SECTION 3

INDIAN POINT UNIT 2 AND UNIT 3 NUCLEAR STATION

DISTRICT HEATING SYSTEM

3.1 Heat Load Assessment

3.1.1 Analyses of the Surrounding Potential Service Area

A survey was conducted of the service area in the vicinity of the Indian Point Generating Station in order to assess availability of heat loads. The heat load density and the proximity of heat load to the heat source are very important for making a district heating system economically viable.

The survey indicated that there are no process steam customers in the vicinity of the Indian Point Nuclear Station. The potential service area includes two schools, a Veterans Hospital, light industrial manufacturing facilities, departmental stores and food supermarkets. In addition, there is a military camp (reservation) called Camp Smith located approximately three miles to the north of the Indian Point nuclear station.

The potential service area for both nuclear units, that is, Indian Point Unit 2 and Unit 3 is the same. Therefore, all potential customers are common for both the district heating system.

3.1.2 Heat Load Determination

In order to estimate heat load for a district hot water heating system, potential customers were identified by reviewing maps telephone contacts with large institutional customers. Furthermore, the fuel bills for customers with large comfort heating loads were collected and reviewed. These facilities are identified and located on sketch 03777-M-SK-3-2. Gas heating bills from each of these customers are summarized in Table 3-1 which shows monthly and annual gas consumption information. It was assumed the existing gas fired boilers and furnaces at the customers' heating plant operate at 75% efficiency. The peak load was estimated by first calculating the equivalent hourly heat load for the coldest month and then adding a 30% margin, and correcting it for baler efficiency. This peak load was used as a design heat load. The peak heat loads are listed in Table 3-2.

Following potential customers were considered for the hotwater district heating system:

Commercial Facilities

- Caldor
- Big V Supermarket (Peekskill)
- Big V Supermarket (Croton on Hudson)\
- First National Store
- Sears Roebuck
- Simon Equity
- Best Newmark
- Grand Union

Government Installation

- Camp Smith Military Reservation

Schools and Hospitals

- Hendrick Hudson High School
- Hendrick Hudson Elementary School
- VA Hospital

Industries

- General Electric Company
- Mearl Corporation

The district hot water heating system was sized based on the sum of customer peak loads, and some design margin for future customer addition.

3.2 Power Plant Retrofit Analysis

This section describes a district hot water heating system for Indian Point Unit 2, how it would be implemented, and what effect it would have on plant performance. Indian Point Units 2 and 3 are identical. Therefore, only Unit 2 systems are described in this section. If unit 3 is selected, the system modifications for district heating equipment would be very similar.

3.2.1 Description of the Existing Plant Configuration

The Indian Point Nuclear Plant is located in the town of Buchanan, New York. The station is comprised of three generating units. Unit 1 has discontinued operation and Unit 3 is operated by NYPA. Unit 2 which is owned by Con Edison has a net power output of 1,007,838 KWe. Unit 3 is almost identical to Unit 2 in all respect including the plant output KWe.

Indian Point Unit 2 is a nuclear generating station with a pressurized water reactor. Steam to the turbine and available for district heating is provided from the secondary cycle. Heat is rejected to the circulating water in a water cooled condenser. The circulating water discharges to the river through discharge canal which is common with the NYPA Unit 3. Unit 2 went into operation in the year 1973 and has an operating license valid to year 2013.

Unit 2 has a high pressure turbine, a moisture separator reheater, an IP turbine, cross over pipe, and two LP turbine cylinders. The HP turbine has one feedwater heating extraction and the LP turbines have four extractions for feedwater heating. One feedwater heater has steam supplied from the HP exhaust. All extractions are uncontrolled. The LP turbines exhaust to a surface condenser operating at 1.5" HgA. Cooling water taken from the Hudson River is pumped to the condenser at the peak rate of 870,000 gpm. It is returned to the river with a maximum temperature rise of 16.15°F. Make-up water to the cycle is supplied at the condenser.

3.2.2 Potential Plant Modifications for District Heating

In order to provide a hot water at 250°F it will be necessary to provide steam to a condensing district heating water heat exchanger at 35.5 psia. This corresponds to a saturation temperature of 260°F and a heater terminal temperature difference of 10°F. The lowest energy extraction point for Indian Point Unit 2 which meets this criteria is the first LP turbine extraction at 70.03 psia extraction pressure at full load. This extraction is currently sized for 526,699 lb/hr. It is proposed this be increased by 78,899 lb/hr for the district water heater. This equals a flow increase of about 15% which is assumed to be within the operating limits of the nozzle design. This should be verified with Westinghouse during the detailed design.

The piping will be modified to include a connection for the district heating water heat exchanger steam supply with a pressure control station. Also, district heating heater drain piping with a level control station would be required and a baffled condenser connection will need to be added. In addition to the district water heat exchanger other equipment which must be located within the plant include district circulating water pumps, expansion tank, pressurizing water pumps, switchgear and control panel. It is assumed the existing plant water laboratory can monitor district heating water through the use of grab samples.

3.2.3 District Heating Equipment Sizing and Layout

Sketch 03777-M-SK-3-1 provides a typical schematic of the district heating power plant retrofit. With a steam extraction of 78,899 lb/hr and an expected return water temperature of 160°F the system will provide 1763 gpm of 250°F water. The system will be comprised of a shell and tube district water heat exchanger, three 50% capacity district heating water circulating pumps, an expansion tank and two 100% capacity pressurizing pumps.

The district hot water circulating pumps will be specified for 900 GPM at a head of 240 feet for full load operation two pump will be operating and one pump will be standby. The pumps will be single stage horizontal centrifugal design with a ductile iron casing. The pumps shall be driven by 75 HP electric motors. Two 100% capacity pressurizing pumps will be provided to insure adequate NPSH during water volume transients associated with changes in system operating temperature. The operating pump will provide up to 20 gpm of water when there is a need for system make-up. Make-up is required when there a leak in the system or to make up volume during heat load reduction due to mild weather when the water temperature in the hotwater system is decreasing. The pumps will be ductile iron horizontal centrifugal single stage pumps.

Expansion and contraction of system water inventory would be accommodated within the expansion tank. The carbon steel tank is sized at 12 feet in diameter and 20 feet long with dished heads with 1/2 inch thick shell. The district water heat exchanger will transfer heat from the extraction steam to the district circulating water. The heat exchanger will be a horizontal condensing heater of the shell and U-tube type. The shell material will be carbon steel and the tubes would be of 304 SS construction. It will be designed to heat 828,610 lb/hr of district circulating water from 160°F to 250°F at peak load. The heat exchanger will have 3,368 square feet of surface area for heat transfer.

In the event the Indian Point Unit 2 is unavailable for steam extraction two 1,100 horsepower hot water boilers will be provided for back up hotwater supply. The district water will be diverted from the heat exchanger to the hot water boilers for district heating heat source. These will be packaged boilers complete with instruments an controls. Make up water will be supplied by make up water softeners sized for 25 gpm to minimize scale formation. Steam will be supplied to the district water heat exchanger by a 12 inch Schedule 40 carbon steel line with a pressure control station. Heater drains would be returned to the condenser by a 6 inch Schedule 40 carbon steel line with the heater liquid level control station. Other piping within the power plant includes the 12 inch pump suction and discharge headers to the district water heater and the hot water boilers, the 2 inch pressurizing pumps suction and discharge lines and the 3 inch pipe to return water back to the expansion tank.

Plant Layout

The district hot water and pressurizing pumps, heater exchanger, expansion tank and make-up water equipment would be located in the turbine building and heater bay of Indian Point Unit 2. The district hot water pumps, pressurizing pumps, and water softeners would be located in the heater bay ground floor at elevation 15'-10" between column lines 18 and 20. The district hot water heat exchanger would be located on the turbine operating floor between column lines B8 and C4 horizontally along column line 22. This location is selected to have minimum impact on access and laydown area around the turbine while still permitting the use of the turbine crane for the heat exchanger installation and maintenance. The expansion tank would be located on the roof of the heater bay, elevation 66 feet, which will ensure adequate NPSH during operating transients. Due to the outdoor location the tank would be provided with an immersion heater and insulation for freeze protection. These are preliminary equipment locations which will be further evaluated during the detailed design of the project should the project be authorized for further detailed study. Because Unit 3 is identical to Unit 2, the plant retrofit scheme would be the same for both units.

Due to the size of the backup hot water boilers it may be necessary to locate them outside of the turbine building in a separate pre-fabricated building. This building has not been estimated as part of the capital costs because it may be possible during the detail system design to locate these boilers within an existing building at the plant site. This would be addressed during the detailed design phase.

The hot water to the district would be provided at a constant flow during the winter months. This flow would be maintained at the system design flow of 1,763 gpm. The water temperature will be regulated by means of a district water heat exchanger bypass valve. The amount of water bypassed is regulated by the return water temperature from the district. As heat load is reduced hot water supply temperature will be reduced by the plant district heating control system.

Steam to the district heat exchanger would be regulated by maintaining a constant pressure in the heat exchanger. As district heat load decreases the steam flow to the heat exchanger decreases causing less steam to condense. As the rate of steam condensation decreases less steam is required to maintain pressure. The heater drain level control valve will maintain the required level of water in the heater to prevent steam blowthrough.

3.2.4 Effects on Plant Generation and Heat Rate

The implementation of a district heating system would result in plant derating but the plant heat rate would improve due to extraction of heat from the turbine cycle. By increasing the first LP extraction flow to 78,981 lb/hr and supplying auxiliary power to the district heating hot water pumps the net power output will be reduced by approximately 4,325 kW. This represents a 0.43% loss of the plant output. By condensing the district heating steam outside the condenser the heat rejection to the river is reduced by 60.22×10^6 Btu/hr or about 0.87% of the full load Indian Point Unit 2 heat rejection to the river. With the plant circulating water flow of 870,000 gpm the new maximum temperature rise would be 16.15°F which is a reduction of 0.14°F. At part load district heating system operation, the improvements in the heat rate and heat rejection to the river would be reduced proportionately.

3.2.5 System Reliability and Back-Up

As with all public utility services the reliability of the heating water supply should be of paramount importance if customers are expected to convert from their current heating systems to the district heating system. High reliability can be achieved by either providing steam supply from two or more units or providing an independent package boiler plant to service the district heating system.

It is assured that a dedicated package boiler plant firing natural gas or No. 2 fuel oil would be provided to insure high reliability. Also the cost of steam from the package boiler will be high due to the high grade fuel which must be used. However, the operating cost associated with the back-up boiler is considered insignificant due to the short duration of expected use. The high reliability which the package boiler provides will improve the likelihood of attracting industrial customers if they can achieve a savings by not maintaining their current heating systems. For these reasons a back-up boiler is included in the system design. It is estimated that two (2) 1100 HP hotwater boilers would be required as the back up heat supply for the Indian Point Station hotwater district heating system. It should be noted that the addition of this equipment represents a potential environmental impact due to boiler emissions.

3.2.6 Power Plant Retrofit Costs

Table 3-4 provides a summary of the major component and installation costs including the hot water distribution piping based on the system described above. It should be noted these are preliminary estimates based on locating equipment with an existing operating plant. During detailed engineering it is possible that consideration of access, space, final equipment size and the need to install the system with minimum impact on the operating plant could increase the cost.

It should be noted that the bulk of the costs are associated with the district hot water piping material and installation. This is due to the long distance between the power plant and the largest customers. There seems to be little potential to reduce this portion of the capital cost.

The cost of modifying heating systems at the customer location is not included in the capital cost estimate. It is assumed the customer will bear this expanse in order to receive the benefit of lower heating costs from the district heating system.

3.3 District Heating Transmission and Distribution System

3.3.1 General Design Considerations

There is no process steam piping for the Indian Point Station. The hotwater piping for the Indian Point is assumed to be normally buried in the ground and will be run by the side of roads and streets, and along the railroad tracks. The hotwater piping would be I.C. Moller type. The low temperature (maximum 250°F) hotwater piping to be used for comfort heating and domestic hotwater load will be of conduit design. The conduit design is very widely used in Europe for this application. It consists of a thin-wall carbon steel carrier pipe encased in polyurethane insulation and polyethylene casing. It also has a built-in leak detection wire embedded into the polyurethane insulation.

3.3.2 Piping System Design

The comfort district heating piping (hotwater piping) is sized based on the heat load to be supported by that section of pipe. The hotwater supply and return temperatures of 250°F and 160°F respectively are used as a design basis on a peak winter day for the design hotwater flow calculation for the hotwater piping system. The district heating plant control system will be designed to vary the hotwater supply temperature to the district heat customers as a function of the outdoor temperature, while keeping the hotwater flow through the piping constant.

The piping system design is described in detail in Section 2.3.2 for the Bowline district heating hotwater system.

