower unit. Not knowing the relative size of the skip car and density of the slag it is hard to determine whether this motor is of a sufficient size.
12. On page 7-51, why is potable water used in the quench tank?
13. There were several comments concerning the cost analysis information presented in chapter 8. The major concern was that all capital and operating costs were estimated based on 1979 dollars. This is not realistic and capital costs should be altered to reflect the construction midpoint date. Also, costs for utilities and estimated landfill costs should be estimated based on the first year of operation.

14. A comment on Table 8-4, page 8-14 is also warranted. The annual operating cost and revenues are estimated based on 400 tons/day. It is our understanding that approximately 200 tons/day can initially be obtained. Thus for 200 tons/day, the revenues will be reduced by one-half ($\frac{1}{2}$) resulting in a tipping fee of close to \$40/ton. Also, if IBM is not the customer but Central Hudson and Gas is, the tipping fee will increase to almost \$45/ton. The tipping fee would increase even further if the capital and operating costs were projected to the year of operation. If the facility is eligible for only forty-five (45) percent State aid, the tipping fee would have to again be adjusted. When all of these items are considered, at 200 tons/day of available refuse, a projected tip fee for the plant of \$50/ton is not unrealistic.

15. On page 8-15, it is stated that the Purox facility includes provisions for the slag to be delivered. What are these provisions? Also, the slag revenues are estimated based on \$3.00/ton but the only market at that price is Dutchess County. (Highland, Ind. seems too far to transport the slag economically) Does this mean that effectively, the County will be selling it to themselves?

16. On page 9-1, the last paragraph states that Union Carbide Corporation will warrant the quality and quantity of the Purox fuel gas, electric power consumption, and oxygen consumption. How long will Union Carbide Corporation provide this warranty and under what conditions?

17. Finally, in Addendum A, the costs attributed to depreciation of equipment are in error. The cost of \$0.80/mile in Table 8-5 was determined using the following assumptions:

- a. straight line depreciation for four years
- b. zero salvage value
- c. the tractor and both trailers all make 450 trips/year

While straight line depreciation may be used, the assumption of zero salvage value on the equipment does not seem realistic. Also, the third assumption is incorrect since if there are two trailers and only one tractor, each trailer should make exactly one-half ($\frac{1}{2}$) the number of trips as the tractor. This fact will also have an effect on the costs attributed to tires. When these items are considered, the resulting transportation costs will be lower.

18. On plan sheet number 4, do the Pit Drain and Sanitary Line behind the north corner of the refuse processing building empty into a manhole at that point?

19. On plan sheet number 7, what is the purpose of the auxiliary boiler? The two (2) wastewater incinerators/boilers should be able to satisfy all the heating requirements of the facility and still operate the cryogenic oxygen unit. What happens to the bag type dust collector when the third process train is installed? Has the decision to have the employee parking lot on the west side of the building been finalized?

August 22, 1979

20. On plan sheet number 19, what is included in the Makeup Water Treatment Package?

21. On plan sheet number 23, no boiler blowdown line is shown for the boilers. Also, where is the blowdown water discharged? Incinerator fuel gas supply line (7) and the flared fuel gas line (8) appear to intersect on assembly #1. Are they on top of one another or should there be a valve?

22. On plan sheet number 24, why are two skip cars per quench tank necessary? Can a single, larger one be used?

23. On plan sheet number 25, where does the scrubbed fuel gas enter and leave the ESP? It is hard to follow on the plan sheet.

24. On plan sheet number 26, the blowdown line for the auxiliary boiler is not shown.

25. On plan sheet number 28, certain piping appears to be missing. Specifically, how is the air transferred from the compressor to the aftercoolers; and from the air surge tank to the cold box? The makeup water line into the feedwater treatment system is also not shown. No apparent lines are shown running to or away from the nitrogen vaporizers. Lines are shown running from the cold box to the liquid O₂ storage tank and from the O₂ tank fill station to the liquid O₂ storage tank. There appear to be no lines running from the O₂ storage tank to the cold box for startup or directly to the converters in the event the cryogenic unit is inoperative.

26. On plan sheet number 33, will the poles shown on this drawing have lights?

The above constitutes the primary comments and questions we have on the consultant's July 1979 report and preliminary plans. If you wish to discuss these items in detail, please feel free to contact me or Mr. Michon at (518) 457-5714. Otherwise we will plan to meet on September 11, 1979.

Very truly yours,

H. Richard Koelling, P.E.
Chief, Technology Section
Bureau of Resource Recovery Programs
Division of Solid Waste Management

TJM:jci

cc: DEC Region 3
Charlotte Rines - Department of Energy (US)
Charles R. Velzy Associates, Inc.

August 31, 1979

Mr. Gregory Bosaz, Jr., P.E.
County of Dutchess
County Office Building
22 Market St.
5th Floor
Poughkeepsie, N.Y. 12607

Re: Dutchess County Pyrolysis Project
CRVA 78-27-1B

Dear Greg:

This letter is in partial response to the letter dated August 22nd written by H. Richard Koelling, P.E. of the New York State Department of Environmental Conservation. A complete response to this letter must await receipt of information from Union Carbide in answer to some of his questions.

In the second paragraph of his letter, Mr. Koelling states, "Therefore, if no market exists for the ferrous metals, the level of funding assistance will be reduced to 45%". This is a disturbing turn of events.

We have reviewed the County's agreement dated December 13, 1977 with the Commissioner of Environmental Conservation of the State of New York concerning implementation of the Environmental Quality Bond Act. In an attachment to that letter the project is described as:

"Construction of a 700 ton per day front end processing system, including size reduction in ferrous metal recovery operations, followed by a back-end pyrolysis system capable of producing a 300 Btu per standard cubic foot fuel gas."

The description also includes an implementation schedule calling for final design plans, specifications and fully executed market or purchasing agreements before February 28, 1979.

Continued on Page 2

Mr. Gregory Bosaz, Jr., P.E..
August 31, 1979
Page 2

As you know, we have kept Mr. Koelling and others in the Department of Environmental Conservation involved in this project as it progressed. They have been aware that the implementation schedule was not compatible with the design program called for by the Department of Energy. They have been aware that the capacity of the plant has been reduced from 700 tons per day to 400 tons per day. They have been aware of our difficulties in locating a market for any recovered materials other than the slag. It was our understanding that these changes or modifications that evolved as the project developed would not affect the financial aspects of the agreement; ie, the grant funds available were not to exceed \$13,449,000 but not more than 50% of the project cost.

With regard to ferrous recovery, we trust that all concerned understand that the recovery equipment will be installed in the plant as presently envisioned, and it will be capable of recovering ferrous when and as a market exists.

With regard to materials recovery in general, we have identified three markets for the slag from the PUROX system. Our economic balance shows income from this recovered material. In short, materials recovery is anticipated for the only material where there appears to be a market at present.

Unfortunately our copy of Mr. Koelling's letter did not include a copy of Page 10, Section B1 of the guideline referred to in the second paragraph of his letter. Can it be that the State guidelines say that materials recovery must include ferrous metals?

It seems to us that before this project can proceed we must have a determination regarding the status of your agreement with the Department of Environmental Conservation with regard to:

- Nominal plant size
- Implementation Schedule
- The specific need for ferrous metal recovery

Continued on Page 3

Mr. Gregory Bosaz, Jr., P.E.
August 31, 1979
Page 3

Should you want to discuss this further, please do not
hesitate to call.

Very truly yours,

Roger S. Hecklinger
Principal

RSH:pp

cc: G.F. Hagenbach
Union Carbide Corp.

September 27, 1979

Mr. Gregory Bosaz, Jr., P.E.
Project Coordinator
Dept. of Solid Waste Management
County of Dutchess
22 Market Street
Poughkeepsie, New York 12601

Re: Dutchess County Pyrolysis Project
CRVA 78-27-1B

Dear Greg:

The purpose of this letter is to respond to the letter dated August 22nd by H. Richard Koelling, P.E. of the New York State Department of Environmental Conservation which listed questions and comments regarding the Final Summary Report for the Dutchess County Pyrolysis Project.

Our response to the second paragraph of Mr. Koelling's letter is contained in our letter of August 31st to you.

The following numbered paragraphs are our response to the numbered comments and questions in Mr. Koelling's letter:

1. A discrepancy has been uncovered between the number of tipping bays shown on the Plans and the number stated on Page 7-24 of the Report. The Plans display the layout of the tipping area as we envision it at present. The Report should be corrected.
2. The question is raised whether there will be sufficient space for 75 yard transfer trailers to maneuver in the tipping area. The maximum length of the transfer trailers is about 55 feet. The tipping floor is 85 feet wide. This is sufficient to maneuver transfer trucks. Once in position to unload, there would be about 30 feet between the front of the truck and the front wall. This should be sufficient for other trucks to pass the unloading transfer vehicle. Also, if needed, the front doors are available to be used for added maneuverability.

Continued on Page 2

September 27, 1979

Mr. Gregory Bosaz, Jr., P.E.
Dutchess County Dept. of Solid Waste Management

Page 2

3. A question is raised regarding the ability of the weighmaster to visually observe activity on the tipping floor so that he can be able to direct traffic. A limited range communication system between the weighmaster and the crane operator is anticipated. A light system operated by the crane operator could also be used. Instrumentation detail would be developed during final design.
4. A question is raised regarding the control of the processing train to maintain bed depth in the converter. The trommel infeed and converter feed conveyors are both variable speed and interconnectable. There is sufficient storage capacity in the converter feed conveyor to store all refuse that is being processed by the front-end system. This procedure will reduce the need to stop the trommel, shear and other front end conveyors when feed to the converter is momentarily stopped.
5. The actual storage capacity of each pit is requested. The capacity to the top of the pit ("water level") can be calculated from the dimensions (105 ft. x 30 ft. x 25 ft.) as 2917 cubic yards per pit.
6. The storage location for bulky items removed from the pit and disposal methods for these items is requested. Bulky items could be stored under the crane rest areas. These materials will be sold. The amount of bulky items is expected to be low. Revenue from sale of bulky items is not included in the economic analysis.
7. The ability of the crane operator to observe flow of refuse into the trommel is questioned. Plan Sheet No. 8 shows that the operator has a clear view of the trommel infeed conveyors from the windows in the cab. The trommel infeed conveyor is variable speed, controlled by the converter feed conveyor. The crane operator's responsibility is to keep the infeed conveyor hoppers full.

Continued on Page 3

September 27, 1979

Mr. Gregory Bosaz, Jr., P.E.
Dutchess County Dept. of Solid Waste Management

Page 3

8. This is a two part question.

The opening size of the shredder hopper is requested. The opening size from Page 7-30 is 72 inches by 46 inches.

Provisions made to protect personnel and equipment from explosion are requested. The shear is not enclosed, so explosion due to dust and gas buildup is eliminated. A water spray system is included to control fires that will occur from time to time.

9. The ability of the stationary compactor hopper to withstand impacts caused by the grapple is questioned. The intent of the construction shown on Plan Sheet No. 9 is to withstand impact loads.

10. This is a three part question.

The type of refractory materials to be used in the hearth is requested. The refractory used to line the hearth is a high quality 90% alumina - 10% chrome oxide material. It is used in both brick form and rammed-in-place plastic monolith, depending on the location within the hearth.

Whether the annual cost for crane rental and hearth relining is included in the total annual cost information is questioned. All costs for hearth relining are included.

A question is raised regarding potential interference between the quench tank and the hearth removal procedure. To remove the hearth, a transfer car is used. The car rides on the rails shown on Plan Sheet 25. The rails straddle the quench tank. When the car is directly under the hearth, four hydraulic jacks are raised to contact support pads on the hearth bottom. The hearth flange can

Continued on Page 4

September 27, 1979

Mr. Gregory Bosaz, Jr., P.E.
Dutchess County Dept. of Solid Waste Management

Page 4

then be disconnected and the jacks lowered allowing the hearth to be moved out to a point where it can be picked up by a crane. The one transfer car rail which extends over the quench tank pit is normally not in place during operation, and is installed prior to hearth removal. A portion of the hearth access platform must also be removed for transfer car travel.

11. The adequacy of a 5 hp motor to move the slag skip cars is questioned. It was not our intent to furnish information in sufficient detail to check out the adequacy of any specific motor size. In this case, Union Carbide has been asked to recheck their motor sizing. They believe that it is properly sized. Should this project proceed, the size of this motor and all other motors will be rechecked for adequacy.
12. The reason for using potable water in the quench tank is questioned. It is not necessary to use potable water from the standpoint of water quality. Potable water is used for the relatively small quantities required as it is a reliable source of water at the pressure required.
13. The use of capital and operating costs based on 1979 dollars is questioned. Our assignment called for cost data using present dollars.
14. This is a two part question.

It is pointed out that the annual operating costs and revenues are estimated based on 400 tons per day, but that if only 200 tons per day were received, revenues would be reduced by one half. This is, of course, true; but since our refuse generation data indicates that more than 400 tons per day would be available in the core area at the

Continued on Page 5

September 27, 1979

Mr. Gregory Bosaz, Jr., P.E.
Dutchess County Dept. of Solid Waste Management

Page 5

time of plant startup, we were advised to assume that 400 tons per day would be available and delivered to the plant when it was ready to receive refuse.

It is pointed out that if IBM is not the customer but instead Central Hudson Electric and Gas Company is the customer, the tipping fee will increase to almost \$45.00 per ton. We cannot establish how this figure was determined. However, IBM is recommended as the customer for the gas because IBM is a more economically attractive customer than Central Hudson Gas and Electric Company.

15. The provisions for slag delivery are questioned. A potential customer is Lone Star Minerals which is headquartered in Highland, Indiana. If they were to purchase the slag, it would be used in the Poughkeepsie area. (New York Trap Rock Corporation is a subsidiary of Lone Star Minerals.) The PUROX facility would request bids for purchase of the slag and would sell the slag to the highest bidder. Slag delivery by PUROX personnel is preferred to avoid storing an unreasonable amount of slag on the PUROX site. Additional revenues from slag delivery should offset the additional cost of equipment and manpower.
16. The length of time that Union Carbide Corporation will provide warranty is questioned. Union Carbide will warrant the quality and quantity of key operating parameters, including the fuel gas, electric power consumption and oxygen consumption, through the plant acceptance test. Extended warranty coverage beyond the acceptance test will be the subject of future negotiations with the County as this project progresses.
17. The method of determining transportation costs to landfill is questioned. The method of handling the various cost elements can be discussed at length without reaching agreement. We know, however, that the overall costs listed compare very favorably with recent haul costs quoted by contractors.

Continued on Page 6

September 27, 1979

Mr. Gregory Bosaz, Jr., P.E.
Dutchess County Dept. of Solid Waste Management

Page 6

18. The location of the pit drain and sanitary line behind the north corner of the refuse processing building is questioned. The pit drain and sanitary line behind the north corner of the refuse processing building empty into a manhole as shown on Plan Sheet 7. Pit drainage is expected to be minimal and intermittent.

19. This is a three part question.

The purpose of the auxiliary boiler is questioned. The auxiliary boiler shown on Plan Sheet 7 would be utilized only during outage of either one of the wastewater incinerator boilers. It is not required for normal operation.

A question is raised regarding the location of the bag type dust collector when the third process train is installed. It will be moved.

The question is raised regarding the finality of the location of the employee parking lot. The location of the employee parking lot is, along with virtually all other aspects of the plant, subject to reevaluation and possible relocation if this project proceeds.

20. The scope of the makeup water treatment package is questioned. The makeup water treatment plant is described on Page 7-52. As a package plant, it includes pretreatment, chemical feed and filtration in one unit.

21. This is a two part question.

It is pointed out that boiler blowdown lines are not shown for the boilers. This is true. This flow, both continuous and intermittent would be disposed of in the same manner as cooling tower blowdown.

Continued on Page 7

September 27, 1979

Mr. Gregory Bosaz, Jr., P.E.
Dutchess County Dept. of Solid Waste Management

Page 7

It is pointed out that incinerator fuel gas supply and the flared fuel gas line appear to intersect. This is not the case. The incinerator gas line runs parallel and directly above the flared fuel gas line.

22. The need for two skip cars per quench tank is questioned. Two cars are proposed to provide redundancy in case of equipment failure.
23. The routing of scrubbed flue gas entering and leaving the electrostatic precipitator is questioned. The inlet and outlet piping on the electrostatic precipitator consists of two concentric pipes on the top center of the electrostatic precipitator. The smaller inlet pipe extends through the collection tubes to the plenum at the bottom of the electrostatic precipitator. The larger outlet pipe connects to the plenum above the collection tubes and is concentric with the inlet pipe.
24. It is pointed out that the auxiliary boiler blowdown line is not shown. This is true. In a final design, of course, it would be included.
25. It is pointed out that on Plan Sheet 28 certain piping seems to be missing. This is true. The intended purpose of Plan Sheet 28 is to show the location of all major equipment in the oxygen plant with sufficient major piping to indicate pipe routing. All piping required is shown on the instrumentation and control diagram, (Sheets 30 and 31).
26. A question is raised regarding lighting on the power poles shown on Plan Sheet 33. Lighting is not included on these poles.

Continued on Page 8

September 27, 1979

Mr. Gregory Bosaz, Jr., P.E.
Dutchess County Dept. of Solid Waste Management

Page 8

We trust this has answered the questions raised by Mr. Koelling.

In addition, it would be helpful to all involved in this project if Mr. Koelling would provide some input to questions raised in the Report. The areas where his help is desired are:

1. On Page xv is pointed out that control of the waste stream is in a large part contingent on propitious enforcement of applicable codes, rules and regulations governing landfill siting and operation. What is the Dept. of Environmental Conservation's current thinking regarding enforcement of Part 360?
2. Table 1-1 on Pages 1-2 and 1-3 lists the status of Dutchess County landfills. All indicate that permit status is "pending". What is the Dept. of Environmental Conservation's current thinking regarding permitting of these facilities?
3. On Page 8-16 and 8-18 it is pointed out that new landfills, operated in accordance with the codes, rules and regulations, established by the New York State Dept. of Environmental Conservation, can be expected to require tipping fees in excess of \$9.00 per ton. Does the Dept. of Environmental Conservation concur with this assessment?

Should you have further questions, please do not hesitate to call.

Very truly yours,

Roger S. Hecklinger, P.E.
Principal

RSH/maf

cc: H. Richard Koelling, P.E.
G.F. Hagenbach

202 Massaroneck Avenue, White Plains, New York 10601

October 19, 1979

Mr. Roger S. Hecklinger, P.E.
Charles R. Velzy Associates, Inc.
355 Main Street
Armonk, NY 10504

Re: Dutchess County
Pyrolysis Project

Dear Mr. Hecklinger:

Mr. H. Richard Koelling, P.E. has asked me to reply to the questions raised to the Department in your letter of September 27, 1979. The following responses will hopefully answer the questions:

1. The Department's current thinking regarding enforcement of GNYCHL Part 360 has continued to be strict enforcement of the rules and regulations. Bear in mind, however, that the new regulations have been applied to existing landfills. An appropriate transition time is needed in some instances in order for the existing facility to become in compliance with Part 360 or to find an alternate site.

2. Table 1-1 on Pages 1-2 and 1-3 has been updated, indicating the current permit status. Of the sites listed, seven will be closed within 3 years, well before the pyrolysis project is proposed to be on line. The Beacon site does not accept household refuse and the two park facilities only service the park areas. When these old existing sites are closed, any new site must be in strict compliance with Part 360.

3. The Department concurs that new landfills operated in accordance with Part 360 will cost more than past practices. The actual tipping fee is dependent on many factors including size of site, volume of waste, availability of cover material and subsurface conditions.

If you have any questions, do not hesitate to call.

Very truly yours,

Salvatore Livolina, P.E.
Senior Sanitary Engineer

SE/vg
cc: H. R. Koelling
G. Brown
J. Hill
J. Harrison
bcc: P. Keller

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

AUG 29 1979

OFFICE OF
RESEARCH AND DEVELOPMENT

Gregory Bosaz, Jr. P.E.
Project Coordinator
Department of Solid Waste Management
County of Dutchess
Poughkeepsie, New York 12601

Dear Mr. Bosaz:

Re: Dutchess County Pyrolysis Project
Department of Energy Grant #EM-78-G-01-5143
N.Y.S. DEC Solid Waste Management
Project Bond Act Project #3-MSWRR-002-Q

I have recently assumed some of Mr. Kurt Jakobsen's duties in the Waste-as-Fuel Program, and have thus been able to review the above mentioned project.

The "PUROX" process has attractive possibilities for energy production and solid waste reduction, along with a net decrease in some emissions. Sadly, application of this technology in Dutchess County would be an unfortunate choice. Conditions within your county are not congested enough to require a system with PUROX's economic and performance capabilities.

The report prepared by your engineer is woefully inadequate. The financial aspects of the project are not well presented, thus misleading to the "Lay" reader. To be specific:

- o Product gas revenues are predicated on 723 Billion BTU per year. My calculations show that after fuel gas (for oxygen production) is subtracted only about 500 Billion BTU per year are available.

- o There is no detailed breakdown of overhead and running costs on a per-ton (approximation) basis. This is serious actual per-ton cost in the absence of a grant is quite high. Running costs alone could be high enough to cause your county to abandon the plant during periods of fiscal austerity.
- o Comparisons with disposal or fuel production alternatives are not shown.
- o Evidence contrary to high landfilling costs abounds:
 - a) the tipping fee for the "solid waste received but not processed" is shown to be \$6.30 per-ton.
 - b) a land cost of \$10,000 per acre near the IBM plant, if applicable to a remoter parcel of 100 acres (out of 500,000 in the County) translates into about \$1.00 per ton disposed.
- o No documentation was found that justifies the suggestion that "two processing lines...provide suitable redundancy."

Pyrolysis in Poughkeepsie does not look feasible. This project appears only to shift civic responsibilities from a local level to the State Level while simultaneously raising costs for everybody in the State. By the time every county has its "piece of the action" the tax payer of Dutchess County will be paying far more than ever anticipated.

If the State of New York does fund this project, hopefully they will do so with full understanding of the financial implications. The report, as presented, does not adequately present the facts. Should you wish to contact me to further discuss the project, I can be reached at (RD-681) IEPD, USEPA Washington, D.C. 20460; telephone (202) 755-0646.

Sincerely yours,

Bernard F. Heiler

Bernard F. Heiler, P.E.
Environmental Engineer
Industrial Extractive Processes
Division, OEET (RD-681)

September 10, 1979

Gregory Bosaz, Jr. P.E.
Project Coordinator
Department of Solid Waste Management
County of Dutchess
Poughkeepsie, N.Y. 12601

RE: Dutchess County Pyrolysis Project

Dear Greg:

This letter is in response to Bernard F. Heiler's letter to you of August 29.

I had presumed that the Environmental Protection Agency was on the mailing list for this project so that they could have the opportunity to make comments on the report with regard to environmental matters. Mr. Heiler's letter does not address environmental concerns at all. Instead, he questions the wisdom of considering the Purox Facility for Dutchess County. A Purox Facility was selected for the study by the Department of Energy and the New York State Environmental Quality Bond Act Funds are "ear marked" for a Purox Facility. We do not want to be placed in the middle of an inter-agency squabble.

On September 5, I spoke with Mr. Heiler by telephone to learn more of his concerns. Our response to each of the points raised in his letter follows:

1. Table 5-1 tabulates the energy to be produced at the Pyrolysis Plant. Total for the year is 723 billion Btu's. Mr. Heiler states, "calculations show that after fuel gas (for oxygen production) is subtracted only about 500 billion Btu per year are available." In other words, he is suggesting that we overstated the gas production by 45%. During our telephone conversation he was unable to tell me how he calculated the 500 billion Btu's but he did say that he had not deducted for oxygen production. We have rechecked our calculations and believe them to be correct. Until Mr. Heiler substantiates his calculations, we really cannot make further comment.

