RESEARCH REPORT

A Performance Assessment of the Lebreton Flats District Heating System Final Report

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A PERFORMANCE ASSESSMENT OF THE LEBRETON FLATS DISTRICT HEATING SYSTEM

FINAL REPORT

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PERFORMANCE ASSESSMENT

of the

LEBRETON FLATS DISTRICT HEATING SYSTEM
Ottawa, Ontario, Canada

Prepared for the

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ABSTRACT

In 1982, the Lebreton Flats District Heating System was commissioned to demonstrate the application of a low temperature district heating system in a high density urban residential setting. After 20 years of operation, Canada Mortgage and Housing Corporation, the owner of the system, commissioned a study to assess the performance of the system in terms of energy use, operational costs, efficiency and other parameters. The study concluded that the system continues to operate in a cost-effective manner, even when compared to other space and domestic hot water heating options that are available today. The system is in good repair but suffers from under-utilisation. Original boiler oversizing adversely affects the seasonal efficiency of the system. Additionally, the disconnection of 63 of the original 205 units served increased the unit overhead costs for system maintenance, taxes, administration, etc. Opportunities to expand the number of units served by the district heating system should be explored to address both issues.

KEY WORDS:

district heating system, energy consumption, energy efficiency, multi-unit residential buildings, operating costs

DISCLAIMER

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EXECUTIVE SUMMARY

The Lebreton Flats District Heating System was commissioned in 1982 as a part of a Federal-Provincial Government initiative to demonstrate and assess the costs and benefits of low temperature district heating systems within the context of North American high density residential developments. The system, located on the West side of downtown Ottawa, Ontario, provides hot water for space heating and domestic hot water for 142 apartments and townhouses. As the system now has 20 years of operational history, Canada Mortgage and Housing Corporation (CMHC), the owner of the system, commissioned a study to review the energy use, operating costs, service history, general condition and client satisfaction with the system. The information generated by the study provides useful feedback concerning the cost-effectiveness of the system and how the system may be improved. The study also serves as a case study of the application of a low temperature district heating system for others who may consider the installation of such a system.

A description of the system including heating plant, distribution-piping network, heating system controls and customer locations is presented. The system was monitored during different seasons as a part of the performance assessment. The observations of water flow and temperature through the system prompted several recommendations for system and control modifications.

A comprehensive non-destructive boiler inspection was commissioned. This resulted in a recommendation to replace the tubes in both boilers.

The historic energy and maintenance expenses were reviewed and it was concluded that the cost of thermal energy is competitive with other heating options despite the fact that the system is oversized and underutilized.

The cost and net present value of improvements to the district heating system and the installation of alternative heating options for the clients of the system were determined and recommendations regarding these options are made. Based on the evaluation, it was determined that the district heating system remains the most cost-effective space and domestic hot water heating option for the clients presently connected to the system. Recommendations for modifications to the system were proposed to improve operational efficiency to reduce costs. Future options for cogeneration and the connection to a larger district heating system network being considered for the next phase of the Lebreton Flats redevelopment are also discussed.

RÉSUMÉ

L'installation de chauffage urbain des Plaines Le Breton a été mise en service en 1982 dans le cadre d'une initiative fédérale-provinciale visant à faire la démonstration et l'évaluation des coûts et des avantages d'un système de chauffage à basse température dans le contexte des aménagements résidentiels à forte densité d'Amérique du Nord. L'installation, située dans la partie ouest du centre-ville d'Ottawa (Ontario), assure le chauffage individuel et l'alimentation en eau chaude de 142 logements et maisons en rangée. Comme elle compte maintenant une vingtaine d'années d'existence, la Société canadienne d'hypothèques et de logement (SCHL), qui en est le propriétaire, a commandé une étude afin d'examiner la consommation d'énergie, les coûts d'exploitation, l'historique de l'entretien et l'état général de l'installation, de même que la satisfaction des clients à son égard. L'étude permettra de recueillir des renseignements utiles sur la rentabilité de l'installation et sur ses améliorations possibles. Elle servira également d'étude de cas sur l'application d'un système de chauffage urbain à basse température pour les groupes qui envisageraient une telle avenue.

On présente une description du système, incluant l'installation de chauffage, le réseau de distribution et de canalisations, les dispositifs de régulation du système de chauffage et l'emplacement des clients. Le système a fait l'objet d'un contrôle continu durant différentes saisons dans le cadre de l'évaluation du rendement. Les observations du débit et de la température de l'eau ont amené la formulation de plusieurs recommandations relativement à des modifications à apporter au système et à ses dispositifs de régulation.

On a demandé une inspection superficielle complète de la chaudière, laquelle a donné lieu à la recommandation de remplacer les tubes dans les deux chaudières.

On a passé en revue l'historique des dépenses de consommation d'énergie et d'entretien et on a conclu que le coût de l'énergie thermique était concurrentiel par rapport aux autres modes de chauffage, et ce, malgré le fait que l'installation est surdimensionnée et sous-utilisée.

On a établi le coût et la valeur actuelle nette, pour les clients, des améliorations à apporter au système de chauffage urbain et de l'installation de modes de chauffage de remplacement et on a formulé des recommandations à cet égard. Les résultats de l'évaluation montrent que l'installation de chauffage urbain demeure le mode de chauffage et d'alimentation en eau chaude le plus économique pour les clients qui y sont actuellement raccordés. On a proposé des modifications à apporter au système pour en améliorer le fonctionnement afin de réduire les coûts. On discute également des options futures qui sont envisagées pour la prochaine phase du réaménagement des Plaines Le Breton, soit la cogénération et le raccordement à un réseau de chauffage urbain plus vaste.

1.0 INTRODUCTION

In 1982, Canada Mortgage and Housing Corporation (CMHC), in cooperation with Energy Mines and Resources Canada and the Ontario Ministry of Energy, commissioned a European-style low temperature district heating system (DHS) in the redevelopment of the Lebreton Flats area of Ottawa. The objectives of the project were to demonstrate and evaluate the performance (energy efficiency, operating costs, reliability, etc.) of a low temperature district heating system within the context of a North American high density residential development.

Over the last 20 years, the system has operated reliably with no extraordinary costs incurred for repairs. However, many of the original objectives of the project remained unexplored. Accordingly, CMHC decided to evaluate the performance of the system given the 20 years of operational history.

To evaluate the performance of the DHS, several different tasks were performed:

- Interviews were held with stakeholders including customers, the plant management, and the mechanical contractor to gain an appreciation of the operational history of the building.
- A review of previous fuel and maintenance expenditures was undertaken. To provide a historical perspective of the costs of the system.
- A comprehensive non-destructive boiler inspection was carried out.
- A review of other heating options for the community was made. Installation and use of other heating systems such as individual gas-fired furnaces and domestic hot water systems were evaluated from a cost-benefit point of view. Also, alternative methods of heating were explored.
- The heating system performance was monitored during several periods. The results of this monitoring allowed an evaluation of the operational efficiency of the system under different load conditions.
- Possibilities for the connection of alternative sources of energy to the DHS were explored and the use of a small co-generation device was investigated, especially relative to economics and the thermal energy capacity factor.

Based on the assessment of the Lebreton Flat District Heating System, conclusions regarding the efficiency and economics of system operation were made and recommendations are presented.

2.0 BACKGROUND: System Description

2.1 General:

The Lebreton Flats District Heating System (DHS) is comprised of a boiler plant, housed in its own building, a primary distribution system to distribute hot water throughout the project and a secondary loop distribution system that delivers hot water to the individual buildings served. Within the buildings, heat exchangers relay the heat to space and domestic hot water heating systems.

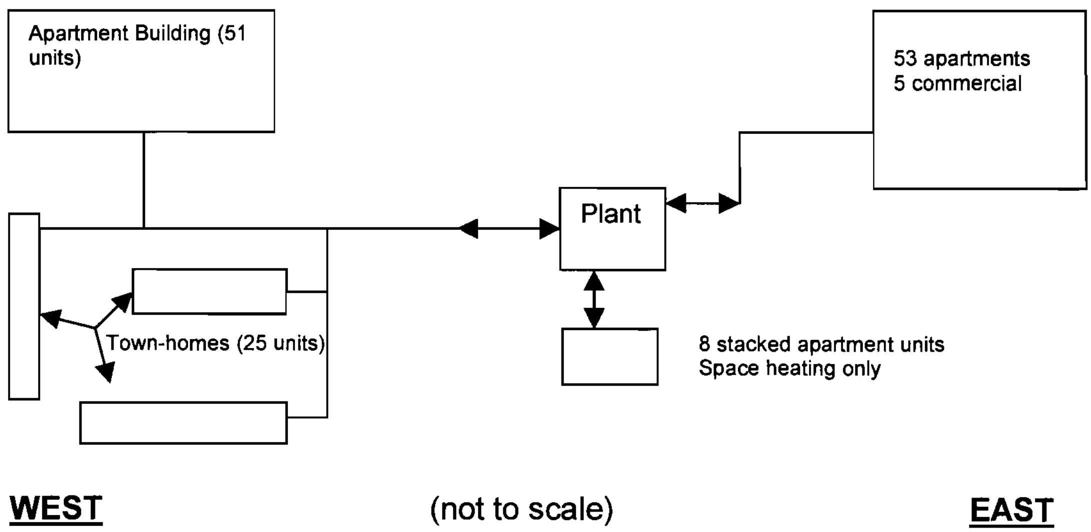


Figure 1: Lebreton DHS Primary Distribution System (2000)

The system originally supplied heat for the space heating and/or domestic hot water for two large apartment buildings and many town-homes in the LeBreton Flats area of Ottawa. In all, 205 units were served by the system. In 1989-90, 63 residential units were disconnected from the system and were converted to individual natural gas space and domestic hot water systems. The remaining system (2001), serving 142 units, is shown in Figure 1. A complete description of the system is described in the report "Lebreton Flats District Heating System Performance Evaluation for the First Two Years of Operation", CMHC, 1984.

2.2 Boiler Plant:

The 113 m^2, unsupervised, boiler plant is located in a centrally located sub-grade building located at 31 Rochester Street. The "roof" of the building holds planter boxes and sitting areas to blend the installation in with the surrounding community. The stack for the boilers is routed up behind an adjacent apartment building.

The original boiler load was estimated to be 2,181 kW thus two 1,250 kW gas-fired, fire tube boilers were installed to service the district. Each boiler is able to over-fire providing a maximum combined capacity of 2,943 kW. System monitoring, performed in 1982-83, found the peak boiler load to be 1,450 kW indicating that the plant heating capacity was significantly oversized even before the 63 units were disconnected[1].

Given the remaining 142 units, the combined peak space and domestic hot water load for the buildings served is now estimated to be 800 kW. This concurs with estimates made of actual load during the 1982-83 monitoring period when adjusted for the loss of the 63 units. Based on measurements conducted later on in this study, this value (800 kW) may be somewhat higher than the actual value (see Appendix L).

Based on the estimated peak heating load of 800 kW, a boiler efficiency of 70%, and by taking into account the 8% ground heat losses, the maximum required boiler input is calculated to be 1240 kW. By comparison, based on the Ottawa standard of 2261 Equivalent Full Load Hours (a value that expresses the hours per year that a boiler would operate at full power to deliver the same energy as it would otherwise operate in a modulating or cyclical mode), the peak boiler energy input of the Lebreton Plant is 1042 kW. This estimate of actual boiler energy input is about 15% less than that calculated from the peak-heating load. This is consistent with the milder winters during the years 1996-99. The comparison between boiler energy inputs also confirms the estimates of boiler efficiency and ground heat losses.

The full load efficiency of the boilers is estimated at 80%, using the lower heating value (LHV) of natural gas (37.45 MJ/m^3). However, with the low load and the summertime on/off cycling, the boiler efficiency is more likely in the 65-70% range. A value of 70% (of the LHV) was used in the calculations.

It is estimated that 85% of the plant energy output is for space heating while the other 15% is used for domestic hot water heating.

2.3 Distribution System:

The distribution system is comprised of 75mm and 100mm prefabricated pipe. The system piping was pre-insulated with polyurethane foam encased in a polyethylene jacket. The distribution system is buried, in the frost zone, under roadways and publics spaces. The sub-grade piping is protected by expansion loops and cushioning to prevent damage due to thermal expansion and contraction. Despite the shallow depth, no surface melting of snow over the distribution system was observed during the first 4 years of operation nor was there any pipe damage due to freezing. Based on flow temperature monitoring in 1999-2000 (Appendix L), heat losses from the distribution system were found to be very low as well indicating that the pipe insulation and distribution system are in good condition.

Water is circulated through the distribution system by 3 – 7.46 kW pumps. Two pumps operate continuously under full load while the third remain in stand-by mode. Under partial load conditions only 1 pump operates.

Design operating conditions for the supply and return water temperatures are 99^0C and 60^0C respectively. System static operating pressure is 149 kPa with an additional pumping head of 419 kPa. Heated water is circulated through the distribution system via two 3.73 kW pumps.

Each building is attached to the primary loop in such a way that any building can be disconnected, via valves located in strategically placed manholes, without disrupting the supply to the rest of the project.

It is estimated that in a properly insulated district heating system piping network, about 8% of the yearly average plant input is lost due to heat losses to the ground. This figure is supported by the system heat loss estimate derived in the 1982-83 monitoring project of the system[1].

2.4 Building Systems

Hot water from the DHS is used to generate hot water within the buildings served via in-tank heat exchangers located in a central domestic hot water heating tank. With the exception of the commercial space in the 170 Booth Building and the 8 unit apartment building adjacent to the plant, the space heating is provided by in-suite fan coil units.

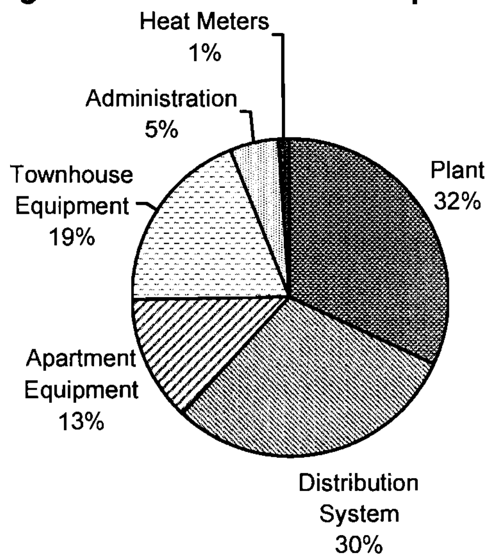
The flow to the individual space heating coils within the buildings is controlled by several different mechanisms. Some are controlled by thermostatic Danfoss-type valves which control the coil outlet temperature. A regular thermostat often controls the airflow through these coils. In some homes and apartments, the valves are permanently open and the air circulation fan and its thermostat control the room temperature. To prevent heating inside the homes and apartments during the summertime, the mechanical contractor closes the main valves to the heating coils.

The controls on the DHW tanks within the buildings are thermostats, which call for district heating water when the DHW temperature falls below the set point. Some tanks have dual thermostats, one for the top, the other for the bottom section of the tank.

2.5 Lebreton District Heating System Capital Costs:

The cost of the plant, distribution system and unit space and domestic hot water heating equipment was approximately $1,300,000 (1981$)[1]. This translates to a project unit cost of $6,340. Figure 2 illustrates the distribution of costs.

Figure 2: Distribution of Capital Costs[1]



Unit costs[1]:	Plant -	Building -	$858/m2	
		Mechanical -	$118/kW	
	Distribution System		$304/m	
	Internal Equipment:			
		Apartments		$1,200/unit
		Townhouse		$4,710/unit
		Stacked Townhouse		$700/unit (conversion costs)

(all costs are in 1981 $CDN)

3.0 Performance Assessment:

3.1 Energy Consumption:

The assessment of the energy performance of the DHS involved the review of utility invoices and financial reports. The review of the historic fuel, electrical and maintenance expenditures over the lifetime of the district heating project proved more difficult than anticipated. Some of the data was missing or difficult to interpret due to missing meter readings, estimated metered readings or conflicting cost information. However, it is felt that enough data was collected from the DHS financial statements and utility bill history to assess the performance of the system and draw valid conclusions.

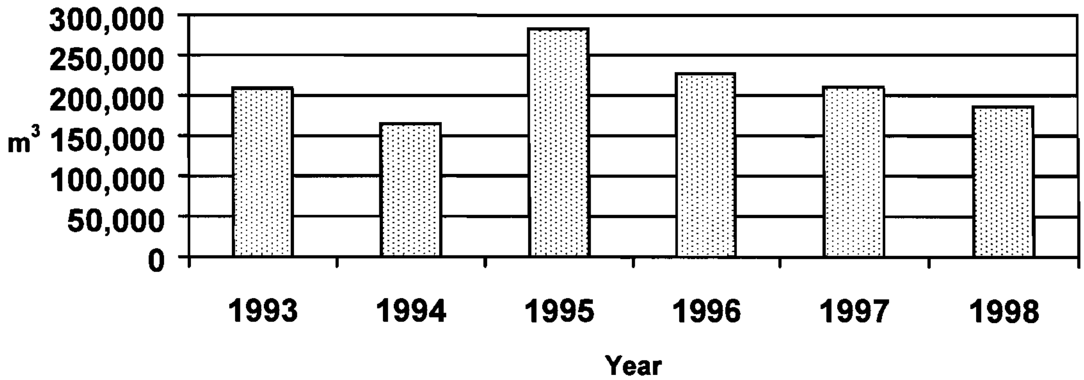
3.1.1 Natural Gas Expenditures

The average annual gas consumption for the years 1993-98 was provided from utility information and is depicted in Figure 3. Gas consumption was multiplied by the calorific value of natural gas (37.45 MJ/m^3, LHV) to obtain energy consumption. The average annual gas consumption during the 6 years was 213,300 m^3 or 2,218 MWh.

The monthly natural gas consumption values for the years 1993-1998 are shown in Appendix I. Although it would appear that no value is shown for some months, some indicate a much higher value than expected. It is thought that these higher values reflect irregular billing or meter readings. The variation in the total amount of natural gas used in most of these years is also provided in Appendix I.

The variation in gas use between years is not very large and may be attributable to the normal variation in the number of degree-days. The exception is the year 1995, when the June invoice indicated a very large increase in use. This increase was due to an "account reconciliation" invoice due to an actual meter reading after many months of estimates.

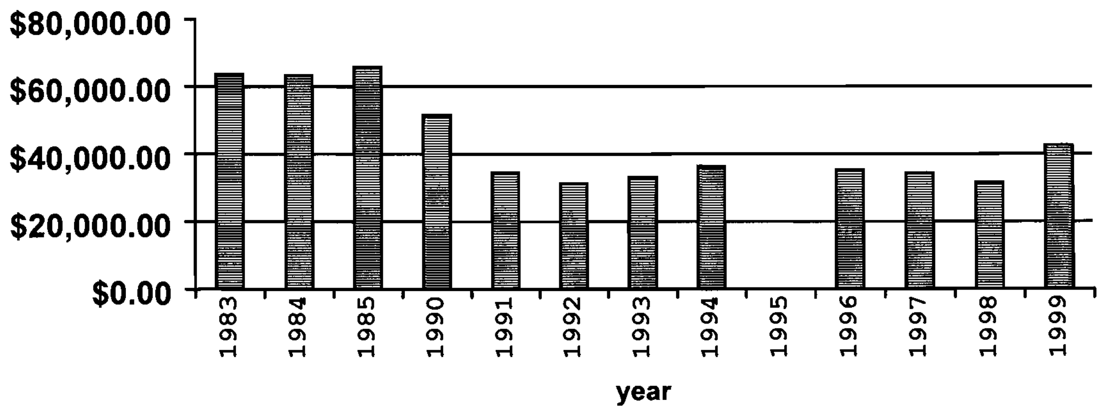
Figure 3: Plant Annual Natural Gas Consumption (1993 - 1998)



The gas consumption depicted in Figure 3 are for the system after the 63 units were disconnected from the system. In comparison, annual gas consumption for 1982 and 1983, when the system was being more fully utilized, was 348,472 m^3 and 358,531 m^3 respectively.

The annual natural gas consumption costs available from the DHS financial records since the system was commissioned are shown in Figure 4. The costs shown include consumption, transmission, metering, administration costs and taxes.

Figure 4: Annual Plant Natural Gas Expenditures



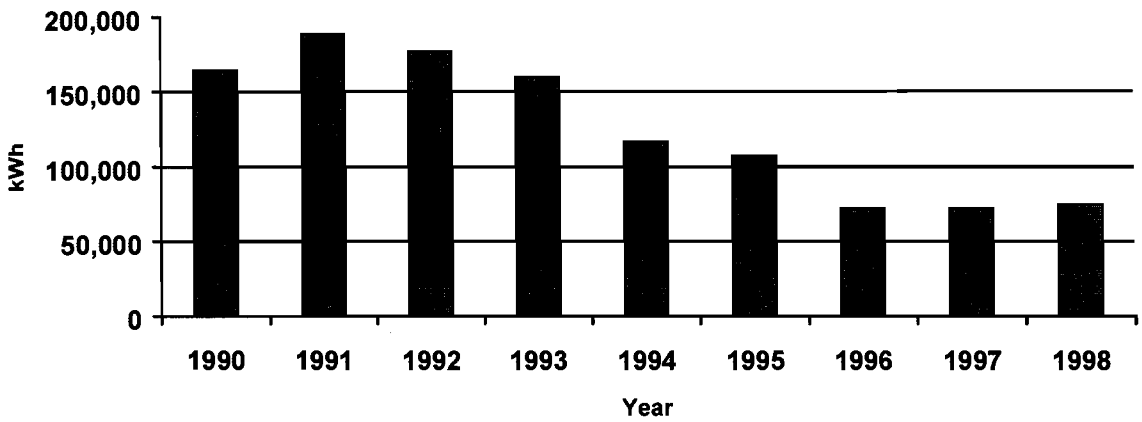
There are no costs available specifically for 1995. The reported costs of natural gas for 1983 and 1984 were $63,472.97 and $63,210.03 (1983$) respectively. The decrease in annual gas use is directly proportional to the load reduction attributable to the disconnection of the 63 units around 1990.

3.1.2 Electricity Consumption

The plant electrical consumption for the years 1990 to 1998 is shown in Figure 5. The monthly electrical consumption for these years is provided in Appendix J. Pre-1990 electricity consumption is also presented in Appendix J but is based on expenditures only as no utility records were available. This appendix also contains a graph of the total electricity use.

The trends in annual electrical consumption are indicative of major changes in the use of electricity. It appears that electricity use was highest in 1985 (not shown). A somewhat lower peak occurred in 1991. From that time on, the use of electricity gradually declined to lower values. The reason for this decline is not readily evident from the consumption or operational history of the system.

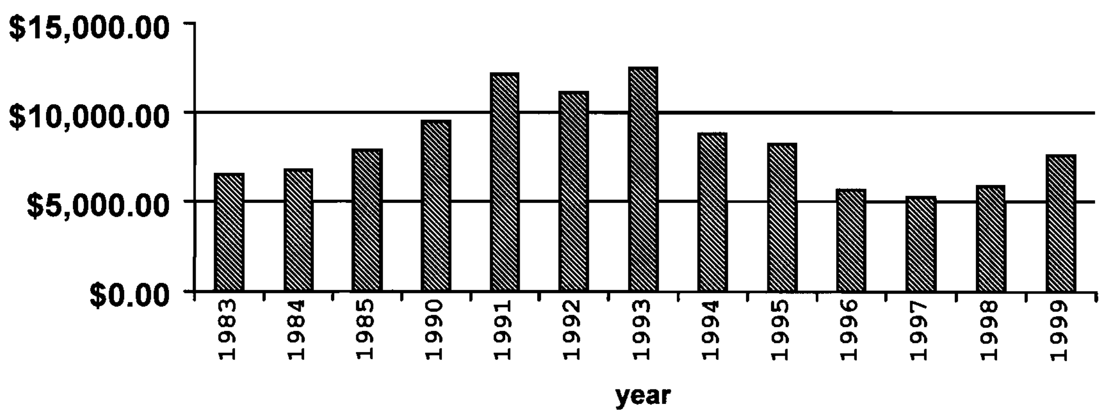
Figure 5: DHS Annual Electricity Consumption



The trend of electricity use in the different seasons in each year is also unclear. This is likely due to infrequent meter readings with many invoices based on an estimate of use.

The annual electricity costs are shown in Figure 6 from the time that the DHS was commissioned. The costs are inclusive of consumption, metering, distribution charges and taxes.

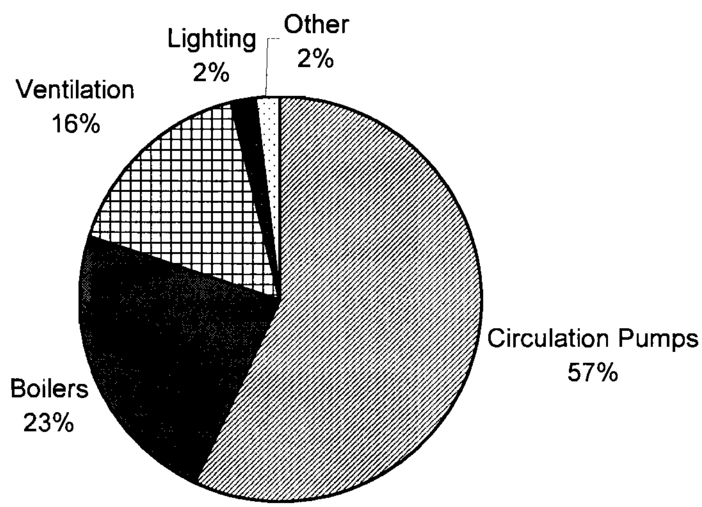
Figure 6: Annual DHS Electricity Expenditures



The costs shown in Figure 6 are those provided in the DHS financial statements, except for the 1994 and 1995 values that were derived from the utility billing records.

An estimated breakdown of the use of electricity in the plant is shown in Figure 7. Most electricity is used by the circulation pumps (57%) and by the fans for the boilers (23%). Therefore, the use of variable speed pump motors may be a viable option. However, variable speed drives are expensive and the pay-back period for this option may range from 10 to 20 years.

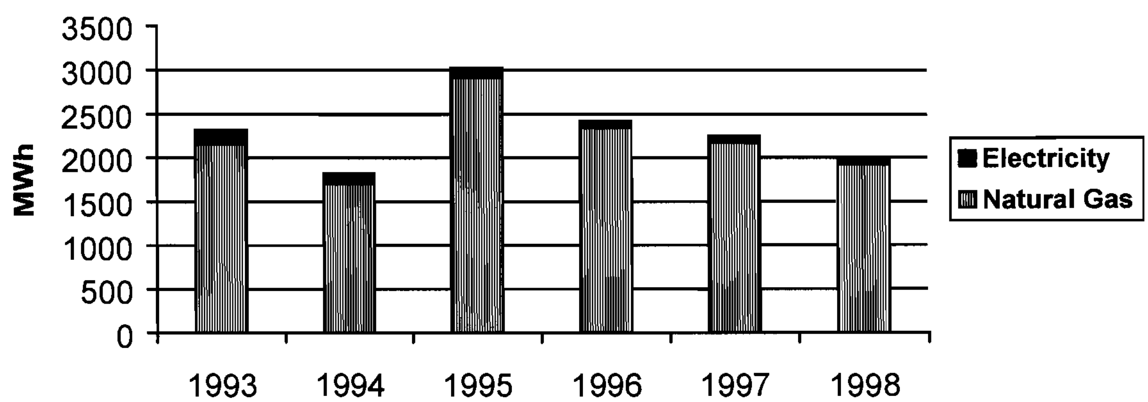
Figure 7: DHS Electricity End Use Points



3.1.3 Total Annual Energy Consumption

The total energy consumption due to natural gas and electricity use for the years that simultaneous and reliable data is available is shown in Figure 8.

Figure 8: Total DHS Annual Energy Consumption



In 1998, the system operated with an electricity use of 74.7 MWh(e) for a thermal input of 1935 MWh(th). The electrical energy consumption for pumping, fans, ventilation and lighting is less than 4% of the thermal energy consumption. However, averaged over time and in terms of costs, the electrical costs are approximately 20% of the total energy expenditures.

On average, 96% of the energy consumed by the DHS is natural gas. The average annual total energy consumption for the given years is 2,305 MWh or 16.2 MWh per dwelling unit. The total average annual energy cost per unit is modest at $300 for the period of 1993 - 1998. By comparison, a 1995 CMHC study of mid-rise residential buildings with natural gas fired space and domestic hot water heating systems found costs in the range of $416 per dwelling unit per year for space heating and hot water[2]. A similar study conducted by CMHC in high-rise residential buildings in Winnipeg in 1993 estimated space and domestic hot water costs at $350 per unit[3].

