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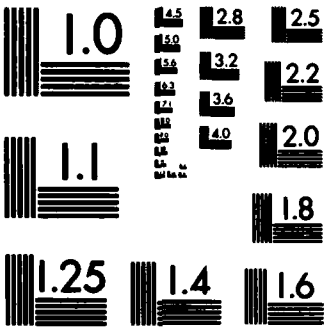

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USAF OEHL REPORT
83-236EQ100GSB

WASTEWATER TREATMENT PLANT EVALUATION

MEDINA ANNEX

LACKLAND AFB, TEXAS

JULY 1983

USAF Occupational and Environmental Health Laboratory
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas 78235

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William E Mabson

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The USAF OEHL conducted an on site wastewater treatment plant evaluation survey at Medina Annex, Lackland AFB from 23-28 February 1983 at the request of HQ ATC/DEV. The survey was requested because biochemical oxygen demand (BOD_5) and suspended solids (SS) from the plant exceeded effluent limitations. The survey analyzed the chemical composition of the influent wastewater and the concentration of the same parameters in the effluent. In addition, the efficiencies of the unit processes of the plant were determined with respect to BOD_5 and SS. A preliminary survey indicated that a hydraulic overload and/

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or discontinuous flow may have caused the excess effluent levels. Recommendations by USAF OEHL were carried out by personnel at the Medina Annex Wastewater Treatment Plant to provide for equalization of flow and flow reduction. Results of the survey indicated that these changes enabled the plant to produce an effluent which meets all effluent requirements.

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USAF OCCUPATIONAL AND ENVIRONMENTAL

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Wastewater Treatment Plant Evaluation

Medina Annex

Lackland AFB, Texas

July 1983

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1Lt Dulcie A. Weisman	Bioenvironmental Engineer
TSgt Benjamin Hernandez	Project NCOIC
Amn Glen S. Wheeler	Water Quality Technician

We also acknowledge the cooperation and support provided by personnel at Medina Annex, Lackland AFB TX.

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I. INTRODUCTION

On 1 February 1983, 3700 ABG/DEE, Lackland AFB TX, requested the USAF Occupational and Environmental Health Laboratory (USAF OEHL) to conduct an on-site wastewater treatment plant (WTP) survey to determine the cause of excessive pollutant discharge from the Lackland Training Annex (Medina) WTP. A survey was conducted at Medina 23-28 February 1983 to accomplish this task.

The objectives of the survey were to determine the characteristics of the influent wastewater, determine loadings and removal efficiencies of the facility and each unit process, to identify problem areas and recommend potential solutions. The parameters of main concern during the survey were five-day biochemical oxygen demand (BOD_5) and suspended solids (SS). Overall treatment of heavy metals and nutrients was also evaluated.

Prior to the survey, the WTP was not meeting its National Pollutant Discharge Elimination System (NPDES) requirements. After conducting a preliminary survey, the USAF OEHL survey team recommended changes in distribution of flows at the plant to reduce loadings. Flow to the contact-stablization unit was reduced from one-half the total flow to approximately one-quarter the flow. This required flow equalization to be incorporated at the plant pump house (see Section IV of the report). Once these changes were made, the survey was conducted.

II. BACKGROUND

Medina Annex is located 12 miles southwest of downtown San Antonio. Its primary mission is to conduct the USAF Officer Training School and the 6993 ES Sq activities. Other activities include ammunition storage, maintenance facilities, and field training for sentry dogs. Housing is provided for the students and base personnel. The effective population, which varies with the number of students, was approximately 1500 during the survey.

The WTP provides secondary treatment of wastes generated at Medina. The wastewater flow is divided for treatment between a trickling filter, which has been in operation since 1954, and a contact-stablization "package plant" installed December 1971. The combined design capacity of the plant is 0.290 million gallons per day.