2. We did not show costs on a per-ton basis. We prefer to show costs in absolute dollars as, in our experience, per-ton figures tend to be quoted out of context. Any or all of the figures on table 8-4 can be divided by 145,000 to determine annual per-ton figure. Mr. Heiler is correct in suggesting that if grant funds were not available, amortization costs for the plant would be high. (Where Mr. Heiler speaks of "overhead", we assume that he is referring to what we called "amortization"; and what he refers to as "running costs" are what we called "operating costs".) Grant funds affect amortization costs but not operating costs. Forgetting amortization for the moment and looking only at operating costs, revenues more than offset the operating costs of the plant. The report is predicated on plant operation by contract with Union Carbide. Therefore, it is difficult to understand why Mr. Heiler feels that the County would "abandon the plant during periods of fiscal austerity".
3. A cost comparison with disposal in landfills is discussed on page 8-16. Our assignment did not include cost comparisons with alternate resource recovery facilities.
4. During our telephone conversation, Mr. Heiler said that he did not mean to suggest that the cost of landfill disposal in Dutchess County would be \$1.00 per-ton disposed. The \$1.00 figure was merely the cost of land aquisition. He recognizes that actual operating costs for landfill will be many times this figure. Apparently the point he was trying to make was that the cost of land aquisition in Dutchess County may be less than it is in some other counties.
5. Our rationale for use of two processing lines is discussed on pages 7-8, 7-34, and 7-35. Apparently Mr. Heiler expected a statistical analysis for one, two, three and four lines. To do this, one would have to develop accurate costs and availability factors for all equipment in each of four different arrangements of equipment. We believe that this

Page 3

RE: Dutchess County Pyrolysis Project
September 10, 1979

would be no more than a mathematical exercise.
We offer the comments referenced above as our
justification for two lines.

Should you or Mr. Heiler want to discuss any of this further,
please feel free to call.

Very truly yours,

Roger S. Hecklinger

RSH/tam

cc: Bernard F. Heiler, P.E.

2 October 1979

1979 OCT -5 PM 1:04
MARKET ST.DUTCHESS CO.
D P W

Mr. Gregory Bosaz, Jr., P.E.
Dutchess County Department of
Solid Waste Management
County Office Building
22 Market Street
Poughkeepsie, New York 12601

Dear Mr. Bosaz:

Resource Systems staff have reviewed the Dutchess County Pyrolysis Project Final Summary Report and associated drawings. Our comments can be grouped into four areas: project economics, waste control, system integration, and helpful additional information.

Project Economics

Because of the summary nature of the cost and operating data presented, Resource Systems could not check details. We found, however, that the residue disposal fee only included waste bypassing the plant during unit outages. Based on the mass balance presented on page 6-2, it seems appropriate to add disposal costs for the unprocessable waste (probably about 2 percent) and the 7 percent separated magnetics for which no market has been found. We also feel that there should be an allowance for operating and facility modifications expenses during start-up.

The estimated 1979 capital cost for this project is almost \$63,000 per ton of installed daily capacity. This does not compare favorably with the typical \$30,000 to \$40,000 per ton of installed capacity for resource recovery facilities without electricity production. The investment in the PUROX gasifiers and appurtenances alone costs almost \$105/lb of steam-raising capacity. This can be compared to environmentally controlled spreader/stoker equipped boilers, which cost about \$65/lb of steam-raising capacity. The spreader/stokers could use the same front end as the proposed PUROX plant.

In our analyses of project economics, we first evaluated the "pure" economics, i.e., grant support was excluded and net disposal costs were projected for 1983 (the first year of operations) assuming industrial revenue bond-type financing. Under these conditions, the net disposal cost is almost triple the projected 1983 sanitary landfill cost. (It is possible that some of this incremental cost could be offset by savings in waste hauling costs.)

The estimated revenues are less than either projected annual debt service or operating and maintenance cost. Consequently, the financial strength of the project is questionable.

Resource Systems also evaluated project economics with the anticipated State and Federal grant support. These analyses indicate that unless transportation costs are significantly less than for a landfill alternative, the County must be prepared to pay a premium for a PUROX plant of \$10/ton or more.

Waste Control

The final report indicates that approximately 400 TPD₇ of waste are generated by the residential, commercial and industrial establishments within the County's core area. Project economics have been based on 100 percent capture of this core area waste, an assumption unsupported by experience in other resource recovery projects. If less than 100 percent of the core area's solid waste actually arrives at the facility, the 1983 price increase will probably cause more industrial/commercial waste to escape the system and thus exacerbate the problem. Since the estimated daily capacity of the Dutchess County landfills is less than the County's generation rate, local generators clearly have disposal options which must be considered as part of the waste control problem. Consequently, waste capture and control need to be addressed, especially in this situation where disposal costs of the resource recovery plant may not be competitive with landfilling.

System Integration

The report indicates that the energy buyer (IBM) can use only part of the energy recovered by the project. Considerable work was done establishing the variability of waste generation and the customer's energy needs. However, Table 5-1 and the associated discussion fail to present the details of integrating waste variability, process availability and energy customer load characteristics. Therefore, Resource Systems cannot verify the total energy expected to be sold in a given year. Because of the marginal nature of project economics, careful verification of the market and the amount of energy to be sold is prudent.

Additional Information

Resource Systems' review could have been more extensive if the following information/drawings had been included in the preliminary design package:

- Process and Instrumentation Drawing. The provided simplified P&ID only covers the PUROX scope of supply; integration of the front end and the fuel user is not included. An expanded drawing would be helpful.
- Process Mass and Energy Balances. The design of any industrial process is based on mass and energy balances. In processes involving heating and phase changes (solid to gas), these balances should be on an elemental basis (e.g., accounting for all C, H₂, S, Cl, etc.). Particular attention should be paid to where the sulfur and halogens go. Rough calculations indicate that the scrubber will concen-

October 2, 1979

trate H_2S , COS , HCl , and HF resulting from refuse gasification. When burned in the waste water burner, they could contribute to boiler corrosion and air pollution. The mass balance will provide information to help identify these potential problems.

- Details on the User Modifications. The report states that space in the IBM boiler house is tight, and an allowance of \$80,000 is provided for modification. Drawings showing the boiler house modifications are needed before the County can check this estimate.
- Basis for Costing. In order to prepare cost estimates, equipment and materials "take-offs" were prepared. These should be submitted to the County along with the appropriate costing assumptions and data. This information will be valuable for analyzing construction bids if the County proceeds with the project.

We hope these comments are useful to you. Please feel free to call on us for explanations, or for any further assistance we might be able to offer under DOE's monitoring program.

Sincerely yours,

H. Gregor Rigo, Ph.D., P.E.
Principal

HGR:afb

cc: Donald Walter
Charlotte Rines

November 6, 1979

Mr. Gregory Bosaz, Jr., P.E.
Project Coordinator
Dept. of Solid Waste Management
County of Dutchess
County Office Building
22 Market Street
Poughkeepsie, New York 12601

Re: Dutchess County Pyrolysis Project
CRVA 78-27-1B

Dear Greg:

This letter is in response to CSI Resource Systems' letter of October 2nd to you written by H. Gregor Rigo. Our responses to the comments are grouped similarly to the letter.

Project Economics

The material and economic balance in the report is based on 145,000 tons of refuse per year flowing to the pyrolysis plant and 125,000 tons per year of refuse being processed. The remaining material (20,000 tons or 14%) which for whatever reason is unprocessed will be sent to landfill along with the unsalable ferrous material for a tipping fee of \$6.00 per ton. The amount of unsalable ferrous material is estimated to be 6,000 tons per year. Thus, a total of 26,000 tons per year will be landfilled at a tipping fee of \$6.00 per ton. This amounts to \$156,000.00 per year. Unfortunately, due to an arithmetic slip up, this is shown as \$126,000.00 per year on Table 8-4.

With regard to the discussion concerning the relative costs of the PUROX facility compared to alternate systems, this is the subject of our ongoing evaluation study. The evaluation study is an addition to the scope of work covered by the report.

Since we are not given the results of the Resource Systems' analysis of project economics, we cannot make specific responses except to say that, of course, waste haulage costs will be less to the PUROX facility than to the distant landfills.

In order to make the statement, "The estimated revenues are less than either projected annual debt service or operating and maintenance costs", revenues are apparently not included for tipping fees nor is credit given for grant assistance. Both tipping fees

Continued on Page 2

November 6, 1979

Mr. Gregory Bosaz, Jr., P.E.
Dept. of Solid Waste Management

Page 2

and grant assistance are integral parts of the project economics. Nevertheless, we agree with the statement, "The financial strength of the project is questionable".

Without access to Resource Systems' economic analysis, we cannot comment on the conclusion that the County must be prepared to pay a premium of \$10.00 per ton except to say that transportation costs will most certainly be significantly less for the PUROX facility than for a landfill alternative.

Waste Control

Project economics are not based on 100% capture of the core area waste. From Table 3-12, it can be seen that something like 440 tons per day of waste will be available in the core area by 1983 assuming no increase in per capita waste generation. When this information was generated, the financial and legal advisors on the County project team advised us to develop plant economics based on 400 tons per day of refuse being delivered to the plant. We agree that waste capture and control is critical to this project. It is being addressed by others on the project team.

System Integration

We agree.

Additional Information

Process and Instrumentation Drawing

We do not feel that the conceptual design required development of an overall plant process and instrumentation drawing. If this project proceeds, several process and instrumentation drawings will be prepared.

Process Mass and Energy Balances

Please see the attached write-up prepared by Union Carbide to address this concern.

Continued on Page 3

November 6, 1979

Mr. Gregory Bosaz, Jr., P.E.
Dept. of Solid Waste Management

Page 3

Details on the User Modifications

Modifications to the users plant will be limited to new fuel trains and appropriate instrumentation interconnections. We believe that our estimate is sufficient to cover this work. If the project proceeds, we will develop detailed information for the specific boilers to be affected.

Basis for Costing

If this project proceeds, Task V is to develop a detailed cost estimate which would include the information requested.

Should you have any questions above the above, please do not hesitate to call.

Very truly yours,

Roger S. Hecklinger

RSH/maf

cc: H. Gregor Rigo

COMMENTS REGARDING "PROCESS MASS AND ENERGY BALANCE" SECTION
OF CSI RESOURCE SYSTEM INC.'S OCTOBER 2 LETTER TO MR. BOSAZ

We are puzzled by the statement that balances should be on an elemental basis since information is presented in that manner on the "200 TPD PUROX System Module/Simplified Heat and Material Balance" drawing, which accompanied the Final Summary Report. The balance shows sulfur to be somewhat equally split between the slag and product gas streams, whereas chlorine is shown to predominantly end up in the wastewater and thus (implicitly) in the wastewater incinerator flue gas stream. Since no specific composition data is available on Dutchess County refuse, the split shown was based on generalized information on U.S. municipal solid waste. However, it is unlikely that there would be any fundamental difference in the Dutchess County case.

The exact dispositions of sulfur and halogens from the system are functions of the manner in which these materials are chemically combined in the refuse which enters the plant. Generally, the fractions that enter the system in inorganic (e.g. salt) form will mostly leave bound in the slag; those which enter in organic compounds (e.g., plastics, rubber) will mostly exit the converter in the off gas stream. Thus if, for example, an unusually large fraction of the chlorine came in as ordinary salt, a larger fraction than that shown on the balance would leave the converter in the slag, rather than in the wet off gas stream.

Both the sulfur and halogens present in the off gas are mainly in acid gas form (H_2S , HCl , etc.). The scrubber is very effective at removing halogen acids, but has little effect on H_2S . Thus almost all the organically-derived sulfur remains in the product gas stream. While this is converted to sulfur oxides when the gas is ultimately used as fuel, the resultant atmospheric emission is much less - on an equivalent heat basis - than occurs when burning coal, and in fact corresponds to that which would be obtained with a very low (0.25 weight %) oil fuel. The emission would be no greater than that from an incinerator processing the same waste, and would not violate either New York State or Federal stationary source rules.

With respect to chlorine, its potentially corrosive presence in the wastewater has been taken into account in the wastewater incinerator design. Incineration of the wastewater will result in emission of chlorine to the atmosphere as HCl . This again is the situation with a solid waste incinerator, and does not constitute a violation of any existing or pending law. UCC believes that this is also true of the manner in which the PUROX System disposes of any other elements or compounds which are of environmental concern.

September 7, 1979

Honorable Lucille P. Pattison
County Executive
County of Dutchess
County Office Building
22 Market St.
Poughkeepsie, N.Y. 12601

Re: Dutchess County Pyrolysis Project
DOE Grant No. EM-78-G-01-5143
New York State DEC Bond Act Project No. 3-MSWRR-002-Q

Dear Mrs. Pattison:

During our meeting with Union Carbide in your office on September 4th, you asked that Union Carbide prepare a statement regarding their position relative to operating the PUROX system. The attached letter dated September 6th is their response.

Should you have questions regarding this matter, please do not hesitate to call.

Very truly yours,

Roger S. Hecklinger
Principal

RSH:pp

Enc.

cc: G. Bosaz, Jr.

September 6, 1979

Mr. Roger S. Hecklinger, P.E.
Charles R. Velzy Associates, Inc.
Consulting Engineers
355 Main Street
Armonk, New York 10504

Dear Mr. Hecklinger:

The Dutchess County Pyrolysis Project report issued July 1979 by Charles R. Velzy Associates recommends that Dutchess County enter into a contract with Union Carbide Corporation for operation of the proposed solid waste facility. Recently Union Carbide Corporation has decided not to pursue direct operating contracts as part of its Environmental Systems Department business.

The PUROX System scope of supply that Union Carbide Corporation is prepared to provide is as follows:

1. The PUROX System process design, beginning with the refuse feeder through the providing of a clean fuel gas.
2. Key PUROX System equipment on an uninstalled basis through the project general contractor.
3. PUROX System warranties relative to key design parameters.

In lieu of a direct operating contract Union Carbide Corporation will provide Dutchess County the following:

1. Assistance in identifying and evaluating acceptable facility operating contractors.
2. Technical assistance contract relative to the PUROX System operation and maintenance.
3. A two-year management contract for directing the operation of the PUROX System with the assumed responsibility for achieving the design performance results.

Hopefully these comments will serve to clarify Union Carbide Corporation's position relative to marketing of the PUROX System. As with any product that Union Carbide Corporation offers into the commercial marketplace it is the intent of Union Carbide to fully support the PUROX System to achieve the performance indicated by the design provided.

If we can be of assistance in providing additional information, please contact me.

Very truly yours,

A handwritten signature in dark ink, appearing to read "Gordon W. Kumke", with a stylized flourish at the end.

Gordon W. Kumke
Manager, Solid Waste Systems

GWK/lld

September 26, 1979

Gordon Kumke, Manager
Solid Waste Systems
Union Carbide Corporation
Linde Division
Old Saw Mill River Road
Tarrytown, New York, 10591

Re: Dutchess County Resource Recovery Project

Dear Mr. Kumke:

This is in response to your letter of September 6, 1979 addressed to Roger Hecklinger, P.E. of C. R. Velzy Associates, our engineers on the above project.

The County finds the Union Carbide proposal for the scope of system supply and operation of the pyrolysis facility unacceptable. Under your proposal, the County must bear an overwhelming burden of risk in what is the first commercial development of your system.

As a basis of discussion, the County would propose the following:

1. Final design of the entire system to be accomplished by Union Carbide and Velzy Associates as joint venturers; design (and bidding documents) to be completed within a negotiated time frame.
2. If New York State bidding laws are amended accordingly, construction of the system to be performed by a sub-contractor of Union Carbide, under a negotiated agreement with a maximum upset price; with cost over-runs to be borne by Union Carbide. Construction of the system would be required within an agreed upon time frame, subject to liquidated damages if time limits are not met.

September 26, 1979

2. (a) If New York State bidding laws are not changed, and public bids are required for construction, then Union Carbide to perform supervision and inspection services during the construction phase.
3. Full responsibility, financial and legal on Union Carbide for operation of system in accordance with established design standards during a start-up phase and an acceptance phase.
4. Five year warranty of Purox components to commence upon acceptance of facility by the County.
5. Operation contract for 20 year period on a cost plus incentive basis (details to be negotiated) with a guaranty from Union Carbide to produce a specific amount of gas at design quality.
6. Guaranty by parent company to support all contractual arrangements.

We look forward to discussing this matter at the meeting to be held on October 1, 1979 at 10:00 a.m. in the County Executive's Office.

Very truly yours,

STEPHEN J. WING

SJW:ld

CC: Roger Hecklinger, P.E.
C. R. Velzy Associates

Lucille P. Pattison, County
Executive

James Spratt, Commissioner of
Public Works

Project Team

ENVIRONMENTAL
SYSTEMS

October 8, 1979

1979 OCT 15 10 11 AM
RECEIVED
SOLID WASTE SYSTEMS
DIVISION
U.S. ENVIRONMENTAL
PROTECTION AGENCY
WASHINGTON, D.C. 20460

Mr. Stephen J. Wing
Dutchess County Attorney
Dutchess County Office Building
Poughkeepsie, New York 12601

Dear Mr. Wing:

We appreciate the recent opportunity for discussions with Dutchess County representatives to delineate the role of Union Carbide Corporation relative to the proposed Dutchess County Pyrolysis Project. We are fully aware of the opportunity that the Dutchess County Project offers for use of the PUROX System, and desire to see the project proceed. A continued exchange of information between Dutchess County and Union Carbide is considered necessary in order to achieve an acceptable relationship for this project.

Our recent discussions with Dutchess County have clearly indicated that the County is seeking to obtain a "Full Service Contract" relative to their proposed Pyrolysis Project involving the PUROX System. Since Union Carbide desires to be responsive to the needs of Dutchess County we intend to develop a relationship with a well qualified firm that has the capability of providing a "Full Service Contract" for the entire Dutchess County Project. The PUROX System would be included as part of the "Full Service Contract" offered by the firm, with Union Carbide providing guarantees and warranties relating to the PUROX System performance. It is Union Carbide's intent to pursue this direction in a time frame that is compatible with the needs of the Dutchess County Pyrolysis Project.

We believe this Union Carbide position is indicative of our continued interest in the Dutchess County Project and our commitment to support the PUROX System commercialization. As definitive progress is made in establishing a qualified firm to provide the "Full Service Contract" desired by Dutchess County we will be in contact with the County.

Thank you again for your continued interest in the PUROX System and please contact me if we can be of further assistance.

Very truly yours,

Gordon W. Kumke
Manager, Solid Waste Systems

GWK/lld

OFFICE OF
THE COUNTY ATTORNEY OF DUTCHESS COUNTY

STEPHEN J. WING
COUNTY ATTORNEY

COUNTY OFFICE BUILDING
POUGHKEEPSIE, N. Y. 12601
TELEPHONE (914) 485-8864

October 30, 1979

Gordon W. Kumke, Manager
Solid Waste Systems
Union Carbide Corporation
Old Saw Mill River Road
Tarrytown, New York 10591

Dear Mr. Kumke:

Thank you for your letter dated October 8, 1979, which I received on October 15, 1979. I have discussed the letter at length with the County Executive and the Commissioner of Public Works and am writing at their request.

You indicate in your letter an accurate understanding of the County's requirement of a "full service" contract for the proposed pyrolysis project. It is unfortunate that Union Carbide or a wholly-owned subsidiary is no longer in a position to provide such an approach. However, the County will consider a timely proposal from a qualified and substantial firm which will provide a full service contract for the design, construction and operation of a resource recovery project utilizing the PUROX system. Of course, favorable consideration on this aspect of the project is contingent on many factors. The firm must meet the County's qualifications. The contract proposal must provide adequate guarantees and allocation of risk advantageous to the County.

A recommendation as to the future of the pyrolysis project will be made in the near future. That recommendation will be based upon the clarification of several issues outstanding in the Velzy report, favorable comparison of the project to other available technologies, favorable development of project economics, and further exploration of acceptable markets.

Gordon W. Kumke, Manager
Page 2

October 30, 1979

The timely intervention of a qualified full service contractor is also vital to the decision-making process. Therefore, your earliest advise on that issue will be most important to the County.

Very truly yours,

STEPHEN J. WING

SJW:ld

CC: Lucille P. Pattison, County Executive

James Spratt, Commissioner of
Public Works

MARSH ST.

1979 OCT 30 PM 5:22

DUPONT CO.
P. W.

LUCILLE P. PATTISON
COUNTY EXECUTIVE

Office of
The Dutchess County Executive
County Office Building - Poughkeepsie, New York 12601
(914) 485-9861

January 4, 1980

Gordon Kumke, Manager
Solid Waste Systems
Union Carbide Corporation
Linde Division
Old Saw Mill River Road
Tarrytown, New York 10591

Dear Mr. Kumke:

It is with sincere regret that I inform you that I am recommending that the County not proceed with the one system procurement of the pyrolysis resource recovery system based upon the Purox technology.

The County and Union Carbide have had a long and cordial relationship. I have only the highest praise for the Union Carbide personnel we have worked with through the years. Unfortunately, because of the position of Union Carbide relative to a full service contract, the anticipated high cost of the Purox system and the apparent availability of other more proven technologies, the County cannot continue pursuing the one system approach to the project.

While we are not precluding Union Carbide from submitting a proposal in the future, at this time we will alter our plans and examine a resource recovery system involving mass burning technology with steam recovery.

I am confident that the Purox technology will have industrial application. I regret that such application may not include the handling of municipal solid waste in Dutchess County.

Yours truly,

Lucille P. Pattison

LUCILLE P. PATTISON
County Executive

October 24, 1979

Gregory Bosaz, Jr., P.E.
County of Dutchess
County Office Building
22 Market St. - 5th Floor
Poughkeepsie, N.Y. 12607

Re: Dutchess County Pyrolysis Project
Technical Services Estimate
CRVA 78-27-1B

NOTES CO.
G P W
OCT 25 PM 4:13
MARKET ST.

Dear Mr. Bosaz:

This letter is in response to yours of September 6th concerning the estimate of Technical Services costs contained in our report of July, 1979. Our comments follow the same numbering system as your letter.

1. Table 8-2 has been revised and is attached. The revised Table includes engineering services for Task I and II. As you point out, inclusion of these tasks does not affect the annual cost of amortization for the proposed plant.
2. You ask for a breakdown of certain costs:
 - a. Further soils investigation is included in Task IV-Velzy. The amount included is \$15,000.
 - b. The cost of a site survey for purposes of acquiring the site is not included. Survey work required for design of the facility will be performed by Velzy. The cost of this work is included in our estimate for Task IV.
 - c. Field testing for concrete work will be performed at the expense of the General Contractor. Field inspection of the equipment as it is installed will be performed by Velzy as part of the Construction and Start up estimate. Field tests on piping and equipment will be performed by the manufacturers at the expense of the General Contractor.
3. We attach Table 8-2a which relates the Velzy and Union Carbide estimates for Task IV to the major construction cost items.

Continued on Page 2

Gregory Bosaz, Jr., P.E.
October 24, 1979
Page 2

4. You ask for an explanation of the significant variance between the total Technical Services costs and available DOE grant funds. The total estimate for Technical Services as shown in revised Table 8-2 is \$3,185,000. The DOE grant funds available are \$1,500,000. The difference between the estimate for technical services and the grant fund available is \$1,685,000. The major reason for this difference is that total Technical Services encompassed a far greater range than that to be covered by the DOE grant funds. We have included an estimate for bond issuance costs of \$625,000. This is not covered by the DOE grant. We estimate a construction startup cost of \$510,000. This is not covered by the DOE grant funds. We have estimated a cost for an environmental assessment of \$50,000. This is required by the New York State DEC and is not covered by the DOE grant funds. The remaining unfunded technical services amount to \$500,000. Please understand that the DOE grant was issued for the low end of a range of design engineering costs estimated by Commissioner Connolly for the grant application. From our first meeting with DOE, we advised them that the value of engineering services through Task V would exceed the grant allowance. We do believe, however, that the major reason that the estimated costs for engineering services through Task V exceed the grant allowance is that the high "first time" costs for engineering the Union Carbide equipment. One half of the unfunded design engineering services can be covered by the DEC grant.
5. In November of 1978, we were asked if completion of Tasks I and II would entail sufficient engineering to determine an accurate cost. Now that they are completed, we believe that our cost estimates provide a sound basis for deciding whether or not to proceed with this project. The purpose of Task IV is to develop the final plans and specifications for bidding. Task V is to provide a final cost estimate. We expect the final cost estimate to compare favorably with the present estimate.

