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NIROP FRIDLEY
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POLYMER ASSESSMENT REPORT FOR GROUNDWATER TREATMENT FACILITY WITH U S NAVY RESPONSE TO REGULATOR COMMENTS TO DRAFT NIROP FRIDLEY MN
8/1/1999
MORRISON KNUDSEN CORPORATION

Polymer Assessment Report
Groundwater Treatment Facility

NIROP Fridley
Fridley, Minnesota

Unit Identification Code: N91192
Contract No. N62467-93-D-1106

August 1999

Revision 0

Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina
29419-9010

NIROP FRIDLEY – FRIDLEY, MINNESOTA
RESPONSES TO COMMENTS ON THE DRAFT POLYMER ASSESSMENT REPORT

Commentator: Joel Sanders, RPM, Southern Division

1) Comment: Please use a smaller binder on the final - double sided copies also.

Response: Agreed. A smaller binder and double sided copies were used for the final report.

2) Comment: Please provide quantity and cost info for the acid and calcium carbonate (i.e. per cleaning, annual). Please provide quantity and cost info for disposal of filter cake.

Response: Agreed. Information on acid, calcium carbonate and disposal of filter cake was included in the final report.

3) Comment: Page 11 - First paragraph - second sentence - delete "and"

Response: The word "and" was deleted.

Commentator: Patrick Mosites, REICC, Southern Division

4) Comment: I have reviewed your report and have no specific comments except to endorse your recommendations to try going six months before the next acid cleaning and to continue to monitor the iron levels and see how they vary through a year cycle.

I would also appreciate your opinion on the need for the polymer. Would the system perform just as well without it and just have a 3 or 4 month acid cleaning? Or is the polymer a good insurance policy to prevent buildup in the lines going to and from the plant? I'm sure this is a question that may be asked in the future during budget cuts.

Response: The polymer anti-scale system was installed based on an evaluation of the site conditions and projected operations cost (See *Operations and Maintenance Cost Analysis Report* prepared by MK dated November 1997). The report indicated that anti-scale polymer treatment would provide the maximum savings for 20 years of operations. The frequency of acid wash projected at that time was quarterly for treatment with anti-scale polymer and weekly without the anti-scale polymer.

However, it may be prudent to revise the cost analysis based on recent operations experience. Currently, we are planning on performing acid washing every six months with the anti-scale system. We do not have any site-specific experience to determine the frequency for acid washing without the anti-scale. It may be possible to rent a small air stripping unit without the anti-scale system to perform a pilot test and determine the acid wash frequency.

As mentioned in the comment, one major advantage of the polymer system is that scale deposits are greatly minimized not only in the air stripping units but also in the long underground piping carrying influent and effluent water. Without the anti-scale polymer, cleanup of the underground piping may be required at regular intervals. Cleaning of underground piping will be difficult, require system shutdown and increase maintenance cost.

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POLYMER ASSESSMENT REPORT
GROUNDWATER TREATMENT FACILITY

NIROP FRIDLEY
FRIDLEY, MINNESOTA

Revision 0

August 1999

CONTRACT N62467-93-D-1106
DELIVERY ORDER #0042
STATEMENT OF WORK #050

Prepared for

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Date: 8/20/99

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MK Program Manager

Date: 8/31/99

EXECUTIVE SUMMARY

Morrison Knudsen Corporation (MK) constructed a Groundwater Treatment Facility (GWTF) for Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM) at Naval Industrial Reserve Ordnance Plant (NIROP) at Fridley, Minnesota, in 1998. The GWTF is currently used for treating the contaminated groundwater collected by extraction wells from the site. The treated effluent is discharged to the Mississippi River under a National Pollution Discharge Elimination System (NPDES) permit.

MK designed and installed an anti-scaling polymer injection system as part of the GWTF. The anti-scale polymer was incorporated to minimize metal and hardness deposition in the air stripping units (ASU). NALCO 8356D and CALGON pHreeGuard 1300 are the two types of polymer approved by the Minnesota Department of Environmental Quality (MDEQ) for use with the GWTF. A preliminary evaluation of the two polymers was performed during the initial eight months of operations of the GWTF. The main objectives were to determine the effectiveness of the polymer injection system and to provide a recommendation for selection of one of the polymers for continued use. Each polymer was used for a period of four months, followed by cleaning of the ASUs with hydrochloric acid.