3.3.3 Piping Layout

The hotwater comfort heating piping would be run by the side of major roads and streets and along the railroad tracks in the service area. The main header would run parallel to the railroad from the Indian Point station to the potential customers. The branch lines to the customers were sized based on the customer peak flow requirement. The piping was sized to limit the maximum pressure drop in the piping circuit to 150 psi thus keeping the district heating circulating water pump shut off head within the piping design pressure of 220 psig. The piping layout for the hotwater system is shown on sketches 03777-M-SK-3-2 and 3-3 for Indian Point Unit-2 and Unit-3 respectively. The piping lengths of the various piping sections are listed along with their respective pressures, temperatures, flows, pressure drop, velocities and other piping properties in Table 3-3. The design pressures and temperatures of the hotwater district heating piping are also listed in this table.

3.3.4 Piping Cost Analyses

Piping costs for the transmission and distribution piping were developed by estimating the costs of the following items for the hotwater piping to potential comfort heating customers.

(a) Removal of existing surface and excavation of trench

(b) Removal and repair of existing road pavement at the road crossing for piping installation

(c) Piping material cost including allowance for valves and fittings, and piping installation costs

(d) Cost of sand bed in the trench for laying pipes and cost of concrete anchors

(e) Cost of back filling the trench after installation of piping and the backfill

(f) Cost of top soil and seeding after tempting of backfill

Cost of piping materials are based on budget estimates from the piping vendors whereas labor costs for excavation, backfilling welding, joint forming, topsoil and seeding, etc are based on Stone & Webster inhouse data. These piping cost estimates are presented in Table 3-5.

3.4 System Capital and Operating Costs and Revenues

3.4.1 System Capital Costs

Table 3-4 provides the capital costs for Indian Point power plant retrofit and hot water piping system. This total was increased by 15% for engineering and 25% for contingency for a total capital cost in 1993 dollars of $9,509,534. These costs are based on manufacturer's budgeting pricing for pumps, heat exchanger and pre-insulated piping and SWEC inhouse data for the remaining piping and components. The estimate assumes the district heating customers bear the cost of equipment within their facilities and does not consider any additional incentives or marketing costs by the utility to induce heating customers to sign up.

3.4.2 Annual Operating Costs

Costs and revenue associated with the operation of the district heating system should be determined on an annual basis. This requires the use of an appropriate discount rate and inflation rate. The annual costs would include replacement power cost, which includes both lost generation and pumping power and O&M costs. The annual O&M costs are normally estimated as equal to 3% of the capital cost for the power plant equipment and 0.5% of the capital costs for hot water piping. These costs are to be estimated by the utility.

The annual replacement power is estimated to be 16,110 MWhrs for the Indian Point district heating system.

3.4.3 System Revenue

System revenue is based on supplying customers with the same quantity of useful heat as in the year 1991 at 90% of the cost paid for in year 1991 by the customers. The large gas users, Veterans Administration Hospital and Camp Smith had relatively the lower rates due to their ability to negotiate large contracts. The annual revenue in 1993 dollars based on participation of all identified customers is estimated at $1,026,020.

INDIAN POINT 2
DISTRICT HOT WATER HEATING SYSTEM
SWEC JOB 03777

TABLE 3-1

SUMMARY OF EXISTING FUEL CONSUMPTION OF POTENTIAL CUSTOMERS
(IN MCF NAT GAS EQUIV.)

FACILITY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEARLY
VA HOSPITAL	272906	303114	284030	256575	206082	109698	58859	57608	58292	71811	168649	255802	2103426
MEARL CORP	10052	12066	8589	8041	3066	334	31	51	34	958	4110	8370	55702
BIG V	6078	6793	5020	3506	423	73	41	41	34	248	2292	4804	29353
GRAND UNION	4046	4432	3050	2458	1190	176	168	145	142	869	1891	3322	21888
CAMP SMITH	23597	26816	19151	15505	5102	2040	1865	1104	9725	8076	9823	19202	142006
HENDRICK HS	101	131	96	146	464	457	518	354	329	551	180	178	3505
HENDRICK ES	529	470	428	301	62	12	1	1	1	73	154	324	2356
COMFORT HEATING	317309	353822	320384	286532	216389	112789	61483	59304	68557	82586	187099	292002	2358236

TABLE 3-2
PEAK HEAT LOAD SUMMARY
INDIAN POINT UNIT 2

FACILITY	MONTHLY PEAK	BTU EQUIV	DAYS IN MONTH	PEAK 10^6BTU/HR	FUR EFF	BTU/HR PER GPM	PEAK GPM
VA HOSPITAL	303114	3.03E+10	31	52.963467742	0.75	42283	939.4
MEARL CORP	12066	1.21E+09	31	2.1083064516	0.75	42283	37.4
BIG V	6793	6.8E+08	31	1.1869489247	0.75	42283	21.1
GRAND UNION	4432	4.4E+08	31	0.7744086022	0.75	42283	13.7
CAMP SMITH	24140	2.41E+10	31	42.180107527	0.75	42283	748.2
HENDRICKS HS	551	55100000	31	0.0962768817	0.75	42283	1.7
HENDRICKS ES	529	52900000	31	0.0924327957	0.75	42283	1.6
						TOTAL	1763

PEAK HEAT LOAD = 74551461 BTU/HR

REQUIRED STEAM FLOW = 78898.78 LB/HR

NOTES
CALCUATION OF PEAK HOT WATER REQUIREMENTS TO EACH FACILITY BASE ON 250 F SUPPLY AND 160 F RETURN USING AVERAGE OF PEAK MONTH HEAT LOAD WITH 30% MARGIN FOR FOR HOURLY RATE OF 1 GPM AT 250 F TRANSFERS 42283 BTU/HR OF HEAT
CE EFFICIENCY = 75%

STONE & WEBSTER ENGINEERING CORP.
CONSOLIDATED EDISON
SWEC JOB NO. 03777

INDIAN POINT UNIT 2
DOCUMENT NO. 03777-LL- 0 REVISION NO.0
SYSTEM: DISTRICT HOT WATER HEATING PIPE SIZING
(DHW)

TABLE 3-3

DATE:JAN 25, 1992

02/04/93

LINE DESIGNATION SYS	SIZE	PIPE CAT.	NO.	INSUL CLASS	FLOWING MEDIUM	DESCRIPTION	PIPE DESIGN PRESS. PSIG	PIPE DESIGN TEMP. F	DESIGN FLOW CONDITIONS PRESS. PSIG	TEMP. F	FLOW G=GPM C=CFM W=#/HR	PRESSURE DROP PSI/100FT	VELOCITY FT/SEC	SEC .ENGTH	PRESS DROP IN SECTION	FLUID DENSITY #/CU.FT	FLUID VISCOCITY CENTIPOIS	REYNOLDS NO.	FRICTION FACTOR f	PIPE ID INCHES	PIPE SCHED
DHW-	12 -		- 1 -		WATER	PUMP DISCHARGE SEC 1S	230	275	90	250	1763 G	0.22	4.995	5000	10.77	58.799	0.228	1.92E+06	0.0136	12.000	40
DHW-	10 -		- 2 -		WATER	SEC 2S	230	275	79	250	942 G	0.16	3.829	3500	5.57	58.799	0.228	1.23E+06	0.0143	10.020	40
DHW-	10 -		- 3 -		WATER	SEC 3S	230	275	74	250	939 G	0.16	3.816	9000	14.23	58.799	0.228	1.22E+06	0.0143	10.020	40
DHW-	10 -		- 4 -		WATER	SEC 4S	230	275	79	250	820 G	0.12	3.334	4000	4.86	58.799	0.228	1.07E+06	0.0144	10.020	40
DHW-	10 -		- 5 -		WATER	SEC 5S	230	275	74	250	783 G	0.11	3.182	6500	7.22	58.799	0.228	1.02E+06	0.0144	10.020	40
DHW-	10 -		- 6 -		WATER	SEC 6S	230	275	67	250	748 G	0.10	3.040	8000	8.14	58.799	0.228	9.73E+05	0.0145	10.020	40
DHW-	10 -		- 9 -		WATER	SEC 6R	230	275	39	106	748 G	0.12	3.040	8000	9.33	61.929	0.640	3.65E+05	0.0150	10.020	40
DHW-	10 -		- 10 -		WATER	SEC 5R	230	275	29	106	783 G	0.13	3.182	6500	8.26	61.929	0.640	3.82E+05	0.0157	10.020	40
DHW-	10 -		- 11 -		WATER	SEC 4R	230	275	21	106	820 G	0.14	3.334	4000	5.55	61.929	0.640	4.01E+05	0.0156	10.020	40
DHW-	10 -		- 12 -		WATER	SEC 3R	230	275	40	106	939 G	0.18	3.816	9000	16.14	61.929	0.640	4.58E+05	0.0154	10.020	40
DHW-	10 -		- 13 -		WATER	SEC 2R	230	275	24	106	942 G	0.18	3.829	3500	6.32	61.929	0.640	4.60E+05	0.0154	10.020	40
DHW-	12 -		- 14 -		WATER	SEC 1R PUMP SUCTION	230	275	17	106	1763 G	0.24	4.995	5000	12.07	61.929	0.640	7.19E+05	0.0145	12.000	40
DHW-	2 -		- 15 -		WATER	HENDRICKS SCHOOLS SUP (SEC 7)	230	275	69	250	3 G	0.01	0.326	2500	0.29	58.799	0.228	2.02E+04	0.0278	1.939	80
DHW-	2 -		- 16 -		WATER	HENDRICKS SCHOOLS RET (SEC 7)	230	275	14	106	3 G	0.02	0.326	2500	0.38	61.929	0.640	1.57E+03	0.0344	1.939	80
DHW-	3 -		- 17 -		WATER	MEARL SUP (SEC 8)	230	275	64	250	59 G	0.31	2.557	500	1.53	58.799	0.228	2.51E+05	0.0189	3.068	40
DHW-	3 -		- 18 -		WATER	MEARL RET (SEC 8)	230	275	11	106	59 G	0.36	2.557	500	1.78	61.929	0.640	9.41E+04	0.0209	3.068	40
DHW-	3 -		- 19 -		WATER	BIG V /GRAND UNION SUP (SEC 9)	230	275	57	250	18 G	0.03	0.780	4000	1.30	58.799	0.228	7.65E+04	0.0215	3.068	40
DHW-	3 -		- 20 -		WATER	BIG V /GRAND UNION RET (SEC 9)	230	275	19	106	18 G	0.04	0.780	4000	1.61	61.929	0.640	2.87E+04	0.0253	3.068	40

CONSOLIDATED EDISON OF NEW YORK
DISTRICT HOT WATER HEATING SYSTEM
SWEC JOB 03777

TABLE 3–4

COST ESTIMATE FOR POWER PLANT MODIFICATIONS
INDIAN POINT UNIT 2

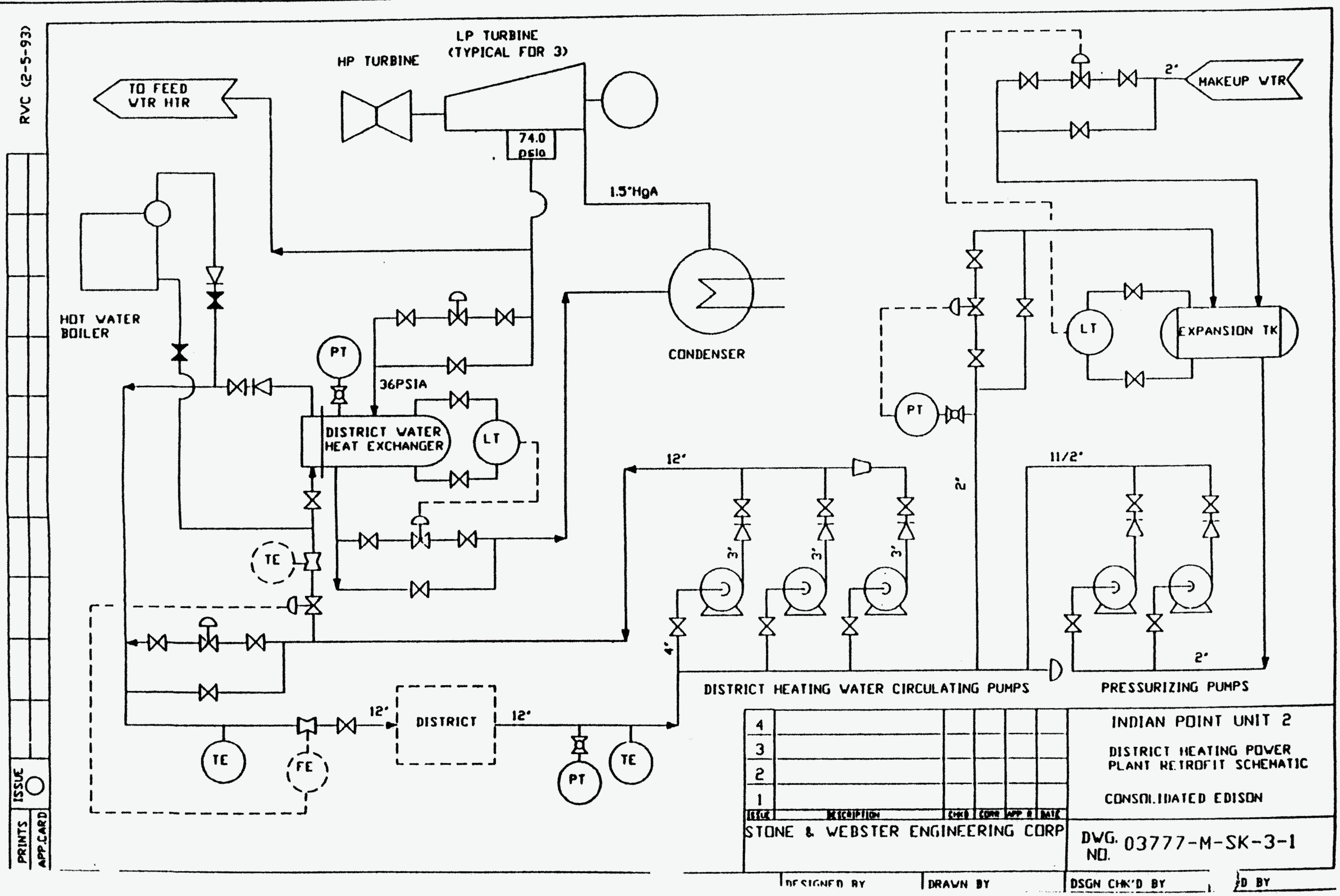
COMPONENT	COST
DISTRICT HEATING(DH) HEAT EXCHANGER	$75,000
D. H. EXPANSION TANK	$83,000
PRESSURIZING PUMPS	$5,000
D.H. CIRCULATING WATER PUMPS	$26,000
MAKE-UP WATER SOFTNER	$20,000
PIPING VALVES & INSULATION	$182,000
PIPING & EQUIPMENT INSTALLATION	$217,000
INSTRUMENTATION & CONTROLS	$120,000
ELECTRICAL INSTALLATION	$125,000
BACK UP BOILERS	$350,000
DISTRICT WATER PIPING (SHOWN ON TABLE 9)	$5,589,524
SUBTOTAL	$6,792,524
CONTINGENCY 25%	$1,698,131
ENGINEERING 15%	$1,018,879
TOTAL	$9,509,534