We trust that this answers the questions raised in your letter, should you have further questions, please do not hesitate to call.

Very truly yours,

Roger S. Hecklinger, P.E.
Principal

TABLE 8-2

ANNUAL AMORTIZATION COST

	TOTAL	AVAILABLE GRANT	REMAINDER
<u>Capital Costs</u>			
Land Acquisition	\$ 80,000		\$ 80,000
Purox Facility	24,235,000	\$12,117,000s	12,118,000
Modifications at Fuel Users Plant	80,000		80,000
Mobile Equipment	300,000	150,000s	150,000
Subtotal	\$24,695,000	\$12,267,000	\$12,428,000
<u>Technical Services</u>			
Engineering			
Tasks I & II	\$ 450,000		
Task IV Velzy	\$ 550,000	\$ 1,500,000f	
Task IV Union Carbide	950,000	250,000s	\$ 250,000
Task V	50,000		
Environmental Assessment	50,000	25,000s	25,000
Construction & Start Up	510,000	255,000s	255,000
Bond Issuance	625,000		625,000
Subtotal	\$ 3,185,000	\$ 2,030,000	\$ 1,155,000
<u>Interest During Construction</u>			\$ 1,315,000
Total			\$14,898,000
<u>Annual Cost of Amortization</u>			\$ 1,270,000

(s) N.Y.S. DEC Grant Funds

(f) U.S. D.O.E. Grant Funds

TABLE 8-2a

TASK IV ENGINEERING COSTS

	UNION CARBIDE	CRVA	TOTAL
Site Work		35,000	35,000
Refuse Processing Building		400,000	400,000
PUROX Processing Area	875,000	20,000	895,000
Cryogenic Oxygen Separator	75,000	20,000	95,000
Cooling Tower		20,000	20,000
Process Water Pumping Station		20,000	20,000
Interconnecting Piping		35,000	35,000
	950,000	550,000	1,500,000

U.S. Department of Energy
Washington, D.C. 20585

NOV 1 1979

Mr. Gregory Bosaz, Jr., P.E.
Dutchess County Department of
Solid Waste
22 Market Street
Poughkeepsie, New York 12601

Dear Greg:

We have completed our review of the Dutchess County Pyrolysis Project Final Summary Report (including conceptual design drawings one through forty-three) and the Organizational and Financial Considerations Summary Report. Our review was based solely on the contents of the reports as prepared by Charles R. Velzy Associates for Dutchess County.

On the whole, the reports are well written and informative. There are some aspects of the report which raised particular questions. We have summarized those questions and you will find them attached. I would appreciate your review and response to those questions. I look forward to hearing from you.

Sincerely,

Charlotte Rines
Program Manager
Community Technology Branch
Office of Conservation and
Solar Energy

Review and Comment

Dutchess County Pyrolysis Project Final Summary Report and Organizational and Financial Considerations Summary Report

I. Final Summary Report - July, 1979

1. Page xii, second paragraph. The following statement is made, "Union Carbide Corporation is interested in entering into a contract to assume responsibility for operation of the entire facility." Recent conversations with Union Carbide personnel indicate that this is not true and deny that they have ever agreed to such a statement. Please confirm their commitment or correct text as necessary.
2. Page xiv, fifth recommendation. Depending upon the outcome of (1) above correct as necessary.
3. Page 3-49 and 3-50. The statement is made that if a returnable bottle bill were enacted the net effect on the plant would be positive. But what about the effect of a bottle bill on revenues? If 70 percent of the glass were removed as stated then the loss in revenues from tipping fees and slag sales would be approximately \$150,000 per year.
4. Page 6-2, Figure 6-1. The O_2 requirement shown in the mass balance is the same value as given for the earlier atmospheric concept. Is it possible that the pressurized system will require a different quantity of O_2 ?
5. Page 6-3, Table 6-1. This table presents the refuse specifications that are acceptable for the PUROX system. Certain materials are indicated as being prohibited. Who assures that these materials are indeed not present in the feedstock? Provide discussion to cover this point.
6. Page 6-5, Table 6-2. The fuel gas characteristics shown are the same as those previously given in the literature for the atmospheric concept. Will the pressurized version of gas characteristics be different?
7. Page 7-41, first and second paragraphs. Some narrative should be presented to explain how the cyclone separator and ESP will be cleaned.
8. Page 7-62, Section 7.7.8. Why aren't critical system controls and instrumentation and minimum plant illumination requirements connected to the emergency generator?

9. Page 8-2, Table 8-1. The following comments all refer to Table 8-1.
 - a. Only \$280,000 has been allocated for site work in Table 8-1. This allocation appears to be much too low in light of the statement made in section 5.2.3, "Because of the rugged topography of the site, cutting and filling will be required to level the site for development. Blasting will be required for rock removal, and suitable materials will have to be imported from off-site for use in structural fills to achieve final grades."
 - b. See review comments on Dwg. 7 for comments on refuse processing building codes.
 - c. Where are spare parts costed? At this early stage of project development four or five percent of equipment cost is not too low a figure to use for spare parts costing estimation. Note also that section 7.8.6 states that an inventory of spare parts will be maintained.
 - d. Where are contingency costs taken into account? What factors were used for each of the major cost items presented? A table should be included listing the contingency cost associated with each of the cost items presented in Table 8-1.
10. Page 8-9, Table 8-2. The following comments refer to Table 8-2.
 - a. Where are engineering contingency costs accounted for?
 - b. If construction management is used, where is this costed, and at what percent?
 - c. How was the interest during construction costs arrived at? What annual rate of interest was assumed, and what construction schedule was used in computing the total dollar cost presented?
11. Page 8-14, Table 8-4. The following comments refer to Table 8-4.
 - a. How were maintenance costs computed? If computed as a percentage of capital costs, provide a table showing the capital cost item (by major category only) indicating what percentage was applied to each unless a uniform figure was used.
 - b. Indicate how landfill tipping fee of \$126,000 was calculated.
 - c. How was the depreciation of mobile equipment cost computed?
 - d. Where are the transportation costs accounted for? Such things as the costs associated with transporting the refuse which should not be fed to the converter to a landfill, and the costs associated with hauling slag to the marketplace.
 - e. Where are the facility start-up costs accounted for? If these costs are included in another cost item then indicate how they were computed.
 - f. Consider providing back-up data to project cost tables in an appendix to the report.

II. Organizational and Financial Considerations Summary Report.

No Comments.

December 7, 1979

Gregory Bosaz, Jr., P.E.
Project Coordinator
Dutchess County
Dept. Public Works
22 Market St.
Poughkeepsie, N.Y. 12601

DUTCHESS CO.
D.P.W.
9 DEC 10 AM 9:44
MARKET ST.

Dear Greg:

The purpose of this letter is to respond to the questions raised by the Department of Energy as transmitted to us by your letter of November 7th. We are following the same numbering system used in the DOE list.

1. The report was predicated on successful negotiation of an operating contract for the Union Carbide Corp. to operate the PUROX facility. At the time the report was submitted (July 23, 1979) there was no question that Union Carbide Corp. was planning to operate the facility. All data used for the operating contract was developed by Union Carbide and incorporated by us into the report. Subsequent to the submittal of the report, Union Carbide Corp. advised us that they would not operate the facility but rather would seek to find another company to operate the facility. This situation is not resolved. It is being addressed by the members of the Project Team.
2. This comment hinges on the outcome of Comment 1 and therefore cannot be addressed at this time.
3. We are asked to comment on the effect of a "bottle bill" on revenues at the PUROX facility. On Pages 3-49 and 3-50 it is not stated that a bottle bill would result in removal of 70% of the glass. Rather it is stated that up to 70% of the glass could be lost without affecting the PUROX process. Be that as it may, bear in mind, plant economics are based on receipt of 145,000 tons of refuse per year and processing of 125,000 tons of refuse per year. A reduction in refuse because of reduction in glass would result in a larger percentage of the received refuse being processed. Thus the loss in tipping fee at the plant would be partially reduced by a reduction in the amount of material hauled to landfill. The net effect will not have much impact on the operating costs of the plant.

Continued on Page 2

Gregory Bosaz, Jr., P.E.
December 7, 1979
Page 2

4. A question is raised regarding the effect of a pressurized PUROX system on the O₂ requirements. The following reply has been received from Union Carbide Corp.:

A new pressurized PUROX System design provides a significant reduction in overall oxygen consumption, but the majority of this reduction results from replacement of the biological wastewater treatment by incineration. When a comparison is made on the basis of a fixed refuse composition, the pressurized design also provides a small reduction in oxygen utilization within the converter. This results from a decrease in the quantity of moisture fed to the converter with the recycled particulate stream, and a corresponding minor improvement in thermal efficiency. However, oxygen consumption is also dependent on refuse composition. Although this dependence is weak it is sufficient in this case to mask the small oxygen reduction resulting from the decrease in recycled moisture.

5. It is pointed out that certain materials are indicated as being prohibited from the PUROX System. The question is raised, who assures that these materials are indeed not present in the feed stock? Of course, there is no way to assure that these materials are not present in feed stock. It is incumbent on all operating personnel particularly those on the tipping floor and the crane operator to be on the lookout for these and other items that may prove troublesome to the entire processing system.

6. Questions raised, does the pressurized version of the PUROX System change the characteristics of the fuel gas? The following response has been received from Union Carbide Corp.:

The pressure level utilized by the new PUROX System design is not sufficient to cause a measureable effect in gas composition.

Continued on Page 3

Gregory Bosaz, Jr., P.E.
December 7, 1979
Page 3

7. We are asked to provide some narrative to explain how the cyclone separator and ESP will be cleaned. The following statement has been received from the Union Carbide Corp.:

The cyclone separator is continuously cleaned through the addition of scrubber water. Therefore, there is no significant deposit buildup, and general cleanup during plant turnaround is sufficient. Provisions are built into the electrostatic precipitator for spray cleaning with a solvent. This cleaning is accomplished without removing the electrostatic precipitator from operation; an approximate bi-monthly cleaning requirement is anticipated. During the plant turnaround the electrostatic precipitator will receive a more thorough cleaning using a specially designed tool to scrape deposits from the tubes. The costs associated with cleaning have been included in the maintenance account.

8. We are asked why critical system controls and instrumentation and minimum plant illumination requirements are not connected to the emergency generator. Critical system controls are connected to the emergency generator. These include process water pumping station and the cooling tower. A control shutdown can be accomplished with these two components operating. Much of the PUROX instrumentation is pneumatic, operated by nitrogen. Nitrogen is available from the liquid storage tank when needed. Some plant illumination is provided for the main processing building. That detail is not shown on the drawings.

9a. The figure of \$280,000 allocated for site work and Table 8-1 was thought to be too low by the reviewer. Please understand that the figure for site work pertains only to the work required in the surrounding area. The work required for the various structures is included in the cost estimate for the structures. For example, in the main receiving area the allowances for rock excavation, import fill, rock back fill from excavation, and soil excavation for the pit exceeds \$400,000.00

Continued on Page 4

Gregory Bosaz, Jr., P.E.
December 7, 1979
Page 4

9b. Review comments on Drawing 7 have not been passed on to us for our response.

9c. Questions raised regarding spare parts. Spare parts are included in the "mechanical" category for the various components.

9d. Questions raised where contingency costs are taken into account. Contingencies were added to the various estimates. In general a 10% contingency was added.

10a. The engineering estimates include contingencies.

10b. The cost estimates do not include construction management. Rather, the estimates are based on award of a minimum number of prime contracts. On site coordination would be handled by a resident engineering staff.

10c. The interest during construction was developed by the financial member of the project team.

11a. Maintenance costs were computed by Union Carbide Corp. as part of their operating contract.

11b. Questions raised regarding how the tipping fee of \$126,000 was calculated. As explained in our letter of November 6th, tipping fee was based on 20,000 tons per year of excess material plus 6,000 tons per year of ferrous material at a tipping fee of \$6 per ton. This amounts to \$156,000 per year. Unfortunately due to an arithmetic slip up, this is shown as \$126,000 per year on Table 8-4.

11c. Questions raised concerning the depreciation of mobile equipment. This figure was based on full depreciation over four years.

Continued on Page 5

Gregory Bosaz, Jr., P.E.
December 7, 1979
Page 5

1ld. Question is raised concerning transportation costs. Costs associated with transporting refuse to the landfill or slag to the market are built into the overall costs. Mobile equipment is discussed on Pages 7-65 and 7-66. Fuel for transportation is discussed on Page 7-56. Drivers are shown on Pages 8-11 and 8-12. The landfill tipping fee is shown on Table 8-4 on Page 8-14.

1le. Question raised regarding facility startup costs. Cost estimates are based on a prime contractor turning operating equipment over to the operating contractor.

Should you want to discuss any of this further, please do not hesitate to call.

Very truly yours,

Roger S. Hecklinger, P.E.
Principal

RSH:p
cc: Charlotte Rines, DOE

AUG 28 1979

Ms. Lucille P. Pattison
County Executive
Office of the Dutchess County Executive
County Office Building
Poughkeepsie, NY 12601

Dear Ms. Pattison:

Commissioner Flacke has asked me to reply to your August 2 letter in which you requested that the State commit 50 percent funding for the proposed County pyrolysis project based on total eligible costs at the time of project bid awards.

As you know, the State has a contract with the County to provide \$13,449,000 of State Environmental Quality Bond Act (EQBA) funds for the County resource recovery project. All but \$213,000 of the EQBA resource recovery grant funds has been appropriated by the Legislature to other municipal resource recovery projects in the State. Therefore, unless the Legislature reappropriates additional EQBA funds from existing projects, funding assistance to this project cannot be realized beyond the present contract amount.

We are currently reviewing the "Final Summary Report" prepared by Velzy Associates on the County resource recovery project. We have forwarded our comments to Mr. Gregory Bosaz of Velzy Associates.

If you have additional questions on this matter, please do not hesitate to contact me (518/457-6603) or Mr. Allan E. Raymond, Director of our Bureau of Resource Recovery, at 518/457-5714.

Sincerely,

Norman H. Nosenchuck, P. E.
Director
Division of Solid Waste Management

pm

cc: DEC Region 3

DUTCHESS COUNTY PYROLYSIS PROJECT

EVALUATION OF ALTERNATE ENERGY SYSTEMS

NOVEMBER, 1979

November 20, 1979

The Honorable Lucille P. Pattison
County Executive
County of Dutchess
County Office Building
22 Market Street
Poughkeepsie, New York 12601

Re: Evaluations of Alternate Energy Systems

Dear Mrs. Pattison:

We are pleased to submit this Evaluation of Alternate Energy Systems in accordance with our agreement dated September 14, 1979.

The report summarizes our findings regarding feasibility, capital costs, operation and maintenance costs, revenues and net tipping fees for alternate solid waste disposal systems. The results can be compared directly with the July 1979 Final Summary Report for the Dutchess County Pyrolysis Project.

We look forward to working with you further on this project as it progresses.

Very truly yours,

Roger S. Hecklinger, P.E.
Principal

RSB/tam

Encl.

EXECUTIVE SUMMARY

The purpose of this study was to compare the recent conceptual design and evaluation of the Union Carbide Corporation PUROX System with specific alternative resource recovery systems for the Dutchess County core area. A number of previous resource recovery studies prepared for Dutchess County were reviewed and updated. In addition, the following specific resource recovery systems were evaluated:

- Modular incinerators with heat recovery

- Waterwall incinerators with convection boilers

- Mass burning incinerators with convection boilers

- Refuse-derived fuel production

- Spreader-stoker fired boiler

In general, the findings of the previous reports remain valid. That is, the number of potential energy users in Dutchess County is limited. Nevertheless, a number of attractive possibilities exist for energy recovery from refuse. These possibilities are discussed for each of the specific systems investigated.

Modular Incinerators with Heat Recovery

Three potential energy users were identified where modular incinerator plants could serve a user. The potential users are the IBM Poughkeepsie plant, Beacon Tex-Print and Texaco in Beacon. Modular systems have two significant advantages. The average haul distance for refuse to the plant

is less for multiple facilities than for a single regional plant. With three users, there is a potential for maximizing steam sales, hence maximizing revenues from sale of energy. The disadvantages associated with this system are: three plants cost more than one plant; and it takes considerably more manpower to operate three modular plants than one central plant.

Waterwall Incinerators with Steam Production

The processing equipment and PUROX gas converters developed for the conceptual design in the previous study could be replaced with waterwall boilers to generate steam from unprocessed refuse. The advantage of this system is lower capital costs than the PUROX facility. Further, steam production rates could be correlated more closely with IBM energy needs than gas production can be correlated with energy needs. The IBM facility in Poughkeepsie is prepared to accept steam from a refuse facility. This would enable them to "mothball" the older boilers in their boiler house. The two package boilers in the boiler house would provide backup steam requirements.

Mass Burning Incinerators with Convection Boilers

A convection boiler would not appear to offer any advantage over a waterwall boiler installation with the possible exception of a moderately lower capital cost. Any capital cost advantage would be more than offset by operating cost increases

and loss of availability. Therefore, this system is not evaluated in detail.

Refuse-Derived Fuel Production

There are no coal-fired boilers in the core area capable of receiving and firing refuse-derived fuel in the quantities potentially available. Therefore, this system is not evaluated in detail.

Spreader-Stoker Fired Boiler

The converter equipment developed for the PUROX facility could be replaced with two spreader-stoker fired boilers to receive the prepared refuse and generate steam for the IBM Poughkeepsie facility. This would result in a somewhat lower capital cost than for the PUROX facility but a higher capital cost than for a waterwall steam generator due to the front-end processing equipment required. Spreader-stoker fired boilers would be more capable of following energy requirements at the IBM plant than the PUROX gas facility. Thus, there is a potential for higher revenues from energy sale.

All evaluations are developed in comparison with the cost for the PUROX facility developed in the 1979 Velzy Report. It is assumed that regardless of the system used, Dutchess County would enter into a contract to operate the facility. A summary of the overall economic findings is displayed in the Summary Table.

SUMMARY TABLE

	PUROX	MODULAR INCINERATION	WATERWALL INCINERATION	RDF INCINERATION
<u>CAPITAL COSTS</u>				
Total	24,695,000	23,147,000	21,994,000	23,166,000
Available Grant	12,267,000	11,452,000	10,932,000	11,518,000
Net Dutchess County	12,428,000	11,695,000	11,062,000	11,648,000
<u>ANNUAL COSTS AND REVENUES</u>				
Amortization	1,270,000	1,183,000	1,107,000	1,169,000
Operating & Maintenance	2,586,000	3,758,000	2,234,000	2,641,000
Total Revenues	1,536,000	2,131,000	1,543,000	1,462,000
Net Annual Cost	2,320,000	2,810,000	1,798,000	2,348,000
<u>NET TIPPING FEE \$/TON</u>	16.00	19.38	12.40	16.19

1. PURPOSE AND SCOPE

The purpose of this report is to compare the appropriateness, feasibility, and overall cost of the Union Carbide Corporation PUROX System to certain alternative resource recovery systems for the Dutchess County core area.

The scope of work may be divided into two parts. The first is a review of previous resource recovery system studies prepared for the County and an updated opinion as to the applicability of such studies to the County. The second part of this report is a feasibility study and cost analysis based on on-site and literature researching, comparing the following resource recovery systems to the PUROX System:

- Modular incinerators with heat recovery;
- Waterwall incinerators with steam production;
- Mass burning incinerator with convection boiler;
- Refuse-derived fuel (RDF) production;
- Spreader-stoker fired boiler.

2. PREVIOUS DUTCHESS COUNTY STUDIES

The Dutchess County Solid Waste Advisory Committee and the Commissioner of Solid Waste prepared several studies regarding solid waste disposal. Those studies were reviewed and, where applicable, information was extracted from them and updated, and is included in the following sections.

2.1 "A Review of Alternate Refuse Disposal Systems"

This report was prepared by the Commissioner of Solid Waste in May, 1974. The report discussed the alternate waste disposal systems considered before the PUROX System was recommended.

2.1.1 Sanitary Landfills. The report states: "Dutchess County's thin soil cover, high groundwater levels, and abundant rock ledges severely limit the number of suitable sites for sanitary landfills". This statement is confirmed by the existing solid waste disposal problem in Dutchess County as evidenced by the lack of acceptable landfills. The airport landfill, which served much of the core area, was closed in January, 1977. Since that time, refuse has been hauled to the Amenia or Orange County landfill, or deposited in other small landfills throughout the County. The County is presently considering reopening the airport landfill for spring and fall disposal of trash. However, it is possible that the cost of operating that landfill with a limited tonnage would be prohibitively expensive. The "Long Term Landfill Siting

Report", prepared in 1978, updated the feasibility of siting a landfill in Dutchess County. That report is discussed in Section 2.5.

2.1.2 Incineration. The following items in the report relating to incineration can be updated in light of recent developments:

1. Technology has improved to a point where air quality standards can be met with proper design. Electrostatic precipitators should be included for all incineration alternatives.

2. The report states that "for best combustion, some shredding is desirable." Demonstrated experience in many operating units establish that shredding is not needed.

3. Although the residue from incineration can be as high as 30 percent by weight, the volume percentage is significantly lower. Therefore, although landfilling is necessary, the landfill life can be extended by a factor of about ten.

4. Steam generated by a facility must be used immediately, or it is wasted. The steam user should be near the disposal plant if incineration is to be considered a viable system. If a steam user is not nearby, electrical power generation could be considered. This alternate steam use increases capital and operating costs, but ensures the sale of all of the energy product.

Several forms of incineration with energy recovery are feasible for Dutchess County, and are discussed in Section 4.

2.1.3 Composting. Composting and biochemical treatment methods are discussed together in the report. Biochemical fractionation through acid hydrolysis to produce ethanol has not progressed past the bench testing stage, and cannot be considered a feasible solution at this time. Biochemical digestion of sewage sludge and refuse is being tested in a 100 TPD facility in Pompano Beach, Florida. Tests to determine design and operating parameters are scheduled over the next few years. This system is also not considered a feasible solution at this time.

Many composting systems have been tried in the United States, but only one has remained in operation. The Fairfield-Hardy facility in Altoona, Pennsylvania has been handling 35 TPD of refuse since 1963. A scale-up of the plant to 400 TPD for Dutchess County might be technically feasible. However, marketing the output from a 400 TPD composting facility is questionable. Several month's storage of the product would be needed during the winter or when market conditions are unfavorable. The failure of all other composting systems was due to the lack of markets for the product. For this reason, we must seriously question composting as a viable alternative for Dutchess County.

2.1.4 High Temperature Combustion. Neither the Torrax nor American Thermogen processes have been demonstrated on a commercial scale in the U.S., and are not considered to be feasible for Dutchess County at this time.

2.1.5 Refuse-Derived Fuel (RDF). The St. Louis RDF facility operated from 1972 until 1975 when initial tests were completed. Plans for a full scale facility proceeded until 1977, when the project was shelved. Combustion Equipment Associates (CEA) has operated a 60 TPD test facility intermittently at the 1000 TPD Brockton, Massachusetts solid waste processing facility since 1977. CEA has also performed test burns of the material at several locations. Ames, Iowa has been producing a fluff RDF since 1976. The technology for producing fluff and powdered RDF has been tested for several years. Several major facilities are in start-up, and the processes are being proposed for commercial scale plants. Densified or pelletized RDF is more costly, and has not yet been proven on a large scale.

