Report on Investigation of Waste Disposal
Minnesota Mining and Manufacturing Company, Chemolite Plant
Washington County
September 22-26, 1958

Minnesota Department of Health
Division of Environmental Sanitation
Section of Water Pollution Control

Tab 3

Exhibit
1020
State of Minnesota v. 3M Co.,
Court File No. 27-CV-10-28862

3MA01933815

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INTRODUCTION

Purpose

This survey was made to determine the characteristics and volume of the wastes discharged into the Mississippi River from the Chemolite Plant of Minnesota Mining and Manufacturing Company in Washington County near Langdon, and to determine the adequacy of the waste treatment facilities now in use.

Scope

The survey consisted of physical observations, measurement of the waste volume, and collection of samples for physical, chemical, and biological examination. In conjunction with sampling and measurement of the plant wastes, several samples were also taken from the Mississippi River above and below the point of waste discharge.

Acknowledgments

Mr. F. B. Richerson, Engineering Manager, Commercial Chemicals, Minnesota Mining and Manufacturing Company, provided information on the waste disposal system at the Chemolite Plant and Mr. Howard Sampair, Maintenance Superintendent, Chemolite Plant, provided working quarters for the field crew and rendered other valuable assistance.

BACKGROUND INFORMATION

Plant Processes

The Chemolite Plant manufactures synthetic resins, varnish, and various adhesives and binders. In addition to the wastes

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from these processes, there are also wastes from research and development pilot-plant operations. As might be expected at such a plant, the wastes are highly variable and exhibit a wide range of characteristics.

Waste Treatment Facilities

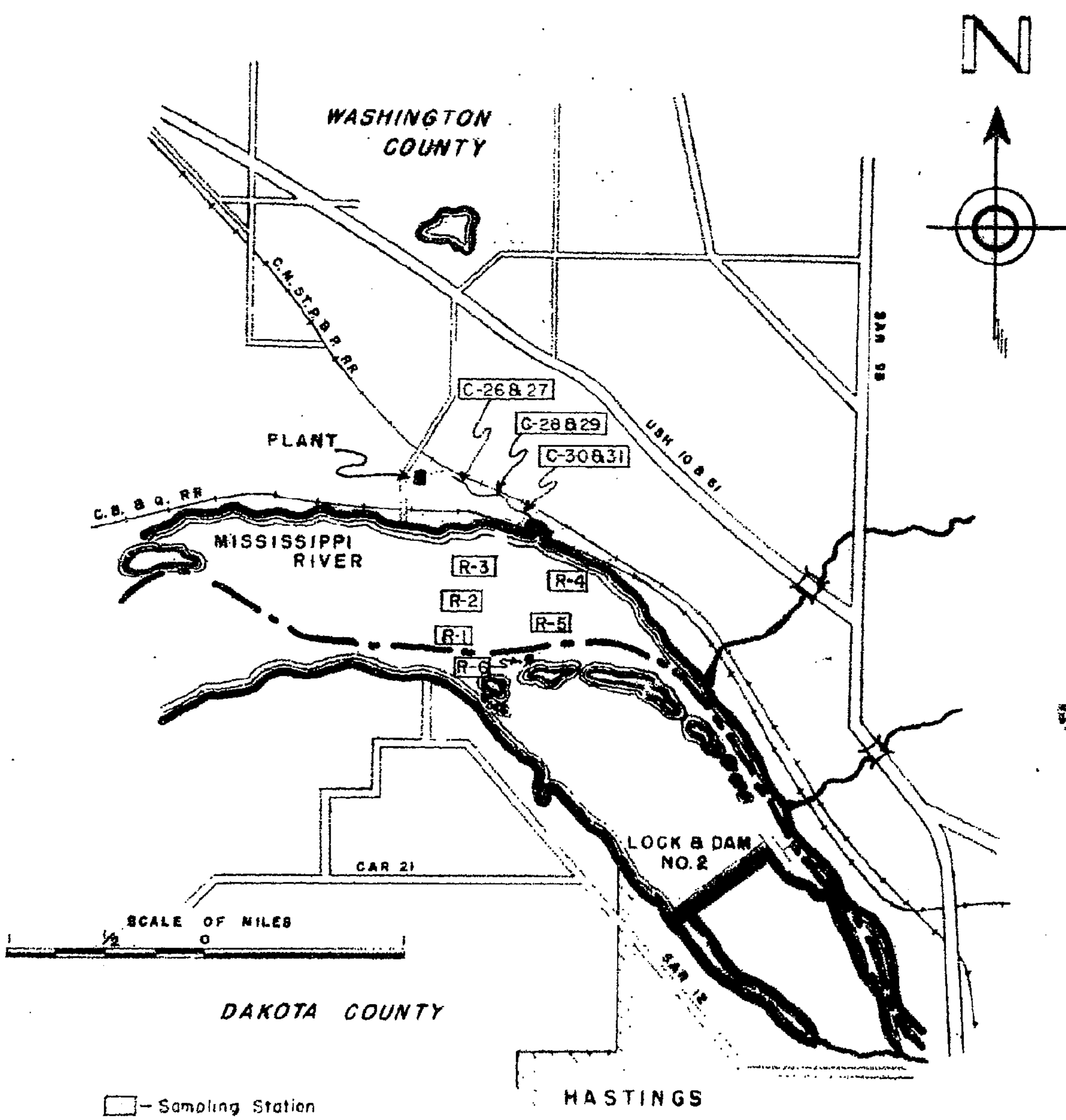
At present, the industrial waste disposal facilities at the Chemolite Plant include a short-term settling and skimming basin, an oxidation lagoon, and an aeration flume. These facilities provide treatment for the large volume of the chemical wastes. In addition, a small seepage pit is provided for separate disposal of a small volume of high-phenolis waste. Cooling water is segregated and discharged separately. Sanitary sewage is treated in two Imhoff tanks with the effluent being discharged into the oxidation lagoon (See Figures I and II for details).

