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ENGINEERING LTD.

ANALYSIS OF DOMESTIC WATER SYSTEM

Grandview Court and Parkview Court

10523 & 10533 UNIVERSITY DRIVE
SURREY, BC

Prepared for:

Brian Spencer, Property Manager

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RE: Domestic Water System Assessment at Strata Plan LMS 1328 Grandview Court and Parkview Court – 10523 & 10533 Univeristy Drive, Surrey, BC

Dear Mr. Spencer,

Following our investigation of the domestic water system at Grandview Court and Parkview Court, located at 10523 & 10533 University Drive, Surrey, British Columbia, we are pleased to present the following report. Our investigation involved testing of water samples collected at the building and destructive testing of a limited number of pipe samples.

Grandview Court consists of a 128 residential unit 16-storey concrete structure on top of three-storey underground parking garage. Parkview Court consists of a 66 residential unit 4-storey wood structure on top of an underground concrete parking garage. The buildings are both approximately 19 years old at the time of this report.

The units investigated were as follows:

Grandview:	
Unit #1304	Bathroom
Hobby Room	Kitchen
Parkview:	
Unit #412	Bathroom
Unit #412	Kitchen

This report consists of a description of the buildings' plumbing system, a description of typical corrosion in a copper pipe system, a discussion of water sample tests and pipe sample tests, followed by our recommendations.

Description of the Existing Domestic Plumbing Distribution System

A typical water distribution system includes both hot and cold water supply pipes. For buildings over 12 storeys, separate pressure zones are usually required within the building to provide adequate pressure for the entire system. In this case, Grandview Court has two pressure zones with booster pumps to provide adequate pressure to all fixtures, and Parkview Court only has one pressure zone since the municipal pressure is adequate.

Pressure Zone at Grandview	Floors Served
Lower Zone	1st Floor to 8th Floor
Upper Zone	9th Floor to 16th Floor

The cold water supply system provides water at the temperature supplied by the municipality. The cold water piping system at Grandview Court is laid out as follows: The mechanical room is located in the first level of the parking garage. Two cold water main pipes distribute from the mechanical room for each pressure zone. One runs horizontally in the ceiling of the first floor, and branches out with vertical risers from the ceiling running up to the eighth floor. The vertical risers supply cold water to the various fixtures of individual suites. The other one runs vertically up to the eighth floor and to the hot water tanks. The piping runs horizontally on the ceiling of the eighth floor and branches out with vertical risers running up to the sixteenth floor. The vertical risers supply cold water to the various fixtures of individual suites.

The cold water piping system at Parkview Court is laid out as follows: the mechanical room is located in the parking garage. A cold water main pipe distributes from the mechanical room. It runs horizontally in the ceiling of the first floor, and then branches out from the ceiling. Vertical risers supply cold water to the various fixtures of individual suites on each floor as it branches out from the ceiling of the first floor running up to the top floor.

The hot water system in Grandview starts from the domestic hot water storage tanks located in the top floor, and then two hot water main pipes distribute to each pressure zone. The pipes run horizontally on the sixteenth and eighth floor and the vertical risers run adjacent to the cold water pipes. The hot water system in Parkview starts from the hot water tank located in the parking garage, and the runs adjacent to the cold water pipes. Unlike the cold water supply system, hot water lines are connected to return lines, which run back to the storage tank. Typically, a pump in the mechanical room allows a constant circulation of water from the hot water tank, through the horizontal pipe, and then back through the return lines to the tank. This continuous circulation is necessary in order to maintain the temperature of the water in the supply pipes and to meet the hot water demand. Without re-circulation, it could take up to five minutes of running a faucet to get hot water.

All hot and cold supply pipes as well as re-circulation pipes at both Grandview and Parkview are made of copper.

Corrosion in a Typical Distribution System Using Copper Pipes

Copper pipe corrosion of a water distribution system is a common phenomenon with many possible causes. Four major factors affecting the internal corrosion of copper pipes are the chemical composition of the water, the temperature of the water, the velocity that the water travels inside the pipe, and the presence of any electrolytic effects.

The chemical composition of the water is determined by the acidity (pH) and the presence of corrosives (oxygen and chlorine). The optimal pH falls between 6.5 to 8.5. The rate of copper corrosion is dependent on the level of pH; the rate increases significantly as pH falls below 6.

The temperature of the water also plays an important role in corrosion reactions rates. The higher the temperature of the medium, the faster the rate of corrosion. Thus, hot water pipes tend to corrode faster than cold water pipes.

The velocity of the water corrodes pipes in two ways: increasing erosion due to friction and the creation of pressure shocks caused by cavitation. Increased friction inside the pipe due to high velocity water results in scouring of the pipe wall by any dissolved solids. Another consideration is that differences in pressure are created around bends and discontinuities in the pipe as high velocity water travels throughout the system. A large enough change in pressure will cause cavitation (water vapour bubbles forming in the pipe), which in turn will produce noise and more importantly, an increase in the rate of pitting of the pipe wall. Cavitation will occur at lower velocities in hot water than in cold. The velocity of water can be reduced by increasing the pipe sizes.

A final consideration is that of electrolytic effects. If two dissimilar metals are in contact with each other in a water solution, a "wet-cell" battery is created and an electric current flows; while deposits form on one of the metals, the other metal dissolves. Unfortunately, the electric potential of iron and copper is such that if iron (or steel) is in contact with copper piping, the copper will dissolve. Steel makes contact with copper pipe at pumps, hangers, wall studs, or wiring conduits. A contact between dissimilar metals can be avoided by using plastic or copper pipe hangers or by insulating non-copper pipe hangers and wires from a direct contact with copper pipes. Installing dielectric unions to isolate steel fittings from the copper system will also mitigate corrosion caused by contact of dissimilar metals.

General corrosion is not suspected to cause a rapid failure of the distribution system; however, it can cause significant thinning of the pipe walls and reduced service life. A proper design can minimize the factors contributing to the corrosion.

Water Quality of Greater Vancouver's Reservoirs

The majority of drinking water to the City of Surrey comes from a network of reservoirs operated by Metro Vancouver. The glacial water from the Metro Vancouver reservoirs is regarded as soft water and slightly acidic. Soft water is low in dissolved calcium and magnesium, and tends to dissolve minerals, especially copper. The average copper content is 0.0006 mg/L to 0.0014 mg/L and pH is 6.5, as shown the 2013 Water Quality Control Annual Report by Metro Vancouver. The reason for the acidic water is the source of water, which comes mainly from natural precipitation. Acidic and soft water has a propensity to cause corrosion in copper pipes that produces blue-green stains. As the water passes from the reservoir passes through re-chlorination stations the pH can change adversely.

Water Testing at Grandview and Parkview

Our investigation involved collecting water samples from: Unit #1304 and Hobby Room at Grandview Court, and Unit #412 at Parkview Court. Four types of water samples were collected: unflushed cold water, unflushed hot water, flushed cold water, and flushed hot water. A total of sixteen samples were collected and tested for pH level and copper content. The results are displayed in Table A1 to Table A4.