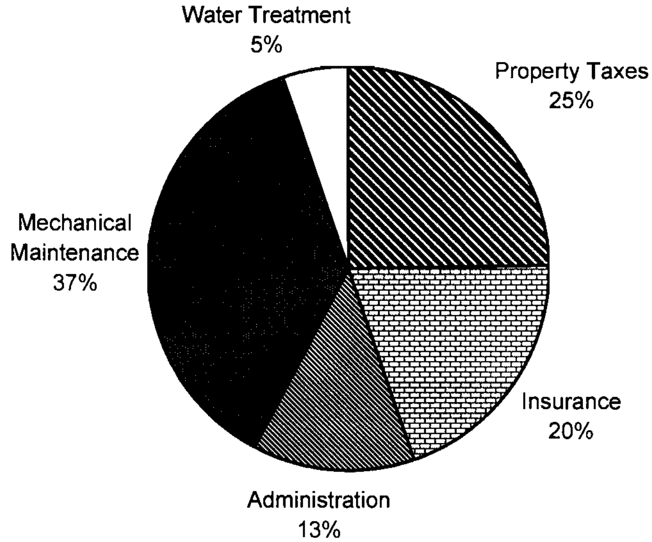
Since 1983, the price of electricity per MWh to the consumer has increased by 89%. The price of gas per cubic metre has increased by 16% since that time.

3.2 Non-Energy Related Expenses

Non-energy related expenses include maintenance costs for the DHS, plant building and site, realty taxes, insurance and administration. The non-energy related expenditures for the Lebreton system were obtained from the DHS financial statements. Several recent statements are shown in Appendix K.

Monthly contributions to a replacement reserve fund are made but are not included in the non-energy costs documented below. An example of the distribution of non-energy expenditures for 1998 is shown in Figure 9. Annual operating expenses are shown in Figure 10 together with natural gas and electricity costs.

Figure 9: Non-Energy Expenditures (1998)



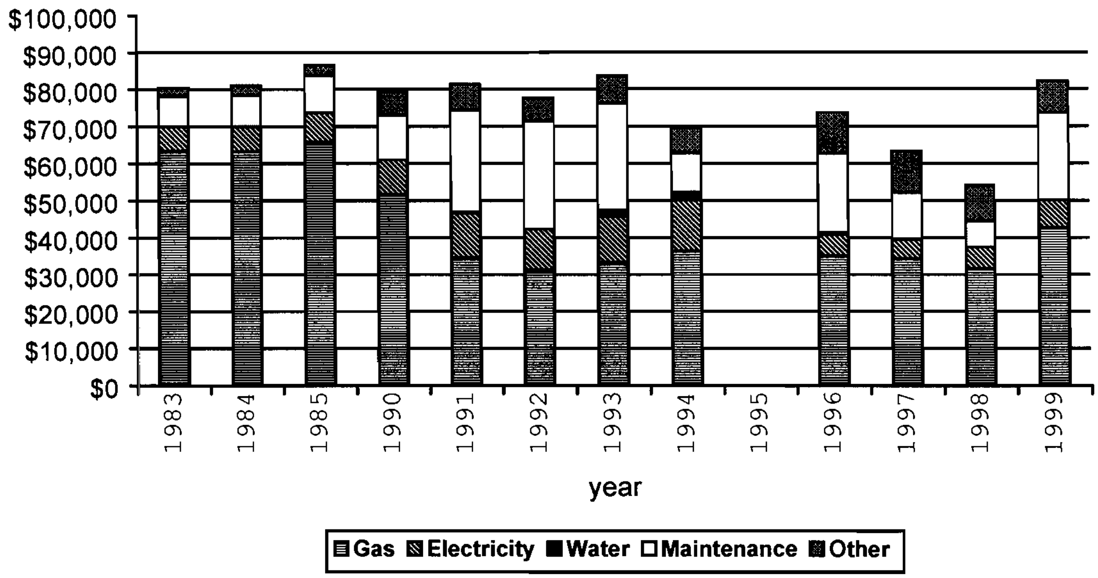
Maintenance, taxes and insurance constitute a significant portion of the total non-energy costs of operating the district heating system. The average non-energy costs since the disconnection of the 63 units in 1990 is $195 per year per unit, excluding allowances for the capital replacement fund.

During the last few years, the expenditures for water and water treatment have been minimal. During the years of 1995 and 1996 the expenditures were higher, presumably due to leaks in the DHS associated with valve freezing and the deterioration of fittings installed to disconnect the 63 units in 1990. Landscaping and grounds keeping costs are modest in 1996 and are likely related to the cleanup after a fitting failure. The maintenance costs include a mechanical service contract that is in the order of $6,000 to $7,000 per year.

3.3 Total DHS Operational Costs

The historical total annual operating costs for the Lebreton Flats District Heating System (exclusive of reserve fund contributions) are presented in Figure 10. The average total annual operating cost of the district heating system for the years shown is $76,059 per year or $496 per unit (adjusted for the disconnection of the 63 units). It is interesting to note that the costs of operation have not increased significantly over time. The impact of the disconnection of the 63 units in 1989-90 can be seen in the change in natural gas consumption. Prior to the disconnection, annual total costs per unit were $400. After the disconnection, the annual total costs per unit were $514 due to the distribution of the non-energy related costs over a smaller client base.

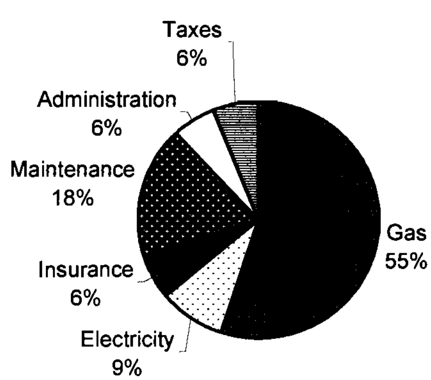
Figure 10: Annual Plant Operating Costs



"Maintenance" expenses in Figure 10 are inclusive of the boiler maintenance contract, mechanical repairs, water treatment, site and building maintenance. "Other" expenses include administration costs and realty taxes.

Figure 11 shows the distribution of the recent average expenses over the years 1996-98. The cost of water and water treatment has been combined with the mechanical maintenance costs. It is clear from Figure 11 that gas purchases (55%) and maintenance (18%) form the bulk of the annual expenses. However, the sum of the other expenses (taxes, administration and insurance) still forms a

Figure 11: Average Breakdown of Expenses 1996-98



significant fraction of the total.

3.4 Assessment of Overall System Performance

The energy performance provides an indication of the district heating system's value for money. Energy costs vary depending on the quality of the energy input source. Electricity, for example, costs about $80/MWh for an individual consumer. The efficiency of electrical energy in terms of heating is almost 100%. Wood chips or sawdust on the other hand can be bought for as low as $10/MWh, depending on the distance of trucking. Space heating and DHW provided by a bio-mass boiler of the size required by for the LeBreton Flats system would have a seasonal efficiency of 70-75% and therefore the energy component of the cost for delivered energy would be about $14/MWh. Natural gas has a price which varies with amount of use and includes connection and delivery charges. In Ottawa, at the rate of use at the boiler plant, the cost is approximately $17/MWh(th). It should be noted that the delivered energy cost must include the capital cost and thermal efficiency of the equipment used, the electrical charges and all maintenance, taxes, insurance and administration in order to be comparable to other heating options.

The cost of delivered energy depends on the efficiency of the energy conversion, i.e. boiler heat losses and stack losses. In the case of a district energy system, the heat losses in the distribution system affect the overall efficiency of energy delivery as well.

The cost per MW delivered to the customers for space heating and DHW was calculated for two recent years for which reasonably accurate figures were available, 1996 and 1998. The cost per MWh includes energy as well as maintenance and other fixed costs. In 1996, the maintenance expenses were higher than normal and the energy use was higher as well due to a cold winter. During 1998, the energy use was average and the maintenance costs were minimal.

The energy performance calculations, using the quoted gas energy content and efficiencies, resulted in the following values. The actual (delivered) energy consumption for the year 1996, corrected for the boiler efficiency (70%, LHV) and ground heat losses (8%) was 1520 MWh. The sum of energy and non-energy related costs was $73,620. The delivered energy cost is therefore $48.44/MWh. The natural gas use was lower in 1998 and the delivered energy was 1246 MWh at a total annual cost of $53,083. The fixed costs were somewhat reduced from the 1996 values, and the delivered energy cost, inclusive of non-energy costs, decreased to $43.37/MWh. Reserve fund contributions for capital replacement and contingency amounts have been excluded from these values. Including the reserve fund contributions would increase the delivered energy cost values by 10 – 20%. The delivered energy cost at the LeBreton Flats DHS can be considered acceptable for thermal heating.

The 1998 delivered energy cost can be broken down in two categories: energy and other costs. The cost per thermal MWh (delivered) for just gas and electricity in the heating plant amounted to $24.35/MWh ($20.54/MWh for gas and $3.81/MWh for electricity use in the plant). The remaining $19.02/MWh is the cost for the non-energy items.

These calculated unit cost values per MWh for space heating and domestic hot water (DHW) service by a DHS can be compared with other forms of energy delivery. For instance, for electricity based systems, the cost of heat is about $80/MWh, not counting the cost of baseboard heaters, electric hot water heaters, their installation and maintenance. To be viable therefore, the cost of heating with a DHS must be less than $80/MWh.

In comparison to other multi-unit residential buildings, a CMHC survey of the energy use of ten high-rise apartment buildings across Canada revealed that on average, the total cost per MWh was $60/MWh[3]. These buildings were heated with natural gas, oil or electricity. However, this quoted value of $60/MWh was exclusive of maintenance costs.

As shown above, the thermal energy delivered to the district heating customers during 1998 was 1246 MWh. For the 142 units served by the system, the average energy used equalled 8.77 MWh per unit per year. Given a total annual cost of $54,040, the cost of energy was $43.37/MWh.

The LeBreton Flats DHS costs compare very well with other heating fuel costs. Even though the boilers are oversized and the system operation can be improved upon, as described elsewhere in this report, these financial figures indicate that the system as a whole is quite economical to operate.

3.5 Physical Condition of Heating Plant and Distribution System

To assess the remaining life of the boilers, a thorough, non-destructive inspection was performed. All boiler tubes were cleaned with a power wire brush. The tubes were then flushed with water and visually inspected. The tube walls were then tested using a non-destructive, ultrasonic based internal rotary inspection system.

It was found that in boiler #1, the walls of 32 of the 70 tubes were below the minimum allowable thickness. External pitting caused this loss in wall thickness. In boiler #2, all 70 tubes were found to be below the minimum allowable wall thickness. As in boiler #1, external pitting caused this loss of wall thickness. The pitting was termed "severe" as the pitting was of a large diameter. The likely cause of the pitting was an inadequate control of water chemistry. The report's recommendation was that the tubes below the minimum allowable thickness in both boilers be replaced. This work was carried out in 2000.

The complete inspection report can be found in Appendix B.

The Federal Industrial Boiler Program (FIBP), the organisation that conducted the study, made several additional observations and recommended the following:

1. Verification that the gas piping is installed in accordance with the CGA code, i.e. gas pressure less than 3.5 kPa (0.5 psig). A pressure gauge should be installed so that the pressure level can be verified,
2. Verification that flame shutoff indicators are working,
3. Install a remote operator callout for boiler failures, and
4. Investigate the possibility of installing a smaller boiler for summer load.

The FIBP report (found in Appendix C) also notes that since the boilers are oversized, they operate for the majority of the time far below the range of optimum efficiency. Cycling the boilers under partial load "on and off" will reduce the efficiency even more. The estimated cost of refurbishing the boilers with new tubes was $8,700.00 per boiler while the installation of fail-safe devices would cost $2,900.00.

No detailed examination of the distribution system was made. However, the system monitoring (described in the next section) indicated that the insulation of the piping network is in reasonably good shape. From the municipal water supply invoices, it appears that no significant leaks are present. The apparent integrity of the insulation and the lack of leaks infers that the pipes are in good condition as well.

3.6 System Monitoring

The distribution system was monitored during the month of 1999 August (provision of DHW only, no space heating) and again during the month of 1999 Novernber, when space heating took place. Besides the system supply temperature, the return temperatures and flows in both East and West Side pipelines were recorded for several days. During the August monitoring period, the supply temperature varied between 85 and 90°C. On the East Side, the flow to the Booth St. CCOC building varied between zero (mostly at night) and 10 m^3/h. The difference between supply and return temperature was measured in the 25 - 30°C range. This temperature difference is expected from heating domestic hot water using an in-tank coil.

The flow going to the West Side was continuous at 25 - 26 m^3/h. Since the thermal load in August is only due to DHW heating, the return temperatures from the West Side were very close to the supply temperature. This indicates that the flow is short-circuited and no significant amount of energy is extracted from the flow. All but one of the domestic hot water tanks on the West Side were examined for control problems but were found to be operating correctly. A discussion with the contractor looking after the systems on the West Side revealed that the building heating systems are shut off in the spring and turned on in the fall.

During the first measurement period, only the domestic hot water systems were operating. The continuous flow on the West side was due to a by-pass valve in the Tompkins building which is opened in the spring to avoid no-flow system conditions. It is important to have a sufficiently high district heating water temperature close to the point of use. The by-pass flow accomplishes this by circulating water even if there is no demand. However, the measured by-pass flow was higher than that required to maintain the DHS temperature level at the DHW systems of the buildings on the West Side at an acceptable level. The temperature difference between supply and return was determined to be about 1°C. On the positive side, this low temperature differential indicates that the insulation of the pipes in the western leg of the system is in reasonable shape.

A consequence of this large by-pass flow is that there is a continuous pumping requirement, which causes electricity to be wasted. More economical variable speed drives (VSD) should be used under these circumstances with the return temperature used to control the speed of the pumps. In the present situation, the amount of bypass flow should be reduced to that which is necessary to prevent operational problems with the pump.

Further system monitoring was carried out in November. During this period, a modest amount of space heating was required. Measurements indicated that the flows to the West Side increased to 39 m^3/h. The temperature differential between supply and return increased to about 4°C. Flows to the East Side increased to 2-14 m^3/h. Due to the increased frequency of problems with the DHW tank controls at 170 Booth, the return temperature was oscillating and the differential between supply and return could not be determined easily.

One reason for higher than required flows during the heating season is uncontrolled flow through some of the individual heating systems. This is the case in some homes and many of the apartments in the Tompkins building. In this situation, the flow through the heating system is constant. The fan is only activated when the thermostat demands heat. This is an inferior control strategy.

It is estimated that coils without fan action can transfer 400-600 W into the living space. Apart from the energy being wasted, if can also cause uncomfortable warm conditions in the shoulder seasons, especially in units with high solar gain. This control strategy leads to higher than required system flows and high system return temperatures.

The reason for modification to the control strategy was to prevent problematic delivery of space heating with the thermostatic control valve. A simple, electrically operated zone valve can reduce this uncontrolled flow to a minimum.

Short term monitoring on individual systems on the West Side was carried out on

1999 November 17, a fairly mild day with temperatures above the freezing point. The supply temperature to the housing units at 30 Preston was measured at 80°C. The DHW tank was equipped with two coils, one above the other and individually controlled. The return temperature from the system was measured at 59.5°C. However, the return temperature from the space heating and DHW systems combined was 75°C, indicating flow short-circuiting through some of the space heating systems. The heating system of the home located above the DHW tank was monitored for a short period and indicated return temperatures between 60 and 65°C. Therefore, the flow to the heating system of this home was controlled. Other space heating systems in this block of five dwellings were obviously not controlled, hence the high return temperature.

Further details on the temperature measurements can be found in Appendix L.

3.7 Interviews with District Heating System Clients

A number of interviews were held with residents of the building served by the district heating system, members of the district heating plant board, maintenance staff and the maintenance contractor to determine past and present opinions on the performance of the district heating plant and its in-house systems.

In general, the residents are satisfied with the space heating and domestic hot water (DHW) service. The temperature levels are generally acceptable, although sometimes the DHW temperature is not constant. It was reported that sometimes the DHW is too hot rather than too cold. In some homes, tenants have difficulties adjusting the space temperature set point because of the different thermostats and regulating valves. The distribution of a clearly written set of heating system operation instructions would be helpful to the residents.

One respondent claimed that he had seen wintertime "hot" spots, where the snow above the heating pipes had melted. This may indicate local deteriorated pipe insulation. However, in Section 3.6 of this report it is shown that overall, the network insulation appears to be in reasonable shape. Also, the residents report being satisfied with the district heating system. The residents that were interviewed reported that it is comfortable in their living space and that there is a sufficient amount of hot water.

During a meeting of the heating plant board (formed by the client housing agencies served by the district heating system), the members expressed unanimous support for the system.

Personal and telephone interviews were held with Mr. Gerald D. Gowan, a heating and plumbing contractor who has serviced the Tompkins Buildings. He indicated that the system, in general, is in very good shape. The maintenance is usually restricted to replacing electric motors on the secondary side pumps. He makes sure that the main building valves of the space heating systems are closed every spring and opened every fall.

When asked about the continuous high flows (much higher than anticipated for summertime operation) in the West Side of the system, Mr. Gowan related the history of the disconnection of the 63 units from the system. He said that when the City Living Complex disconnected from the system, the shut-off valves to the buildings were simply closed. This action resulted in a pipe rupture, when, a few years later, the water in the dead ends froze during a prolonged cold spell. The situation was resolved by removing the valves then welding a section of pipe between the supply and return pipes. However, this action resulted in loss of pressure down the line. Therefore, the lines to the 63 unit complex were capped at the main line.

During periods with no space heating load, water flow through the pipelines is not required when the temperature of the DHW tanks is at or above set point. However, prolonged times of no flow in the piping system can result in cool water temperatures. When the DHW in the storage tanks requires heating, it could take some time before sufficiently hot water arrives at the heat exchanger. Therefore, to avoid no-flow situations during summertime operation with resulting cooled-off DH water near the DHW-tank heat exchanger, a bypass valve in the Tompkins building is routinely opened in the spring to maintain flow. Our measurements indicated that this flow was higher than required. This is further discussed in Section 3.5. It should also be noted here that the absence of flow in a pipeline might be the cause of accelerated corrosion.

3.8 Evaluation of DHS Improvements and Alternative Heating Systems

There are other possibilities to supply the residents served by the Lebreton Flats District Heating System with heat and domestic hot water. Possibilities include the installation of a small Combined Heat and Power system in the plant. Another is the connection of the system to an external district energy system proposed for the downtown Ottawa area. If this plan materialises then a connection may prove to be very economic since the expected price of delivered heat from such a system would be less than $40/MWh.

Another heating option would be to disconnect the resident customers from the distribution system and install individual heating systems. This would involve constructing suitable buildings for the boilers near the larger apartment buildings including stacks, a smaller boiler for the apartment building at 33 Rochester St. and individual furnaces (plus domestic hot water heaters) for the town-homes. Another option, the installation of electric baseboard heating throughout, was not considered due to the negative bias (and high cost) of this heating method, using a very high quality fuel (electricity) for a low quality product: 20°C air or 55°C water.

The Net Present Value (NPV) of four different options was calculated. The different options are listed in Table 5. The NPV is an expression of the monetary value of a project at its inception. The NPV includes the cost of borrowing the initial capital required to establish the project. As time goes by, the project incurs costs such as fuel, maintenance, insurance and taxes. On the positive side, the project generates income from energy sales. For each year, the cost and income are compared. If the initial capital expense in high, then the project will have a negative NPV for the first several years, due to interest payments. If there is sufficient income to offset the costs, the NPV will eventually change from negative to positive. In general, it is desirable to have the NPV become positive in a reasonably short time. The exact time period desired depends also on the equipment lifetime. The NPV calculations in this report are based on a 25-year period of operation.

Table 3: Description of Options

Option 1	Retubing and upgrading the existing boilers
Option 2	Installation of individual boilers and furnaces
Option 3	Installation of two 500 kW boilers
Option 4	Installation of a Combined Heat and Power System

Similarly, the Net Present Cost (NPC) of the options was evaluated. The NPC is a measure of the difference of NPV and net present revenue. The NPC includes the equipment and installation, all gas and electricity purchases, taxes, insurance, maintenance and administration including the interest on these items, but excludes all revenue. The NPC is therefore a method of comparing the cost of different options without considering any income.

Option 1 is the refurbishment of the existing boilers and the continued operation of the present system. A second option is the installation of an individual heating system at each of the buildings and homes. A third option is removal of one of the boilers and the installation of two individual 500 kW boilers. The fourth option is the installation of a CHP system where the exhaust heat is used to supply the DHS and the electricity is used for internal consumption with the remainder sold. In all four options, the bank interest rate was set at 8%. The NPV values are quoted to the nearest one thousand dollars.

Normal escalation factors were applied to the Consumer Price Index (CPI), electrical and Operating and Maintenance (O&M) expenses. The base costs are the averages of the years 1996-1998, the years for which accurate figures were available. The cost of electricity and gas use in the heating plant was included. Taxes, insurance, water treatment, administration and the cost of the mechanical contract were also included. The 1998 LeBreton Flats revenue from heat sales was included at the rate of $75,000 per year. A similar energy revenue stream was used in Option 2 (individual furnaces) so the different options can be compared. In Options 2 and 3 the maintenance and energy use cost have been adjusted for those particular scenarios.

All capital and installation costs are estimates based on experience gained from working on similar projects. Therefore, financial information presented in this report should be considered as estimates and not as quotes.

3.8.1 Option 1: Retubing and Upgrading

To calculate the NPV of Option 1, the system was assumed to remain essentially the same. The boiler repair costs are included. These costs, two times $8,700 plus $2,910 (see Appendix D) are spread over the first two years. The 25-year NPV for the Option 1 scenario is $123k. This means that the value of this proposed project at its onset is equal to $123k. The details can be found in Appendix E. If the $75k per year energy revenue is ignored, the (25-year) NPC equals $908k.

3.8.2 Option 2: Individual Boilers and Furnaces

For Option 2, the following assumptions and cost estimates were used. Each of the larger buildings would have their own boiler at a total installed cost of $150,000 each. This cost includes a structure to house the boiler and the chimney. The cost of a boiler for the 8-unit apartment building is estimated at $15,000 and would be located in the basement. Each of the 25 town-homes would be equipped with a furnace and hot water tank at a cost of $5,000. Maintenance for the individual furnaces and hot water tanks was estimated at $125 per unit, per year. This option would require construction in each building and home and would result in some inconvenience to the occupants.

The two boilers to be installed in the apartment buildings would have a combined maintenance contract valued at $6,031. as per Option 1. The insurance would be reduced to $2,500. The water quality contract for both large apartment buildings was assumed to be $860. The total capital cost for this option is $440,000. The estimates include space preparation. It has also been assumed that the furnaces and hot water tanks in the homes will need to be replaced in 15 years. The cost of electricity was reduced to 25% of the Option 1 level since there are no main circulation pumps in this option. Also, since individual furnaces will operate at a higher efficiency than boilers on an on-off cycle and pipe heat losses have been eliminated, the gas consumption was reduced by 20% compared to Option 1. Taxes and administration are eliminated. Insurance and maintenance now total $11,656.

Assuming that the total project "revenue" would remain at $75k, the 25-year NPV for Option 2 was calculated at negative $25k. The details can be found in Appendix F. The Option 2 NPV is therefore a non-starter. The NPC (no income assumed) of Option 2 was calculated at $1,059k. Option 2 is therefore the most costly option, and is therefore not recommended.

3.8.3 Option 3: Installation of Smaller Boilers

In Option 3, one boiler is removed to make room for two smaller (500kW) modulating boilers. The purchase price including installation is estimated at $75k. These boilers are capable of being operated in a much more efficient configuration and are estimated to reduce gas consumption by 15%. Maintenance on these units has been reduced to $12k. Electricity use in this option has been reduced by 5% due to lower blower fan requirements. The NPV of this option is $243k, which is much higher than that of Option 1. The details can be found in Appendix G. The Option 3 NPC was calculated at $847k, a cost that is lower than that of Option 1.

3.8.4 Option 4: Combined Heat and Power

In this option, the boilers are retubed and a 75kW microturbine is installed. The installed cost of the turbine is estimated at $1,500/kW. The electricity generated by the turbine supplies the needs of the plant and the remainder is sold to the grid at $0.045/kW for a total $23,625. The recoverable heat from the turbine amounts to about 150 kW and this heat is used to supply the DHS. Since the heat supplied by the CHP system is much less than the peak load, heating beyond this level is supplied by the boilers. Since it is base loaded, it is estimated that the CHP system supplies about 40% of the total yearly heating energy requirements.

To calculate the NPV of the CHP option, the total maintenance cost has been increased by 3% of the capital cost of the microturbine or $3,375. It is anticipated that the CHP system will cause the amount of administration to increase to $9000 per year. Because gas is now used to generate electricity in addition to heat, the amount of gas use has increased and the cost estimated at $46,628. With these figures, the NPV was calculated at $116k. The details are shown in Appendix H. The NPC was calculated using revenue of $23,625 in order to keep a comparison with the other options possible. The NPC was calculated as $592k. This compares with the other options as shown in Table 2.

Table 2: Comparison of Options 1-4

Option	Net Present Value	Net Present Cost
1. Present Situation	$123k	$908k
2. Indiv. Furnaces & Boilers	$-25k	$1,059k
3. 2-500kW Boilers	$243k	$847k
4. Combined Heat & Power	$116k	$592k

It should be noted that the cost estimates in Table 2 are based on educated estimates and are based on experience with similar projects. A more detailed study with refined estimates should be performed for any option that is considered for construction. However, the estimates in Table 2 are useful for comparisons between the options.

3.8.5 Connection to Another Heat Source

The possibility of obtaining waste heat from a nearby source (paper mill or CHP-plant) is attractive. A new development on LeBreton Flats is actively being considered. It is estimated that the thermal energy purchased from such a source may be in the order of $20-30/MWh. Pipeline construction between the source of this thermal energy and the present plant is required. It is estimated that the cost of this pipeline would add $8-10/MWh to the cost of the heat. The total cost would therefore be less than $40/MWh. This is a very attractive cost for delivered energy to the LeBreton Flats district heating system.

3.8.6 Discussion of DHS System Improvements

The NPV values for the four options listed in Table 2 indicate that the most economical option for the LeBreton Flats District heating system is to replace one of the existing boilers with two high efficiency 500 kW boilers. This will reduce the gas consumption by up to 15% and electricity use by 5%.

The installation of individual furnaces and boilers would result in the highest immediate expense and the lowest NPV. This option is therefore not recommended.

The CHP option with electricity sales to the grid does not appear to result in the best economic operation, since it has a low NPV. This is due to the high cost of installing a CHP-system.

Therefore, it is recommended that one of the boilers be replaced with two smaller, high efficiency, modulating boilers. This option accommodates the possibility of future connection to an economical source of thermal energy. The use of waste heat from an external source would also reduce some of the non-energy costs. Insurance on the plant would be eliminated. Mechanical maintenance could be reduced by 75-80%. Connection to an external source of thermal energy is considered to be the best option for the future.

The option with the immediate least capital expense is the refurbishment of the boilers, although this is not necessarily the best long-term solution.

A predefined maintenance plan should be established to manage the cost of the equipment and spare parts. Using the FBI survey described in Appendix C, a plan can be developed for the next 5 years of operation, enabling an estimate to be made of the overall cost of upkeep. Developing such a program will allow maintenance costs to be anticipated and budgeted for.

4.0 CONCLUSIONS

The observations and calculations undertaken during this study indicate that the Lebreton Flats District Heating System, over 20 years of operation, has been, and continues to be, both economical and reliable. The system is more than capable of supplying adequate space heat and domestic hot water to the buildings served.

The system does not operate at its optimum efficiency. There are a number of relatively straightforward actions that could be implemented that would improve the operating conditions and reduce the overall cost of the operation.

If the existing system is maintained in its present state, an improvement in economics may be obtained through the simple adjustment of the boiler operation. The simplest approach would be to improve the capacity factor. The low capacity factor of boiler operation during most of the year reduces the system efficiency. This is especially true during the summertime, when only domestic hot water is required. Also, the boiler efficiency is reduced due to the cyclical operation of the boiler. If the boiler must operate in a cyclical manner then several long cycles are better than many short cycles. Some form of storage tank may provide a measure of improvement in the process.

The high flows to the West Side of the system are also a major impediment to the system's efficiency. The constant high flow rate indicates a high electrical draw for the circulating pumps. To reduce the amount of electricity used by the pumps, the installation of variable speed pumps (or a smaller pump in parallel) is recommended. However, this should only be done following the reduction of the West Side bypass flow.

Eliminating unwanted hot water flow through the air heating coils within individual units when the set temperature has been reached can make an improvement in the comfort level within the buildings. A simple way of achieving this would involve the installation of a zone valve that operates in parallel with the forced air circulator.

The evaluation concluded that the DHW systems that were monitored were functioning well at the time of inspection. Some evidence of sporadic malfunctioning of one or more of the control systems has been found and further monitoring will help indicate if the situation is serious or not.

Increasing the customer base for the district heating system should be a priority as the system can take on more load without incurring significant costs for major boiler or distribution system upgrades. Increasing the number of clients served by the system will also help to distribute the non-energy related costs of operation over a larger client base thereby reducing the overall cost of energy produced by the plant.

While it is possible to replace the existing system with either individual systems or with a power generating system, it is felt that the existing infrastructure would not justify either the immediate capital cost or the inconvenience placed upon the tenants. Maintaining the status quo, albeit in an improved state would offer the potential for incorporating advanced technology (microturbines or external district energy systems) when they become available within a 5 year timeframe. Installing replacement boilers will create an immediate saving, but a long-term commitment. Replacing one of the existing boilers with two high efficiency, 500 kW boilers is recommended as the best option for the system. This option will reduce energy use and has the highest NPV of the options investigated.