The flow diverted to the trickling filter side of the plant goes through a bar screen, Imhoff tank, a dosing chamber, and the trickling filter. Solids are then removed in a secondary clarifier. Settled sludge is recycled to the Imhoff tank. The package plant (i.e., all processes necessary for secondary treatment, except chlorination, are combined into a compact unit) was designed to utilize activated sludge operating under contact-stablization conditions. Solids are separated in a secondary clarifier, and then the flow is combined with the flow from the trickling filter for disinfection.

During 1973, a survey was conducted by USAF Environmental Health Laboratory (USAF EHL), Kelly AFB TX, to determine the loading and treatment

efficiences of the plant and to propose performance specification for the plant. Results of the study were published in USAF EHL (K) TR 73-9, "Wastewater Treatment Evaluation and Proposed Performance Specifications."

III. METHODS AND MATERIALS

The treatment plant was evaluated by establishing seven sampling locations in the treatment facility. These sites are listed in Table 1 and shown in Figure 1. Sampling for, and analysis of, heavy metals and nutrients was accomplished at Stations 1 and 7 only. Unit processes were analyzed by determining BOD_5 and SS reduction.

Table 1

Sample Locations Used in the Wastewater Treatment Plant Evaluation, Medina Annex, February 1983

Station	Location
1	Imhoff/Influent
2	Imhoff Tank Effluent
3	Contact Stablization Effluent
4	Trickling Filter Effluent
5	Secondary Clarifier Effluent
6	Combined Point Effluent
7	Chlorine Contact Tank Effluent

Flow measurements were taken at Station 1 and at the WTP's built-in parshall flume used for continuous measurement of plant effluent flow. The difference between the flow volumes would give the flow through the contact-stablization plant. A Manning F-3000A dipper flow meter was used in conjunction with a Palmer-Bowlus flume to record 24-hour flows for 6 consecutive days at the influent to the Imhoff Tank. The existing parshall flume was used in conjunction with a Manning F-3000A dipper flow meter to determine plant effluent for the same time period.

Collection of daily composite samples was accomplished at Stations 1 through 7 using one ISCO Model 2100 and six ISCO Model 1580 automatic samplers. Samples were collected for 24-hour periods for six consecutive days beginning at approximately 0800 on 23 Feb 1983. Samples were not preserved due to the rapidity with which the analyses were accomplished.

Analysis of samples for BOD_5 and SS was accomplished by survey personnel. The remaining analyses were done by The Analytical Services Division (USAF OEHL/SA) at Brooks AFB. All analyses were performed in accordance with "Standard Methods," 15th Edition, and US EPA approved analytical procedures.