The applicability of an RDF facility for Dutchess County would depend on the available markets for the RDF, which are discussed in Section 3. A portion of the revenues from RDF processing facilities is derived from the sale of recovered ferrous metals. The ferrous marketing survey performed during 1979 showed that recovered ferrous metals are not currently marketable in the Dutchess County area. This would adversely affect the overall plant economics.

2.1.6 High Pressure Combustion. The technology for high pressure combustion is still in the developmental stage. No commercially sized units have been tested, and the system is not yet feasible for Dutchess County.

2.1.7 Black-Clawson System. Paper fiber reclamation is feasible if a large paper industry is in the immediate vicinity, as is the case in Franklin, Ohio. Alternatively, the process could be used to produce a refuse-derived fuel, as in Hempstead, New York. The Hempstead facility is presently operating at less than full capacity. The material reclamation portion of the facility was designed to separate noncombustible material into the following fractions: ferrous metals, mixed nonferrous metals, aluminum, and color-sorted glass (flint, amber, and green). No market is available for the ferrous metals, which are being landfilled. Operating problems have prevented the efficient separation of nonferrous metals and aluminum. The glass sorting system cannot separate the flint glass from the colored glass with adequate quality control (the flint glass product is contaminated with some mixed colors) and the value is decreased below its projected level.

The Black-Clawson System's applicability to Dutchess County is limited, since there are no known markets nearby for the recovered materials. The overall economics would be unfavorable in the absence of such markets. The major salable output of the facility would be steam or electricity from the organic portion of the refuse. This energy product could be marketed in Dutchess County. However, the preprocessing for materials recovery adds an expense which cannot be recovered in the absence of viable markets for the recovered material. Thus, this system is not considered feasible for the County at this time.

2.1.8 Pyrolysis. Three pyrolysis systems are mentioned in the report. The Monsanto Landgard process failed to operate to specifications when installed in Baltimore. Monsanto is no longer marketing this system. The City of Baltimore has since modified the system substantially, and the plant is now operational at a reduced capacity. We do not consider this system to be a feasible solution for Dutchess County.

The Occidental Petroleum Corporation process, (formerly known as the Garrett process) was installed as a 200 TPD demonstration unit near San Diego. Initial tests conducted at this plant indicated many problems with the system. Testing has been suspended for more than a year with no definitive information as to whether additional testing will be undertaken. This process is still in the developmental stage and does not have applicability to Dutchess County.

The third pyrolysis process that was discussed in the report is Union Carbide's PUROX System. That system was the subject of the nine month conceptual design study which was completed by this firm in July, 1979, (1979 Velzy Report) and is the basis for comparison of the other systems being considered.

2.2 "Interim Report on Municipal Solid Waste"

This report was submitted by the Dutchess County Solid Waste Advisory Committee in September, 1976. The purpose of the study was to evaluate the status of technology and processes in the area of solid waste disposal and to determine those

processes and systems which might provide technically, economically, and environmentally sound solutions to Dutchess County's long term municipal solid waste disposal problem. A review of the report results in the following updated information:

1. The estimates available for the amounts of waste generated in the Dutchess County core area were inadequate. Those rates were updated in the 1979 Velzy Report.

2. Grant money from EPA for construction of the solid waste facility is not available, as the Federal government does not have a construction grants program in the solid waste management field at this time. New York State does have a grant available which remains unchanged at 50 percent to a maximum of \$13,449,000.

3. The position of Commissioner of Solid Waste was filled. However, it is again vacant. The position should be filled again, to maintain continuity in the effort to solve Dutchess County's solid waste disposal problem.

4. The expanded energy marketing survey (Section 3) shows that steam is now a marketable energy form. This results in incineration becoming a feasible means of disposal. In the past, incineration was discarded due to the lack of a steam market.

5. The CPU-1000 incinerator turbine and the Garrett pyrolysis system remain unproven on a commercial scale, and are not considered feasible for Dutchess County at this time.

6. Combustion Equipment Associates (CEA) has constructed an 1800 TPD RDF facility in Bridgeport, Connecticut to produce Eco-Fuel II. The fuel is a dry powder that is to be combusted in suspension fired boilers. The Bridgeport facility is presently in shakedown. Markets for this type of fuel are discussed in Section 3.

7. The Union Carbide PUROX System was the subject of the 1979 study. Tests at the South Charleston facility have been completed, and the system is technically feasible for the size proposed for Dutchess County. Dutchess County should require firm commitments from UCC regarding construction and operation of the facility such that the County assumes a minimum of risk.

The question regarding quality and marketability of the PUROX slag residue has been resolved in the 1979 Velzy Report, where firms have shown a willingness to purchase the slag through letters of intent.

Union Carbide has recommended that the PUROX fuel gas not be burned in a gas turbine to produce electricity.

Sewage sludge has been tested successfully in the PUROX converter. However, the relocation of the plant to the Arlington site precludes the consolidation of the Tri-Municipal

Sewage Treatment Plant and the PUROX facility. Also, the construction time schedules are incompatible, and planning for both systems to be constructed concurrently could result in unnecessary delays, causing higher costs and risks to be incurred.

The output from the proposed 400 TPD facility has been found to be compatible with IBM's fuel demand. On an annual basis, 85 percent of the gas produced by the plant could be consumed by IBM. In addition, up to three percent could be sold to the Arlington Sewage Treatment Plant.

The question of the value of Trap Rock land was answered in the 1979 Velzy Report, when both the County and an outside appraiser reviewed the land and established the approximate value. Other questions raised in the 1976 interim report regarding the PUROX System have been answered in the 1979 Velzy Report.

8. The Reprocessed Waste Materials (RWM) System has not yet been proven on a large scale. Test burns of RDF pellets were scheduled to take place at Harlem Valley State Hospital in 1976, but were never performed. This system is not considered feasible for Dutchess County at this time.

9. Landfills are discussed in detail in Section 2.4. The cost is high for Dutchess County to develop a landfill near the core area. The Orange County or Amenia landfill could be used on an interim basis for disposal until the resource recovery

facility is built. Those landfills could then be used as a backup for facility down time or excessive refuse collection. In this manner, Dutchess County would not have to locate any new landfills.

2.3 "Interim Recommendations on Solid Waste Disposal"

This report was prepared by the Dutchess County Environmental Management Council Ad Hoc Committee on Solid Waste in September, 1976. It reviewed the environmental and institutional aspects of solid waste disposal for the County.

2.3.1 Landfill. No areas in Dutchess County could be identified as environmentally acceptable for a long term landfill or balefill operation. Only inert materials were recommended to be landfilled in the County. This conclusion was further supported by later studies showing that Dutchess County soils are not compatible with landfills. Landfilling should be used as an interim solution or as a backup for a resource recovery facility. This recommendation of the report remains unchanged. Dutchess County may have to go outside the County to find a suitable landfill considering both environmental and economic reasons. The economics of the 1979 Velzy Report were based on using the Orange County landfill in Goshen, rather than developing one in Dutchess County, based on the environmental and economic advantages.

2.3.2 Energy Recovery Systems. Dutchess County has remained dedicated to the goal of energy recovery for many years. Only those systems which have been tested and proven on a commercial scale should be considered, to protect the interest of the County. The use of RDF was discarded due to the lack of a suitable market at the time of the 1976 report. An updated marketing survey is discussed in Section 3.

The PUROX System was discussed as producing energy in the most usable form (gas), but having the drawback of high capital costs. These costs were updated in the 1979 Velzy Report. However, net cost should be the determining factor in selecting a system, rather than capital cost alone. On the basis of net cost, the PUROX System is compatible with alternate systems.

The Garrett System, which produces a pyrolytic oil, was also discussed. That system's technology has not been proven to the extent of the PUROX System, and it is not recommended as a viable alternative at this time.

The report states that all three systems could incorporate front-end recovery of valuable materials. The 1979 marketing study showed that ferrous metals are not salable in the Dutchess County area, and must be landfilled. Glass and aluminum recovery systems are still in the developmental stage and should not be considered for implementation in any system at this time. Sufficient space in the processing building could be allocated for future installation of processing equipment if markets for these products should develop in the future.

The report did not explore the possibility of marketing steam or electricity. These are viable alternatives, provided that suitable markets can be found. Potential markets for these systems are discussed in Section 3.

2.3.3 Private vs Public Enterprise. The report states the advantages and disadvantages of private vs public ownership and operation, and remains open as to the method of procurement and operation. It is advantageous for Dutchess County to own the facility, since tax free, lower interest bonds could finance the facility, leading to lower amortized capital costs. Also, at this time, New York State will finance 50 percent of the construction cost (to a maximum of \$13,449,000) if the County is the owner. This, too, would reduce costs. The facility could be operated either by County employees, or by an industry or third party by contract. The decision on operation should be made based on complexity of equipment and plant operation, and guarantees by manufacturers.

In summary, ownership should remain with the County, but operation should be evaluated for each system.

2.4 "Long Term Landfill Siting Report"

This report was prepared by the Dutchess County Commissioner of Solid Waste Management in May, 1978. The study evaluated all lands within Dutchess County, identified possible sites, and recommended one site with the minimal environmental impact on the County. The recommended site is in the Town of

Beekman, about 14 miles from the Arlington site. Travel between the sites is along County roads.

The cost of purchasing the land, preparing it to meet the State landfill requirements, and purchasing mobile equipment is high. Operating costs are also high for a landfill, if used only as a backup to a resource recovery facility. Operating costs could be decreased if the landfill were used as a long term solid waste disposal solution for Dutchess County.

It may be more economical to use an existing landfill, such as in Amenia or Orange County, as backup for an energy recovery facility, and pay the tipping fee, rather than for Dutchess County to own and operate a landfill. This should be the subject of further investigation and hearings during final design of the selected system.

3. EXPANDED ENERGY MARKETING SURVEY

In 1978, the Dutchess County Commissioner of Solid Waste Management performed an energy marketing survey of 47 major industries and institutions in the County. Questionnaires were returned from 26 of those contacted, and ten responses showed an interest in the project and reported energy consumption data. Only IBM's energy usage is compatible with the potential output from a regional solid waste facility. Several smaller energy consumers could use the output from modular incinerators located at a number of sites throughout the core area.

Large industries which did not respond to the questionnaire were contacted again during the preparation of the 1979 Velzy Report, to assure that all potential markets had been examined. The expanded survey also searched for secondary gas markets near the Arlington site. The Arlington Sewage Treatment Plant, presently an oil user, could utilize some PUROX gas in their fluidized bed incinerator.

The expanded energy marketing survey continued during the preparation of this "Evaluation of Alternate Energy Systems" report. Large coal users within and outside Dutchess County were identified, to examine the potential marketability of RDF. The ensuing sections describe the energy consumption of the various fuel users.

3.1 Equivalent Refuse Energy

The fuel consumption of industries responding to the marketing survey was converted to a steam demand, then converted

back to an equivalent tonnage of refuse which would have to be burned to produce that amount of steam. The efficiency of producing steam from each type of fuel is as follows:

Coal	83 percent
Oil	80 percent
Gas	77 percent
RDF	70 percent
Mass burning (power)	63 percent
Mass burning (steam)	60 percent
PUROX	48 percent

The PUROX efficiency is low because it is the product of two efficiencies. The 1979 Velzy Report showed a net production efficiency of 62 percent. The combustion efficiency is estimated at 77 percent, for an overall net efficiency of 48 percent.

The estimated equivalent tonnage required to produce sufficient steam for each facility is based on the above efficiencies. No provision for standby is included.

The relative value of energy from municipal solid waste varies as it flows along the energy transition path from fuel to steam to electrical energy. Refuse energy as RDF can be used to supplant other fuels in an existing boiler. The value of the RDF is equivalent to the value of the supplanted fuel energy less any costs associated with introducing the fuel into the boiler or disposing of the residue from combustion. At such

times when RDF is not available, the boiler operators can shift readily to the normal fuel used in the boiler plant.

The value of refuse energy furnished as steam to a user can be determined in more than one way. The value of the steam generated from refuse is equivalent to the value of the fuel supplanted when the steam supplied to the market is interruptible. The user must maintain his boiler capacity in a standby condition ready to operate when steam from refuse is not available. On the other hand, the steam user could discontinue operation of the steam generating plant if steam from the refuse plant is guaranteed by means of generating redundancy and auxiliary fuel provisions at the refuse plant. This would provide the user additional savings in operation, maintenance and manpower. Thus, the value of the steam energy from the refuse plant would increase significantly. However, additional capital costs would be required at the refuse plant to provide the necessary redundancy and auxiliary fuel firing capability. In effect, the standby generating capability of the user's plant would be at the refuse plant where it would be available at times when refuse energy is not produced.

If electrical energy is sold to the local utility, the value of refuse energy is equivalent to the cost of fuel supplanted at the electrical utility. The fossil fuel costs for a utility are almost invariably less than the fossil fuel costs for an industrial user. The value of supplanted fuel decreases further if the utility generates a portion of its power from nuclear energy. Further, the electrical generating efficiency

of a refuse plant is significantly less than that of a utility plant. Consequently, the value of refuse energy is less in the form of electricity sold to an electric utility than in the form of steam sold to an industrial user. Further, the cost of turbine generators and condensers must be added to the refuse plant and the capital cost of boilers to generate electricity increase due to the higher temperatures and pressures required. The only countering economic effect is that all electrical energy generated should be salable to the electric utility, whereas all of the steam energy produced may not be salable to an industrial user.

3.2 Coal Users

Coal users could purchase RDF to be co-fired with coal or purchase steam from an incinerator to reduce coal consumption. The RDF could be produced at a regional facility and transported to the various markets.

One coal user was identified during the marketing survey at the Wassaic Development Center in Amenia. That institution uses about 21,000 tons of coal per year, the equivalent energy output of a 200 TPD incinerator, on an average annual basis. The actual energy use varies from a low during the summer of 12,000 pounds of steam per hour to a high during the winter of 80,000 pounds per hour. This is equal to approximately 50 TPD and 350 TPD respectively. The most economically viable system would be designed to handle between the minimum and average demand or perhaps 125 TPD equivalent. A 125 TPD incinerator

with steam generating capability could be installed at this site.

An alternative is to co-fire RDF in the coal boiler in as much as a 1:1 heat input ratio with coal. Therefore, an annual average of about 90 TPD of RDF could be utilized by this institution. The disadvantage to this market is the one-way haul distance of about 30 miles from the core area. It is about the same distance as the Amenia landfill which presently charges a tipping fee of \$9.00 per ton. The tipping fee at the incinerator should be competitive with that at the Amenia landfill. A slightly higher fee would probably be acceptable to most refuse haulers, since they prefer to tip on a paved surface rather than in a landfill, to reduce wear on their equipment, and for ease of tipping. The overall economics of constructing the regional RDF facility and transporting the fuel must be considered and compared to the net cost of other alternatives of regional disposal.

Two other coal users were found in the expanded market survey. The Harlem Valley Hospital in Dover uses 14,500 tons of coal per year (140 TPD refuse equivalent), and the Middletown State Hospital in Orange County uses 13,500 tons per year (130 TPD refuse equivalent). Data pertaining to the variations in consumption was not available. If these facilities are comparable to the Wassaic Development Center, the range at the Harlem Valley Hospital would be 35 to 240 TPD, and at the Middletown Hospital would be 35 to 230 TPD. These should be designed for about 75 TPD each. A modular incinerator at either

of these hospitals would have difficulty in being competitive, due to the long haul distance and the proximity of the Amenia landfill and the Orange County landfill. A total of about 120 TPD of RDF could be co-fired at the two hospitals. Again, the overall economics would have to be compared with other possible regional solutions.

The total potential RDF consumption of the three coal users in the area could be about 210 TPD, if RDF could be stored indefinitely and used throughout the year. The actual amount of RDF fired would be somewhat less, due to the seasonal variation in energy consumption and the difficulty of storing RDF. This survey indicates that there is presently an insufficient amount of coal being used in the area to warrant construction of a facility to produce RDF. The situation may change in the future if IBM is required to convert to coal-fired boilers. This is not certain at the present time. As an alternate, a coarse refuse-derived fuel could be produced using a front-end arrangement similar to that in the PUROX facility design. That RDF could be fired into a new spreader-stoker incinerator constructed at the Arlington site specifically for the project. This system is discussed in Section 4.3.

3.3 Gas Users

Two natural gas users were identified in the marketing survey and a third potential user was identified in the 1979 Velzy Report. One user, Beacon Tex-Print, Ltd., noted that the natural gas is used in processing, rather than producing steam.

This industry could therefore not utilize a product gas from the resource recovery facility. Their heating fuel is No. 6 fuel oil, and their energy consumption is discussed in Section 3.4.

Vassar College uses a combination of No. 4 fuel oil and natural gas for heating and cooling. Their fuel gas consumption is equivalent to the output from a 70 TPD PUROX facility. The total energy consumption could alternatively be replaced by a 100 TPD modular incinerator, on an annual average basis. The College's seasonal variation actually ranges from a 40 TPD demand in the summer to a 170 TPD demand in the winter. The capacity for a modular incinerator should be in the vicinity of 75 TPD. The size of the facility would vary depending on refuse availability and overall economics.

A third potential gas user was identified during the 1979 report investigations. The Arlington Sewage Treatment Plant presently uses about 15,000 gallons of fuel oil per month for sludge disposal in their fluidized bed incinerator. The incinerator could easily be adapted to accept a product fuel gas. The refuse tonnage to produce the equivalent heat input is 12 TPD, annual average. While this seems insignificant, it represents a potential economic improvement if the Arlington site is used for a PUROX facility, since IBM cannot use all of the product gas.

3.4 Oil Users

Ten industries and institutions which utilize oil as their energy source have been identified. Three of the ten use

steam in their process, and have a relatively continuous demand. The other seven use the oil for heating and cooling, and the energy demand varies seasonally.

Beacon Tex-Print uses 1,800,000 gallons of No. 6 fuel oil per year on a continuous basis. There is a slight increase in demand in the winter due to the additional heating requirement. Their demand is equivalent to the output from a 100 TPD modular incinerator. The modular incinerator would be required to produce steam at 80 psi in this application. The incinerator should be designed for up to 100 TPD, depending on refuse availability and economics.

The Pawling Rubber Co. uses 300,000 gallons of No. 6 fuel oil per year on a continuous basis. This is equivalent to the output of a 16 TPD incinerator. Since Pawling is outside the core area and the size of the potential plant is small, this cannot be considered to be a potential customer for the core area.

The third industry that has a continuous demand for steam is Texaco in Beacon. They use 1,400,000 gallons of No. 6 fuel oil per year, which equates to the potential output of a modular incinerator with a capacity of about 75 TPD. Such an incinerator could be installed to supply Texaco with the necessary steam at 120 psig. The success of this installation would depend on refuse availability and overall economics.

The IBM facility in Poughkeepsie uses an annual average of about 1900 million Btu's per day. IBM's fuel usage is presently No. 6 fuel oil. However, in the past, they have used

natural gas and No. 2 fuel oil, also. Details of their energy consumption are in Table 5-1 of the 1979 Velzy Report. Their consumption is equivalent to the output from an incinerator of about 270 TPD, or the gas produced from a 330 TPD PUROX facility. A small mass burning incinerator could be considered for this application rather than a series of modular incinerators, to improve overall efficiency of steam production. IBM's theoretical fuel consumption is fairly evenly distributed throughout the year, and it is compatible with the output from a regional PUROX facility serving the core area. About 95 percent of the output from such a regional facility could normally be utilized by IBM. The actual gas usage on an annual basis would be somewhat lower than this value, due to variable energy demand, refuse availability, scheduled and unscheduled equipment down time, etc.

Marist College uses 400,000 gallons of oil per year, or the equivalent of a 20 TPD incinerator. Since their usage is small and concentrated during the winter months, it is not a feasible market for steam.

Vassar College uses 945,000 gallons of No. 4 fuel oil per year in addition to natural gas. If the entire steam demand is supplied by an incinerator, an equivalent of 105 TPD would be required. Since their demand is seasonal, an incinerator no larger than 75 TPD should be considered, with peak heating loads supplied by existing gas or oil-fired boilers.

The Fishkill Correctional Facility was considered as a market for the PUROX facility during the 1979 Velzy Report

investigations. Detailed information was obtained to evaluate their usage. Their demand ranges between about 80,000 gallons per month during the four warm months and 370,000 gallons per month during the four cold months. These usages equate to 50 TPD and 250 TPD incinerators, respectively, with an average equivalent usage of 150 TPD. A 100 TPD incinerator could be considered feasible for this application. Scheduled maintenance could be performed during the summer, resulting in a compatibility of the system output with the facility demand on a year-round basis.

The Beacon Terminal Corp. is a leasing company, and did not furnish the actual oil usage data for their facility. They did mention, however, that steam is used for heat and some processing, and the consumption varies with time, depending on the occupant's steam demand. The variable nature of steam usage makes this industry an infeasible market.

Chemprene, Inc. uses 225,000 gallons of No. 4 oil per year, the equivalent of the output from a 12 TPD incinerator. This is too small to consider as a viable market. Likewise, Nabisco, Inc. uses 150,000 gallons per year; the equivalent of an eight TPD unit. This, also, is not a viable market.

3.5 Steam Users

Dutchess County does not have a steam grid in the downtown area of any of its communities. Industries which require steam produce it independently in their own boilers.

3.6 Power Generation

Two options regarding power generation are available: on-site generation using incineration or pyrolysis gas, and off-site generation at the Danskammer Power Plant using pyrolysis gas. It is not feasible to transport steam produced by incineration from the Arlington site to generate power at Danskammer.

Mass burning systems are capable of producing about 6,500 kw of power (annual average), assuming the same refuse quantities as described in the 1979 Velzy Report. Pyrolysis (the PUROX System) could produce about 5,000 kw of power from the same refuse. The amount of power utilized within each plant would have to be determined to arrive at a value of the net salable energy. The revenue from sale of power to Central Hudson would be about \$1,000,000 per year for the mass burning facility, and \$850,000 per year for the PUROX facility. The overall economics developed thus far indicate that neither of these systems is cost-effective.

3.7 Summary

The expanded energy marketing survey resulted in a reduction in the number of feasible technologies for Dutchess County. The small number of coal users and relatively small amount of coal burned indicates that RDF production and sale is not feasible. Unless coal usage increases substantially in the County in the future, RDF production systems should not be considered further. A coarse RDF, using a front end similar to

the PUROX facility design, could be burned in a spreader-stoker fired incinerator-boiler constructed specifically for this project. Steam could then be sold to IBM. The production of a powdered, highly refined fluff, or pelletized RDF is not necessary for such a facility, so higher production costs cannot be justified.

The only gas user large enough to accept most of the output from a PUROX facility is IBM. A small amount of gas could also be sold to the Arlington Sewage Treatment Plant. This was the proposed system in the 1979 Velzy Report, and is used as the base for evaluation of alternate systems.

A higher net quantity of steam is produced from mass burning systems than from the PUROX System because less refuse energy is used within the facility to operate the process. Therefore, less refuse is required by a mass burning system to produce the same amount of steam. No single industry in the core area, including IBM, is capable of accepting the output from one regional solid waste disposal facility. If economics show that it is cost-effective to build a 400 TPD mass burning facility at the Arlington site, it must be realized that some of the energy produced in the form of steam would be wasted. As pointed out earlier, IBM's energy requirements are approximately equal to 95 percent of the output capability of the PUROX facility proposed in the 1979 Velzy Report. Also, the additional energy sold to the Arlington Sewage Treatment Plant must be in the form of gas, rather than steam. One possibility is to install a 250 TPD facility at the Arlington site and

smaller incinerators at other sites where energy could be sold to other industries. This modular incineration alternative could reduce haul distances by providing small local incinerators at several locations within the core area. The potential exists for modular incinerators to be installed in the following locations:

Vassar College - Poughkeepsie City	75 TPD
IBM - Poughkeepsie Town	250 TPD
Beacon Tex-Print - Beacon	100 TPD
Texaco - Beacon	75 TPD
Fishkill Correctional Facility-Fishkill	100 TPD
Total	600 TPD

Construction costs can be minimized and economy of scale maximized by constructing the largest of these facilities. A 250 TPD unit at the Arlington site selling essentially all its steam to IBM could handle the refuse produced in the Poughkeepsie area. Vassar College and the Fishkill Correctional Facility are not so desirable as markets, since energy usage varies considerably on a seasonal basis. Beacon Tex-Print and Texaco could utilize most of the output of a 100 TPD and 75 TPD modular incinerator, respectively, on a continuous basis. These industries would provide service for the southern core area. The total capacity of these plants would be 425 TPD, in close agreement with the available refuse quantities from the 1979 Velzy Report. This is the recommended course of action for the modular incinerator approach. The 250 TPD facility serving IBM could be a mass burning facility, rather than a modular

incinerator, depending on an economic comparison of the two systems.