The following five factors were used for assessment of the two polymers:

- Variation of iron and manganese concentrations in the influent and effluent
- Changes in differential pressure across the ASUs
- Ease of scale removal by acid cleaning
- Unit cost for each polymer and the amount of polymer used
- Quantity of filter cake generated after each acid cleaning. This factor did not contribute much to the evaluation because the amount of solids generated over the four months for each polymer was minimal.

The assessment indicated that the polymer injection system was effective and the two selected polymers performed equally well. The unit cost of CALGON pHreeGuard 1300 is substantially less than NALCO 8356D. Therefore, it is recommended that the CALGON polymer be used at the GWTF. The effectiveness and cost of the polymer should be continually evaluated as part of the Operations and Maintenance (O&M) of the GWTF.

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LIST OF FIGURES

ACRONYMS

ASU	air stripping unit
GWTF	Groundwater Treatment Facility
MDEQ	Minnesota Department of Environmental Quality
MK	Morrison Knudsen Corporation
NIROP	Naval Industrial Reserve Ordinance Plant
NPDES	National Pollution Discharge Elimination System
O&M	operations and maintenance
SOUTHNAVFACENGCOM	Southern Division, Naval Facilities Engineering Command

1.0
INTRODUCTION

This Polymer Assessment Report has been prepared by Morrison Knudsen Corporation (MK) for Southern Division, Naval Facilities Engineering Command (SOUTHNAVFACENGCOM), under contract number N62467-93-D-1106, Delivery Order 0042 and Statement of Work 050.

Morrison Knudsen Corporation (MK) constructed a Groundwater Treatment Facility (GWTF) for SOUTHNAVFACENGCOM at Naval Industrial Reserve Ordnance Plant (NIROP) at Fridley, Minnesota, in 1998 [MK 1999]. The GWTF is currently used for treating contaminated groundwater collected by extraction wells from the site. The treated effluent is discharged to the Mississippi River under a National Pollution Discharge Elimination System (NPDES) permit.

Groundwater chemistry data from the site indicated a potential for scaling problem with the GWTF [RMT, 1997]. Initially, periodic acid cleaning of the air stripping units (ASU) was considered sufficient to resolve the problem [RMT, 1997a]. After additional evaluation, MK recommended anti-scale polymer injection into the influent to minimize the amount of metal and hardness deposition in the piping and ASU [MK, 1997]. Therefore, MK designed and installed an anti-scaling polymer injection system as part of the GWTF. NALCO 8356D and CALGON pHreeGuard 1300 are the two types of polymers approved by the Minnesota Department of Environmental Quality (MDEQ) for use with the GWTF.

The performance of the two types of polymer was evaluated during the initial eight months of operations of the GWTF. The main objectives were to determine the effectiveness of the polymer injection system and to provide a recommendation for selection of one of the polymers for continued use. Each polymer was used for a period of four months, followed by cleaning of the ASUs with hydrochloric acid.

2.0
METHODOLOGY

The following five factors were considered for assessment of the two polymers NALCO 8356D and CALGON pHreeGuard 1300.

- Variation of iron and manganese concentrations in the influent and effluent
- Changes in differential pressure across ASUs
- Ease of scale removal by acid cleaning
- Unit cost for each polymer and the amount of polymer used
- Quantity of filter cake generated after each acid cleaning. This factor did not contribute much to the evaluation because the amount of solids generated over the four months for each polymer was minimal.

2.1 IRON AND MANAGNESE CONCENTRATIONS

One of the reasons for scaling was attributed to high concentrations of iron and manganese in the groundwater. These two constituents would not only cause fouling on the air stripper trays, but would be difficult to remove from the trays once deposition occurred. To determine the concentration of iron and manganese, samples were collected from the influent and effluent streams twice every month and tested at an off-site laboratory. The laboratory results were evaluated to determine how well each polymer was keeping these materials suspended in the water. If metal concentration in the effluent was lower than that in the influent, then some of the metals were being deposited inside the ASUs. Ideally, the influent and effluent streams should show similar concentrations, indicating that the polymer was maintaining the metals in suspension during the stripping process.