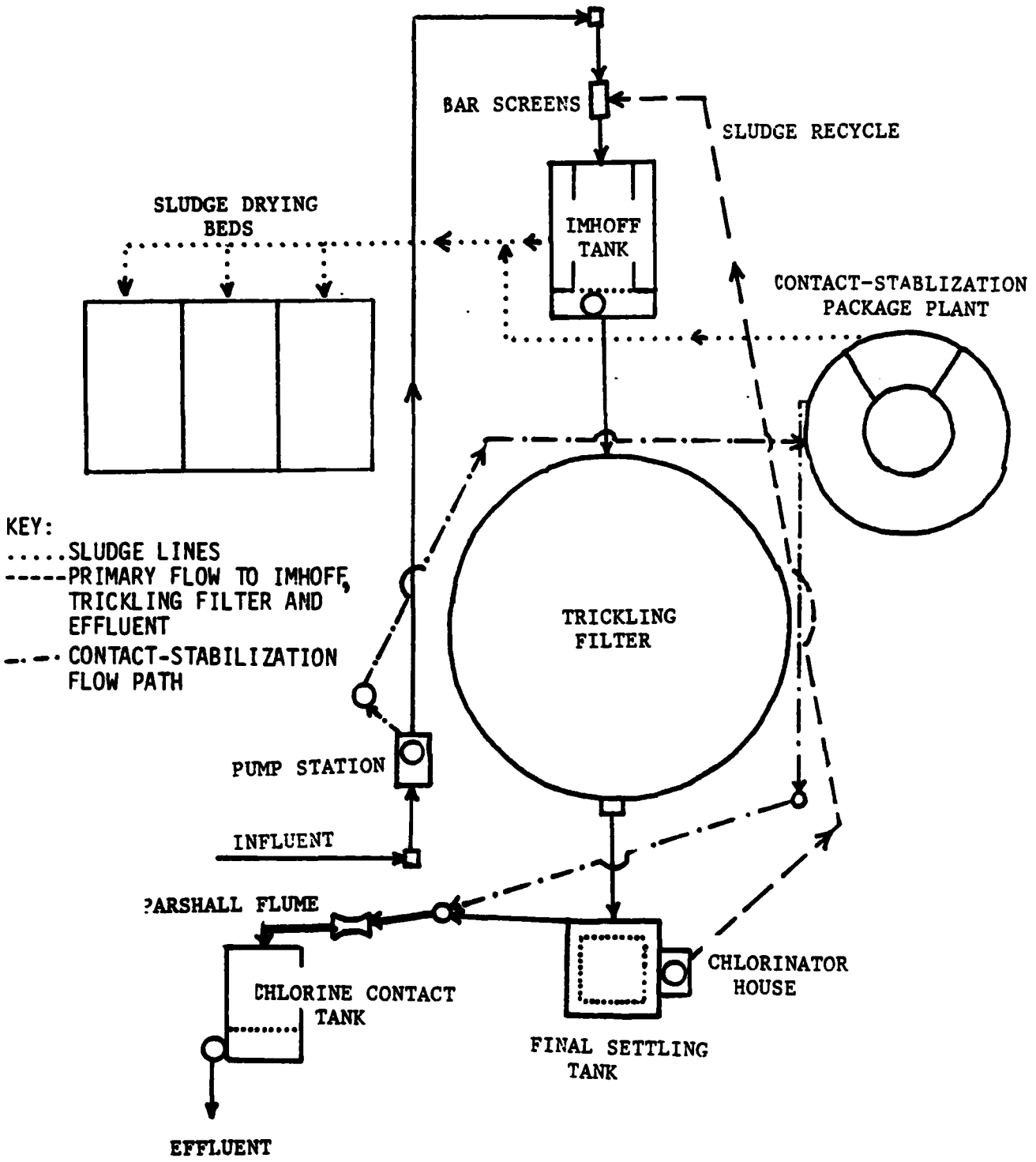

Figure 1. Plan View, Medina Annex Wastewater Treatment Plant, February 1983

IV. RESULTS AND DISCUSSION

Table 2 summarizes the influent and effluent chemical concentrations of the Medina WTP at the time of the survey. Based on the analyses in Table 2 the wastewater entering the WTP can be characterized as a municipal waste, i.e., the waste is primarily organic in nature. The average influent BOD_5 concentration was found to be 212 mg/L. This is a medium strength sewage and should present no unusual treatment problems. Influent suspended solids averaged 272 mg/L. Influent heavy metal concentrations for the most part were below the detectable limits of analysis and were not a contributing factor to the wastewater characterization.

Table 2

Average Influent and Effluent Chemical Concentrations, Medina Annex Wastewater Treatment Plant, February 1983

Parameter	Concentration (mg/L) Influent	Effluent
Flow (MGD)	0.174*	**
BOD_5	212	18
COD	213	52
Suspended Solids	272	14
Nitrogen, Kjeldahl	38	12
Phosphorous	23	6
Arsenic	<0.01	<0.01
Cadmium	<0.01	<0.01
Chromium	<0.05	<0.05
Copper	<0.026	<0.023
Lead	<0.05	<0.05
Manganese	<0.05	<0.05
Mercury	<0.003	<0.002
Nickel	<0.117	<0.038
Selenium	<0.01	<0.01
Silver	<0.01	<0.01
Zinc	<0.219	<0.062

* Imhoff/Trickling Filter only
** Unable to obtain accurate measurement

The NPDES permit requirements for the Medina WTP are summarized in Table 3. As shown by the sampling results in Table 2, the plant was found to meet all effluent requirements of the NPDES permit. Heavy metal concentrations were compared to the Texas Dept. of Water Resources General Regulations for Hazardous Metals (Table 4). Again, effluent concentrations were found to be in compliance.