5.0 FUTURE OPPORTUNITIES

Another possibility for reducing the non-energy cost is to connect to a source of waste heat. The development of the LeBreton Flats is now actively being considered. It is expected that this development will be supplied with waste heat from a local paper mill or a large CHP plant. It would be very attractive financially to connect to such a source. Most of the non-energy related costs would be saved as well as all the gas purchases. It was estimated that the pipeline required to transport the water to the existing plant would add less than $10/MWh to the delivered energy cost.

It has been shown in the report that this thermal energy may be available for less than $40/MWh. This would make the DHS option very attractive economically. It is expected that this development may be completed in as little as 3-4 years.

A possibility for cost reduction is to sell more heat. While most of the fixed costs remain the same, higher heat sales mean lower unit cost. This requires the connection of additional loads.

ACKNOWLEDGEMENTS

The initial review of LeBreton Flats DHS financial statements and fuel invoices was done by Julia Matynska. Tom Onno performed the monitoring on the system and suggested explanations for the sometimes peculiar performance of the system. Carl Chaboyer did a great job in assisting with site inspections, cost estimates and suggested improvements to the draft report. His encouragement throughout the project is very much appreciated. Ken Church provided the basis for the Net Present Value spreadsheets and provided helpful comments on the draft of the report. Lynn Ciavaglia used his know-how to determine the system flows. Finally, Michael Wiggin provided instructive comments, which resulted in an improved structure of the report and an improved background on the quoted cost values.

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2. Scanada Consultants Limited, "Field Investigations of Indoor Environment and Energy Usage in Mid-Rise Residential Buildings", Canada Mortgage and Housing Corporation, 1997.
3. Scanada Consultants Limited, "Energy Audits of High-Rise Residential Buildings", Canada Mortgage and Housing Corporation, 1996.

APPENDIX A

Work Objective Statement

Work Objective:

To provide CMHC and the consumers of the LeBreton Flats Central Heating plant with the necessary information to make well-informed choices regarding the continued operation of the heating plant. Information to be provided will consist of data on the past plant maintenance cost and future expected costs and the efficiency of past and present operation. Recommendations for improved operations and possibilities for an expanded business case will be presented.

Tasks:

1 To gain a full appreciation for the operation of the district heating system, interviews will be held with all stakeholders including customers, committee members, members of the original design team, contractors etc. The information collected during the interviews will help develop a good understanding of the different requirements and desires of the various stakeholders. NRCan will work with CMHC in the development of the questionnaire instrument.

1 Review of previous fuel expenditures: This review will provide a historical perspective to the operation and maintenance of the system. It will also serve to identify the seasonal energy load profile of the district heating system and will help determine the magnitude of additional heat loads that can be connected to the system. CMHC and the stakeholders will provide all available expenditure files for this purpose.

3. System Energy Performance: The results of Tasks 1 and 2 will be used to establish the energy performance of the present system. The annual energy consumption, energy costs, maintenance and repair costs, cost per MWh delivered (based on input energy consumption only and input energy consumption and annual reserve fund contribution requirements) and seasonal energy efficiency will be established so that a comparison with other heat sources can be made.

4. Concurrently, work will be undertaken to investigate the general health of the heat generation and distribution system. For this task, historical records on maintenance and repairs, as supplied by CMHC and the community stakeholders will be reviewed. Non-destructive evaluation methods will be evaluated and employed, if feasible. The outcome of this task will result in an estimate of the maintenance and major repair and replacement requirements and associated costs over the next 30 years. The review of historical records will be undertaken by CES-staff. On the basis of the CES results, a reputable engineering company, acceptable to CMHC, will be contracted to provide the estimate of the reserve fund requirements necessary to sustain the heating systems over the next 35

year period.

5 Review of other heating options for the community: Installation and use of other heating systems such as electric baseboard heating and individual gas-fired furnaces - domestic hot water systems will be evaluated from a cost-benefit point of view and a comparative analysis will be performed based on installed cost, estimated annual cost for fuel, services and major repairs and replacements over time. Recommendations regarding the best options available to the housing community stakeholders will be presented.

5 Interim report: Using the information obtained from Tasks 1-5 and preliminary information from Task 7, an interim report will be prepared. This report will contain the assessment of the condition and performance of the existing district heating system and the submission of recommendation regarding the continued operation of the system in light of other heating options available.

5 Heating system performance monitoring: Monitoring of flows, supply and return temperatures in the power plant and individual buildings and homes will allow the determination of diurnal and seasonal load profiles. Where instrumentation is lacking, CES will undertake to connect instrumentation in a non-intrusive way, if possible, and monitor the systems for a few days at the time. This monitoring will take place during the spring, summer, fall and winter seasons to obtain data at different climatic conditions. The results of this monitoring will allow an evaluation of the operational efficiency of the system under different load conditions. The boiler efficiency will be calculated. Comparisons with other, similar systems can be made and the amount of short-circuited flow (if any) can be estimated.

5 The operation of the present system with the connected loads will be simulated using LICHEAT-software. The results of this analysis will determine the adequacy of the piping for the intended loads and possible additional loads. Opportunities for connecting other loads within a reasonable radius of the power plant will be identified and actively pursued.

5 Based on the outcome of the LICHEAT analysis, possibilities for the connection of other heat sources will be explored. This task will be done concurrently with tasks 1-5. Waste heat from the E.B. Eddy plant or the Cliff St. Plant are possibilities. Alternatively, the use of a small co-generation device will be investigated, especially relative to economics and the thermal energy capacity factor.

5 Review of ownership options: A number of possibilities for plant ownership and/or management and the underground piping will be explored. Possible

alternative ownership/management arrangements include ESCO management, local utility or stakeholder ownership, etc.

5 Final Report: A final report will be issued that summarizes the results of the interim report (with the interim report included in the appendices of the final report). The findings of the interim will be evaluated in light of the findings of the seasonal performance monitoring and changes will be made as necessary. The final report will document the findings of Tasks 7 through 10.

Upon completion of the monitoring, an appendix to the report will be prepared. It is not expected that any conclusions will be invalidated by the monitoring results. However, should the results indicate that one or more of our recommendations can be improved, the entire report will be updated and re-issued as the final report.

APPENDIX B

Boiler Inspection Report

EXECUTIVE SUMMARY

This report is based on the non-destructive testing survey of the tubes in two firetube boilers located at Lebreton Flats Non Profit Community Housing Central Heating Plant. The survey was conducted for the Federal Industrial Boiler Program by To-Spec Inspection Services Inc., during the month of August, 1999.

The purpose of this survey was to determine by non-destructive testing, the true state of the boiler tubes. The scope of inspection and testing carried out included the following:

1) Power wire brush cleaning of all tubes in both boilers.

2) Flushing all tubes with water.

3) Visual inspection of all tubes.

4) Testing of all tubes using the internal rotary inspection system (I.R.I.S.).

SUMMARY OF FINDINGS

- In boiler #1, 32 tubes were found to be below the minimum allowable wall thickness.
  Wall lose was caused by external pitting on all tubes.

- In boiler #2, 70 tubes were found to be below the minimum allowable wall thickness.
  Large diameter severe pitting was found. Pitting was external on all tubes.

The following action items have been identified

If the original design integrity of the boilers is to be preserved, tubes below the minimum allowable wall thickness should be replaced.

Table of Contents.

Background

This report is based on the non-destructive examination (NDE) survey of the tubes in boilers 1 and 2 at the Lebreton Flats Non Profit Community Central Heating Plant, located at 31 Rochester ST., Ottawa, Ontario. The survey was conducted by To-Spec Inspection Services Inc., during the week of August 8, 1999.

The purpose of this survey was to determine by visual and non-destructive testing the true state of the tubes to which we were given access. The I.R.I.S. 3000 Internal Rotary Inspection System was used to obtain wall thickness information on the tubes. I.R.I.S. inspection is digitized ultrasonic testing employing the emmersion technique. Water is the means of coupling between the transducer and the tube. The transducer is contained in a water driven turbine, which is held within the tube by a centering device. The ultrasonic pulses are emitted along a path parallel to the tube axis through an aquatic medium. The pulses are then reflected radially by a 45 degree mirror to the wall of the tube. The mirror turns by the action of the turbine. The reflections or echoes reflected by the inner and outer walls of the tube follow the same path back to the transducer. The time interval between the first reflection from the inner wall and the reflection from the outer wall of the tube gives the wall thickness. Readings were taken along the entire internal, length of the tubes.

In order to achieve the high degree of accuracy inherent with this technology, it is very important that the tubes to be inspected be thoroughly cleaned internally.

2.0 INSPECTION AND TESTING OF BOILERS

TO-SPEC INC.
INSPECTION AND TESTING

C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

INSPECTION REPORT

CLIENT: Lebreton Flats Non Profit Community Heat Plant.

Site and date of inspection: Central Heating Plant , Ottawa Canada. 11 and 12 August 1999.

Scope of inspection: To determine the minimum thickness on the 2.5" O.D. tubes of boiler #1 and 2.

Technique:

The immersion ultrasonic method using the I.R.I.S process was used. A 15 MHZ .250" dia. probe with a focal lens (Panametrics serial # VS019 161478) was used , with the IRIS instrument serial # 14322. Tube #1 was as on the diagram, and the 0 inch origin point of inspection was opposite the burner side for Boiler #1 and at the burner side for Boiler #2.

Equipment(s) inspected: Boiler #1 and #2.

Summary of results:

Boiler #1:

The Nominal wall thickness is 0.120"
The minimum thickness found was 0.090" caused by External Pitting. The General thickness was ranging from 0.110" to 0.115" and reaching 0.100" at pitted area. The pitting was external on all tubes.

Boiler #2:

The minimum thickness found was 0.070" caused by External Pitting. The General thickness was ranging from 0.110" to 0.115" and reaching 0.070" at pitted area. The pitting was external on all tubes. The pitts were severe and with a diameter of up to 40 degree of arc as shown in picture of tube A28.

The wall thicknesses of the tubes , are individually written in its (their) own following report(s).

Technician(s): Pierre Gauvin.
Report Date: August 12 1999.

2.1 BOILER #1 I.R.I.S. RESULTS

TO-SPEC INC. C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
INSPECTION AND TESTING N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

Client: Lebreton Flats N.P. Com. H.P. Equipment: Boiler No. 1
Tube Diameter (O.D): 2.500" Tube Thickness (nominal): 0.120" Length: 12'06"
Material: Steel (Carbon) Velocity: 5930m/s Area: Ottawa,31 City Living
Inspection from: 0" Opposite burner, Tube A1 as in Drawing

ROW TUBE	*	MIN.	THICKNESS	DISTANCE MIN.	MAX.	COMMENT
A-1	*	0.100"	to "	0' 6"	to 12' 6"	E.PT
A-2		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-3		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-4		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-5		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-6		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-7		0.110"	to "	0' 6"	to 12' 6"	E.PT
A-8		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-9		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-10		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-11		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-12		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-13		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-14		0.110"	to "	0' 6"	to 12' 6"	E.PT
A-15		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-16		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-17		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-18		0.110"	to "	0' 6"	to 12' 6"	E.PT
A-19		0.110"	to "	0' 6"	to 12' 6"	E.PT
A-20		0.110"	to "	0' 6"	to 12' 6"	E.PT
A-21		0.110"	to "	0' 6"	to 12' 6"	E.PT
A-22		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-23		0.110"	to "	0' 6"	to 12' 6"	E.PT
A-24		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-25		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-26		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-27		0.100"	to "	0' 6"	to 12' 6"	E.PT
A-28		0.100"	to "	0' 6"	to 12' 6"	E.PT
B-1	*	0.090"	to "	0' 6"	to 12' 6"	E.PT
B-2		0.100"	to "	0' 6"	to 12' 6"	E.PT
B-3		0.100"	to "	0' 6"	to 12' 6"	E.PT
B-4		0.105"	to "	0' 6"	to 12' 6"	E.PT
B-5		0.110"	to "	0' 6"	to 12' 6"	E.PT
B-6		0.110"	to "	0' 6"	to 12' 6"	E.PT
B-7		0.110"	to "	0' 6"	to 12' 6"	E.PT
B-8		0.110"	to "	0' 6"	to 12' 6"	E.PT
B-9		0.110"	to "	0' 6"	to 12' 6"	E.PT

:chnician(s): Pierre Gauvin

PT= Internal pitting ICC/E= Corosion Erosion at baffle
PT= External pitting DPP @= Distance at which probe cannot pass
CR= Internal corrosion I.E= Internal erosion '= Foot "= Inch
CR= External corrosion E.E= External erosion *= Picture

TO-SPEC INC.
INSPECTION AND TESTING

C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

Client: Lebreton Flats N.P. Com. H.P. Equipment: Boiler No. 1
Tube Diameter (O.D): 2.500" Tube Thickness (nominal): 0.120" Length: 12'06"
Material: Steel (Carbon) Velocity: 5930m/s Area: Ottawa,31 City Living
Inspection from: 0" Opposite burner, Tube A1 as in Drawing

ROW TUBE *	MIN. THICKNESS		DISTANCE MIN.		MAX.	COMMENT
B-10	0.110" to	"	0' 6"	to	12' 6"	E.PT
B-11	0.105" to	"	0' 6"	to	12' 6"	E.PT
B-12	0.100" to	"	0' 6"	to	12' 6"	E.PT
B-13	0.105" to	"	0' 6"	to	12' 6"	E.PT
B-14	0.100" to	"	0' 6"	to	12' 6"	E.PT
B-15	0.110" to	"	0' 6"	to	12' 6"	E.PT
B-16	0.105" to	"	0' 6"	to	12' 6"	E.PT
B-17	0.110" to	"	0' 6"	to	12' 6"	E.PT
B-18	0.110" to	"	0' 6"	to	12' 6"	E.PT
B-19	0.105" to	"	0' 6"	to	12' 6"	E.PT
B-20	0.110" to	"	0' 6"	to	12' 6"	E.PT
C-1	0.110" to	"	0' 6"	to	12' 6"	E.PT
C-2	0.120" to	"	0' 6"	to	12' 6"	
C-3	0.110" to	"	0' 6"	to	12' 6"	E.PT
C-4	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-5	0.105" to	"	0' 6"	to	12' 6"	E.PT
C-6	0.110" to	"	0' 6"	to	12' 6"	E.PT
C-7	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-8	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-9	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-10	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-11	0.120" to	"	0' 6"	to	12' 6"	
C-12	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-13	0.110" to	"	0' 6"	to	12' 6"	E.PT
C-14	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-15	0.120" to	"	0' 6"	to	12' 6"	
C-16	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-17	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-18	0.110" to	"	0' 6"	to	12' 6"	E.PT
C-19	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-20	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-21	0.115" to	"	0' 6"	to	12' 6"	E.PT
C-22	0.110" to	"	0' 6"	to	12' 6"	E.PT

chnician(s): Pierre Gauvin

PT= Internal pitting ICC/E= Corosion Erosion at baffle
PT= External pitting DPP @= Distance at which probe cannot pass
CR= Internal corrosion I.E= Internal erosion '= Foot "= Inch
CR= External corrosion E.E= External erosion *= Picture

TO-SPEC INC. C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
INSPECTION AND TESTING N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

Client: Lebreton Flats N.P. Com. H.P. Equipment: Boiler No. 1
Tube Diameter (O.D): 2.500" Tube Thickness (nominal): 0.120" Length: 12'06"
Material: Steel (Carbon) Velocity: 5930m/s Area: Ottawa,31 City Living
Inspection from: 0" Opposite burner, Tube A1 as in Drawing

ROW TUBE	*	MIN. THICKNESS	DISTANCE MIN.	MAX.	COMMENT

The following tube(s) have lost 12.5% or more of their nominal thickness:

A/1	A/2	A/3	A/4	A/5	A/6	A/8	A/9	A/10	A/11
A/12	A/13	A/15	A/16	A/17	A/22	A/24	A/25	A/26	A/27
A/28	B/1	B/2	B/3	B/4	B/11	B/12	B/13	B/14	B/16
B/19	C/5								

Technician(s): Pierre Gauvin

I.PT= Internal pitting ICC/E= Corosion Erosion at baffle
E.PT= External pitting DPP @= Distance at which probe cannot pass
I.CR= Internal corrosion I.E= Internal erosion '= Foot "= Inch
E.CR= External corrosion E.E= External erosion *= Picture

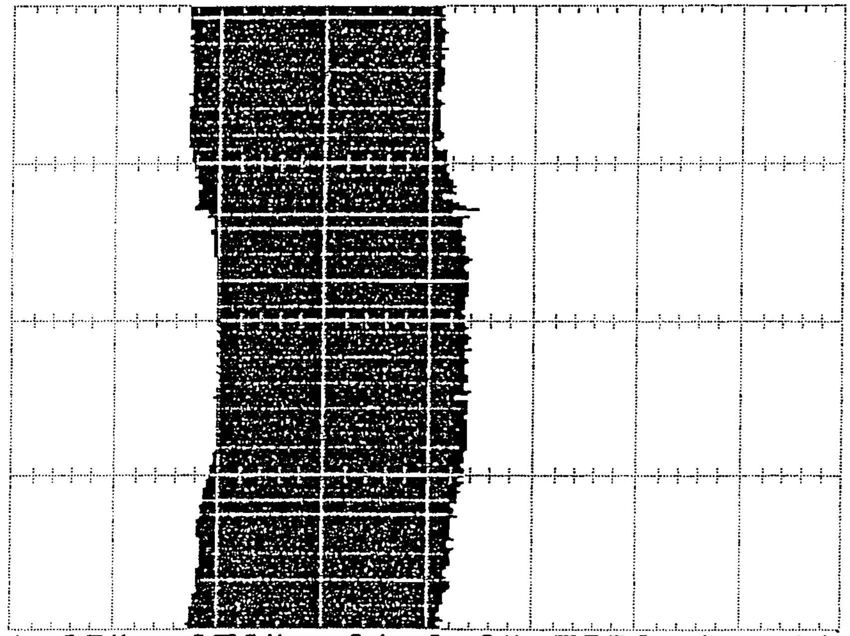
TO-SPEC INC.
INSPECTION AND TESTING

C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

Lebreton Flats 11/08/99
Boil# 1 2.5/.120"/12'6" A 1

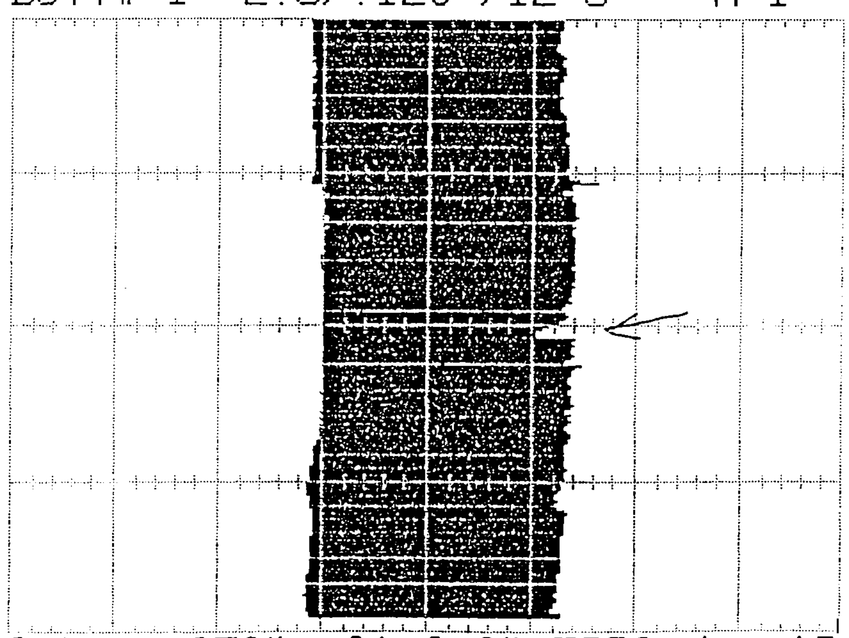


1.03" .050" 0' 0.0" 5930m/s A1

Defect type: NONE

Minimum Wall Thickness: .120

Lebreton Flats 11/08/99
Boil# 1 2.5/.120"/12'6" A 1



Defect type: EXTERNAL PITTING

Minimum Wall Thickness: .100

TO-SPEC INC.
INSPECTION AND TESTING

C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
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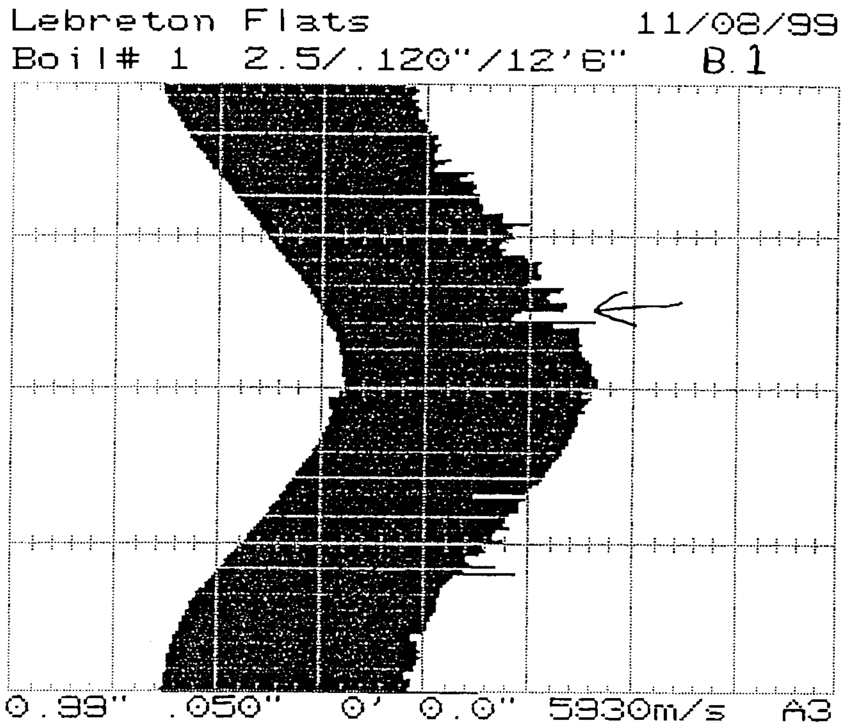
TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

Defect type: EXTERNAL

PITTING

Minimum Wall Thickness: .090

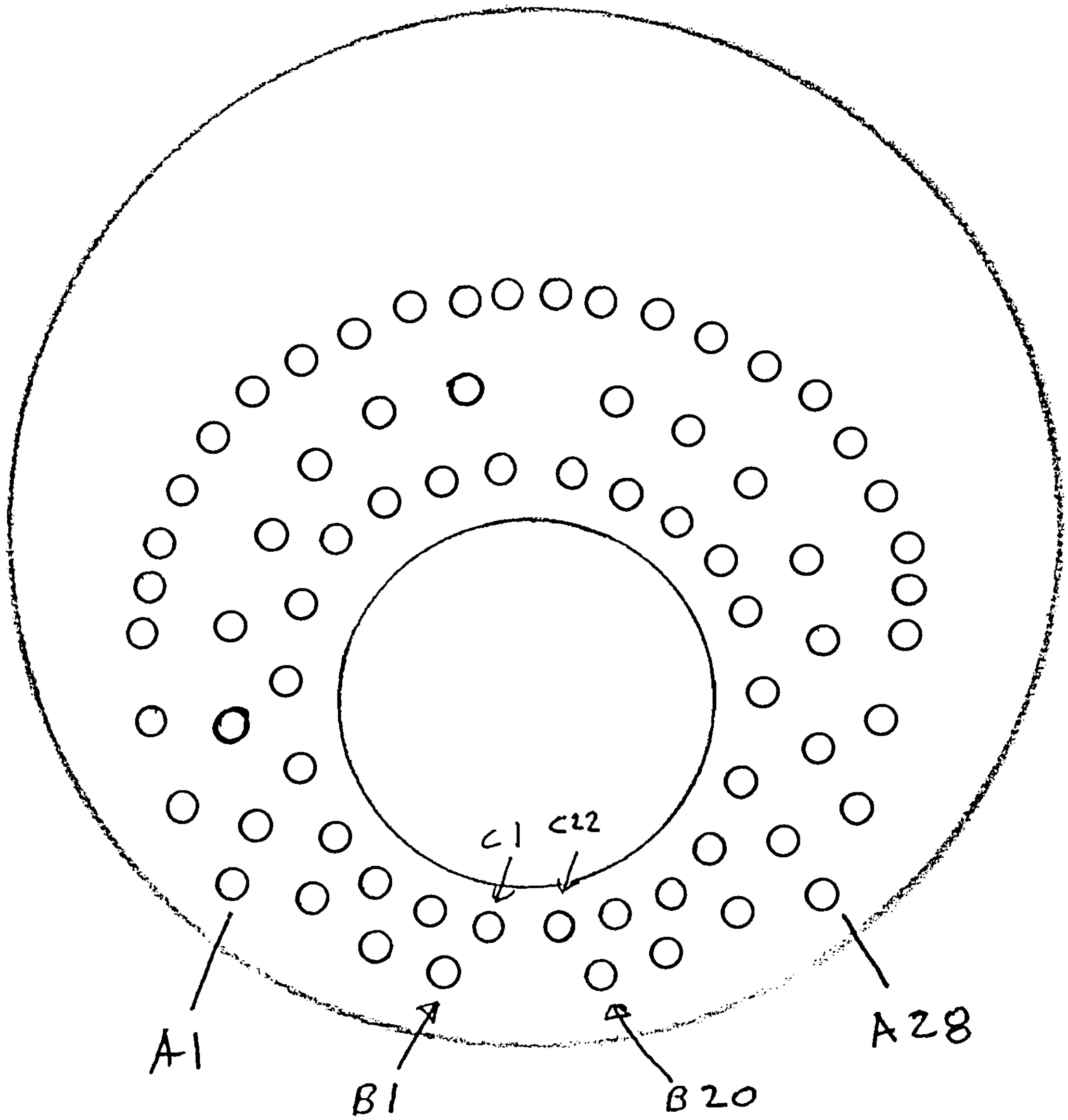


TO-SPEC INC. C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
INSPECTION AND TESTING N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

BOILER #1 AND #2



VIEW FROM OPPOSITE SIDE OF BURNER FOR BURNER #1
AND FROM BURNER SIDE FOR BOILER #2

* NOT TO SCALE

2.2 RECOMMENDATIONS

If the original design integrity of the boiler is to be preserved, tubes below the minimum allowable wall thickness should be replaced.