IP2EST.WK1

TABLE 3-5 DISTRICT HOT WATER HEATING PIPING COST EST...

CLIENT - CON EDISON	ESTIMATE NO.	J.O. NO. - 03777.00	SHT 1 OF 1
DESCRIPTION OF WORK - District Heating Hot Water Piping From INDIAN POINT STATION	QTY BY - SWEC	CHECKED BY - SWEC	PRICES BY
	DATE -	APPROVED	

ACCOUNT NO.	DESCRIPTION	QUANTITIES	UNIT COST UNITS	MAT'L	MH'S	RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
2000	Excavation (note 1)	74446	cy	3.00	0.08	56.00	$223,338	$333,518	$556,856	5956
2100	Backfill (note 1)	55835	cy	1.50	0.05	56.00	$83,752	$156,337	$240,088	2792
2200	Remove existing road (note 1)	500	sy	1.50	0.05	56.00	$750	$1,400	$2,150	25
2300	Repair of Existing Road	500	sy	5.00	0.10	56.00	$2,500	$2,800	$5,300	50
2400	Topsoil and seeding	47778	sy	0.15	0.04	56.00	$7,167	$107,022	$114,189	1911
2500	Sand bed	3981	cy	3.50	0.16	56.00	$13,935	$35,674	$49,609	637
2600	Concrete Anchors	25	cy	150.00	5.00	56.00	$3,750	$7,000	$10,750	125
2700	Piping - 12"	10000	ft	59.34	0.18	56.00	$593,355	$100,800	$694,155	1800
2700	Piping - 10"	62000	ft	47.80	0.18	56.00	$2,963,352	$624,960	$3,588,312	11160
2700	Piping - 8"	0	ft	34.71	0.18	56.00	$0	$0	$0	0
2700	Piping - 6"	0	ft	24.93	0.18	56.00	$0	$0	$0	0
2700	Piping - 4"	0	ft	18.62	0.18	56.00	$0	$0	$0	0
2700	Piping - 3"	9000	ft	14.55	0.18	56.00	$130,977	$90,720	$221,697	1620
2700	Piping - 2"	5000	ft	11.20	0.18	56.00	$56,018	$50,400	$106,418	900
	Sub-total Cost						$4,078,893	$1,510,631	$5,589,524	
	Contingency (25%)						$1,019,723	$377,658	$1,397,381	
	TOTAL COST						$5,098,616	$1,888,289	$6,986,905	
Note:	1. The material costs include equipment rental and operating costs.									


RVC (2-5-93)
TO FEED WTR HTR
HP TURBINE
LP TURBINE (TYPICAL FOR 3)
74.0 psia
1.5"HgA
MAKEUP WTR
2"
HOT WATER BOILER
PT
36PSIA
DISTRICT WATER HEAT EXCHANGER
LT
CONDENSER
LT
EXPANSION TK
PT
12"
11/2"
2"
3"
3"
3"
TE
TE
FE
DISTRICT
12"
12"
PT
TE
4"
2"
DISTRICT HEATING WATER CIRCULATING PUMPS
PRESSURIZING PUMPS
4
3
2
1
ISSUE
DESCRIPTION
CHK'D
CORD
APP'R
DATE
INDIAN POINT UNIT 2
DISTRICT HEATING POWER PLANT RETROFIT SCHEMATIC
CONSOLIDATED EDISON
STONE & WEBSTER ENGINEERING CORP
DWG. NO. 03777-M-SK-3-1
DESIGNED BY
DRAWN BY
DSGN CHK'D BY
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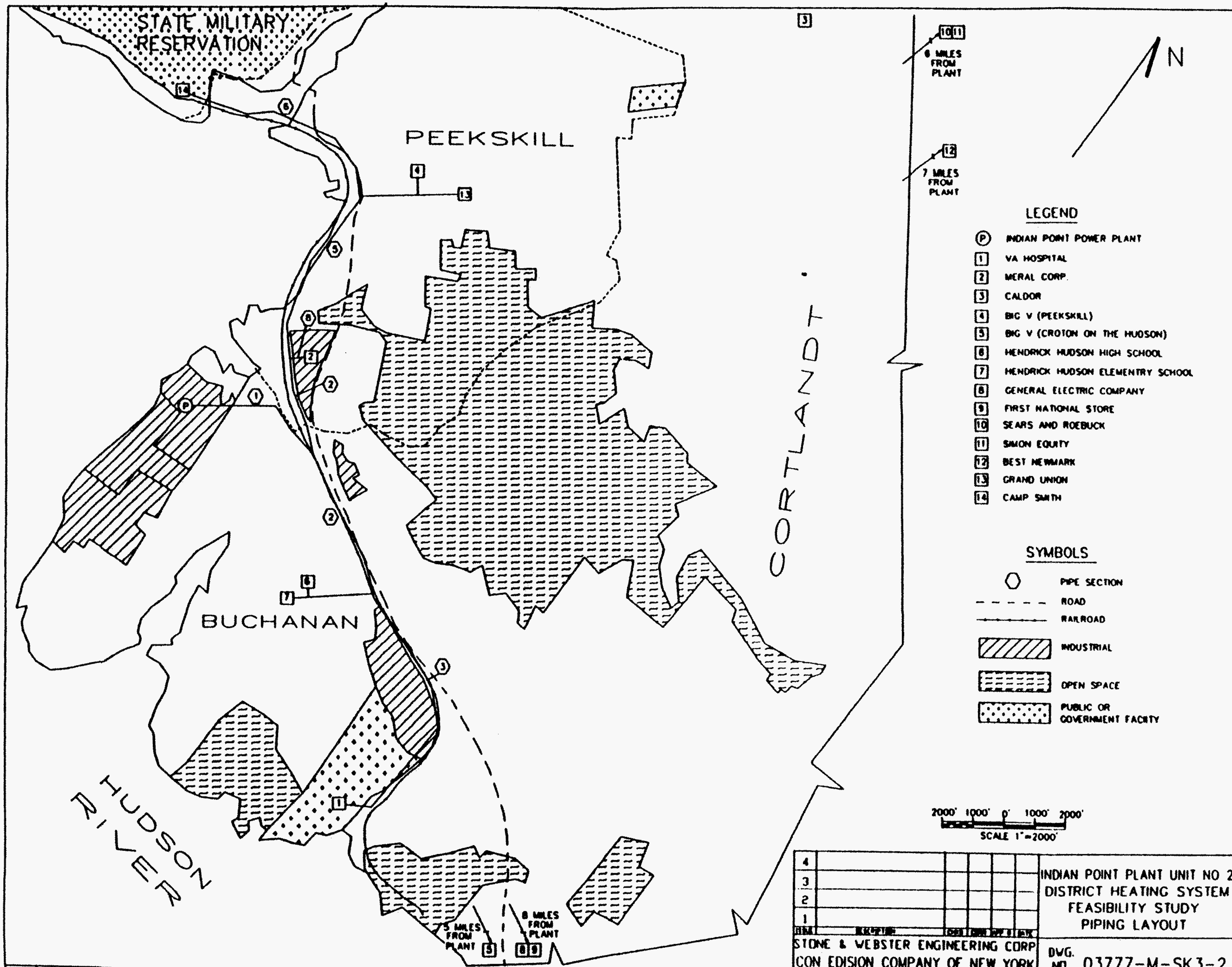
ISSUE
PRINTS
APP.CARD



4					
3					
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1					

INDIAN POINT PLANT UNIT NO 2
DISTRICT HEATING SYSTEM
FEASIBILITY STUDY
PIPING LAYOUT

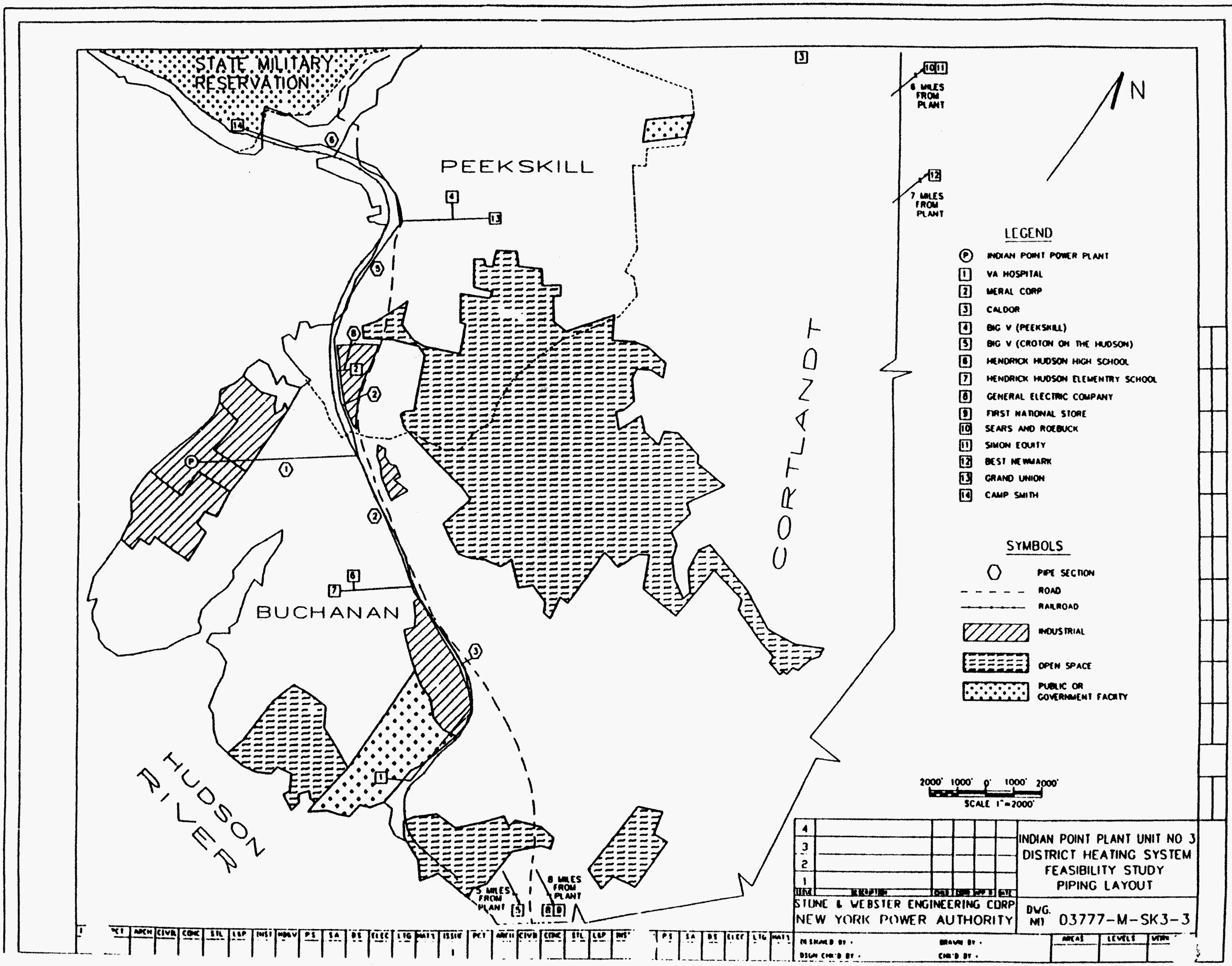
STONE & WEBSTER ENGINEERING CORP
CON EDISION COMPANY OF NEW YORK

DWG. NO. 03777-M-SK3-2

DESIGNED BY : DRAWN BY :
DSGN CHK'D BY : CHK'D BY :