Table 3

NPDES Permit Requirements
for Medina Annex Wastewater Treatment Plant, February 1983

Effluent Characteristic	Discharge Limits Average		Sample	
30 Day	30 Day	7 Day	Frequency	Type
Flow	0.290	2.293	Daily	N/A
BOD_5 (5-day, mg/L)	20	30	Weekly	Composite
Suspended Solids	20	30	Weekly	Composite
Fecal Coliform	200	400	Weekly	Grab
pH		6.0-9.0	Daily	In Situ

Table 4

Quality Levels for Hazardous Metals for Inland Waters
of the State of Texas, October 1980

Parameter	Average Quality* (mg/L)
Arsenic	0.1
Barium	1.0
Cadmium	0.05
Chromium	0.5
Copper	0.5
Lead	0.5
Manganese	1.0
Mercury	0.005
Nickel	1.0
Selenium	0.05
Silver	0.05
Zinc	1.0

*The arithmetic average (weighted by flow value) of all daily determinations of concentrations made during a calendar month.

Flow data were obtained for the trickling filter side of the plant only. Usable effluent flow values were unattainable because the parshall flume was not operating properly. Flow backed up into the throat of the flume and prevented the required critical depth from being developed. This caused the flow readings to be higher than actual conditions. Efforts were made to correct the problem temporarily and to locate another point for flow measurement; however, they were unsuccessful.

The average flow through the trickling filter was 0.174 MGD (121 GPM). Periods of zero flow through the plant were observed and recorded, even though there was a 25 percent (0.048 MGD) recycle of flow to the trickling filter. Two factors caused this. First, the pump capacity of the plant, while adequate for peak flows, was over designed for average flows. The pumping rate could not be reduced to accommodate lower influent wastewater flow rates. The second factor was the lack of storage, for flow equalization, provided by the plant. These two factors, in combination, caused alternating conditions of hydraulic overloading and zero flow in the plant. Both conditions decreased the efficiency of treatment.

Plant personnel, acting on recommendations from USAF OEHL's preliminary survey, were able to modify the pumping scheme at the plant to alleviate this problem. Flow to the package plant was reduced by diverting flow to the trickling filter side. Improved flow equalization was achieved by adjusting the floats for pump activation and deactivation.

The removal efficiencies of each process are shown in Table 5. Overall plant efficiency for BOD_5 and SS was 92 and 95 percent, respectively. All the processes were operating within expected removal efficiencies except for the trickling filter/secondary clarifier combination. According to the National Research Council (NRC) Formula (1) (developed as a result of extensive analysis of operational records of stone media filters serving military installations) the efficiency should have been 86 percent. The actual BOD_5 reduction through these two units was only 66 percent. There are several factors which could cause this reduction in efficiency. First, the recirculation of wastes through the filter during winter months had a cooling effect on the waste which reduced the bio-oxidation capability of the bacteria. Second, the discontinuous flow allowed the filter bed to dry, causing clogging and possible loss of viable microorganisms. This reduced the effective surface area of the filter.