2.3 BOILER #2 I.R.I.S. RESULTS

TO-SPEC INC.
INSPECTION AND TESTING

C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

Client: Lebreton Flats N.P. Com. H.P. Equipment: Boiler No. 2
Tube Diameter (O.D): 2.500" Tube Thickness (nominal): 0.120" Length: 12'06"
Material: Steel (Carbon) Velocity: 5930m/s Area: Ottawa, 31 City Living
Inspection from: 0" at burner side, Tube A1 as in Drawing

ROW TUBE	*	MIN. THICKNESS		DISTANCE MIN.		MAX.	COMMENT
B-10		0.090"	to "	0' 6"	to	12' 6"	E.PT
B-11		0.100"	to "	0' 6"	to	12' 6"	E.PT
B-12		0.080"	to "	0' 6"	to	12' 6"	E.PT
B-13		0.085"	to "	0' 6"	to	12' 6"	E.PT
B-14		0.095"	to "	0' 6"	to	12' 6"	E.PT
B-15		0.085"	to "	0' 6"	to	12' 6"	E.PT
B-16		0.085"	to "	0' 6"	to	12' 6"	E.PT
B-17		0.090"	to "	0' 6"	to	12' 6"	E.PT
B-18		0.090"	to "	0' 6"	to	12' 6"	E.PT
B-19		0.090"	to "	0' 6"	to	12' 6"	E.PT
B-20		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-1		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-2		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-3		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-4		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-5		0.085"	to "	0' 6"	to	12' 6"	E.PT
C-6		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-7		0.085"	to "	0' 6"	to	12' 6"	E.PT
C-8		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-9		0.085"	to "	0' 6"	to	12' 6"	E.PT
C-10		0.095"	to "	0' 6"	to	12' 6"	E.PT
C-11		0.085"	to "	0' 6"	to	12' 6"	E.PT
C-12		0.095"	to "	0' 6"	to	12' 6"	E.PT
C-13		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-14		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-15		0.085"	to "	0' 6"	to	12' 6"	E.PT
C-16		0.085"	to "	0' 6"	to	12' 6"	E.PT
C-17		0.095"	to "	0' 6"	to	12' 6"	E.PT
C-18		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-19		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-20		0.090"	to "	0' 6"	to	12' 6"	E.PT
C-21		0.100"	to "	0' 6"	to	12' 6"	E.PT
C-22		0.090"	to "	0' 6"	to	12' 6"	E.PT

chnician(s): Pierre Gauvin

PT= Internal pitting ICC/E= Corosion Erosion at baffle
PT= External pitting DPP @= Distance at which probe cannot pass
CR= Internal corrosion I.E= Internal erosion '= Foot "= Inch
CR= External corrosion E.E= External erosion *= Picture

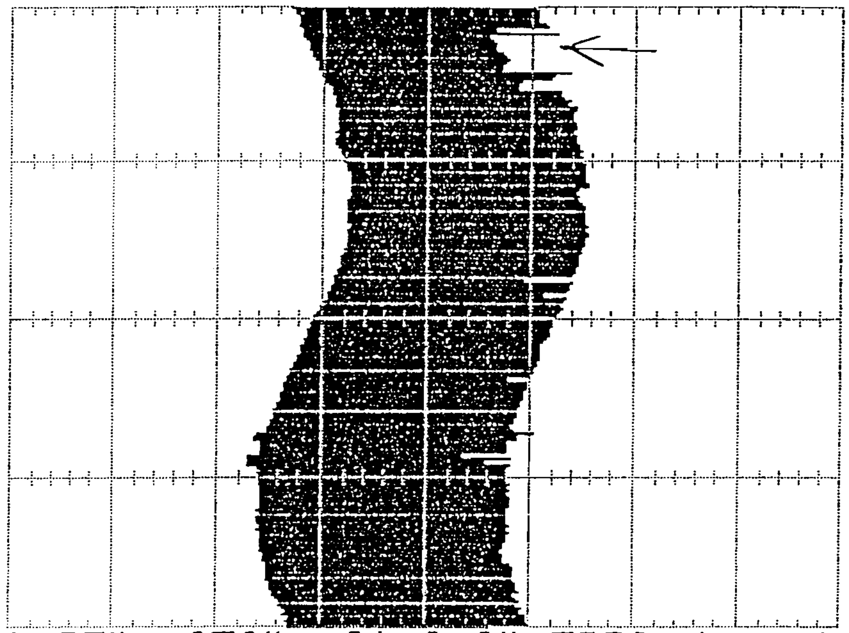
TO-SPEC INC.
INSPECTION AND TESTING

C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

Lebreton Flats 12/08/99
Boil# 2 2.5/.120"/12'6" A1

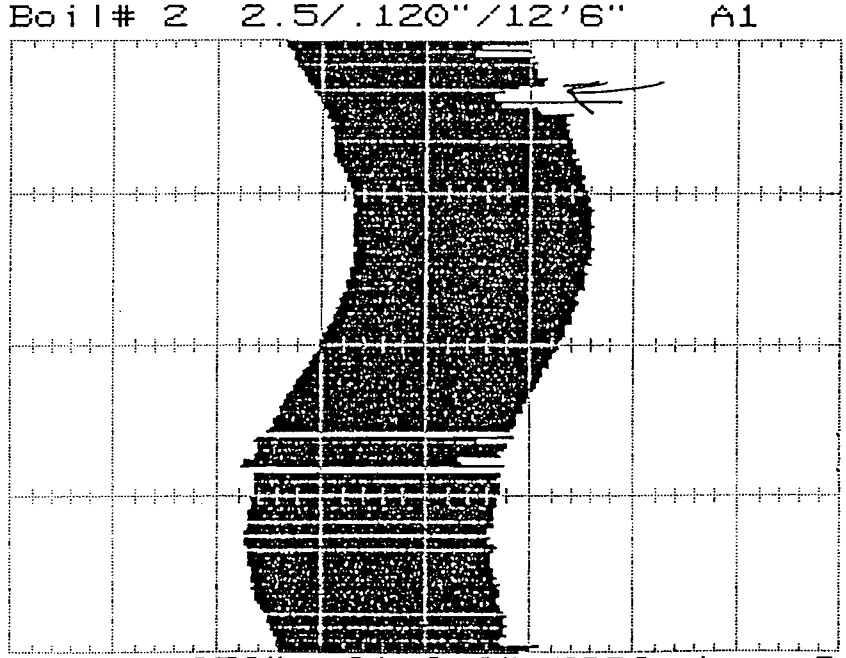


0.97" .050" 0' 0.0" 5930m/s 1

Defect type: EXTERNAL PITTING

Minimum Wall Thickness: .090

Lebreton Flats 12/08/99
Boil# 2 2.5/.120"/12'6" A1



0.97" .050" 0' 0.0" 5930m/s 2

Defect type: EXTERNAL PITTING

Minimum Wall Thickness: .080

TO-SPEC INC.
INSPECTION AND TESTING

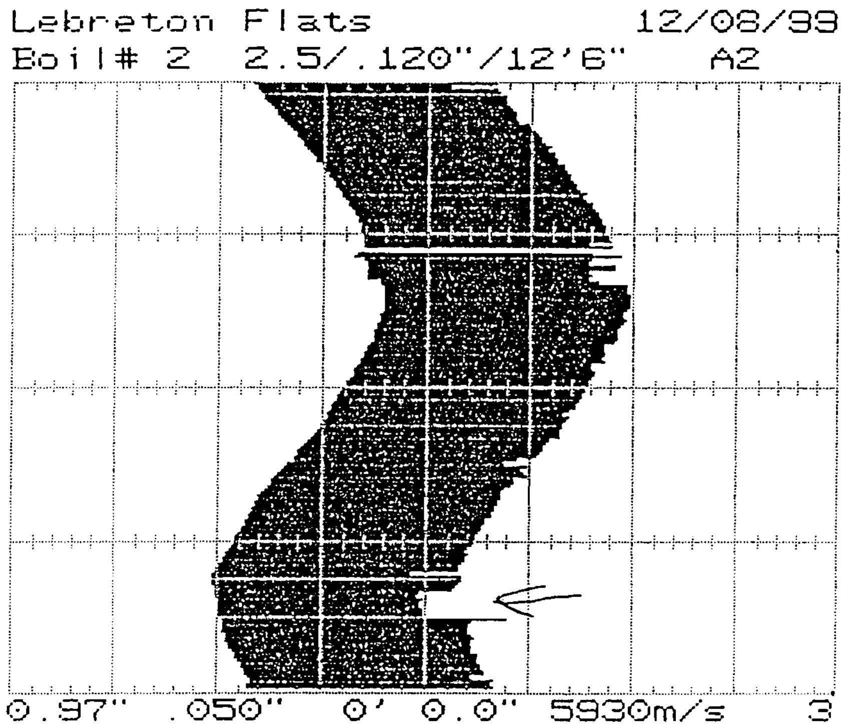
C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

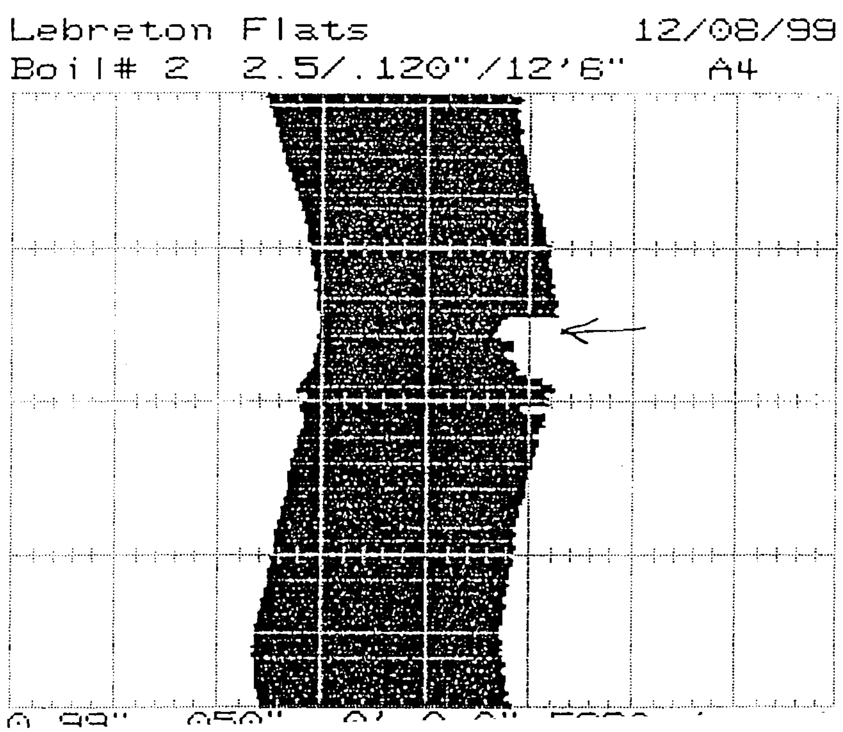
Defect type: EXTERNAL PITTING

Minimum Wall Thickness: .095



Defect type: EXTERNAL PITTING

Minimum Wall Thickness: .080"



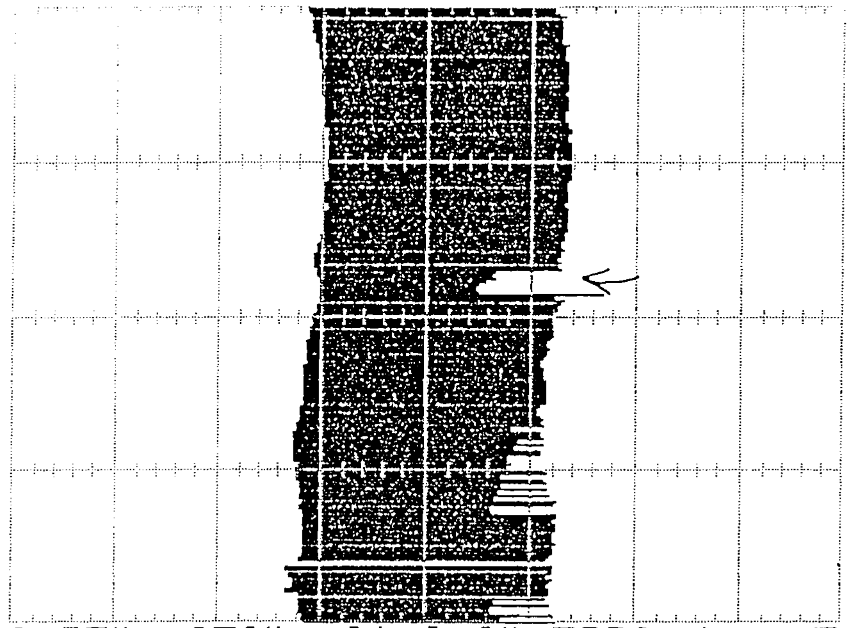
TO-SPEC INC.
INSPECTION AND TESTING

C.W.B. CERTIFIED CSA W178 WELDING INSPECTION
N.A.C.E CERTIFIED COATING INSPECTIONS

TO-SPEC INC. 3-270 WESTHILL AVENUE, OTTAWA, ONTARIO K1Z 7H6

TEL: (613) 761-1511 FAX: (613) 761-1838

Lebreton Flats 12/08/99
Boil# 2 2.5/.120"/12'6" A7

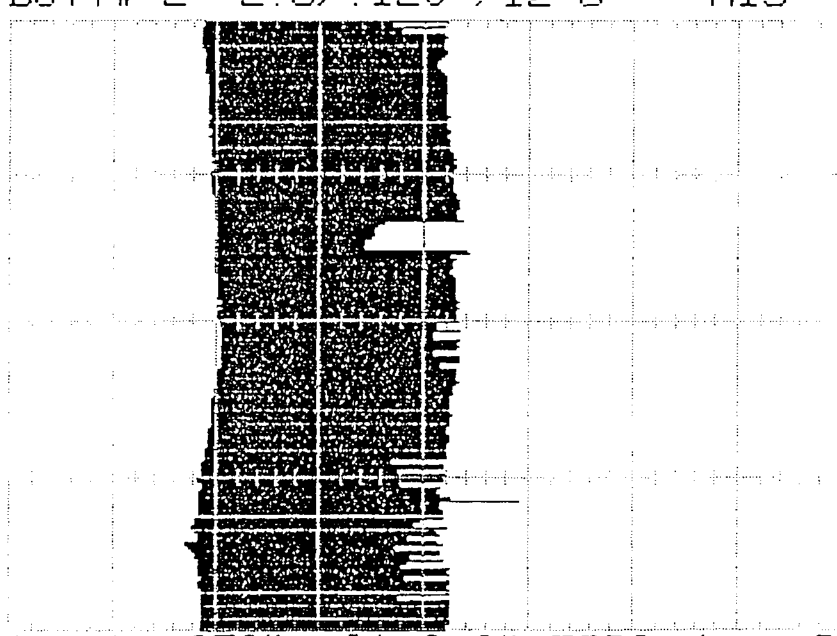


0.97" .050" 0' 0.0" 5930m/s 5

Defect type: EXTERNAL PITTING

Minimum Wall Thickness: .070

Lebreton Flats 12/08/99
Boil# 2 2.5/.120"/12'6" A13



1.01" .050" 0' 0.0" 5930m/s 6

Defect type: EXTERNAL PITTING

Minimum Wall Thickness: .070

2.4 RECOMMENDATIONS

If the original design integrity of the boiler is to be preserved, tubes below the minimum allowable wall thickness should be replaced.

APPENDIX C

Recommendations
from the
Federal Industrial Boiler Program

(Note: 1 BHP equals 9.8096 kW)

Site Survey - Rochester St. Heating Plant
By: Federal Industrial Boiler Program

The Federal Industrial Boiler Program performed a site survey of the heating equipment as part of the Community Energy Group's study of the district heating system. The survey was conducted on August 11 and 12, 1999, at the same time that nondestructive testing was performed on the boilers.

The heating plant, built in 1981, consists of two 150 HP Volcano fire tube water boilers and the distribution pumps for the district water piping system. The boilers are natural gas fired with no backup fuel. As per the operating staff, the boilers are sized so that one boiler can carry the peak winter heating loads with the second boiler being the standby boiler. However a lead/lag control system is installed that would allow for the second boiler to come on automatically if the load were to exceed the capacity of one boiler. It was turned on at the time of the survey. The burners are typical for 1981 installation and are not low NO_x design.

Observations

1. Only one boiler was operating during the two days of the survey. On August 11, boiler 2 was in operation. It would cycle on for approximately 10 minutes every hour. On August 12, over a 2 hour period, the fan on boiler 1 was running continuously without the burner running. There appeared to be a flame failure; although there was no indication of a fault on the control panel.
2. The flue gas was tested on Boiler 2 at minimum fire with the following results: O_2 – 5.5%, CO – 0 ppm, CO_2 – 8.8%.
3. The controls do not appear to be up to current TSSA standards for unmanned plants. In the event of a failure, as seen on Boiler 1, remote notification to the plant operator is required usually by means of a telephone pager. The controls are also required to provide a local indication until the operator rectifies the problem.
4. The burner gas piping contains only one shutoff valve and no pressure switches, which is not typical for boilers of this size. The CGA gas code allows this arrangement for burners with a supply pressure and burner pressure less than 0.5 psig and if the single shutoff valve is interlocked to the burner safety system. It was not possible to verify these conditions. It is possible that this system does not meet current CGA standards. Typically burners of this size would have two safety shutoff valves and a low and high gas pressure switch burner cutoff to meet the CGA code.

Recommendations

1. Verify that the burner piping is installed in accordance with the CGA code, ie gas supply pressure to be less than 0.5 psig.
2. Verify that flame shutoff indications are working on both boilers. The control panels have indications for High Water Temperature, Flame Failure and Low Water Level. These should indicate a problem when it exists and lockout the boiler operation until

corrected by the operator. It would also be advantageous to have the fan stop if a failure occurs.

3. Verify if a remote operator callout for boiler failures exists. If yes, confirm that it works properly. If no, update controls to include one.
4. Investigate seasonal average and peak loads versus boiler sizing. The boilers are oversized for the summer load and savings are possible by installing smaller boilers sized for the summer and shoulder loads.

Conclusions

The Rochester St. heating plant is fairly typical for heating plants for this application, although the heating plant room is much smaller than usual. The issues of both the Canadian Gas Association (CGA) and the Ontario Technical Standards and Safety Authority (TSSA) compliance are of some concern. If any modifications are made to the boiler/burner equipment, these systems will have to be upgraded to meet the current codes.

Opportunities for improved, ie less cost/more efficient, operation are limited. Since the boilers are sized to meet the peak load, for a large portion of the year they lose efficiency because they operate below the range of optimum efficiency, typically 60% to 90% load. When cycling on and off, as seen during the site visit, the efficiency is even less. The alternative would be to install a third, smaller boiler that would operate at higher firing rates during the summer and shoulder months. Finding room in the heating plant would be an issue, but the optimum sized boiler could be as low as 25 to 50 HP, which is physically a very small boiler. A heating load sizing study would have to be done to determine the optimum size.

The burners are typical for 1981 vintage and therefore would not be a low NO_x design. Guidelines, now under discussion within the Ontario government, for limiting NO_x emissions would not apply to these boilers. The guidelines are intended to apply to boilers sized to consume more than 10 million Btu/hr of fuel; but these boilers consume only 6.4 million Btu/hr. If the owner is concerned about reducing its emissions, low NO_x burners are available.

NAME PLATE DATA

Boiler 1

MODEL: 26B-15001-D8	SERIAL NO: 9023 S	ORDER NO: C50395
MAX W PRESS: 105	YEAR: 1981	CRN: B1133.5
CAP: 153 HP	HEATING SURFACE: 630 ft^2	
ELE: 575V 3PH 60Hz 6Amps	GAS INPUT: 6.410 million Btu/hr	
MAN PRESS: 3" WC	INLET PRESS: 7" WC	

Boiler 1 Fan Motor

Alstohm 7.5 HP RPM 3515 3 PH 575 Volts 7.9 Amps 60 Hz

F-INSLN	SER FACTOR: 1.15	CODE: H
MAX AMB: 40 °C	INSUL CLASS: B	NOM EFF: 88.5
MODEL: HKH26	SER NO: 980492002	

Boiler 2

MODEL: 26B-15001-D8	SERIAL NO: 9024 S	ORDER NO: C50395
MAX W PRESS: 105	YEAR: 1981	CRN: B1133.5
CAP: 153 HP	HEATING SURFACE: 630 ft^2	
ELE: 575V 3PH 60Hz 6Amps	GAS INPUT: 6.410 million Btu/hr	
MAN PRESS: 3" WC	INLET PRESS: 7" WC	

Boiler 2 Fan Motor

Doerr 7.5 HP RPM 3500 60 Hz

MOTOR: FR J184T 575 Volts 7.5 Amps Cont. Duty 3 PH

TYPE: P SER FACTOR: 1.15 CODE: H

MAX AMB: 40 °C TEFC INSUL CLASS: B

APPENDIX D

Quote for Boiler Remedial Work

Volcano Technologies Inc.
Une compagnie du groupe Thermogenics

CANADIAN BOILER SOCIETY

By fax: 947-1599

November 12th, 1999

NRCan - Natural Resources Canada
ETB/CANMET Energy Technology Center
Bells Corners Complex, Building 3, 2nd floor
Nepean, Ontario K1A 1M1
Attention: Mr. Paul Dockrill
Quotation: QO-991112-1
Project: LeBreton Flats
31 Rochester Street North
Ottawa, Ont
File C-50395
Equipment: Two (2) Volcano 150 hp hot water boiler firing natural gas model 26B-1500I-D8.

We are pleased to offer a price to carry out work as follows;

A) Retubing of boilers using grade A, SA178, 12 ga. boiler tubes.

PRICE PER BOILER:...$ 8,700.00

B) Supply and install all the necessary fail safe devices to comply with the requirement of guarded plant status including local annonciation.

PRICE PER BOILER:... $ 2,910.00

- Taxes extra
- Terms of payment: net 30 days

Hoping this is to your entire satisfaction, I remain,

Yours Truly

RAYMOND FAUTEUX
BRANCH MANAGER

Appendix E

Net Present Value and Net Present Cost Calculations

of the

Option 1 Scenario:

Boiler Remedial Work

	A	B	C	D	E	F	G	H	I	J
1										
2	Lebreton Flats District Energy Project - Statement of Cashflows									
3	Retubing of both units									
4										
5										
6	INCLUDING REVENUES				YEAR	2000	2001	2002	2003	2004
7	ESCALATION FACTORS									
8										
9	Combined Escalation	COMB					*2.50%*	*2.70%*	*2.30%*	*1.83%*
10	CPI	CPI					*1.88%*	*2.10%*	*1.66%*	*1.77%*
11	Gas Escalation	GAS					*3.12%*	*3.30%*	*2.93%*	*1.89%*
12	Electrical Escalation	ELECT					*1.88%*	*2.10%*	*1.66%*	*1.77%*
13	Escalation Factor	CPI				1	1.02	1.04	1.06	1.08
14	Escalation Factor	GAS				1	1.03	1.07	1.10	1.12
15	Escalation Factor	ELECT				1	1.02	1.04	1.06	1.08
16	REVENUES									
17		$75					$76.41	$78.01	$79.30	$80.71
18	OPERATING EXPENSES									
19										
20	**Cooling Water**									
21	water cost		$1,392.00				1.418	1.448	1.472	1.498
22	gas cost	$33,670	$33,670.00				34.721	35.867	36.919	37.615
23	electrical cost	$5,852	$5,852				5.962	6.087	6.188	6.298
24										
25	**Operating & Maintenance**									
26	O&M Other ($,000's)	*CPI*	$19				19.6009	20.0126	20.3442	20.7051
27	G&A ($,000)	*CPI*	$3				3.4526	3.5251	3.5835	3.6471
28	Capital Replacement ($,000)	*CPI*					8.7000	11.6000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	*CPI*	0.0%	*of*	$0.00	*M$*	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**						73.8539	78.5393	68.5065	69.7629
31										
32	**NET REVENUE ($,000)**					0	**2.5529**	**-0.5277**	**10.7977**	**10.9483**
33							**2.553**	**-0.489**	**9.257**	**8.691**
34							0	1	2	3
35	**NPV(after financing)**	Rate	8.00%							
36		Present value		$122,520						
37										
38										
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**	1								
40										
41										

	A	K	L	M	N	O	P	Q	R
1									
2	Lebreton Flats District Energy Proj								
3	Retubing of both units								
4									
5									
6	INCLUDING REVENUES	2005	2006	2007	2008	2009	2010	2011	2012
7	ESCALATION FACTORS								
8									
9	Combined Escalation	2.05%	2.33%	2.42%	2.42%	1.98%	1.81%	1.63%	1.62%
10	CPI	2.02%	2.33%	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%
11	Gas Escalation	2.08%	2.34%	2.42%	2.42%	2.01%	1.87%	1.71%	1.71%
12	Electrical Escalation	2.02%	2.33%	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%
13	Escalation Factor	1.10	1.12	1.15	1.18	1.20	1.22	1.24	1.26
14	Escalation Factor	1.14	1.17	1.20	1.22	1.25	1.27	1.29	1.32
15	Escalation Factor	1.10	1.12	1.15	1.18	1.20	1.22	1.24	1.26
16	REVENUES								
17		$82.34	$84.26	$86.31	$88.40	$90.12	$91.69	$93.11	$94.54
18	OPERATING EXPENSES								
19									
20	**Cooling Water**								
21	water cost	1.528	1.564	1.602	1.641	1.673	1.702	1.728	1.755
22	gas cost	38.396	39.293	40.243	41.216	42.045	42.832	43.566	44.310
23	electrical cost	6.425	6.575	6.734	6.898	7.032	7.154	7.265	7.376
24									
25	**Operating & Maintenance**								
26	O&M Other ($,000's)	21.1234	21.6158	22.1404	22.6786	23.1182	23.5209	23.8850	24.2515
27	G&A ($,000)	3.7208	3.8075	3.8999	3.9947	4.0721	4.1430	4.2072	4.2717
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	71.1933	72.8545	74.6189	76.4276	77.9394	79.3517	80.6514	81.9640
31									
32	NET REVENUE ($,000)	**11.1485**	**11.4065**	**11.6873**	**11.9764**	**12.1782**	**12.3357**	**12.4555**	**12.5716**
33		**8.194**	**7.763**	**7.365**	**6.988**	**6.580**	**6.171**	**5.769**	**5.392**
34		4	5	6	7	8	9	10	11
35	**NPV(after financing)**								
36									
37									
38									
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**								
40									
41									

	A	S	T	U	V	W	X	Y	Z
1									
2	**Lebreton Flats District Energy Proj**								
3	**Retubing of both units**								
4									
5									
6	**INCLUDING REVENUES**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
7	ESCALATION FACTORS								
8									
9	Combined Escalation	*1.56%*	*1.48%*	*1.35%*	*1.45%*	*1.52%*	*1.58%*	*1.50%*	*1.53%*
10	CPI	*1.47%*	*1.60%*	*1.46%*	*1.56%*	*1.64%*	*1.71%*	*1.62%*	*1.66%*
11	Gas Escalation	*1.65%*	*1.36%*	*1.24%*	*1.33%*	*1.40%*	*1.46%*	*1.38%*	*1.41%*
12	Electrical Escalation	*1.47%*	*1.60%*	*1.46%*	*1.56%*	*1.64%*	*1.71%*	*1.62%*	*1.66%*
13	Escalation Factor	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.43
14	Escalation Factor	1.34	1.36	1.37	1.39	1.41	1.43	1.45	1.47
15	Escalation Factor	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.43
16	REVENUES								
17		$95.93	$97.46	$98.88	$100.43	$102.08	$103.82	$105.51	$107.26
18	OPERATING EXPENSES								
19									
20	**Cooling Water**								
21	water cost	1.780	1.809	1.835	1.864	1.895	1.927	1.958	1.991
22	gas cost	45.042	45.654	46.223	46.839	47.493	48.184	48.849	49.537
23	electrical cost	7.485	7.604	7.715	7.836	7.965	8.101	8.232	8.369
24									
25	**Operating & Maintenance**								
26	O&M Other ($,000's)	24.6081	25.0017	25.3664	25.7632	26.1866	26.6339	27.0663	27.5149
27	G&A ($,000)	4.3346	4.4039	4.4681	4.5380	4.6126	4.6914	4.7675	4.8466
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	83.2494	84.4733	85.6077	86.8399	88.1515	89.5371	90.8734	92.2577
31									
32	NET REVENUE ($,000)	**12.6762**	**12.9866**	**13.2737**	**13.5885**	**13.9273**	**14.2853**	**14.6345**	**14.9990**
33		**5.034**	**4.775**	**4.519**	**4.284**	**4.065**	**3.861**	**3.662**	**3.475**
34		12	13	14	15	16	17	18	19
35	**NPV(after financing)**								
36									
37									
38									
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**								
40									
41									

	A	AA	AB	AC	AD	AE	AF
1							
2	**Lebreton Flats District Energy Proj**						
3	**Retubing of both units**						
4							
5							
6	**INCLUDING REVENUES**	**2021**	**2022**	**2023**	**2024**	**2025**	
7	**ESCALATION FACTORS**						
8							
9	Combined Escalation	*1.41%*	*1.38%*	*1.39%*	*0.00%*	*0.00%*	
10	CPI	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
11	Gas Escalation	*1.30%*	*1.28%*	*1.27%*	*0.00%*	*0.00%*	
12	Electrical Escalation	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
13	Escalation Factor	1.45	1.47	1.50	1.50	1.50	
14	Escalation Factor	1.49	1.51	1.53	1.53	1.53	
15	Escalation Factor	1.45	1.47	1.50	1.50	1.50	
16	**REVENUES**						
17		$108.89	$110.52	$112.18	$112.18	$112.18	
18	**OPERATING EXPENSES**						
19							
20	**Cooling Water**						
21	water cost	2.021	2.051	2.082	2.082	2.082	
22	gas cost	50.182	50.822	51.469	51.469	51.469	
23	electrical cost	8.497	8.623	8.753	8.753	8.753	
24							
25	**Operating & Maintenance**						
26	O&M Other ($,000's)	27.9347	28.3515	28.7767	28.7767	28.7767	
27	G&A ($,000)	4.9205	4.9939	5.0688	5.0688	5.0688	
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	
30	**Total O&M and G&A Costs ($, 000)**	93.5549	94.8421	96.1489	96.1489	96.1489	
31							
32	**NET REVENUE ($,000)**	**15.3380**	**15.6759**	**16.0262**	**16.0262**	**16.0262**	
33		**3.291**	**3.114**	**2.948**	**2.730**	**2.527**	
34		20	21	22	23	24	
35	**NPV(after financing)**						
36							
37							
38							
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**						
40							
41							

	A	B	C	D	E	F	G	H	I	J
1										
2	**Lebreton Flats District Energy Project - Net Present Cost**									
3	Retubing of Boilers									
4										
5										
6	INCLUDING REVENUES				YEAR	2000	2001	2002	2003	2004
7	ESCALATION FACTORS									
8										
9	Combined Escalation	COMB					*2.50%*	*2.70%*	2.30%	*1.83%*
10	CPI	CPI					*1.88%*	*2.10%*	*1.66%*	*1.77%*
11	Gas Escalation	GAS					*3.12%*	*3.30%*	*2.93%*	*1.89%*
12	Electrical Escalation	ELECT					*1.88%*	*2.10%*	*1.66%*	*1.77%*
13	Escalation Factor	CPI				1	1.02	1.04	1.06	1.08
14	Escalation Factor	GAS				1	1.03	1.07	1.10	1.12
15	Escalation Factor	ELECT				1	1.02	1.04	1.06	1.08
16	REVENUES									
17		$0					$0.00	$0.00	$0.00	$0.00
18	OPERATING EXPENSES									
19										
20	**Cooling Water**									
21	water cost		$1,392.00				1.418	1.448	1.472	1.498
22	gas cost	$33,670	$33,670.00				34.721	35.867	36.919	37.615
23	electrical cost	$5,582	$5,582				5.687	5.806	5.902	6.007
24										
25	**Operating & Maintenance**									
26	O&M Other ($,000's)	*CPI*	$19				19.6009	20.0126	20.3442	20.7051
27	G&A ($,000)	*CPI*	$3				3.4526	3.5251	3.5835	3.6471
28	Capital Replacement ($,000)	*CPI*					8.7000	11.6000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	*CPI*	0.0%	*of*	$0.00	*M$*	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**						73.5788	78.2585	68.2210	69.4723
31										
32	NET REVENUE ($,000)					0	-73.5788	-78.2585	-68.2210	-69.4723
33							-73.579	-72.462	-58.489	-55.149
34							0	1	2	3
35	**NPV(after financing)**	Rate	8.00%							
36		Present Cost		-$907,637						
37										
38										
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**	1								
40										
41										