AREAS	LEVELS	WORK PKG

ISSUE	PCT.	ARCH	CIVIL	CONC	STL	L&P	INST	HG&V	P.S.	SA	DS	ELEC	LTG	MAT'L	ISSUE	PCT	ARCH	CIVIL	CONC	STL	L&P	INST	HG&V	PS	SA	DS	ELEC	LTG	MAT'L


STATE MILITARY RESERVATION
PEEKSKILL
BUCHANAN
CORTLANDT
HUDSON RIVER
N
6 MILES FROM PLANT
7 MILES FROM PLANT
5 MILES FROM PLANT
8 MILES FROM PLANT
LEGEND
P INDIAN POINT POWER PLANT
1 VA HOSPITAL
2 MERAL CORP
3 CALDOR
4 BIG V (PEEKSKILL)
5 BIG V (CROTON ON THE HUDSON)
6 HENDRICK HUDSON HIGH SCHOOL
7 HENDRICK HUDSON ELEMENTRY SCHOOL
8 GENERAL ELECTRIC COMPANY
9 FIRST NATIONAL STORE
10 SEARS AND ROEBUCK
11 SIMON EQUITY
12 BEST NEWMARK
13 GRAND UNION
14 CAMP SMITH
SYMBOLS
PIPE SECTION
ROAD
RAILROAD
INDUSTRIAL
OPEN SPACE
PUBLIC OR GOVERNMENT FACILITY
2000' 1000' 0' 1000' 2000'
SCALE 1"=2000'
INDIAN POINT PLANT UNIT NO 3
DISTRICT HEATING SYSTEM
FEASIBILITY STUDY
PIPING LAYOUT
STONE & WEBSTER ENGINEERING CORP
NEW YORK POWER AUTHORITY
DWG. NO 03777-M-SK3-3

SECTION 4

SECTION 4

ROSETON ELECTRIC GENERATING STATION DISTRICT HEATING SYSTEM

4.1 Heat Load Assessment

4.1.1 Analyses of the Surrounding Potential Service Area

A survey was conducted of the service area in the vicinity of the Roseton Generating Station in order to assess availability of heat loads. The survey indicated that there are three potential process steam customers approximately seven miles southwest of Roseton Generating Station. They are Windsor Textiles, Fry Copy Systems, and Arma Textiles which are identified as potential customer numbers 10, 11, and 12 on study drawing number 03777-M-SK-4-2. Stone & Webster had received the annual fuel consumption data for these customers. It was assumed that 80% of annual fuel consumption was expended for generation of process steam and the remaining 20% was used to support the comfort heating load. The combined process steam load for all three potential customers is calculated at 47, 463 lb/hr.

In addition to the three potential customers discussed above, eleven other potential district heating customers are identified within a seven mile radius of the Roseton Plant for comfort heating load. The first potential district heating customer is Middlehope Elementary School which is located approximately one mile south of the Roseton Plant. There are a total of seven schools, two colleges, one hospital (Saint Lukes Hospital), two textile factories, and two industrial establishments in the potential service area in the vicinity of the Roseton Generating Station.

4.1.2 Heat Load Determination

Heat load density and proximity of the heat load to the heat source (Roseton Generating Station) are very important for making a district heating system economically viable. The first step in establishing a heat load was to identify potential customers for both process and comfort heating in the service area within close proximity of the Roseton Plant. As mentioned in the paragraph above, a total of fourteen potential district heating customers, were identified within a seven mile radius of the Roseton Station. Following potential customers were considered for the Roseton Generating Station process steam export and hotwater district heating system.

Schools and Hospital

- Middlehope Elementary School
- Montgomery Street School
- Gidney Avenue School
- Mount Saint Mary College
- North Junior High School
- Newburgh Free Academy
- Washington Street School
- West Street School
- South Junior High School
- Saint Lukes Hospital

Industries

- Windsor Textiles
- Fry Copy Systems
- Arma Textiles
- American Whipped Products

These customers are identified and located on sketch 03777-M-SK-4-2. Gas heating bills from each of these customers are summarized in Table 4-1 which shows annual gas consumption information. It was assumed the existing gas fired boilers and furnaces at the customers' heating plants operate at 75% efficiency. The peak load was estimated by first calculating the equivalent hourly heat load for the coldest month and then adding a 30% margin, and correcting it for boiler efficiency. This peak load was used as a design heat load. Peak heat loads are also listed in Table 4-1.

The steam export to the three potential process steam customers was considered independently. The district hotwater heating system was sized based on the sum of customer peak loads, plus some design margin for future customer addition.

4.1.3 Steam Sendout to Potential Process Steam Customers

This analysis was prepared to determine the feasibility of transporting steam from the Roseton Generating Station to the potential process steam customers to reduce the thermal discharge to the Hudson River while satisfying the customers' process steam requirements.

<u>Design Parameters and Assumptions</u>

- Steam will be provided at an approximate pressure of 150 psia at the customer's plant or facility.
- Distance of the potential customers to the Roseton Station is approximately seven miles, and the piping trench length is estimated at 36,500 feet. The piping would run along the major roads and streets as shown on M-SK-4-2.
- The steam and condensate piping will be run side by side in the same trench.
- Assumed 100% condensate return from the customers to Roseton Station.
- Roseton Generating Station has two identical units, that is, Unit 1 and Unit 2 with a maximum capacity of 600 MWe each. Either Unit 1 or Unit 2 could supply the process steam load.

Description of Potential System Design

The potential source considered for process steam for this application was extraction point B on the turbine heat balance No. R12-IB.3b. The extraction steam conditions at the extraction point B are 283 psia and 850°F. No other extractions from the intermediate or low pressure turbines could provide the flow and pressure required. Since the operating conditions of the (283 psia and 850°F) are the closest to the required conditions its use was evaluated.

Using a 10 inch process steam transport line, run along the main road and streets, the pressure drop per mile is calculated at approximately 20.8 psi (see Table 4-2). The total line drop would be 140 psi, which would result in 143 psia available at the customers' facilities. This flow and pressure would permit the use of some of the extraction steam currently used for the Number 6 H.P. heater. This will reduce generator output by 5813 KWe which will account for 0.97% of plant output. Thermal load on the condenser will be reduced by 38.54 MMBTU/hr or about 1.0%. This will reduce circulating water discharge temperature to the river by 0.15°F from the Roseton Station.

A 4 inch return line would be required to carry up to 110 gpm of condensate back to the Roseton plant. The total pressure drop would be approximately 150 psi. Based on a condensate return temperature of over 180°F, the condensate could return to the cycle through the low pressure heater drains.

Both the steam and condensate lines would be run with pre-insulated pipe installed below ground in a common trench. The capital cost includes the cost of trenches and manholes. The cost of furnishing and installing steam and condensate pipe to the process steam customers is estimated at $12,750,825.

Summary - Process Steam Load

Providing steam to process steam customers will reduce thermal discharge to the Hudson River by 0.15°F from the Roseton Station. Although it is feasible to provide steam to the process steam customers it will reduce the Roseton Plant electric power generation by 5.81 MWe at design steam export flow of 47,463 lb/hr.

4.2 Power Plant Retrofit Analysis

This section describes the plant modification required at the Roseton Generating station to support the design of a district heating system, and evaluates the effect it would have on plant performance. It discusses the feasibility of locating various district heating system equipment in the Unit 1 turbine building.

4.2.1 Description of the Existing Plant Configuration

The Roseton Generating Station is located one mile north of the town of Newburgh, New York. The station is comprised of two generating units installed during the early seventies. The nominal capacities of the units at the Roseton Station are 600 MW each. These units are both tandem compound turbines with steam reheat and several stages of extraction steam for feedwater heating. This permits flexibility in selecting the optimum steam pressure to match district heating needs. Exhaust steam is condensed in a water cooled condenser. At full load this results in the discharge to the river of 2,598 x 10^6 Btu/hr from each of the two units.

It was determined that Unit 1 was the best candidate for modification to supply district heating steam due to the available space in the turbine building of Unit 1 for accommodating the district heating equipment.

Roseton Unit 1 has a high pressure turbine, a steam reheater, an IP turbine, cross over pipe and LP turbine. The IP turbine has two feedwater heating extraction and the LP turbine has four extractions for feedwater heating. All extractions are uncontrolled. The LP turbine exhausts to a surface condenser operating at 1.5" HgA. Cooling water taken from the Hudson River is pumped to the condensers at the rate of 641,000 GPM in summer (four pump operation) and 418,000 GPM (two pump operation) in winter. It is returned to the river with a maximum temperature rise of 16.21°F in summer and 24.86°F in winter. Make-up water is supplied to the system in the condenser.

4.2.2 Potential Plant Modifications for District Heating

In order to supply a hot water system with 250°F water it will be necessary to provide steam to a condensing district heating water heat exchanger at 35.5 psia. This provides a saturation temperature of 260°F and a heater terminal temperature difference of 10°F. The lowest energy extraction point for Roseton Unit 1 which meets this criteria is extraction D at 60.05 psia at full load operation. This extraction is currently sized for 89, 884 lb/hr and it is proposed this be used for the district water heater. The remaining extraction steam from the extraction D could be used for feedwater heating in FW heater No. 4.

The piping will be modified to include a connection for the district heating water heat exchanger steam supply with a pressure control station. Also heater drain piping with a level control station and a baffled condenser connection will need to be added. In addition to the district water heat exchanger other equipment which must be located within the plant include district hot water pumps, expansion tank, water softening equipment, pressurizing water pumps, switchgear and control panel. It is assumed the existing plant water laboratory can monitor district heating water through the use of grab samples.

4.2.3 District Heating Equipment Sizing and Layout

Sketch 03777-M-SK-4-1 provides a schematic of the district heating power plant retrofit. With a steam extraction of 30,959 lb/hr and an expected return water temperature of 160°F the system will provide the required 776 gpm of hot water at 250°F to satisfy the district comfort heating demand. The system will be comprised of a shell and tube district water heat exchanger, three 50% capacity district heating water circulating pumps, an expansion tank and two 100% capacity pressurizing pumps.

The district hot water circulating water pumps would be specified at 400 gpm at a head of 300 feet. For full load operation two pumps will be operating and one pump will be on standby. The pumps will be of single stage horizontal centrifugal design with a ductile iron casing. The pumps will be driven by 50 HP electric motors. Two 100% capacity pressurizing pumps will be provided. The operating pressurizing pump will provide up to 20 gpm of water when there is a need for system make-up. Make-up is required when there a leak in the system or to make up volume during heat load reduction when average water temperature is decreasing. The pumps will be ductile iron horizontal centrifugal single stage pumps.

Expansion and contraction of system liquid volume will be accommodated within the expansion tank. The carbon steel tank will be 10 feet in diameter and 16 feet long with dished heads with 1/2 inch thick shell. The district water heat exchanger will transfer heat from the extraction steam to the district circulating water. The heat exchanger will be a horizontal condensing heater of the shell and U-tube type. The shell will be carbon steel and the tubes will be made of 304 SS. It will be designed to heat 364,720 lb/hr of district circulating water from 160°F to 250°F. The heat exchanger will provide 1960 square feet of surface for heat transfer.

In the event the Roseton Station Unit 1 is unavailable for steam extraction a package hot water boiler will be provided for back up. The same is true if Unit 2 were selected for district heating. The district water will be diverted from the heat exchanger to the hot water boiler for heating. The packaged boiler will be complete with instruments and controls. Water chemistry will be maintained by make up water softeners sized for 25 gpm to minimize scale formation. Steam will be supplied to the district water heat exchanger by a 12" Schedule 40 carbon steel line with a pressure control station. Heater drains would be returned to the condenser by a 4" Schedule 40 carbon steel line with the heater liquid level control station. Other piping within the power plant includes the 10" pump suction header, the 10" pump discharge header to the district water heater and the hot water boilers, the 2" pressurizing pumps suction and discharge lines and the 2" pipe to recycle water back to the expansion tank.

Plant Layout

The pumping and heating equipment would be located in the Roseton Unit 1 turbine building. District hot water circulating water pumps, water softener and pressurizing pumps would be located in the basement floor at elevation 5 ft, between column lines 2 and 3 & Ar and B. The district water heat exchanger would be located on the turbine mezzanine floor between column lines 2 and 3 & Ar and B directly above the district heating equipment on the basement floor. Two hotwater boilers with a capacity of 600 BHP each would be required for backup heat supply. Due to the size of the hot water boilers it will be necessary to locate the boilers in a separate new building. The district water expansion tank could be located on the roof of the turbine building. It would need to be insulated and freeze protected with an immersion heater.