Table A1 – pH and Copper Content in Water from Bathroom of Unit #1304 at Grandview

	Copper Content (mg/L)	**pH**
"Standing" Cold Water (unflushed)	0.50	5.6
"Direct" Cold Water (flushed)	0.05	5.6
"Standing" Hot Water (unflushed)	0.70	5.7
"Direct" Hot Water (flushed)	0.70	5.6

The average pH of the above samples was 5.63
The average Copper Content of the above samples was 0.49 mg/L

Table A2 – pH and Copper Content in Water from Kitchen of Hobby Room at Grandview

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.70	5.9
"Direct" Cold Water (flushed)	0.20	5.9
"Standing" Hot Water (unflushed)	0.20	5.9
"Direct" Hot Water (flushed)	0.70	6.0

The average pH of the above samples was 5.93
The average Copper Content of the above samples was 0.45 mg/L

Table A3– pH and Copper Content in Water from Bathroom of Unit #412 at Parkview

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.70	6.2
"Direct" Cold Water (flushed)	0.20	6.2
"Standing" Hot Water (unflushed)	0.70	6.3
"Direct" Hot Water (flushed)	0.70	6.2

The average pH of the above samples was 6.23
The average Copper Content of the above samples was 0.58 mg/L

Table A4– pH and Copper Content in Water from Kitchen of Unit #412 at Parkview

	Copper Content (mg/L)	pH
"Standing" Cold Water (unflushed)	0.70	6.0
"Direct" Cold Water (flushed)	0.50	6.0
"Standing" Hot Water (unflushed)	0.70	6.1
"Direct" Hot Water (flushed)	0.70	6.1

The average pH of the above samples was 6.05
The average Copper Content of the above samples was 0.65 mg/L

Note: Results shown in the above tables are based on the analysis of tap water samples taken by our firm. All values have an experimental error of +/- 0.1 mg/L and +/- .1pH

The average pH and copper content of all samples was found to be 5.96 and 0.54 mg/L. The pH level indicates that the water is acidic and below the "ideal" pH range for drinking water of 6.5 to 8.5.

The copper content of 0.54 mg/L is found to be fairly high, but it is lower than the aesthetic objective amount of 1.0 mg/L in the "Guidelines for Canadian Drinking Water Quality," published in 2012. Adverse health effects occur at levels much higher than the aesthetic objective.

High levels of dissolved copper often indicate an accelerated rate of corrosion, typically involving thinning of the pipe walls throughout rather than simply localized pitting.

These average values also reinforce the correlation that excess copper content is observed when pH value drops blow 6.

As previously noted, the concentration of copper in the Metro Vancouver reservoirs (2013) is typically in the range of 0.0006 mg/L to 0.0014 mg/L. This means virtually all the dissolved copper is originating from the corrosion of the copper pipes throughout the building. The fact that most unflushed water samples had higher copper content than flushed samples also supports the observation.

Destructive Testing of Pipe Samples from Grandview and Parkview

Eighteen pipe samples in total were obtained for destructive testing. Four pipe samples were taken from previous leak pipe repairs. Six samples were obtained for each pressure zone at Grandview. All samples were found to be Type L copper, which is the minimum standard acceptable by code. Sample A1-C3 were from Grandview and Samples D1 – E1 were from Parkview. A description of these samples is provided in Table B.

Table B – Description of Samples

Sample	Description/ Location	Pipe Type	Hot/Cold	Pipe Diameter (inches)	Sample Length (inches)
A1	Main, 8th Floor, Upper Zone, Grandview	L	Cold	2½"	12"
A2	Main, 16th Floor, Upper Zone, Grandview	L	Hot	2"	15"
A3	Riser, Unit #1304, Upper Zone, Grandview	L	Cold	1"	12"
A4	Riser, Unit #1304, Upper Zone, Grandview	L	Hot	1½"	12"
A5	Recirculation, 8th Floor, Upper Zone, Grandview	L	Hot	1"	14"
A6	Recirculation, Mechanical Room, Upper Zone, Grandview	L	Hot	1"	13"

Sample	**Description/ Location**	**Pipe Type**	**Hot/Cold**	**Pipe Diameter (inches)**	**Sample Length (inches)**
B1	Main, Hobby Room, Lower Zone, Grandview	L	Cold	2"	15"
B2	Main, 8th Floor, Lower Zone, Grandview	L	Hot	3"	14"
B3	Riser, 1st Floor, Lower Zone, Grandview	L	Cold	2"	15"
B4	Riser, 1ST Floor, Lower Zone, Grandview	L	Hot	1¼"	13"
B5	Recirculation, Hobby Room, Lower Zone, Grandview	L	Hot	1"	14"
B6	Recirculation, Mechanical Room, Lower Zone, Grandview	L	Hot	1"	13"
C1*	Riser, 15th Floor, Upper Zone, Grandview	L	Hot	2½"	15"
C2*	Riser, 4th Floor, Lower Zone, Grandview	L	Hot	1¼"	18"
C3*	Recirculation, Grandview	L	Hot	1"	14"
D1	Main, Mechanical Room, Parkview	L	Cold	4"	14"
D2	Main, Mechanical Room, Parkview	L	Hot	4"	14"
D3	Riser, 3rd Floor, Parkview	L	Cold	1¼"	15"
D4	Riser, 3rd Floor, Parkview	L	Hot	1¼"	12"
D5	Recirculation, Parking Garage, Parkview	L	Hot	1¼"	18"

Sample	Description/ Location	Pipe Type	Hot/Cold	Pipe Diameter (inches)	Sample Length (inches)
D6	Recirculation, Mechanical Room, Parkview	L	Hot	1¼"	15"
E1*	Main, 1st Floor, Parkview	L	Hot	1¼"	17"

*These samples were taken from previous pipe repairs.

Destructive testing involves both macroscopic and microscopic examinations. Microscopic examination of the samples determines the nature of the pitting. For example, velocity related pitting due to undersized pipes leaves a specific signature or type of pit-shape.

Macroscopic examination involves a visual inspection of pipe samples such as measuring the wall thickness, observing different types of failures, checking for corrosion or scouring patterns, and determining the number of pinholes in the sample.

The examination results are shown in Table C.

Table C – Summary of Results from Pipe Sample Examination

Sample	Hot/ Cold	Original Thickness (mm)	Wall Loss (%)	Colour Code*	Condition
A1	Cold	2.03	7.98		Uniform corrosion with shallow pitting with minor velocity wear; green-brown surface
A2	Hot	1.78	2.19		Uniform corrosion with multiple black mounds over deep pits; green-black surface. Pinhole noted on surface.
A3	Cold	1.27	19.61		Uniform corrosion with major velocity wear and shallow pitting; brown surface
A4	Hot	1.52	3.29		Uniform corrosion with multiple green and black mounds and numerous shallow pits; black surface
A5	Hot	1.27	21.89		Severe corrosion with numerous deep penetrating pits of various sizes and depth throughout;

Sample	Hot/ Cold	Original Thickness (mm)	Wall Loss (%)	Colour Code*	Condition
					moderate water swept marks, green-black surface
A6	Hot	1.27	37.32		Severe corrosion with numerous black mounds, severe velocity wear marks; brown surface
B1	Cold	1.78	3.54		Uniform corrosion with small green mounds over early pitting; Minor velocity wear marks; green-brown surface
B2	Hot	2.29	3.58		Uniform corrosion with multiple black and green mounds over deep pits; black surface
B3	Cold	1.78	1.97		Uniform corrosion with shallow pitting and minor velocity wear; brown surface
B4	Hot	2.29	5.93		Uniform corrosion with green mounds over deep pits; numerous shallow pitting throughout; green-brown surface
B5	Hot	1.78	11.73		Severe corrosion with green mounds over deep penetrating pits; Moderate velocity wear, brown-black surface
B6	Hot	1.4	10.08		Severe corrosion with pitting of various sizes; moderate velocity marks; black surface
C1	Hot	1.27	1.53		Uniform corrosion with multiple large green mounds over deep pits; green-black surface
C2	Hot	1.27	2.79		Uniform corrosion with numerous green mounds over deep pits; moderate velocity wear; black surface
C3	Hot	2.03	17.48		Severe corrosion with deep penetrating pits; severe water scouring marks; black surface
D1	Cold	1.4	2.51		Uniform corrosion with small

Sample	Hot/ Cold	Original Thickness (mm)	Wall Loss (%)	Colour Code*	Condition
					shallow pitting; minor velocity wear marks; brown surface
D2	Hot	1.27	1.68		Uniform corrosion with multiple green mounds over deep pits; numerous shallow pits and minor velocity wear; black surface
D3	Cold	2.79	4.29		Minor velocity wear and shallow longitudinal pitting; brown surface
D4	Hot	2.79	4.86		Deep pits with numerous shallow pits; multiple small green mounds; green-black surface
D5	Hot	1.4	31.07		Severe corrosion with numerous deep and shallow pits; a deep penetrating pit was observed; severe velocity scouring marks; brown-black surface
D6	Hot	1.4	5.79		Minor velocity wear and various small pits; green-black surface
E1	Hot	1.4	5.14		Numerous small shallow pits; deep penetrating pits; minor velocity wear marks; black surface

Note: Results shown in above table are based on the analysis of half-pipe segments from each sample. Wall loss shown has an experimental error of +/- 5%.