2.2 DIFFERENTIAL PRESSURE

Differential pressure monitoring is useful because increased differential pressure indicates possible blockage of the ASUs. As the trays in a stripper become fouled, it gets harder to force air through the unit, and the blower pressure gradually increases. Effective polymers will result in less scaling and thus, minimal increase in the differential pressure.

The differential pressure across each ASU was obtained by monitoring and recording the stripper outlet air pressure and the stripper inlet or blower pressure. These data were automatically recorded and charted for each ASU as part of the data acquisition system of the GWTF.

2.3 ACID CLEANING

After each trial period, the air strippers were cleaned with a 7.5% hydrochloric acid solution to remove any scale buildup on the trays. During the acid cleaning process, the ease of removal of the scale on the trays was evaluated. If scale is dissolved

3.0
POLYMER ASSESSMENT

This section presents a summary of results from the evaluation of NALCO 8356D and CALGON pHreeGuard 1300 polymers. NALCO polymer was used from 14 October 1998 to 17 February 1999. CALGON polymer has been in use since 18 February 1999. During the trial period, vendor representatives visited the site regularly to check on the performance of their respective polymers. The service and assistance provided by both vendors were equally excellent.

As discussed in Section 2.0, five factors were considered for evaluation of the polymers. As the trial progressed, it was determined that natural factors, such as weather and groundwater conditions, had a significant impact on the performance of the GWTF. The natural factors are an uncontrolled variable and may have biased some of the results.

3.1 NALCO 8356D

Iron and Manganese Concentrations: Based on analytical assessment, the NALCO polymer performed well against metal deposition. Iron and manganese concentrations were very similar in the influent and effluent water, indicating that most of these metals remained in the water during the stripping process (See Figure 3-1). During this trial period, the iron and manganese concentrations in the ground water remained fairly constant at levels of 550-750 ug/l and 300-400 ug/l, respectively. Only one pair of influent and effluent samples showed high (> 1,100 ug/l and 1,500 ug/l respectively) concentrations of iron. The higher concentration of iron in the effluent was probably a result of cleanup of previous deposits. Analysis of scale deposits in the air strippers during this period showed that the scaling was 95-97% calcium carbonate, indicating that this polymer did not control water hardness as well as it did the metals.

Differential Pressure: During the four-month trial period, the differential pressure increased from approximately 37-41 psi to 42 psi (See the linear regression lines on Figure 3-2). The pressure increase was a matter of concern because as the differential pressure inside the ASU increases, the overall efficiency of the stripping process decreases. Increased differential pressure would also result in the need for more frequent acid cleaning cycles. However, the increased differential pressure was below the set point of 45 psi for alarm condition and there was no shut down of the GWTF.

Acid Cleaning: The acid cleaning that followed the NALCO trial period was effective in removing the deposits because the deposits in the strippers were mostly calcium carbonate. Hydrochloric acid used in the cleaning removed the scale quickly and completely.