The above layout reflects a preliminary evaluation which must be confirmed during the detailed engineering and design feasibility study.

Water to the district would be provided at a constant flow during the winter months. This flow would be maintained at the system design of 776 gpm. The water temperature will be regulated by means of a district water heat exchanger bypass valve. The amount of water bypassed is regulated by the return water temperature from the district. As heat load is reduced hot water supply temperature will be reduced by the plant district heating control system.

Steam to the district heat exchanger would be regulated by maintaining a constant pressure in the heat exchanger. As district heat load decreases the steam flow through the heat exchanger decreases causing less steam to condense. As the rate of steam condensation decreases less steam is required to maintain pressure. The heater drain level control valve will maintain the required level of water in the heater to prevent steam blowthrough.

4.2.4 Effects on Plant Generation and Heat Rate

The implementation of a district heating system would result in Roseton Unit 1 derating but the Unit heat rate would improve due to extraction of heat from the turbine cycle. The net power output will be reduced by approximately 2449 kWe. This represents a 0.41% loss of the plant output. By condensing this steam outside the condenser heat rejection to the river is reduced by 32.84×10^6 Btu/hr or about 0.95% of the full load heat rejection to the river. With the circulating water flow of 418,000 GPM the new maximum temperature rise would be 24.7°F. This is a reduction of 0.12°F. At part load district heating system operation heat rejection to the river would be reduced proportionately.

4.2.5 System Reliability and Back-Up

As with all public utility services the reliability of the heating water supply should be of paramount importance if customers are expected to convert from their current heating systems to the district heating system. High reliability can be achieved by either providing steam supply from two or more units or providing an independent package boiler to service the district heating system. The most secure approach to insure high reliability would be to provide a dedicated package boilers firing natural gas, No. 2 or No. 6 fuel oil. Two package boilers with 600 BHP capacity (each boiler) would be required. The cost of steam from the package boiler will be high due to the high grade fuel which must be used. The operating cost associated with the back-up boiler is considered insignificant due to the short duration of expected use. The higher reliability which the package boiler provides will improve the likelihood of attracting industrial customers if they can achieve a savings by not maintaining their current heating systems. For these reasons a back-up boiler is included in the system design. It is estimated that two (2) 600 HP hotwater boilers would be required as the back up heat supply for the Roseton hotwater district heating system. It should be noted that the addition of this equipment represents a potential environmental impact due to boiler emissions.

4.2.6 Power Plant Retrofit Costs

Table 4-4 provides a summary of the major component and installation costs including the hot water distribution piping based on the system described above. It should be noted these are preliminary estimates based on locating equipment with an existing operating plant. During detailed engineering it is possible that consideration of access, space, final equipment size and the need to install the system with minimum impact on the operating plant could increase the cost.

It should be noted that the bulk of the costs are associated with the district water piping material and installation. This is due to the long distance between the power plant and the potential customers. There seems to be little potential to reduce this portion of the capital cost.

The cost of modifying heating systems at the customer location is not included in the capital cost estimate. It is assumed the customer will bear this expanse in order to receive the benefit of lower heating costs from the district heating system.

4.3 District Heating Transmission and Distribution System

4.3.1 General Design Considerations

This section addresses three different piping systems available for the steam and hot water transmission and distribution system. The steam and hotwater piping is assumed to be normally buried in the ground and will be run by the side of roads and streets, and along the railroad tracks. The piping system for steam and condensate return lines will be Perma-

Pipe or Ricwil type and the hotwater piping would be I.C. Moller type. The high temperature steam lines (500°F) will need thermal expansion loops at a certain interval and manholes for steam trap maintenance. An additional 15 percent cost has been added to both procurement and installation costs to allow for the cost of expansion loops. In addition, ten manholes are assumed per mile for the steam piping for steam trap maintenance at a cost of $2000 per manhole.

The low temperature (maximum 250°F) hot-water piping to be used for comfort heating and domestic hotwater load will be of conduit design. The conduit design is very widely used in Europe for this application. It consists of a thin-wall carbon steel carrier pipe encased in polyurethane insulation and polyethylene casing. It also has a built-in leak detection wire embedded into the polyurethane insulation.

4.3.2 Piping System Design

The steam line to process steam customers was sized for a pressure drop of 20.8 psi per mile of pipe to achieve the required process steam conditions at the customers' facilities. The condensate from the plant will need to be pumped back to the Roseton Station to minimize station make-up water requirements.

The comfort district heating piping (hotwater piping) is sized based on the heat load to be supported by that section of pipe. The hotwater supply and return temperatures of 250°F and 160°F respectively are used as a design basis on a peak winter day for the design hotwater flow calculation for the hotwater piping system. The district heating plant control system will be designed to vary the hotwater supply temperature to the district heat customers as a function of the outdoor temperature, while keeping the hotwater flow through the piping constant.

The shop fabricated conduit piping for the hotwater service is less expensive to install because it will be shipped in 40 feet length with the polyurethane foam and polyethylene casing all in one piece. During the manufacture of the conduit the polyurethane foam is poured in the space between the steel pipe and the casing in a liquid form, thus forming and expanding in the space and bonding itself to the steel pipe and casing walls. This type of construction will provide structurally stable insulation that will not shift or shrink. No clamps are required to fasten the insulation in place as in the conventional piping system. The supply and return lines will be installed side by side in the same trench.

The I.C. Moller type of hotwater piping system can be installed without any expansion loops. It uses E-Muffs (E-System Installation Technique). The E-Muff is a corrugated sleeve type component that operates only once when it is fixed to absorb movement corresponding to a certain pipe length at the mean temperature (usually 160°F.) The first time the hotwater is sent through the piping system, the piping will expand and the E-muff will be compressed. The E-muff is fixed by welding at this time, and the piping system is virtually stress-free at this point. (The system is full of hotwater at a mean temperature of 160°F which is approximately midway between the two extreme condition of 70°F and 250°F corresponding to cold or hot piping conditions). The piping system is thus locked at this mean temperature, and future temperature variations will be converted into allowable material stresses in the steel pipes. Thus the use of E-muffs eliminates the need for the conventional thermal expansion loops required with the other systems.

The I.C. Moller piping system offers the following advantages compared with the conventional systems:

(a) Pipe anchors are not required in the main run of supply and return headers since the thermal expansion loops are eliminated. (Pipe anchors may be required at the building entrances).

(b) Branch connections could be installed later without the need for inserting tee fittings in the main run of pipe.

(c) The outer polyethylene jacket is fusion welded for strength and air tightness thus ground water cannot penetrate the joint. This is of special importance where the piping system crosses a water stream.

(d) Piping installation costs are substantially reduced due to elimination of thermal expansion loops and the associated pipe anchors.

(e) The I.C. Moller thin walled pipe can be procured as curved pipe to match the contour of gentle curves in the system, thus eliminating the need for additional pipe fittings.

The drawback of the I.C. Moller piping is that it can not be used at a service temperature higher than 250°F because above this temperature the polyurethane foam starts melting. Therefore, for higher temperature steam or hotwater lines, Perma-Pipe or Ricwil type systems will need to be used.

4.3.3 Piping Layout

For the steam sendout and condensate return pipe to process steam customers, it was assumed that these lines will be run in a trench next to the main road and streets leading from the Roseton Station to the customers. Obtaining the right of way for running these lines would require a detailed investigation of the existing right of way ownership of the utilities, municipalities and private property owners of the adjoining properties. The crossing of water streams and wetlands disturbance, etc. could pose additional problems. This investigation is outside the scope of this study.

The hotwater comfort heating piping would be run by the side of major roads and streets in the service area. The 10 inch main header would run parallel to major road and streets from the Roseton Station to the potential customers. The branch lines to the customers were sized based on the customer peak flow requirement. The piping was sized to limit the maximum pressure drop in the piping circuit to 150 psi thus keeping the district heating circulating water pump shut off head within the piping design pressure of 220 psig. The piping layout for the hotwater system is shown on Sketch 03777-M-SK-4-2 for the Roseton system. The piping lengths of the various piping sections are listed along with their respective pressures, temperatures, flows, pressure drop, velocities and other piping properties in Table 4-3. The design pressures and temperatures of the hotwater district heating piping are also listed in this table.

4.3.4 Piping Cost Analyses

Piping costs for the transmission and distribution piping were developed by estimating the costs of the following items for both the process steam line and the hotwater piping to potential customers.

(a) Removal of existing surface and excavation of trench
(b) Removal and repair of existing road pavement at the road crossing for piping installation
(c) Piping material cost including allowance for valves and fittings, and piping installation costs
(d) Cost of sand bed in the trench for laying pipes and cost of concrete anchors
(e) Cost of back filling the trench after installation of piping and the backfill
(f) Cost of top soil and seeding after tempting of backfill
(g) Cost of expansion loops and manholes for the steam piping

Cost of piping materials are based on budget estimates from the piping vendors whereas labor costs for excavation, backfilling welding, joint forming, topsoil and seeding, etc are based on Stone & Webster inhouse data. These piping cost estimates are presented in Tables 4-5 and 4-6.

4.4 <u>System Capital And Operating Costs And Revenues</u>

4.4.1 System Capital Costs

Table 4-4 provides the capital costs for design and construction of a district heating system including the cost of plant retrofit. This total was increased by 15% for engineering and 25% for contingency for a total capital cost in 1993 dollars of $9,407,254. These costs are based on manufacturer's budgetary pricing for pumps, heat exchanger and pre-insulated piping and SWEC in house data for the remaining piping and components. This estimate assumes the district heating customers bear the cost of equipment within their facilities and does not consider any additional incentives or costs by the utility to induce heating customers to sign up.

4.4.2 Annual Operating Costs

Costs and revenue associated with the operation of the district heating system should be determined on an annual basis. This requires the use of an appropriate discount rate and inflation rate. The annual costs would include replacement power cost, which includes both lost generation and pumping power and O&M costs. The annual O&M costs are normally estimated at 3% of the capital cost of the power plant equipment, and 0.5% of the capital costs for piping based on past experience. These costs are to be estimated by the utility. The annual replacement power is estimated to be 11,296 MWhrs for the Roseton hotwater district heating system.

The operating cost due to lost generation for process steam to customers is $1,212,581 per year based on a replacement power cost of 3¢/kw hr. The cost is much greater than the potential annual revenue of $875,663 therefore, it was not evaluated further.

4.4.3 District Heating System Revenue

District heating system revenue is based on supplying customers with the same quantity of useful heat as in the year 1991 at approximately 90% of that year's billing for natural gas. The annual revenue in 1993 dollars based on participation of all identified customers is estimated at $758,587.

CENTRAL HUDSON GAS AND ELECTRIC CORP.
SWEC JOB 3777

TABLE 4-1

PEAK HEAT LOAD SUMMARY FOR
ROSETON DISTRICT HEATING SYSTEM

FACILITY	ANNUAL MCF	PEAK FACTOR	PEAK MONTH	PEAK 10^6 BTU/HR	FURN EFF	BTU/HR PER GPM	PEAK GPM
MIDDLEHOPE ELEM SCH	5000	0.1749	875	1.1754	0.75	42283	20.8
MONTGOMERY ST SCH	2663	0.1749	466	0.6260	0.75	42283	11.1
ST LUKES HOSPITAL	38740	0.128	4959	6.6649	0.75	42283	118.2
GIDNEY AVE SCH	450	0.1749	79	0.1058	0.75	42283	1.9
MT ST MARY COL	20000	0.128	2560	3.4409	0.75	42283	61.0
NORTH JR HIGH SCH	12044	0.1749	2106	2.8313	0.75	42283	50.2
NEWBURGH ACADEMY	29748	0.1749	5203	6.9932	0.75	42283	124.0
WASHINGTON ST SCH	1546	0.1749	270	0.3634	0.75	42283	6.4
WEST ST SCH	2760	0.1749	483	0.6488	0.75	42283	11.5
WINDSOR TEXTILES	13600	0.1749	2379	3.1971	0.75	42283	56.7
FRY COPY SYSTEMS	15000	0.1749	2624	3.5262	0.75	42283	62.5
ARMA TEXTILES	38408	0.1749	6718	9.0290	0.75	42283	160.2
AMER WHIPPED PRODUCT	9200	0.1749	1609	2.1627	0.75	42283	38.4
SOUTH JR HIGH SCH	12741	0.1749	2228	2.9952	0.75	42283	53.1
TOTAL	201900						776

PEAK EXPORT MMBTU/HR 32.82

NOTES:
CALCULATION OF PEAK HOT WATER REQUIREMENTS TO EACH FACILITY BASED ON 250 F SUPPLY AND 160 F RETURN USING AVERAGE OF PEAK MONTH HEAT LOAD FOR HOURLY RATE
1 GPM AT 250 F TRANSFERS 42283 BTU/HR OF HEAT
ASSUME CUSTOMER FURNACE EFFICIENCY = 75%

THE PEAK HEAT LOADS FOR ROSETON POTENTIAL CUSTOMERS ARE NOT AVAILABLE. THEREFORE, PEAK FACTORS FROM BOWLINE CUSTOMERS DATA WERE USED FOR ROSETON CUSTOMERS AS FOLLOWS.