**We have included a colour coded indicator as follows:*

	Severe corrosion/erosion
	Moderate corrosion/erosion
	Mild corrosion/erosion

In general, the pipe samples displayed moderate thinning. The wall loss in the samples varied from 1.53 to 37.32 percent with average being 9.37 percent. The wall loss within the samples varies, but the average wall thickness generally gives a good indication of the pipe wall condition. The highest degree of wall loss was found in the recirculation pipes. Large wall loss also support the findings of high copper contents from the water samples.

An example of uniform corrosion and cold-water pitting is seen in sample A1 (refer to Photo 1). Uniform corrosion is a general form of corrosion where the entire surface of the pipe wall is thinning at a uniform rate. A tarnished copper surface and shallow narrow pits characterize uniform corrosion and cold water pitting respectively.

Hot water pipes, such as Samples B2 represent typical uniform to severe velocity scouring and hot water pitting. Such deteriorations are characterized by deep pits of small cross section that are capped by greenish-black mounds and water-swept marks (refer to Photo 15). The causes of such corrosion are usually high velocity water and high temperature (> 60 °C).

The recirculation pipes are in the worst condition due to the constant circulation of water throughout the day and high temperature. See sample A6 and D5 for examples.

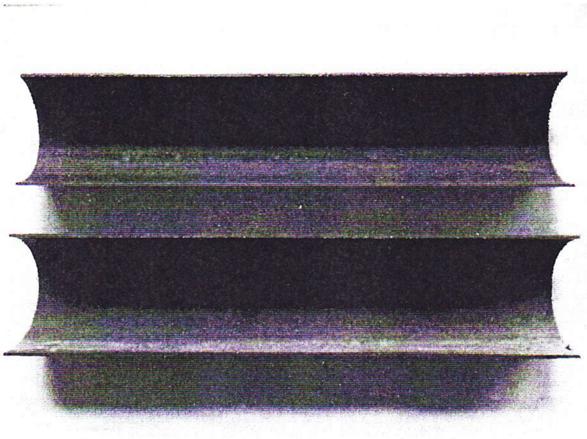