	A	K	L	M	N	O	P	Q	R
1									
2	Lebreton Flats District E								
3	Retubing of Boilers								
4									
5									
6	**INCLUDING REVENUES**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
7	ESCALATION FACTORS								
8									
9	Combined Escalation	*2.05%*	*2.33%*	*2.42%*	*2.42%*	*1.98%*	*1.81%*	*1.63%*	*1.62%*
10	CPI	*2.02%*	*2.33%*	*2.43%*	*2.43%*	*1.94%*	*1.74%*	*1.55%*	*1.53%*
11	Gas Escalation	*2.08%*	*2.34%*	*2.42%*	*2.42%*	*2.01%*	*1.87%*	*1.71%*	*1.71%*
12	Electrical Escalation	*2.02%*	*2.33%*	*2.43%*	*2.43%*	*1.94%*	*1.74%*	*1.55%*	*1.53%*
13	Escalation Factor	1.10	1.12	1.15	1.18	1.20	1.22	1.24	1.26
14	Escalation Factor	1.14	1.17	1.20	1.22	1.25	1.27	1.29	1.32
15	Escalation Factor	1.10	1.12	1.15	1.18	1.20	1.22	1.24	1.26
16	REVENUES								
17		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
18	OPERATING EXPENSES								
19									
20	**Cooling Water**								
21	water cost	1.528	1.564	1.602	1.641	1.673	1.702	1.728	1.755
22	gas cost	38.396	39.293	40.243	41.216	42.045	42.832	43.566	44.310
23	electrical cost	6.128	6.271	6.423	6.580	6.707	6.824	6.930	7.036
24									
25	**Operating & Maintenance**								
26	O&M Other ($,000's)	21.1234	21.6158	22.1404	22.6786	23.1182	23.5209	23.8850	24.2515
27	G&A ($,000)	3.7208	3.8075	3.8999	3.9947	4.0721	4.1430	4.2072	4.2717
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	70.8969	72.5511	74.3082	76.1093	77.6150	79.0216	80.3162	81.6237
31									
32	NET REVENUE ($,000)	**-70.8969**	**-72.5511**	**-74.3082**	**-76.1093**	**-77.6150**	**-79.0216**	**-80.3162**	**-81.6237**
33		**-52.111**	**-49.377**	**-46.827**	**-44.409**	**-41.933**	**-39.530**	**-37.202**	**-35.007**
34		4	5	6	7	8	9	10	11
35	**NPV(after financing)**								
36									
37									
38									
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**								
40									
41									

	A	S	T	U	V	W	X	Y	Z
1									
2	**Lebreton Flats District E**								
3	Retubing of Boilers								
4									
5									
6	INCLUDING REVENUES	2013	2014	2015	2016	2017	2018	2019	2020
7	ESCALATION FACTORS								
8									
9	Combined Escalation	*1.56%*	*1.48%*	*1.35%*	*1.45%*	*1.52%*	*1.58%*	*1.50%*	*1.53%*
10	CPI	*1.47%*	*1.60%*	*1.46%*	*1.56%*	*1.64%*	*1.71%*	*1.62%*	*1.66%*
11	Gas Escalation	*1.65%*	*1.36%*	*1.24%*	*1.33%*	*1.40%*	*1.46%*	*1.38%*	*1.41%*
12	Electrical Escalation	*1.47%*	*1.60%*	*1.46%*	*1.56%*	*1.64%*	*1.71%*	*1.62%*	*1.66%*
13	Escalation Factor	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.43
14	Escalation Factor	1.34	1.36	1.37	1.39	1.41	1.43	1.45	1.47
15	Escalation Factor	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.43
16	REVENUES								
17		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
18	OPERATING EXPENSES								
19									
20	**Cooling Water**								
21	water cost	1.780	1.809	1.835	1.864	1.895	1.927	1.958	1.991
22	gas cost	45.042	45.654	46.223	46.839	47.493	48.184	48.849	49.537
23	electrical cost	7.139	7.254	7.359	7.475	7.597	7.727	7.853	7.983
24									
25	**Operating & Maintenance**								
26	O&M Other ($,000's)	24.6081	25.0017	25.3664	25.7632	26.1866	26.6339	27.0663	27.5149
27	G&A ($,000)	4.3346	4.4039	4.4681	4.5380	4.6126	4.6914	4.7675	4.8466
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	82.9041	84.1224	85.2518	86.4783	87.7840	89.1634	90.4935	91.8716
31									
32	NET REVENUE ($,000)	**-82.9041**	**-84.1224**	**-85.2518**	**-86.4783**	**-87.7840**	**-89.1634**	**-90.4935**	**-91.8716**
33		**-32.922**	**-30.932**	**-29.025**	**-27.262**	**-25.623**	**-24.098**	**-22.646**	**-21.288**
34		12	13	14	15	16	17	18	19
35	**NPV(after financing)**								
36									
37									
38									
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**								
40									
41									

	A	AA	AB	AC	AD	AE	AF
1							
2	**Lebreton Flats District E**						
3	Retubing of Boilers						
4							
5							
6	INCLUDING REVENUES	**2021**	**2022**	**2023**	**2024**	**2025**	
7	ESCALATION FACTORS						
8							
9	Combined Escalation	*1.41%*	*1.38%*	*1.39%*	*0.00%*	*0.00%*	
10	CPI	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
11	Gas Escalation	*1.30%*	*1.28%*	*1.27%*	*0.00%*	*0.00%*	
12	Electrical Escalation	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
13	Escalation Factor	1.45	1.47	1.50	1.50	1.50	
14	Escalation Factor	1.49	1.51	1.53	1.53	1.53	
15	Escalation Factor	1.45	1.47	1.50	1.50	1.50	
16	REVENUES						
17		$0.00	$0.00	$0.00	$0.00	$0.00	
18	OPERATING EXPENSES						
19							
20	**Cooling Water**						
21	water cost	2.021	2.051	2.082	2.082	2.082	
22	gas cost	50.182	50.822	51.469	51.469	51.469	
23	electrical cost	8.105	8.225	8.349	8.349	8.349	
24							
25	**Operating & Maintenance**						
26	O&M Other ($,000's)	27.9347	28.3515	28.7767	28.7767	28.7767	
27	G&A ($,000)	4.9205	4.9939	5.0688	5.0688	5.0688	
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	
30	**Total O&M and G&A Costs ($, 000)**	93.1629	94.4442	95.7450	95.7450	95.7450	
31							
32	NET REVENUE ($,000)	**-93.1629**	**-94.4442**	**-95.7450**	**-95.7450**	**-95.7450**	
33		**-19.988**	**-18.762**	**-17.611**	**-16.307**	**-15.099**	
34		20	21	22	23	24	
35	**NPV(after financing)**						
36							
37							
38							
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**						
40							
41							

Appendix F

Net Present Value and Net Present Cost Calculations

of the

Option 2 Scenario:

Use of Individual Furnaces and Boilers

	A	B	C	D	E	F	G	H	I	J
1										
2	**Lebreton Flats District Energy Project - Statement of Cashflows**									
3	**Individual Boilers and Furnaces**									
4										
5										
6					YEAR	2000	2001	2002	2003	2004
7	ESCALATION FACTORS									
8										
9	Combined Escalation	COMB					*2.50%*	*2.70%*	*2.30%*	*1.83%*
10	CPI	CPI					*1.88%*	*2.10%*	*1.66%*	*1.77%*
11	Gas Escalation	GAS					*3.12%*	*3.30%*	*2.93%*	*1.89%*
12	Electrical Escalation	ELECT					*1.88%*	*2.10%*	*1.66%*	*1.77%*
13	Escalation Factor	CPI				1	1.02	1.04	1.06	1.08
14	Escalation Factor	GAS				1	1.03	1.07	1.10	1.12
15	Escalation Factor	ELECT				1	1.02	1.04	1.06	1.08
16	REVENUES									
17	**Energy revenues**	$75					$76.41	$78.01	$79.30	$80.71
18	OPERATING EXPENSES									
19										
20	**Cooling Water**									
21	water cost		$860.00				0.876	0.895	0.909	0.925
22	gas cost	$33,670	$26,936.00				27.776	28.693	29.535	30.092
23	electrical cost	$5,852	1,463.00				1.490	1.522	1.547	1.574
24										
25	**Operating & Maintenance**									
26	O&M Other ($,000's)	*CPI*	$9				8.6910	8.8736	9.0206	9.1806
27	G&A ($,000)	*CPI*	$2				2.0375	2.0803	2.1148	2.1523
28	Capital Replacement ($,000)	*CPI*					115.0000	115.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	*CPI*	0.0%	*of*	$0.00	*M$*	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**						155.8716	157.0636	43.1270	43.9249
31										
32	**NET REVENUE ($,000)**					0	**-79.4648**	**-79.0519**	**36.1772**	**36.7863**
33							**-79.465**	**-73.196**	**31.016**	**29.202**
34							0	1	2	3
35	**NPV(after financing)**	Rate	8.00%							
36		Present value		$251,111						
37										
38										
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**	1								
40										
41										

	A	K	L	M	N	O	P	Q	R
1									
2	**Lebreton Flats District Energy**								
3	Individual Boilers and Furnaces								
4									
5									
6		**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
7	ESCALATION FACTORS								
8									
9	Combined Escalation	2.05%	2.33%	2.42%	2.42%	1.98%	1.81%	1.63%	1.62%
10	CPI	2.02%	2.33%	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%
11	Gas Escalation	2.08%	2.34%	2.42%	2.42%	2.01%	1.87%	1.71%	1.71%
12	Electrical Escalation	2.02%	2.33%	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%
13	Escalation Factor	1.10	1.12	1.15	1.18	1.20	1.22	1.24	1.26
14	Escalation Factor	1.14	1.17	1.20	1.22	1.25	1.27	1.29	1.32
15	Escalation Factor	1.10	1.12	1.15	1.18	1.20	1.22	1.24	1.26
16	REVENUES								
17	**Energy revenues**	$82.34	$84.26	$86.31	$88.40	$90.12	$91.69	$93.11	$94.54
18	OPERATING EXPENSES								
19									
20	**Cooling Water**								
21	water cost	0.944	0.966	0.990	1.014	1.033	1.051	1.068	1.084
22	gas cost	30.717	31.434	32.194	32.973	33.636	34.266	34.853	35.448
23	electrical cost	1.606	1.644	1.684	1.724	1.758	1.789	1.816	1.844
24									
25	**Operating & Maintenance**								
26	O&M Other ($,000's)	9.3661	9.5844	9.8170	10.0557	10.2506	10.4291	10.5906	10.7531
27	G&A ($,000)	2.1958	2.2470	2.3015	2.3574	2.4031	2.4450	2.4829	2.5209
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	44.8291	45.8754	46.9858	48.1238	49.0809	49.9796	50.8103	51.6500
31	.								
32	**NET REVENUE ($,000)**	**37.5127**	**38.3856**	**39.3204**	**40.2802**	**41.0367**	**41.7078**	**42.2966**	**42.8856**
33		**27.573**	**26.125**	**24.779**	**23.503**	**22.171**	**20.864**	**19.592**	**18.393**
34		4	5	6	7	8	9	10	11
35	**NPV(after financing)**								
36									
37									
38									
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**								
40									
41									

	A	S	T	U	V	W	X	Y	Z
1									
2	**Lebreton Flats District Energy**								
3	**Individual Boilers and Furnaces**								
4									
5									
6		2013	2014	2015	2016	2017	2018	2019	2020
7	ESCALATION FACTORS								
8									
9	Combined Escalation	*1.56%*	*1.48%*	*1.35%*	*1.45%*	*1.52%*	*1.58%*	*1.50%*	*1.53%*
10	CPI	*1.47%*	*1.60%*	*1.46%*	*1.56%*	*1.64%*	*1.71%*	*1.62%*	*1.66%*
11	Gas Escalation	*1.65%*	*1.36%*	*1.24%*	*1.33%*	*1.40%*	*1.46%*	*1.38%*	*1.41%*
12	Electrical Escalation	*1.47%*	*1.60%*	*1.46%*	*1.56%*	*1.64%*	*1.71%*	*1.62%*	*1.66%*
13	Escalation Factor	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.43
14	Escalation Factor	1.34	1.36	1.37	1.39	1.41	1.43	1.45	1.47
15	Escalation Factor	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.43
16	REVENUES								
17	**Energy revenues**	$95.93	$97.46	$98.88	$100.43	$102.08	$103.82	$105.51	$107.26
18	OPERATING EXPENSES								
19									
20	**Cooling Water**								
21	water cost	1.100	1.118	1.134	1.152	1.171	1.190	1.210	1.230
22	gas cost	36.033	36.524	36.978	37.471	37.994	38.547	39.079	39.629
23	electrical cost	1.871	1.901	1.929	1.959	1.991	2.025	2.058	2.092
24									
25	**Operating & Maintenance**								
26	O&M Other ($,000's)	10.9112	11.0857	11.2474	11.4234	11.6111	11.8094	12.0012	12.2001
27	G&A ($,000)	2.5580	2.5989	2.6368	2.6781	2.7221	2.7686	2.8135	2.8602
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	52.4737	53.2268	53.9250	54.6829	55.4892	56.3410	57.1617	58.0117
31									
32	**NET REVENUE ($,000)**	**43.4519**	**44.2330**	**44.9564**	**45.7454**	**46.5896**	**47.4814**	**48.3461**	**49.2450**
33		**17.255**	**16.264**	**15.306**	**14.421**	**13.599**	**12.833**	**12.099**	**11.411**
34		12	13	14	15	16	17	18	19
35	**NPV(after financing)**								
36									
37									
38									
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**								
40									
41									

	A	AA	AB	AC	AD	AE	AF
1							
2	**Lebreton Flats District Energy**						
3	**Individual Boilers and Furnaces**						
4							
5							
6		**2021**	**2022**	**2023**	**2024**	**2025**	
7	ESCALATION FACTORS						
8							
9	Combined Escalation	*1.41%*	*1.38%*	*1.39%*	*0.00%*	*0.00%*	
10	CPI	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
11	Gas Escalation	*1.30%*	*1.28%*	*1.27%*	*0.00%*	*0.00%*	
12	Electrical Escalation	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
13	Escalation Factor	1.45	1.47	1.50	1.50	1.50	
14	Escalation Factor	1.49	1.51	1.53	1.53	1.53	
15	Escalation Factor	1.45	1.47	1.50	1.50	1.50	
16	REVENUES						
17	**Energy revenues**	$108.89	$110.52	$112.18	$112.18	$112.18	
18	OPERATING EXPENSES						
19							
20	**Cooling Water**						
21	water cost	1.249	1.267	1.286	1.286	1.286	
22	gas cost	40.146	40.658	41.175	41.175	41.175	
23	electrical cost	2.124	2.156	2.188	2.188	2.188	
24							
25	**Operating & Maintenance**						
26	O&M Other ($,000's)	12.3862	12.5711	12.7595	12.7595	12.7595	
27	G&A ($,000)	2.9038	2.9471	2.9913	2.9913	2.9913	
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	
30	**Total O&M and G&A Costs ($, 000)**	58.8085	59.5990	60.4003	60.4003	60.4003	
31							
32	NET REVENUE ($,000)	**50.0844**	**50.9190**	**51.7748**	**51.7748**	**51.7748**	
33		**10.746**	**10.115**	**9.523**	**8.818**	**8.165**	
34		20	21	22	23	24	
35	**NPV(after financing)**						
36							
37							
38							
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**						
40							
41							

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	**Lebreton Flats District Energy Project - Net Present Cost**											
3	**Individual Boilers and Furnaces**											
4												
5												
6					YEAR	2000	2001	2002	2003	2004	2005	2006
7	ESCALATION FACTORS											
8												
9	Combined Escalation	COMB					2.50%	2.70%	2.30%	1.83%	2.05%	2.33%
10	CPI	CPI					1.88%	2.10%	1.66%	1.77%	2.02%	2.33%
11	Gas Escalation	GAS					3.12%	3.30%	2.93%	1.89%	2.08%	2.34%
12	Electrical Escalation	ELECT					1.88%	2.10%	1.66%	1.77%	2.02%	2.33%
13	Escalation Factor	CPI				1	1.02	1.04	1.06	1.08	1.10	1.12
14	Escalation Factor	GAS				1	1.03	1.07	1.10	1.12	1.14	1.17
15	Escalation Factor	ELECT				1	1.02	1.04	1.06	1.08	1.10	1.12
16	REVENUES											
17	**Energy revenues**	$0					$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
18	OPERATING EXPENSES											
19												
20	**Cooling Water**											
21	water cost		$860.00				0.876	0.895	0.909	0.925	0.944	0.966
22	gas cost	$33,670	$26,936.00				27.776	28.693	29.535	30.092	30.717	31.434
23	electrical cost	$5,852	1,463.00				1.490	1.522	1.547	1.574	1.606	1.644
24												
25	**Operating & Maintenance**											
26	O&M Other ($,000's)	*CPI*	$9				8.6910	8.8736	9.0206	9.1806	9.3661	9.5844
27	G&A ($,000)	*CPI*	$2				2.0375	2.0803	2.1148	2.1523	2.1958	2.2470
28	Capital Replacement ($,000)	*CPI*					115.0000	115.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	*CPI*	0.0%	*of*	$0.00	*M$*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**						155.8716	157.0636	43.1270	43.9249	44.8291	45.8754
31												
32	**NET REVENUE ($,000)**					0	-155.8716	-157.0636	-43.1270	-43.9249	-44.8291	-45.8754
33							-155.872	-145.429	-36.974	-34.869	-32.951	-31.222
34							0	1	2	3	4	5
35	**NPV(after financing)**	Rate	8.00%									
36		Present Cost		-$782,769								
37												
38												
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**	1										
40												
41												

	A	M	N	O	P	Q	R	S	T	U	V
1											
2	**Lebreton Flats District Energ**										
3	**Individual Boilers and Furnaces**										
4											
5											
6		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
7	ESCALATION FACTORS										
8											
9	Combined Escalation	*2.42%*	*2.42%*	*1.98%*	*1.81%*	*1.63%*	*1.62%*	*1.56%*	*1.48%*	*1.35%*	*1.45%*
10	CPI	*2.43%*	*2.43%*	*1.94%*	*1.74%*	*1.55%*	*1.53%*	*1.47%*	*1.60%*	*1.46%*	*1.56%*
11	Gas Escalation	*2.42%*	*2.42%*	*2.01%*	*1.87%*	*1.71%*	*1.71%*	*1.65%*	*1.36%*	*1.24%*	*1.33%*
12	Electrical Escalation	*2.43%*	*2.43%*	*1.94%*	*1.74%*	*1.55%*	*1.53%*	*1.47%*	*1.60%*	*1.46%*	*1.56%*
13	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
14	Escalation Factor	1.20	1.22	1.25	1.27	1.29	1.32	1.34	1.36	1.37	1.39
15	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
16	REVENUES										
17	**Energy revenues**	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
18	OPERATING EXPENSES										
19											
20	**Cooling Water**										
21	water cost	0.990	1.014	1.033	1.051	1.068	1.084	1.100	1.118	1.134	1.152
22	gas cost	32.194	32.973	33.636	34.266	34.853	35.448	36.033	36.524	36.978	37.471
23	electrical cost	1.684	1.724	1.758	1.789	1.816	1.844	1.871	1.901	1.929	1.959
24											
25	**Operating & Maintenance**										
26	O&M Other ($,000's)	9.8170	10.0557	10.2506	10.4291	10.5906	10.7531	10.9112	11.0857	11.2474	11.4234
27	G&A ($,000)	2.3015	2.3574	2.4031	2.4450	2.4829	2.5209	2.5580	2.5989	2.6368	2.6781
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	46.9858	48.1238	49.0809	49.9796	50.8103	51.6500	52.4737	53.2268	53.9250	54.6829
31											
32	**NET REVENUE ($,000)**	**-46.9858**	**-48.1238**	**-49.0809**	**-49.9796**	**-50.8103**	**-51.6500**	**-52.4737**	**-53.2268**	**-53.9250**	**-54.6829**
33		**-29.609**	**-28.080**	**-26.517**	**-25.002**	**-23.535**	**-22.152**	**-20.838**	**-19.571**	**-18.359**	**-17.238**
34		6	7	8	9	10	11	12	13	14	15
35	**NPV(after financing)**										
36											
37											
38											
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**										
40											
41											

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1											
2	Lebreton Flats District Energ										
3	Individual Boilers and Furnaces										
4											
5											
6		2017	2018	2019	2020	2021	2022	2023	2024	2025	
7	ESCALATION FACTORS										
8											
9	Combined Escalation	1.52%	1.58%	1.50%	1.53%	1.41%	1.38%	1.39%	0.00%	0.00%	
10	CPI	1.64%	1.71%	1.62%	1.66%	1.53%	1.49%	1.50%	0.00%	0.00%	
11	Gas Escalation	1.40%	1.46%	1.38%	1.41%	1.30%	1.28%	1.27%	0.00%	0.00%	
12	Electrical Escalation	1.64%	1.71%	1.62%	1.66%	1.53%	1.49%	1.50%	0.00%	0.00%	
13	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
14	Escalation Factor	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.53	1.53	
15	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
16	REVENUES										
17	Energy revenues	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
18	OPERATING EXPENSES										
19											
20	Cooling Water										
21	water cost	1.171	1.190	1.210	1.230	1.249	1.267	1.286	1.286	1.286	
22	gas cost	37.994	38.547	39.079	39.629	40.146	40.658	41.175	41.175	41.175	
23	electrical cost	1.991	2.025	2.058	2.092	2.124	2.156	2.188	2.188	2.188	
24											
25	Operating & Maintenance										
26	O&M Other ($,000's)	11.6111	11.8094	12.0012	12.2001	12.3862	12.5711	12.7595	12.7595	12.7595	
27	G&A ($,000)	2.7221	2.7686	2.8135	2.8602	2.9038	2.9471	2.9913	2.9913	2.9913	
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
30	Total O&M and G&A Costs ($, 000)	55.4892	56.3410	57.1617	58.0117	58.8085	59.5990	60.4003	60.4003	60.4003	
31											
32	NET REVENUE ($,000)	-55.4892	-56.3410	-57.1617	-58.0117	-58.8085	-59.5990	-60.4003	-60.4003	-60.4003	
33		-16.197	-15.227	-14.305	-13.442	-12.617	-11.840	-11.110	-10.287	-9.525	
34		16	17	18	19	20	21	22	23	24	
35	NPV(after financing)										
36											
37											
38											
39	Escalation Rate (Nrcan=1, Gas=2, Flat=3)										
40											
41											

Appendix G

Net Present Value and Net Present Cost Calculations

of the

Option 3 Scenario:

Replacement of One Boiler with Three Smaller Boilers

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Lebreton Flats District Energy Project - Statement of Cashflows											
3	Installation of Three New (500kW) Boilers											
4												
5												
6	INCLUDING REVENUES				YEAR	2000	2001	2002	2003	2004	2005	2006
7	ESCALATION FACTORS											
8												
9	Combined Escalation	COMB					*2.50%*	*2.70%*	*2.30%*	*1.83%*	*2.05%*	*2.33%*
10	CPI	CPI					*1.88%*	*2.10%*	*1.66%*	*1.77%*	*2.02%*	*2.33%*
11	Gas Escalation	GAS					*3.12%*	*3.30%*	*2.93%*	*1.89%*	*2.08%*	*2.34%*
12	Electrical Escalation	ELECT					*1.88%*	*2.10%*	*1.66%*	*1.77%*	*2.02%*	*2.33%*
13	Escalation Factor	CPI				1	1.02	1.04	1.06	1.08	1.10	1.12
14	Escalation Factor	GAS				1	1.03	1.07	1.10	1.12	1.14	1.17
15	Escalation Factor	ELECT				1	1.02	1.04	1.06	1.08	1.10	1.12
16	REVENUES											
17		$75					$76.41	$78.01	$79.30	$80.71	$82.34	$84.26
18	OPERATING EXPENSES											
19												
20	**Cooling Water**											
21	water cost		$1,392.00				1.418	1.448	1.472	1.498	1.528	1.564
22	gas cost	$33,670	$28,619.50				29.512	30.487	31.381	31.973	32.637	33.399
23	electrical cost	$5,852	5,559.40				5.664	5.783	5.878	5.983	6.104	6.246
24												
25	**Operating & Maintenance**											
26	O&M Other ($,000's)	*CPI*	$14				14.2626	14.5622	14.8034	15.0661	15.3705	15.7287
27	G&A ($,000)	*CPI*	$3				3.4526	3.5251	3.5835	3.6471	3.7208	3.8075
28	Capital Replacement ($,000)	*CPI*					103.4000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	*CPI*	0.0%	*of*	$0.00	*M$*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**						157.7094	55.8046	57.1185	58.1667	59.3597	60.7448
31												
32	NET REVENUE ($,000)					0	**-81.3027**	**22.2071**	**22.1857**	**22.5445**	**22.9821**	**23.5162**
33							**-81.303**	**20.562**	**19.021**	**17.897**	**16.893**	**16.005**
34							0	1	2	3	4	5
35	**NPV(after financing)**	Rate	8.00%									
36		Present value		$186,846								
37												
38												
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**	1										
40												
41												

	A	M	N	O	P	Q	R	S	T	U	V
1											
2	**Lebreton Flats District Energy**										
3	**Installation of Three New (500kW)**										
4											
5											
6	INCLUDING REVENUES	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
7	ESCALATION FACTORS										
8											
9	Combined Escalation	2.42%	2.42%	1.98%	1.81%	1.63%	1.62%	1.56%	1.48%	1.35%	1.45%
10	CPI	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%	1.47%	1.60%	1.46%	1.56%
11	Gas Escalation	2.42%	2.42%	2.01%	1.87%	1.71%	1.71%	1.65%	1.36%	1.24%	1.33%
12	Electrical Escalation	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%	1.47%	1.60%	1.46%	1.56%
13	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
14	Escalation Factor	1.20	1.22	1.25	1.27	1.29	1.32	1.34	1.36	1.37	1.39
15	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
16	REVENUES										
17		$86.31	$88.40	$90.12	$91.69	$93.11	$94.54	$95.93	$97.46	$98.88	$100.43
18	OPERATING EXPENSES										
19											
20	**Cooling Water**										
21	water cost	1.602	1.641	1.673	1.702	1.728	1.755	1.780	1.809	1.835	1.864
22	gas cost	34.206	35.033	35.738	36.407	37.031	37.663	38.285	38.806	39.289	39.813
23	electrical cost	6.397	6.553	6.680	6.796	6.902	7.007	7.111	7.224	7.330	7.444
24											
25	**Operating & Maintenance**										
26	O&M Other ($,000's)	16.1105	16.5021	16.8220	17.1150	17.3800	17.6466	17.9061	18.1925	18.4579	18.7466
27	G&A ($,000)	3.8999	3.9947	4.0721	4.1430	4.2072	4.2717	4.3346	4.4039	4.4681	4.5380
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	62.2159	63.7239	64.9848	66.1633	67.2482	68.3438	69.4169	70.4357	71.3801	72.4057
31											
32	NET REVENUE ($,000)	**24.0903**	**24.6801**	**25.1327**	**25.5241**	**25.8588**	**26.1918**	**26.5087**	**27.0241**	**27.5014**	**28.0227**
33		**15.181**	**14.401**	**13.578**	**12.768**	**11.978**	**11.233**	**10.527**	**9.937**	**9.363**	**8.834**
34		6	7	8	9	10	11	12	13	14	15
35	**NPV(after financing)**										
36											
37											
38											
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**										
40											
41											