In July, 1955, Minnesota Mining and Manufacturing Company applied for a permit to construct and operate an overflow weir and an aeration flume. Prior to that time, all of the plant wastes were discharged into a seepage lagoon and only cooling water was discharged to the river. However, after a period of use, the seepage lagoon became sealed, thereby making it necessary to provide an overflow in order to dispose of the waste water.

On August 23, 1955, the Water Pollution Control Commission approved plans and granted a permit to Minnesota Mining and Manufacturing Company for construction of an outfall structure to discharge the lagoon effluent to the Mississippi River. The lagoon was also dredged and enlarged to provide oxidation capacity and the high-phenolic wastes were segregated for separate disposal

MAP TO ACCOMPANY REPORT OF INVESTIGATION OF INDUSTRIAL WASTE DISPOSAL AT MINNESOTA MINING AND MANUFACTURING COMPANY COTTAGE GROVE TWP., WASHINGTON COUNTY

SEPTEMBER 22-28, 1958



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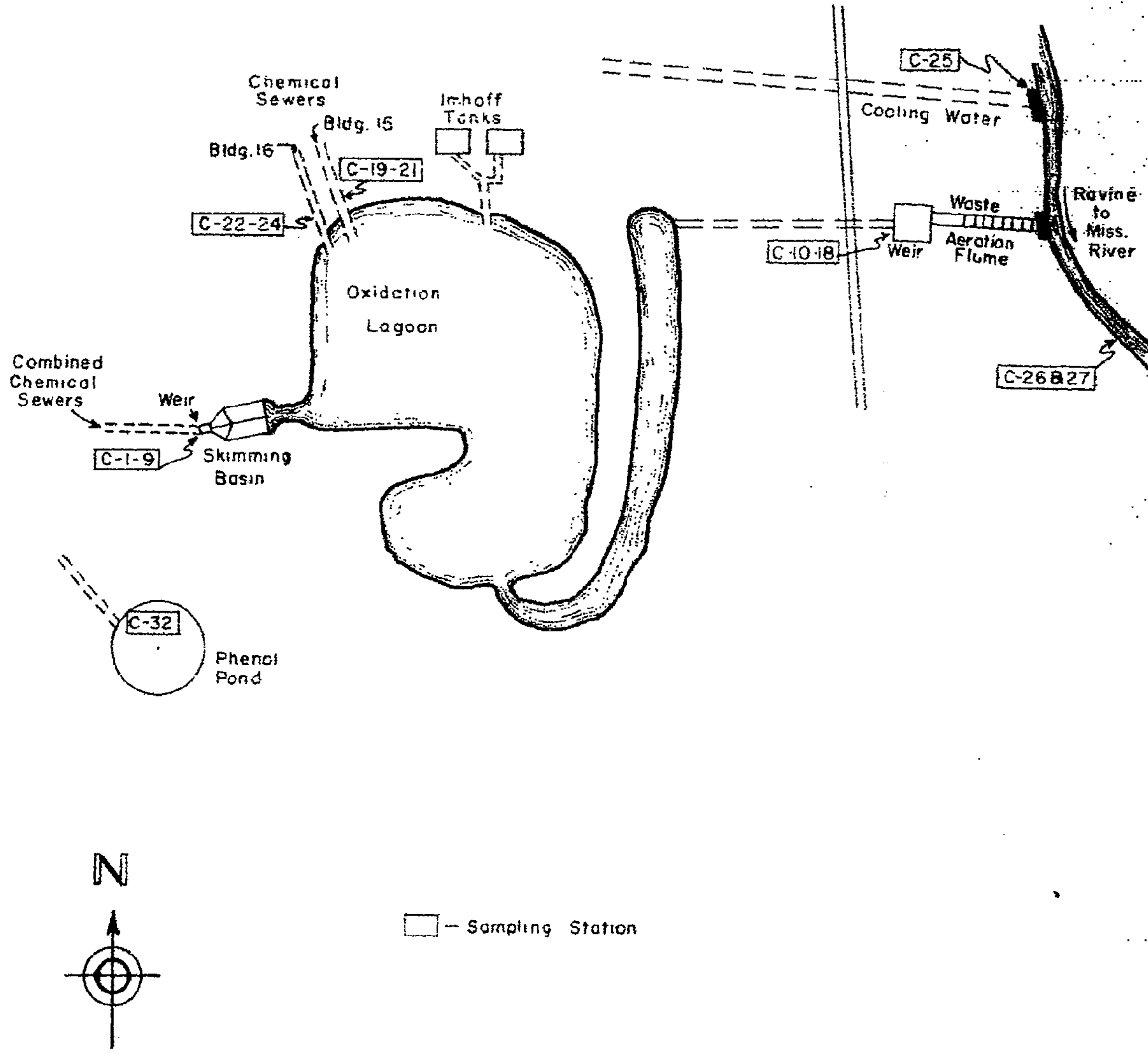
SKETCH MAP OF WASTE DISPOSAL SYSTEM
MINNESOTA MINING AND MANUFACTURING COMPANY
CHEMOLITE PLANT, WASHINGTON COUNTY