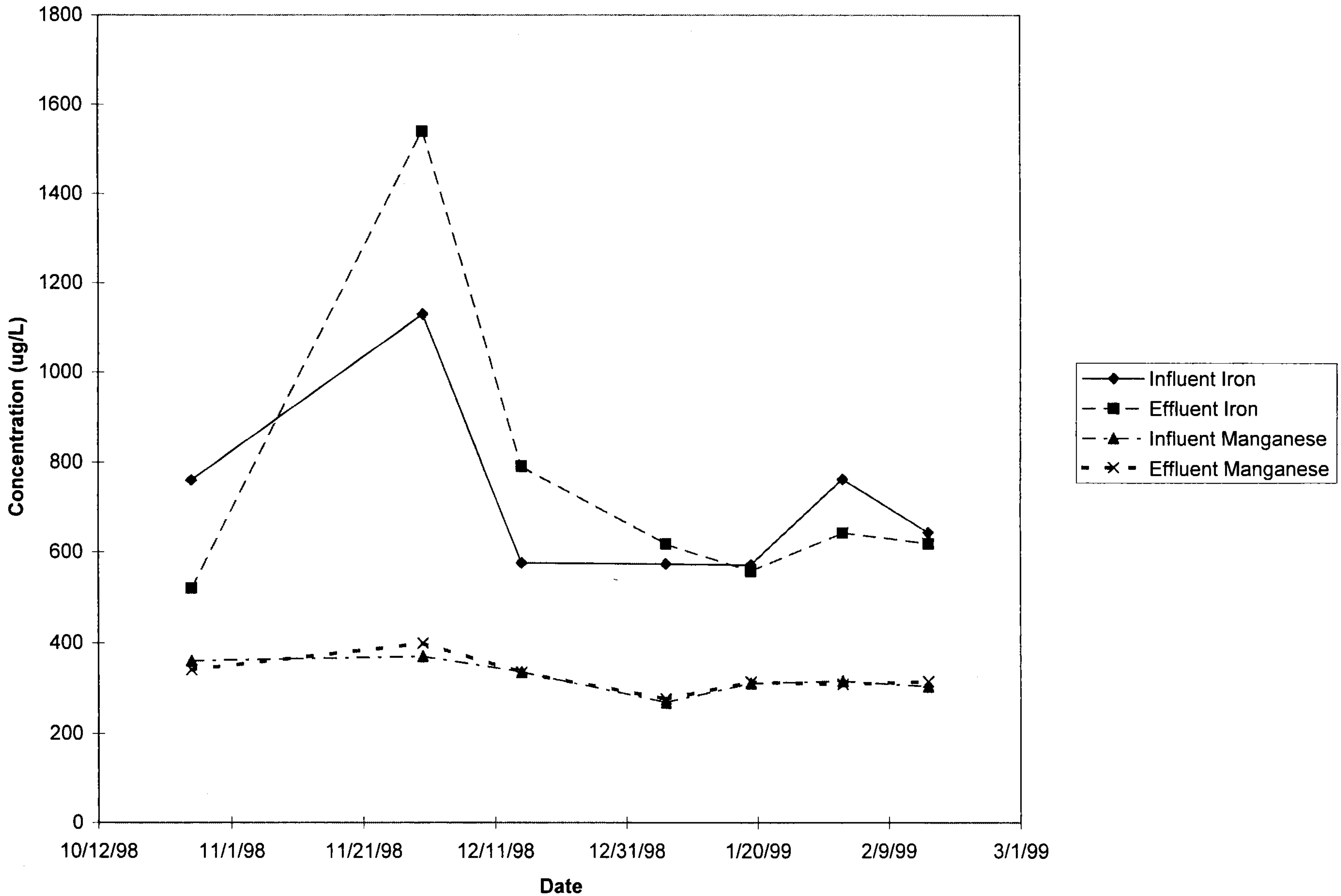

FIGURE 3-1
NALCO - IRON AND MANGANESE CONCENTRATIONS

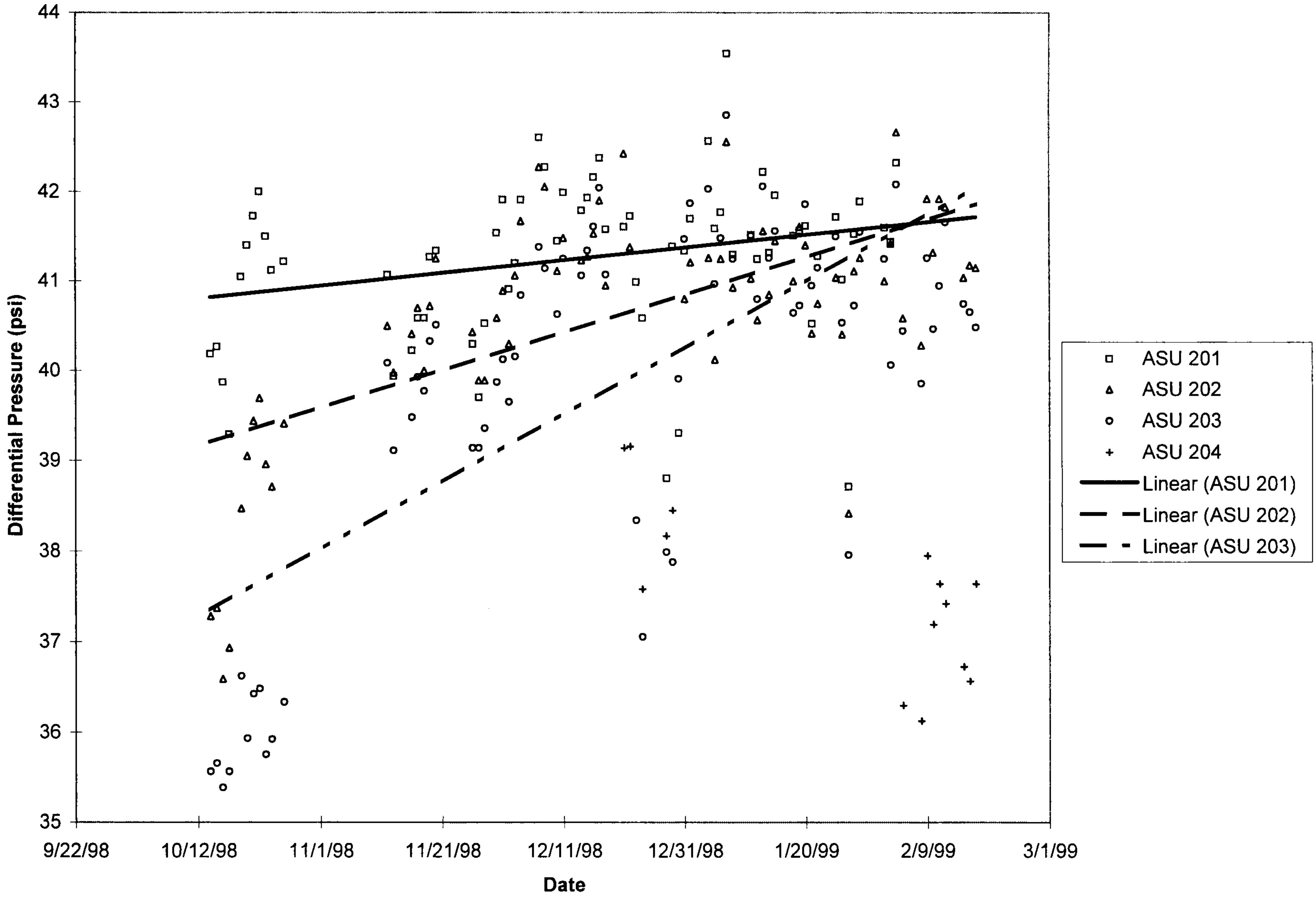

FIGURE 3-2
NALCO - DIFFERENTIAL PRESSURE

Cost: The cost of the Nalco polymer is $19.80 per gallon. At the recommended dosage of 3 ppm, about 80 gallons will be used in a month. Therefore, the annual cost of NALCO polymer is estimated to be approximately $19,000.

3.2 CALGON pHreeGUARD 1300

Iron and Manganese Concentrations: During the CALGON trial period, the iron levels in the groundwater rose dramatically. Instead of 550-750 ug/l, they were found to be as high as 1,350 ug/l, and remained at 900-1,000 ug/l for about two months (See Figure 3-3). Seasonal variation in groundwater may have contributed to the increased iron levels in the groundwater. The CALGON polymer was able to maintain between 600 and 650 ppm in the effluent water throughout the stripping process. Thus, there were some deposits of iron in the ASUs.

Compared to NALCO, the CALGON polymer performed better in maintaining the calcium carbonate concentrations. An analysis of the deposits in the air strippers during this trial period showed that the scale was about 50% iron compounds and about 20% calcium carbonate.

Differential Pressure: During this trial period, the differential air pressure across the ASUs remained steady or decreased slightly. The pressures started at 37- 41 psi and decreased to 37- 40 psi by the end of the four-month trial (See Figure 3-4). The slight decrease may be due to changes in the weather conditions as discussed in Section 3.3.