Photo 1. Pipe Sample A1 – Cold Main

Photo 2. Pipe Sample A1 – Shallow Pitting

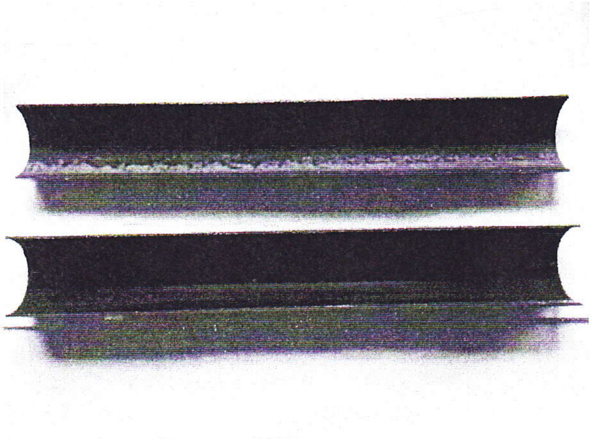

Photo 3. Pipe Sample A2 – Hot Main

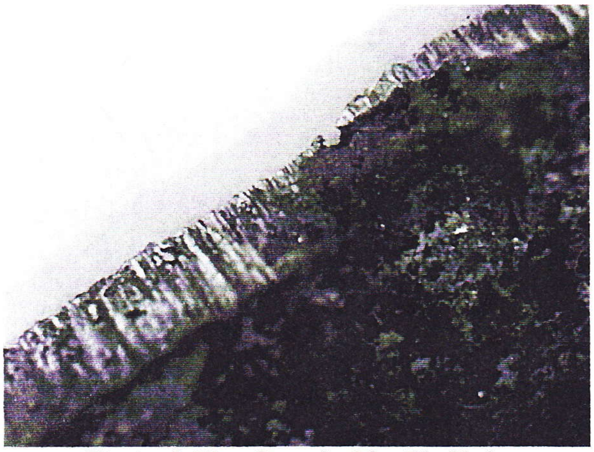

Photo 4. Pipe Sample A2 –Pin Hole

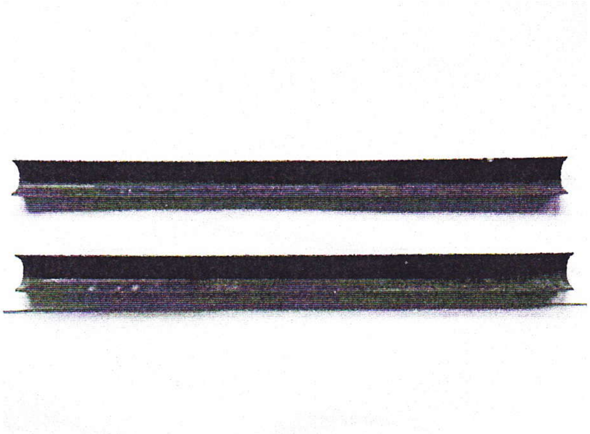

Photo 5. Pipe Sample A3 – Cold Riser

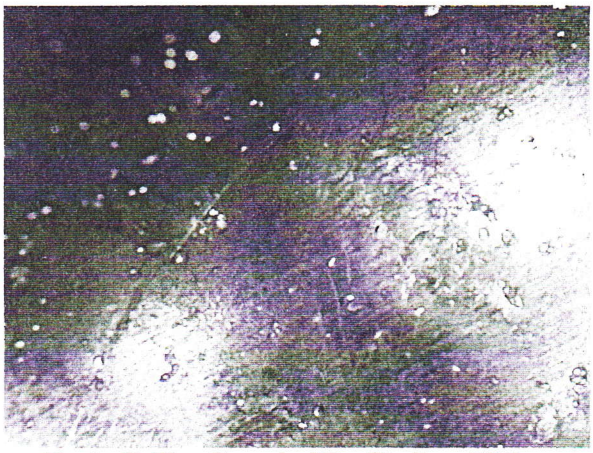

Photo 6. Pipe Sample A3 – Shallow Pitting

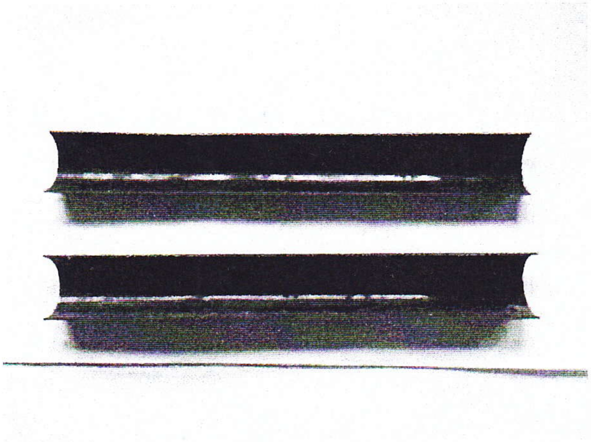

Photo 7. Pipe Sample A4 – Hot Riser

Photo 8. Pipe Sample A4 – Deep Pit

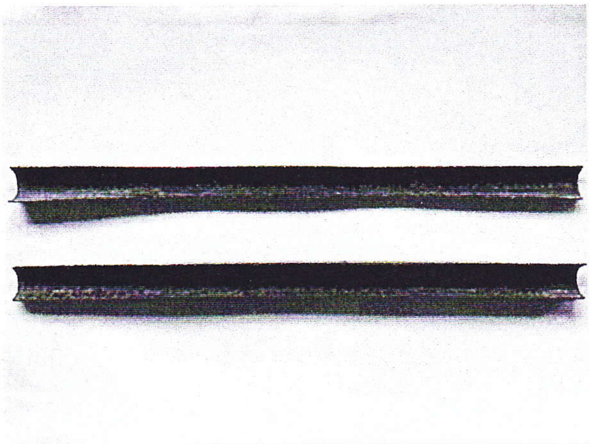

Photo 9. Pipe Sample A5 – Recirc

Photo 10. Pipe Sample A5 – Numerous Pitting

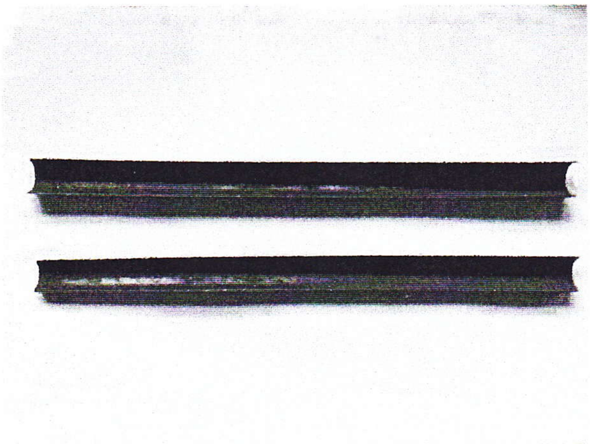

Photo 11. Pipe Sample A6 – Recirc

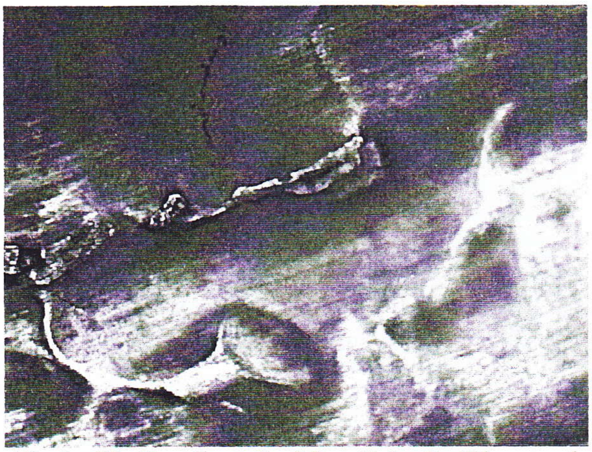

Photo 12. Pipe Sample A6 – Velocity Wear and Mounds

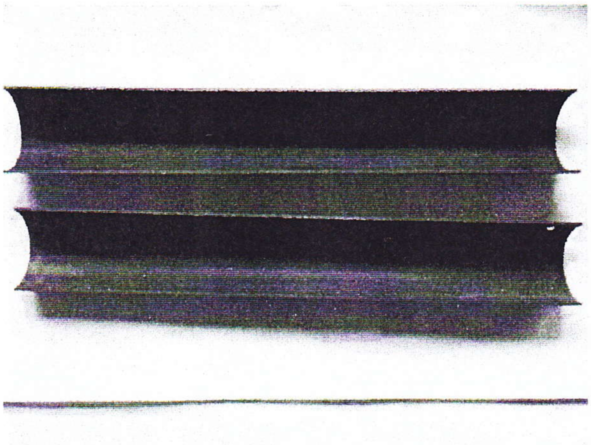

Photo 13. Pipe Sample B1 – Cold Main

Photo 14. Pipe Sample B1 – Early Pitting

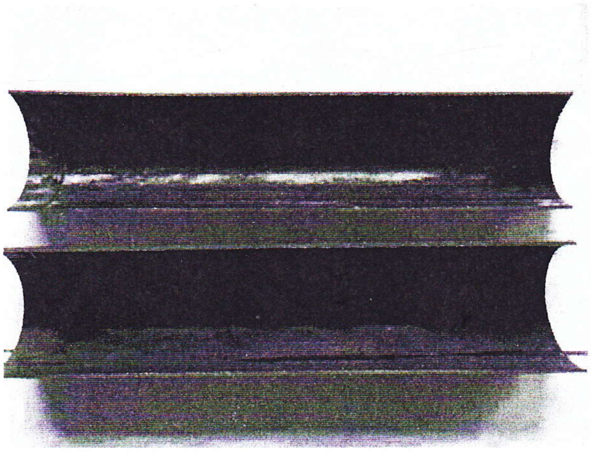

Photo 15. Pipe Sample B2 – Hot Main

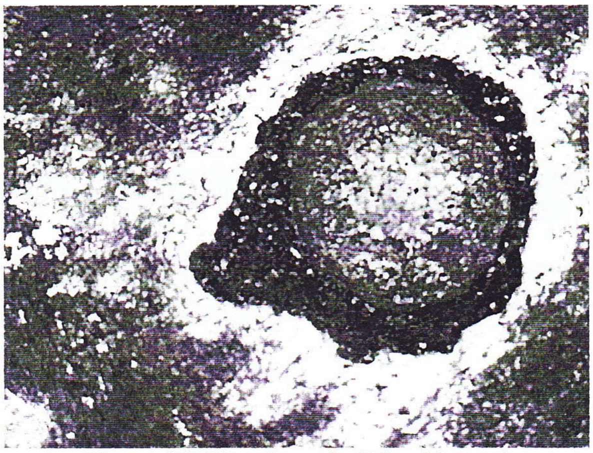

Photo 16. Pipe Sample B2 –Mound

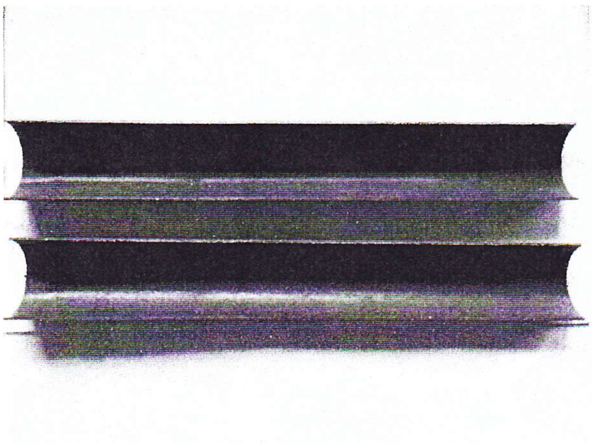

Photo 17. Pipe Sample B3 – Cold Riser

Photo 18. Pipe Sample B3 – Early Pitting

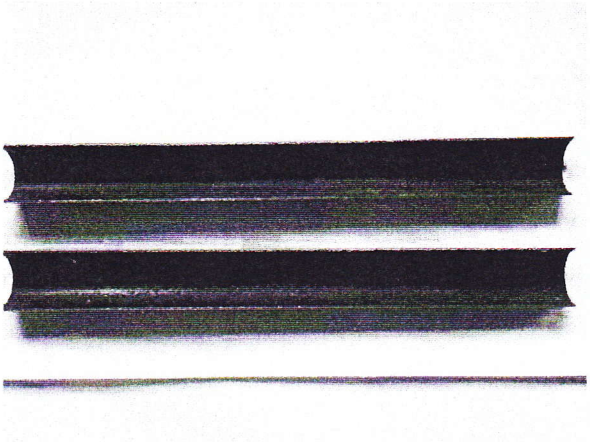

Photo 19. Pipe Sample B4 – Hot Riser

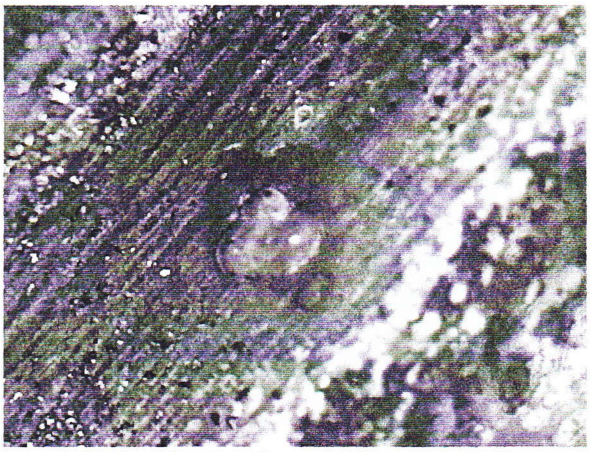

Photo 20. Pipe Sample B4 - Deep Pit

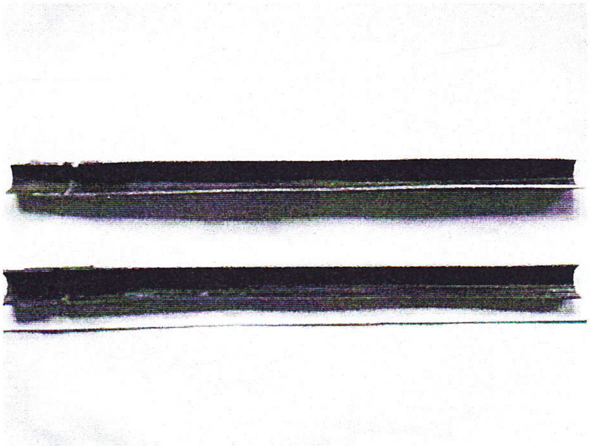

Photo 21. Pipe Sample B5 – Recirc

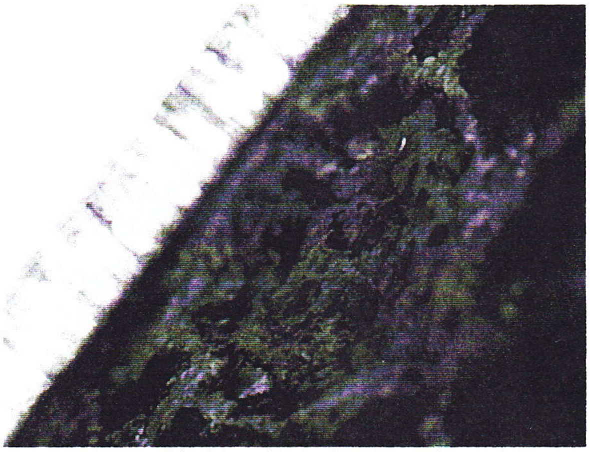

Photo 22. Pipe Sample B5 - Mound