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1											
2	**Lebreton Flats District Energy**										
3	**Installation of Three New (500kW)**										
4											
5											
6	INCLUDING REVENUES	2017	2018	2019	2020	2021	2022	2023	2024	2025	
7	ESCALATION FACTORS										
8											
9	Combined Escalation	*1.52%*	*1.58%*	*1.50%*	*1.53%*	*1.41%*	*1.38%*	*1.39%*	*0.00%*	*0.00%*	
10	CPI	*1.64%*	*1.71%*	*1.62%*	*1.66%*	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
11	Gas Escalation	*1.40%*	*1.46%*	*1.38%*	*1.41%*	*1.30%*	*1.28%*	*1.27%*	*0.00%*	*0.00%*	
12	Electrical Escalation	*1.64%*	*1.71%*	*1.62%*	*1.66%*	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
13	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
14	Escalation Factor	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.53	1.53	
15	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
16	REVENUES										
17		$102.08	$103.82	$105.51	$107.26	$108.89	$110.52	$112.18	$112.18	$112.18	
18	OPERATING EXPENSES										
19											
20	**Cooling Water**										
21	water cost	1.895	1.927	1.958	1.991	2.021	2.051	2.082	2.082	2.082	
22	gas cost	40.369	40.956	41.522	42.106	42.655	43.199	43.748	43.748	43.748	
23	electrical cost	7.567	7.696	7.821	7.950	8.072	8.192	8.315	8.315	8.315	
24											
25	**Operating & Maintenance**										
26	O&M Other ($,000's)	19.0547	19.3802	19.6948	20.0212	20.3267	20.6300	20.9394	20.9394	20.9394	
27	G&A ($,000)	4.6126	4.6914	4.7675	4.8466	4.9205	4.9939	5.0688	5.0688	5.0688	
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
30	**Total O&M and G&A Costs ($, 000)**	73.4974	74.6508	75.7629	76.9151	77.9948	79.0661	80.1536	80.1536	80.1536	
31											
32	NET REVENUE ($,000)	**28.5814**	**29.1716**	**29.7449**	**30.3416**	**30.8981**	**31.4519**	**32.0215**	**32.0215**	**32.0215**	
33		**8.343**	**7.884**	**7.444**	**7.031**	**6.629**	**6.248**	**5.890**	**5.454**	**5.050**	
34		16	17	18	19	20	21	22	23	24	
35	**NPV(after financing)**										
36											
37											
38											
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**										
40											
41											

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Lebreton Flats District Energy Project - Net Present Cost											
3	Installation of Three New (500kW) Boilers											
4												
5												
6	INCLUDING REVENUES				YEAR	2000	2001	2002	2003	2004	2005	2006
7	ESCALATION FACTORS											
8												
9	Combined Escalation	COMB					*2.50%*	*2.70%*	*2.30%*	*1.83%*	*2.05%*	*2.33%*
10	CPI	CPI					*1.88%*	*2.10%*	*1.66%*	*1.77%*	*2.02%*	*2.33%*
11	Gas Escalation	GAS					*3.12%*	*3.30%*	*2.93%*	*1.89%*	*2.08%*	*2.34%*
12	Electrical Escalation	ELECT					*1.88%*	*2.10%*	*1.66%*	*1.77%*	*2.02%*	*2.33%*
13	Escalation Factor	CPI				1	1.02	1.04	1.06	1.08	1.10	1.12
14	Escalation Factor	GAS				1	1.03	1.07	1.10	1.12	1.14	1.17
15	Escalation Factor	ELECT				1	1.02	1.04	1.06	1.08	1.10	1.12
16	REVENUES											
17		$0					$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
18	OPERATING EXPENSES											
19												
20	**Cooling Water**											
21	water cost		$1,392.00				1.418	1.448	1.472	1.498	1.528	1.564
22	gas cost	$33,670	$28,619.50				29.512	30.487	31.381	31.973	32.637	33.399
23	electrical cost	$5,852	5,559.40				5.664	5.783	5.878	5.983	6.104	6.246
24												
25	**Operating & Maintenance**											
26	O&M Other ($,000's)	*CPI*	$14				14.2626	14.5622	14.8034	15.0661	15.3705	15.7287
27	G&A ($,000)	*CPI*	$3				3.4526	3.5251	3.5835	3.6471	3.7208	3.8075
28	Capital Replacement ($,000)	*CPI*					103.4000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	*CPI*	0.0%	*of*	$0.00	*M$*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**						157.7094	55.8046	57.1185	58.1667	59.3597	60.7448
31												
32	**NET REVENUE ($,000)**					0	**-157.7094**	**-55.8046**	**-57.1185**	**-58.1667**	**-59.3597**	**-60.7448**
33							**-157.709**	**-51.671**	**-48.970**	**-46.175**	**-43.631**	**-41.342**
34							0	1	2	3	4	5
35	**NPV(after financing)**	Rate	8.00%									
36		Present Cost		-$847,034								
37												
38												
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**	1										
40												
41												

	A	M	N	O	P	Q	R	S	T	U	V
1											
2	Lebreton Flats District Energy										
3	Installation of Three New (500kW)										
4											
5											
6	INCLUDING REVENUES	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
7	ESCALATION FACTORS										
8											
9	Combined Escalation	2.42%	2.42%	1.98%	1.81%	1.63%	1.62%	1.56%	1.48%	1.35%	1.45%
10	CPI	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%	1.47%	1.60%	1.46%	1.56%
11	Gas Escalation	2.42%	2.42%	2.01%	1.87%	1.71%	1.71%	1.65%	1.36%	1.24%	1.33%
12	Electrical Escalation	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%	1.47%	1.60%	1.46%	1.56%
13	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
14	Escalation Factor	1.20	1.22	1.25	1.27	1.29	1.32	1.34	1.36	1.37	1.39
15	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
16	REVENUES										
17		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
18	OPERATING EXPENSES										
19											
20	**Cooling Water**										
21	water cost	1.602	1.641	1.673	1.702	1.728	1.755	1.780	1.809	1.835	1.864
22	gas cost	34.206	35.033	35.738	36.407	37.031	37.663	38.285	38.806	39.289	39.813
23	electrical cost	6.397	6.553	6.680	6.796	6.902	7.007	7.111	7.224	7.330	7.444
24											
25	**Operating & Maintenance**										
26	O&M Other ($,000's)	16.1105	16.5021	16.8220	17.1150	17.3800	17.6466	17.9061	18.1925	18.4579	18.7466
27	G&A ($,000)	3.8999	3.9947	4.0721	4.1430	4.2072	4.2717	4.3346	4.4039	4.4681	4.5380
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	62.2159	63.7239	64.9848	66.1633	67.2482	68.3438	69.4169	70.4357	71.3801	72.4057
31											
32	NET REVENUE ($,000)	**-62.2159**	**-63.7239**	**-64.9848**	**-66.1633**	**-67.2482**	**-68.3438**	**-69.4169**	**-70.4357**	**-71.3801**	**-72.4057**
33		**-39.207**	**-37.182**	**-35.109**	**-33.098**	**-31.149**	**-29.311**	**-27.566**	**-25.899**	**-24.302**	**-22.825**
34		6	7	8	9	10	11	12	13	14	15
35	**NPV(after financing)**										
36											
37											
38											
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**										
40											
41											

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1											
2	Lebreton Flats District Energy										
3	Installation of Three New (500kW)										
4											
5											
6	**INCLUDING REVENUES**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	
7	ESCALATION FACTORS										
8											
9	Combined Escalation	*1.52%*	*1.58%*	*1.50%*	*1.53%*	*1.41%*	*1.38%*	*1.39%*	*0.00%*	*0.00%*	
10	CPI	*1.64%*	*1.71%*	*1.62%*	*1.66%*	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
11	Gas Escalation	*1.40%*	*1.46%*	*1.38%*	*1.41%*	*1.30%*	*1.28%*	*1.27%*	*0.00%*	*0.00%*	
12	Electrical Escalation	*1.64%*	*1.71%*	*1.62%*	*1.66%*	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
13	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
14	Escalation Factor	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.53	1.53	
15	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
16	REVENUES										
17		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	
18	OPERATING EXPENSES										
19											
20	**Cooling Water**										
21	water cost	1.895	1.927	1.958	1.991	2.021	2.051	2.082	2.082	2.082	
22	gas cost	40.369	40.956	41.522	42.106	42.655	43.199	43.748	43.748	43.748	
23	electrical cost	7.567	7.696	7.821	7.950	8.072	8.192	8.315	8.315	8.315	
24											
25	**Operating & Maintenance**										
26	O&M Other ($,000's)	19.0547	19.3802	19.6948	20.0212	20.3267	20.6300	20.9394	20.9394	20.9394	
27	G&A ($,000)	4.6126	4.6914	4.7675	4.8466	4.9205	4.9939	5.0688	5.0688	5.0688	
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
30	**Total O&M and G&A Costs ($, 000)**	73.4974	74.6508	75.7629	76.9151	77.9948	79.0661	80.1536	80.1536	80.1536	
31											
32	NET REVENUE ($,000)	**-73.4974**	**-74.6508**	**-75.7629**	**-76.9151**	**-77.9948**	**-79.0661**	**-80.1536**	**-80.1536**	**-80.1536**	
33		**-21.453**	**-20.176**	**-18.960**	**-17.822**	**-16.734**	**-15.707**	**-14.743**	**-13.651**	**-12.640**	
34		16	17	18	19	20	21	22	23	24	
35	**NPV(after financing)**										
36											
37											
38											
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**										
40											
41											

Appendix H

Net Present Value and Net Present Cost Calculations

of the

Option 4 Scenario:

Installation of a Combined Heat and Power System

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Lebreton Flats District Energy Project - Statement of Cashflows											
3	Installation of CHP											
4												
5												
6	INCLUDING REVENUES				YEAR	2000	2001	2002	2003	2004	2005	2006
7	ESCALATION FACTORS											
8												
9	Combined Escalation	COMB					*2.50%*	*2.70%*	*2.30%*	*1.83%*	*2.05%*	*2.33%*
10	CPI	CPI					*1.88%*	*2.10%*	*1.66%*	*1.77%*	*2.02%*	*2.33%*
11	Gas Escalation	GAS					*3.12%*	*3.30%*	*2.93%*	*1.89%*	*2.08%*	*2.34%*
12	Electrical Escalation	ELECT					*1.88%*	*2.10%*	*1.66%*	*1.77%*	*2.02%*	*2.33%*
13	Escalation Factor	CPI				1	1.02	1.04	1.06	1.08	1.10	1.12
14	Escalation Factor	GAS				1	1.03	1.07	1.10	1.12	1.14	1.17
15	Escalation Factor	ELECT				1	1.02	1.04	1.06	1.08	1.10	1.12
16	REVENUES											
17		$75					$76.41	$78.01	$79.30	$80.71	$82.34	$84.26
18	OPERATING EXPENSES											
19												
20	**Cooling Water**											
21	water cost		$1,392.00				1.418	1.448	1.472	1.498	1.528	1.564
22	gas cost	$46,628	$46,628.00				48.083	49.670	51.128	52.091	53.173	54.415
23	electrical cost	#######	($23,625)				-24.068	-24.574	-24.981	-25.424	-25.938	-26.542
24												
25	**Operating & Maintenance**											
26	O&M Other ($,000's)	*CPI*	$22				22.4127	22.8834	23.2626	23.6753	24.1536	24.7166
27	G&A ($,000)	*CPI*	$9				9.1688	9.3614	9.5165	9.6853	9.8810	10.1113
28	Capital Replacement ($,000)	*CPI*					121.2000	11.6000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	*CPI*	0.0%	*of*	$0.00	*M$*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**						178.2143	70.3892	60.3977	61.5260	62.7980	64.2643
31												
32	**NET REVENUE ($,000)**					0	**-101.8075**	**7.6224**	**18.9065**	**19.1852**	**19.5437**	**19.9967**
33							**-101.808**	**7.058**	**16.209**	**15.230**	**14.365**	**13.609**
34							0	1	2	3	4	5
35	**NPV(after financing)**	Rate	8.00%									
36		Present value		$116,193								
37												
38												
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**	1										
40												
41												

	A	M	N	O	P	Q	R	S	T	U	V
1											
2	**Lebreton Flats District Energy**										
3	**Installation of CHP**										
4											
5											
6	INCLUDING REVENUES	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
7	ESCALATION FACTORS										
8											
9	Combined Escalation	*2.42%*	*2.42%*	*1.98%*	*1.81%*	*1.63%*	*1.62%*	*1.56%*	*1.48%*	*1.35%*	*1.45%*
10	CPI	*2.43%*	*2.43%*	*1.94%*	*1.74%*	*1.55%*	*1.53%*	*1.47%*	*1.60%*	*1.46%*	*1.56%*
11	Gas Escalation	*2.42%*	*2.42%*	*2.01%*	*1.87%*	*1.71%*	*1.71%*	*1.65%*	*1.36%*	*1.24%*	*1.33%*
12	Electrical Escalation	*2.43%*	*2.43%*	*1.94%*	*1.74%*	*1.55%*	*1.53%*	*1.47%*	*1.60%*	*1.46%*	*1.56%*
13	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
14	Escalation Factor	1.20	1.22	1.25	1.27	1.29	1.32	1.34	1.36	1.37	1.39
15	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
16	REVENUES										
17		$86.31	$88.40	$90.12	$91.69	$93.11	$94.54	$95.93	$97.46	$98.88	$100.43
18	OPERATING EXPENSES										
19											
20	**Cooling Water**										
21	water cost	1.602	1.641	1.673	1.702	1.728	1.755	1.780	1.809	1.835	1.864
22	gas cost	55.730	57.078	58.226	59.316	60.333	61.363	62.376	63.225	64.012	64.865
23	electrical cost	-27.186	-27.847	-28.387	-28.882	-29.329	-29.779	-30.217	-30.700	-31.148	-31.635
24											
25	**Operating & Maintenance**										
26	O&M Other ($,000's)	25.3165	25.9318	26.4345	26.8950	27.3114	27.7304	28.1382	28.5882	29.0052	29.4590
27	G&A ($,000)	10.3567	10.6085	10.8141	11.0025	11.1728	11.3443	11.5111	11.6952	11.8658	12.0514
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	65.8187	67.4115	68.7602	70.0336	71.2165	72.4132	73.5891	74.6170	75.5701	76.6039
31											
32	NET REVENUE ($,000)	**20.4876**	**20.9925**	**21.3574**	**21.6538**	**21.8905**	**22.1224**	**22.3365**	**22.8428**	**23.3114**	**23.8244**
33		**12.911**	**12.249**	**11.539**	**10.832**	**10.140**	**9.488**	**8.870**	**8.399**	**7.937**	**7.510**
34		6	7	8	9	10	11	12	13	14	15
35	**NPV(after financing)**										
36											
37											
38											
39	Escalation Rate (Nrcan=1, Gas=2, Flat=3)										
40											
41											

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1											
2	**Lebreton Flats District Energy**										
3	**Installation of CHP**										
4											
5											
6	INCLUDING REVENUES	2017	2018	2019	2020	2021	2022	2023	2024	2025	
7	ESCALATION FACTORS										
8											
9	Combined Escalation	*1.52%*	*1.58%*	*1.50%*	*1.53%*	*1.41%*	*1.38%*	*1.39%*	*0.00%*	*0.00%*	
10	CPI	*1.64%*	*1.71%*	*1.62%*	*1.66%*	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
11	Gas Escalation	*1.40%*	*1.46%*	*1.38%*	*1.41%*	*1.30%*	*1.28%*	*1.27%*	*0.00%*	*0.00%*	
12	Electrical Escalation	*1.64%*	*1.71%*	*1.62%*	*1.66%*	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
13	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
14	Escalation Factor	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.53	1.53	
15	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
16	REVENUES										
17		$102.08	$103.82	$105.51	$107.26	$108.89	$110.52	$112.18	$112.18	$112.18	
18	OPERATING EXPENSES										
19											
20	**Cooling Water**										
21	water cost	1.895	1.927	1.958	1.991	2.021	2.051	2.082	2.082	2.082	
22	gas cost	65.771	66.728	67.649	68.601	69.495	70.381	71.277	71.277	71.277	
23	electrical cost	-32.155	-32.704	-33.235	-33.786	-34.301	-34.813	-35.335	-35.335	-35.335	
24											
25	**Operating & Maintenance**										
26	O&M Other ($,000's)	29.9431	30.4546	30.9490	31.4620	31.9419	32.4186	32.9047	32.9047	32.9047	
27	G&A ($,000)	12.2495	12.4587	12.6609	12.8708	13.0672	13.2622	13.4610	13.4610	13.4610	
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
30	**Total O&M and G&A Costs ($, 000)**	77.7029	78.8639	79.9817	81.1386	82.2238	83.2999	84.3892	84.3892	84.3892	
31											
32	NET REVENUE ($,000)	**24.3759**	**24.9585**	**25.5262**	**26.1181**	**26.6692**	**27.2181**	**27.7859**	**27.7859**	**27.7859**	
33		**7.115**	**6.746**	**6.388**	**6.052**	**5.722**	**5.407**	**5.111**	**4.732**	**4.382**	
34		16	17	18	19	20	21	22	23	24	
35	**NPV(after financing)**										
36											
37											
38											
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**										
40											
41											

23/08/00

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2	Lebreton Flats District Energy Project - Net Present Cost											
3	Installation of CHP											
4												
5												
6	INCLUDING REVENUES				YEAR	2000	2001	2002	2003	2004	2005	2006
7	ESCALATION FACTORS											
8												
9	Combined Escalation	COMB					*2.50%*	*2.70%*	*2.30%*	*1.83%*	*2.05%*	*2.33%*
10	CPI	CPI					*1.88%*	*2.10%*	*1.66%*	*1.77%*	*2.02%*	*2.33%*
11	Gas Escalation	GAS					*3.12%*	*3.30%*	*2.93%*	*1.89%*	*2.08%*	*2.34%*
12	Electrical Escalation	ELECT					*1.88%*	*2.10%*	*1.66%*	*1.77%*	*2.02%*	*2.33%*
13	Escalation Factor	CPI				1	1.02	1.04	1.06	1.08	1.10	1.12
14	Escalation Factor	GAS				1	1.03	1.07	1.10	1.12	1.14	1.17
15	Escalation Factor	ELECT				1	1.02	1.04	1.06	1.08	1.10	1.12
16	REVENUES											
17		$24					$24.07	$24.57	$24.98	$25.42	$25.94	$26.54
18	OPERATING EXPENSES											
19												
20	**Cooling Water**											
21	water cost		$1,392.00				1.418	1.448	1.472	1.498	1.528	1.564
22	gas cost	$46,628	$46,628.00				48.083	49.670	51.128	52.091	53.173	54.415
23	electrical cost	#######	($23,625)				-24.068	-24.574	-24.981	-25.424	-25.938	-26.542
24												
25	**Operating & Maintenance**											
26	O&M Other ($,000's)	*CPI*	$22				22.4127	22.8834	23.2626	23.6753	24.1536	24.7166
27	G&A ($,000)	*CPI*	$9				9.1688	9.3614	9.5165	9.6853	9.8810	10.1113
28	Capital Replacement ($,000)	*CPI*					121.2000	11.6000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	*CPI*	0.0%	*of*	$0.00	*M$*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**						178.2143	70.3892	60.3977	61.5260	62.7980	64.2643
31												
32	NET REVENUE ($,000)					0	-154.1462	-45.8156	-35.4168	-36.1020	-36.8604	-37.7220
33							-154.146	-42.422	-30.364	-28.659	-27.093	-25.673
34							0	1	2	3	4	5
35	**NPV(after financing)**	Rate	8.00%									
36		Present Cost		-$592,015								
37												
38												
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**	1										
40												
41												

	A	M	N	O	P	Q	R	S	T	U	V
1											
2	Lebreton Flats Distri										
3	Installation of CHP										
4											
5											
6	INCLUDING REVENUES	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
7	ESCALATION FACTORS										
8											
9	Combined Escalation	2.42%	2.42%	1.98%	1.81%	1.63%	1.62%	1.56%	1.48%	1.35%	1.45%
10	CPI	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%	1.47%	1.60%	1.46%	1.56%
11	Gas Escalation	2.42%	2.42%	2.01%	1.87%	1.71%	1.71%	1.65%	1.36%	1.24%	1.33%
12	Electrical Escalation	2.43%	2.43%	1.94%	1.74%	1.55%	1.53%	1.47%	1.60%	1.46%	1.56%
13	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
14	Escalation Factor	1.20	1.22	1.25	1.27	1.29	1.32	1.34	1.36	1.37	1.39
15	Escalation Factor	1.15	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34
16	REVENUES										
17		$27.19	$27.85	$28.39	$28.88	$29.33	$29.78	$30.22	$30.70	$31.15	$31.63
18	OPERATING EXPENSES										
19											
20	**Cooling Water**										
21	water cost	1.602	1.641	1.673	1.702	1.728	1.755	1.780	1.809	1.835	1.864
22	gas cost	55.730	57.078	58.226	59.316	60.333	61.363	62.376	63.225	64.012	64.865
23	electrical cost	-27.186	-27.847	-28.387	-28.882	-29.329	-29.779	-30.217	-30.700	-31.148	-31.635
24											
25	**Operating & Maintenance**										
26	O&M Other ($,000's)	25.3165	25.9318	26.4345	26.8950	27.3114	27.7304	28.1382	28.5882	29.0052	29.4590
27	G&A ($,000)	10.3567	10.6085	10.8141	11.0025	11.1728	11.3443	11.5111	11.6952	11.8658	12.0514
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
30	**Total O&M and G&A Costs ($, 000)**	65.8187	67.4115	68.7602	70.0336	71.2165	72.4132	73.5891	74.6170	75.5701	76.6039
31											
32	**NET REVENUE ($,000)**	**-38.6322**	**-39.5643**	**-40.3732**	**-41.1521**	**-41.8878**	**-42.6345**	**-43.3725**	**-43.9172**	**-44.4224**	**-44.9690**
33		**-24.345**	**-23.085**	**-21.812**	**-20.586**	**-19.402**	**-18.285**	**-17.224**	**-16.148**	**-15.124**	**-14.176**
34		6	7	8	9	10	11	12	13	14	15
35	**NPV(after financing)**										
36											
37											
38											
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**										
40											
41											

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF
1											
2	Lebreton Flats Distri										
3	Installation of CHP										
4											
5											
6	INCLUDING REVENUES	2017	2018	2019	2020	2021	2022	2023	2024	2025	
7	ESCALATION FACTORS										
8											
9	Combined Escalation	*1.52%*	*1.58%*	*1.50%*	*1.53%*	*1.41%*	*1.38%*	*1.39%*	*0.00%*	*0.00%*	
10	CPI	*1.64%*	*1.71%*	*1.62%*	*1.66%*	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
11	Gas Escalation	*1.40%*	*1.46%*	*1.38%*	*1.41%*	*1.30%*	*1.28%*	*1.27%*	*0.00%*	*0.00%*	
12	Electrical Escalation	*1.64%*	*1.71%*	*1.62%*	*1.66%*	*1.53%*	*1.49%*	*1.50%*	*0.00%*	*0.00%*	
13	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
14	Escalation Factor	1.41	1.43	1.45	1.47	1.49	1.51	1.53	1.53	1.53	
15	Escalation Factor	1.36	1.38	1.41	1.43	1.45	1.47	1.50	1.50	1.50	
16	REVENUES										
17		$32.15	$32.70	$33.23	$33.79	$34.30	$34.81	$35.34	$35.34	$35.34	
18	OPERATING EXPENSES										
19											
20	**Cooling Water**										
21	water cost	1.895	1.927	1.958	1.991	2.021	2.051	2.082	2.082	2.082	
22	gas cost	65.771	66.728	67.649	68.601	69.495	70.381	71.277	71.277	71.277	
23	electrical cost	-32.155	-32.704	-33.235	-33.786	-34.301	-34.813	-35.335	-35.335	-35.335	
24											
25	**Operating & Maintenance**										
26	O&M Other ($,000's)	29.9431	30.4546	30.9490	31.4620	31.9419	32.4186	32.9047	32.9047	32.9047	
27	G&A ($,000)	12.2495	12.4587	12.6609	12.8708	13.0672	13.2622	13.4610	13.4610	13.4610	
28	Capital Replacement ($,000)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
29	Property Tax (0% of capital, $000's)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
30	**Total O&M and G&A Costs ($, 000)**	77.7029	78.8639	79.9817	81.1386	82.2238	83.2999	84.3892	84.3892	84.3892	
31											
32	NET REVENUE ($,000)	**-45.5481**	**-46.1598**	**-46.7467**	**-47.3527**	**-47.9225**	**-48.4867**	**-49.0540**	**-49.0540**	**-49.0540**	
33		**-13.295**	**-12.476**	**-11.698**	**-10.972**	**-10.282**	**-9.632**	**-9.023**	**-8.355**	**-7.736**	
34		16	17	18	19	20	21	22	23	24	
35	**NPV(after financing)**										
36											
37											
38											
39	**Escalation Rate (Nrcan=1, Gas=2, Flat=3)**										
40											
41											

Appendix I

Variation in the Use of Natural Gas

Gas Consumption

Month	Year	Consumption (m^3)	Comment
Jan	93	41645	
Feb		36246	
March		44716	
April		35138	
May		10583	
June		4762	
July			value not provided
August			value not provided
Sept			value not provided
Oct		16178	
Nov		7872	
Dec		11765	
	SUM:	208905	
Jan	94	18028	
Feb		22014	
March		80559	value seems high
April		13920	
May		6481	
June		2980	
July		1394	
August		1487	
Sept		1394	
Oct		2374	
Nov		5164	
Dec		9076	
	SUM:	164871	
Jan	95	17747	
Feb		15331	
March		15461	
April		9394	
May		7685	
June		149073	Value seems high
July		6603	
August		6816	
Sept		6391	
Oct		8807	
Nov		12699	
Dec		26416	
	SUM:	282423	

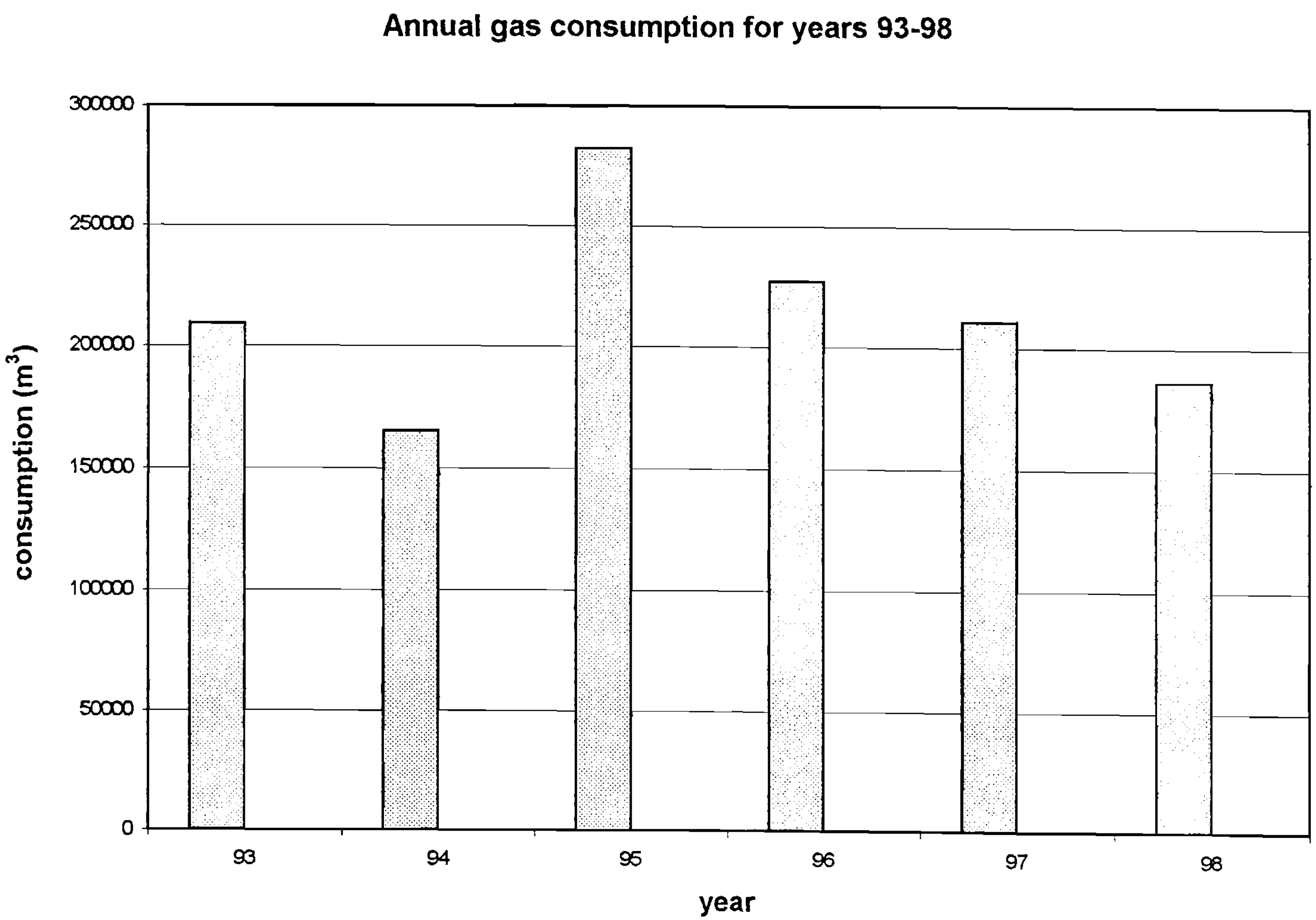
208905	93
164871	94
282423	95
227003	96
210510	97
186041	98

Jan	96	38594
Feb		35828
March		27906
April		25407
May		15354
June		8005
July		6816
August		6391
Sept		6391
Oct		14994
Nov		16442
Dec		24875
	SUM:	227003