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Feb. 4, 1959

Fig. II

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in a pit on the plant grounds. Under the conditions of the plan approval, certain limitations were imposed on the quantity and type of wastes that could be discharged. These limitations included:

1. No wastes should be discharged until the phenolic wastes were segregated.

2. The total waste discharge should not exceed 2,200 gpm (gallons per minute) including the cooling water.

3. The wastes, as discharged to the river, should not contain more than 100 ppm BOD (5-day biochemical oxygen demand).

In 1957, a short-term detention tank was also constructed and placed in operation to facilitate removal of floatable materials which formed scum mats on the surface of the lagoon and reduced the efficiency of oxidation.

Previous Investigations

Samples of the waste discharged from the Chemolite Plant have been obtained in the past, usually as a part of a general investigation of industries discharging into the Mississippi River or as a result of specific complaints. Since the construction of the stabilization lagoon and the aeration flume, however, no major investigation has been made.

Reports on the effluent quality are received from the Company at regular intervals. The reports have shown, in general, wide variations in the quality of the effluent, especially in regard to BOD.

PLANT INVESTIGATION

Sampling Stations and Procedures

Figures I and II show the locations at which samples were taken and a description of the stations is given in Table 1.

The samples taken at the inlet to the skimming basin were collected manually at one-half hour intervals. The samples were collected in proportion to the waste flow and were composited every 8 hours. The temperature, pH, and appearance of each individual sample was recorded. All samples collected were taken to the Department laboratory for analysis.

Samples at the lagoon outlet were collected by a mechanical sampler which takes samples automatically in proportion to the flow rate. The collection container of the sampler was emptied once every 8 hours and a portion of this sample served as the composite for the period.

All of the remaining samples were single or "grab" samples. Samples of the waste discharged from Buildings 15 and 16 were collected once each day during the survey. Single samples of the cooling water and the contents of the phenol pond were also taken. Samples were collected at three different stations in the ravine leading to the river.

Flow Measurement

To facilitate flow measurement during the survey period, the Company installed a temporary rectangular weir in the main chemical sewer above the skimming basin. A level recorder was installed upstream from the weir to provide a continuous record of the hydraulic head.

The flow rates at the skimming basin ranged from 375 to 1,000 gpm (gallons per minute), with an average of 620 gpm. The total waste discharged from the main chemical sewer into the lagoon on a daily basis was 826,600(1), 840,000 and 938,400 gallons, respectively, for the three days.

Permanent facilities for measuring the waste flow at the outlet of the lagoon have been provided by construction of a V-notch weir at a point in the outlet line immediately above the aeration flume. This weir can be adjusted to control the liquid level of the stabilization lagoon. A level recorder installed in the approach channel to the weir was used to make a continuous record of the head on the weir.

The rate of flow from the lagoon ranged from 678 to 790 gpm with an average of 740 gpm. The total waste discharged was 916,000(1), 1,070,000 and 1,127,000 gallons, respectively, for the three days.

Estimates of the wastes discharged from Buildings 15 and 16 were made in manholes outside the building using a bucket and a stopwatch at the same time when the samples were taken. The discharge from Building 15 ranged from 3.6 to 26 gpm (three estimates made) while the discharge from Building 16 ranged from 12 to 60 gpm.

The wastes from Buildings 15 and 16 together with the Imhoff tank effluent (estimated at 20 gpm) in conjunction with normal measurement errors and the reservoir effect of the lagoon should

(1) 22 hours only

account for the apparent difference in the waste flow entering and leaving the lagoon.

Discussion of Results

A description of the sampling stations is given in Table 1. The analytical data are tabulated in Tables 2, 3, and 4.

Table 5 contains a summary of the amount of BOD in pounds calculated entering and leaving the lagoon. The calculated results presented in Table 5 do not include the BOD represented by the waste from Buildings 15 and 16 and the Imhoff tank, since the strength and volume of these wastes were not considered significant in comparison with the wastes discharged from the main chemical sewer.