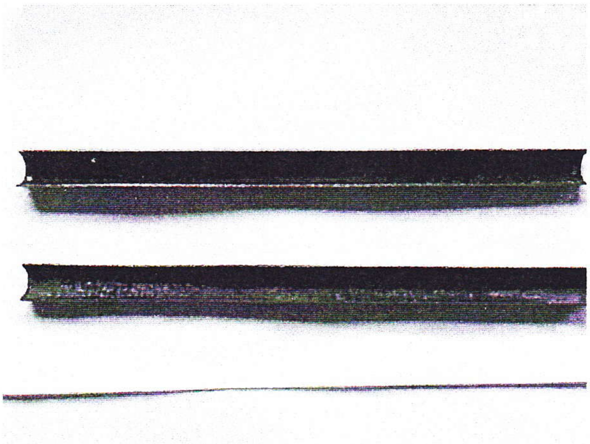

Photo 23. Pipe Sample B6 – Recirc

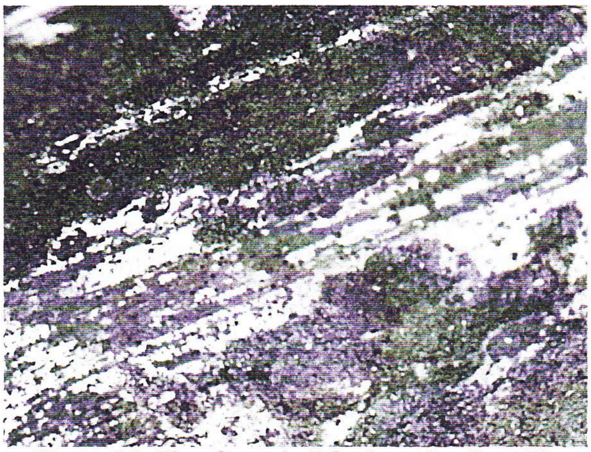

Photo 24. Pipe Sample B6 -Longitudinal Pit

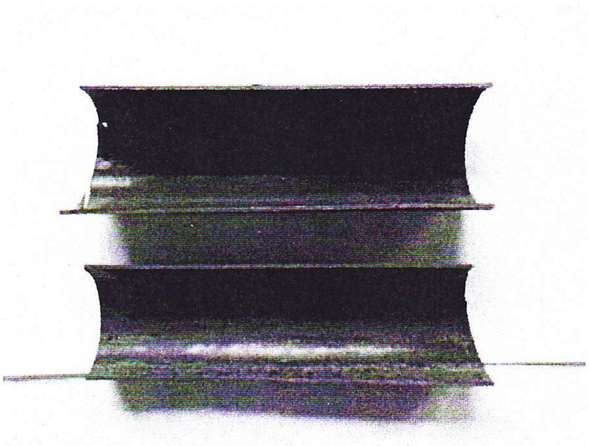

Photo 25. Pipe Sample C1 – Hot Riser

Photo 26. Pipe Sample C1 - Deep Pit

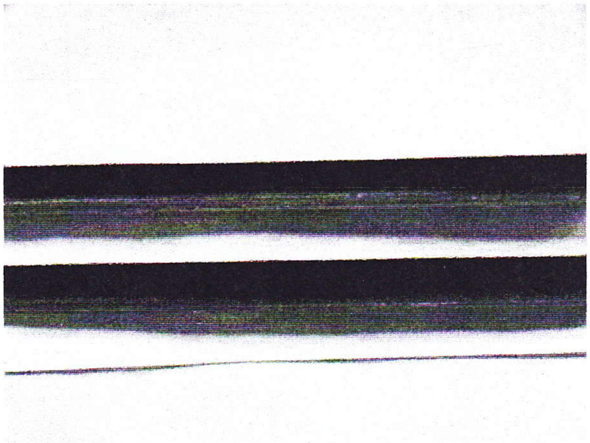

Photo 27. Pipe Sample C2 – Hot Riser

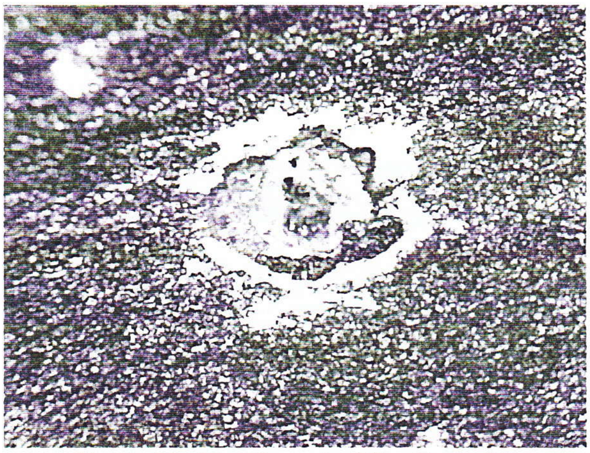

Photo 28. Pipe Sample C2 - Deep Pit

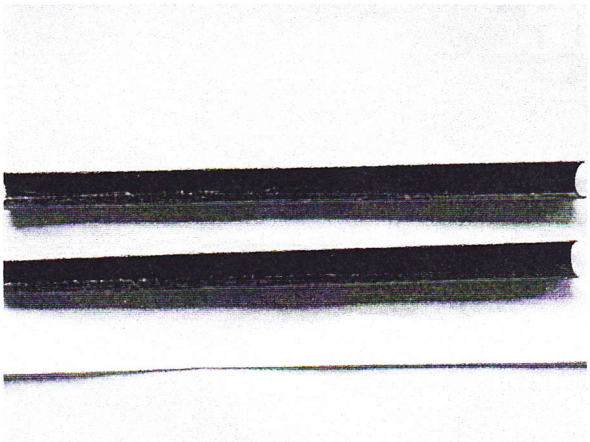

Photo 29. Pipe Sample C3 – Recirc

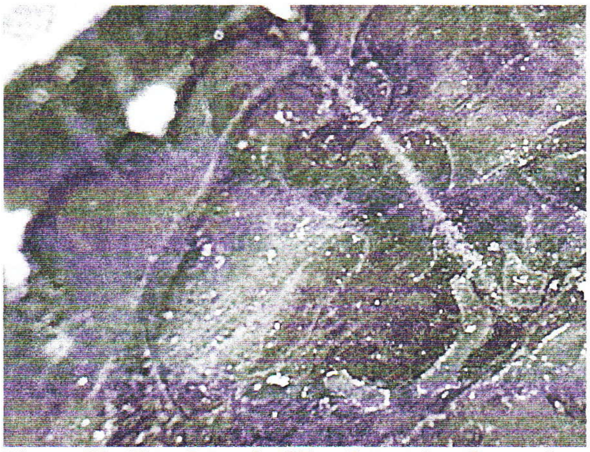

Photo 30. Pipe Sample C3 - Extensive Corrosion

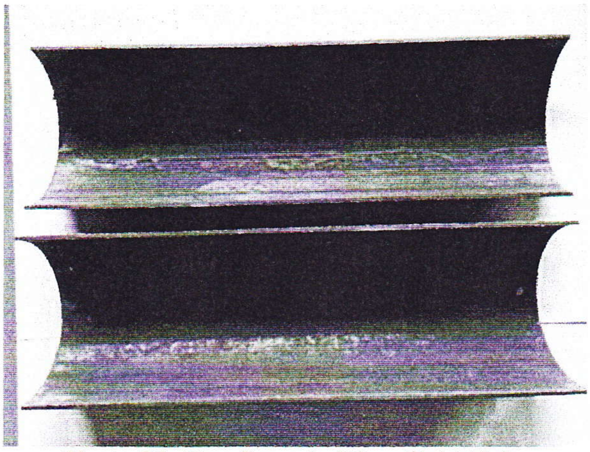

Photo 31. Pipe Sample D1 – Cold Main

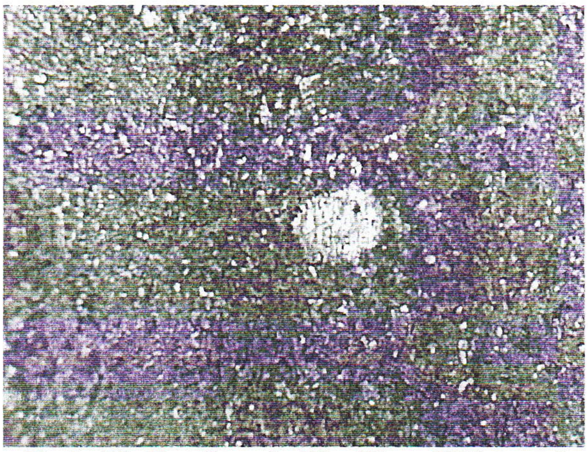

Photo 32. Pipe Sample D1 - Minor Pitting and Velocity Wear

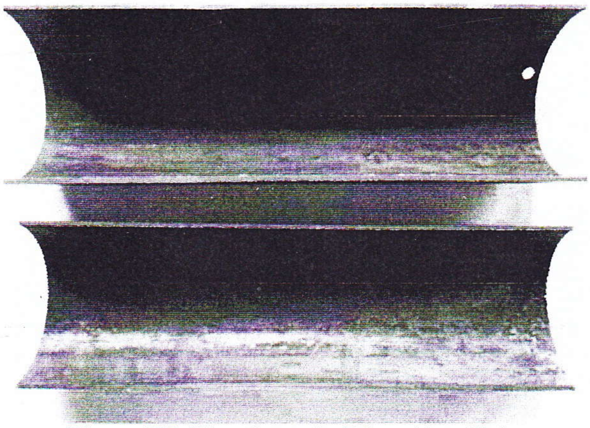

Photo 33. Pipe Sample D2 – Hot Main

Photo 34. Pipe Sample D2 - Pitting

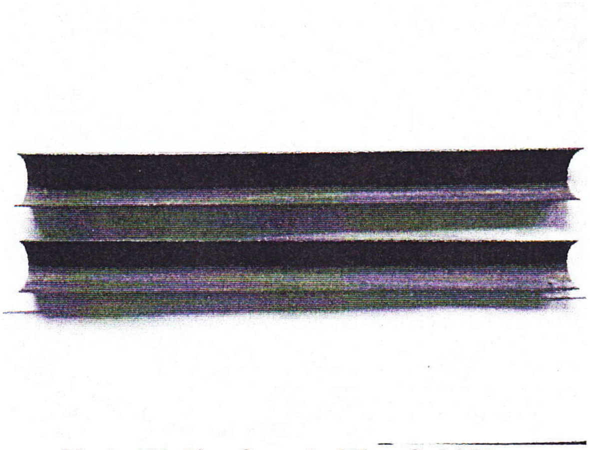

Photo 35. Pipe Sample D3 – Cold Riser

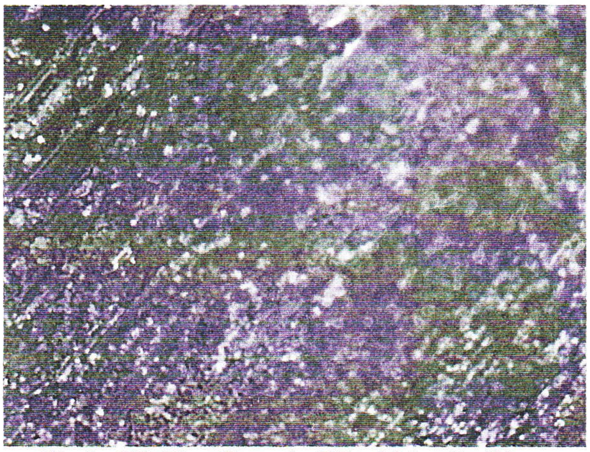

Photo 36. Pipe Sample D3 - Velocity Wear

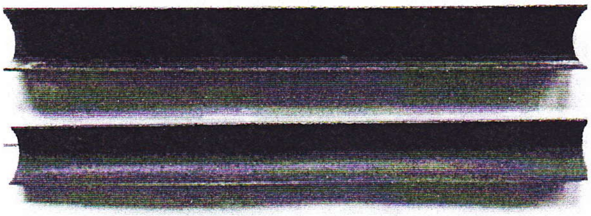

Photo 37. Pipe Sample D4 – Hot Riser

Photo 38. Pipe Sample D4 - Pitting

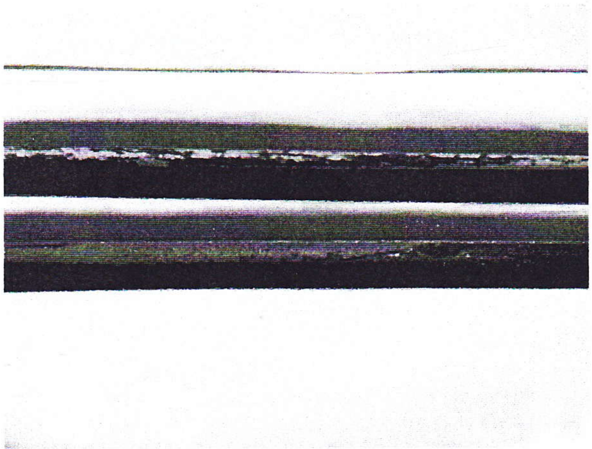

Photo 39. Pipe Sample D5 – Recirc

Photo 40. Pipe Sample D5 - Severe Corrosion and Deep Pits

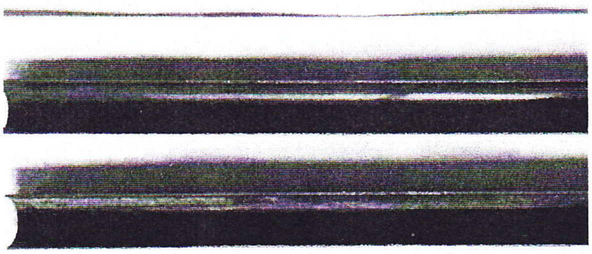

Photo 41. Pipe Sample D6 – Recirc

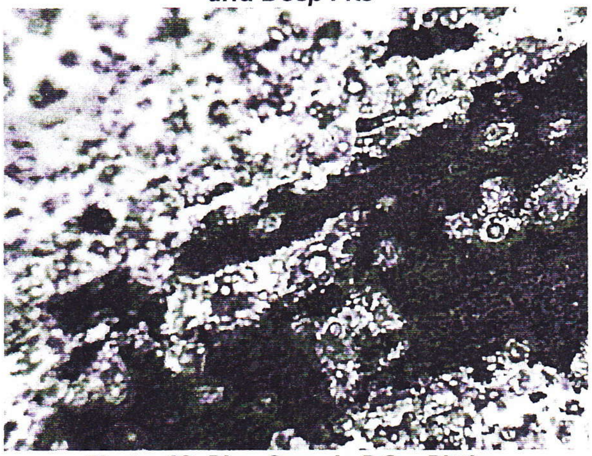

Photo 42. Pipe Sample D6 - Pitting

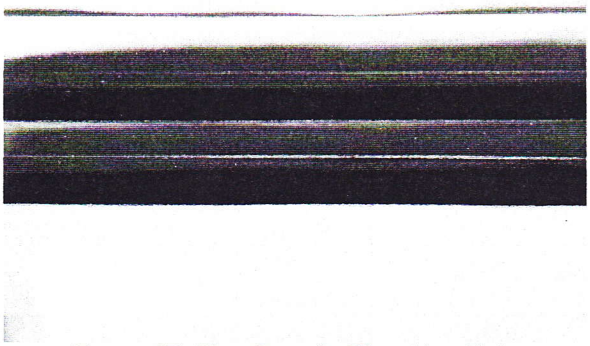