The final option available to Dutchess County is on-site power generation. (Power generation at Central Hudson by burning PUROX gas was studied in the 1979 Velzy Report, and was found more costly than selling the gas to IBM. It is therefore not considered in this study.) The feasibility of installing and operating power generating facilities at the Arlington site are discussed in Section 4.5.

4. AVAILABLE TECHNOLOGY

Available technology is considered to include those systems which have operated successfully at design capacity on a commercial scale for a reasonable period of time. Technology which has not been demonstrated or must be scaled up to the Dutchess County size should not be considered by the County as implementation would carry a higher degree of risk.

4.1 Modular Incineration

Modular incinerators are small mass burning units that are pre-engineered for low equipment capital cost and ease of installation. Until recently, they have been constructed in primary combustion chamber sizes as large as 25 TPD for industrial, institutional, and commercial applications. They are now being marketed in somewhat larger sizes to small municipalities for solid waste disposal.

4.1.1 Process Description. Figure 4-1 shows a modular incinerator (Consumat) cross-section. The units can handle either raw or processed solid waste. Waste is delivered to a tipping floor where it is stored until fed into a charging hopper by a front-end loader. When full, the charging hopper closes and an automatic ram stoker feeds the waste into the primary combustion chamber. The flow of air into the primary combustion chamber is controlled to maintain "starved air" or pyrolytic conditions. Smoke and gases produced in the primary combustion chamber rise and flow into a secondary combustion

TYPICAL MODULAR INCINERATOR SECTION (CONSUMAT)

chamber where combustion is completed. Auxiliary fuel is needed in this step to raise the temperature sufficiently high to ensure complete combustion of the smoke and pyrolytic gases. Heat recovery equipment may be added to extract energy from the gases discharged from the secondary combustion chamber prior to their release to the atmosphere.

The ash can be removed by a wet or dry system, although a quench tank arrangement is usually recommended. The ash and other noncombustible waste materials would be disposed of in a landfill.

4.1.2 Status of Technology. Modular starved air incinerators with heat recovery have been utilized in industrial and municipal applications for a number of years. Most large facilities (100 TPD or greater) are designed using 25 TPD modules. The largest facilities operated to date are in North Little Rock, Arkansas and Salem, Virginia, and have design capacities of 100 TPD.

Although the technology has been utilized for a number of years, there is little data available to determine the cost-effectiveness or reliability of the process. Present experience with existing installed systems indicates that each energy module must be shut down weekly to clean the boiler tubes manually. This is not a problem for the systems presently in operation, since steam is supplied on a five-day basis, and the tubes are cleaned on the weekends. For around the clock

operation, this requires multiple units to provide continuous steam production.

Federal air pollution new source performance standards (NSPS) limit discharge of particulate matter to a maximum of 0.08 grains per standard cubic foot (gr/scf) corrected to 12 percent carbon dioxide for incinerators which charge refuse at a rate of 50 TPD or more. Modular incinerator manufacturers claim that their units can be operated to limit emissions to 0.10 gr/scf, or 25 percent above the standard, without any air pollution control devices. It has not yet been determined whether they can meet either of these emission levels without air pollution control equipment. For the purpose of this study, it is assumed that any incineration facility constructed for Dutchess County would have to meet the Federal NSPS of 0.08 gr/scf corrected to 12 percent carbon dioxide. Modular incinerators for Dutchess County would therefore be equipped with air pollution control devices to assure operation within the Federal standards.

Manufacturers' claims of boiler efficiency "approaching 100 percent" are unreasonable. An independent evaluation stated that 40 to 60 percent is more likely. This compares with established boiler efficiencies for mass burning units ranging from 60 to 65 percent.

Several installations using the Consumat modular incinerator are under construction, and three have been burning municipal solid waste. Of those three, one 100 TPD facility (consisting of four 25 TPD modules) in North Little

Rock, Arkansas, was recently closed down. It had operated since 1977, and was closed due to higher than expected operating costs. The manufacturer expects to obtain an operating contract from the city and resume operation. Another 16 TPD facility has operated since 1975 in Siloam Springs, Arkansas. In 1979, the energy recovery section of that installation was abandoned due to severe corrosion of the boiler tubes. The operating cost has also risen to around \$30 per ton. The third unit (100 TPD in four 25 TPD primary combustion chamber modules) went on line in 1979 in Salem, Virginia. The first operation of the plant at rates approaching design capacity occurred in July and August of 1979.

4.1.3 Advantages and Disadvantages. The modular incineration concept allows several facilities to be installed around the County, increasing the flexibility of matching the sale of product steam to using industries. Several installations throughout the core area also would reduce average haul distances to the solid waste disposal point. If uniform plant modules by a single manufacturer are used, parts could be interchangeable from one facility to another. Likewise, personnel could be trained to operate any of the facilities, since the units could be of similar construction, and maintenance personnel could be shared among the plants. The units are relatively low in capital cost, when compared to alternate disposal systems. They also allow for incremental increases in overall plant size as refuse quantities increase.

The primary disadvantage of locating a number of facilities throughout the core area is the loss of certain economies of scale related to construction costs. Each facility would need a scale, receiving area, front-end loaders, ash removal facilities, and air pollution control devices. Around the clock operation of several smaller facilities is also a severe detriment since each facility must have operators available all the time. Each boiler module must be maintained weekly, based on current design and operating experience. Excess capacity is therefore needed to satisfy a steam customer operating seven days per week and to provide standby capability.

There is little data available to prove or disprove manufacturers' claims. Actual throughput at existing plants reportedly has not been as great as rated capacities. The amount of auxiliary fuel needed to combust all the organics has not been documented. Equipment life, downtime, repairs, etc., have not been definitely quantified. A facility that could have provided such data in the plant size range considered feasible for Dutchess County has now closed down after two years of operation. In the consideration of this system, conservative design parameters should be developed from data collected at comparably sized plants which have operated for a reasonable length of time.

4.1.4 Application to Dutchess County. The marketing survey described in Section 3 indicated that the energy produced at three facilities could be marketed: 250 TPD - (IBM) 100 TPD -

(Beacon Tex-Print), and 75 TPD - (Texaco). This is in close agreement with the amount of refuse available in the core area. The plants should be constructed such that component parts could be interchangeable. Standby steam generating facilities would be required at each facility for periods when units are down for scheduled or unscheduled maintenance.

The facilities would be designed using parameters comparable to those used to design the PUROX facility. The buildings would be capable of being expanded to handle future increases in the amount of refuse delivered to the plant. The future capacities of the facilities would be 350, 150, and 100 TPD, respectively, for the present 250, 100, and 75 TPD plants. This would allow for future processing capability of 600 TPD, as in the original design.

In each case, the architectural appearance of the plant structures would be similar to that of the PUROX facility. A minimum of three day's storage of refuse would be provided at each facility such that sufficient fuel would be available for equipment operation during weekends and to handle peak refuse variations. A transfer packer would provide a means of removing solid waste when the facility was not able to handle the accumulated refuse. An overall plant availability of 85 percent is assumed for this system. Air pollution control devices would control stack emissions to within acceptable levels. Ash would be collected in dump trucks and hauled to a landfill.

The IBM plant would be at the Arlington site and would have a pit and crane arrangement, similar to the PUROX design.

A minimum of three day's storage at the expanded plant capacity would be included. A layout of the IBM facility is shown in Figure 4-2. The IBM plant would have two pits, each 80 feet long by 25 feet wide by 25 feet deep. The receiving area would be 200 feet long by 55 feet wide. This area is narrower than that designed for PUROX, since large transfer trailers would not be using the facility. Two cranes would feed the hoppers to the modular incinerators.

The IBM facility would contain six 50 TPD incinerators arranged in a row, as recommended by the manufacturer. The incinerators would be inside a 200 by 70 foot processing building. A 50 by 30 foot control, maintenance, and locker room would be adjacent to the incinerator building. The incinerators would be arranged in pairs, with each pair feeding one common energy recovery system. One standby energy system would be included so weekly maintenance on the boilers could be performed without interrupting steam production. Each energy recovery system would consist of a boiler and appurtenances to produce 200 psig saturated steam. The steam would be piped to the IBM boiler house and tied into their existing system. Steam pressure at the boiler house would be 150 psig.

Ash would be collected and transported to a landfill for disposal. Also, any unprocessed refuse would be hauled by transfer trailers to a landfill.

The Tex-Print facility would require purchasing about five acres of land within a one-half mile radius of Beacon Tex-Print. A siting study is not included in this study, and

FIGURE 4-2

MODULAR INCINERATOR - ARLINGTON SITE

would be performed if the system proves to be cost-effective. Land is assumed to have the same unit value as that in the Arlington site.

This facility would have a floor dump and front-end loader arrangement. The receiving area would be in a 150-square-foot building. Refuse would be piled to a height of 12 feet. Two front-end loaders would be used to charge refuse into the incinerator hoppers and rehandle the refuse for better storage.

Four 25 TPD incinerators would be arranged in pairs in a row, as in the IBM facility. Each pair of units would be connected to a common energy recovery module. A third energy recovery unit would be included as in the case of the IBM facility to minimize scheduled down time. The incinerators would be in a 120 by 55 foot processing building. A 55 by 30 foot office, control, maintenance, and locker room would be adjacent to the incinerator building. Sufficient room for future plant expansion would be available on the site. The energy recovery modules would produce saturated steam at 80 psig at the market, to be compatible with Tex-Print's needs.

The Texaco facility would require about four acres of land in the vicinity of Texaco in Beacon. The precise site has not been located. A unit cost of land is used which is comparable to that of the Arlington site.

This facility would have a floor dump and front-end loader arrangement as in the case of the Tex-Print plant. The receiving area would be a 135-square-foot building, where refuse

would be piled to a height of 12 feet. Two front-end loaders would maneuver the refuse and charge the incinerator hoppers.

Three 25 TPD incinerators, arranged in a row, feeding two common energy recovery modules, would process the waste. A third energy recovery unit would be included to minimize scheduled maintenance time. The processing building would be about 100 by 55 feet in size. A 55 by 35 foot office, control, maintenance, and locker room area would be adjacent to the incinerator area. Space for future expansion would be available on the site. The energy recovery modules would produce saturated steam at 120 psig at the market, to be compatible with Texaco's needs.

Each plant would have a 60-ton scale to weigh refuse trucks for billing purposes. One superintendent and administrative assistant would be responsible for the three facilities. The main office would be at the IBM facility.

4.2 Waterwall Incineration

Waterwall incinerators represent demonstrated state-of-the-art for large scale resource recovery facilities. The technology has been proven over the last several years in the United States. There are presently a number of U.S. installations producing steam on a reliable basis.

4.2.1 Process Description. Figure 4-3 shows a waterwall incinerator cross-section. A typical waterwall incinerator uses a pit and crane arrangement similar to that designed for the

TYPICAL WATERWALL INCINERATOR SECTION

PUROX facility. No front-end processing is employed, and "as received" refuse is fed directly into the charging hopper leading to the combustion chamber. An automatic feeder introduces refuse from the hopper onto the grates. Automatic stoking provides uniform combustion and a high degree of burnout in the combustion chamber.

The walls inside the combustion chamber are cooled by water-carrying tubes. Hot combustion gases release heat to the water, turning it to steam, as the gases are cooled. Gases are cooled further by passing through a convection bank, where additional heat is recovered. The cooled gases pass through a cleaning device (usually an electrostatic precipitator), and are discharged to the atmosphere. Steam can be sold directly to an industry for heating and cooling or used in a turbine to generate electricity.

Residue from the system is water quenched and collected for disposal. Some systems propose ferrous and nonferrous metal recovery from the residue. However, to date, the markets for this material have been limited and site-specific. The residue has also been proposed for use as a roadbed material. Firm markets have not been established for this use, and a cost for landfilling these materials is included in the overall economics.

4.2.2 Status of Technology. Waterwall incineration technology has been used in Europe for many years. The technology has also been used in the United States since 1967, when the first

waterwall facility went on line in Norfolk, Virginia, at the Navy Yard. It has provided steam to the Navy Yard since it went on line.

The Chicago Northwest incinerator went on line in 1971. A market for the steam was not developed until recently. Steam is expected to be sold in the near future. A similar situation occurred in Harrisburg, where the incinerator had operated since 1972, and steam sale began in 1978.

Oceanside, New York converted a mass burning incinerator with a convection boiler to a waterwall incinerator in 1974. There, steam is used to generate electricity for in-plant uses. The steam is also used in a desalinization plant, constructed as a part of the original disposal facility, to provide boiler makeup and other process water.

Saugus, Massachusetts is an example where a private owner/operator constructed a waterwall incinerator. The facility was completed in 1975, and steam is sold to a nearby industry.

Several installations were equipped originally with mechanical cyclone air pollution control devices. Those systems could not meet the Federal and State emission standards, and had to be retrofitted with electrostatic precipitators (ESP). Any mass burning system designed for Dutchess County should include an ESP as the air pollution control device.

Operating problems encountered with early installations have been overcome by improved designs. Boiler tube metal wastage has been controlled by providing a coating of silicon

carbide over the tubes in the high temperature area of the furnace. In the past, an improperly designed soot blowing system could result in the need for periodic manual cleaning of the boiler tubes. Slag buildup on the walls has been reduced by air cooling the walls along the grate line.

This technology has been tested and improved over the years such that a facility can be designed and constructed to provide a reliable, efficient operation with a minimal amount of risk to the owner.

4.2.3 Advantages and Disadvantages. Waterwall incineration is presently the most proven and reliable resource recovery system on the market. It can handle raw refuse, thus eliminating the need for preprocessing. This results in the highest net efficiency of energy recovery of all resource recovery systems. Simple operation results in less manpower to operate the facility. The steam produced by the facility could be used for heating, cooling, or power generation. The high reliability would minimize the amount of refuse which would require landfilling.

Waterwall incineration as a disposal process becomes more cost-effective as the plant size increases up to a plant size of several thousand tons of rated capacity per day. Therefore, in Dutchess County, one regional facility could be constructed. This would require longer haul distances than the modular incineration approach. Steam generation can be varied to suit user requirements to a greater degree than with the PUROX

facility, however, the steam quantity would be in excess of IBM's needs. This steam could either be condensed or used to produce power, depending on the overall plant economics.

4.2.4 Application to Dutchess County. The marketing survey described in Section 3 showed that only IBM could use most of the output from a waterwall incinerator, so the plant would be built at the Arlington site. Figure 4-4 shows the layout for a waterwall incineration facility at the Arlington site.

The architectural treatment of the facility would be similar to that of the PUROX facility. The system would have a receiving area (including pit and crane) similar to that in the PUROX design. The pits would be capable of handling 600 TPD, with three day's storage, as in the other system. A stationary refuse compactor would provide the capability of removing refuse from the facility.

Electrostatic precipitators would provide air pollution control. Residue would be collected and hauled to a landfill in dump trucks. The Airport landfill could be used to dispose of the residue, since the ash is inert. Solid waste would have to be landfilled at the Amenia or Orange County landfill.

The facility would have two pits, each 105 feet long, 30 feet wide and 25 feet deep, as in the PUROX design. The receiving area would be the same as the PUROX facility design. The two 400 TPD incinerators would be in a 70 by 60 foot processing building, adjacent to the 60 foot by 40 foot control,

FIGURE 4-4

WATERWALL INCINERATOR — ARLINGTON SITE

maintenance, and locker room areas. The electrostatic precipitators would be outside the building.

The boilers would produce 200 psig steam which would be piped to the IBM boiler house and tied into their existing system. Additional steam needed by IBM would be produced by IBM in their package boilers. The older boilers at IBM could be "mothballed". Excess steam produced by the refuse facility would be condensed.

4.3 RDF Combustion in a Spreader-Stoker Firing System

The marketing survey described in Section 3 showed that RDF cannot be marketed for firing into any existing boilers in the County. A new facility must therefore be constructed for on-site RDF combustion. The system with the most reliability and furthest along in development requiring the least amount of processing is the spreader-stoker incinerator, firing a coarse RDF.

4.3.1 Process Description. The RDF would have characteristics similar to the preprocessed fuel which would be fed to the PUROX converters. A front end system similar to the one designed in the 1979 Velzy Report would be used.

The preprocessed refuse would be fired into the furnaces and begin to combust while in suspension. Burning refuse particles would fall onto a grate where combustion would be completed prior to ash discharge. This method of firing allows

a high degree of burnout and better combustion efficiency than other incineration methods.

4.3.2 Status of Technology. The technologies of two systems are combined in this alternative. These are RDF production and spreader-stoker technologies.

RDF technology varies with the type of system. Fluff and powdered RDF have been produced and tested in suspension-fired boilers. Densified RDF is still in the developmental stage. RDF from these systems would generally be used as supplementary fuel in suspension-fired coal burning units. Coarse RDF could be fired in a spreader-stoker incinerator, to eliminate some degree of preprocessing. In a spreader-stoker, RDF is introduced into the furnace in suspension where combustion begins. The RDF falls onto a travelling grate where combustion is completed. A coarse RDF system is more applicable when RDF does not have to be transported to the market, as is the case with Dutchess County.

The spreader-stoker has been used for many years to burn coal, wood waste, bark, and bagasse. It has been used recently in RDF facilities. Spreader-stoker boiler plants are operating in Akron, Ohio and Hamilton, Ontario. Others are under construction in Albany, New York and at the Hooker Chemical Company facility in Niagara Falls, New York. The technology to produce a coarse RDF is well advanced.

4.3.3 Advantages and Disadvantages. This process is relatively simple when compared with some other resource recovery systems. Problems with handling, storing, and transporting RDF to other facilities are eliminated. The regionalized concept would tend to lower overall construction and plant operating costs due to economy of scale.

A disadvantage of the system is that all the steam could not be marketed and some steam would be wasted. Steam generation could be varied to suit user requirements to a greater degree than with the PUROX facility, however, the steam quantity would be in excess of IBM's needs. This steam could either be condensed or used to produce power, depending on the overall plant economics.

Haul distances would be longer from outlying areas due to the regionalized facility. RDF production includes the potential operating problems that are inherent in shredding operations.

4.3.4 Application to Dutchess County. The only feasible arrangement using this system would be to utilize the Arlington site and sell most of the steam to IBM. It is possible that excess steam may be used to generate power to operate the facility. An economic evaluation would be required to determine the cost-effectiveness of this option. Figure 4-5 shows the layout for this facility at the Arlington site.

A front-end processing train similar to the one designed for the PUROX facility (i.e., pit and crane, trommel, shear, and

FIGURE 4-5

RDF/SPREADER-STOKER INCINERATOR - ARLINGTON SITE

magnetic separator) would be used in this system. Two trains would be installed. The PUROX converters would be replaced by two spreader-stoker incinerators with heat recovery equipment. Electrostatic precipitators would control stack emissions. Residue would be collected and hauled by truck to a landfill.

The receiving and processing areas are similar to those in the PUROX design. Other details pertaining to steam production and sale to IBM are the same as those discussed under waterwall incineration.

4.4 Mass Burning Furnace with Convection Boiler

Convection boilers have been used for many years to recover waste heat from incinerator stack gases. They have been used where energy recovery is not the primary concern, since their efficiency is somewhat less than that of alternate methods of heat recovery.

4.4.1 Process Description. The physical arrangement of the equipment would be similar to that of the waterwall incinerator. The essential difference between the processes is that the furnace does not contain water cooled walls. Figure 4-6 shows a cross-section of a mass burning unit with a convection boiler. The mechanical air pollution control devices would be replaced by electrostatic precipitators.

4.4.2 Status of Technology. The technology of a convection, or waste heat boiler has been used for many years. Improvements to

TYPICAL CONVECTION FURNACE SECTION

the system design have led to the more recent use of the waterwall incinerator.

Oceanside, New York began producing electricity for in-plant use with a convection boiler in 1965. Slag buildup and boiler tube metal wastage led to the conversion of that facility in 1974 and 1977 to waterwall incineration. High temperature corrosion and tube metal wastage has been reduced significantly by lowering the combustion gas temperature through the use of water cooled walls prior to the convection bank and by reducing gas velocities over the convection surface. The convection boiler is actually the predecessor of the waterwall incinerator.

4.4.3 Advantages and Disadvantages. This system has a lower capital cost than waterwall incineration, since all components are identical except the water cooled walls. Refuse preprocessing is unnecessary, so problems associated with front-end systems are eliminated. One regional facility would allow construction and operating savings from economy of scale, but result in added costs due to longer haul distances.

The primary disadvantage to the process is that it is not as efficient as a waterwall incinerator plant and has no greater reliability. This would lower projected revenues from IBM during times when all the steam could be used. It would also provide IBM with less than the optimum amount of steam for their needs. Operating problems, which have been resolved by water cooled walls, would be present in this system. For these

reasons, it is not recommended for Dutchess County, and will not be discussed further.

4.5 Power Generation

Electrical power generating equipment can be added to any facility which produces a relatively high pressure steam. The power could be used for in-plant needs, or if in sufficient quantities, could be sold to a power utility. The type of equipment selected would depend on the specific needs of the user. Power generation is sometimes cost-effective on large facilities, and rarely on small facilities. Therefore, it will be considered for the regional facility only.

4.5.1 Process Description. Steam produced by a waterwall (or spreader-stoker) incinerator could be of sufficiently high temperature and pressure to be used in a turbine to generate electricity. The specific needs of the facility would determine the entering and exiting steam conditions and the type of turbine best suited for the application.

Superheated steam produced by combustion of solid waste would be passed through a turbogenerator to produce electricity. The resulting steam would be condensed and used as the boiler feedwater. Excess steam (if any) would bypass the turbine and be condensed. The resulting electricity could be used in-plant or sold to the local utility.

4.5.2 Status of Technology. Power generating equipment has been operating for many years at several solid waste processing facilities. The Oceanside Disposal Plant in the Town of Hempstead, New York has produced electricity for in-plant use since 1965. Other facilities either operating or under construction are in Hempstead, Niagara Falls, Columbus, and Dade County. The technology of producing power from steam is an old, well-established technology. Risks inherent in this scheme are associated with the production of steam from the burning of solid waste.

Power generating equipment is costly to purchase and maintain. It is usually not cost-effective for small applications, and will be considered only for regional disposal facilities in Dutchess County.

4.5.3 Advantages and Disadvantages. Power generation offers the primary advantage of a market for all of the steam produced by the solid waste facility. Little of the steam would be wasted, thereby maximizing revenues. However, this is achieved at a substantial incremental capital cost. The problem of requiring a standby steam generating facility to assure uninterrupted service to the market is also eliminated. Power would be sold only when the facility is operating, and no provision for standby would be needed.

The main disadvantage to the system is the high capital cost. Power generating equipment also requires skilled personnel to operate and maintain it properly.

4.5.4 Application to Dutchess County. Power generation from solid waste is feasible only for large scale plants. It might therefore be worth considering at the regional facility which would be at the Arlington site. The equipment would be compatible with the waterwall and spreader-stoker alternatives. For these systems, the boiler would be designed for higher operating temperatures and pressures, and a superheater section would be added. Power generation would not be cost-effective for the PUROX facility. Union Carbide has stated that the facility designed for the 1979 Velzy Report, which does not include power generation, is the most cost-effective one for the Dutchess County application.