Table 5

Unit Process Removal Efficiencies for Medina Annex Wastewater Treatment Plant, February 1983

Process	Concentration (mg/L) BOD_5	Concentration (mg/L) SS	Removal Efficiency (%) BOD_5	Removal Efficiency (%) SS
Influent	212	272	N/A	N/A
Imhoff Effluent	138	69	35	75
Trickling Filter Effluent	59	84	57	N/A
Secondary Clarifier Effluent	47	29	20	66
Contact-Stablization Effluent	19	17	91	94
Combined Trickling Filter and Package Plant Effluent	28	26	87	90
Chlorination Effluent	18	14	36	46
Overall Plant Performance	--	--	92	95

The WTP unit processes were evaluated by determining the loading parameters shown in Table 6. Each process was operated within recommended ranges. Loadings for the contact-stablization unit could not be determined due to the lack of flow data. It was interesting to note that sludge was not wasted from the plant. This appeared to be due to two factors. First, the long retention time in the Imhoff tank enabled it to digest the settled solids more efficiently. Second, the contact-stablization unit was operating at a low sludge production level.

Table 6

Unit Process Loading Parameters for Medina Annex Wastewater Treatment Plant, February 1983

Process	Units	Actual	Recommended*
Imhoff Tank			
Surface Loading	gpd/ft^2	500	500-700
Weir Loading	gpd/ft	14,500	<15,000
Detention Time	hours	4	1.5-2.5
Trickling Filter			
Hydraulic Loading	gpd/ft^2	73	25-90
Organic Loading	Lbs BOD_5/day/ 1000-ft^3	14	5-25
Secondary Clarifier			
Surface Loading	gpd/ft^2	680	500-700
Weir Loading	gpd/ft	2720	<15,000
Chlorination Tank			
Contact Time	minutes	10	20-30

*Water Pollution Control Federation, "Wastewater Treatment Plant Design" MOP-8, 1977

The chlorine contact tank served as a clarifier in addition to its purpose of destruction of microorganisms. Forty-six percent of the suspended solids entering the tank were removed. The BOD_5 was reduced by 36 percent. The contact time in the tank was approximately 10 minutes. The recommended time is 20-30 minutes. The additional contact time was provided by the travel time in the effluent pipe to Medio Creek.

V. OBSERVATIONS AND CONCLUSIONS

A. The plant is currently meeting effluent requirements established by the NPDES permit and Texas Water Quality Standards.

B. The plant is operating at near capacity. Overloading to the package plant, indicated by a rising sludge blanket in its clarifier, occurred prior

to reduction in rates as discussed in Section I. The Imhoff operated near design capacity when recycle flow was added.

C. The influent pumps lacked sufficient flow control to accommodate varying flow conditions.

D. The capacity of the recycle pump from the trickling filter clarifier was greater than necessary. The pump could only be operated for 10 minutes each hour to keep the Imhoff from being overloaded hydraulically. This caused the settled solids in the clarifier to become anaerobic. Anaerobic conditions produce gases that float solids to the surface. Resuspended solids then overflow the effluent weir.

E. Resuspended solids were also present in the chlorination tank.

VI. RECOMMENDATIONS

A. Equalize flow to the trickling filter by providing greater storage capacity at the pump house and the dosing chamber from the Imhoff tank.

B. Reduce the flow going to the contact-stablization unit to reduce loss of biomass through hydraulic overloading. Under normal operating conditions the flow to the package plant should not exceed 70 GPM.

C. Reduce the capacity of the recycle pump from the secondary clarifier, and increase its time of operation each hour. We recommend the recycle pump be operated no less than 30 minutes each hour. The recycle flow should be limited to 15 gpm to reduce hydraulic overloading to the Imhoff tank and secondary clarifier.

D. Install and/or repair flow measurement devices for the contact-stablization unit, plant influent, and the effluent parshall flume.

E. Sludge should be removed from the chlorination tank as part of a routine maintenance program.

F. Additional units or a new treatment plant with greater capacity will be required due to the increase in wastewater quantity if expansion of base operations occurs.

Reference

1. Water Pollution Control Federation, "Wastewater Treatment Plant Design," MOP-8, 1977, pg 293.

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