Photo 43. Pipe Sample E1 – Hot Main

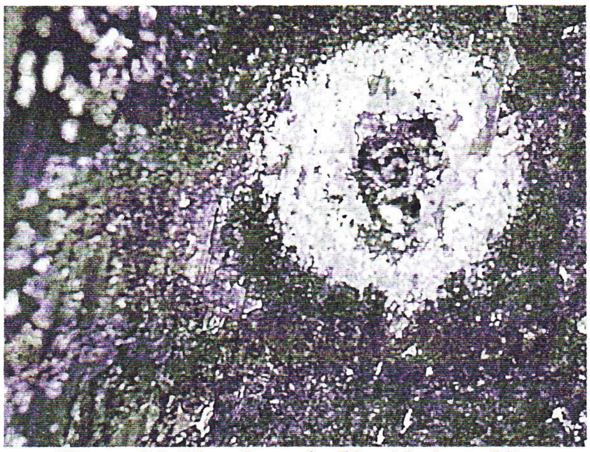

Photo 44. Pipe Sample E1 - Various Pits

Historical Data and Interview of Building Caretaker

The following information was provided by the building caretaker for MAE's review:

Grandview			Parkview		
Unit	Date	Problem	Unit	Date	Problem
1306	21-Feb-13	Leak	312	25-Mar-13	Leak
1303	26-Feb-13	Leak	115	26-Mar-13	Leak
1602	13-Mar-13	Leak	Main Floor	26-Mar-13	Hallway Leak
1002	01-May-13	Leak	3rd Floor	13-May-13	Hallway Leak
808	14-May-13	Leak	102	21-May-13	Leak
808	03-Jun-13	Leak	114	19-Jun-13	Leak
8th Floor	17-Jun-13	Hallway Leak	102	08-Aug-13	Leak
3rd Floor	24-Jul-13	Hallway Leak	Main Floor	15-Aug-13	Hallway Leak
804	08-Aug-13	Leak	Main Floor	23-Aug-13	Leak
8th Floor	09-Aug-13	Hallway Leak	Amenity Room	21-Oct-13	Hallway Leak
408	06-Sep-13	Leak	3rd Floor	31-Oct-13	Hallway Leak
1506	15-Oct-13	Leak	P1 Hallway	08-Nov-13	Leak
808	31-Oct-13	Leak	114	05-Dec-13	Leak
109	20-Nov-13	Leak	105	28-Jan-14	Leak
1303	23-Nov-13	Leak			
1304	23-Dec-13	Leak			
1502	31-Dec-13	Leak			
1502	28-Jan-14	Leak			
Boiler Room	04-Feb-14	Leak			

MAE interviewed the building caretaker, and majority of these leaks had occurred in lateral lines of domestic hot water system. Leakages were usually observed on the ceilings of floor hallway, bathrooms and kitchens in suites.

Mechanical Room Equipment