Superheated steam at 450 psig and 660 F would enter a straight condensing steam turbine-generator and exit at two inches mercury pressure. Two parallel systems, each with half of the total plant capacity, would produce about 3200 kw net output each.

As an alternative, higher pressure and temperature steam could be sent to a backpressure turbine to produce electricity. The exhaust steam at 200 psig could be sent to IBM for heat. This alternative requires steam pressures and temperatures in excess of those accepted in current practice in similar refuse facilities. For this reason, a backpressure turbine is not recommended.

The revenues obtained from sale of power to Central Hudson would not offset the additional capital cost of equipment

and operating and maintenance costs. If no steam market were available, this might be the only alternative to PUROX. However, the proximity and steam demand of IBM provides a long term reliable market for steam. Power generation is not recommended at this time. If IBM elects not to participate as the primary market for recovered energy, then power generation should be re-evaluated in greater detail. Under the present circumstances, it appears that IBM is willing to purchase steam or gas from the resource recovery facility. This route should be followed, and power generation should not be considered until that market option is completely exhausted.

5. COST ANALYSIS

5.1 General

Cost estimates for alternate systems are presented in a format similar to those in the 1979 Velzy Report so they can be compared directly with PUROX costs. The level of detail in this study is significantly less than that of the 1979 Velzy Report. This precludes the preparation of a capital cost breakdown by components, as in Table 8-1 (Project Capital Costs) of the Velzy Report. Capital costs for alternate systems are presented as a lump sum. Amortization and annual costs are broken down and presented in a manner similar to that in the prior study.

5.2 Land Acquisition

The PUROX study determined that the Arlington site is best suited for the solid waste disposal facility if IBM were the market for the energy. It is assumed that this will remain true for the other regional facilities and the modular incinerator serving IBM. The cost for the Arlington site is estimated at \$80,000. The unit cost for land for other modular incineration sites is assumed to be \$7,000 per acre, the approximate cost for the Arlington site. Thus, the costs for the other sites would be estimated as \$35,000 for the Tex-Print site and \$28,000 for the Texaco site.

5.3 Construction Cost

Cost information for the construction of the facilities has been taken largely from published information modified as necessary on the basis of unit cost, and information developed during the preparation of the 1979 Velzy Report. Major equipment prices are based on manufacturer's estimates for fabrication, delivery, and installation. All costs are based on July, 1979 prices, to be comparable to the PUROX facility cost.

Unit mechanical equipment costs were taken, where applicable, from the PUROX facility study. Equipment costs estimated on this basis include items such as the scale, cranes, trommels, stationary refuse compactor, heating and ventilating equipment, and mobile equipment. Where mechanical equipment is different from that in the PUROX facility, new cost estimates were obtained from manufacturers or suitable adjustments were made in previous estimates.

The general construction cost of buildings was obtained from the unit cost (dollars per square foot) for the receiving area, pits, and processing buildings in the PUROX design. The building costs are therefore estimated using comparable structural and architectural parameters.

The process water pumping station in the PUROX facility design was used for process and fire protection water, since an adequate quantity of water is not available in the area. For the facilities at the Arlington site, fire protection water and boiler makeup water will be obtained via a pumping station. A minimal difference in cost would be due to the pump and pipe

sizes. The full cost of the process water pumping station is included for all systems which utilize the Arlington site. Fire protection and boiler makeup water is assumed to be available from the local water utility for the other sites.

Interconnecting piping costs would also be comparable to the cost in the PUROX design for any facility using the Arlington site. Fire protection, sanitary wastewater, potable water, and process steam would require about the same amount of piping. The process water needs would be different, but pipe sizes and lengths would be about the same. The product gas line to IBM would be replaced by a more costly product steam line and condensate return line. The interconnecting piping costs for all sites has been estimated from unit costs from the PUROX facility and adjusted to reflect the higher cost of steam and condensate lines.

The cost of mobile equipment is taken directly from the PUROX facility design.

Electrical costs, where not available directly from the PUROX design, are estimated as a percentage of the general plus mechanical equipment categories.

The capital cost for each of the facilities (including a total of three modular incineration facilities) is estimated as follows:

PUROX	\$24,700,000
Modular Incineration	23,100,000
Waterwall Incineration	22,000,000
RDF Incineration	23,200,000

5.4 Amortization of Capital Costs

Grant funds from the U.S. Department of Energy have been awarded to Dutchess County for the implementation of a system to produce a combustible gas from refuse. Based on a discussion with DOE personnel, for the purpose of this study, we have assumed that these funds would be available for any demonstration of energy recovery in Dutchess County. Based on a discussion with New York State Department of Environmental Conservation personnel, for the purpose of this study, we have assumed that the New York State Department of Environmental Conservation will fund 50 percent of the project cost up to a grant amount of \$13,449,000.

Amortization costs are developed using the same rationale as for the PUROX facility. This includes:

- The cost of bond issuance is estimated to be
4.2 percent of the bond issue;
- Interest during construction is estimated to be
9.7 percent of the capital cost plus technical
services;
- Bond terms are 7.5 percent for 30 years;
- Task IV engineering is estimated for each
alternative;

- Task V engineering is estimated at \$50,000;
- Environmental assessment is estimated at \$100,000 for regional solutions and \$200,000 for modular solution. The increase is due to air quality modeling for incineration alternatives, and impact analysis for three sites in the modular incineration alternative;
- Construction and startup engineering costs are the same as those for the PUROX facility.

Tables 5-1a, b, c, and d show the amortized capital cost of each alternative. The amortized cost of the PUROX facility as determined in the 1979 Velzy Report is reprinted as Table 5-1a for comparison.

5.5 Annual Operating Costs and Revenues

For this study, it is assumed that the County would contract the plant operation, as in the case with PUROX. The annual contract cost is estimated by proportioning the number of personnel required to operate the plant to the number and cost of the PUROX annual contract. Table 5-2 shows the operating staff needed at each facility, and that proposed for the PUROX facility. Maintenance costs are estimated based on equipment complexity and maintenance costs of similar facilities.

Estimates for utilities are based on usage and current price schedules. These include the cost for electricity, fuel, water, and miscellaneous other utilities.

TABLE 5-1a
PUROX
ANNUAL AMORTIZATION COST

	TOTAL	AVAILABLE GRANT	REMAINDER
<u>Capital Costs</u>			
Land Acquisition	\$ 80,000		\$ 80,000
Purox Facility	24,235,000	\$12,117,000s	12,118,000
Modifications at Fuel Users Plant	80,000		80,000
Mobile Equipment	300,000	150,000s	150,000
Subtotal	\$24,695,000	\$12,267,000	\$12,428,000
<u>Technical Services</u>			
Engineering			
Tasks I & II	\$ 450,000		
Task IV Velzy	\$ 550,000	\$ 1,500,000f } 250,000s }	\$ 250,000
Task IV Union Carbide	950,000		
Task V	50,000		
Environmental Assessment	50,000	25,000s	25,000
Construction & Start Up	510,000	255,000s	255,000
Bond Issuance	625,000		625,000
Subtotal	\$ 3,185,000	\$ 2,030,000	\$ 1,155,000
<u>Interest During Construction</u>			\$ 1,315,000
Total			\$14,898,000
<u>Annual Cost of Amortization</u>			\$ 1,270,000

(s) N.Y.S. DEC Grant Funds

(f) U.S. D.O.E. Grant Funds

TABLE 5-1b

MODULAR INCINERATION
ANNUAL AMORTIZATION COST

	TOTAL	AVAILABLE STATE GRANT	REMAINDER
<u>Capital Costs</u>			
Land Acquisition	\$ 143,000	\$ 0	\$ 143,000
Processing Facilities	22,304,000	11,152,000s	11,152,000
Modifications at Fuel User's Plant	100,000	0	100,000
Mobile Equipment	600,000	300,000s	300,000
Subtotal	\$23,147,000	\$11,452,000	\$11,695,000
<u>Technical Services</u>			
Engineering			
Task IV	\$ 1,200,000	\$ 1,050,000f	
Task V	50,000	100,000s	\$ 100,000
Environmental Assessment	200,000	100,000s	100,000
Construction & Startup	510,000	255,000s	255,000
Bond Issuance	587,000	0	587,000
Subtotal	\$ 2,547,000	\$ 1,505,000	\$ 1,042,000
<u>Interest During Construction</u>			\$ 1,235,000
Total			13,972,000
<u>Annual Cost of Amortization</u>			\$ 1,183,000

(s) N.Y.S. DEC Grant Funds

(f) U.S. D.O.E. Grant Funds

TABLE 5-1c

WATERWALL INCINERATION
ANNUAL AMORTIZATION COST*

	TOTAL	AVAILABLE STATE GRANT	REMAINDER
<u>Capital Costs</u>			
Land Acquisition	\$ 80,000	\$ 0	\$ 80,000
Processing Facilities	21,576,000	10,788,000s	10,788,000
Modifications at Fuel User's Plant	50,000	0	50,000
Mobile Equipment	288,000	144,000s	144,000
Subtotal	\$21,944,000	\$ 10,932,000	\$ 11,062,000
<u>Technical Services</u>			
Engineering			
Task IV	\$ 1,000,000	\$ 1,050,000f }	\$ 0
Task V	50,000		
Environmental Assessment	100,000	50,000s	50,000
Construction & Startup	510,000	255,000s	255,000
Bond Issuance	549,000	0	549,000
Subtotal	\$ 2,209,000	\$ 1,355,000	\$ 854,000
<u>Interest During Construction</u>			\$ 1,156,000
Total			\$ 13,072,000
<u>Annual Cost of Amortization</u>			\$ 1,107,000

(s) N.Y.S. DEC Grant Funds

(f) U.S. D.O.E. Grant Funds

TABLE 5-1d
RDF INCINERATION
ANNUAL AMORTIZATION COST

	TOTAL	AVAILABLE STATE GRANT	REMAINDER
<u>Capital Costs</u>			
Land Acquisition	\$ 80,000	\$ 0	\$ 80,000
Processing Facilities	22,748,000	11,374,000s	11,374,000
Modifications at Fuel User's Plant	50,000	0	50,000
Mobile Equipment	288,000	144,000s	144,000
Subtotal	\$ 23,166,000	\$ 11,518,000	\$ 11,648,000
<u>Technical Services</u>			
Engineering			
Task IV	\$ 1,100,000	\$ 1,050,000f	\$ 50,000
Task V	50,000	50,000s	50,000
Environmental Assessment	100,000	50,000s	50,000
Construction & Startup	510,000	255,000s	255,000
Bond Issuance	580,000	0	580,000
Subtotal	\$ 2,340,000	\$ 1,405,000	935,000
<u>Interest During Construction</u>			\$ 1,221,000
Total			\$ 13,804,000
<u>Annual Cost of Amortization</u>			\$ 1,169,000

(s) N.Y.S. DEC Grant Funds
(f) U.S. D.O.E. Grant Funds

TABLE 5-2

OPERATING STAFF - ALL SYSTEMS

	PUROX	IBM	TEX-PRINT	TEXACO	TOTAL	WATER - WALL	RDF
<u>ADMINISTRATION</u>							
Plant Superintendent	1	1	-	-	1	1	1
Administrative Assistant	1	1	-	-	1	1	1
<u>OPERATIONS</u>							
Shift Supervisor	5	5	5	5	15	5	5
Weighmaster	2	2	1	1	4	2	2
Crane Operator	4	5	-	-	5	4	4
Front End Loader Operator	-	-	5	5	10	-	-
Front End Operator	4	-	-	-	-	-	4
Front End Day Operator	1	-	-	-	-	-	1
PUROX System Operator	5	-	-	-	-	-	-
Boiler Operator	-	5	5	5	15	5	5
Gas Cleaning Operator	5	-	-	-	-	5	5
Cryo Day Operator	1	-	-	-	-	-	-
Laborer	2	2	1	1	4	2	2
<u>MAINTENANCE</u>							
Mechanic/Welder	4	6	1	1	8	4	4
<u>TRUCK DRIVERS</u>							
Slag	1	-	-	-	-	-	-
Ferrous/Refuse	1	1	-	-	1	1	1
Residue	-	1	1	1	3	2	2
TOTAL	37	29	19	19	67	32	37

The tipping fee of \$16.00 per ton for the PUROX facility resulted in a net operating surplus of \$136,000 per year. This amount is added to the annual cost for each alternative to provide an equivalent comparison of tipping fees. In this manner, the "bottom line" tipping fee for each alternative can be compared with the \$16.00 per ton for PUROX and have the same amount of reserves.

Revenues will be collected in the form of a tipping fee and by the sale of steam. Ferrous metals, if removed from the waste stream, would be landfilled, since there is no market in Dutchess County. Also, the ash from incineration is not considered to be marketable, and would also be landfilled. The revenues from the sale of energy is calculated for each alternative.

The dollar amount which must be made up each year is reported as the net annual deficit. This amount must come from either County taxes, a benefit assessment, tipping fees, or some combination of the three. The net annual deficit already includes the same operating surplus as was used for the PUROX facility. The deficit divided by the tons received at the plant (145,000) yields the net tipping fee. This tipping fee can be compared directly to the \$16.00 per ton fee for the PUROX facility.

Table 5-3 itemizes the annual operating costs and revenues for the alternative systems. Annual costs for the

TABLE 5-3

ANNUAL OPERATING COST & REVENUE - ALL SYSTEMS

	PUROX	MODULAR INCINERATION	WATERWALL INCINERATION	RDF INCINERATION
<u>AMORTIZATION</u>	1,270,000	1,183,000	1,107,000	1,169,000
<u>OPERATING COSTS</u>				
Operating Contract	1,200,000	2,173,000	1,038,000	1,200,000
Labor*	-	-	-	-
Insurance*	-	-	-	-
Maintenance	502,000	400,000	400,000	450,000
Utilities	495,000	447,000	245,000	409,000
Miscellaneous Supplies	52,000	60,000	50,000	50,000
Landfill Tipping Fee	126,000	392,000	293,000	324,000
Depreciation of Mobile Equipment	75,000	150,000	72,000	72,000
Operating Surplus	136,000	136,000	136,000	136,000
Subtotal	2,586,000	3,758,000	2,234,000	2,641,000
<u>REVENUES</u>				
Energy	1,468,000	2,131,000	1,543,000	1,462,000
Slag	68,000	-	-	-
<u>NET ANNUAL DEFICIT</u>	2,320,000	2,810,000	1,798,000	2,348,000
<u>NET TIPPING FEE (145,000 TPY)</u>	16.00	19.38	12.40	16.19

*Included in Operating Contract

PUROX facility are included for direct comparison. The net tipping fees for the systems are as follows:

PUROX	\$16.00
Modular Incineration	\$19.38
Waterwall Incineration	\$12.40
RDF Incineration	\$16.19

REPORT OF THE DUTCHESS COUNTY RESOURCE RECOVERY TASK FORCE

Commentaries issued after "Evaluation of Alternate
Energy Systems"

"REVISED ESTIMATES OF ALTERNATE ENERGY SYSTEMS"

BY

DEPARTMENT OF SOLID WASTE MANAGEMENT

DECEMBER 1979

DUTCHESS COUNTY PYROLYSIS PROJECT

Explanation of Adjusted Project Cost Estimates of "Purox" and " Alternate Resource Recovery Systems "

ANNUAL AMORTIZATION COSTS

A - Capital Costs

Capital cost amounts have been adjusted in this section of our estimates to reflect the impact of two factors which will ultimately reduce benefits derived from New York State E.Q.B.A. grants.

CRVA estimates are based upon estimated construction costs for July 1979 and 50% State grant assistance on net construction and engineering costs.

Since the State has granted to Dutchess County a grant not to exceed \$13,449,000, we have reduced available grant amounts to reflect the impact of the combined effect of moderate inflationary construction cost increases and the maximum state grant that will be available through project completion. We have therefore used historical data of the Chemical Engineering Cost Index (specifically for the "Purox" part of the pyrolysis system) and the Engineering News Report Cost Index (for all other parts of the pyrolysis system and all parts of all alternate systems) for the past five years to determine a moderate extrapolated construction cost increase factor from July 1979 to the estimated construction mid-point for all systems (April 1983). Attached please find figure 1 & 2 and Appendix A indicating our computations for these adjustments.

We have also been advised by the N.Y. State Bureau of Resource Recovery Programs that, in accordance with "Guidelines for Determination of Eligible Costs of Solid Waste Mangement Projects Pursuant to the E.Q.B.A. of 1972, Dutchess County cannot benefit by a 50% grant assistance due to the lack of a market for recoverable ferrous metals. We have therefore adjusted all grant amounts to reflect maximum grants of 45% and applied further reductions to reflect lack of matching assistance due to inflation.

B - Technical Services

Fee support by State Grant assistance has been reduced to 45% in accordance with explanations furnished in A - Capital Costs above. Please further note that our estimates as well as CRVA estimates assumes additional grant assistance from the U.S. Department of Energy of \$1,050,000 for all systems without any firm comittment by D.O.E.

C - Contingencies

According to recent discussions with CRVA construction costs of each system include a contingency factor of 10% to cover such contingencies for present incompleteness of design and details, lack of detailed estimates based upon final bidding documents, possible change order extras during construction and start-up/ shake down costs. CRVA has verbally tried to assure us of the adequacy of their estimates and application of contingency factors.

As much as we would prefer to assume the adequacy of their estimates (particularly based upon their good professional reputation) we feel compelled to take a more conservative position due to the past history of this new-born industry, due to lack of CRVA detailed estimates and our ability to confirm the adequacy of same, and due to our own experience with more conventional capital construction projects.

We have therefore added an additional contingency factor of 5% for the "Purox" system and (due to further lack of design) an additional contingency factor of 10% for all other systems to cover such contingencies for present incompleteness of design and details, lack of detailed estimates based upon final bidding documents and possible change order extras during construction.

To address the significant additional costs which may arise during the start-up and shake-down period we have added nominal amounts of additional costs reflecting 6 months of each systems operating and maintenance costs and 5% of each systems total mechanical and electrical construction cost. The start-up and shake-down period may vary in length from three months to a year or more. Due to the present lack of historical cost data associated with this phase of the project for each system, we have chosen the above approach which does not necessarily equitably weigh the complexity and maturity of technology of each system. As this project proceed into a bidding stage or negotiated contract stage contractual obligations will be specified to limit the liability of the County or Authority. This does not however mean that these additional contingent costs will disappear. They will inherently and prudently be taken into account by each Contractor(s) and/or Developer and will be included as "Capital Costs".

It should be further noted that the costs associated for each system does not reflect costs of a "Full-Service Contract". Due to lack of historical data and comparative analysis of same, we can only logically conclude greater costs should be assumed due to the greater liabilities that must be assumed by a Full-Service Contractor.

Cost of Amortization for this start-up and shake-down period have been included in line item D-2 "Interim Construction Cost Financing" which assumes a three year construction cost draw down.

D - Financing Costs

Bond issuance costs include Bond Counsel, Fiscal Consultants, Printing Costs, Rating Agency Fees and other related issuance costs which would be incurred when processing in the financing stage of the project.

E - Administrative Costs

We have added to the CRVA estimates these costs which describes additional costs that will be incurred by the County and/or Authority for project management to acceptance of the project. These costs reflect supervision and administrative costs by the County and additional outside consultant fees which will be necessary to successfully provide guidance for this project. It is possible with approval by the Dutchess County Legislature that some of these costs may be absorbed by the County as a grant in order to demonstrate a further share in the success of this project.

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I

ANNUAL AMORTIZATION COST PUROX

	Total w/o Subsidy	Available Grant	Remainder
A. <u>Capital Costs</u>			
1. Land Acquisition	<u>80,000</u>	<u>-0-</u>	<u>80,000</u>
2. Facility Construction Cost	<u>24,235,000</u>	<u>10,009,000</u>	<u>14,226,000</u>
3. Modifications at Fuel User's Plant	<u>80,000</u>	<u>-0-</u>	<u>80,000</u>
4. Mobile Equipment	<u>300,000</u>	<u>124,000</u>	<u>176,000</u>
Subtotal	<u>24,695,000</u>	<u>10,133,000</u>	<u>14,562,000</u>
B. <u>Technical Services</u>			
1. Engineering Task I & II	<u>450,000</u>	<u>450,000</u>	<u>-0-</u>
a. Task IV & V	<u>1,550,000</u>	<u>1,050,000</u>	
b. Environmental Assessment	<u>50,000</u>		<u>583,000</u>
c. Construction & Startup	<u>510,000</u>	<u>477,000</u>	
Subtotal	<u>2,560,000</u>	<u>1,977,000</u>	<u>583,000</u>
C. <u>Contingencies</u>			
1. General Construction Cost @ 5% of A2 & A3	<u>1,216,000</u>	<u>-0-</u>	<u>1,216,000</u>
2. Start-up and Shake-down Costs			
a. 6 mos. Operating & Maintenance Cost	<u>1,521,000</u>	<u>-0-</u>	<u>1,521,000</u>
b. 5% Equipment Costs	<u>875,000</u>	<u>-0-</u>	<u>875,000</u>
Subtotal	<u>3,612,000</u>	<u>-0-</u>	<u>3,612,000</u>

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I cont'd.

ANNUAL AMORTIZATION COST		PUROX	
	Total w/o Subsidy	Available Grant	Total With Grants XXXXXXX
D. <u>Financing Costs</u>			
1. Bond Reserve Fund	3,407,000	-0-	2,095,000
2. Interim Construction Cost Financing	4,345,000	-0-	2,671,000
3. Revenues from Construction Fund	(-) 391,000	-0-	(-) 240,000
4. Financing State Grant Retainer	-0-	-0-	101,000
5. Bond Issuance Costs	1,689,000	-0-	1,039,000
Subtotal	9,050,000	-0-	5,666,000
E. <u>Administrative Costs</u>			
1. County & Authority Administrative expenses through 10/84	210,000	-0-	210,000
2. Project Consultant Fees	100,000	-0-	100,000
Subtotal	310,000	-0-	310,000
F. <u>Bond Issue</u>			
	(40,227,000)	(12,110,000)	24,733,000

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I

ANNUAL AMORTIZATION COST MODULAR INCINERATION - 3 PLANTS 425 TPD

	Total w/o Subsidy	Available Grant	Remainder
A. <u>Capital Costs</u>			
1. Land Acquisition	<u>143,000</u>	<u>-0-</u>	<u>143,000</u>
2. Facility Construction Cost	<u>22,304,000</u>	<u>9,613,000</u>	<u>12,691,000</u>
3. Modifications at Fuel User's Plant	<u>100,000</u>	<u>-0-</u>	<u>100,000</u>
4. Mobile Equipment	<u>600,000</u>	<u>259,000</u>	<u>341,000</u>
Subtotal	<u>23,147,000</u>	<u>9,872,000</u>	<u>13,275,000</u>
B. <u>Technical Services</u>			
1. Engineering Task I & II	<u>450,000</u>	<u>450,000</u>	<u>-0-</u>
a. Task IV & V	<u>1,250,000</u>	<u>1,050,000</u>	
b. Environmental Assessment	<u>200,000</u>		<u>501,000</u>
c. Construction & Startup	<u>510,000</u>	<u>409,000</u>	
Subtotal	<u>2,410,000</u>	<u>1,909,000</u>	<u>501,000</u>
C. <u>Contingencies</u>			
1. General Construction Cost @ 10% of A2 & A3	<u>2,240,000</u>	<u>-0-</u>	<u>2,240,000</u>
2. Start-up and Shake-down Costs			
a. 6 mos. Operating & Maintenance Cost	<u>2,094,000</u>	<u>-0-</u>	<u>2,094,000</u>
b. 5% Equipment Costs	<u>741,000</u>	<u>-0-</u>	<u>741,000</u>
Subtotal	<u>5,075,000</u>	<u>-0-</u>	<u>5,075,000</u>

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I cont'd.