As can be seen from Table 5, the quantity of BOD in the wastes leaving the lagoon each day (5,895 lbs., 7,610 lbs, and 8,360 lbs.), was greater than the BOD entering the lagoon each day (4,375 lbs., 2,775 lbs., and 6,941 lbs.), over the same period. Expressed as concentrations, these values are 722 mg/l, 852 mg/l, and 890 mg/l leaving the lagoon and 635 mg/l, 386 mg/l, and 740 mg/l entering the lagoon.

This anomalous situation may be explained in part by the difference in the waste flow into and out of the lagoon and the reservoir effect, and possibly to poor reduction in waste concentration in the lagoon and good housekeeping practices on the part of the Company during the survey period. Another possible factor may be bacteriological action on some waste constituent which ordinarily may exert little or no oxygen demand in the raw waste but which, after a period of bacteriological attack in the lagoon, may be fragmented into smaller parts which may be more readily susceptible to biochemical action and may, therefore, exert a significant oxygen demand in the lagoon effluent.

All wastes from the plant, except cooling water, flow down the aeration flume which is located at the outlet of the lagoon. Single samples of the waste flow for dissolved oxygen analysis were collected twice above and below the flume in order to estimate its aeration efficiency. The results of the tests revealed increases of 3.5 mg/l and 3.7 mg/l of dissolved oxygen in the aerated waste over the original values of 2.9 and 2.3 mg/l found in the lagoon effluent. The increases found were of a transient nature, however, because of the high residual BOD of the effluent and other factors. This is shown by the decrease in the dissolved oxygen content of the waste flow, including cooling water, to the value of 3.7 mg/l found halfway down the ravine and 3.9 mg/l found at the inlet to the lower pond near the river.

The lagoon effluent is diluted approximately two to one by the addition of cooling water discharged at an estimated rate of 1,500 gpm into the ravine below the aeration flume. Analysis of the two waste samples collected in the ravine below the point of addition of the cooling water revealed BOD concentrations of 200 mg/l and 300 mg/l; compared to lagoon effluent concentrations in the range of 600 - 1000 mg/l.

The samples obtained farther down the ravine, about halfway to the river, showed BOD concentrations of 190 mg/l and 325 mg/l while at the inlet to the lower pond, the BOD concentrations were 185 mg/l and 275 mg/l, indicating little, if any, further oxidation of the waste in its travel down the course of the ravine.

As shown in the tables, the phenol concentrations of the waste was well below the recommended limitation of 1.0 mg/l. The phenol concentration found in the lagoon effluent samples ranged from 0.088 to 0.26 mg/l. At the inlet to the lower pond, the phenol concentration of the combined waste and cooling water stream was 0.24 and 0.068 mg/l for the two samples obtained. According to the monthly reports submitted by the Company, the phenol concentration of the lagoon effluent has usually been below 1.0 mg/l ever since the major source of phenol was segregated from the total waste stream and disposed of separately in the pit.

Specific limitations have not been recommended for the discharge of fluorides, but the Company was asked to include this determination in the monthly report. At the time of the survey, the fluorides concentration found ranged from 4.3 mg/l to 9.1 mg/l in the lagoon effluent samples, and was 4.2 mg/l and 3.2 mg/l in the two samples of combined waste and cooling water taken at the inlet to the lower pond.

COD (chemical oxygen demand) determinations were also made on the plant waste in order to evaluate a possible correlation between COD and BOD. The COD determination is usually less troublesome and more rapid then the BOD determination. The COD concentration was found to be 360 mg/l and 390 mg/l in the two samples taken at the inlet to the lower pond, compared to a BOD of 185 and 275 mg/l in the same samples, indicating a poor correlation for these samples. The degree of correlation of these items in the lagoon effluent samples appears to be somewhat better but a statistical evaluation has not yet been made to determine the coefficient.

There were extreme variations in the pH of the raw waste discharged from the main chemical sewer, but the detention in the lagoon and other factors resulted in a nearly neutral effluent (pH approximately 7.0).

Very high concentrations of phosphorus and nitrogen were found in the lagoon effluent samples. These elements are considered important from the viewpoint of possible stimulation of biological growths, such as algae, in the receiving waters.

TOXICITY OF WASTES

To determine the toxicity of the wastes on fish life, if any, a number of test fish native to the Mississippi River in this area were subjected to different concentrations of the lagoon effluent. Controls were also established, using ordinary Mississippi River water.

In the undiluted effluent, the test fish died within 3 to 5 minutes; however, if a source of oxygen was introduced into the waste, the fish were able to survive for more than 96 hours. The oxygen concentration of the undiluted waste was found to be zero after several hours in the laboratory before oxygen was added. Apparently, the fish died in the undiluted effluent because of a lack of oxygen rather than because of any obvious toxic effects.

Some adverse effects were noticed at dilution ratios lower than 200 to 1; i.e., the protective mucous covering of the fish became altered such that over longer periods of time it might seriously impair the essential processes of the fish or make it more susceptible to disease which could lead to its death; also, after short periods of time in the aerated waste, the fish appeared to lose their sense of stability. Generally, it required from 4 to 8 minutes for the fish to regain its equilibrium and be able to swim in normal fashion after being immersed in the aerated waste. During the testing, it was also noted that the pectoral and pelvic fins and the gill regions of the fish became unusually red, indicating either a physiological response to or an irritation from the waste.