In Grandview, there are two mechanical rooms. The mechanical room in the top floor consists of two boilers (Raytherm, Model No.: 624 WTB-N, Serial No.: 019420988, Input: 627 BTU; Raypak, Model No. WH3-0624, Serial No.:1204338309, Input: 627 BTU), two identical hot water tanks (UL, Model No.:M3ST200R5A, Capacity 200 US Gallons, Test Pressure 300 PSI, Working Pressure 150 Max PSI) and a recirculation pump (Bell & Gossett, Model No: M80039, 3/4HP). The Raytherm boiler was installed in 1998 and was around 16 years. Raypak boiler was installed in 2011 and was around 3 years. The service life of standard boiler is expected to be approximately 25 years. Therefore, the Raytherm boiler will likely require replacement in the near future. The hot water tanks were installed in 2006. The mechanical room in the parking garage consists of triplex booster system that includes three booster pumps for domestic cold water supply (Plad Triplex Serial No.: 94-83990; Pump #1, Model #G74261 5HP, Pump #2 Model #DEF4DP 7.5HP, Pump #3 Model #DEF4DP 7.5HP), and a fire pump for fire pipes (Serial No.: 93-67908). Refer to Photos M1, M2, and M3. In Parkview, there is one mechanical room located in the parking garage. The mechanical room consists of a boiler (Raypak, Model No.: WH3-0624, Serial No.:100731877,Input 627 BTU) and two identical hot water tanks (UL, Model No.:M3ST200R5A, Capacity 200 US Gallons, Test Pressure 300 PSI, Working Pressure 150 Max PSI) and a recirculation pump(Armstrong, Model No.: 816549-091, 1/6HP). The boiler was installed in 2010 and was around 4 years ago and the hot water tanks were installed in 2006 and were around 8 years ago. Refer to Photo M4, M5, and M6.