ANNUAL AMORTIZATION COST MODULAR INCINERATION - 3 PLANTS 425 TPD

	Total w/o Subsidy	Available Grant	Remainder
D. <u>Financing Costs</u>			
1. Bond Reserve Fund	<u>3,381,000</u>	<u>-0-</u>	<u>2,105,000</u>
2. Interim Construction Cost Financing	<u>4,312,000</u>	<u>-0-</u>	<u>2,684,000</u>
3. Revenues from Construction Fund	<u>(-) 388,000</u>	<u>-0-</u>	<u>(-) 241,000</u>
4. Financing State Grant Retainer	<u>-0-</u>	<u>-0-</u>	<u>101,000</u>
5. Bond Issuance Costs	<u>1,677,000</u>	<u>-0-</u>	<u>1,044,000</u>
Subtotal	<u>8,982,000</u>	<u>-0-</u>	<u>5,693,000</u>
E. <u>Administrative Costs</u>			
1. County & Authority Administrative expenses through 10/84	<u>210,000</u>	<u>-0-</u>	<u>210,000</u>
2. Project Consultant Fees	<u>100,000</u>	<u>-0-</u>	<u>100,000</u>
Subtotal	<u>310,000</u>	<u>-0-</u>	<u>310,000</u>
F. <u>Bond Issue</u>	<u>(39,924,000)</u>	<u>(11,781,000)</u>	<u>24,854,000</u>

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I

ANNUAL AMORTIZATION COST WATERWALL INCINERATION

	Total w/o Subsidy	Available Grant	Remainder
A. <u>Capital Costs</u>			
1. Land Acquisition	<u>80,000</u>	<u>-0-</u>	<u>80,000</u>
2. Facility Construction Cost	<u>21,576,000</u>	<u>9,709,000</u>	<u>11,867,000</u>
3. Modifications at Fuel User's Plant	<u>50,000</u>	<u>-0-</u>	<u>50,000</u>
4. Mobile Equipment	<u>288,000</u>	<u>130,000</u>	<u>158,000</u>
Subtotal	<u>21,994,000</u>	<u>9,839,000</u>	<u>12,155,000</u>
B. <u>Technical Services</u>			
1. Engineering Task I & II	<u>450,000</u>	<u>450,000</u>	<u>-0-</u>
a. Task IV & V	<u>1,050,000</u>	<u>1,050,000</u>	
b. Environmental Assessment	<u>100,000</u>		<u>336,000</u>
c. Construction & Startup	<u>510,000</u>	<u>274,000</u>	
Subtotal	<u>2,110,000</u>	<u>1,774,000</u>	<u>336,000</u>
C. <u>Contingencies</u>			
1. General Construction Cost @ 10% of A2 & A3	<u>2,163,000</u>	<u>151,000</u>	<u>2,012,000</u>
2. Start-up and Shake-down Costs			
a. 6 mos. Operating & Maintenance Cost	<u>1,334,000</u>	<u>-0-</u>	<u>1,334,000</u>
b. 5% Equipment Costs	<u>792,000</u>	<u>-0-</u>	<u>792,000</u>
Subtotal	<u>4,289,000</u>	<u>-0-</u>	<u>4,138,000</u>

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I cont'd.

ANNUAL AMORTIZATION COST

WATERWALL INCINERATION

	Total w/o Subsidy	Available Grant	Total With Grants 1,000,000
D. <u>Financing Costs</u>			
1. Bond Reserve Fund	<u>3,137,000</u>	<u>-0-</u>	<u>1,862,000</u>
2. Interim Construction Cost Financing	<u>4,000,000</u>	<u>-0-</u>	<u>2,375,000</u>
3. Revenues from Construction Fund	<u>(-) 360,000</u>	<u>-0-</u>	<u>(-) 214,000</u>
4. Financing State Grant Retainer	<u>-0-</u>	<u>-0-</u>	<u>101,000</u>
5. Bond Issuance Costs	<u>1,555,000</u>	<u>-0-</u>	<u>924,000</u>
Subtotal	<u>8,332,000</u>	<u>-0-</u>	<u>5,048,000</u>
E. <u>Administrative Costs</u>			
1. County & Authority Administrative expenses through 10/84	<u>210,000</u>	<u>-0-</u>	<u>210,000</u>
2. Project Consultant Fees	<u>100,000</u>	<u>-0-</u>	<u>100,000</u>
Subtotal	<u>310,000</u>	<u>-0-</u>	<u>310,000</u>
F. <u>Bond Issue</u>	<u>(37,035,000)</u>	<u>(11,764,000)</u>	<u>21,987,000</u>

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I

ANNUAL AMORTIZATION COST RDF INCINERATION

	Total w/o Subsidy	Available Grant	Remainder
A. <u>Capital Costs</u>			
1. Land Acquisition	<u>80,000</u>	<u>-0-</u>	<u>80,000</u>
2. Facility Construction Cost	<u>22,748,000</u>	<u>9,827,000</u>	<u>12,921,000</u>
3. Modifications at Fuel User's Plant	<u>50,000</u>	<u>-0-</u>	<u>50,000</u>
4. Mobile Equipment	<u>288,000</u>	<u>124,000</u>	<u>164,000</u>
Subtotal	<u>23,166,000</u>	<u>9,951,000</u>	<u>13,215,000</u>
B. <u>Technical Services</u>			
1. Engineering Task I & II	<u>450,000</u>	<u>450,000</u>	<u>-0-</u>
a. Task IV & V	<u>1,150,000</u>	<u>1,050,000</u>	
b. Environmental Assessment	<u>100,000</u>		<u>391,000</u>
c. Construction & Startup	<u>510,000</u>	<u>319,000</u>	
Subtotal	<u>2,210,000</u>	<u>1,819,000</u>	<u>391,000</u>
C. <u>Contingencies</u>			
1. General Construction Cost @ 10% of A2 & A3	<u>2,280,000</u>	<u>-0-</u>	<u>2,280,000</u>
2. Start-up and Shake-down Costs			
a. 6 mos. Operating & Maintenance Cost	<u>1,514,000</u>	<u>-0-</u>	<u>1,514,000</u>
b. 5% Equipment Costs	<u>782,000</u>	<u>-0-</u>	<u>782,000</u>
Subtotal	<u>4,576,000</u>	<u>-0-</u>	<u>4,576,000</u>

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I cont'd.

ANNUAL AMORTIZATION COST RDF INCINERATION

	Total w/o Subsidy	Available Grant	Total With Grant 20,300,000
D. <u>Financing Costs</u>			
1. Bond Reserve Fund	<u>3,307,000</u>	<u>-0-</u>	<u>2,032,000</u>
2. Interim Construction Cost Financing	<u>4,217,000</u>	<u>-0-</u>	<u>2,591,000</u>
3. Revenues from Construction Fund	<u>(-) 379,000</u>	<u>-0-</u>	<u>(-) 233,000</u>
4. Financing State Grant Retainer	<u>-0-</u>	<u>-0-</u>	<u>101,000</u>
5. Bond Issuance Costs	<u>1,640,000</u>	<u>-0-</u>	<u>1,008,000</u>
Subtotal	<u>8,785,000</u>	<u>-0-</u>	<u>5,499,000</u>
E. <u>Administrative Costs</u>			
1. County & Authority Administrative expenses through 10/84	<u>210,000</u>	<u>-0-</u>	<u>210,000</u>
2. Project Consultant Fees	<u>100,000</u>	<u>-0-</u>	<u>100,000</u>
Subtotal	<u>310,000</u>	<u>-0-</u>	<u>310,000</u>
F. <u>Bond Issue</u>	<u>(39,047,000)</u>	<u>(11,770,000)</u>	<u>23,991,000</u>

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I

ANNUAL AMORTIZATION COST MODULAR INCINERATION -1 PLANT 400 TPD

	Total w/o Subsidy	Available Grant	Remainder
A. Capital Costs			
1. Land Acquisition	80,000	-0-	80,000
2. Facility Construction Cost	17,090,000	7,691,000	9,399,000
3. Modifications at Fuel User's Plant	50,000	-0-	50,000
4. Mobile Equipment	288,000	130,000	158,000
Subtotal	17,508,000	7,821,000	9,687,000
B. Technical Services			
1. Engineering Task I & II	450,000	450,000	-0-
a. Task IV & V	1,050,000	1,050,000	
b. Environmental Assessment	100,000		336,000
c. Construction & Startup	510,000	274,000	
Subtotal	2,110,000	1,774,000	336,000
C. Contingencies			
1. General Construction Cost @ 10% of A2 & A3	1,714,000	771,000	943,000
2. Start-up and Shake-down Costs			
a. 6 mos. Operating & Maintenance Cost	1,351,000	-0-	1,351,000
b. 5% Equipment Costs	564,000	254,000	310,000
Subtotal	3,629,000	1,025,000	2,604,000

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE I cont'd.

ANNUAL AMORTIZATION COST <u>MODULAR INCINERATION-1 PLANT 400 TPD</u>			
	Total w/o Subsidy	Available Grant	Total With Grants XXXXXXX
D. <u>Financing Costs</u>			
1. Bond Reserve Fund	<u>2,574,000</u>	<u>-0-</u>	<u>1,425,000</u>
2. Interim Construction Cost Financing	<u>3,283,000</u>	<u>-0-</u>	<u>1,817,000</u>
3. Revenues from Construction Fund	<u>(-) 295,000</u>	<u>-0-</u>	<u>(-) 164,000</u>
4. Financing State Grant Retainer	<u>-0-</u>	<u>-0-</u>	<u>101,000</u>
5. Bond Issuance Costs	<u>1,277,000</u>	<u>-0-</u>	<u>707,000</u>
Subtotal	<u>6,839,000</u>		<u>3,886,000</u>
E. <u>Administrative Costs</u>			
1. County & Authority Administrative expenses through 10/84	<u>210,000</u>	<u>-0-</u>	<u>210,000</u>
2. Project Consultant Fees	<u>100,000</u>	<u>-0-</u>	<u>100,000</u>
Subtotal	<u>310,000</u>	<u>-0-</u>	<u>310,000</u>
F. <u>Bond Issue</u>	<u>30,396,000</u>	<u>(10,620,000)</u>	<u>16,823,000</u>

DUTCHESS COUNTY PYROLYSIS PROJECT

Explanation of Adjusted Project Cost Estimates of "Purox" and "Alternate Resource Recovery Systems"

ANNUAL OPERATING COSTS AND REVENUES

1. Amortization of Bond Issue

It should be noted that the interest rate and terms of the Bond Issue are an educated guess at this time. It is virtually impossible to forecast these costs for the year 1984, particularly taking into consideration the uncertainties of present financial market conditions.

Due to present economic uncertainties we have tried to restrain ourselves to 1979 cost data. We have done this also to provide a more realistic comparison with our present methods of solid waste disposal. By varying interest rates, each type of energy inflation factor, labor and material inflation factors, it is almost possible to make anyone of the systems evaluated by CRVA the more competitive system.

2. Operating Expenses

We have adjusted CRVA estimates only in two areas, namely 2.b Maintenance and Replacement Costs and 2.g Authority Administrative Costs.

With respect to the latter (Administrative Costs) the County Team Members had initially assumed a "Total County Project", therefore, administrative costs could be equitably absorbed in the County's annual operating budget. We have found through investigation and analysis of this study that a total County project is not presently feasible. Consequently, we feel it may be more equitable to charge all administrative costs directly to the Project and its users. This does not however preclude the ability of having a solid waste district and/or authority which will ultimately benefit all parts of the County. It should, however, be accepted as equitable that senior participants to the initial project should gain some equitable advantage in the future by virtue of the initial risks and costs involved.

With respect to the costs that should be allotted for "Maintenance and Replacement Costs", we appear to demonstrate significant diversion of opinion with CRVA. It is our opinion, due to lack of detailed estimates to prove otherwise, due to the lack of long term data on existing resource recovery systems, due to our experience with the maintenance of our own capital projects and due to what we are aware of in limited published data in this area, that CRVA estimates should be increased. We have perhaps formulated an arbitrary parameter type adjustment (as we have in the area of contingencies) which approximately doubles the cost CRVA estimates in this area. We have estimated these costs to be equal to the combined total of 1% of CRVA estimated General Construction Cost and 5% of Mechanical/Electrical Construction Cost. To add credance to our more conservative approach on this matter is the fact that the Project's term of the Bonds is estimated at 30 years rather than typical G.O. 20 year bonds, consequently the cost of obsolescence and replacement enters into the picture more significantly.

We wish to point out certain characteristics of "Operating Contract Costs" as developed by CRVA that may require further analysis. As we admit that some of our pro-rated adjustments to CRVA estimates may not equitably reflect costs for each system, we believe the same argument may hold true for CRVA's method of pro-rating operating contract costs based on their estimate of the number of personnel required to support each system using Union Carbide's estimate as a base cost. We believe further analysis or detailed explanation may be prudent to resolve such observations as follows regarding total

personnel required for each project as indicated in Table 5-2 of CRVA's "Evaluation of Alternate Energy Systems":

- a) IBM Modular Incineration (400 TPD) and 425 TPD Modular Incineration designates 5 crane operators compared to all other systems of 4 crane operators.
- b) 400 TPD Modular Incineration designates 5 gas cleaning operators compared to none indicated for 425 TPD - 3 Plant Modular Incineration.
- c) 425 TPD - 3 Plant Modular Incineration indicates 8 Mechanic/Welders and 400 TPD - 1 Plant Modular Incineration indicates 6 Mechanic/Welders compared to the "Purox" and "RDF" systems which have a more complex front-end system.
- d) Published data available to us does not coincide with CRVA's estimate of personnel required for modular incineration.

3. Revenues

We have adjusted this part of CRVA's estimate only to reflect assumed interest revenues derived from setting up a Bond Reserve Fund indicated in Para. D-1 of Annual Amortization Cost explained hereinbefore.

General Comments

We have not applied a constant operating surplus for all systems as indicated in CRVA estimates to limit ourselves of any distortions in unit price tipping fees.

Please note that, due to lack of response from their plant, we have not addressed the possibility of IBM-Fishkill as an energy customer of a resource recovery system. Based upon our present estimates, the application of either Waterwall or Modular Incineration appears worthy of future study. Such a study would include a comparative analysis of tipping fees and transportation costs taking into consideration IBM Poughkeepsie and IBM Fishkill as potential energy users. Part of this study would include the possibility of increasing population and increasing solid waste generation in the southern part of the County. If transportation costs keep increasing at their present rate, a further study is warranted to determine the feasibility of a transfer station or a smaller resource recover plant at the northern part of our Core Area.

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE II

ANNUAL OPERATING COSTS & REVENUES		PUROX
1.	<u>Amortization of Bond Issue</u> (24,733,000 for 30 yrs @ 7½%) (.0847)	2,095,000
	(Amortization of Bond Issue w/o Subsidy)	(3,407,000)
2.	<u>Operating Expenses</u>	
a.	Operating Contract	1,200,000
b.	Maintenance & Replacement Costs	943,000
c.	Utilities	495,000
d.	Miscellaneous Supplies	52,000
e.	Landfill Tipping Fees	156,000
f.	Depreciation on Mobile Equipment	75,000
g.	Authority Administrative Costs	120,000
	Subtotal	3,041,000
3.	<u>Revenues</u>	
a.	Interest on Bond Reserve Fund (2,095,000 @ 9%)	189,000
	Interest on Bond Reserve Fund w/o Subsidy	(307,000)
b.	Gas Sales	1,468,000
c.	Steam Sales	-0-
d.	Slag Sales	68,000
	Subtotal	1,725,000
	Subtotal w/o Subsidy	(1,843,000)
4.	<u>Net Deficit</u>	3,411,000
	(Net Deficit w/o Subsidy)	(4,605,000)
5.	<u>Minimum Tip Fee @ 145,000 TPY</u>	\$23.52/ton
6.	(Tip Fee Without Grant Support)	(\$31.79/ton)

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE II

ANNUAL OPERATING COSTS & REVENUES		MODULAR INCINERATION	425 TPD
1.	Amortization of Bond Issue (24,854,000 for 30 yrs.@7½%) (.0847)	2,105,000	
	(Amortization of Bond Issue w/o Subsidy)	(3,381,000)	
2.	<u>Operating Expenses</u>		
a.	Operating Contract	2,173,000	
b.	Maintenance & Replacement Costs	816,000	
c.	Utilities	447,000	
d.	Miscellaneous Supplies	60,000	
e.	Landfill Tipping Fees	392,000	
f.	Depreciation on Mobile Equipment	150,000	
g.	Authority Administrative Costs	120,000	
	Subtotal	4,158,000	
3.	<u>Revenues</u>		
a.	Interest on Bond Reserve Fund (2,105,000 @ 9%)	189,000	
	Interest on Bond Reserve Fund w/o Subsidy	(304,000)	
b.	Gas Sales	-0-	
c.	Steam Sales	2,131,000	
d.	Slag Sales	-0-	
	Subtotal	2,320,000	
	Subtotal w/o Subsidy	(2,435,000)	
4.	<u>Net Deficit</u>	3,943,000	
	(Net Deficit w/o Subsidy)	(5,104,000)	
5.	<u>Minimum Tip Fee @ 155,000TPY</u>	\$ 25.44/ton	
6.	<u>(Tip Fee Without Grant Support)</u>	(\$ 32.93/ton	

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE II

ANNUAL OPERATING COSTS & REVENUES Waterwall Incineration

1. <u>Amortization of Bond Issue</u> (21,987,000 for 30 yrs @ 7½%) (.0847)	1,862,000
(Amortization of Bond Issue w/o Subsidy)	(3,137,000)
2. <u>Operating Expenses</u>	
a. Operating Contract	1,038,000
b. Maintenance & Replacement Costs	850,000
c. Utilities	245,000
d. Miscellaneous Supplies	50,000
e. Landfill Tipping Fees	293,000
f. Depreciation on Mobile Equipment	72,000
g. Authority Administrative Costs	120,000
Subtotal	2,668,000
3. <u>Revenues</u>	
a. Interest on Bond Reserve Fund (1,862,000 @ 9%)	168,000
Interest on Bond Reserve Fund w/o Subsidy	(282,000)
b. Gas Sales	-0-
c. Steam Sales	1,543,000
d. Slag Sales	-0-
Subtotal	1,711,000
Subtotal w/o Subsidy	(1,825,000)
4. <u>Net Deficit</u>	2,819,000
(Net Deficit w/o Subsidy)	(3,980,000)
5. <u>Minimum Tip Fee @ 145,000 TPY</u>	\$19.44/ton
6. (Tip Fee Without Grant Support)	(\$27.45/ton)

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE II

ANNUAL OPERATING COSTS & REVENUES

RDF INCINERATION

1. <u>Amortization of Bond Issue</u> (23,991,000 for 30 yrs @ 7½%) (.0847)	2,032,000
(Amortization of Bond Issue w/o Subsidy)	(3,307,000)
2. <u>Operating Expenses</u>	
a. Operating Contract	1,200,000
b. Maintenance & Replacement Costs	853,000
c. Utilities	409,000
d. Miscellaneous Supplies	50,000
e. Landfill Tipping Fees	324,000
f. Depreciation on Mobile Equipment	72,000
g. Authority Administrative Costs	120,000
Subtotal	3,028,000
3. <u>Revenues</u>	
a. Interest on Bond Reserve Fund (2,032,000 @ 9%)	183,000
Interest on Bond Reserve Fund w/o Subsidy	(351,000)
b. Gas Sales	-0-
c. Steam Sales	1,462,000
d. Slag Sales	-0-
Subtotal	1,645,000
Subtotal w/o Subsidy	(1,813,000)
4. <u>Net Deficit</u>	3,415,000
(Net Deficit w/o Subsidy)	(4,522,000)
5. <u>Minimum Tip Fee @ 145,000 TPY</u>	\$23.55/ton
6. (Tip Fee Without Grant Support)	(\$31.19/ton)

DUTCHESS COUNTY PYROLYSIS PROJECT - SCHEDULE II

ANNUAL OPERATING COSTS & REVENUES Modular Incineration - 400 TPD

1. <u>Amortization of Bond Issue</u> (16,823,000 for 30 yrs @ 7½%) (.0847)	1,425,000
(Amortization of Bond Issue w/o Subsidy)	(2,574,000)
2. <u>Operating Expenses</u>	
a. Operating Contract	1,135,000
b. Maintenance & Replacement Costs	623,000
c. Utilities	300,000
d. Miscellaneous Supplies	60,000
e. Landfill Tipping Fees	392,000
f. Depreciation on Mobile Equipment	72,000
g. Authority Administrative Costs	120,000
Subtotal	2,702,000
3. <u>Revenues</u>	
a. Interest on Bond Reserve Fund (1,425,000 @ 9%)	128,000
Interest on Bond Reserve Fund w/o Subsidy	(232,000)
b. Gas Sales	-0-
c. Steam Sales	1,380,000
d. Slag Sales	-0-
Subtotal	1,508,000
Subtotal w/o Subsidy	(1,612,000)
4. <u>Net Deficit</u>	2,619,000
(Net Deficit w/o Subsidy)	(3,664,000)
5. <u>Minimum Tip Fee @ 145,000 TPY</u>	\$18.06/ton
6. (Tip Fee Without Grant Support)	(\$25.27/ton)

COMPARISON OF SYSTEMS FOR VARIOUS DATA

	Purox	Mod. Incin. 3 Plants	Waterwall Incineration	RDF Incin.	Mod. Incin. 1 Plant
Subsidized Tip Fee	\$23.52/ton	\$25.44/ton	\$19.44/ton *	\$23.55/ton	\$18.06/ton *
Unsubsidized Tip Fee	\$31.79/ton	\$32.93/ton	\$27.45/ton *	\$31.19/ton	\$25.27/ton *
Total Waste to be Land Filled per year	26,000 tons *	65,333 tons	48,833 tons	54,000 tons	65,333 tons
Present Capacity per yr.	145,000 tons	155,000 tons	145,000 tons	145,000 tons	145,000 tons
Total Waste Reduction	119,000 tons *	89,667 tons	96,167 tons	91,000 tons	89,667 tons
Total Reduction %	82.07 *	57.85	66.32	62.76	61.84
Cost/ton of waste eliminated from landfill	\$28.66 *	\$44.31	\$29.31	\$37.53	\$29.21
Materials Recovery Ability	Yes *	No	No	Yes *	No
Expansion Capacity	Yes *	Yes *	Yes *	Yes *	No
Material & Energy Revenues per ton rec'd	\$10.59/ton	\$13.75/ton *	\$10.64/ton	\$10.08/ton	\$ 9.52/ton
Revenues-Utilities per ton received	\$ 7.18/ton	\$10.86/ton *	\$ 8.95/ton	\$ 7.26/ton	\$ 7.45/ton
Operating Expenses per ton received	\$20.97/ton	\$27.02/ton	\$18.40/ton *	\$20.88/ton	\$18.63/ton

Most Favorable *

ESTIMATE OF REDUCTION IN STATE GRANT ASSISTANCE DUE TO INFLATION .

A. Purox

2a.	14,140,000 x 1.24937	=	\$17,666,091	
2b.	10,095,000 x 1.31875	=	13,312,781	
4.	300,000 x 1.31875	=	<u>395,625</u>	
	Construction Cost at Bid		\$31,374,497	
	Maximum State Grant	=	13,449,000	
	- Fee Support @ 45%	=	<u>477,000</u>	
	Net for Construction	=	12,972,000	= 41.3%
	Construction Cost	=	<u>31,374,497</u>	

B. Modular Incineration

2.	22,304,000 x 1.31875	=	\$29,413,400	
4.	600,000 x 1.31875	=	<u>791,250</u>	
	Construction Cost at Bid	=	\$30,204,650	
	Maximum State Grant	=	13,449,000	
	- Fee Support @ 45%	=	<u>409,000</u>	
	Net for Construction	=	13,040,000	= 43.1%
	Construction Cost	=	<u>30,204,650</u>	

C. Waterwall Incineration

2.	\$21,576,000 x 1.31875	=	\$28,453,350	
4.	288,000 x 1.31875	=	<u>379,800</u>	
	Construction Cost at Bid	=	\$28,833,150	
	Maximum State Grant	=	13,449,000	
	- Fee Support @ 45%	=	<u>274,000</u>	
	Net for Construction	=	13,175,000	= 45.6% or 45% Maximum
	Construction Cost	=	<u>28,833,150</u>	

ESTIMATE OF REDUCTION IN STATE GRANT ASSISTANCE DUE TO INFLATION cont'd.