RIVER SURVEY

Flow Data

On the day that the river samples were collected, Wednesday, September 24, 1958, the discharge from the Hastings dam was 5,500 cfs (mean daily flow). During the rest of the survey week, the discharge rates ranged between 4,700 and 6,000 cfs.[1]

Sampling Stations

A total of six water samples were collected above and below the junction of the waste stream and the Mississippi River. Three samples were taken on a cross-section approximately 300 yards above and below the stream outlet at stations approximately equidistant from each other and the shore. The sampling stations are shown in Figure I.

(1) Data obtained from U.S. Corps of Engineers, St. Paul office.

Analytical Results (See Table 6)

A review of the results of the analyses shows little indication of any immediate effect of the discharge of the wastes on the river. However, it should be noted that no samples were collected in the immediate vicinity of the stream outlet. There is also a good possibility in view of the nature of the river that if the waste stream was not immediately diluted by the river water, but was maintained for some distance below the outlet zone in a manner similar to a stream within the river itself, the limited sampling procedure would not be likely to reveal the presence of the waste because of the distance between the stations.

SUMMARY

1. The survey indicates that the waste from this plant in terms of 5-day BOD was not meeting the recommended discharge limitation established by the Water Pollution Control Commission. According to the recommendations, the waste as discharged should not exceed 100 mg/l of BOD at the inlet to the lower pond. At the time of the survey, BOD concentrations of 185 mg/l and 275 mg/l were found in the samples at that station. The concentration of the other major waste constituents did not appear to be excessive or to be causing unsatisfactory conditions in the river.

2. On a BOD basis, the population equivalent of the plant waste as discharged from the lagoon ranged from 35,400 to 50,000 with an average of about 44,000 over the three-day sampling period.

3. Actual measurements of the quantity of cooling water were not made. Using data supplied by company personnel and the known dilution of the waste constituents after mixing with the cooling water, the discharge of cooling water was approximately 1,500 gpm. The 1,500 gpm of cooling water plus the 740 gpm average discharge from the lagoon constituted a total of approximately 2,200 gpm discharged to the river, which is within the recommended limits.

4. The tests on the aeration flume indicated that the unit was providing a transient increase in the oxygen content of the waste, but the added oxygen was almost completely dissipated before the waste flow reached the river.

5. The stabilization lagoon did not appear to be functioning effectively as an oxidation unit as shown by the BOD and bacteriological analyses, but appeared to act principally as a mixing basin which prevented surges of flow or "slugs" of chemicals from reaching the river without mixing.

6. Additional waste treatment or control facilities are needed to provide effective reduction in the strength of the wastes to the recommended levels.

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Public Health Engineering Aide

E. O. Thomas
Public Health Biologist

Approved:
Harvey G. Rogers, Chief
Section of Water Pollution Control

MINNESOTA DEPARTMENT OF HEALTH
Division of Environmental Sanitation
Section of Water Pollution Control

Minnesota Mining and Manufacturing Company Survey
September 22-26, 1958

Table 1

Description of Samples

Code	Time	Date	Source and Location
C-1	10:00 A.M. - 4:00 P.M.	Tuesday, September 23	Primary raw waste, main chemical sewer
C-2	4:00 P.M. - 12:00 M.	Tuesday, September 23	Primary raw waste, main chemical sewer
C-3	12:00 M. - 8:00 A.M.	Wednesday, September 24	Primary raw waste, main chemical sewer
C-4	8:00 A.M. - 4:00 P.M.	Wednesday, September 24	Primary raw waste, main chemical sewer
C-5	4:00 P.M. - 12:00 M.	Wednesday, September 24	Primary raw waste, main chemical sewer
C-6	12:00 M. - 8:00 A.M.	Thursday, September 25	Primary raw waste, main chemical sewer
C-7	8:00 A.M. - 4:00 P.M.	Thursday, September 25	Primary raw waste, main chemical sewer
C-8	4:00 P.M. - 12:00 M.	Thursday, September 25	Primary raw waste, main chemical sewer
C-9	12:00 M. - 8:00 A.M.	Friday, September 26	Primary raw waste, main chemical sewer
C-10	8:00 A.M. - 4:00 P.M.	Tuesday, September 23	Lagoon effluent at weir box
C-11	4:00 P.M. - 12:00 M.	Tuesday, September 23	Lagoon effluent at weir box
C-12	12:00 M. - 8:00 A.M.	Wednesday, September 24	Lagoon effluent at weir box
C-13	8:00 A.M. - 4:00 P.M.	Wednesday, September 24	Lagoon effluent at weir box
C-14	4:00 P.M. - 12:00 M.	Wednesday, September 24	Lagoon effluent at weir box
C-15	12:00 M. - 8:00 A.M.	Thursday, September 25	Lagoon effluent at weir box
C-16	8:00 A.M. - 4:00 P.M.	Thursday, September 25	Lagoon effluent at weir box
C-17	4:00 P.M. - 12:00 M.	Thursday, September 25	Lagoon effluent at weir box
C-18	12:00 M. - 8:00 A.M.	Friday, September 26	Lagoon effluent at weir box
C-19	1:45 P.M.	Tuesday, September 23	Sewer, Building 15 - raw waste
C-20	1:30 P.M.	Wednesday, September 24	Sewer, Building 15 - raw waste
C-21	1:45 P.M.	Thursday, September 25	Sewer, Building 15 - raw waste
C-22	3:45 P.M.	Tuesday, September 23	Sewer, Building 16 - raw waste
C-23	2:45 P.M.	Wednesday, September 24	Sewer, Building 16 - raw waste
C-24	2:00 P.M.	Thursday, September 25	Sewer, Building 16 - raw waste
C-25	12:00 N.	Thursday, September 25	Cooling water before mixing
C-26	3:15 P.M.	Tuesday, September 23	Ravine - after mixing with cooling water
C-27	12:00 N.	Thursday, September 25	Ravine - after mixing with cooling water
C-28	3:00 P.M.	Tuesday, September 23	Ravine - halfway to river