Acid Cleaning: Initially, there was some concern that the trays would be difficult to clean due to the high iron level in the deposits. However, the scale was removed completely by the acid. Again, there were very few solids present in the air strippers, indicating satisfactory performance over the four-month trial period.

Cost: The cost of the CALGON polymer is $10.22 per gallon. During the trial period, it was determined that the optimum dosage was 3 ppm. At this rate, approximately 80 gallons of polymer will be used in a month. The annual cost for CALGON polymer is estimated to be approximately $9,811, which is about half the cost of NALCO polymer.

Other costs associated with acid cleaning are expected to remain the same for both the polymers. The cost of hydrochloric acid is $1.12 per gallon. At 600 gallons per year, the annual cost for hydrochloric acid is $672. The cost of powdered calcium carbonate used in neutralization of acid is $0.24 per pound. At 1,500 pounds per year, the annual cost for calcium carbonate is $360. The disposal of two drums of filter cake, excluding laboratory testing, will cost $500 annually.

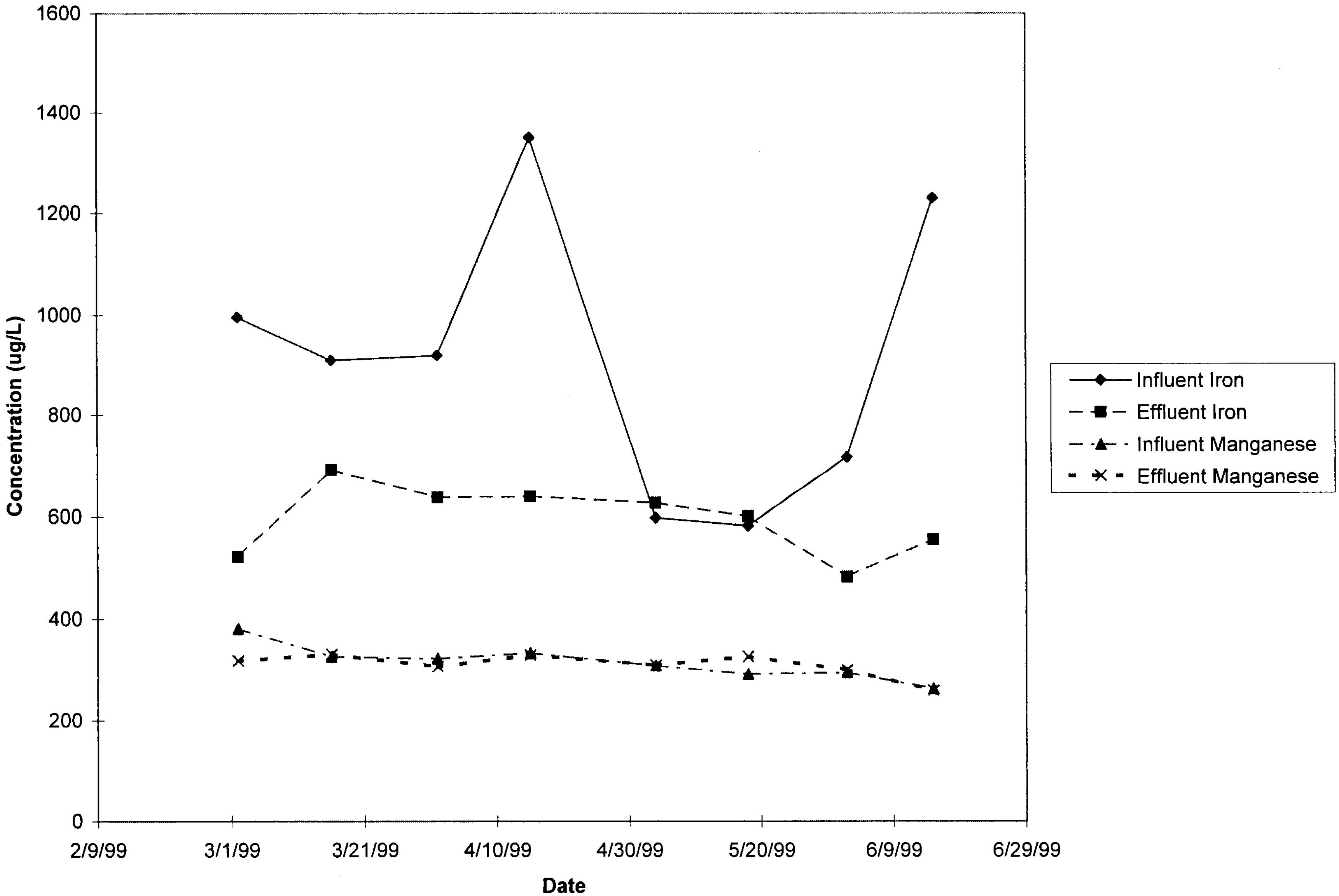

FIGURE 3-3
CALGON - IRON AND MANGANESE CONCENTRATIONS

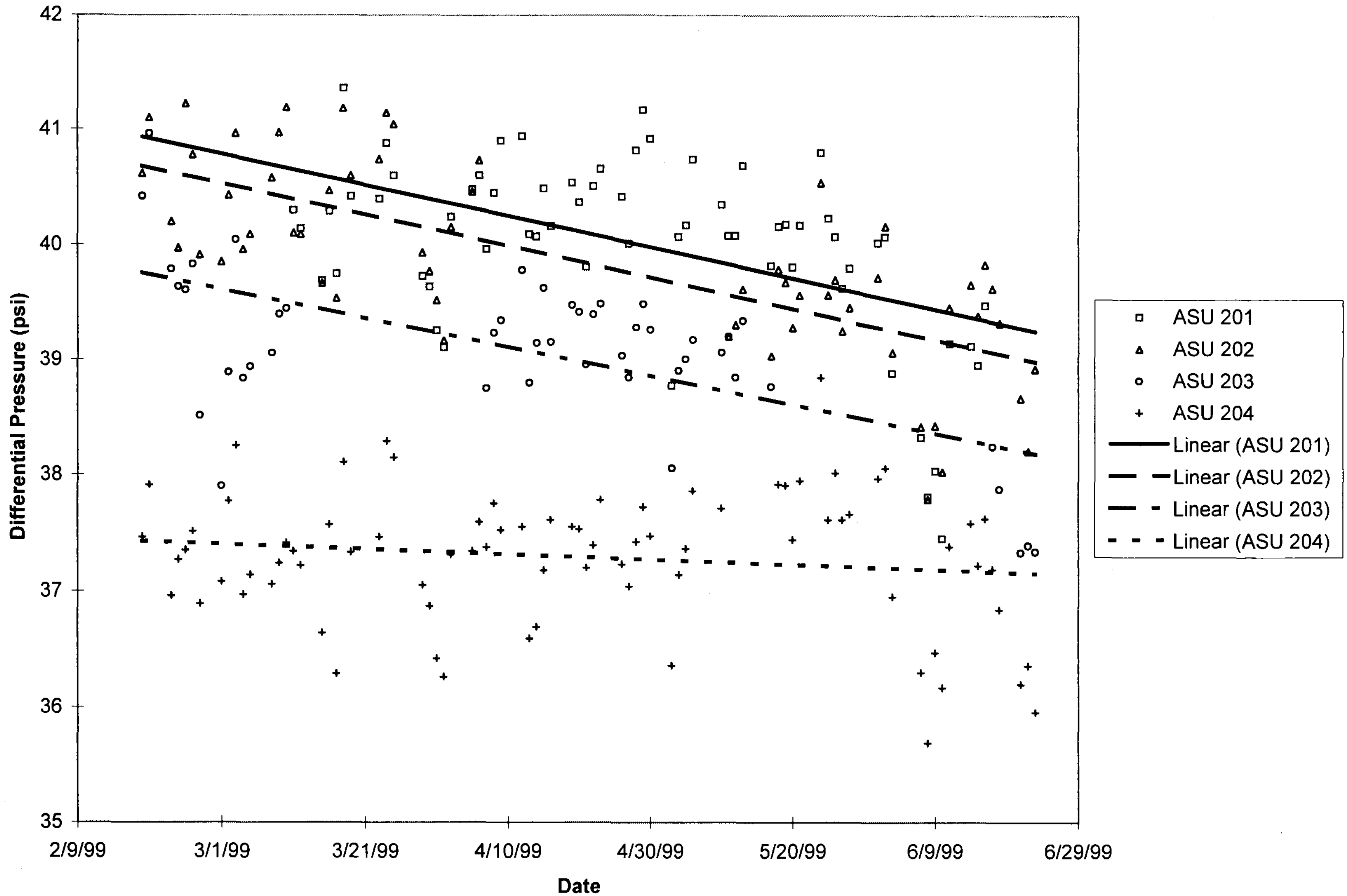

FIGURE 3-4
CALGON - DIFFERENTIAL PRESSURE

3.3 NATURAL FACTORS

Changes in weather conditions had minimal impact on the polymer performance. However, it was found that the weather had a noticeable effect on the performance of the ASUs. Changes in the temperature and humidity of the air outside the plant caused fluctuations in the airflow rate and inlet pressure of the air strippers. Therefore, the differential air pressures across