(1) BOWLINE SUM OF CONFORT HEATING PEAK = 30931
BOWLINE SUM OF ANNUAL CONFORT HEATING = 176764

$$\text{PEAK FACTOR} = \frac{30931}{176764} = 0.17498472$$

(2) BOWLINE SUM OF HOSPITAL HEATING PEAK = 17290
BOWLINE SUM OF ANNUAL HOSPITAL HEATING = 135029

$$\text{PEAK FACTOR} = \frac{17290}{135029} = 0.12804656$$

STEAM PIPE SIZING FROM ROSETON STATION
TO PROCESS STEAM CUSTOMERS

PIPE SIZE	IN	8	10	12
FLOW	LB/HR	47463	47463	47463
TEMP. OF FLUID	F	650	650	650
PIPE SCHED		40	40	40

PIPE ID	IN	7.98	10.02	12.00
SPICIFIC VOLUME	CU.FT./LB	2.630	2.630	2.630
FLUID VISCOCITY	CENTIPOISE	0.022	0.022	0.022
FLUID VELOCITY	FT/SEC	99.83	63.33	44.16
RENOLDS NO.		1.71E+06	1.36E+06	1.13E+06
FRICTION FACTOR		0.0146	0.0142	0.0140
PDROP PSI/100FT		0.898	0.280	0.112
TOTAL PDROP	PSI	62.736	20.789	8.780

	L/D			
STRAIGHT PIPE	FT.	5280	5280	5280
L.R. ELBOW	14	60	60	60
L.R.45 ELBOW	14			
THROUGH TEE	20			
BRANCH TEE	60	12	12	12
GLOBE VALVE	340	2	2	2
BUTTERFLY VALVE	45			
GATE VALVE	13	25	25	25
CHECK VALVE	100			
ENTRANCES	.5/F			
EXITS	1/F			
NO. OF REDUCERS				
REDUCER SIZE	OUTLET			
REDUCERS K		0.000	0.000	0.000
NO. OF ENLARGERS				
ENLARGER SIZE	OUTLET			
ENLARGERS K		0.000	0.000	0.000
MISC. L/D				

TOTAL EQUIVALENT LENGTH	6985.94	7421.78	7845.00

MISC PRESS DROP	PSI			

CENTRAL HUDSON GAS AND ELECTRIC CORP. ROSETON STATION DISTRICT HEATING PIPE SIZING TABLE 4-3

SWEC JOB NO. 03777

					PIPE DES.		DESIGN FLOW CONDITIONS							FLUID	FLUID		FRICTION	PIPE	
					PR.	EMP	PR.	TEMP	FLOW	PR.	VEL.	SEC.	PR.	DENSITY	VIS.	REYNOLDS	FACTOR	ID	PIPE
SYS	SIZE	NO	MEDIUM	DESCRIPTION	PSIG	F	PSIG	F	GPM	#/100FT	FT/SEC	LEN.	DROP	#/CU.FT	CENT.	NUMBER	f	INCH.	SCHE
DHW	10	1	WATER	SEC 1 S SYSTEM SUPPLY	175	260	115	250	776	0.11	3.153	5000	5.46	58.799	0.228	1.01E+06	0.0145	10.020	STD
DHW	10	2	WATER	SEC 2 S	175	260	110	250	755	0.10	3.068	18600	19.25	58.799	0.228	9.82E+05	0.0145	10.020	STD
DHW	8	3	WATER	SEC 3 S	175	260	90	250	366	0.08	2.347	1300	1.06	58.799	0.228	5.99E+05	0.0155	7.981	STD
DHW	6	4	WATER	SEC 4 S	175	260	89	250	237	0.14	2.633	1800	2.54	58.799	0.228	5.10E+05	0.0162	6.065	STD
DHW	6	5	WATER	SEC 5 S	175	260	87	250	174	0.08	1.934	1400	1.09	58.799	0.228	3.75E+05	0.0168	6.065	STD
DHW	8	6	WATER	SEC 6 S	175	260	89	250	389	0.09	2.489	5400	4.91	58.799	0.228	6.35E+05	0.0154	7.981	STD
DHW	8	7	WATER	SEC 7 S	175	260	84	250	297	0.05	1.900	1500	0.81	58.799	0.228	4.84E+05	0.0157	7.981	STD
DHW	8	8	WATER	SEC 8 S	175	260	83	250	290	0.05	1.855	1400	0.72	58.799	0.228	4.73E+05	0.0158	7.981	STD
DHW	8	9	WATER	SEC 9 S	175	260	83	250	278	0.05	1.778	4600	2.19	58.799	0.228	4.53E+05	0.0158	7.981	STD
DHW	4	10	WATER	SEC 10 S	175	260	81	250	91	0.18	2.291	1100	1.96	58.799	0.228	2.95E+05	0.0179	4.026	STD
DHW	4	11	WATER	SEC 10 R	175	260	59	160	91	0.19	2.291	1100	2.13	60.994	0.400	1.74E+05	0.0188	4.026	STD
DHW	8	12	WATER	SEC 9 R	175	260	56	160	278	0.05	1.781	4600	2.41	60.994	0.400	2.69E+05	0.0167	7.981	STD
DHW	8	13	WATER	SEC 8 R	175	260	54	160	290	0.06	1.858	1400	0.79	60.994	0.400	2.80E+05	0.0166	7.981	STD
DHW	8	14	WATER	SEC 7 R	175	260	53	160	297	0.06	1.902	1500	0.89	60.994	0.400	2.87E+05	0.0166	7.981	STD
DHW	8	15	WATER	SEC 6 R	175	260	52	160	389	0.10	2.492	5400	5.34	60.994	0.400	3.76E+05	0.0161	7.981	STD
DHW	6	16	WATER	SEC 5 R	175	260	59	160	174	0.08	1.930	1400	1.19	60.994	0.400	2.21E+05	0.0175	6.065	STD
DHW	6	17	WATER	SEC 4 R	175	260	58	160	236	0.15	2.618	1800	2.72	60.994	0.400	3.00E+05	0.0170	6.065	STD
DHW	8	18	WATER	SEC 3 R	175	260	55	160	366	0.09	2.344	1300	1.14	60.994	0.400	3.53E+05	0.0162	7.981	STD
DHW	10	19	WATER	SEC 2 R	175	260	52	160	755	0.11	3.068	18000	20.10	60.994	0.400	5.81E+05	0.0151	10.020	STD
DHW	10	20	WATER	SEC 1 R PUMP SUCTION	175	260	32	160	776	0.12	3.153	5000	5.88	60.994	0.400	5.97E+05	0.0150	10.020	STD
DHW	2	21	WATER	MIDDLEHOPE ELEM SCH S	175	260	110	250	21	0.43	2.279	400	1.73	58.799	0.228	1.41E+05	0.0213	1.939	8
DHW	2	22	WATER	MIDDLEHOPE ELEM SCH R	175	260	42	160	21	0.47	2.279	400	1.89	60.994	0.400	8.35E+04	0.0224	1.939	8
DHW	2	23	WATER	MONTGOMERY ST SCH S	175	260	90	250	11	0.13	1.194	200	0.25	58.799	0.228	7.40E+04	0.0227	1.939	8
DHW	2	24	WATER	MONTGOMERY ST SCH R	175	260	55	160	11	0.14	1.194	200	0.28	60.994	0.400	4.37E+04	0.0243	1.939	8
DHW	3	25	WATER	ST LUKES HOSPITAL S	175	260	90	250	118	1.18	5.115	1600	18.88	58.799	0.228	5.01E+05	0.0182	3.068	STD
DHW	3	26	WATER	ST LUKES HOSPITAL R	175	260	55	160	118	1.26	5.115	1600	20.14	60.994	0.400	2.96E+05	0.0187	3.068	STD
DHW	2	27	WATER	GIDNEY AVE SCH S	175	260	89	250	2	0.01	0.217	100	0.01	58.799	0.228	1.34E+04	0.0302	1.939	8
DHW	2	28	WATER	GIDNEY AVE SCH R	175	260	58	160	2	0.01	0.217	100	0.01	60.994	0.400	7.95E+03	0.0340	1.939	8
DHW	2	29	WATER	MT ST MARY'S COL S	175	260	89	250	61	2.48	5.825	150	3.72	58.799	0.228	3.85E+05	0.0198	2.067	STD
DHW	2	30	WATER	MT ST MARY'S COL R	175	260	58	160	61	2.64	5.825	150	3.96	60.994	0.400	2.27E+05	0.0204	2.067	STD
DHW	2	31	WATER	NORTH JR HIGH SCH S	175	260	87	250	50	1.68	4.775	100	1.68	58.799	0.228	3.15E+05	0.0200	2.067	STD
DHW	2	32	WATER	NORTH JR HIGH SCH R	175	260	59	160	50	1.80	4.775	100	1.80	60.994	0.400	1.86E+05	0.0206	2.067	STD
DHW	4	33	WATER	NEWBURGH FREE ACAD. S	175	260	87	250	124	0.32	3.121	1700	5.49	58.799	0.228	4.02E+05	0.0176	4.026	STD
DHW	4	34	WATER	NEWBURGH FREE ACAD. R	175	260	59	160	124	0.35	3.121	1700	5.93	60.994	0.400	2.37E+05	0.0183	4.026	STD
DHW	2	35	WATER	WASHINGTON ST SCH S	175	260	84	250	7	0.05	0.760	500	0.27	58.799	0.228	4.71E+04	0.0241	1.939	8
DHW	2	36	WATER	WASHINGTON ST SCH R	175	260	53	160	7	0.06	0.760	500	0.31	60.994	0.400	2.78E+04	0.0262	1.939	8
DHW	2	37	WATER	WEST ST SCH S	175	260	84	250	12	0.15	1.302	1700	2.54	58.799	0.228	8.07E+04	0.0225	1.939	8
DHW	2	38	WATER	WEST ST SCH R	175	260	53	160	12	0.17	1.302	1700	2.82	60.994	0.400	4.77E+04	0.0240	1.939	8
DHW	2	39	WATER	WINDSOR TEXTILES S	175	260	83	250	57	2.17	5.443	100	2.17	58.799	0.228	3.60E+05	0.0199	2.067	STD

CENTRAL HUDSON GAS AND ELECTRIC CORP. ROSETON STATION DISTRICT HEATING PIPE SIZING TABLE 4-3

SWEC JOB NO. 03777

					PIPE DES.		DESIGN FLOW CONDITIONS							FLUID	FLUID		FRICTION	PIPE	
					PR.	EMP	PR.	TEMP	FLOW	PR.	VEL.	SEC.	PR.	DENSITY	VIS.	REYNOLDS	FACTOR	ID	PIPE
SYS	SIZE	NO	MEDIUM	DESCRIPTION	PSIG	F	PSIG	F	GPM	#/100FT	FT/SEC	LEN.	DROP	#/CU.FT	CENT.	NUMBER	f	INCH.	SCHED
DHW	2	40	WATER	WINDSOR TEXTILES R	175	260	56	160	57	2.31	5.443	100	2.31	60.994	0.400	2.13E+05	0.0204	2.067	STD
DHW	3	41	WATER	FRY COPY SYSTEMS S	175	260	81	250	63	0.35	2.731	100	0.35	58.799	0.228	2.68E+05	0.0188	3.068	STD
DHW	3	42	WATER	FRY COPY SYSTEMS R	175	260	59	160	63	0.38	2.731	100	0.38	60.994	0.400	1.58E+05	0.0197	3.068	STD
DHW	4	43	WATER	ARMA TEXTILES S	175	260	81	250	160	0.53	4.027	100	0.53	58.799	0.228	5.18E+05	0.0173	4.026	STD
DHW	4	44	WATER	ARMA TEXTILES R	175	260	59	160	160	0.57	4.027	100	0.57	60.994	0.400	3.06E+05	0.0179	4.026	STD
DHW	2	45	WATER	AMERICAN WHIPPED PRODUC	175	260	81	250	39	1.44	4.232	100	1.44	58.799	0.228	2.62E+05	0.0204	1.939	80
DHW	2	46	WATER	AMERICAN WHIPPED PRODUC	175	260	59	160	39	1.54	4.232	100	1.54	60.994	0.400	1.55E+05	0.0211	1.939	80
DHW	4	47	WATER	SOUTH JR HIGH SCH S	175	260	81	250	53	0.06	1.334	2600	1.65	58.799	0.228	1.72E+05	0.0189	4.026	STD
DHW	4	48	WATER	SOUTH JR HIGH SCH R	175	260	59	160	53	0.07	1.334	2600	1.82	60.994	0.400	1.01E+05	0.0201	4.026	STD