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Minnesota Mining and Manufacturing Company Survey
September 22-26, 1958

Table 1 cont'd.

Description of Samples

Code	Time	Date	Source and Location
C-29	11:00 A.M.	Thursday, September 25	Ravine - halfway to river
C-30	2:45 P.M.	Tuesday, September 23	Ravine outlet to lower pond
C-31	10:00 A.M.	Thursday, September 25	Ravine outlet to lower pond
C-32	10:30 A.M.	Thursday, September 25	Phenol pit

MINNESOTA DEPARTMENT OF HEALTH
Division of Environmental Sanitation
Section of Water Pollution Control

Minnesota Mining and Manufacturing Company Survey
September 22-26, 1958

Table 2

Primary Raw Waste, Main Chemical Sewers - Composite Samples

Determination*	C-1	C-2	C-3	C-4	C-5	C-6	C-7	C-8	C-9
Total Solids	1,300	1,640	3,000	2,250	1,230	1,510	910	1,230	1,040
Total Volatile Matter	320	330	1,200	410	320	310	220	220	170
Suspended Solids	270	280	60	440	470	260	310	320	130
Suspended Volatile Matter	70	70	30	140	110	50	60	70	23
Turbidity (scale units)	64	100	40	110	81	110	75	80	80
Hardness	380	190	330	430	280	300	160	260	200
Alkalinity (or Acidity)	550	490	Ac-620	450	440	540	390	540	550
Chlorides	22	170	19	20	120	210	40	130	10
lfates	17	37	1,700	50	34	35	65	41	37
Fluorides	1.2	1.4	1.4	2.2	0.84	1.1	1.3	1.1	1.3
Biochemical Oxygen Demand, 5-day	1,240	210	540	410	400	375	460	175	2,800
Phosphorus	86	41	76	850	710	63	4.8	89	71
Organic Nitrogen	-	-	8.0	1.6	3.8	0.56	1.4	1.8	1.9
Ammonia	24	3.4	130	3.2	8.0	4.0	17	1.8	4.3
Nitrates	<0.05**	<0.05	0.56	<0.02	1.5	<0.02	<0.05	<0.05	<0.05
Nitrites	0.095	0.15	-	0.12	0.13	-	-	-	-
Chemical Oxygen Demand	2,100	-	620	680	880	580	610	340	4,600
pH value	-	7.0	2.5	8.5	8.5	-	9.4	9.6	9.6
Phenolics	0.03	-	-	-	-	-	-	-	-

*As mg/l unless otherwise noted
See Table 1 for code.
** < means "less than"

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MINNESOTA DEPARTMENT OF HEALTH
Division of Environmental Sanitation
Section of Water Pollution Control

Minnesota Mining and Manufacturing Company Survey
September 22-26, 1958

Table 3

Lagoon Effluent - Composite Samples

Determination*	C-10	C-11	C-12	C-13	C-14	C-15	C-16	C-17	C-18
Total Solids	1,000	1,020	970	1,000	1,050	1,300	1,080	1,060	990
Total Volatile Matter	190	190	170	190	270	330	180	150	130
Suspended Solids	120	70	120	96	73	320	62	62	28
Suspended Volatile Matter	71	40	80	50	38	210	28	23	11
Turbidity (scale units)	40	40	50	60	66	120	50	60	50
Hardness	270	300	240	340	320	300	200	200	180
Alkalinity	200	170	180	180	170	120	200	200	230
Chlorides	21	59	54	61	65	68	65	70	64
Sulfates	350	350	310	400	450	440	370	370	350
Fluorides	6.7	6.2	6.6	8.6	4.3	9.1	8.7	4.8	9.6
Biochemical Oxygen Demand, 5-day	650	645	990	850	710	1,000	950	825	900
Phosphorus	20	18	29	35	28	30	29	35	24
Organic Nitrogen	6.2	5.1	5.1	1.2	5.2	-	8.5	5.4	16
Ammonia	20	17	26	5.0	19	22	19	18	20
Nitrates	0.42	0.20	0.40	0.28	0.40	0.82	0.36	0.48	0.20
Nitrites	0.04	0.05	-	0.06	0.06	-	-	-	-
Chemical Oxygen Demand	720	810	1,100	880	1,100	1,100	1,000	-	800
pH value	-	6.9	6.8	7.0	7.0	-	7.3	7.2	7.3
Phenolics	0.088	-	0.12	0.17	0.15	0.26	0.22	0.24	-