the ASUs are also impacted by the weather conditions. Thus, the data shown in Figures 3-2 and 3-4 may be biased by the weather conditions, as NALCO and CALGON polymers were used in winter and spring, respectively. However, during this preliminary assessment, the magnitude of the impact of weather conditions on differential pressure was not evaluated.

A large increase in the iron concentration of the influent water was observed at the beginning of March and remained high for about two months. This was probably caused by the above normal precipitation in March and April 1999. The high rainfall, coupled with the spring snow melt, may have caused the water level in the extraction wells to rise, introducing additional iron to the system that previously was not there. While this only lasted for about two months, it may occur each spring and adjustments to the polymer injection rate may be required to compensate for the high iron concentration.

4.0
CONCLUSIONS AND RECOMMENDATION

The performance of NALCO 8356D and CALGON pHreeGUARD 1300 polymers was evaluated for the GWTF at NIROP Fridley. The objectives of this assessment were to determine the effectiveness of the polymer injection system and to provide a recommendation for selection of one of the polymers for continued use.

The results from the assessment indicate that the polymer injection system, designed and installed by MK, performed better than anticipated. This resulted in reduced frequency in acid cleaning of the ASUs. During the eight-month assessment period, acid cleaning was performed after every four months of operation rather than the three months as previously planned. It is recommended that the next acid cleaning be performed after six months of operations followed by an assessment of the effectiveness of the acid cleaning.