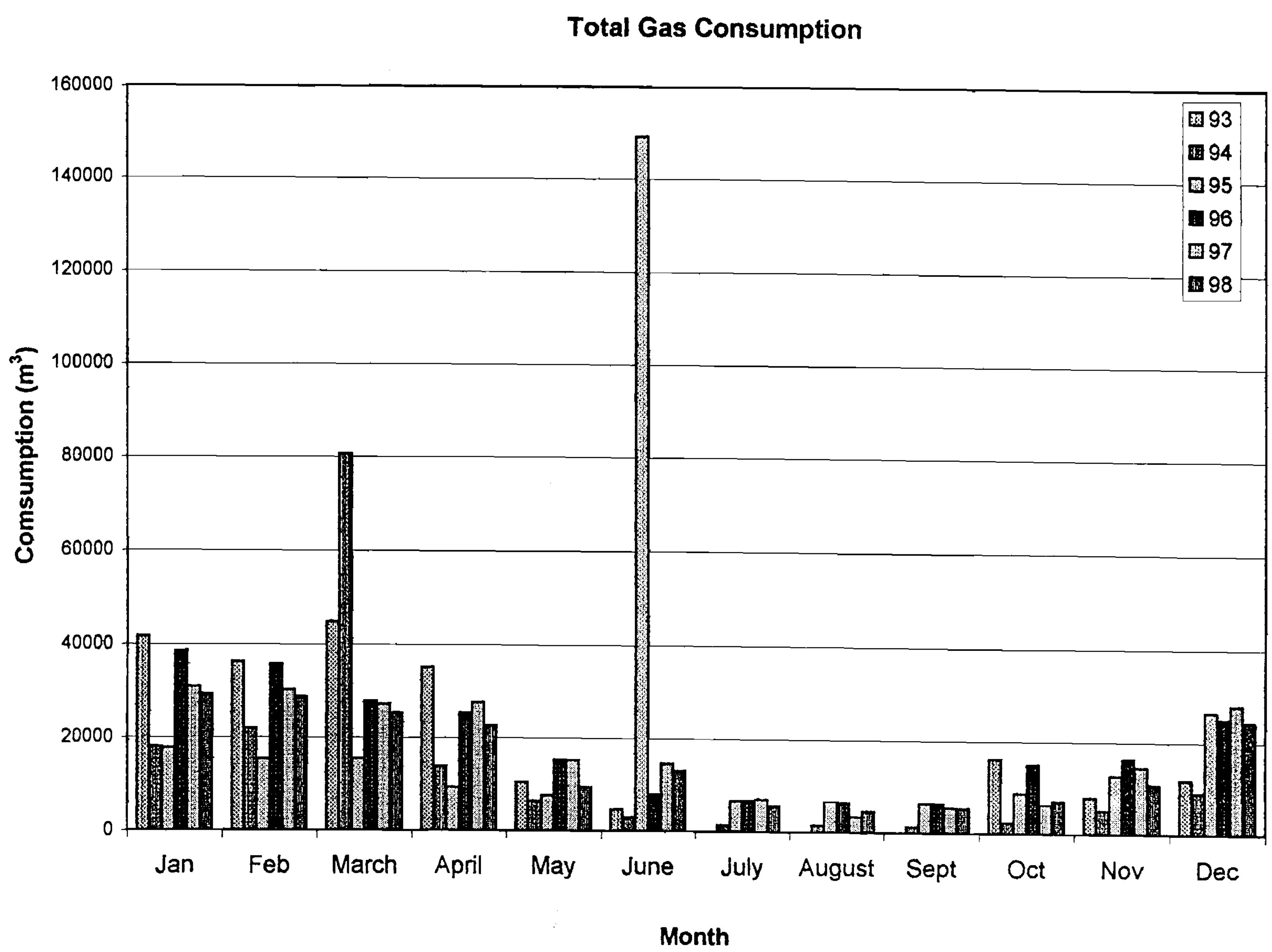
Jan	97	30917
Feb		30161
March		27036
April		27600
May		15212
June		14654
July		7031
August		3490
Sept		5600
Oct		6479
Nov		14529
Dec		27801
	SUM:	210510

Jan	98	29237
Feb		28742
March		25243
April		22560
May		9382
June		13042
July		5600
August		4666
Sept		5459
Oct		7068
Nov		10807
Dec		24235
	SUM:	186041

Jan	99	29351
Feb		29433
March		27226
April		27682
May		9538
June		15799
July		4963
August		
Sept		
Oct		
Nov		
Dec		



Annual gas consumption for years 93-98
consumption (m3)
300000
250000
200000
150000
100000
50000
0
93
94
95
96
97
98
year


Total Gas Consumption
160000
140000
120000
100000
80000
60000
40000
20000
0
Comsumption (m3)
Jan
Feb
March
April
May
June
July
August
Sept
Oct
Nov
Dec
Month
93
94
95
96
97
98

Appendix J

Variation in the Use of Electricity

Electricity Consumption

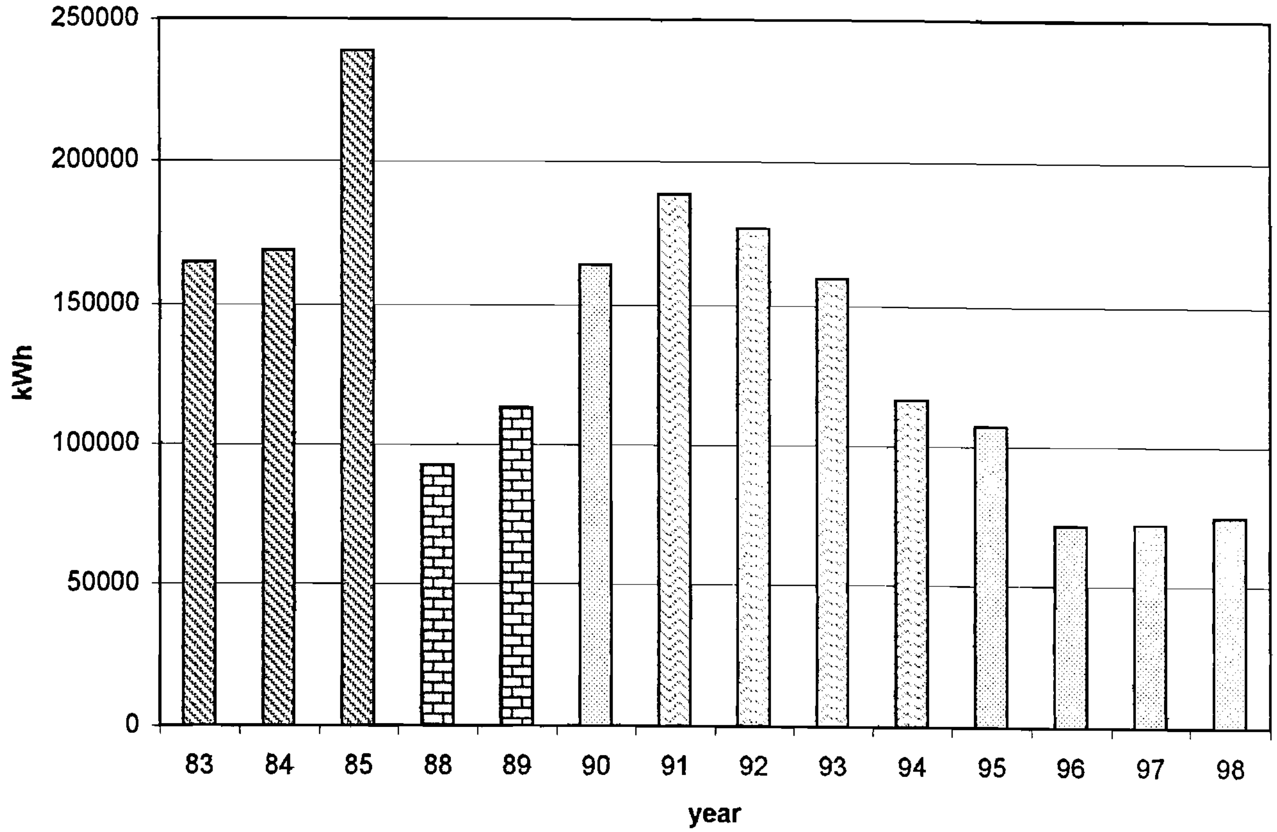
Month	$ spent	Year		total kWh per quarter		per month
Jan		83				21702.33
Feb						21702.33
March	2372.52		11702.32558	65106.98		21702.33
April						16203.1
May						16203.1
June	1875.94		6203.100775	48609.30		16203.1
July						7025
Aug						7025
Sept	926.67		6775	21075.00		7025
Oct						10039.42
Nov					total kWh:	10039.42
Dec	1319.36	6494.49	39.42414175	30118.27	164909.55	10039.42
Jan		84				21699.34
Feb						21699.34
March	2372.25		11699.33555	65098.01		21699.34
April						13527.46
May						13527.46
June	1634.33		3527.464009	40582.39		13527.46
July						10155.37
Aug						10155.37
Sept	1329.83		155.3709856	30466.11		10155.37
Oct						10970.43
Nov					total kWh:	10970.43
Dec	1403.43	6739.84	970.4318937	32911.30	169057.81	10970.43
Jan		85				25209.41
Feb						25209.41
March	2689.21		15209.41307	75628.24		25209.41
April						17338.1
May						17338.1
June	1978.43		7338.095238	52014.29		17338.1
July						11434.11
Aug						11434.11
Sept	1445.3		1434.108527	34302.33		11434.11
Oct						14640.09
Nov					total kWh:	14640.09
Dec	1734.8	7847.74	4640.088594	43920.27	238776.41	14640.09

MONTH	kWh	Year	Comment	cost acc to the kWh				
				=(given kWh) -(250+12250)	$$ calc. Acc. to kWh spent and hydro rates			
Jan		88	values not provided					
Feb			values not provided					
March			values not provided					
April			values not provided					
May			values not provided		$$			
June	12450			-50	666.73			
July	14250			1750	735.55			
Aug	10050			-2450	538.57			
Sept	13725			1225	715.71			
Oct	10950			-1550	586.63			
Nov	14175	total kWh:		1675	732.72	Sum ($)		
Dec	17250	92850		4750	848.95	4824.85		
Jan	16350	89		3850	861.95	30.74		
Feb	17250			4750	898.58			
March	18150			5650	935.21			
April	15300			2800	819.21			
May	15075			2575	810.05			
June	12450			-50	702.44			
July			values not provided					
Aug			values not provided					
Sept			values not provided					
Oct			values not provided					
Nov		total kWh:	values not provided			Sum($)		
Dec	18525	113100		6025	950.47	5977.89		
Jan	17175	90		4675	951.53	37.95		
Feb	14100			1600	818.38			
March	15150			2650	863.85			
April	11925			-575	714.72			
May	14550			2050	837.87			
June	13575			1075	795.65			
July	12150			-350	728.17			
Aug	12975			475	769.67			
Sept	13425			925	789.15			
Oct	12675			175	756.68			
Nov	11850	total kWh:		-650	710.23	Sum ($)		
Dec	14700	164250		2200	844.36	9580.24	9467.44	112.80
Jan	13725	91		1225	862.93	42.55		
Feb	14100			1600	880.52			
March	14625			2125	905.14			
April	21450			8950	1225.23			
May	15150			2650	929.76			
June	16425			3925	989.56			
July	15900			3400	964.94			
Aug	17100		2 values given for	4600	1021.22			
	15750		Aug-take higher valu	3250	957.90			
`ept	13350			850	845.34			
Oct	14550			2050	901.62			

Nov	15750	total kWh:	3250	957.90	Sum ($)		
Dec	16425	188550	3925	989.56	12431.60	12137.71	293.89
Jan	13950	92	1450	965.32	64.28		
Feb	18000		5500	1176.33			
March	16350		3850	1090.36			
April	16200		3700	1082.55			
May	16200		3700	1082.55			
June	16725		4225	1109.90			
July	16500		4000	1098.18			
Aug	16575		4075	1102.08			
Sept	15000		2500	1020.03			
Oct	8400		-4100	598.27			
Nov	10125	total kWh:	-2375	720.91	Sum ($)		
Dec	12825	176850	325	906.71	11953.16	11096.86	856.30
Jan	14550	93	2050	1072.41	1022.66		
Feb	15375		2875	1118.78			
March	16350		3850	1173.57			
April	13725		1225	1026.05			
May	14025		1525	1042.91			
June	12975		475	983.90			
July	13125		625	992.33			
Aug	11700		-800	896.00			
Sept	9075		-3425	695.19			
Oct	13200		700	996.54			
Nov	11400	total kWh:	-1100	873.05	Sum ($)		
Dec	13950	159450	1450	1038.69	11909.39	12581.58	-672.19
Jan	13575	94	1075	1017.62			
Feb	15825		3325	1144.07			
March	13425		925	1009.19			
April	9825		-2675	752.56			
May	11025		-1475	844.36			
June	10800		-1700	827.15			
July	8550		-3950	655.03			
Aug	6375		-6125	488.64			
Sept	6525		-5975	500.11			
Oct	5925		-6575	454.21			
Nov	6450	total kWh:	-6050	494.38	Sum ($)		
Dec	8025	116325	-4475	614.86	8802.17	4858.55	3943.62
Jan	11025	95	-1475	844.36			
Feb	10950		-1550	838.63			
March	10575		-1925	809.94		83	
April	10350		-2150	792.73		84	
May	11700		-800	896.00		85	
June	7350		-5150	563.23		88	Jan
July	5250		-7250	402.58		89	Feb
Aug	5850		-6650	448.48		90	March
Sept	8475		-4025	649.29		91	April
Oct	7725		-4775	591.91		92	May

Nov	7350	total kWh:	-5150	563.23	Sum ($)	93	June
Dec	10425	107025	-2075	798.46	8198.81	94	July
						95	Aug
Jan	3300	96	-9200	253.40		96	Sept
Feb	9225		-3275	706.66		97	Oct
March	6450		-6050	494.38		98	Nov
April	8625		-3875	660.76		99	Dec
May	3975		-8525	305.04			
June	7800		-4700	597.65			
July	3600		-8900	276.35			
Aug	5700		-6800	437.00			
Sept	4275		-8225	327.99			
Oct	5479		-7021	420.09			
Nov	5475	total kWh:	-7025	419.79	Sum ($)		
Dec	7800	71704	-4700	597.65	5496.76	6000	-503.24
Jan	5325	97	-7175	408.31			
Feb	7200		-5300	551.75			
March	7200		-5300	551.75			
April	7050		-5450	540.28			
May	5475		-7025	419.79			
June	5250		-7250	402.58			
July	5175		-7325	396.84			
Aug	4950		-7550	379.63			
Sept	5325		-7175	408.31			
Oct	6225		-6275	477.16			
Nov	5325	total kWh:	-7175	408.31	Sum ($)		
Dec	7500	72000	-5000	574.70	5519.40	5048	471.40
Jan	6900	98	-5600	528.80			
Feb	7425		-5075	568.96			
March	6225		-6275	477.16			
April	6525		-5975	500.11			
May	6000		-6500	459.95			
June	5550		-6950	425.53			
July	7200		-5300	551.75			
Aug	5925		-6575	454.21			
Sept	5550		-6950	425.53			
Oct	5400		-7100	414.05			
Nov	4575	total kWh:	-7925	350.94	Sum ($)		
Dec	7425	74700	-5075	568.96	5725.95		

annual hydro consumption for years 88-99



Appendix K

LeBreton Flats Non-Profit Community Heating

Statements of Revenue & Expenditures

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
STATEMENT OF REVENUE & EXPENDITURE

For the period December 31, 1998	Actual 1998	Budget 1998	DIFF. 1998
REVENUE			
Heat Sales	74,766.48	74,766.00	0.48
GST on Sales	5,233.68	5,234.00	(0.32)
Interest	710.83	0.00	710.83
Sundry	0.00	0.00	0.00
	80,710.99	80,000.00	710.99
EXPENDITURE			
Taxes	4,081.20	3,705.00	376.20
Insurance	3,315.60	3,316.00	(0.40)
Replacement Reserve	7,440.00	7,440.00	0.00
Gas	31,569.46	36,600.00	(5,030.54)
Hydro	5,852.26	6,000.00	(147.74)
Water	62.94	500.00	(437.06)
Administration	2,185.55	4,200.00	(2,014.45)
Landscape & Grounds	0.00	0.00	0.00
Water Treatment	860.04	860.00	0.04
M & G Mech. Contract	6,031.00	7,500.00	(1,469.00)
Misc. Maint. Expenses - water leak	81.52	0.00	81.52
Study	0.00	2,500.00	(2,500.00)
GST Input Credits (pd to vendors)	3,939.11	4,500.00	(560.89)
GST Net Expense (pd rev. canada)	1,294.57	734.00	560.57
Contingency	0.00	2,145.00	(2,145.00)
	66,713.25	80,000.00	(13,286.75)
OPERATING SURPLUS / (LOSS)	13,997.74	0.00	13,997.74
CAPITAL REPLACEMENT EXPENSES (see attached)	11,967.02		
NET OPERATING SURPLUS / (LOSS) (after capital expenses)	2,030.72		

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
BALANCE SHEET

	Dec.31/98
ASSETS	
Cash Operating Acct	25,879.46
Cash Reserve Acct	0.00
Petty Cash	0.00
Heat Sales Receivable	0.00
GST Rebate Receivable	0.00
Sundry Accts Receivable	873.69
Prepaid Insturance	0.00
Prepaid Taxes	0.00
Total Assets	26,753.15
LIABILITIES	
Accounts payable	10,896.18
Replacement reserve	14,880.00
Total Liabilites	25,776.18
EQUITY	
Previous Years Losses	(1,053.75)
1998 Operating Surplus Aug.31	2,030.72
Total Equity	976.97
Total Liability Plus Equity	26,753.15

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
LIST OF PAYABLES

	Dec.31/98
Heat for Dec.	6,426.06
Hydro for Dec.	700.88
Water for Dec.	20.17
Management	300.00
Contracts	2,154.50
Taxes	0.00
GST Rev. Canada	1,294.57
Total payables	10,896.18

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
STATEMENT OF REVENUE & EXPENDITURE

For the period December 31, 1997

	12 months DEC/97	Budget 1997	Proposed Budget 1998
REVENUE			
Heat Sales	74,766.48	74,766.00	74,766.00
GST on Sales	5,233.68	5,234.00	5,234.00
Interest	186.80	0.00	0.00
Sundry	0.00	0.00	0.00
	80,186.96	80,000.00	80,000.00
EXPENDITURE			
Taxes	3,576.91	3,705.00	3,705.00
Insurance	3,315.60	3,316.00	3,316.00
Replacement Reserve	7,440.00	7,440.00	7,440.00
Gas	34,295.49	36,600.00	36,600.00
Hydro	5,243.13	6,000.00	6,000.00
Water	59.18	500.00	500.00
Administration	4,276.33	4,200.00	4,200.00
Landscape & Grounds	159.57	0.00	0.00
Water Treatment	860.04	860.00	860.00
M & G Mech. Contract	6,203.59	7,500.00	7,500.00
Misc. Maint. Expenses - water leak	5,354.82	0.00	0.00
Study	0.00	2,500.00	2,500.00
GST Input Credits (pd to vendors)	4,410.12	4,500.00	4,500.00
GST Net Expense (pd rev. canada)	823.56	734.00	734.00
Contingency	0.00	2,145.00	2,145.00
	76,018.34	80,000.00	80,000.00
OPERATING SURPLUS / (LOSS)	4,168.62	0.00	0.00
CAPITAL REPLACEMENT EXPENSES (see attached -2 items)	2,917.17		
NET OPERATING SURPLUS / (LOSS) (after capital expenses)	1,251.45		

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
BALANCE SHEET

	DEC. 31/97
ASSETS	
Cash Operating Acct	14,556.71
Cash Reserve Acct	0.00
Petty Cash	100.00
Heat Sales Receivable	0.00
GST Rebate Receivable	0.00
Sundry Accts Receivable	0.00
Prepaid Insturance	0.00
Prepaid Taxes	0.00
Total Assets	14,658.71
LIABILITIES	
Accounts payable	8,272.43
Replacement reserve	7,440.00
Total Liabilites	15,712.43
EQUITY	
Previous Years Losses	(2,305.17)
1997 Operating Surplus	1,251.45
Total Equity	(1,053.72)
Total Liability Plus Equity	14,658.71

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
LIST OF PAYABLES

	DEC. 31/97
Heat for Nov. (est.)	5,471.87
Hydro for Nov. (est.)	565.83
Water for Nov. (est.)	0.00
Management 2 mths @ 350.00	350.00
M G Mechanical	1,049.36
Misc.	11.81
GST Rev. Canada	823.56
Total payables	8,272.43

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
STATEMENT OF REVENUE & EXPENDITURE

For the period December 31, 1996	12 months DEC/96	Budget 1996	Proposed Budget 1997
REVENUE			
Heat Sales	74,766.48	74,766.00	74,766.00
GST on Sales	5,233.62	5,234.00	5,234.00
Interest	156.86	0.00	0.00
Sundry	2.00	0.00	0.00
	80,158.96	80,000.00	80,000.00
EXPENDITURE			
Taxes	3,804.00	4,000.00	3,705.00
Insurance	3,409.56	0.00	3,316.00
Replacement Reserve	7,440.00	7,200.00	7,440.00
Gas	35,145.71	37,000.00	36,600.00
Hydro	5,651.44	14,400.00	6,000.00
Water	455.60	5,000.00	500.00
Administration	3,705.08	1,800.00	4,200.00
Landscape & Grounds	1,302.85	0.00	0.00
Water Treatment	1,877.75	2,040.00	860.00
M & G Mech. Contract	14,640.71	8,560.00	7,500.00
Mechanical Replacement (reserve items)	2,940.93		
Roof Replacement (reserve items)	642.83	0.00	0.00
Misc. Maint. Expenses	44.00	0.00	0.00
Study	0.00	0.00	2,500.00
GST Input Credits (pd to vendors)	4,991.48	0.00	4,500.00
GST Net Expense (pd rev. canada)	242.14	0.00	734.00
Contingency	0.00	0.00	2,145.00
	86,294.08	80,000.00	80,000.00
OPERATING SURPLUS / (LOSS)	(6,135.12)	0.00	0.00

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
BALANCE SHEET

	DEC. 31/96
ASSETS	
Cash Operating Acct	3,965.12
Petty Cash	100.00
Prepaid Insturance	0.00
Replacement Reserve	0.00
Heat Sales Receivable	6,666.68
Sundry Accts Receivable	3,022.08
Total Assets	13,753.88
LIABILITIES	
Accounts payable	16,059.05
Replacement reserve	0.00
Total liabilites	16,059.05
PREVIOUS YEARS SURPLUS	3,829.95
1996 OPERATING LOSS	(6,135.12)
NET LOSS TO DEC. 31/96	(2,305.17)
	13,753.88

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
STATEMENT OF REVENUE & EXPENDITURE

For the period July 1/94 to December 31/95	18 months DEC/95
REVENUE	
Heat Sales	112,149.72
GST on Sales	7,850.32
Interest	0.00
Sundry	2.00
	120,002.04
EXPENDITURE	
Taxes	5,633.78
Insurance	3,100.68
Replacement Reserve	11,160.00
Gas	52,850.34
Hydro	11,758.66
Water	388.87
Water Treatment	2,803.13
Administration	883.93
M & G Mech. Contract	13,666.01
Roof Replacement	4,212.61
Misc. Maint. Expenses	1,863.76
GST Input Credits (pd to vendors)	5,995.42
GST Net Expense (pd rev. canada)	1,854.90
	116,172.09
OPERATING SURPLUS	3,829.95

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
BALANCE SHEET

	DEC. 31/95
ASSETS	
Cash Operating Acct	10,313.56
Replacement Reserve	11,160.00
Heat Sales Receivable	10,973.32
Sundry Accts Receivable	3,000.00
	35,446.88
LIABILITIES	
Accounts payable	20,456.93
Replacement reserve	11,160.00
	31,616.93
OPERATING SURPLUS	3,829.95
	35,446.88

LEBRETON FLATS NON PROFIT COMMUNITY HEATING
NOTES TO THE AUDIT DECEMBER 31, 1995

1. REVENUE & EXPENSES

This is the first financial year end statement for the plant and represents an eighteen month period from July 1/94 to Dec. 31/95. For the 1996 year end, the 95 figures will be pro rated to twelve months in order to have comparative numbers.

2. REPLACEMENT RESERVE

Under the management agreement with CMHC, the plant manager is required to submit $620.00 month to CMHC to fund future capital expenditures. In a subsequent letter from CMHC, dated June 21/94, the plant manager is authorized to fund the reserve in an interest bearing account. As of Dec. 31/95, the fund ($11,160) was fully funded in the plant's general account and not an interest bearing account.

3. AVERAGE UNIT COST FOR HEAT

The total expenses of $116,172. for eighteen months pro rated (67%) to a twelve month period equals $77,488.00 for a yearly cost. The following table represents the average cost to heat the units for CCOC and Tompkins Coop.

TOMPKINS		CCOC	
10 Preston		33 Rochester	8
Walnut Court		170 Booth	53
30 Preston		Booth Commercial	4
217 Primrose			
	76 units		65 units

	UNITS	% UNITS	% COST	TOTAL COST	UNIT COST
TOMPKINS	76	53.9	64.6	$50,057.	$658.65
CCOC	65	46.1	35.4	$27,431.	$422.02
TOTALS	141	100.0	100.0	$77,488.	$549.56

Appendix L

Details of the 1999 August System Temperature Monitoring

By T. Onno, Gagest Developments Inc.

Details of the 1999 August Temperature Monitoring

By T. Onno, Gagest Developments Inc.

The plant supply temperature is shown in Fig. 1. It is fairly steady at about 83°C, with some fluctuation as the boiler control system cycles on and off. At midnight, on 1999 Aug. 11, the system goes into erratic operation and over a two day period the supply temperature drops to 40°C. Near midnight on Aug. 13 the system recovers and stabilizes at a slightly higher temperature.

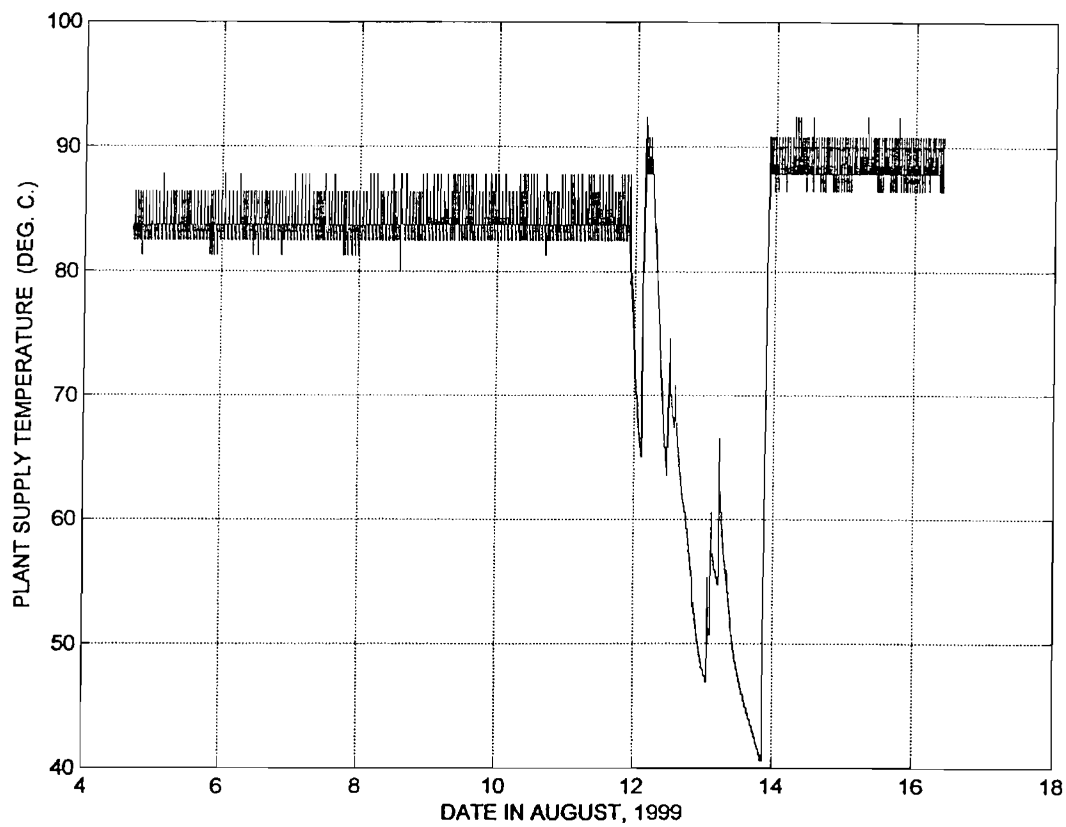


Fig. 1: Plant Supply Temperature During Warm Weather Operation

The temperature difference between plant supply and West return is shown in Fig. 2. The data was heavily filtered to eliminate the boiler control system fluctuations. This was accomplished by a digital filter with about a one hour time constant. Filtering was applied in both the forward and reverse directions to cancel phase distortion and retain accurate time correlation.