*As mg/l unless otherwise noted

MINNESOTA DEPARTMENT OF HEALTH
Division of Environmental Sanitation
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Minnesota Mining and Manufacturing Company Survey
September 22-26, 1958

Table 4

Miscellaneous - Single Samples

Determination**	C-19	C-20	C-21	C-22	C-23	C-24	C-25
Temperature (°F)	67	69	70	62	62	58	66
Coliform Group Organisms (MPN/100 ml)	-	-	<200*	-	-	4900	2200
Total Solids	670	1160	270	330	330	260	280
Total Volatile Matter	260	600	150	130	120	60	60
Suspended Solids	31	190	86	3	27	3	9
Suspended Volatile Matter	7	41	10	<3	13	1	4
Turbidity (scale units)	20	38	25	5	3	5	5
Hardness	350	150	220	240	190	190	250
Alkalinity (or Acidity)	Ac-2200	Ac-11000	Ac-1800	200	200	180	200
Chlorides	24	55	24	2	5	15	7
Sulfates	41	22	36	32	32	38	33
Fluorides	14	5800	11	3.2	8.4	5.4	2.3
Biochemical Oxygen Demand 5-day	21	20	27	29	160	45	15
Dissolved Oxygen	-	-	-	-	-	-	8.5
Phosphorus	1.2	0.42	4.5	0.56	0.55	1.6	0.28
Organic Nitrogen	0.56	0.48	4.0	0.44	NF	0.8	1.3
Ammonia	0.24	NF***	NF	0.04	0.32	0.08	0.24
Nitrates	5.0	0.88	3.5	1.2	0.01	0.38	2.4
Nitrites	0.06	0.01	-	0.095	0.11	-	-
Chemical Oxygen Demand	-	-	-	-	-	-	-
pH value	2.9	2.2	3.2	7.5	8.5	7.8	9.0
Phenolics	-	-	-	-	-	-	-

* < means "less than"
**as mg/l unless otherwise noted
***NF means "not found"

Tab 3

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MINNESOTA DEPARTMENT OF HEALTH
Division of Environmental Sanitation
Section of Water Pollution Control

Minnesota Mining and Manufacturing Company Survey
September 22-26, 1958

Table 4 cont'd.

Miscellaneous - Single Samples

Determination*	C-26	C-27	C-28	C-29	C-30	C-31	C-32
Temperature (°F)	70	66	71	64	72	63	64
Coliform Group Organisms MPN/100 ml)	-	>2400000**	-	>2400000	-	>2400000	-
Total Solids	480	500	480	540	450	550	22250
Total Volatile Matter	110	90	60	100	130	110	20480
Suspended Solids	25	14	38	31	36	27	770
Suspended Volatile Matter	20	5	26	14	24	12	170
Turbidity (scale units)	15	25	17	25	12	25	280
Hardness	240	230	230	240	260	230	140
Alkalinity (or Acidity)	200	190	200	200	200	200	1300
Chlorides	18	24	17	27	25	31	-
Sulfates	100	180	110	140	110	140	-
Fluorides	2.4	3.2	2.8	3.4	4.2	3.2	-
Biochemical Oxygen Demand 5-day	200	300	190	325	185	275	<7000
Dissolved Oxygen	-	7.1	-	3.7	-	3.9	-
Phosphorus	6.0	11	8.0	11	6.4	11	2.3
Organic Nitrogen	3.0	4.0	2.2	3.4	1.9	2.9	0.16
Ammonia	5.1	5.4	5.6	6.6	5.1	6.1	9.4
Nitrates	0.22	0.1	0.22	<0.05***	0.06	<0.05	-
Nitrites	0.11	-	0.22	-	0.06	-	-
Chemical Oxygen Demand	-	-	-	-	360	390	-
pH value	7.9	8.4	7.9	8.2	7.7	8.2	9.0
Phenolics	0.03	0.072	0.018	0.12	0.24	0.068	61000

*as mg/l unless otherwise noted
** >means greater than
** < means less than

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MINNESOTA DEPARTMENT OF HEALTH
Division of Environmental Sanitation
Section of Water Pollution Control