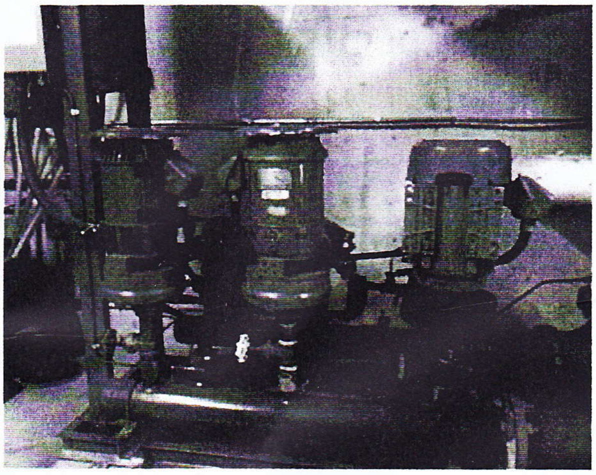

Photo M1.Triplex Booster Pumps at Grandview

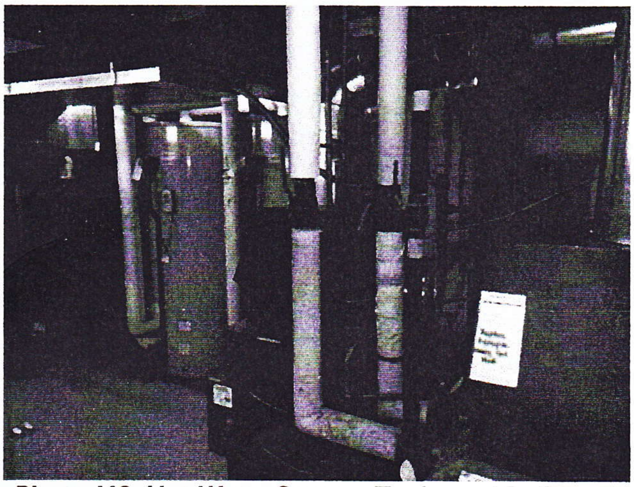

Photo M2. Hot Water Storage Tanks and Boilers at Grandview

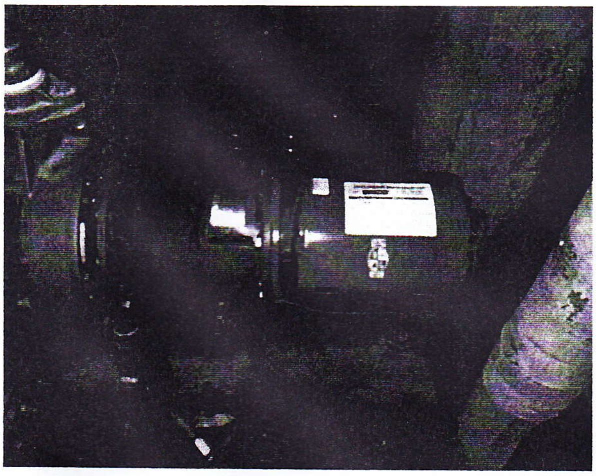

Photo M3. Re-circulation Pump at Grandview

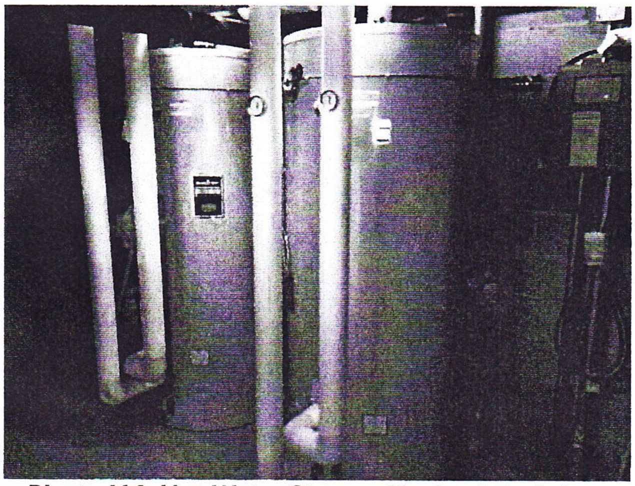

Photo M4. Hot Water Storage Tanks at Parkview

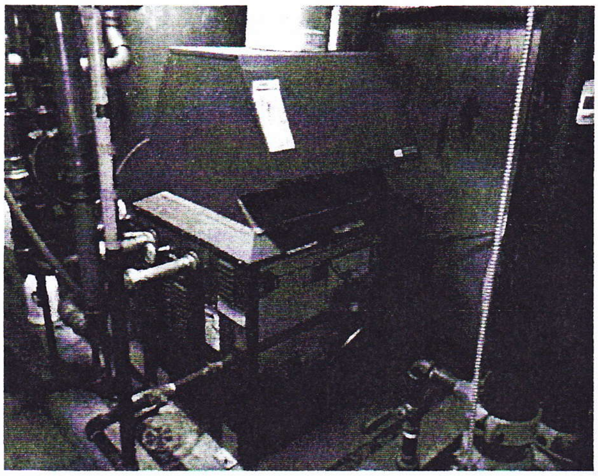

Photo M5. Boiler at Parkview

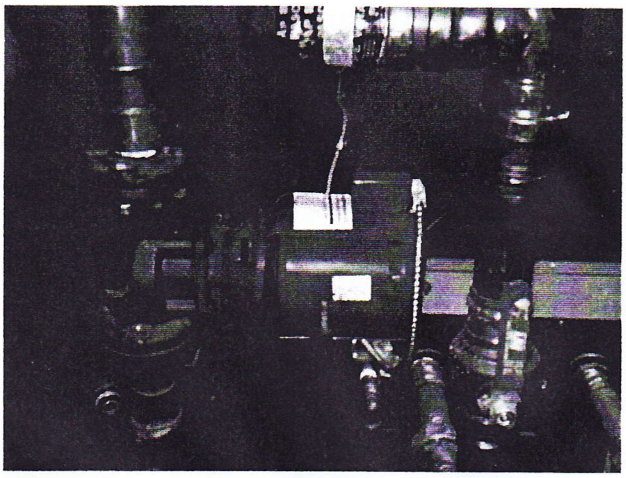

Photo M6. Re-circulation Pump at Parkview

General Assessment

A summary of the results of our analysis is as follows:

- The average pH is acidic; therefore, we suspect an elevated damage to copper piping and associated aesthetic problems that usually arise from acidic water.
- Dissolved copper levels show that the level of corrosion is high at this time. Due to the age of the piping, the rate of copper dissolving will increase in the future.
- The amount of thinning of pipes varied in each sample. The level of thinning in the samples ranged from 1.53 percent to 37.32 percent wall loss. The average wall loss is about 9.37 percent.
- A typical copper pipe system in Vancouver lasts 20 to 25 years. This system is approximately 19 years old and has approximately reached its expected service life.
- Corrosion generally follows a pattern of three phases: initial fluctuating leak frequency, followed by steady state (almost predictable) leak frequency, followed by the final stage of exponentially increasing leak frequency. This building is likely at the stage of steady state leak frequency.
- Based on the existing condition and our testing, we recommend replacement of the domestic water system within 3 years.

Recommendations

Our results indicate that the copper pipes exhibit moderate wear at this time. It is our understanding that several locations throughout the building have already been re-piped piecemeal due to on-going leaks. Partial repairs generally result in a poorer quality overall system due to inconsistencies of design or workmanship and is also much more expensive than a comprehensive repair strategy.

Based on the age of the domestic water system the results of our testing and the frequency of leaks being experienced in these buildings, a comprehensive re-pipe is recommended within 3 years. A complete domestic water pipe replacement scheme will likely cost in the range of $1,250,000 to $1,500,000 including engineering fees.

Corrosion generally follows a somewhat random distribution pattern and so it is reasonable to expect some areas of the system to be in relatively good condition while others are in relatively poor condition.

It should be noted that extraordinary circumstances might cause a large number of concurrent leaks. There may be a pressure spike from the GVRD supply, significant thermal movement of the building due to extreme temperature swings, or even a minor seismic event.

We trust this meets your requirements at this time and should you have any questions or concerns, please contact our office.

Sincerely,
McCUAIG & ASSOCIATES ENGINEERING LTD.

Prepared by:	***Reviewed by:***
Shilin Sun, E.I.T.	Jak McCuaig, P. Eng.

Ref. No. 20140217-C-RPT-RPT-01-FNL