CENTRAL HUDSON GAS AND ELECTRIC CORP. TABLE 4–4
ROSETON DISTRICT HOT WATER HEATING SYSTEM
SWEC JOB 03777

COST ESTIMATE FOR POWER PLANT MODIFICATIONS
ROSETON POWER STATION

COMPONENT	COST
DISTRICT HEATING(DH) HEAT EXCHANGER	$47,000
D. H. EXPANSION TANK	$56,500
PRESSURIZING PUMPS	$5,000
D.H. CIRCULATING WATER PUMPS	$18,000
MAKE–UP WATER SOFTNER	$12,000
PIPING VALVES & INSULATION	$120,000
PIPING AND EQUIPMENT INSTALLATION	$170,000
INSTRUMENTATION & CONTROLS	$100,000
ELECTRICAL INSTALLATION	$90,000
BACK UP BOILERS	$220,000
DISTRICT WATER PIPING (SHOWN ON TABLE 4–6)	$5,880,967
SUBTOTAL	$6,719,467
CONTINGENCY 25%	$1,679,867
ENGINEERING 15%	$1,007,920
TOTAL	$9,407,254

ROS4–4.WK1

TABLE 4-5 STEAM LINE PIPING COST ESTIMATE

CLIENT - Central Hudson Gas and Electric Corp. Roseton Station	ESTIMATE NO.	J.O. NO. - 03777.00	SHT 1 OF 1
DESCRIPTION OF WORK - Steam and Condensate Piping From Roseton Staion To Process Steam Customers	QTY BY - SWEC	CHECKED BY - SWEC	PRICES BY
	DATE -	APPROVED	

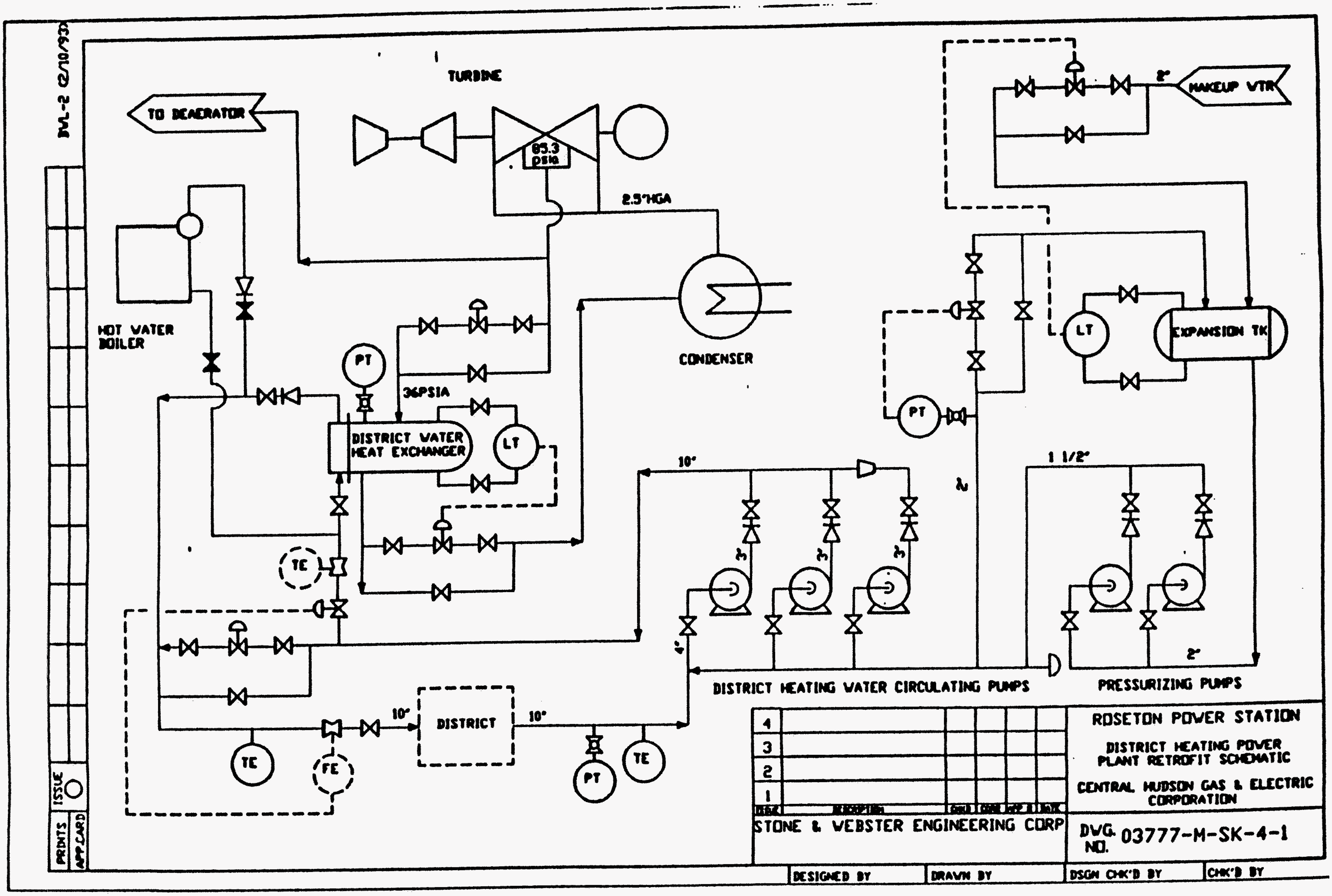
ACCOUNT NO.	DESCRIPTION	QUANTITIES	UNIT COST UNITS	MAT'L	MH'S	RATE	MATERIAL	LABOR	TOTAL	MAN-HOUR
2000	Excavation (note 1)	67594	cy	3.00	0.08	56.00	$202,783	$302,823	$505,606	
2100	Backfill (note 1)	55641	cy	1.50	0.05	56.00	$83,461	$155,794	$239,255	278
2200	Remove existing road (note 1)	1482	sy	1.50	0.05	56.00	$2,223	$4,149	$6,372	7
2300	Repair of Existing Road	1482	sy	5.00	0.10	56.00	$7,409	$8,299	$15,708	14
2400	Topsoil and seeding	30269	sy	0.15	0.04	56.00	$4,540	$67,804	$72,344	121
2500	Sand bed	3384	cy	3.50	0.16	56.00	$11,842	$30,317	$42,159	54
2600	Concrete Anchors	55	cy	150.00	5.00	56.00	$8,213	$15,330	$23,543	27
2700	Steam (10") & Condensate Piping (4")	36500	ft	150.00	1.20	56.00	$5,475,000	$2,452,800	$7,927,800	4380
2700	Allowance for expansion loops	5475	ft	150.00	1.20	56.00	$821,250	$367,920	$1,189,170	657
2800	Manholes	73	ea	2000.00	8.00	56.00	$146,000	$32,704	$178,704	58
	Sub-total Cost						$6,762,722	$3,437,939	$10,200,660	
	Contingency (25%)						$1,690,680	$859,485	$2,550,165	
	TOTAL COST						$8,453,402	$4,297,423	$12,750,825	
Note:	1. The material costs include equipment rental and operating costs.									

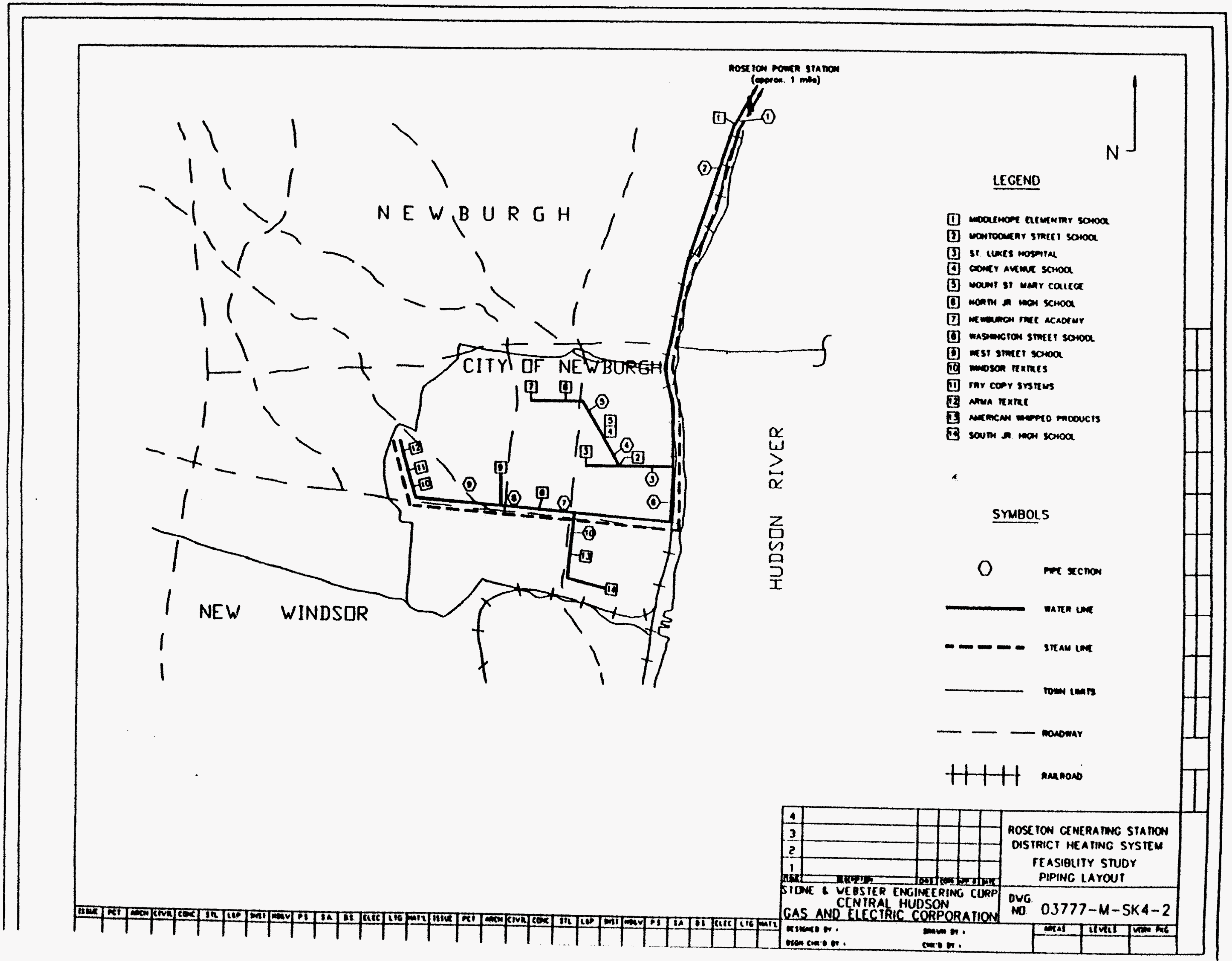
TABLE 4-6

DISTRICT HOT WATER HEATING PIPING COST ESTIMATE

CLIENT – Central Hudson Gas and Electric Corp. Roseton Station	ESTIMATE NO.	J.O. NO. – 03777.00	SHT 1 OF 1
DESCRIPTION OF WORK – District Heating Hot Water Piping	QTY BY – SWEC	CHECKED BY – SWEC	PRICES BY
	DATE –	APPROVED	

ACCOUNT NO.	DESCRIPTION	QUANTITIES	UNIT COST UNITS	MAT'L	MH'S	RATE	MATERIAL	LABOR	TOTAL	MAN-HOURS
2000	Excavation (note 1)	87094	cy	3.00	0.08	56.00	$261,282	$390,181	$651,463	6968
2100	Backfill (note 1)	65321	cy	1.50	0.05	56.00	$97,981	$182,897	$280,878	3266
2200	Remove existing road (note 1)	500	sy	1.50	0.05	56.00	$750	$1,400	$2,150	25
2300	Repair of Existing Road	500	sy	5.00	0.10	56.00	$2,500	$2,800	$5,300	50
2400	Topsoil and seeding	56944	sy	0.15	0.04	56.00	$8,542	$127,556	$136,097	2278
2500	Sand bed	4745	cy	3.50	0.16	56.00	$16,609	$42,519	$59,127	759
2600	Concrete Anchors	25	cy	150.00	5.00	56.00	$3,750	$7,000	$10,750	125
2700	Piping – 12"	0	ft	59.34	0.18	56.00	$0	$0	$0	0
2700	Piping – 10"	46600	ft	47.80	0.18	56.00	$2,227,294	$469,728	$2,697,022	8388
2700	Piping – 8"	28400	ft	34.71	0.18	56.00	$985,849	$286,272	$1,272,121	5112
2700	Piping – 6"	6400	ft	24.93	0.18	56.00	$159,533	$64,512	$224,045	1152
2700	Piping – 4"	11000	ft	18.62	0.18	56.00	$204,782	$110,880	$315,662	1980
2700	Piping – 3"	3400	ft	14.55	0.18	56.00	$49,480	$34,272	$83,752	612
2700	Piping – 2"	6700	ft	11.20	0.18	56.00	$75,063	$67,536	$142,599	1206
	Sub-total Cost						$4,093,414	$1,787,553	$5,880,967	
	Contingency (25%)						$1,023,353	$446,888	$1,470,242	
	TOTAL COST						$5,116,767	$2,234,441	$7,351,208	
Note:	1. The material costs include equipment rental and operating costs.									


