WATER CHEMISTRY EVALUATION
CITY OF MT. PLEASANT
JUNE 2000

1.0 EXECUTIVE SUMMARY

The raw water supply for the City of Mt. Pleasant (City) is characterized by high hardness, high iron and manganese, and high total dissolved solids. In December 1995, the new City of Mt. Pleasant Water Treatment Facility, a lime softening plant, went into service. Prior to this, most City water customers utilized in-home softening units to treat their water. The new treatment plant utilizes lime, caustic soda, and other chemicals to treat the water to remove the iron and manganese, and reduce the hardness and total dissolved solids. The new plant now delivers water to City customers that has low hardness, very low iron and manganese concentrations, and lower total dissolved solids.

Even though the water quality is greatly improved since the new treatment has been online, the City has continued to receive some water quality complaints. The complaints typically involve rusty colored water or premature hot water heater failure. This engineering investigation was authorized by the City to evaluate the water chemistry, determine the cause of the water quality complaints, and recommend operational changes or other methods to improve water quality. During this investigation, we evaluated water treatment plant operating data, reviewed customer complaint records, and compiled and evaluated lead and copper sampling data and Michigan Department of Environmental Quality (MDEQ) routine monitoring results. In addition, a sampling program was developed and samples at various locations throughout the water supply and distribution system were collected and analyzed. The data from the water samples were utilized to characterize the water chemistry and to calculate the calcium carbonate stability index. This index is widely used in the water industry to predict whether a particular water will be aggressive (corrosive) or stable (scale-forming). A negative calcium carbonate stability index indicates a water that will usually tend to be aggressive, while a positive calcium carbonate stability index indicates a water that will tend to be stable. This is not an exact indicator; however, it is a technique that is widely used for this type of evaluation.

Based on the work completed for this investigation, the water quality produced by the City's water treatment facility appears to be excellent. Water in conformance with all public health regulations, with low hardness, and with negligible iron and manganese concentrations is delivered to City customers. The calcium carbonate stability index of the finished water leaving the plant, and of the finished water samples collected in the

distribution system was positive, in the range of +0.8 to +0.9. This would indicate that the water produced by the treatment facility is not aggressive or corrosive, but rather will tend to be stable or scale-forming. This conclusion is supported by the lead and copper sampling results which show a significant reduction in copper concentrations since 1995, when the new treatment facility went online.

A significant number of City customers continue to use their in-home softening units, despite the fact that the new treatment plant is producing good quality water with low hardness. The finished water hardness was 104 milligrams per liter (mg/L) as $CaCO_3$ on the day that the samples for this study were collected. In comparison, water from Lake Michigan or Lake Huron, which supplies many water customers in the State of Michigan, has a hardness of 130 to 140 mg/L as $CaCO_3$. The water quality complaint file contained nine complaint logs, all involving colored water or hot water heater replacement. All nine of these were from customers using in-home softening units. The in-home softening units reduce the calcium concentration, essentially to zero, by replacing it with sodium. Our evaluation determined that the in-home softening units would change the calcium carbonate stability index from approximately +0.9 to -0.97 or lower. Based on this analysis, the water treated by an in-home softening device would be expected to be more corrosive than the water produced by the treatment plant. To improve water quality and reduce the possibility of corrosion, it is recommended that all City customers discontinue the use of any in-home softening units. Other recommendations include the possible adjustment of some chemical feed doses in the treatment plant, and expanding the complaint log forms to include more information to assist in evaluating future complaints.

2.0 INTRODUCTION

The water supply for the City of Mt. Pleasant consists of eight wells completed in the glacial drift aquifer and one Ranny Collector. The raw water supply is characterized by high hardness, high total dissolved solids, and relatively high iron and manganese concentrations. Prior to 1995, the water was pumped directly to city customers without treatment for hardness reduction or iron removal. Because of the poor water quality, most city water customers utilized ion exchange softeners in their homes or businesses to reduce the hardness and iron concentrations.

In the mid-1990s a new water treatment plant was designed and constructed, and in December 1995 the new water treatment facility was placed in operation. The water treatment facility is a softening plant with a design capacity of 8 million gallons per day (mgd). It was designed to reduce the hardness level from greater than 400 mg/L as $CaCO_3$to approximately 110 mg/L as $CaCO_3$. The water treatment plant includes an aerator, solids-contact clarifiers, a recarbonation system, dual-media filters, and various chemical feed systems. The raw water is pumped to the treatment plant from

several remote well fields. The first treatment step is aeration. The water is pumped to the top of the aerator, and then cascades downward over a series of trays. Air flows upward counter-current to the water, removing carbon dioxide and hydrogen sulfide, and oxidizing iron. From the aerator the water flows to two solids contact clarifiers. Lime and sodium hydroxide are added to raise the pH to 11.0 or higher. calcium carbonate and magnesium hydroxide precipitates develop and form a sludge blanket in the clarifier. As these precipitates grow in size, they eventually settle, collecting in the bottom of the clarifier from which they are periodically removed. A coagulant, ferric chloride, and a polymer are added to aid the settling process. Following the solids contact clarifiers, the water flows to recarbonation tanks where carbon dioxide is added to reduce the pH to a level of 9.0 to 9.2. After recarbonation, the water flows to eight dual-media filter cells to remove any remaining particulate material. Polyphosphate is added at this step to inhibit calcium carbonate formation in the filter media. Fluoride is added to improve dental health and sodium hypochlorite is used as a disinfectant. At the end of the treatment process, the finished water flows to the ground level storage and high service pumping facility which is located at a site remote from the treatment plant. The treatment process significantly improves the water quality by reducing the hardness, iron, manganese, and total dissolved solids.

Since the water treatment plant was started up in December 1995, it has consistently produced a high quality finished water, always in conformance with drinking water standards established by the Michigan Safe Drinking Water Act.

In the fall of 1999, the City of Mt. Pleasant authorized Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) to conduct this water chemistry evaluation. The objective of this investigation is to review the treatment plant operating data, evaluate the finished water quality, and recommend any treatment modifications which may improve water quality and reduce the frequency of hot water heater failures or red water complaints. To achieve this objective, treatment plant operating data were reviewed in detail and additional samples were collected and analyzed from various locations throughout the distribution system. In addition, a computer spreadsheet was developed to allow the City to review and analyze water quality data and to estimate the stability of the water.