As discussed in Section 6 of the main report, the West flow is a combination of a large flow through a short circuit connection, mixed with a variable flow due to DHW demand. Since a short circuit flow will not cause any temperature difference, it can be assumed that the temperature difference will be lowest when the dominant flow is due to short circuits. This is found to be the case, since Fig. 2 shows the lowest temperature difference in the periods after midnight. Aug. 9 is a Monday, and a sharp peak in temperature difference can be observed at about 8:00 AM, as occupants use DHW, which probably operates at a temperature difference of over 30°C. Another large peak is seen in the evening. The modest, 2°C temperature difference is indicative of the large ratio between flow used for DHW preparation and short-circuited flow.

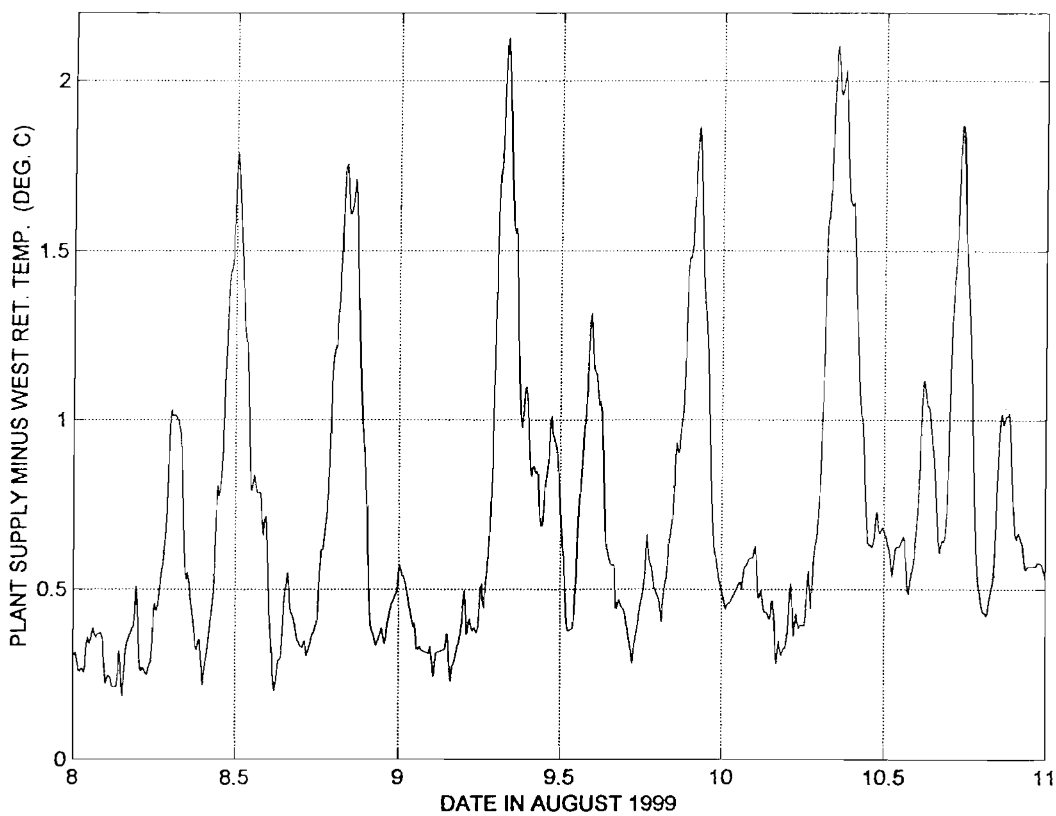


Fig. 2: Warm Weather West Side Temperature Difference

In a properly operating district heating system with multiple loads distributed by distance, a fluctuation in the supply temperature will not be seen directly in the return temperature. Some well-controlled loads will actually have a reduction in return temperature if the supply temperature increases. Also, even a medium size system can have time delays of over 30 minutes of the flow around the furthest part of the loop. The return temperature will be made up of flow through multiple loads and various time delays. As these flows mix in the return line, there will be a "smearing effect" of supply temperature fluctuations.

The only way that the supply temperature fluctuations will be reflected accurately in the return line is if the load is a short-circuit at a single point. Fig. 3 shows this to be the case in the middle of the night. If the return temperature is incremented by 0.4°C to compensate for temperature lost to the ground, it is seen to very accurately reflect the supply temperature fluctuation. If the pipe diameter and water flow velocity are known, the distance to the short circuit can be calculated.

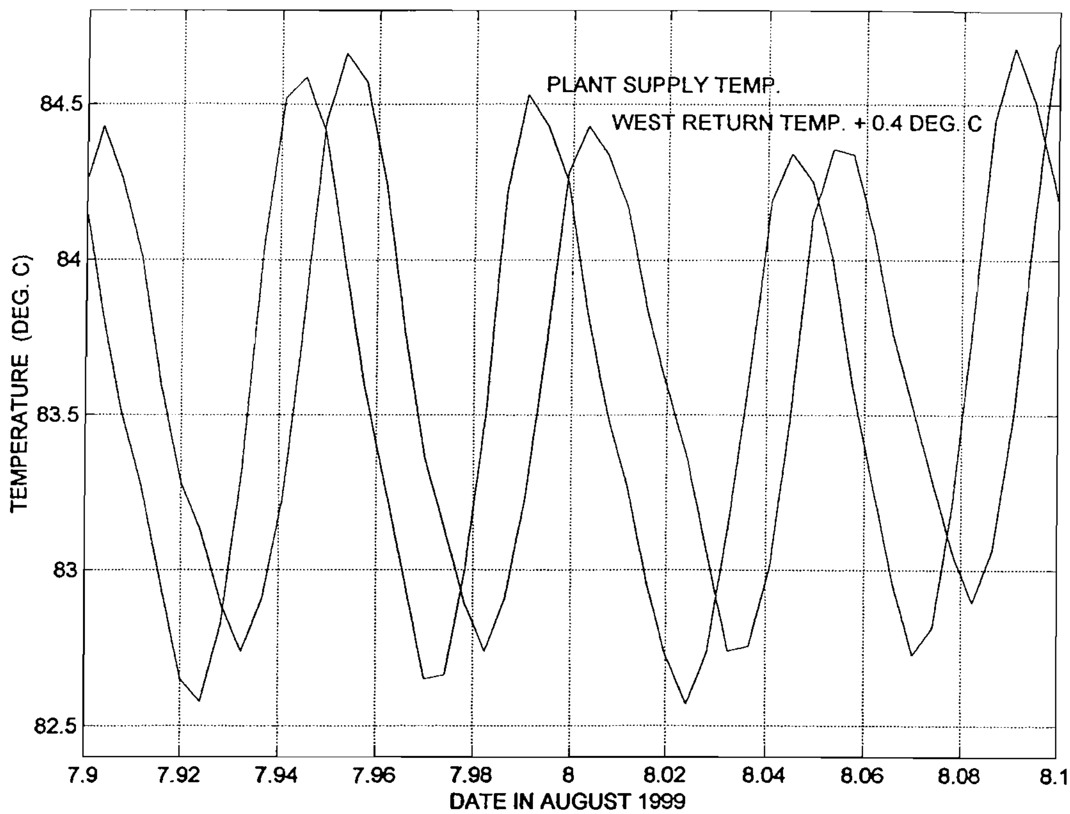


Fig 3: Time Difference Between Supply and West Return Temperature Fluctuations

The only load during this period of warm weather was the DHW system in the CCOC apartment building. This DHW was supplied by a large storage tank with a coil heat exchanger installed inside the tank. As shown in Fig. 4, during the daytime, when significant quantities of hot water were being supplied, the return temperature was approximately 55°C, giving a temperature difference of almost 30°C. After midnight, the return temperature is seen to slowly increase until morning when it suddenly drops. This is due to the flow reducing to zero when the DHW demand disappears. Because of installation considerations, the temperature sensor was located about 5 metres before the connection with the West Side return pipe. Due to short circuit flows, the West Side return temperature was always within a few degrees of the supply temperature. With no flow in the East return line, the hot downstream water caused the water to be heated by a combination of convection and conduction effects.

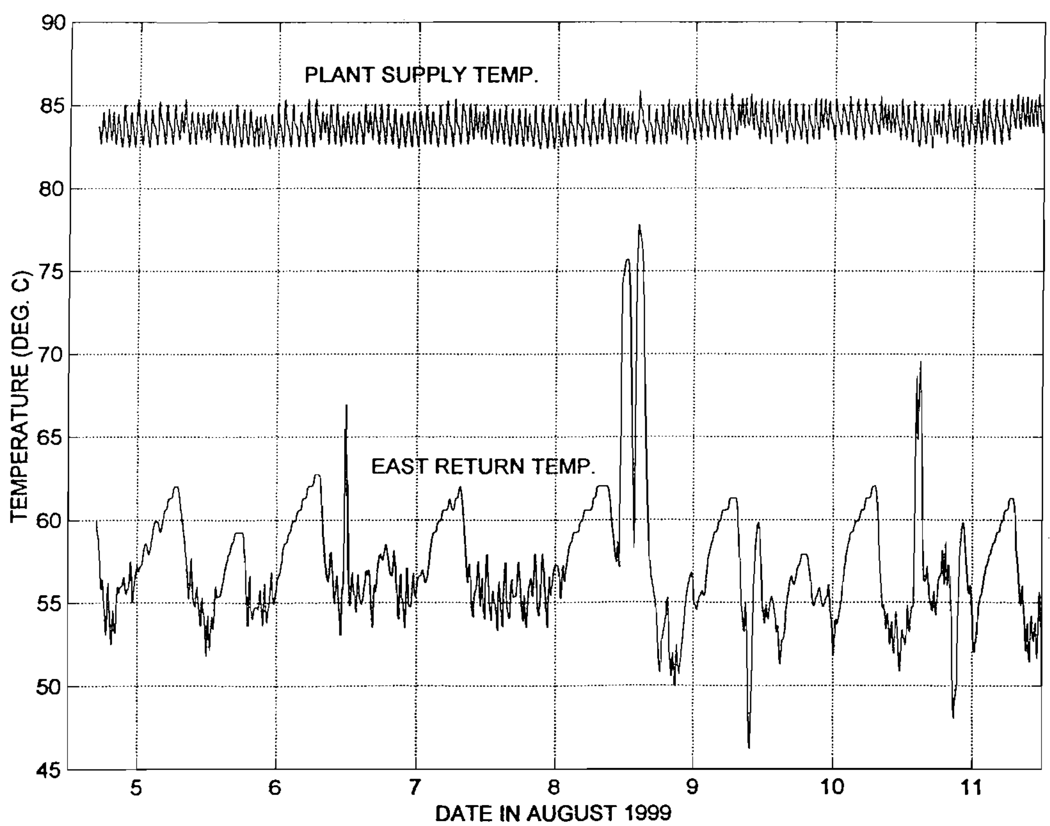


Fig. 4: Warm Weather Supply Temperature and East Return Temperature

On three occasions, the East return temperature is seen to suddenly increase. This is most noticable in the middle of the day on 1999 August 8th. The temperature rises to over 75°C and stays there for more than two hours. The reason for this is not clear. It could be due to control system intermittent failures or data system measurement problems. Further monitoring at the storage tank is required to identify the problem.

Some further temperature measurements were done in September and October. System flow measurements are not available for this period. Nevertheless, a number of interesting observations can be made from this temperature data. The plant supply temperature is shown in Figure 5. It can be observed that the temperature is steady up to around October 12th, when the supply temperature drops to 35°C. Figure 6 shows the details of this interruption in supply. It appears as if two separate control malfunctions occurred, the last one being serious enough to lower the system temperature to almost ambient levels.

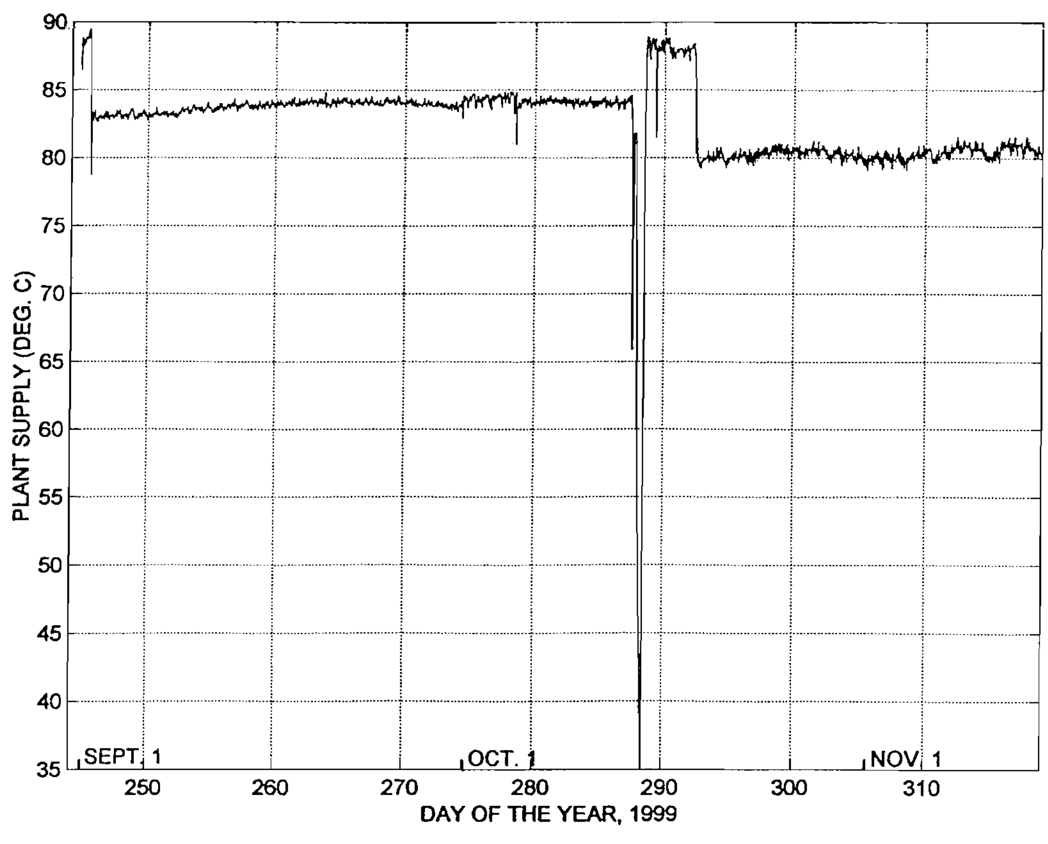


Figure 5: Plant Supply Temperature

The plant supply and West Side return temperature are shown in Figure 7. The figure indicates that the temperature difference is very small for summertime operation.

It is also shown the effect on the temperature difference when the heating systems are reconnected at the end of September. The temperature difference increases by two or three degrees, as shown in Figure 8. The suspected control problems at the DHW tank in the CCOC building first indicated in Figure 4 are continuing and increasing in frequency.

Figure 9 shows the return temperature in the East leg of the system and the spiked temperature profile indicates that the control problems are getting worse. The graph shows data from before the start of the heating season. Therefore, the DHW tank controls are implicated. Figure 10 shows a close-up of the temperature spikes, indicating that the control problems can occur several times per day.

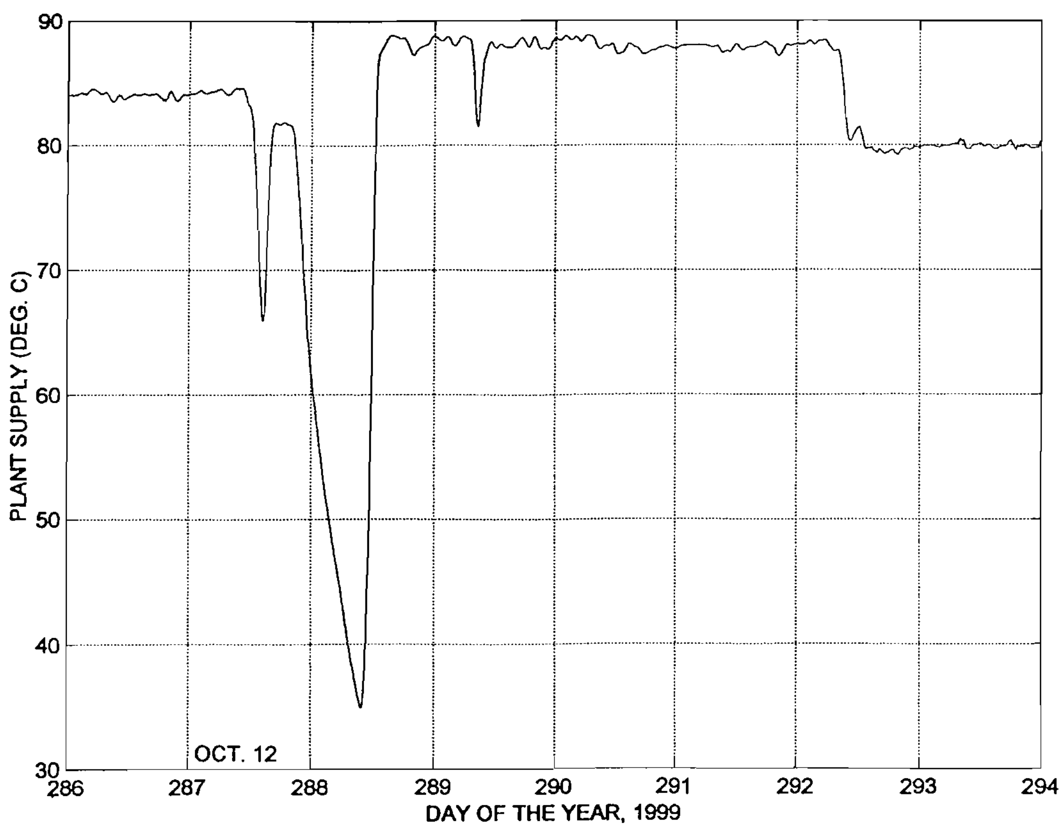


Figure 6: Detail of Plant Supply Temperature

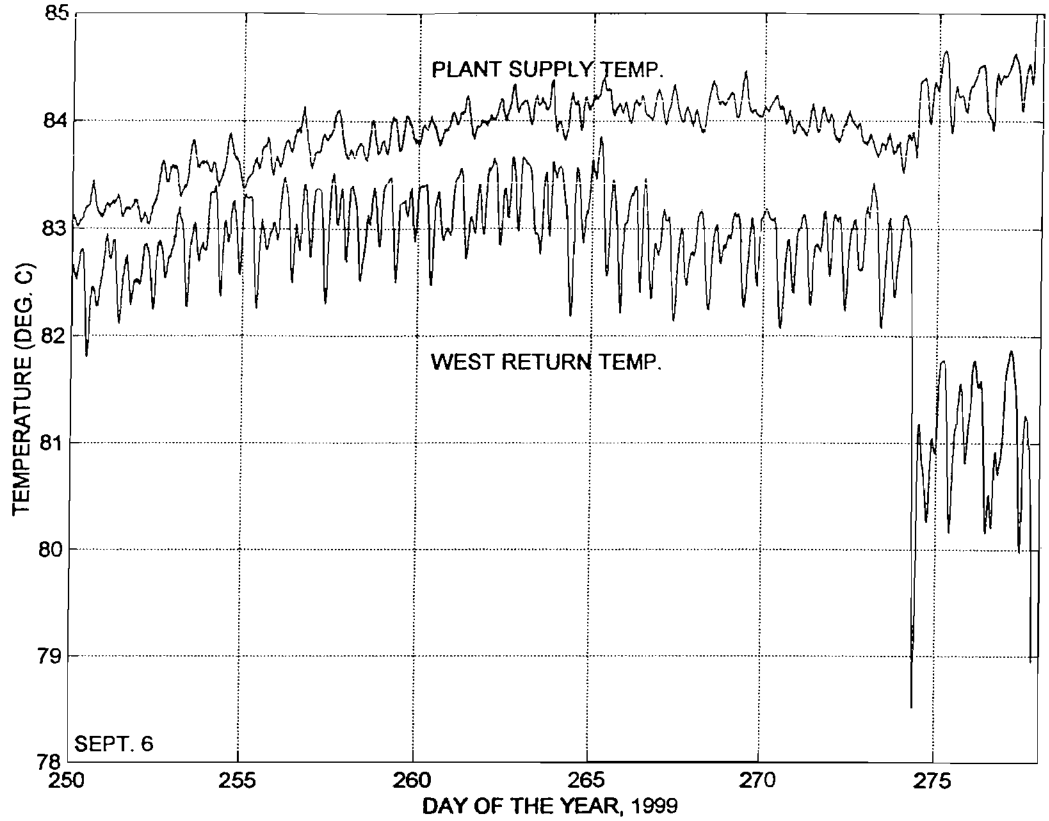


Figure 7: Plant Supply and West Return Temperature

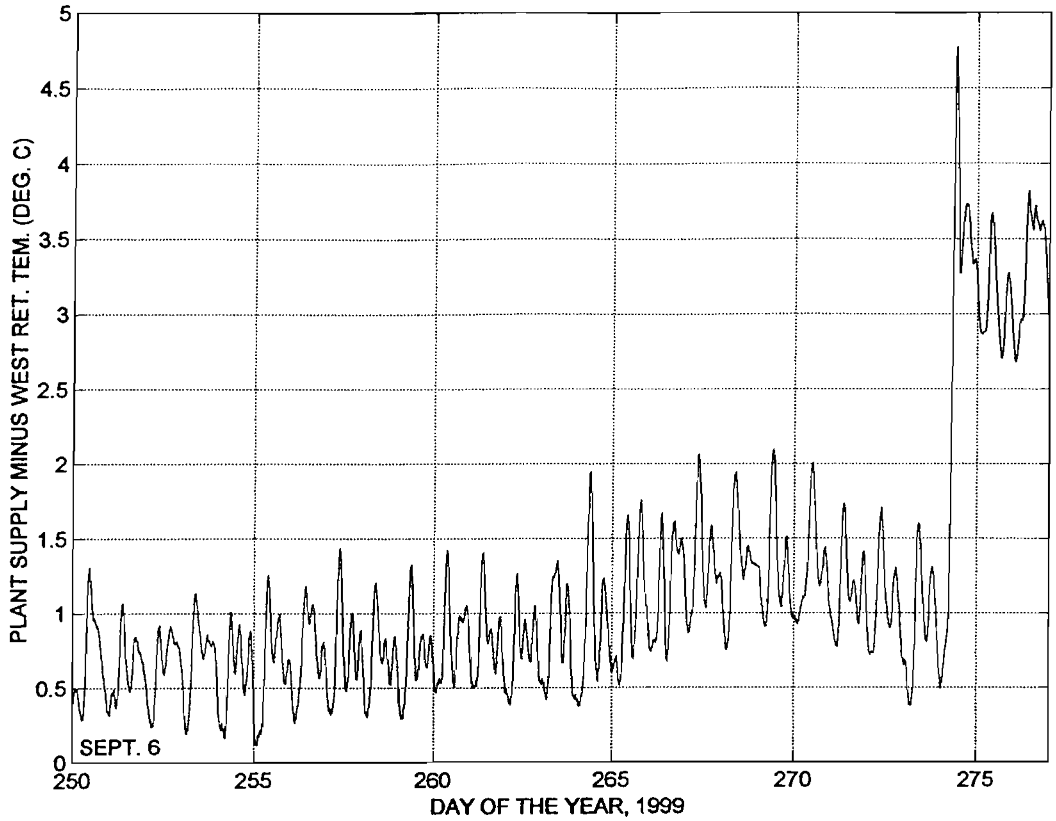


Figure 8: West Side Supply and Return Temperature Difference

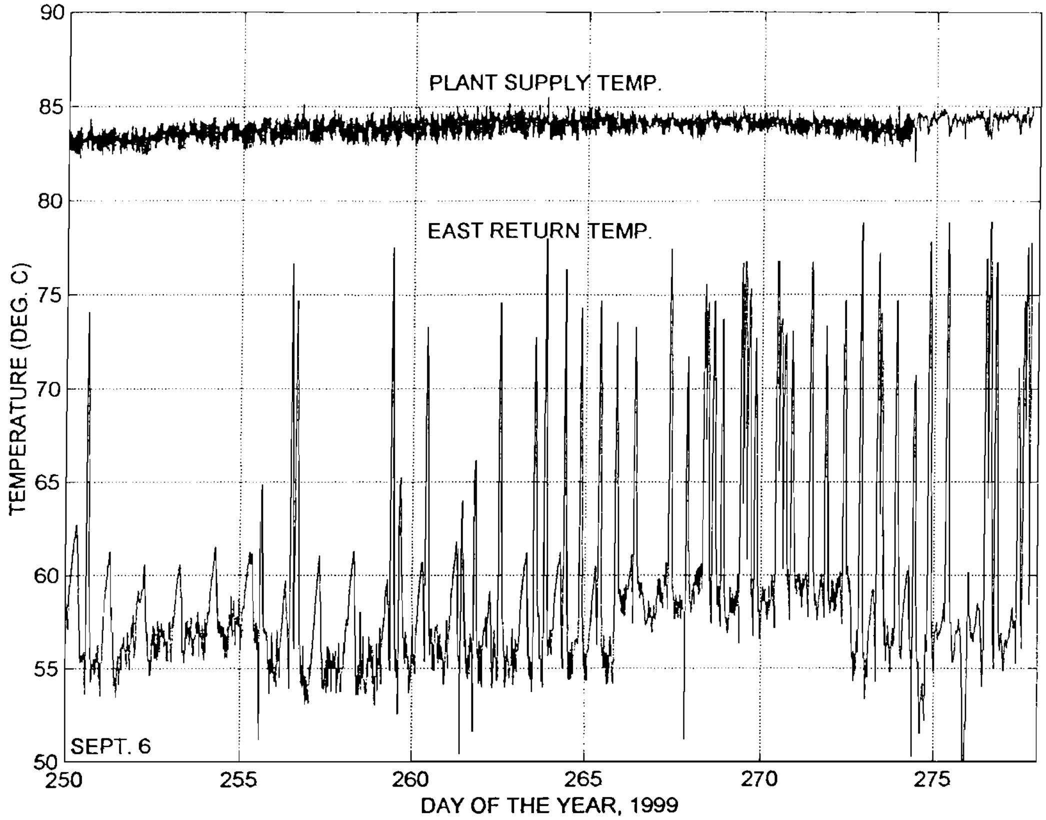


Figure 9: Plant Supply and East Side Return Temperature Difference.

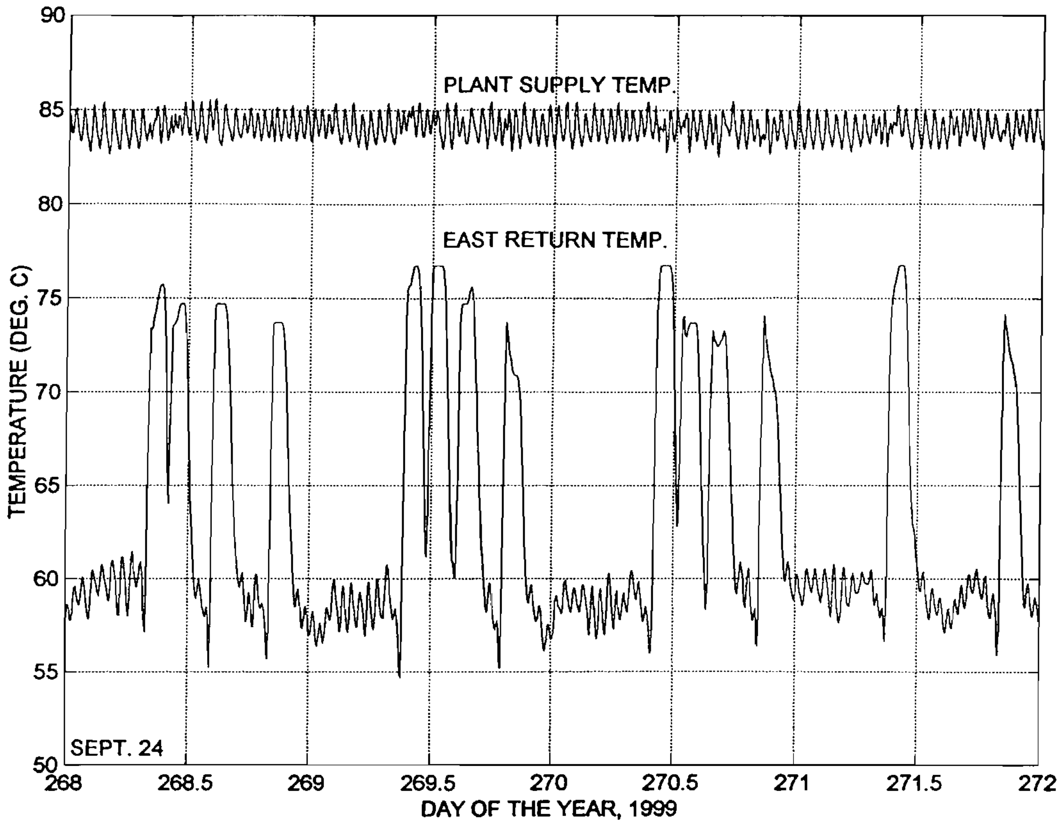


Figure 10: Detail of East Side Return Temperature