Minnesota Mining and Manufacturing Company Survey
September 22-26, 1958

Table 5

PRIMARY RAW WASTE

Composite Sample	Date	Sampling Period	Flow per shift (gal)	Total Daily Flow (gal)	5-day BOD/shift (mg/l)	5-day BOD/shift (lbs)	Total Daily Discharge of 5-day BOD from 8 AM to 8 AM (mg/l)	Total Daily Discharge of 5-day BOD from 8 AM to 8 AM (lbs)	Total Daily Discharge of 5-day BOD from 8 AM to 8 AM (Pop Equiv*)
C-1	9/23	10 AM - 4 PM	265,950		1240	2740			
C-2	9/23	4 PM - 12 M	323,200	826,600**	210	565	635**	4375**	26,200**
C-3	9/24	12 M - 8 AM	237,450		540	1070			
C-4	9/24	8 AM - 4 PM	266,250		410	908			
C-5	9/24	4 PM - 12 M	347,500	840,000	400	1160	386	2775	16,600
C-6	9/25	12 M - 8 AM	226,250		375	707			
C-7	9/25	8 AM - 4 PM	349,190		460	1340			
C-8	9/25	4 PM - 12 M	371,750	938,440	175	541	740	6941	41,600
C-9	9/26	12 M - 8 AM	217,500		2800	5060			

LAGOON EFFLUENT

Composite Sample	Date	Sampling Period	Flow per shift (gal)	Total Daily Flow (gal)	5-day BOD/shift (mg/l)	5-day BOD/shift (lbs)	Total Daily Discharge of 5-day BOD from 8 AM to 8 AM (mg/l)	Total Daily Discharge of 5-day BOD from 8 AM to 8 AM (lbs)	Total Daily Discharge of 5-day BOD from 8 AM to 8 AM (Pop Equiv*)
C-10	9/23	10 AM - 4 PM	244,000		650	1320			
C-11	9/23	4 PM - 12 M	336,000	916,000**	645	1805	772**	5895**	35,400**
C-12	9/24	12 M - 8 AM	336,000		990	2770			
C-13	9/24	8 AM - 4 PM	346,000		850	2450			
C-14	9/24	4 PM - 12 M	357,000	1,070,000	710	2110	852	7610	45,700
C-15	9/25	12 M - 8 AM	367,000		1000	3050			
C-16	9/25	8 AM - 4 PM	367,000		950	2900			
C-17	9/25	4 PM - 12 M	380,000	1,127,000	825	2610	890	8360	50,000
C-18	9/26	12 M - 8 AM	380,000		900	2850			

*Calculated on basis of 1/6 of lb. of 5-day BOD per capita per day
**22 hour period

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Table 6

RIVER SAMPLES

Determination*	R-1	R-2	R-3	R-4	R-5	R-6
Temperature (°F)	70	70	70	70	70	70
Coliform Group Organisms (MPN/100 ml)	92,000	92,000	92,000	160,000	160,000	-
Total Solids	300	330	300	300	300	410
Total Volatile Matter	100	140	130	130	140	130
Suspended Solids	47	58	51	55	58	40
Suspended Volatile Matter	15	16	15	16	18	14
Turbidity	22	25	20	20	20	19
Total Hardness	270	270	230	270	230	210
Alkalinity	170	160	160	170	160	170
pH value	7.9	7.5	7.8	7.8	8.0	8.0
Chlorides	7	5	7	7	7	8
Sulfates	63	57	60	66	55	55
Fluorides	0.4	0.3	0.6	0.4	0.48	0.32
Dissolved Oxygen	8.4	6.3	7.9	7.4	8.2	6.8
Biochemical Oxygen Demand, 5-day	6.5	6.1	6.3	6.4	5.8	5.8
Phosphorus	0.28	0.21	0.24	0.10	0.50	0.22
Ammonia	0.72	0.21	0.64	0.80	1.1	1.3
Organic Nitrogen	1.5	1.4	1.2	1.3	1.8	1.1
Nitrites	0.035	0.035	-	-	-	-
Nitrates	$<$0.02	0.20	0.32	0.32	$<$0.02	0.44
Phenolics	$<$0.005	$<$0.005	$<$0.005	$<$0.005	0.016	$<$0.005

*As mg/1 unless noted otherwise
** $<$ means "less than"

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Table 7

Field Data - Composite Sampling

Sampling Period	Raw Waste Temp. Range (°F)	Raw Waste pH Range	Lagoon Effluent pH
10:00 AM - 4:00 PM 9/23/58	64 - 70	6.6 - 11.3	-
4:00 PM - 12:00 M 9/23/58	62 - 89	7.3 - 11.0	6.9
12:00 M - 8:00 AM 9/24/58	63 - 77	9.2 - 10.5	6.8
8:00 AM - 4:00 PM 9/24/58	62 - 69	3.1 - 10.8	7.0
4:00 PM - 12:00 M 9/24/58	59 - 68	8.0 - 10.2	7.0
12:00 M - 8:00 AM 9/25/58	63 - 82	7.8 - 11.6	-
8:00 AM - 4:00 PM 9/25/58	60 - 64	4.0 - 11.2	7.3
4:00 PM - 12:00 M 9/25/58	60 - 64	6.9 - 12.0	7.2
12:00 M - 8:00 AM 9/26/58	63 - 71	9.0 - 10.0	7.3