During the assessment, it was observed that both polymers performed equally well with minor exceptions. Based on analytical results, the NALCO polymer was better at keeping metal concentrations at similar levels in the influent and effluent water. Though not conclusive, differential pressure measurements indicate CALGON polymer performed better than NALCO polymer. Nonetheless, the acid cleaning presented no problems after each polymer use, and the amount of solids generated was minimal. Therefore, on a technical basis, either of the products may be used at the GWTF.

The only major difference between the two products was the cost. On an annual basis, the CALGON polymer is predicted to cost half as much as the NALCO polymer. Therefore, CALGON pHreeGUARD 1300 is recommended for use at the GWTF. The effectiveness and cost of the polymer should be continually evaluated as part of the Operations and Maintenance (O&M) of the GWTF.

The concentration of iron in the influent varied from 500 ug/l to 1,500 ug/l. This variation was probably due to precipitation and seasonal weather changes. It is recommended that laboratory analysis be performed monthly to determine the concentration of iron in the influent and the dosage of the polymer adjusted accordingly.

5.0
REFERENCES

Morrison Knudsen Corporation, January 1999, *Construction Completion Report*. [MK, 1999]

RMT, Inc., June 1997, *Basis for Design*. [RMT, 1997]

RMT, Inc., July/September 1997, *Approved Drawings and Specifications*. [RMT, 1997a]

Morrison Knudsen Corporation, November 1997, *Operations and Maintenance Cost Analysis Report*. [MK, 1997]