D. RDF Incineration

2.	\$22,748,000 x 1.31875	=	\$29,998,925	
4.	288,000 x 1.31875	=	<u>379,800</u>	
	Construction Cost at Bid	=	\$30,378,725	
	Maximum State Grant	=	13,449,000	
	- Fee Support @ 45%	=	<u>319,000</u>	
	Net for Construction	=	\$13,130,000	= 43.2%
	Construction Cost	=	<u>30,378,725</u>	

E. Modular Incineration - 1 plant @ 400 TPD

2.	\$17,090,000 x 1.31875	=	\$22,537,437	
4.	288,000 x 1.31875	=	<u>379,800</u>	
	Construction Cost at Bid	=	\$22,917,237	
	Maximum State Grant	=	\$13,449,000	
	- Fee Support @ 45%	=	<u>274,000</u>	
	Net for Construction	=	13,175,000	= 57.4% or 45% Maximum
	Construction Cost	=	<u>22,917,237</u>	

ESTIMATE OF STATE GRANT ASSISTANCE FOR CONTINGENCIES

A. Purox - None

B. Modular Incinerator - None

C. Water Wall Incineration

Construction Cost at Bid	=	28,833,150	
Maximum State Grant	=	13,449,000	
- Fee Support @ 45%	= (-)	274,000	
- 45% of Constr. Cost	= (-)	<u>12,974,917</u>	
Net for Contingencies	=	<u>200,083</u>	= 7%
2,163,000 x 1.31875	=	<u>2,852,456</u>	

D. RDF Incineration - None

E. Modular Incinerator 1 plant @ 400 TPD

Construction Cost at Bid	=	22,537,437	
Maximum State Grant	=	13,449,000	
- Fee Support @ 45%	= (-)	274,000	
-45% of Construction Cost	= (-)	<u>10,141,846</u>	
Net for Contingencies	=	<u>3,033,154</u>	
(1,714,000 + 564,000) x 1.31875	=	<u>3,004,113</u>	= 100% or 45% max.

ESTIMATE OF COUNTY PROJECT TEAM COSTS

(For Period 7/79 to 10/84)

Pjt. Coord. or Comm. of Solid Waste	70 hrs. x 11.66	=	816.20
Dept. of Solid Waste Secretary	60 hrs. x 5.79	=	347.40
Asst. to County Executive	10 hrs. x 9.11	=	91.10
Comm. of Finance	10 hrs. x 18.10	=	181.00
County Attorney	16 hrs. x 19.09	=	305.44
Comptroller	16 hrs. x 14.16	=	226.56
Comm. of Public Works	10 hrs. x 20.10	=	201.00
Public Health Administrator	10 hrs. x 14.25	=	<u>142.50</u>
Total Salaries		=	\$2,311.20
Salary Overhead @ 31.25%		=	722.25
Office Stationary, Telephone, Printing &			
Copying, Postage & Travel Expenses		=	<u>300.00</u>
Total Cost Month		=	\$3,333.45
Total Cost from 7/79 to 10/84 (63)		=	\$210,000.00

ESTIMATE OF MAINTENANCE & REPLACEMENT COSTS

A. Purox

G.C.	6,820,000 x 1%	=	68,200	
M/E	<u>17,495,000</u> x 5%	=	<u>874,750</u>	
Total	24,315,000		\$942,950	(3.88%)

B. Modular Incineration

G.C.	7,477,000 x 1%	=	74,770	
M/E	<u>14,827,000</u> x 5%	=	<u>741,350</u>	
Total	22,304,000		\$816,120	(3.66%)

C. Water Wall Incineration

G.C.	5,782,000 x 1%	=	57,820	
M/E	<u>15,844,000</u> x 5%	=	<u>792,200</u>	
Total	21,626,000		\$850,020	(3.93%)

D. RDF Incineration

G.C.	7,167,000 x 1%	=	71,670	
M/E	<u>15,631,000</u> x 5%	=	<u>781,550</u>	
Total	22,798,000		\$853,220	(3.74%)

E. Modular Incineration - 1 plant @ 400 TPD

G.C.	5,857,000 x 1%	=	58,570	
M/E	<u>11,283,000</u> x 5%	=	<u>564,150</u>	
Total	17,140,000		\$622,720	(3.63%)

ENR COST INDEX

FIGURE 2

January 2, 1980

Charles R Velzy Associates, Inc.
Consulting Engineers
355 Main Street
Armonk, New York 10504
Telephone: 914/273-9840

Mr. Stephen J. Wing
County Attorney
County of Dutchess
County Office Building
22 Market Street - 5th Floor
Poughkeepsie, New York 12601

Dear Steve:

Per your telephone conversation of December 31, with Mr. Grillo, we are enclosing a copy of a proposed schedule, cost information, and assumptions for a mass burning system (based on waterwall incineration) for Dutchess County. We feel that these numbers reflect a reasonable amount of conservativeness and take into account a modest inflation rate over the implementation period. We feel that the resulting first year net tipping fee of under \$16.00 per ton is feasible, based on a 400 ton per day facility being constructed in accordance with the attached implementation schedule.

We look forward to working with you as this project progresses.

Very truly yours,

Roger S. Hecklinger
Principal

RSH/maf
encl.

COST PROJECTION ASSUMPTIONS

CAPITAL COSTS

A. Capital Costs

All items are inflated 28 percent. (3 years at 8.5 percent per year, based on ENR construction cost index increase over last five years), to show cost of facility at construction midpoint (7/79 to 7/82). NYSDEC grant was applied at 45 percent to maximum of \$13,449,000.

B. Technical Services

No change in numbers from original report.

C. Contingencies

The following construction contingencies were added, as a percentage of facility construction and modification to user's plant:

Mass burning	-	5 percent
All others	-	10 percent

Also, startup and shakedown contingencies were added as follows:

Mass burning	-	\$ 500,000
PUROX	-	1,000,000
Modular	-	1,000,000
RDF	-	1,500,000

D. Financing

Percentages used in financing items were given to CRVA by Dutchess County. Note bond reserve, construction fund revenues, and state grant retainer financing were not included in the original report.

E. Administration

County expenses incurred during project implementation are not included. We feel these costs are already included in the County budget and should continue to be paid by County tax revenues. New costs to the County, which are a direct result of this project are included elsewhere. The cost for additional consultants, to oversee the project have been included.

MASS BURNING (WATERWALL)

	<u>TOTAL</u>	<u>AVAILABLE GRANT</u>	<u>REMAINDER</u>
A. CAPITAL COSTS			
1. Land	102,000	0	102,000
2. Facility Construction	29,117,000	12,963,000	16,154,000
3. Modifications at User	64,000	0	64,000
4. Mobile Equipment	369,000	166,000	203,000
SUBTOTAL	29,652,000	13,129,000	16,523,000
B. TECHNICAL SERVICES			
1. Engineering Task I & II	450,000	450,000	0
2. Task IV & V	1,050,000	1,050,000	0
3. Environmental Assessment	100,000	45,000	55,000
4. Construction & Start-up	510,000	230,000	280,000
C. CONTINGENCIES			
1. Gen. Const. - 5% of A2 & A3	1,459,000	0	1,459,000
2. Startup/Shakedown	500,000	0	500,000
SUBTOTAL	1,959,000	0	1,959,000
D. FINANCING			
1. Bond Reserve	3,696,000	0	2,074,000
2. Interim Financing	4,713,000		2,644,000
3. Revenues - Const. Fund	- 424,000		- 238,000
4. Fin. - State Grant Retainer	0	0	101,000
5. Bond Issuance	1,833,000		1,028,000
SUBTOTAL	9,818,000		5,609,000
E. ADMINISTRATIVE			
1. County Expenses	0	0	0
2. Consultants	100,000	45,000	55,000
SUBTOTAL	100,000	45,000	55,000
F. BOND ISSUE	43,639,000		24,481,000

\$ 3,696,000/YR

2,074,000/YR

\$13,449,000 Grant Used

MASS BURNING (WATERWALL)

ANNUAL COST - 1st YEAR OF OPERATION

WITH GRANT

1. AMORTIZATION	\$2,074,000
2. OPERATING EXPENSES	
a. Operating Contract	\$1,456,000
b. Maintenance & Replacement	850,000
c. Utilities	432,000
d. Misc. Supplies	70,000
e. Landfill Tipping Fee	411,000
f. Depreciation of Mobile Equip.	92,000
g. Authority Administration Costs	50,000
SUBTOTAL	\$3,361,000
3. REVENUES	
a. Interest on Bond Reserve Fund	\$ 187,000
b. Energy Sale	2,991,000
c. Ferrous Sale	0
d. Residue Sale	0
SUBTOTAL	\$3,178,000
4. NET DEFICIT (1+2 -3)	\$2,257,000
5. MINIMUM TIP FEE @ 145,000 TPY Without Operating Surplus	\$ 15.57

IMPLEMENTATION SCHEDULE - MASS BURNING
(WATERWALL INCINERATION)

Submit PUROX Conceptual Design Report (Basis of plant economics)	7/79
Begin negotiations with Energy Market	1/80
Approval of project by Dutchess County Legislature	3/80
Begin Design, environmental work, state permit applications	3/80
Complete Design, prepare bids	3/81
Bid award, start of construction	7/81
Construction midpoint	7/82
Complete construction, begin startup/shakedown	7/83
Complete shakedown, plant acceptance	1/84
Midpoint first year operation	7/84

ANNUAL COSTS

1. Amortization

No change in numbers - 30 years at 7-1/2 percent.

2. Operating Expenses

- a. Operating contract - Cost inflated 5 years at 7 percent (to midpoint first year operation).
- b. Maintenance and Replacement - This cost has been increased to show a more conservative estimate, as requested by the County.
- c. Utilities - Cost inflated 5 years at 12 percent.
- d. Miscellaneous Supplies - Cost inflated 5 years at 7 percent.
- e. Landfill tipping fee - cost inflated 5 years at 7 percent.
- f. Depreciation of mobile equipment - no charge (25 percent of initial cost).
- g. Authority Administration costs - Not in initial report - shows increased cost to County for solid waste disposal administration.

3. Revenues

- a. Interest on bond reserve - not in original report; added on recommendation of County financial advisor.
- b. Energy - Inflated 10 percent plus 5 years at 12 percent. Initial increase due to recent known price raises in cost of oil.
- c. Ferrous - It is assumed that no market will be available by plant startup.
- d. Residue - Increased 5 years at 7 percent, where applicable.
- e. Note: Operating surplus is not included in these cost estimates.

D. C. Dept. of Solid Waste Mgmt.
22 Market Street

January 21, 1980

Roger S. Hecklinger, P.E.
Charles R. Velzy Assoc., Inc.
355 Main Street
Armonk, N.Y. 10504

Dear Mr. Hecklinger:

Please be advised that your correspondence of January 2, 1980, indicating your opinion of the probable project costs of each resource recovery system as of July 1984, shall be attached to the final project report. A copy of this letter setting forth certain considerations with regard to your estimates will also be appended.

Re: Cost Escalation Factors

It appears reasonable to assume today that energy prices will escalate at a greater rate than most other commodities, but the primary difficulty is in predicting the magnitude of those factors; therefore, we must consider your escalation factors with caution.

Re: Capital Cost Contingencies

The assumptions we made in adding contingency factors to your original estimates were as follows:

5% of construction costs was allocated for contingencies occurring during construction.

5% of construction costs was allocated as a variance between engineer's final estimate and lowest responsible bidder. This factor gives us approximately a 90% chance of being within the budget at the time of the engineer's final estimate.

5% of construction costs was allocated to compensate for accuracy and completeness of detail differences between conceptual design and final design estimates.

5% of construction costs was allocated to compensate for accuracy and completeness of detail differences between schematic design and conceptual design estimates. This last factor was added to all other systems except "Purox" to compensate for the difference in engineering work expended for each system.

Taking into consideration that your original estimates contained a 10% contingency factor, we applied the remaining factors as applicable. The application of the above factors was made with the intent that these are factors applicable to all normal public works projects.

To the above we added contingency factors under the heading Start-up and Shake-down costs to reflect the differences between a normal public works project and the construction of a resource recovery plant. From our general knowledge of the implementation of past resource recovery projects in this Country, we do not believe these factors are too conservative.

Re: County & Authority Administrative Expenses (Annual Amortization Costs) & Authority Administrative Costs (Annual Operating Costs and Revenues)

In this area we prefer to show this as a cost of the project and leave the decision to the County Executive and the County Legislators as to how these will be dealt with.

Re: Maintenance & Replacement Costs

Maintenance and replacement costs, increased substantially from your previous estimate, will be subject to further study.

Very truly yours,

Gregory Bosaz, Jr., P.E.
Project Coordinator

GB:1

Dept. of Solid Waste Mgmt.
22 Market Street

Memo to: County Project Team Members - P. Amodeo, P. Hackett, M. Murphy,
J. Spratt & S. Wing

From: Gregory Bosaz, Jr., P.E. *GB*
Project Coordinator

Date: January 7, 1980

Re: Updated Status Report on Solid Waste Mgmt. Facilities

Attached, for your information, is a copy of an updated Status Report
for Solid Waste Management Facilities in Dutchess County.

DUTCHESS COUNTY SOLID WASTE MANAGEMENT FACILITIES

FACILITY	TOTAL LAND AREA	CAPACITY	SITE LIFE	PERMIT STATUS	PROPERTY OWNER	LOCATION
<u>TRANSFER STATIONS</u>						
(V) PAWLING Transfer Station #Y14T01	13.4A	7.65 T/day	—	Issued 9/15/78	T. Pawling	Swamp Road 1/2 mi. West of Rt. 22
(T) PLEASANT VALLEY Transfer Station #Y14T02	Unknown Very Limited	12 T/day	—	Appl. Pending Permit Anticipated	T. Pleasant Valley	Sherow Rd., adjacent to Highway Dept. garage
(T) EAST FISHKILL Watch Hill Holding Corp. Transfer Station #Y14T03	Unknown Very Limited	40T/week	—	Issued 12/29/78	Watch Hill Hold. Corp.	Rt. 82, 1/2 mi. West of Old Hopewell Road
(C) POUGHKEEPSIE Transfer Station #Y14T05	8.85 A DPW Facility	60T/day from City (480T/day) Capacity		Issued 8/7/79	City of Pok.	Howard St. Extension City of Poughkeepsie

LANDFILLS

(T) POUGHKEEPSIE Dutchess Sanitation Co. (Landfill) #Y14S01	10A	160T/day (Less corrugated)	4½ yrs.	Application Pending	Dutchess Sani- tation Service	275 Van Wagner Rd. T. Poughkeepsie
(T) MILAN (Landfill) #Y14S02	10A	133 CY/Wk	7 yrs.	Permit Issued 4/20/79	(T) Milan	Bounded by Taconic Prkway, Route 199 and South Road
(V) TIVOLI (Landfill) #Y14S03	3A	10 T/day	9½ yrs.	Permit Issued 10/25/79	(V) Tivoli	Freeborn Lane 1.5 Miles East of Route 9C
(T) LA GRANGE Baird State Park #Y14S04	5A	Unknown	Unknown	Application Pending	N.Y.S. Office of Parks & Recreation	—
(C) BEACON (Landfill)				Appl. Pending		Dennings Avenue

DUTCHESS COUNTY SOLID WASTE MANAGEMENT FACILITIES (Cont'd)

FACILITY	TOTAL LAND AREA	CAPACITY	SITE LIFE	PERMIT STATUS	PROPERTY OWNERS	LOCATION
<u>LANDFILLS (cont.)</u>						
(T) BEEKMAN (Landfill) #Y14S06	13.6A	8 T/day	5 yrs.	Permit Issued 10/24/79	(T) Beekman	Pleasant Ridge Rd. 1 mile North of Route 55
(T) CLINTON (Landfill) #Y14S07	0.95A	30 T/week	2 yrs.	Appl. Pending Permit Anticipated	(T) Clinton	Slate Quarry Road 3 Miles east of 9G
(T) DOVER (Landfill) #Y14S08	5+A	15 T/Day	1-3 yrs.	Permit Issued 4/20/79	Leased to (T) Dover	C.R. 21, 1/4 mile West of Wingdale
(T) EAST FISHKILL (Landfill) #Y14S09	7.07A	2200 T/Mo.	6 months	Permit Issued 10/24/79	Leased to (T) East Fish.	Hosner Mtn. Road 1000 Ft. East of Taconic
(T) FISHKILL (Landfill) #Y14S10	7.89A	2400 CY/Mo.	6 months	Permit Issued 10/24/79	Leased to (T) Fishkill	Cary Rd. 1 mile east of I-84
HARLEM VALLEY LANDFILL CORP. (T) Amenia (Landfill) #Y14S11	10+ A	80 T/day	2½ yrs.	Permit Issued 10/24/79	Harlem Valley Landfill Corp.	Route 22, 2 miles South of Amenia
(T) NORTHEAST (Landfill) #Y14S13	30A	41 CY/day	9½ yrs.	Permit Issued 4/20/79	(T) Northeast	Regan Rd., 500 Ft. East of the RR Tracks
(T) PINE PLAINS (Landfill) #Y14S14	Approx 5A	Unknown	15½ yrs.	Appl. Pending Permit Anticipated	John Hoffman	Hoffman Road, 1/4 Miles East of Silvernails Rd.
(T) RHINEBECK (Landfill) #Y14S15	10A	500 CY/Week	4 yrs. 7 yrs. w/ expansion	Application Pending	(T) Rhinebeck	Stone Church Rd. 1-1/2 miles East of Rt. 9

DUTCHESS COUNTY SOLID WASTE MANAGEMENT FACILITIES (Cont.)

FACILITY <u>LANDFILLS</u>	TOTAL LAND AREA	CAPACITY	SITE LIFE	PERMIT STATUS	PROPERTY OWNER	LOCATION
(T) STANFORD (Landfill) #Y14S16	8A	7T/Day	3 yrs.	Permit Issued 4/20/79	(T) Stanford	Bangall - Amenis 1-1/2 mile East of Rt. 82/C.R. 65 Int
(T) UNIONVALE (landfill) #Y14S17	2A	4 T/day	5½ yrs.	Permit Issued 8/7/79	(T) Unionvale	Rt. 55, 3½ miles southeast of Faconic Prky.
(T) WASHINGTON (landfill) #Y14S18	40+A	60-70 T/wk	200+ yrs.	Permit Issued 4/20/79	(T) Washsi ngton	Rt. 343, East of Chestnut Ridge Rd.
440 WILCOX PARK (T) Milan (Landfill) #Y14S20	0.75A	0.2 T/day	25 yrs.	Application pending Permit Anticipated	Dutchess County	South end of Park T. Milan
<u>BALER</u>						
DUTCHESS SANITATION CO. (T) Poughkeepsie (Baler) #Y14P01	—	20 T/day	—	Application Pending	Dutchess Sanitation Service	27 Van Wagner Rd (T) Poughkeepsie

OTHER FACILITIES

MISCELLANEOUS

<u>Facility</u>	<u>Location</u>	<u>Type of Waste</u>
Redl Property	Salt Point Turnpike T. Poughkeepsie	Construction & Demolition Debris
Alexander Property	Sheafe Road T. Poughkeepsie	Construction & Demolition Debris Spring Clean-up, T. Poughkeepsie & City of Poughkeepsie
Van deWater Property	Van Wagner Road T. Poughkeepsie	T. Poughkeepsie Spring Clean-up
Red Wing Sand & Gravel	Rt. 82 T. La Grange	T. La Grange Spring Clean-up

SEPTAGE

McCann Property	Rt. 52 T. Fishkill	Septage & Sewage Sludge - lagoon and land spread
Anagnos Property	Mill Rd. T. Red Hook	Septage - lagoon and land spread
Jones Property (Losee)	Cardinal Road T. Hyde Park	Septage - lagoon
Moore Farm	Rte 82A T. Northeast	Septage - Lagoon
WDAN Property	Ryan Road T. Pine Plains	Septage - Lagoon
Smith Townsend Property	Townsend Road T. East Fishkill	Septage - Lagoon
O'Dell Property	Joe Phillips Rd. T. Beekman	Septage - Pits
Vincent Property	Dover Furnace Rd. T. Dover	Septage - Land Spread

SEPTAGE

<u>Facility</u>	<u>Location</u>	<u>Type of Waste</u>
Village of Millbrook	T. Washington Landfill Rte. 343, T. Washington	Sludge - Lagoon
Village of Wappingers Falls	Franklindale Ave. Wappingers Falls	Sludge - Pits
Alexander Property	Sheafe Rd. T. Poughkeepsie	Grit & ash pits - (Arlington STP)

STATUS OF SOLID WASTE MANAGEMENT - SOUTHERN DUTCHESS AND
NORTHWESTERN DUTCHESS COUNTY - DECEMBER, 1979

Southern Dutchess County

Four operating landfills currently exist in the southern portion of Dutchess County, located in the Towns of Beekman, Fishkill, East Fishkill and the City of Beacon. Projected site life for the Beekman site is five (5) years. Closure is anticipated within six (6) months for the Fishkill and East Fishkill sites. The Beacon landfill operates on a limited basis and accepts mostly commercial office wastes and construction and demolition debris, with all other wastes (residential and otherwise) hauled to Orange County.

It is expected that a new joint Fishkill/East Fishkill landfill will be established in Fishkill to coincide with the closure of the two existing sites. This facility will handle solid waste from both Towns as well as the Village of Fishkill (presently utilizing the Town of Fishkill landfill). Engineering work is virtually complete and the formal landfill application is expected to be submitted to the Dutchess County Health Department in January of 1980. Anticipated site life is approximately ten (10) years for the entire property; development may or may not be in phased stages.

The future of the Beacon landfill is presently in question due to restrictions that will be placed on its use to be specified in the forthcoming Operating Permit, and also due to a recently announced property rent increase of substantial magnitude. It is expected that the City of Beacon will be seriously re-evaluating the future of this landfill facility.

Northwestern Dutchess County

This portion of the County, encompassing the Towns of Red Hook, Rhinebeck and Hyde Park and the Villages of Tivoli, Red Hook, and Rhinebeck, currently has two (2) operating landfills (the Town of Hyde Park landfill closed October 31, 1979). The Village of Tivoli landfill, accepting wastes from the Village of Tivoli and parts of the Town of Red Hook, has a projected site life of nine (9) years. The Town of Rhinebeck landfill, accepting wastes from the Town and Village of Rhinebeck, the Village of Red Hook (under contract), and parts of the Town of Red Hook, has a projected site life of two and one-half (2½) years. Hyde Park refuse haulers are believed to be hauling predominantly to the Dutchess Sanitation Service landfill in the Town of Poughkeepsie.

Future solid waste management plans for Northwestern Dutchess County consist solely of a proposal to expand the Rhinebeck landfill, which will add approximately three (3) years to the projected facility life. This expansion also involves an application for a Freshwater Wetlands Permit. These plans and applications are currently under review by the NYS Department of Environmental Conservation and the Dutchess County Health Department. Should this application for an expanded facility be denied, the Town of Rhinebeck has stated that it will not renew its contract with the Village of Red Hook. Furthermore, the Town can be expected to take action to prevent refuse from the Town of Red Hook continuing to find its way illegally into the Rhinebeck landfill.

Finally, the possibility of closing the Village of Tivoli Landfill (a marginal operation) and hauling these wastes to the Town of Rhinebeck landfill (an option previously discussed) would also be eliminated should the Rhinebeck expansion application be denied.