DVL-2 (2/10/93)
TURBINE
TO DEAERATOR
85.3 psia
2.5"HGA
CONDENSER
HOT WATER BOILER
PT
36PSIA
DISTRICT WATER HEAT EXCHANGER
LT
TE
10"
3"
4"
DISTRICT
10"
10"
TE
FE
PT
TE
DISTRICT HEATING WATER CIRCULATING PUMPS
2"
MAKEUP WTR
PT
LT
EXPANSION TK
1 1/2"
2"
PRESSURIZING PUMPS
ISSUE
PRINTS
APP.CARD
4
3
2
1
ROSETON POWER STATION
DISTRICT HEATING POWER PLANT RETROFIT SCHEMATIC
CENTRAL HUDSON GAS & ELECTRIC CORPORATION
STONE & WEBSTER ENGINEERING CORP
DWG. NO. 03777-M-SK-4-1
DESIGNED BY
DRAWN BY
DSGN CHK'D BY
CHK'D BY


ROSETON POWER STATION
(approx. 1 mile)
N
NEWBURGH
CITY OF NEWBURGH
HUDSON RIVER
NEW WINDSOR
LEGEND
1 MIDDLEHOPE ELEMENTRY SCHOOL
2 MONTGOMERY STREET SCHOOL
3 ST. LUKES HOSPITAL
4 GIDNEY AVENUE SCHOOL
5 MOUNT ST MARY COLLEGE
6 NORTH JR HIGH SCHOOL
7 NEWBURGH FREE ACADEMY
8 WASHINGTON STREET SCHOOL
9 WEST STREET SCHOOL
10 WINDSOR TEXTILES
11 FRY COPY SYSTEMS
12 ARMA TEXTILE
13 AMERICAN WHIPPED PRODUCTS
14 SOUTH JR. HIGH SCHOOL
SYMBOLS
PIPE SECTION
WATER LINE
STEAM LINE
TOWN LIMITS
ROADWAY
RAILROAD
ROSETON GENERATING STATION
DISTRICT HEATING SYSTEM
FEASIBLITY STUDY
PIPING LAYOUT
STONE & WEBSTER ENGINEERING CORP
CENTRAL HUDSON
GAS AND ELECTRIC CORPORATION
DWG. NO. 03777-M-SK4-2

SECTION 5

SECTION 5

IMPACT OF DISTRICT HEATING ON RIVER WATER TEMPERATURE FOR ALL PLANTS

5.1 Bowline Point Station

The current maximum temperature rise for Bowline Unit 2 due to condenser heat duty is about 17.15 °F. The temperature rise with steam export to U.S. Gypsum is 16.93 °F, a reduction of 0.22 °F. By installing a district hot water heating system the temperature rise will be 16.83 °F, a reduction of 0.32 °F. Even if both of these systems were implemented together the total reduction in circulating water discharge temperature would be 0.54 °F. This assumes that both systems are simultaneously operating at peak loads. But the district heating peak only occurs for a few months a year in winter. At this time of the year the mean river temperature is approximately 40°F. During the summer months when the river water temperature increases to an average of approximately 80°F only U.S. Gypsum process system would use steam close to its peak demand. Under this condition the combined effect of both systems would be to reduce circulating water discharge temperature by about 0.35 °F.

Bowline Unit 2 accounts for about 50% of the circulating water used at the Bowline Station site. When the temperature reduction is considered as part of the overall site discharges from the Bowline Station the average temperature reduction is less than 0.27 °F at peak loads and only 0.18 °F during the summer months.

5.2 Indian Point Station

The current maximum temperature rise for the Indian Point Unit 2 due to condenser heat duty is about 16.3°F. The temperature rise is calculated to be 16.15°F if heating steam would be supplied to the hotwater district heating system. Thus with the installation of a district heating system, the circulating water temperature could only be lowered by 0.15°F based on Indian Point Unit 2 circulating water flow. Since both Indian Point Unit 2 and Unit 3 circulating water discharge into a common canal, the combined water temperature would only be reduced by 0.07°F.

In summer months, district heating system would only provide domestic hotwater load to the customers. Summer domestic hotwater load is usually 15% of the winter peak heating load. Therefore, the reduction in combined circulating water temperature from both Unit 1 and 2 is estimated at 0.01°F during the summer months.

Indian Point Units 2 and 3 would have the same district heating customers. Therefore either the Consolidated Edison Plant (Unit 2) or the NYPA plant (Unit 3) could be modified but not both. For the purpose of this analysis Unit 2 was selected but results would be identical for Unit 3.

5.3 Roseton Generating Station

The current maximum temperature rise for Roseton Generating Station due to condenser heat duty is about 16.21°F. The temperature rise with steam export to process steam customers is 16.06°F, a reduction of 0.15°F. By installing a district hot water heating system the temperature rise would be 16.13°F, a reduction of 0.08°F. Even if both of these systems were implemented together the total reduction in circulating water discharge temperature would be 0.23°F. This assumes that both systems are simultaneously operating at peak loads. But the peak only occurs for a few months a year in winter. At this time of the year the mean river temperature is approximately 40°F. During the summer months when the river water temperature increases to 80°F only process steam customers would use steam close to its peak demand. Under this condition the combined effect of the steam export and district heating systems would be to reduce circulating water discharge temperature by about 0.17°F.

SECTION 6

SECTION 6
DISTRICT COOLING SYSTEM APPLICATION

General

A brief investigation of potential application of district cooling systems (circulation of chilled water from a central plant) in the service areas of the Bowline Point, Indian Point, and Roseton Electric Generating Stations was conducted and is addressed in this section. The investigation was conducted for the service area of the Bowline Point Station, and then the potential for a district cooling system at the Indian Point and Roseton Generating Stations was determined by comparison of the available cooling loads at these stations to the cooling load for Bowline Point Station Service area. The following paragraphs describes the district cooling investigation.

6.1 Bowline Point District Cooling System

In order to determine the potential for application of a district cooling system at a particular site, there are five activities which need to be performed before a determination could be made if such a system would be feasible. These activities are as follows:

- Cooling Load Assessment
- Central Chiller Plant Assessment
- Steam Supply and Chilled Water Distribution System Assessment
- System Costs Estimates
- Economic Analysis

A typical central chiller plant could employ electric motor driven centrifugal chillers, steam turbine driven centrifugal chillers, or steam or hotwater absorption chillers or any combination of the above chillers. For the purpose of our study, we could only use steam turbine driven centrifugal chillers or steam absorption chillers because the objective of the study is to export steam to the chiller plant, thereby reducing the quantity of steam to be condensed at the power station condensers. This would result in reducing the thermal discharge to the Hudson river. Therefore, use of electric motor driven centrifugal chillers is excluded for this study.

Cooling Load Assessment

In order to determine the capacity of the chiller plant, it is necessary to assess the availability of potential cooling loads in the service area covered by the Bowline Point power station. Several inquiries were made with potential customers to determine if they had central cooling systems at the present time, and to determine their interest in district cooling system.

All eighteen potential district heating customers listed on District Heating System Feasibility Study Drawing No. 03777-M-SK-2-2 were evaluated for district cooling application. It was determined that only three out of the eighteen customers could use district cooling. They are customer numbers 4, 5, and 15, that is Greenville and Riverside Nursing Homes and Helen Hays Hospital. None of the school buildings or industrial facilities in the Kay Fries Industrial Park or the U.S. Gypsum Corporation have central air conditioning systems. Some of the offices at the industrial facilities either have small room air conditioners or a small roof-mounted heat pump to cool few small offices or laboratories, but all of the factory buildings and the school buildings are not cooled. At the Helen Hays hospital only the main pavilion which is the most recent building constructed is air conditioned. The other hospital buildings such as bone center and animal laboratories, etc are very old and have no central air conditioning. They have few individual room air conditioners for office staff. Main pavilion accounts for approximately 25 percent of the hospital building areas.

The Helen Hays hospital is located approximately 3.5 miles northwest of the Bowline Point plant and the two nursing homes are located approximately two miles southwest of the plant. Thus there is not enough cooling load density in the Bowline Point Plant Service area, and the three potential cooling load customers are too far from the Bowline Point power plant.

Chiller Plant Assessment

The chiller plant capacity and chiller sizes are determined from the results of the cooling load assessment. Total installed capacity of a central chiller plant is usually less than the sum total of the peak cooling loads of the potential customers. The reason for this trimming of the plant capacity is that all peak loads do no occur at the same time. This is called a plant diversity factor, and is usually figured at 75% to 80% of the sum total of all peak loads.

The central chiller plant is usually located near the largest cooling load customers to reduce the length of the expensive chilled water piping loop. For the Bowline Point Station service area, the prospective cooling loads are far apart. The distance between the Helen Hays hospital and the two nursing homes is approximately 3.5 miles. Therefore, chilled water piping runs would be very expensive. The chiller plant will include either steam turbine driven centrifugal chillers or steam absorption chillers requiring 125 psig steam at the chillers. In either case, a high pressure steam line (200 psig steam pressure at the Bowline Plant) would be required to carry the steam to the chiller plant.

The two stage steam absorption chillers usually require steam pressures ranging from 45 psig to 125 psig for their operation. Single stage absorption chillers could work with lower pressure steam, but their steam consumption is very high. The two stage absorption chillers are much more efficient when high pressure steam is available, and they are most efficient and work at their full capacity when the steam pressure at the chiller inlet is 115 psig. The absorption chillers could be designed to work with hotwater but the hotwater temperature has to be 350°F to 400°F. The steam turbine driven centrifugal chillers have a higher coefficient of performance compared to their absorption chiller counterpart which make them more competitive.

The chiller plant would probably be located at the Helen Hays hospital. A detailed economic analysis would be required to determine the optimum location of the Chiller plant. Chilled water lines from the chiller plant would need to be run to the nursing homes 3.5 miles away which would be a very expensive proposition.

Steam Supply and Chilled Water Distribution System

A 200 psig steam supply line would need to be run from the Bowline Point Power Station to the central chiller plant at the Helen Hays hospital. This would be a 400°F steam line 3.5 miles long which would be expensive.

The chilled water piping would need to be run from the chiller plant to feed the hospital chilled water loop, and an additional chilled water loop would need to be run to the two nursing homes 3.5 miles southeast of the hospital. The usual chilled water supply temperature is 42°F to 44°F and the return water temperature is 58°F to 60°F. Due to only 16°F to 18°F temperature difference (ΔT), and 6 to 8 ft/sec average water velocity, chilled water piping headers are usually larger and much more expensive.

The chilled water piping is usually buried in the ground with 4 to 5 feet of dirt cover for protection from freezing. The piping material could be either ductile iron, carbon steel coated and wrapped, or carbon steel pre insulated jacketed pipe similar to the I.C. Moller hotwater piping.

The chilled water circulating pumps would be required to circulate the chilled water from the chiller plant to the customers and back. There will be cost associated with excavation, pipe,
fitup and welding or joining, backfill, temping, topsoil and seeding, etc. for the steam and chilled water piping installation.

Conclusion

Based on the above discussions, it is evident that district cooling is a completely independent system, and would need installation of 3.5 mile long high temperature steam supply line for the chillers and another 3.5 miles of chilled water supply and return lines between the central chiller plant and the two nursing homes. The chiller plant would house the new chillers and the circulating pumps. The cost of the high pressure steam supply line and the chilled water lines are estimated in excess of 11 million dollars. The central chiller plant would cost in excess of 1.5 million dollars. Therefore, the total district cooling system cost would exceed 12 million dollars. The cooling season peak occurs in the month of July and August. Cooling load is very small during the rest of the year. The revenue generated from the three potential cooling load customers would not justify the cooling system design and construction cost. This preliminary investigation shows that district cooling system is economically not feasible in the Bowline Point Station service area.

6.2 Indian Point District Cooling System

For the Indiana Point Station service area, there are four potential district cooling customers. They are customer numbers, 1, 3, 10, and 13, namely V.A. Hospital, Caldor, Sears and Roebuck and Grand Union Departmental Stores. These four potential customers are spread out over a distance of 10 to 12 miles. Building a district cooling system connecting the four would cost much more than the cooling system discussed in subsection 6.1 for the Bowline Point service area. Therefore, such a system would be economically not feasible.

6.3 Roseton Station District Cooling System

For the service area of the Roseton Generating Station, Saint Lukes Hospital is the only potential district cooling customer. The hospital is located approximately five miles from the Roseton Station. To run a high pressure steam line from the power station to the hospital would cost in excess of 6 million dollars. In addition, there will be an additional cost for the chiller plant modification. Hospital currently has its own cooling system. Therefore, such an expense is not justified just to feed steam from the Roseton Station to the hospital.